

REPAIR AND SERVICE MANUAL

# ***TRACKER***

## **LX4**

699326- A  
Issued August 2019

For any questions on material contained in this manual, contact an authorized representative for clarification.

Read and understand all labels located on the vehicle. Always replace any damaged or missing labels.

The following symbols appear throughout this manual and on your vehicle. Your safety is involved when these symbols are used. Become familiar with their meanings before reading the manual.

 **DANGER** indicates a hazardous situation that, if not avoided, will result in death or serious injury.

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

 **CAUTION** indicates a hazardous situation that, if not avoided, could result in minor or moderate injury.

 **WARNING** Failure to comply with the warnings in this manual can result in severe injury or death.

 **WARNING** Read this entire manual carefully before operating this vehicle. Do not attempt to operate this vehicle until you have thorough knowledge of the controls and features.

 **WARNING** Regular inspections and maintenance, along with good operating techniques, will help ensure your safe enjoyment of the capabilities and reliability of this vehicle.

## MANUFACTURER'S INTENDED USE

This vehicle is designed and manufactured in the United States of America (USA). The standards and specifications listed in the following text originate in the USA unless otherwise indicated.

## EXHAUST EMISSION

The exhaust emissions of this vehicle's engine complies with regulations set forth by the Environmental Protection Agency (EPA) of the United States of America (USA) at time of manufacture. Significant fines could result from modifications or tampering with the engine, fuel ignition or air intake systems.

## BATTERY PROLONGED STORAGE

Batteries discharge over time. The rate of discharge changes according to the ambient temperature, the age and condition of the batteries.

Completely charged batteries will not freeze in winter temperatures unless the temperature is less than -75°F (-60°C).

## BATTERY DISPOSAL

Lead-acid batteries are recyclable. Return discarded batteries to distributor, manufacturer or lead smelter for recycling. For neutralized spills, put residue in acid-resistant containers with absorbent material such as sand. Dispose in accordance with local, state and federal regulations for acid and lead compounds. Contact local or state environmental authorized people for the disposal information.

# REPAIR AND SERVICE MANUAL

## 72V ELECTRIC POWERED

LX4

STARTING MODEL YEAR 2020

Never modify the vehicle in any way that will alter the weight distribution of the vehicle, decrease its stability or increase the speed beyond the factory specifications. Such modifications can cause serious personal injury or death. Textron Specialized Vehicles, Inc. prohibits and disclaims responsibility for any such modifications or any other alteration which would adversely affect the safety of the vehicle.

The manufacturer reserves the right to incorporate engineering and design changes to products in this manual, without obligation to include these changes on units sold previously.

The information contained in this manual may be revised periodically by the manufacturer, and therefore is subject to change without notice.

THE MANUFACTURER DISCLAIMS LIABILITY FOR ERRORS IN THIS MANUAL, and SPECIFICALLY DISCLAIMS LIABILITY FOR INCIDENTAL AND CONSEQUENTIAL DAMAGES resulting from the use of the information and materials in this Manual.

These are the original instructions as defined by 2006/42/EC.

### MANUFACTURER INFORMATION:

Textron Specialized Vehicles, Inc.  
1451 Marvin Griffin Road  
Augusta, Georgia, USA 30906-3852

Dealer: 800-286-4804  
Consumer: 877-294-6727

[www.trackeroffroad.com](http://www.trackeroffroad.com)

# GENERAL INFORMATION

The use of non-Original Equipment Manufacturer (OEM) approved parts may void the warranty.

Overfilling battery may void the warranty.

Tampering with or adjusting the governor to permit vehicle to operate above factory specifications will void the vehicle warranty.

When servicing engines, all adjustments and replacement components must be per original vehicle specifications in order to maintain the United States of America Federal and State emission certification applicable at the time of manufacture.

## BATTERY PROLONGED STORAGE

Batteries self-discharge over time. The rate of self-discharge varies depending on the ambient temperature, the age and condition of the battery.

A fully charged battery will not freeze unless the temperature falls below  $-75^{\circ}\text{F}$  ( $-60^{\circ}\text{C}$ ).

For winter storage, the batteries must be clean, fully charged and disconnected from any source of electrical drain.

The battery charger can remain connected to the vehicle to maintain a full charge on the batteries. If power to the charger is disconnected or interrupted, the battery charger continues to check the charge on the battery pack. This pulls power from the battery pack and eventually drains the batteries if power is not restored in a timely manner.

As with all electric vehicles, the batteries must be checked and recharged as required or at a minimum of 30 day intervals.

Check and maintain the proper fluid level in all battery cells during the storage period. Correct fluid level is required for maximum battery performance.

## BATTERY DISPOSAL

Lead-acid batteries are recyclable. Return whole scrap batteries to distributor, manufacturer or lead smelter for recycling. For neutralized spills, place residue in acid-resistant containers with absorbent material, sand or earth and dispose of in accordance with local, state and federal regulations for acid and lead compounds. Contact local and/or state environmental officials regarding disposal information.

# SAFETY INFORMATION

This manual has been designed to assist in the maintenance of the vehicle in accordance with procedures developed by the manufacturer. Following these procedures and troubleshooting tips will ensure the best possible service from the product. To reduce the chance of personal injury and/or property damage, the following instructions must be carefully observed:

*Certain replacement parts can be used independently and/or in combination with other accessories to modify this vehicle to permit it to operate at or in excess of 20 mph. When a vehicle is modified in anyway by the Distributor, Dealer, or customer to operate at or in excess of 20mph on public streets or roads. UNDER FEDERAL LAW the modified product will be a Low Speed Vehicle (LSV) subject to the strictures and requirement of Federal Motor Vehicle Safety Standard 571.500. In these instances, pursuant to Federal law the Distributor or Dealer MUST equip the product with headlights, rear lights, turn signals, seat belts, top, horn and all other modifications for LSV's mandated in FMVSS 571.500, and affix a Vehicle Identification Number to the product in accordance with the requirements of FMVSS 571.565. Pursuant to FMVSS 571.500, and in accordance with the State laws applicable in the places of sale and use of the product, the Distributor, Dealer or customer modifying the vehicle also will be the Final Vehicle Manufacturer for the LSV, and required to title or register the vehicle as mandated by State law.*

Information on FMVSS 571.500 is found at Title 49 of the Code of Federal Regulations, section 571.500. For information online, go to [www.ecfr.gov](http://www.ecfr.gov).

The manufacturer will NOT approve Distributor, Dealer or customer changes that change this vehicle into a Low Speed Vehicle (LSV).

This vehicle meets the current applicable standard for safety and performance requirements.

## GENERAL

Many vehicles are used for a variety of tasks beyond their original intended use; therefore it is impossible to anticipate and warn against every possible combination of circumstances that may occur. Warnings cannot replace good common sense driving practices. Common sense driving practices do more to prevent accidents and injury than warnings and instructions can provide.

The manufacturer strongly suggests anyone operating the vehicle read the entire owner's manual provided with the purchase of the vehicle, paying particular attention to the CAUTIONS, WARNINGS and DANGERS within.

For any questions or concerns, contact your dealer.

The manufacturer reserves the right to make design changes without obligation to make these changes on units previously sold and the information in this manual is subject to change without notice.

The manufacturer is not liable for errors in this manual or for incidental or consequential damages that result from the use of the material in this manual.

This vehicle conforms to the current applicable standard for safety and performance requirements.

This vehicle is designed and manufactured for off road use. It does not conform to Federal Motor Vehicle Safety Standards and is not intended for operation on public streets.

Refer to GENERAL SPECIFICATIONS for vehicle seating capacity. Do not exceed number of occupants indicated.

### WARNING

***Never modify the vehicle in any way that will alter the weight distribution of the vehicle, decrease its stability, increase the speed or extend the stopping distance beyond the factory specification. Such modifications can result in serious personal injury or death.***

Modifications that increase the speed and/or weight of the vehicle will extend the braking distance and may reduce the stability of the vehicle. Do not make any such modifications or changes. The manufacturer prohibits and disclaims responsibility for any such modifications or any other alteration which would adversely affect the safety of the vehicle.

Speed should be moderated by the environmental conditions, terrain and common sense.

# SAFETY INFO

## GENERAL OPERATION

### ALWAYS:

- Use the vehicle in a responsible manner and keep the vehicle in safe operating condition.
- Read and observe all warnings and operation instruction labels on the vehicle.
- Follow all safety rules in the area where the vehicle is being operated.
- When there is a risk of lightning, leave the vehicle and look for a safe location to wait until the lightning has stopped.
- Reduce speed to compensate for poor terrain or conditions.
- Apply brakes to control speed on steep grades.
- Reduce speed in damp or wet areas.
- Use caution when approaching sharp or blind turns.
- Use caution when driving over loose terrain.
- Use caution when driving in areas where pedestrians are present.

## MAINTENANCE

### ALWAYS:

- Replace damaged or missing warning, caution or information labels.
- Maintain the vehicle according to the manufacturer's periodic service schedule. See PERIODIC SERVICE SCHEDULE section.
- Ensure that repairs are performed by trained and qualified persons.
- Follow the manufacturer's maintenance procedures.
- Use insulated tools near the battery to prevent sparks or battery explosion.
- Check the polarity of the battery terminals and be sure to rewire the battery correctly.
- Use specified replacement parts. Never use replacement parts of lesser quality.
- Use recommended tools.
- Determine that tools and procedures not specifically recommended by the manufacturer will not compromise the safety of personnel, nor jeopardize the safe operation of the vehicle.
- Lift the vehicle in accordance with the manufacturer's instructions. Chock the wheels and support the vehicle with safety stands. Never get under a vehicle that is supported by a jack alone.
- Never service a vehicle in an area where exposed flame is present or persons are smoking.
- Be aware that a vehicle that is not performing properly is a potential hazard and must not be operated.
- Test drive vehicle after repairs or maintenance in a safe area, free of vehicular and pedestrian traffic.
- Keep complete records of the maintenance history of the vehicle.

## VENTILATION

### ALWAYS:

- Charge vehicle in a well ventilated area.
- Charge in an area free of flammable liquids and items.
- Charge a vehicle in an area that is free from flame or spark. Pay particular attention to natural gas or propane gas water heaters and furnaces.
- Use a dedicated circuit for battery charger. Do not permit other appliances to be plugged into the receptacle when the charger is in operation.
- Operate charger in accordance with manufacturers recommendations or applicable electrical code.

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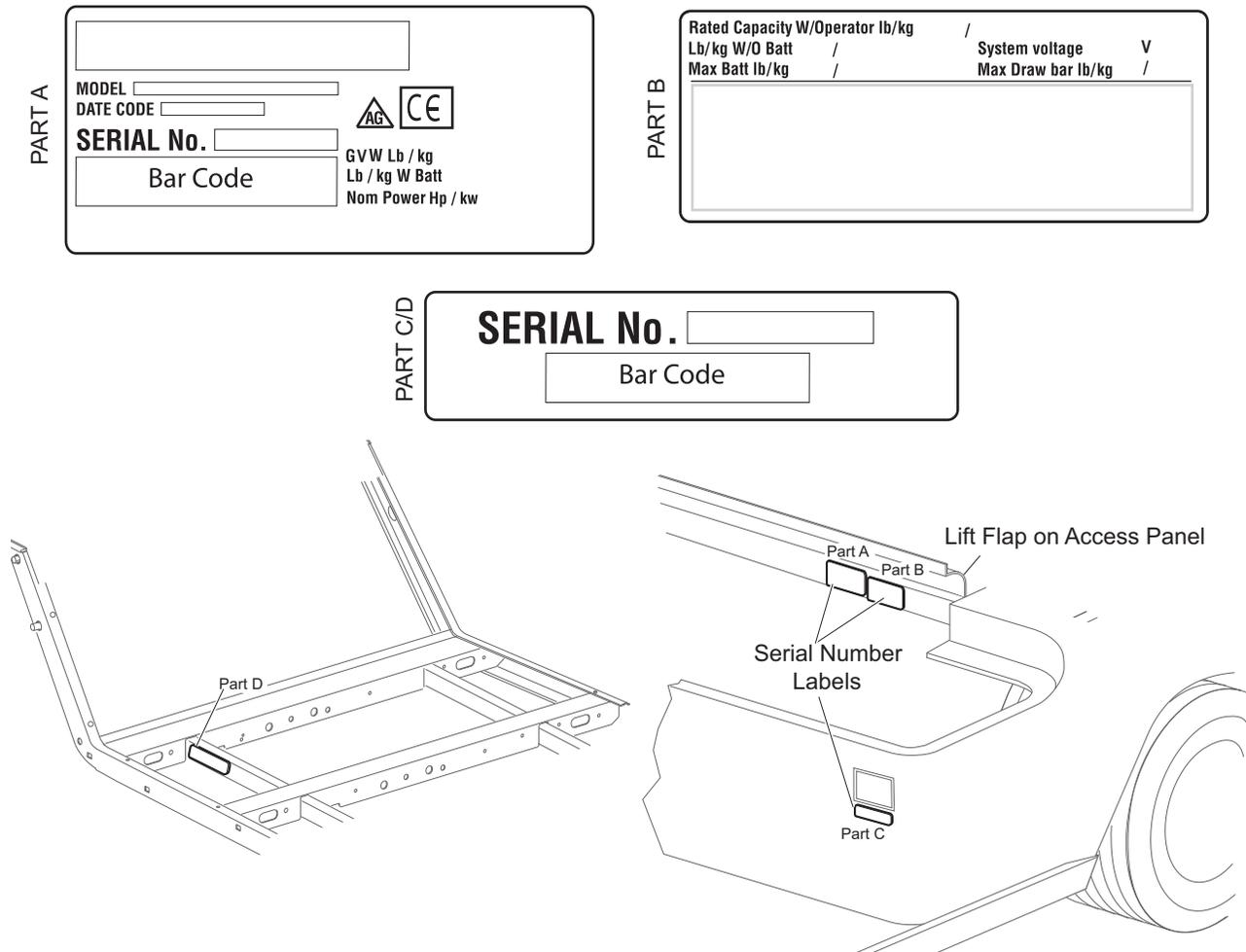


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Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

# GENERAL INFORMATION AND ROUTINE MAINTENANCE

## SERIAL NUMBER AND VIN LOCATION



**Figure 1 Serial Number and VIN Location**

The serial number can be found in three locations on the vehicle.

- Part A and B are located on the frame crossmember under the seat.
- Part C is located on the seat wrap panel on the driver's side of the vehicle.
- Part D is located on the frame under the floorboard.

Design changes take place on an ongoing basis. To obtain correct components for the vehicle, the manufacture date code, serial number and vehicle model must be provided when ordering service parts.

# GENERAL INFO

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

## TRANSPORTING VEHICLE

### Towing

**⚠ WARNING** Do not ride or allow other people on the vehicle being towed.

Do not try to tow the vehicle with ropes, chains or any device different from a tow bar approved by the factory.

Do not tow the vehicle on highways.

Do not tow the vehicle at speeds more than 12 mph (19 kph).

### Hauling

**⚠ WARNING** Make sure you secure the vehicle and all items before you move a vehicle on a trailer.

Do not allow any people on a vehicle being moved on a trailer.

Remove the windshield before you move a vehicle on a trailer.

Maximum speed with canopy top installed is 50 mph (80 kph).

If you move the vehicle on a trailer at highway speeds, the canopy top must be removed and the seat bottom secured.

When you move the vehicle on a trailer below highway speeds, check for tight hardware and cracks in canopy top at the mounting points.

The rated capacity of the trailer or truck must be more than the weight of the vehicle and load plus 1000 lbs. (454 kg). Refer to GENERAL SPECIFICATIONS for the weight of the vehicle.

Secure the vehicle to the trailer with ratchet tie downs.

## SERVICING THE ELECTRIC VEHICLE

**⚠ WARNING** To decrease the risk of severe injury or death, resulting from improper servicing techniques, observe the following warnings:

Do not attempt any type of servicing operations before reading and understanding all notices, cautions and warnings in this manual.

Any servicing requiring adjustments to be made to the powertrain while the motor is running, must be made with both wheels raised.



Wear eye protection when working on vehicle. In particular, use care when working around batteries or using solvents or compressed air.

To decrease the risk of causing an electrical arc, which could result in a battery explosion, turn off all electrical loads from the batteries before removing any heavy gauge battery wires.

It is in the best interest of both vehicle owner and servicing dealer to carefully follow the procedures in this manual. Adequate preventive maintenance, applied at regular intervals, helps keep the vehicle both dependable and economical.

Before a new vehicle is put into operation, complete the items shown in the INITIAL SERVICE CHART.

### Initial Service Chart

Item	Service Operation
Battery Charger	Remove from vehicle and read operating instructions.
Batteries	Charge. Batteries must be fully charged before initial use.
Seats	Remove protective plastic covering
Brakes	Check operation; adjust if necessary
	Establish acceptable stopping distance for brake performance test
Tires	Check air pressure; adjust if necessary (Refer to RECOMMENDED TIRE PRESSURE on page 21.)
Vehicle Inspection	Visually inspect overall vehicle for leaks or damage that could have developed in shipping.
	Inspect for loose hardware; tighten if necessary.

Figure 2 Initial Service Chart

## ROUTINE MAINTENANCE

**NOTICE:** Some maintenance items must be serviced more frequently on vehicles used under severe driving conditions.

This vehicle will give years of satisfactory service if it receives regular maintenance. Refer to the Periodic Service Schedule for appropriate service intervals. Refer to illustration below for appropriate lubrication location (Figure 3).

# GENERAL INFO

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

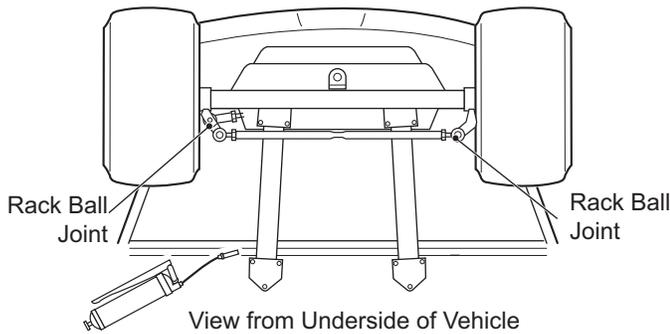


Figure 3 Lubrication Points

**CAUTION** Do not use more than three (3) pumps of grease in any grease fitting at any one time. Excess grease may cause grease seals to fail or grease to move into areas that could damage components.

## REAR AXLE

The only maintenance required for the first five years is the periodic inspection of the lubricant level. The rear axle is provided with a lubricant level check/fill plug located on the bottom of the differential. Unless leakage is evident, the lubricant only needs replacement after five years. The procedure to follow for checking the rear axle lubricant level is in the REAR AXLE section.

## BRAKES

After the vehicle has been put into service, it is recommended that the brakes be checked daily by performing a brake test.

**WARNING** To decrease the risk of severe injury or death resulting from operating a vehicle with improperly operating brake system, the braking system must be properly maintained. All driving brake tests must be done in a safe location with regard for the safety of all personnel.

For information on conducting a brake test, refer to BRAKES section.

## TIRES

Tire condition should be inspected per the Periodic Service Schedule. Inflation pressures should be checked when tires are cool. Be sure to reinstall valve dust cap after checking or inflating.

For additional information, refer to WHEELS AND TIRES section.

## LIGHT BULB REPLACEMENT

Refer to ELECTRICAL SYSTEM for information regarding light bulb replacement.

## CANOPY AND WINDSHIELD

**WARNING** The canopy does not provide protection from roll over or falling objects.

The windshield provides only minimal protection from tree limbs or flying objects.

The canopy and windshield supply some protection from the elements, but do not keep the operator and passenger dry in heavy rain.

Clean the windshield with lots of water and a clean cloth. Minor scratches may be removed using a commercial plastic polish or Plexus plastic cleaner.

## VEHICLE CLEANING AND CARE

**WARNING** Read and understand all instructions supplied by the manufacturer of the pressure washer before use.

**CAUTION** When you clean the outside of the vehicle with a pressure washer, do not use more than 700 psi pressure. Keep a minimum distance of 12 inches from the spray nozzle to the painted surface. Do not clean the plastic parts with abrasive solvents.

Make sure you use correct methods and cleaning materials to prevent risk of damage to the outside of the vehicle. The use of more than 700 psi water pressure can cause injury to anyone in the area or damage to vehicle.

Clean the windshield with water and a clean cloth. Remove small scratches with a plastic polish or Plexus® plastic cleaner, available from the service parts department.

Apply a soap and water solution with a sponge or soft brush to clean the vinyl seats and plastic or rubber trim. Dry with a cloth.

Use a commercially available vinyl and rubber cleaner to remove oil, tar, asphalt, shoe polish, etc.

Wash the vehicle frequently with cool water and mild detergent to protect the painted surfaces.

Apply wax that is for clear coat automotive finishes to improve the appearance and protection of the painted surfaces. Do not apply wax to matte finish surfaces.

Materials used as fertilizers or for dust control can collect on the bottom of the vehicle. These materials will cause corrosion of components if not removed. Clean areas where mud or dirt can collect. Loosen the sediment that is packed in closed areas to help with removal. Be careful not to damage the paint.

# GENERAL INFO

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

## VEHICLE CARE PRODUCTS

To help maintain the vehicle, there are several products available through local Distributors, authorized Branches, or the Service Parts Department.

- **Touch-Up Paint (Contact a service parts representative for availability).**  
Specially formulated to match vehicle colors for use on TPE (plastic) bodies.
- **Multi-Purpose Battery Protectant (P/N 606312)**  
Formulated to form a long-term, flexible, non-tacky, dry coating that will not crack, peel or flake over a wide temperature range.
- **Multi-Purpose Hand Cleaner (P/N 607636)**  
An industrial strength cleaner containing no harsh solvents, yet gently lifts grease off hands. May be used with or without water.
- **Battery Maintenance Kit (P/N 25587G01)**  
System for complete battery cleaning and watering, with battery maintenance instructions.
- **Plexus Plastic Cleaner and Polish (P/N 606314)**  
Removes minor scratches from windshield.

## HARDWARE

Periodically, inspect the vehicle for loose fasteners. Use care when tightening fasteners. Refer to the table for the torque values (Figure 4).

Standard:

- Grade 2 hardware is unmarked.
- Grade 5 hardware can be identified by three marks on the hex head.
- Grade 8 hardware is identified by six marks on the head.

The class specification is marked on metric hardware.

ALL TORQUE FIGURES ARE IN FT. LBS. (Nm)										
Unless otherwise noted in text, tighten all hardware in accordance with this chart.										
This chart specifies 'lubricated' torque figures. Fasteners that are plated or lubricated when installed are considered 'wet' and require approximately 80% of the torque required for 'dry' fasteners.										
BOLT SIZE	1/4"	5/16"	3/8"	7/16"	1/2"	9/16"	5/8"	3/4"	7/8"	1"
Grade 2 	4 (5)	8 (11)	15 (20)	24 (33)	35 (47)	55 (75)	75 (102)	130 (176)	125 (169)	190 (258)
Grade 5 	6 (8)	13 (18)	23 (31)	35 (47)	55 (75)	80 (108)	110 (149)	200 (271)	320 (434)	480 (651)
Grade 8 	6 (8)	18 (24)	35 (47)	55 (75)	80 (108)	110 (149)	170 (230)	280 (380)	460 (624)	680 (922)
BOLT SIZE	M4	M5	M6	M8	M10	M12	M14			
Class 5.8  (Grade 2)	1 (2)	2 (3)	4 (6)	10 (14)	20 (27)	35 (47)	55 (76.4)			
Class 8.8  (Grade 5)	2 (3)	4 (6)	7 (10)	18 (24)	35 (47)	61 (83)	97 (131)			
Class 10.9  (Grade 8)	3 (4)	6 (8)	10 (14)	25 (34)	49 (66)	86 (117)	136 (184)			

Figure 4 Torque Specifications

*Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.*

## Notes:

A large grid of graph paper for taking notes, consisting of 20 columns and 30 rows of small squares.



## SAFETY

### NOTICES, CAUTIONS, WARNINGS AND DANGERS

Read the *NOTICES*, *CAUTIONS*, *WARNINGS*, and *DANGERS* in this manual. The person who services a vehicle needs mechanical skill and experience to recognize possible hazardous conditions. Incorrect service or repair can cause damage to the vehicle, or make the vehicle dangerous to operate.

**NOTICE:** A *NOTICE* indicates and describes information not related to personal injury.

#### CAUTION

A *CAUTION* indicates a dangerous condition that can cause injury that is not life threatening.

#### WARNING

A *WARNING* indicates a dangerous condition that can cause death or serious injury.

#### DANGER

A *DANGER* indicates a dangerous condition that will cause death or serious injury.

### IMPORTANT SAFETY WARNING

Normal use, age, wear or abuse can cause some components on the vehicle to fail.

The manufacturer cannot know all possible component failures or the methods that failures can occur.

A vehicle in need of repair does not operate correctly and can be dangerous.

Be careful when you service the vehicle. Be aware of your safety and the safety of others in the area, if the vehicle unexpectedly moves.

Some components are heavy, spring loaded, corrosive, explosive, can cause high amperage or get hot. Battery acid and hydrogen gas can cause injury. Do not put your hands, face, feet or body in a location that can expose them to injury if an unexpected situation occurs.

Always use the correct tools shown in the tool list and wear approved safety equipment.

### MODIFICATIONS TO VEHICLE

Do not modify the vehicle in any manner that will change the weight distribution of the vehicle.

#### WARNING

*Changes to the weight distribution or the center of gravity decreases the stability of the vehicle and can cause it to easily turn over.*

### GENERAL MAINTENANCE

#### WARNING

*Always use correct service procedures. Never do any type of service procedure before you read and understand all notices, cautions, warnings and dangers in this manual.*

When any maintenance procedure or inspection is done, make sure the technician or anyone else in the area is safe. Use caution to prevent damage to the vehicle.

Always read and understand the **entire** relevant manual section before attempting any inspection or service.

### BEFORE SERVICING THE VEHICLE

Before attempting to inspect or service a vehicle, be sure to read and understand the following warnings:

#### WARNING

*Remove all jewelry before you work on the vehicle.*

*Do not allow loose clothing or hair to contact the moving parts.*

*Do not touch hot objects.*

*Before you engage or adjust the powertrain, lift and support the vehicle on the jack stands.*

*Wear OSHA approved clothing and eye protection when working on anything that could expose the body or eyes to potential injury. In particular, use care when working around batteries, using compressed air or solvents.*

*Always remove the key from key switch before you disconnect an active circuit.*

*When you connect the battery cables, pay particular attention to the polarity of the battery terminals. Do not confuse the positive and negative cables.*

*Engage the parking brake, except when the powertrain must be allowed to rotate or the brake system needs service.*

*If repairs are to be made that will require welding or cutting, the batteries must be removed.*

### Additional Warnings Specific to Electrical System

Before working on the electrical system, be sure to read and understand the following warnings that pertain to electrical system or maintenance.

# SAFETY

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

## ⚠ WARNING

Open flame or sparks can cause an explosion. Keep all flammable materials away from the batteries.

Explosive hydrogen gas is created during the charge cycle of the batteries. Good ventilation can remove gas from the buildings. The air must change every 12 minutes.

Make sure that the key switch is in the OFF position, and the key removed. Make sure all electrical accessories are disabled before you start to service the vehicle.

The batteries must be removed before any service or repairs that can cause sparks.

Never disconnect an active circuit at a battery terminal.

## SAFETY FIRST



BEND KNEES  
WHEN  
LIFTING

Be careful, the batteries are heavy. Use correct safety procedures to lift a battery. Always lift the battery with a commercially available battery lifting device. Make sure that you do not tilt the battery during removal or installation. An electrolyte spill

can cause burns and damage.

The electrolyte in a storage battery is an acid solution which can cause burns to the skin and eyes. Always use clean water to wash electrolyte from your body or eyes. Get medical assistance immediately.



When you service the vehicle, always wear eye protection. Be careful when working around batteries, or using solvents or compressed air.

Any electrolyte spills should be neutralized with a solution of 1/4 cup (60 ml) sodium bicarbonate (baking soda) dissolved in 1-1/2 gallons (6 liters) of water and flushed with water.



Use insulated wrenches to decrease the risk of a dropped wrench from shorting out a battery, which could result in an explosion and severe personal injury or death.

Aerosol containers of battery terminal protectant must be used with extreme care. Insulate metal container to prevent can from contacting battery terminals, which could result in an explosion.

## ⚠ CAUTION

Overfilling batteries may result in electrolyte being expelled from the battery during the charge cycle.

Expelled electrolyte may cause damage to the vehicle and storage facility.

## BATTERY REMOVAL AND INSTALLATION

### Tool List

### Quantity

Insulated Wrench, 9/16".....	1
Socket, 9/16".....	1
Ratchet.....	1
Battery Carrier.....	1
Torque Wrench, in. lbs. ....	1
Torque Wrench, ft. lbs. ....	1

**NOTICE:** Hardware that is removed must always be installed in its original position unless otherwise specified. If torque values are not specified, refer to the Torque Specifications table in the GENERAL INFORMATION AND ROUTINE MAINTENANCE section.

Turn vehicle key to OFF and remove it from vehicle. Ensure all optional electrical accessories are turned OFF.

Using an insulated wrench, remove the negative (-) cable first, the positive (+) cable and then all other cables from the vehicle batteries. Remove the battery hold down by removing the hardware and lifting the retainer from the batteries.

Remove the batteries using a commercial battery carrier.

If the batteries have been cleaned and any acid in the battery rack area neutralized on a regular basis, corrosion to the battery racks or surrounding area should not be present. If any corrosion is found, remove with a putty knife and wire brush. Wash the area with a solution of sodium bicarbonate (baking soda) and water and thoroughly dry before priming and painting with a corrosion resistant paint.

Place batteries in the battery rack. Install the battery hold downs and tighten the nuts to torque value specified below.

Item	Torque Specification
Battery hold down	16 - 19 ft. lbs. (21.6 - 25.7 Nm)

To decrease the risk of movement but not tight enough to cause distortion of the battery cases.

Inspect all wires and terminals and clean any corrosion from the battery terminals or the wire terminals with a solution of sodium bicarbonate (baking soda) and wire brush if required.

## ⚠ WARNING

Aerosol containers of battery terminal protectant must be used with extreme care. Insulate metal container to decrease the risk of the can contacting battery terminals which could result in an explosion.

# SAFETY

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

Make sure to connect battery cables as shown (Figure 1). **Connect the positive (+) battery cable first**, other battery connecting cables, and then **connect the negative (-) cable last**. Ensure that all battery terminals are installed with crimp up. Tighten the battery post hardware to torque value specified below.

Item	Torque Specification
Battery post hardware	90 - 100 in. lbs. (10 - 11 Nm)

Protect the battery terminals and battery cable terminals with a commercially available protective coating.

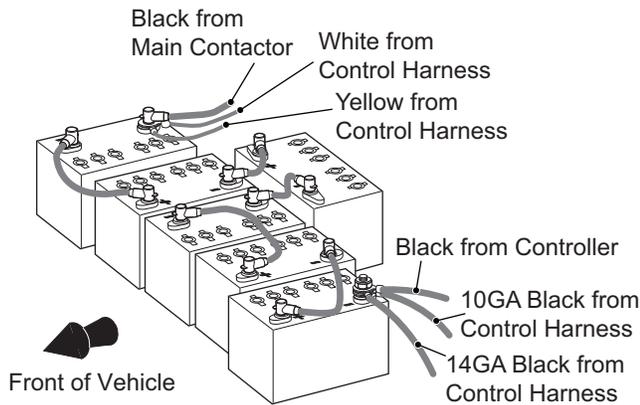


Figure 1 Battery Connections

## LIFTING THE VEHICLE

Tool List	Quantity
Floor Jack.....	1
Jack Stands.....	4
Chocks .....	4

**WARNING** *The vehicle is not stable during the lifting process.*

**Make sure the vehicle is on a hard and level surface.**

**Never get below a vehicle that is supported by a jack only.**

**Make sure a vehicle that is supported on jack stands is stable before you get below the vehicle.**

**Put wheel chocks in front and behind the wheels that remain on the ground.**

**Do not allow any person in or on the vehicle being lifted.**

### CAUTION

**When you lift the vehicle, put the jacks and jack stands at the areas indicated (Figure 2).**

### How to lift the entire vehicle

1. Install the wheel chocks in front and behind each front wheel.
2. Put the jack below the center of the rear frame cross-member.
3. Lift the vehicle enough to put jack stands below the outer ends of the rear axle as shown.
4. Lower the jack and test the stability of the vehicle on the two jack stands.
5. Put the jack at the center of the front axle.
6. Lift the vehicle enough to put two jack stands below the front frame crossmember as shown.
7. Lower the jack and test the stability of the vehicle on all four jack stands.

### How to lift the rear of the vehicle only

1. Put the wheel chocks in front and behind each front wheel.
2. Put the jack below the center of the rear frame cross-member.
3. Lift the vehicle enough to put a jack stand below the outer ends of the rear axle as shown.
4. Lower the jack and test the stability of the vehicle on the two jack stands.

### How to lift the front of the vehicle only

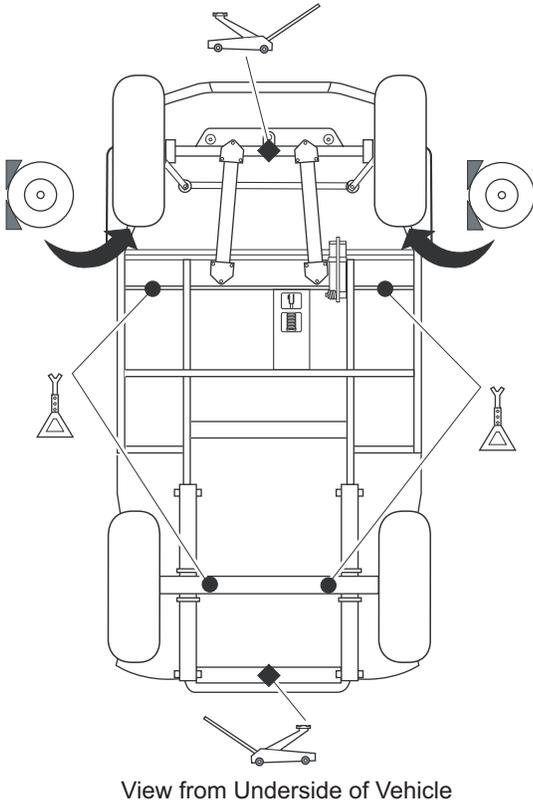
1. Put the wheel chocks in front and behind each rear wheel.
2. Put the jack at the center of the front axle.
3. Lift the vehicle enough to put two jack stands below the front frame crossmember as shown.
4. Lower the jack and test the stability of the vehicle on the two jack stands.

# SAFETY

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

## Lower the vehicle

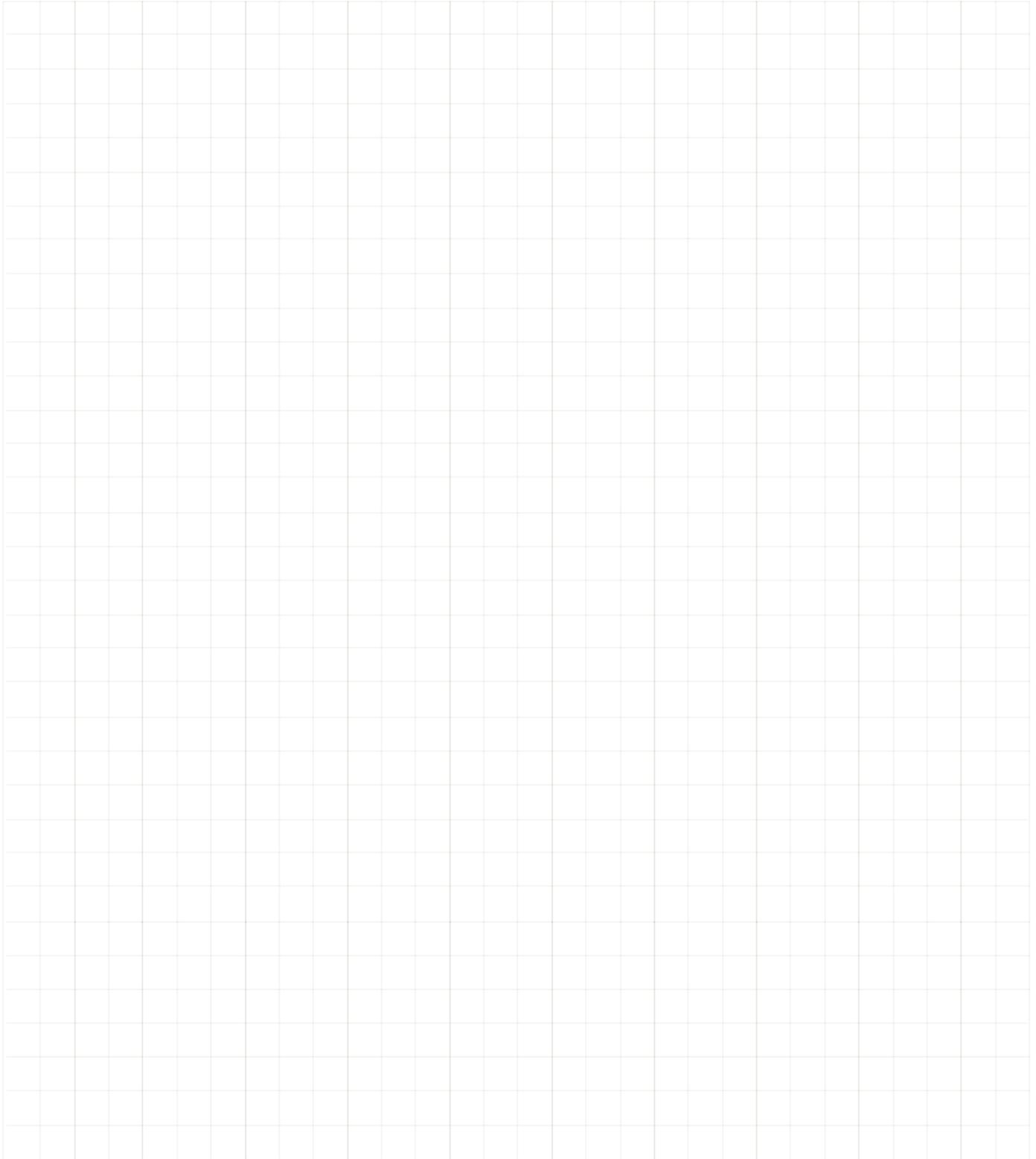
1. Lift the vehicle enough to remove the jack stands.
2. Carefully lower the vehicle to the ground with the jack.



**Figure 2 Lifting the Vehicle**

*Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.*

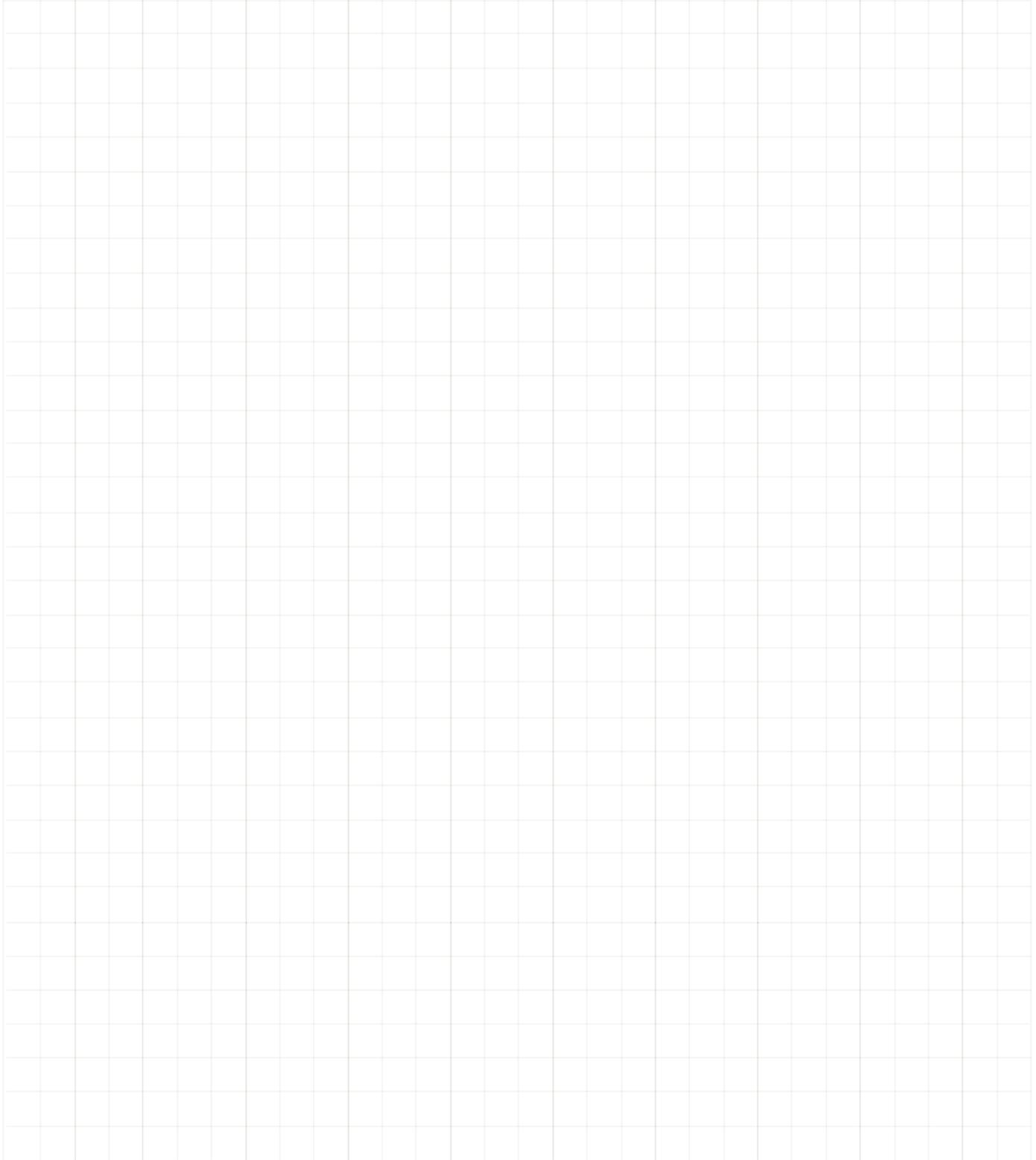
## Notes:

A large grid of graph paper for taking notes, consisting of 20 columns and 30 rows of small squares.

# SAFETY

*Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.*

## Notes:

A large grid of graph paper for taking notes, consisting of 20 columns and 30 rows of small squares.

## BODY

### GENERAL

**NOTICE:** Hardware that is removed must always be installed in its original position unless otherwise specified. If torque values are not specified, refer to the Torque Specifications table in the GENERAL INFORMATION AND ROUTINE MAINTENANCE section.

**WARNING** To decrease the risk of injury or death from battery explosion, batteries should always be removed before any servicing that will generate sparks.

It is important to use a sharp drill bit when removing the rivets on the side of the vehicle. Use extreme care when drilling out the rivets located in the front of the body and the bottom side of the body. Excessive pressure could result in the drill bit being forced through the body panel and penetrating an internal component. It is recommended that a protective piece of sheet metal be placed between the battery and the rivet as extra protection. Use of a drill depth stop will also provide additional protection.

Body components can be replaced with a minimum of special tools. Most body components are held in position with standard removable hardware (nuts, bolts, washers and screws). Some components are installed with pop rivets that require the rivet head be removed to push the shank of the rivet out. The rivet head can be removed by drilling into the head with a sharp drill bit that is slightly larger than the shank of the rivet (Figure 1). Do not allow the drill bit to push through and damage components behind the rivet. Use a sharp drill bit that needs minimum pressure to correctly cut, and put a piece of protective sheet metal between the panel and components behind the panel.

### BODY COMPONENT REPLACEMENT

To replace the body components, remove the mounting hardware, replace the component and secure with hardware in the original position.

The following illustrations indicate the assembly methods for the different components.(Figure 1) (Figure 2) (Figure 3).

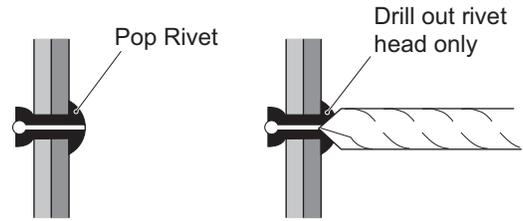


Figure 1 Drill Out Metal Rivet

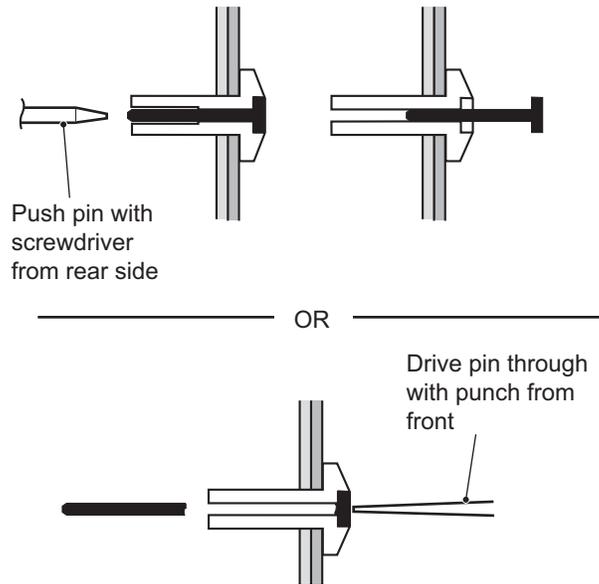


Figure 2 Drive Rivet Removal

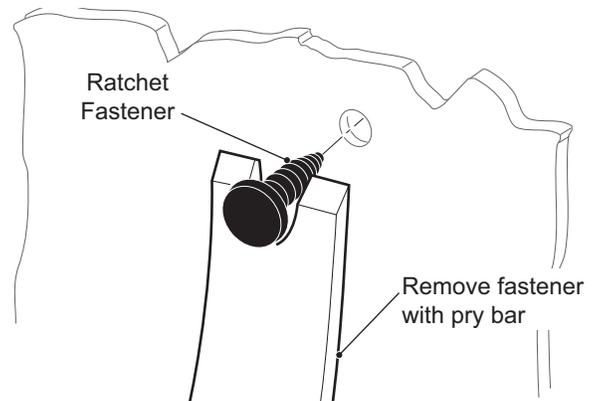


Figure 3 Remove Ratchet Fastener

# BODY

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

## Instrument Panel Replacement

Tool List	Quantity
Drill .....	1
Drill Bit, #10 .....	1
Wrench, 5/16" .....	1
Phillips Screwdriver .....	1
Pry Bar.....	1
Punch, Small .....	1
Hammer.....	1
Pop Rivet Tool .....	1

**NOTICE:** The instrument panel (1) may be removed without removing the cowl (5) or may be removed as part of the cowl (Figure 4).

**WARNING** To decrease the risk of injury due to lack of vehicle information, the correct safety label must be on the instrument panel at all times.

To decrease the risk of personal injury, disconnect negative (-) battery cable before servicing vehicle.

When you install a new instrument panel (1), the plate with the safety label (2) must be moved to the new instrument panel.

When ordering a replacement instrument panel (1), provide vehicle serial number to the service parts represen-

tative who will provide the correct part number for the safety label.

Using an insulated wrench, disconnect the battery cable at the negative (-) battery terminal.

Pull the front of the floor mat (3) up to expose the rivets (4), that secure the instrument panel (1) to the floor. Drill out the rivets attaching the bottom of the instrument panel (1) to the floor and across the top of the instrument panel attaching it to the cowl (5) (Figure 4).

Pull the instrument panel away from the cowl a short distance. Note the location of all wires connected to the switches. Disconnect all wires before removing the instrument panel.

To remove the control panel assembly from the instrument panel, remove the three self tapping screw (6).

Install the new control panel assembly into the new instrument panel, locking the four tabs into the notches in the instrument panel. Secure the new control panel with the self tapping screws (6) removed in the previous step.

Connect the wires to the switches and reposition the new instrument panel. Use new pop rivets (4) to install the new instrument panel.

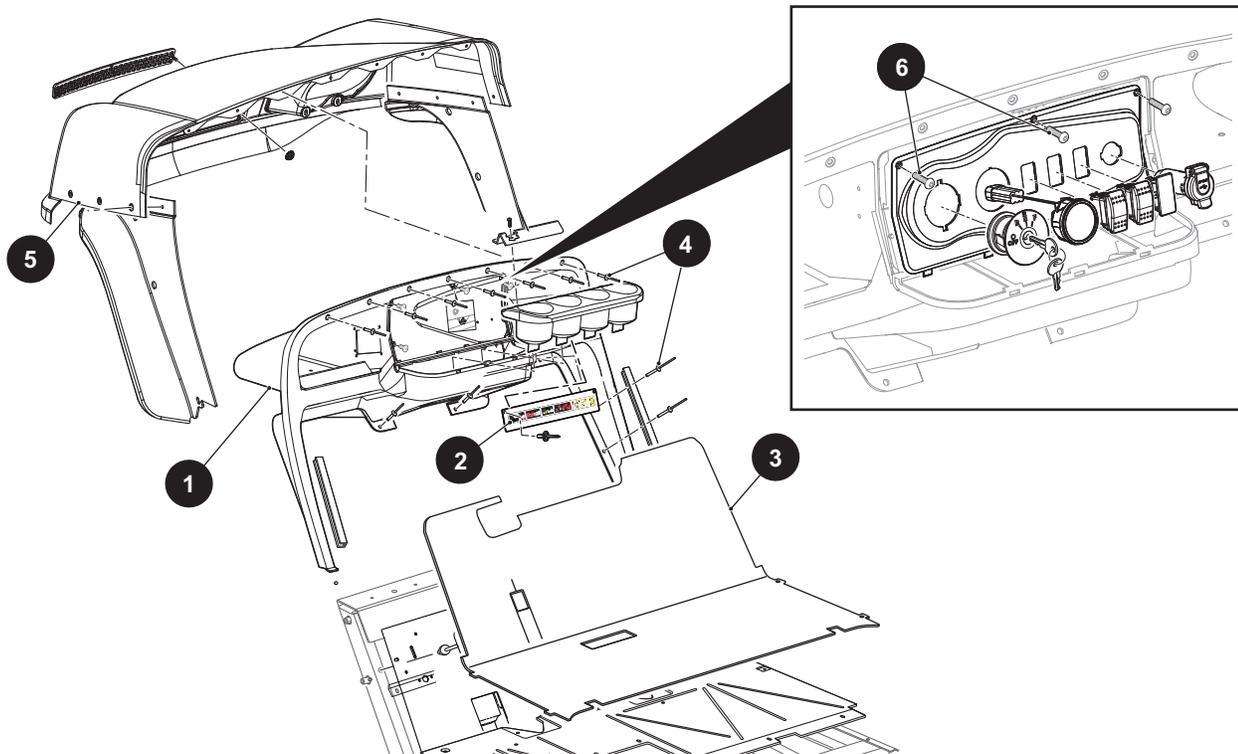


Figure 4 Front Body

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

## Cowl Replacement

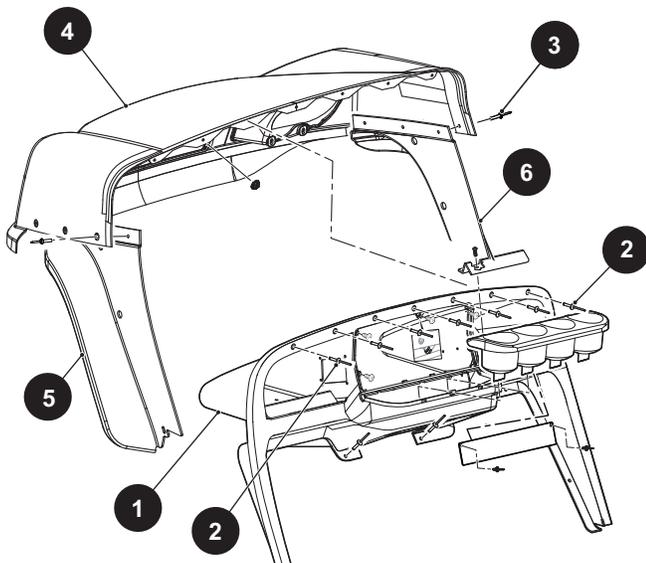
Tool List	Quantity
Drill .....	1
Drill Bit, 7/32" .....	1
Phillips Screwdriver .....	1
Punch, Small .....	1
Pop Rivet Tool .....	1
Duct Tape .....	1
Hammer.....	1

**NOTICE:** The cowl can be removed along with the front fenders.

**⚠ WARNING** To decrease the risk of personal injury, disconnect negative (-) battery cable before servicing vehicle.

Drill out seven rivets (2) across top of instrument panel (1) that secure the instrument panel to the cowl (4) (Figure 5).

Drill out six rivets (3) (three on each side) that secure the cowl to the front fenders (5, 6).



**Figure 5 Cowl Replacement**

Raise cowl (4) and unplug headlights.

Remove cowl (4) from vehicle and transfer lights to new cowl.

Install cowl in the reverse order of removal using new rivets (2, 3).

## Front Fascia Replacement

Tool List	Quantity
Wrench, 7/16" .....	1
Pry Bar .....	1

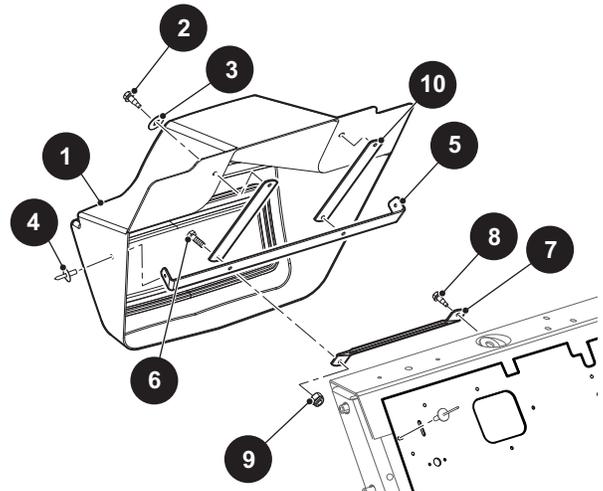
The front fascia (1) need not be removed to replace any other body components (Figure 6).

If the front fascia (1) is damaged, remove two bolts (2) and washers (3) securing the front fascia (1) to the frame (Figure 6).

Remove the two rivets (4) securing the front shield to the bracket (5).

If the mounting bracket (5), or cowl straps (10) are damaged, remove the hex head bolts (6) and nuts (9) that secure the bracket (5) and straps (10) to the frame.

Install in the reverse order of removal using new rivets (4).



**Figure 6 Front Fascia Replacement**

# BODY

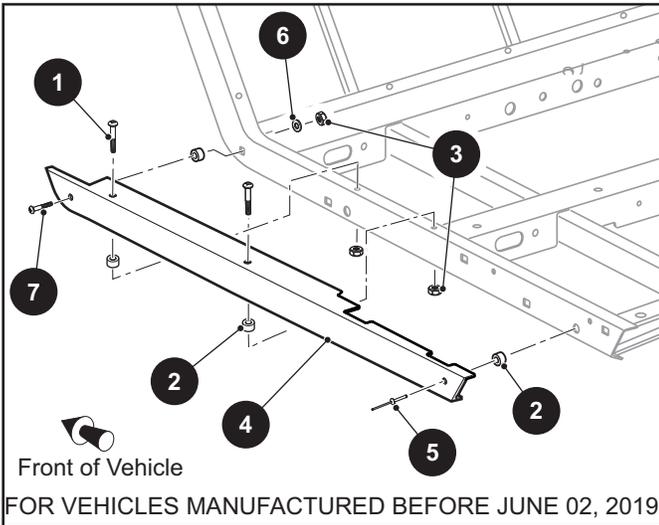
Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

## Rocker Panel Replacement

### Tool List

	Quantity
Phillips Screwdriver .....	1
Socket, 3/8" .....	1
Ratchet .....	1
Torque Wrench, in. lbs.....	1

### For Vehicles Manufactured Before June 02, 2019:



**Figure 7 Rocker Panel**

Drill out the rivet (5) that secures the rocker panel (4) to the vehicle frame. Retain spacer (2) for reuse (Figure 7).

Remove two torx bolts (1), spacers (2) and nuts (3) from top portion of rocker panel (4).

Remove phillips head screw (7), spacer (2), washer (6) and nut (3) from side of the rocker panel (4). Retain torx bolts, screws, washers, spacers and nuts for reuse; new rivets (5) will be required.

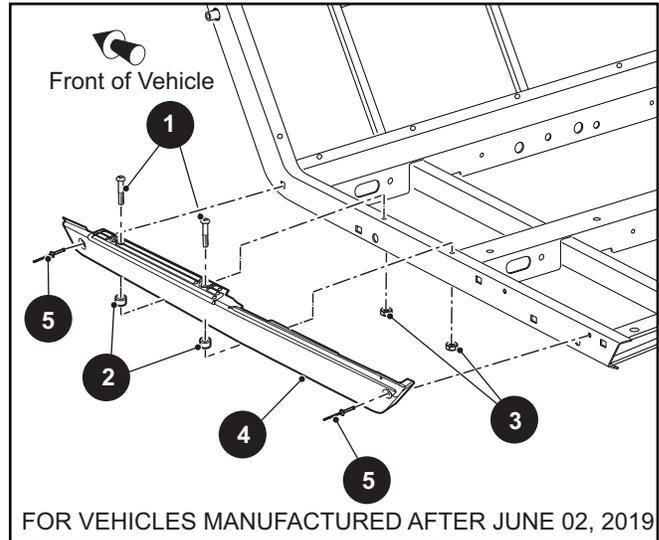
Remove the rocker panel.

Repeat steps at opposite side of vehicle if necessary.

Install in the reverse order of removal using new rivets (5). Tighten head screw (7) to torque value specified below.

Item	Torque Specification
1	45 - 55 in. lbs. (5 - 6.2 Nm)
7	18 - 20 in. lbs. (2 - 2.3 Nm)

### For Vehicles Manufactured After June 02, 2019:



**Figure 8 Rocker Panel**

Drill out the rivets (5) that secures the rocker panel (4) to the vehicle frame. (Figure 8).

Remove two torx bolts (1), spacers (2) and nuts (3) from top portion of rocker panel (4).

Remove the rocker panel.

Repeat steps at opposite side of vehicle if necessary.

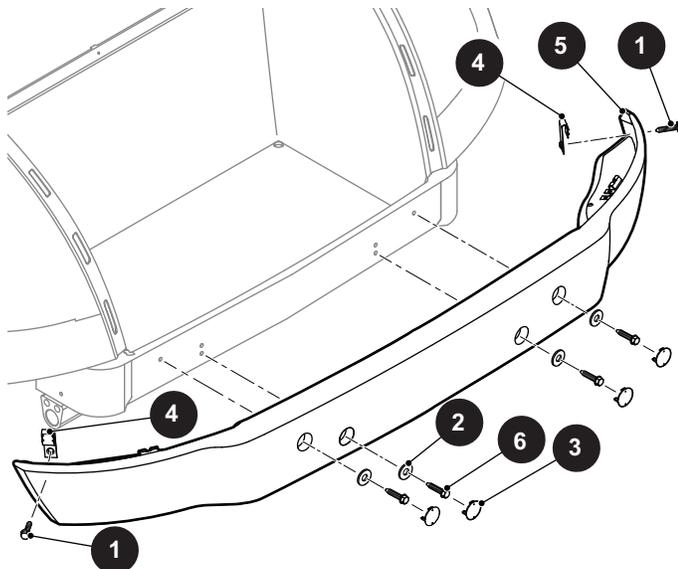
Install in the reverse order of removal using new rivets (5). Tighten the nuts (3) to torque value specified below.

Item	Torque Specification
3	45 - 55 ft. lbs. (5 - 6.2 Nm)

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

## Rear Bumper Replacement

Tool List	Quantity
Flat Screwdriver .....	1
Allen Wrench, 7/32" .....	1



**Figure 9 Rear Bumper**

To remove the bumper (5), remove the bolts (1) at each end of the rear bumper.

Carefully remove the plugs (3) with a screwdriver. Remove the shoulder bolts (6) and washers (2) underneath the plugs.

Remove the rear bumper.

To replace the bumper, engage the top of the bumper with the underside of the fenders. Push bumper upward as fender slides between the bumper clips (4) and the bumper. Install bolts (6) and washers (2) through holes in the bumper into the frame and tighten to the torque value specified below.

Item	Torque Specification
1, 6	8 - 12 ft. lbs. (11 - 16 Nm)

Replace bumper plugs.

Secure each end of the bumper to the fender with bolt (1), J-nut (4) and tighten bolt (1) to the torque value specified above.

## Rear Fender Liner Replacement

Tool List	Quantity
Drill.....	1
Drill Bit .....	1
Pry Bar .....	1
Pop Rivet Tool.....	1
Torque Wrench, ft. lbs.....	1

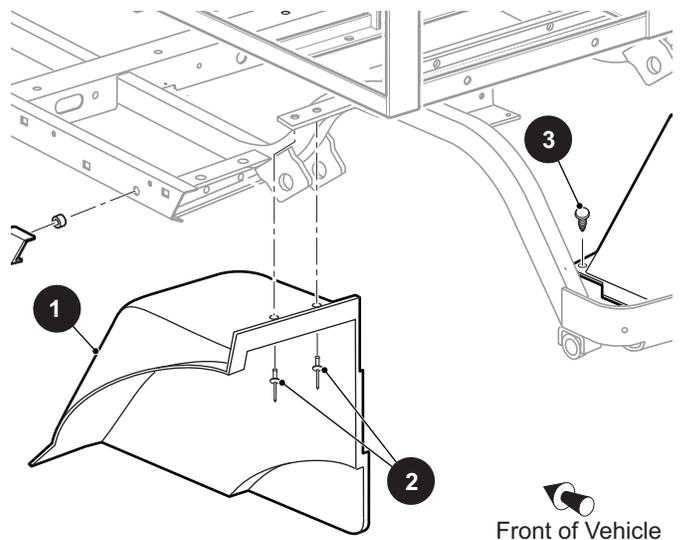
Disconnect the taillight leads from the wiring harness and remove taillights from fenders.

Remove two ratchet rivets (3) securing rear fender (1) to bottom of the frame (Figure 10).

Remove two rivets (2) from the frame at the top.

Repeat steps at opposite side of vehicle if necessary.

Install in reverse order of removal using new rivets.



**Figure 10 Rear Fender Liner Replacement**

# BODY

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

## SEAT REPLACEMENT

Tool List	Quantity
Drill .....	1
Drill Bit .....	1
Extension 3" LG.....	1
Socket, 7/16" .....	1
Socket, 1/2" .....	1
Socket, 9/16" .....	1
Rubber Mallet .....	1
Ratchet .....	1
Wrench, 7/16" .....	1
Wrench, 1/2" .....	1
Wrench, 9/16" .....	1
Phillips Screwdriver .....	1
Torque Wrench, ft. lbs.....	1

### Rear Seat Bottom Replacement

Remove the seat bottom assembly by removing bolts (18), flat washers (13) and nuts (17) as shown.

Install in reverse order of removal.

Tighten the nuts (17) to the torque value specified below.

Item	Torque Specification
17	8 - 10 ft. lbs. (11 - 13 Nm)

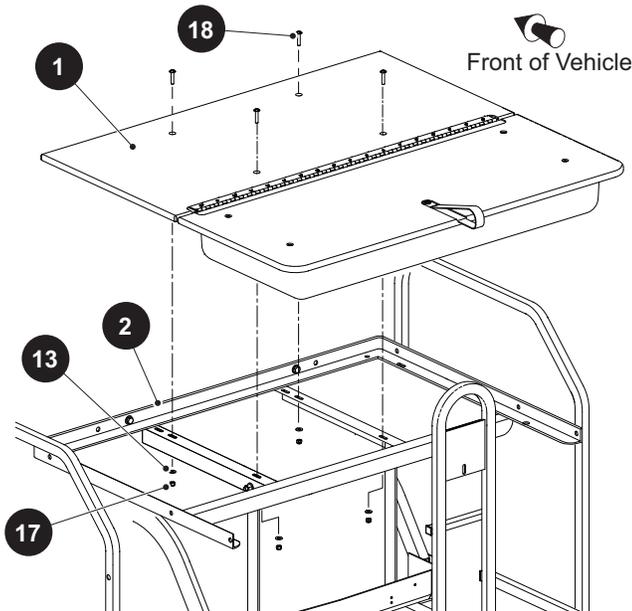


Figure 11 Rear Seat Bottom Replacement

### Seat Back Replacement

Remove the rear seat back assembly (8) by removing bolts (21) and lock washers (14) on each side as shown.

Install in reverse order of removal.

Tighten the bolts (21) to the torque value specified below.

Item	Torque Specification
21	8 - 12 ft. lbs. (11 - 16 Nm)

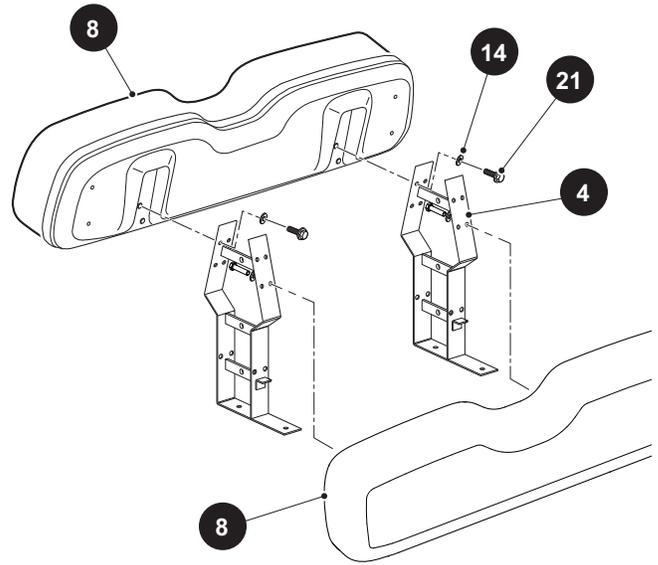


Figure 12 Seat Back Replacement

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

## Arm Rest Replacement

Remove the bolt (10), flat washer (20) and low profile nut (15) securing the arm rest (5) to the side of seat frame weldment (2) on the passenger side of the vehicle.

Remove the bolt (12), flat washers (20) and lock nut (16) securing the lower portion of arm rest (5) to the footrest weldment (3).

Remove the arm rest from the passenger side of the vehicle.

Repeat the above procedure to remove the arm rest from the driver side of the vehicle.

Install the arm rest in reverse order of removal.

Tighten the nuts (15, 16) to the torque value specified below.

Item	Torque Specification
15, 16	31 - 35 ft. lbs. (42 - 47 Nm)

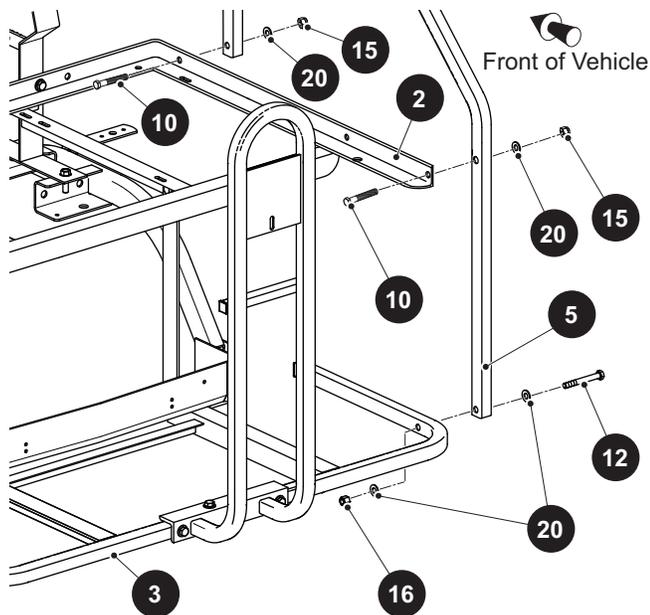


Figure 13 Arm Rest Replacement

## Foot Rest and Handrail Installation

Remove the handrail (7) attached to the foot rest weldment (3) by removing the lock nuts (16), flat washers (20), bolts (22).

Install in reverse order of removal.

Tighten the lock nuts (16) to the torque value specified below.

Item	Torque Specification
16	31 - 35 ft. lbs. (42 - 47 Nm)

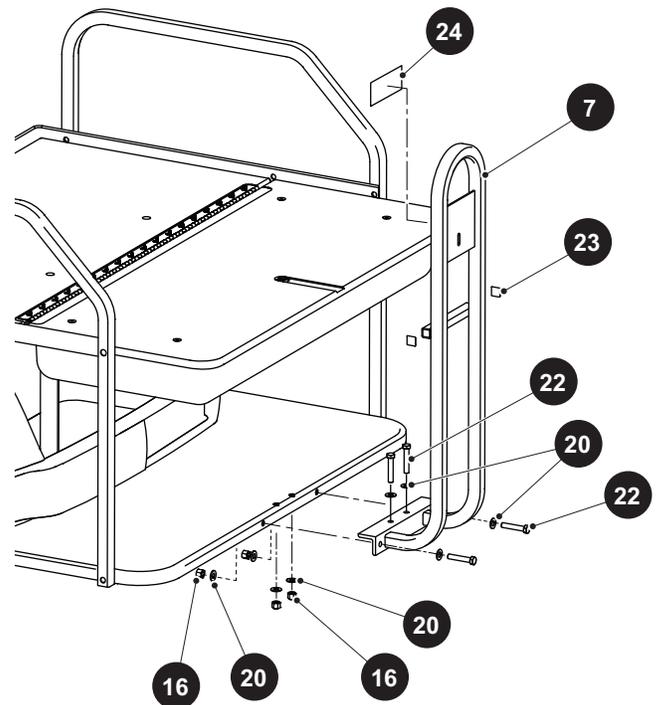


Figure 14 Handrail Replacement

Remove the footrest weldment by removing bolts (11), flat washers (20) and nuts (16) from underneath frame on each side.

Install in reverse order of removal.

Tighten the nuts (16) to the torque value specified below.

Item	Torque Specification
16	31 - 35 ft. lbs. (42 - 47 Nm)

# BODY

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

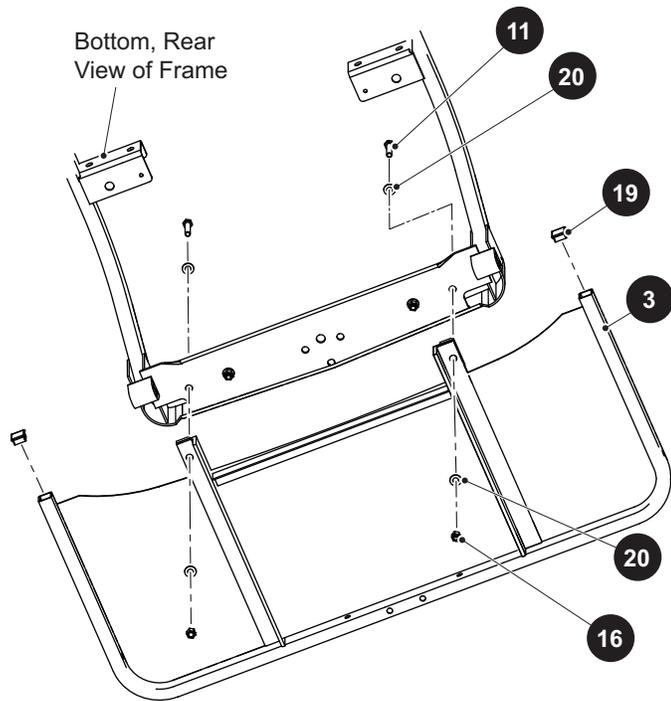
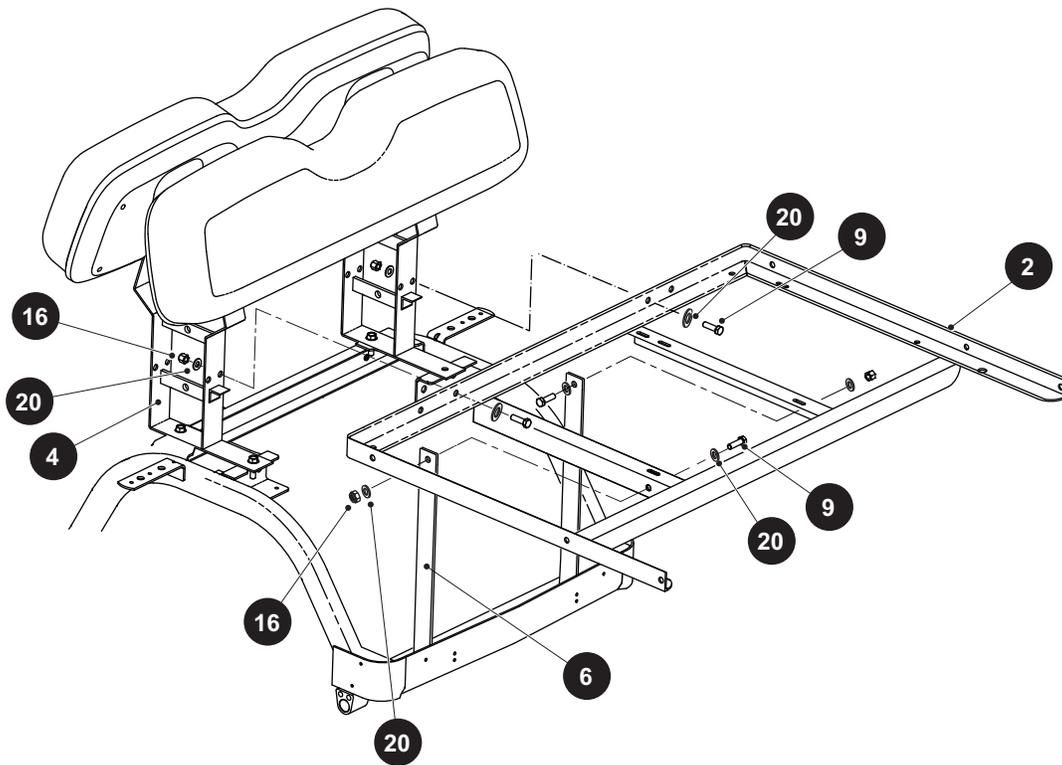


Figure 15 Footrest Weldment Replacement

## Rear Seat Frame Replacement



Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

## Figure 16 Rear Seat Frame Replacement

Remove the bolts (9), flat washers (20) and nuts (16) securing the rear seat frame (2) to the seat back supports (4).

Remove the rear seat frame (2) by removing the bolts (9), flat washers (20) and nuts (16) securing the rear seat frame (2) to the seat frame support (6).

Install in reverse order of removal.

Tighten the nuts (16) to the torque value specified below.

Item	Torque Specification
16	31 - 35 ft. lbs. (42 - 47 Nm)

## Seat Frame Support Replacement

Remove the bolts (10), flat washers (20) and nuts (16) from the securing the seat frame supports (6) to the frame.

Install in reverse order of removal.

Tighten the nuts (16) to the torque value specified below.

Item	Torque Specification
16	31 - 35 ft. lbs. (42 - 47 Nm)

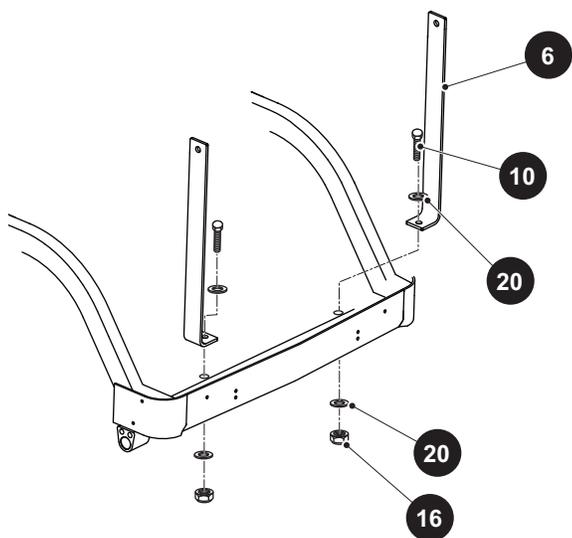


Figure 17 Seat Frame Support Replacement

## Seat Back Support Replacement

Remove the seat back support (4) by removing the bolts (9) securing the seat back support to the vehicle frame.

Install in reverse order of removal.

Tighten the bolt (9) to the torque value specified below.

Item	Torque Specification
9	31 - 35 ft. lbs. (42 - 47 Nm)

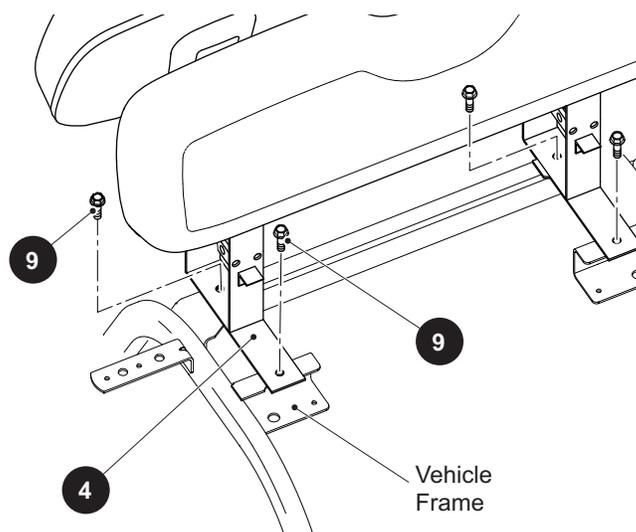


Figure 18 Seat Back Support

# BODY

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

## BODY REPLACEMENT

Tool List	Quantity
Drill .....	1
Drill Bit, 7/32" .....	1
Drill Bit, 3/16" .....	1
Drill Bit, 5/16" .....	1
Drill Depth Stop .....	1
Socket, 3/8" .....	1
Socket, 1/4" .....	1
Socket, 9/16" .....	1
Ratchet, 3/8" drive .....	1
Wrench, 3/8" .....	1
Wrench, 1/4" .....	1
Wrench, 9/16" .....	1
Pop Rivet Tool .....	1
Phillips Screwdriver .....	1
Pry Bar.....	1

Remove the rocker panels, see Rocker Panel Replacement.

Remove the seat bottom and seat back, see Seat Replacement.

**⚠ WARNING** *Extreme care must be used when drilling out rivets located near the battery. To avoid penetrating the battery with the drill bit use a drill depth stop positioned to prevent penetration of the body panel.*

**Place a piece of sheet metal between the battery case and the rivets to be removed as a secondary precaution.**

At the front of the rear body, remove the rivets (2) securing the rear body to the frame and floorboard area. Drill out the heads of the large head rivets (1) that secure the bottom of the body panel to the side of the vehicle (Figure 19).

Remove rear bumper as described in "Rear Bumper Replacement".

Remove the rivets (4) that secure the floor of the bagwell area to the frame underneath.

Remove the body (3).

If the access panel (6) is to be reused, remove the screws (5) securing the access panel to the body panel.

Remove the access panel (6).

Install the rear body (3) in the reverse order of removal using new rivets. Tighten the screws (5) to the torque value specified below.

Item	Torque Specification
5	5 - 7 in. lbs. ( .6 - .8 Nm)

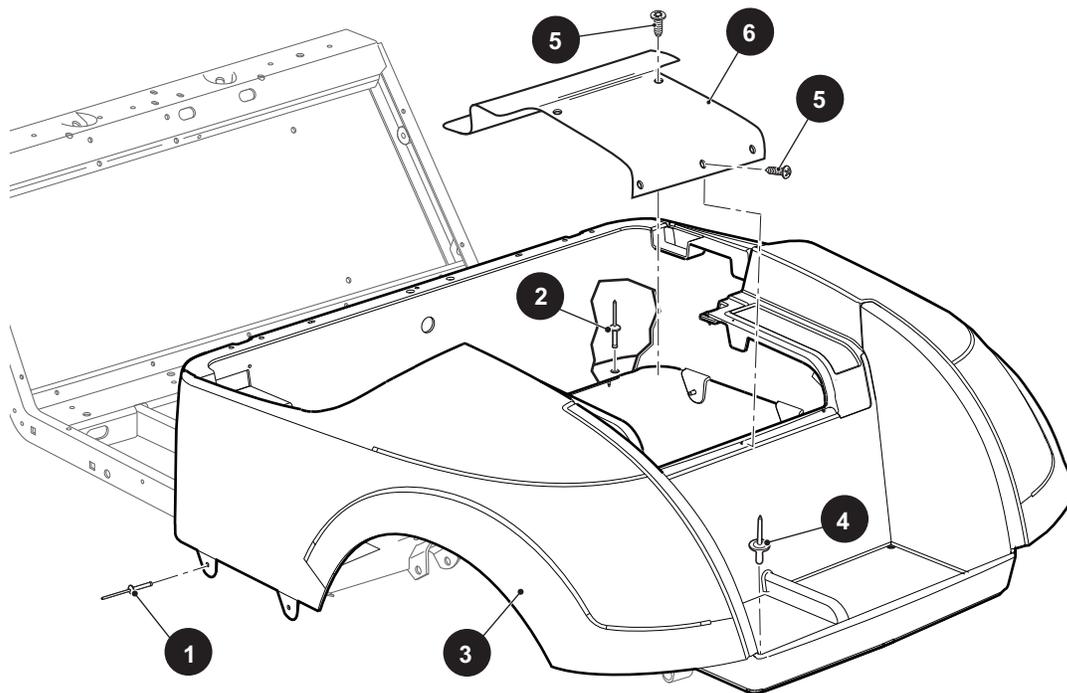


Figure 19 Body Components (Rear)

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

## PAINTING

Follow the paint manufacturer's recommendations for specific painting procedures and information.

**⚠ WARNING** *All painting must be done in an area with adequate ventilation to safely disperse harmful vapors.*

*Wear eye protection and respirator, following manufacturer's instructions, to protect from over-spray and airborne mist.*

**⚠ CAUTION** *Provide protection from over-spray to vehicle and surrounding area.*

### Minor Scratches

For minor scratches, the manufacturer suggests the following steps be taken to repair the Durashield™ body:

1. Thoroughly clean the surface to be repaired with alcohol and dry.
2. Touch up damaged area with sequential coats (two coats minimum recommended, allowing 30 - 45 minutes between coats, increasing to 45 - 60 minutes in higher humidity) using brush on touch-up paint, until coating layer is visible, slightly above the surface of the part.
3. Use 400 grit "wet" sand paper to blend touch up area level with the rest of the part being repaired. Use a polishing compound (3M Finesse or automotive grade) to renew gloss and to further blend and transition newly painted surface.
4. Clean with alcohol and dry.
5. (Optional but recommended) Follow this process with clear coat to renew and protect depth of finish.
6. Wax or polish with Carnauba base product, available at any automotive parts distributor.

### Larger Scratches

For larger scratches, the manufacturer suggests the following steps be taken to repair the Durashield™ body:

1. Thoroughly clean the surface to be repaired with alcohol and dry.
2. Mask the area to be painted (common masking tape is adequate) prior to repair and use aerosol type touch-up paint.
3. Apply spray touch up paint in light even overlapping strokes. Multiple coats may be applied to provide adequate coverage and finish. Always remember to shake the can for a minimum of one minute to mix the paint and achieve the best color match.
4. After painting, allow to dry overnight. Smooth the mask lines using 400 grit "wet" sand paper to blend touch up area level with the rest of the part being repaired. Use a polishing compound (3M Finesse or

automotive grade) to renew gloss and to further blend and transition newly painted surface.

5. Clean with alcohol and dry.
6. (Optional but recommended) Follow this process with clear coat to renew and protect depth of finish.
7. Wax or polish with Carnauba base product, available at any automotive parts distributor.

### Complete Panel Repair

In situations where large panels or areas must be painted, touch up paint is not recommended. In such cases professional painting or panel replacement is called for. The manufacturer suggests body panel replacement be considered as a cost effective alternative to painting. If the decision to repaint is taken, the task can be accomplished by any paint and body shop with experience in painting TPE panels. TPE is a common material in modern automobile bodies and all body shops should be familiar with the materials and processes required.

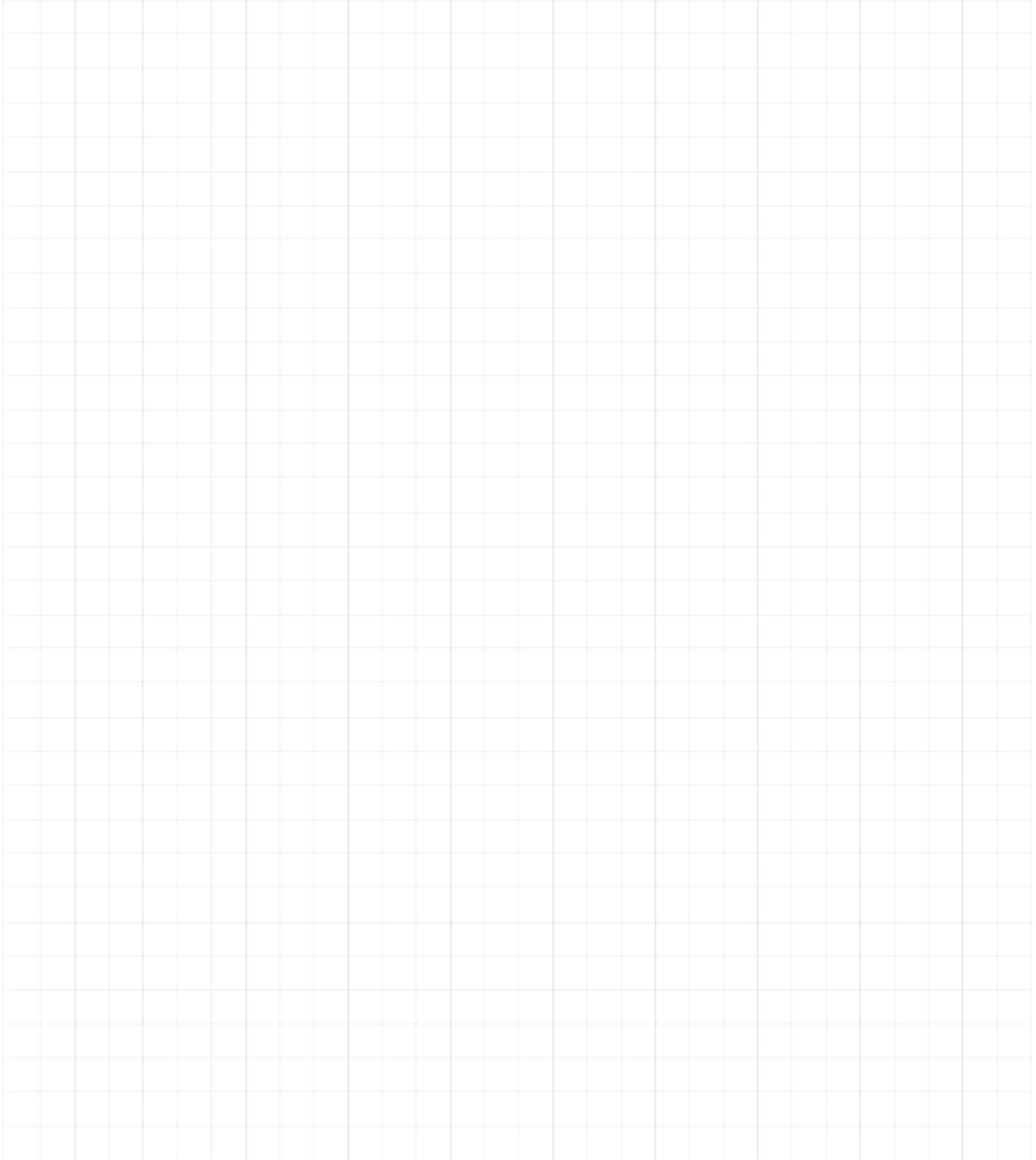
The finish will include an application of a primer coat, a base color coat and a clear coat. The manufacturer does not supply these materials due to the variety of paint manufacturers and the preferences of the individual painter.

Most paint manufacturers can perform a computer paint match to assure accurate color matching.

# BODY

*Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.*

## Notes:

A large grid of graph paper for taking notes, consisting of 20 columns and 30 rows of small squares.

# WHEELS AND TIRES

## WHEEL AND TIRE SERVICE

Tool List	Quantity
Lug Wrench, 3/4" .....	1
Impact Wrench.....	1
Impact Socket, 3/4".....	1
Torque Wrench, ft. lbs.....	1

**⚠ WARNING**

*To decrease the risk of tire explosion, add small amounts of air to the tire at intervals to seat the tire beads. Over inflation of*

*small tires can occur in a few seconds.*

*Do not over inflate the tires. Excess pressure can cause the tire to separate from the wheel or explode.*

*Protect face and eyes when removing a tire valve core.*

*Use only sockets made for use with impact wrenches to decrease the risk of injury caused by a broken socket.*

*Do not use tires that have a recommended tire inflation pressure less than the tire pressure recommended in the vehicle owner's guide.*

### Recommended Tire Pressure

Use caution when you inflate the tires. Because of the low volume of the small tires, over inflation can occur in seconds. Over inflation can cause the tire to separate from the wheel or cause a tire explosion.

The general recommended tire inflation pressure is 18-22 psi (124 - 152 kPa). Tire inflation pressure can be adjusted for the condition of the terrain.

For outdoor applications with primary use on areas with grass, consider the following:

- Slightly higher tire inflation pressure is suitable on hard surfaces.
- A lower pressure decreases the risk of tires cutting into turf.

For hard surfaces or pavement, tire inflation pressure must be in the higher allowed range, but not more than recommended on the tire sidewall.

All four tires must have the same pressure for best control qualities. Always install the valve stem cap after you check or inflate the tires.

Tire Pressure Range	Terrain Conditions	Recommendation
18 - 22 psi (124 - 152 kPa)	Hard surfaces or pavement	Inflate to higher pressure within the range; never exceed maximum pressure indicated
	Soft terrain or turf	Inflate to lower pressure within the range to reduce potential damage to the terrain or turf

### Tire Repair

The vehicle is equipped with low-pressure tubeless tires mounted on one piece rims.

The most cost effective way to repair a flat tire with a puncture in the tread portion of the tire is to use a commercial tire plug. For large holes and cuts, replace the tire.

**NOTICE:** *Tire plug tools and plugs are available in automotive outlets. The tire does not have to be removed from the wheel to install a tire plug.*

If the tire is flat, lift the vehicle and remove the wheel. Refer to the SAFETY section for the lifting procedure and safety information. Inflate the tire to maximum recommended pressure. Submerge the tire in water to find the leak, and mark with chalk. Insert the tire plug in accordance with manufacturers specifications.

If the tire is being removed or mounted, the tire-changing machine manufacturers recommendations must be followed to minimize the possibility of personal injury. Be sure to place tire on wheel correctly. The arrow on the tire indicates direction of rotation when moving forward.

**⚠ WARNING**

*To decrease the risk of injury, make sure the mounting/demounting machine is anchored to the floor. Wear*

*OSHA approved safety equipment when mounting/demounting tires.*

Follow all instructions and safety warnings provided by the mounting/demounting machine manufacturer.

# WHEELS AND TIRES

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

## Wheel Installation

### CAUTION

To decrease the risk of component damage, do not tighten lug nuts to more than 85 ft. lbs. (115 Nm) torque.

**NOTICE:** Always follow the cross-sequence pattern when you install the lug nuts to make sure the wheel is evenly seated against the hub.

With the valve stem to the outside of wheel, install the wheel onto the hub with lug nuts.

Finger tighten lug nuts (1) in the cross-sequence pattern as shown (Figure 1). Continue to tighten the lug nuts in 20 ft. lbs. (27 Nm) increments in the cross-sequence pattern until the correct torque value shown below is reached.

Item	Torque Specification
1	50 - 85 ft.lbs. (68 - 115 Nm)

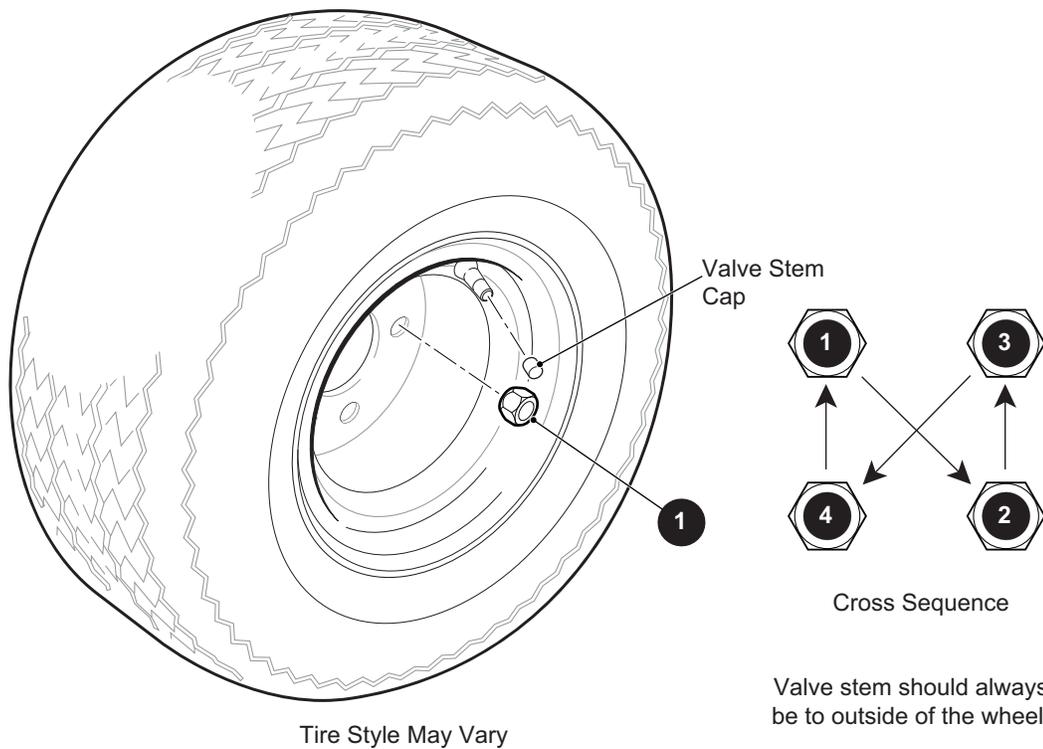


Figure 1 Wheels and Tires

# WHEELS AND TIRES

*Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.*

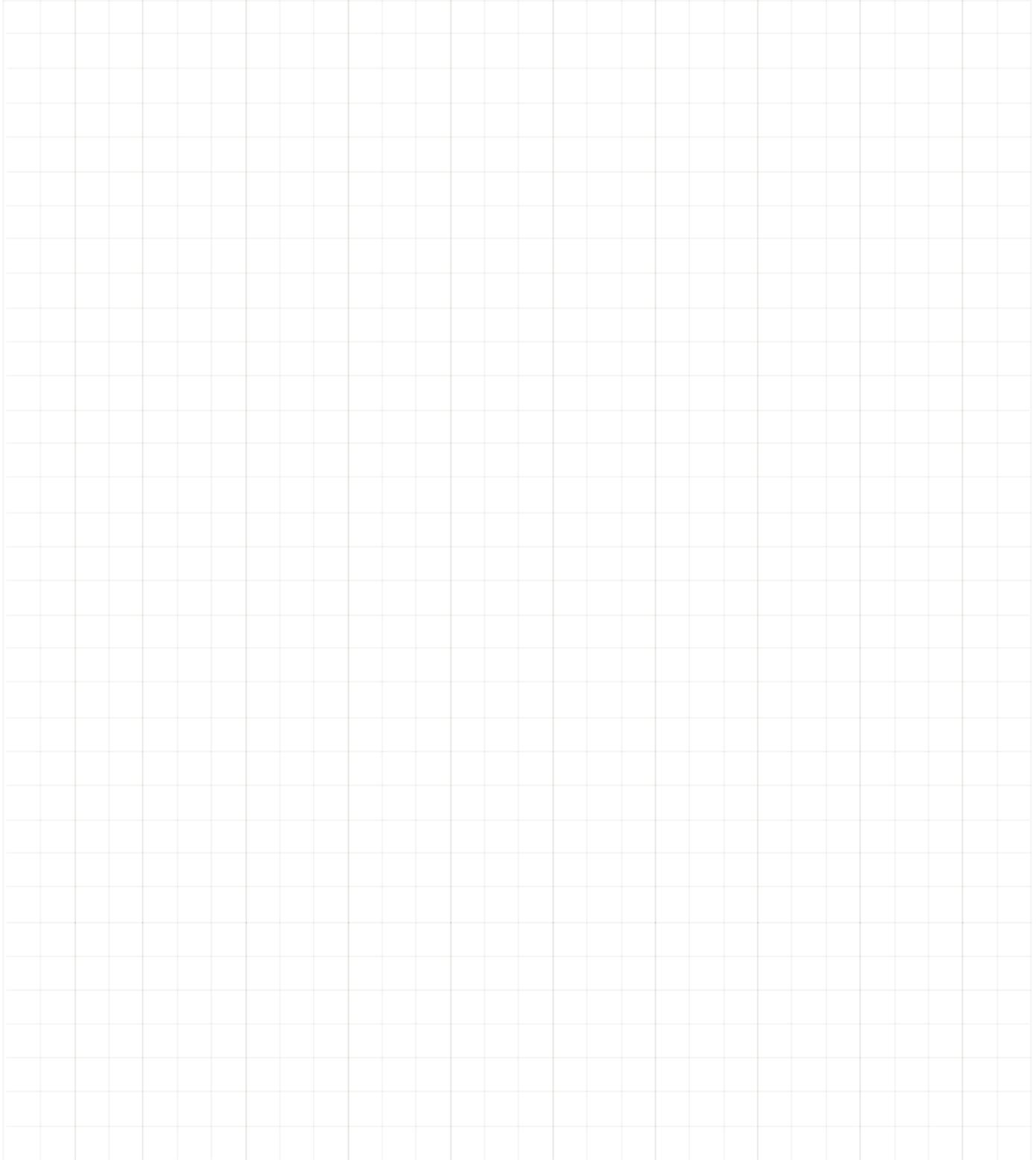
## Notes:

A large grid of graph paper for taking notes, consisting of 20 columns and 30 rows of small squares.

# WHEELS AND TIRES

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

## Notes:

A large grid of graph paper for taking notes, consisting of 20 columns and 30 rows of small squares.

## FRONT SUSPENSION AND STEERING

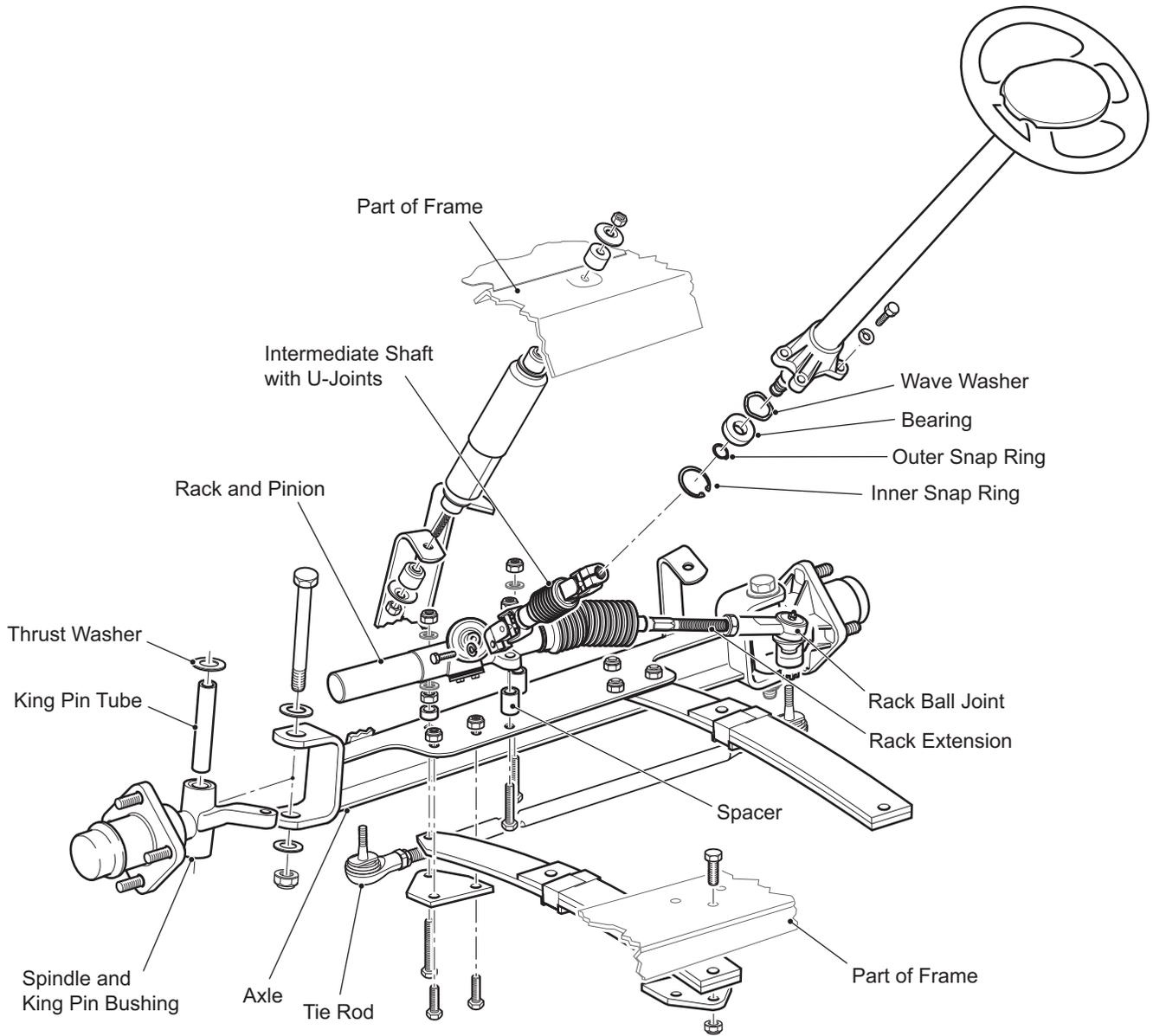


Figure 1 Axle Mounted Steering and Front Suspension

# FRONT SUSPENSION AND STEERING

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

## MAINTENANCE

**NOTICE:** Hardware that is removed must always be installed in its original position unless otherwise specified. If torque values are not specified, refer to the Torque Specifications table in the GENERAL INFORMATION AND ROUTINE MAINTENANCE section.

Routine maintenance of the front suspension and steering consists of:

- Periodic inspections for loose, worn or damaged components
- Alignment checks
- Lubrication of ball joints and wheel bearings

See Lubrication Points in the GENERAL INFORMATION & ROUTINE MAINTENANCE section and Periodic Service Schedule Table in PERIODIC SERVICE SCHEDULE section. Maintain correct adjustment of the front bearings. Repack in accordance with the Periodic Service Schedule, or if a bearing replacement is required. Routine examination of tires provides indications of a required alignment.

## Lubrication

### Tool List

	Quantity
Grease Pump .....	1
Shop Towels .....	AR

Apply grease to the rack ball joint (1) (Figure 2). Wipe off old grease and dirt from the grease fitting. Do not use more than three (3) pumps of grease in any grease fitting. Wipe off grease that is forced out of the rubber boot.

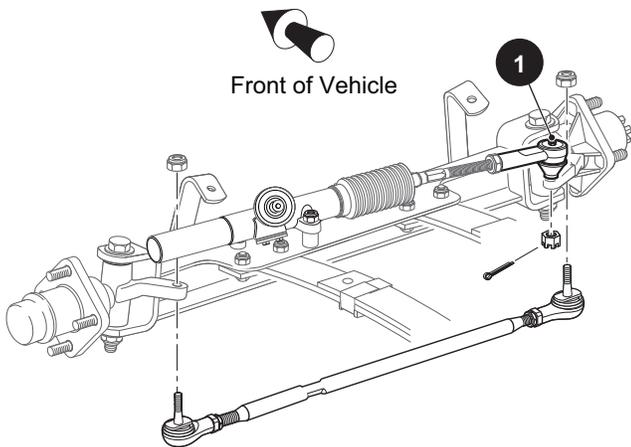


Figure 2 Lubrication Points

**CAUTION** Do not use more than three (3) pumps of grease in any grease fitting at any one time. Excess grease can cause grease seals to fail, or grease to move into areas that could damage components.

## Wheel Bearing and King Pin Bushing Inspection

**WARNING** To decrease the risk of possible injury or death resulting from a vehicle falling from a jack, follow the lifting procedure in SAFETY section of this manual. Be sure vehicle is on a firm and level surface.

**Never get under a vehicle while it is supported by a jack. Use jack stands and test stability of vehicle on stands before starting any repair procedure. Always place chocks in front and behind wheels not being raised. Use extreme care since the vehicle is extremely unstable during the lifting process.**

Lift the front of the vehicle and support on jack stands as instructed in SAFETY section. Observe all warnings.

Rotate the front wheel and feel for any roughness. While holding spindle with one hand, grasp bottom of tire with other hand and rock tire back and forth on the spindle.

**NOTICE:** Some minor rocking movement of tire is normal.

If excess movement is detected, the wheel bearing may require repacking/adjusting or replacement. For instructions on wheel bearing packing and wheel bearing adjustment, See *Wheel Bearing Packing*.

If the wheel bearing is in good condition, a worn spindle bearing is indicated. The spindle bearings cannot be replaced. Spindles with pre-installed bearings are available through service parts department. See *Spindle Replacement*.

## Wheel Bearing Packing

### Tool List

	Quantity
Grease Pump.....	1
Bearing Packer (Recommended).....	1
Shop Towels.....	AR

Lift the front of the vehicle and support on jack stands as instructed in SAFETY section. Observe all warnings.

Remove the hub assembly (1) from the spindle and disassemble (Figure 3).

Clean all bearings (2), grease seal (3), hub (4) and dust cap (5) in solvent (Figure 3). Dry thoroughly.

Inspect bearings for signs of damage. Pitting or a blue coloration of the rollers indicates bearing replacement is necessary. If the roller portion of the bearing is to be replaced, the race must also be replaced. (Figure 11).

# FRONT SUSPENSION AND STEERING

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

The front wheel bearings are tapered roller type and must be packed with grease at installation or any time the bearing is removed for inspection.

It is recommended that a bearing packer attached to a grease pump be used; however, manual packing is acceptable if done correctly.

To pack a bearing manually, place a dab of grease in palm of hand and dip bearing in grease. Force the grease up through and around all of the rollers until the entire bearing is saturated in grease.

Assemble hub and install on spindle. See *Hub Replacement*.

**NOTICE:** Once hub is placed onto spindle and before outer wheel bearing is installed, fill the area between the inner and outer wheel bearings 1/2 - 3/4 full with grease.

Replace dust cap (5) (Figure 3) and lower the vehicle as instructed in the SAFETY section.

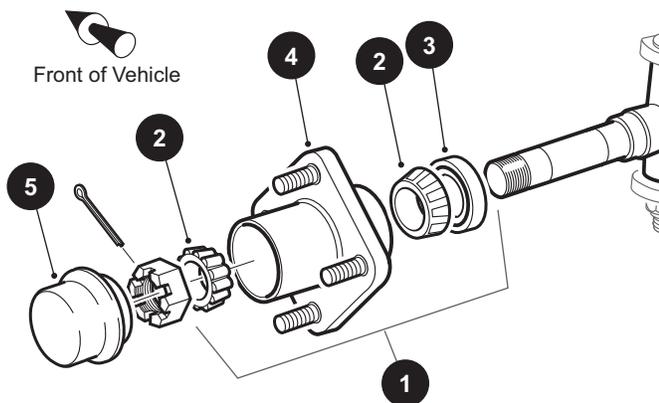


Figure 3 Pack Wheel Bearing

## Wheel Bearing Adjustment

Tool List	Quantity
Socket, 1 1/2" .....	1
Ratchet .....	1

If performing a wheel bearing adjustment only, lift and support front of vehicle as instructed in SAFETY section. Observe all warnings.

Remove the dust cap (1) and the cotter pin (2). Loosen the castellated nut (3) (Figure 4).

If performing a wheel bearing adjustment as part of another procedure, make sure wheel is mounted to the hub hand tight with lug nuts (4), and hub is loosely retained on spindle (5) with the castellated nut (Figure 4).

Seat the bearings by rotating wheel while tightening castellated nut until slight resistance is felt.

Rotate the wheel two to three more turns to displace

excess grease. If required, tighten the castellated nut (3) again until slight resistance is felt. If the cotter pin hole in the spindle (5) aligns with a slot in the castellated nut, insert a new cotter pin (2). If the hole does not align, **loosen** the castellated nut to align with the **closest available** slot in the nut.

Check for smooth and free rotation of the wheel, and an absence of play when the wheel is grasped by the outside of the tire. Bend the cotter pin (2) against the flats of the castellated nut (3).

Replace the dust cap (1) and lower the vehicle as instructed in the SAFETY section.

If completing a wheel bearing adjustment as part of another procedure, tighten front wheels as instructed in the WHEELS AND TIRES section.

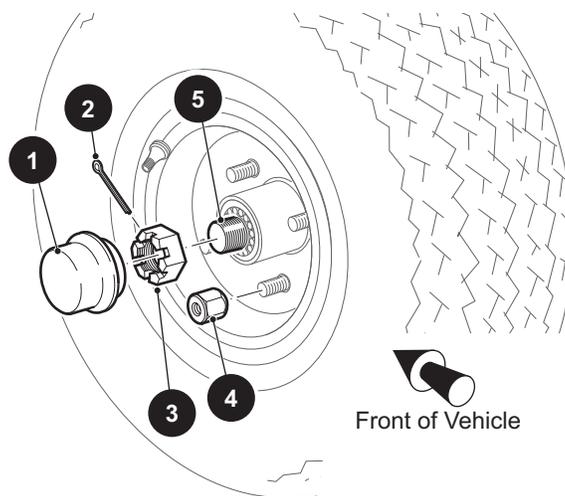


Figure 4 Bearing Adjustment

## Wheel Alignment

Tool List	Quantity
Measuring Tape .....	1
Chalk.....	1
Wrench, 9/16" .....	1
Wrench, 3/4" .....	1
Crowfoot Socket, 3/4" .....	1
Torque Wrench, ft. lbs. ....	1
Socket, 13 mm, .....	1
Ratchet .....	1
Torque Wrench, in. lbs. ....	1

Lift and support front of the vehicle as instructed in the SAFETY section. Observe all warnings.

Confirm the alignment of the front springs. See *Front Spring Replacement* for procedures.

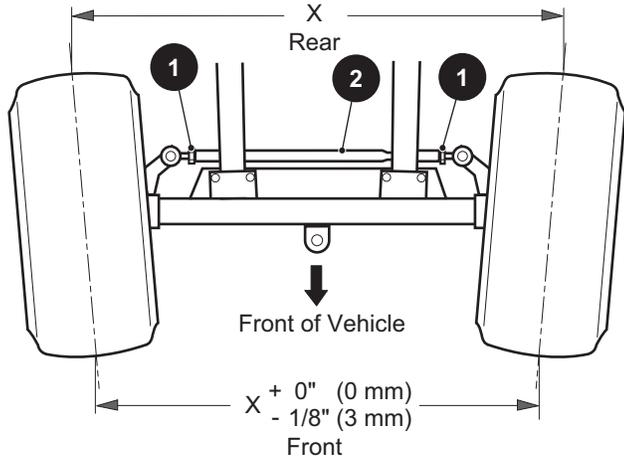
Rotate each wheel and scribe a chalk line around the circumference of the tire at the center of the tread pattern.

# FRONT SUSPENSION AND STEERING

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

Lower vehicle and, with tires in the straight ahead position, roll it forward approximately five feet in order to allow the tires to take their normal running position.

Measure the distance between the chalk lines at both the front and rear of the tires (Figure 5). The measurement taken at the front of the tires should be 0" - 1/8" (0 - 3 mm) less than the rear.



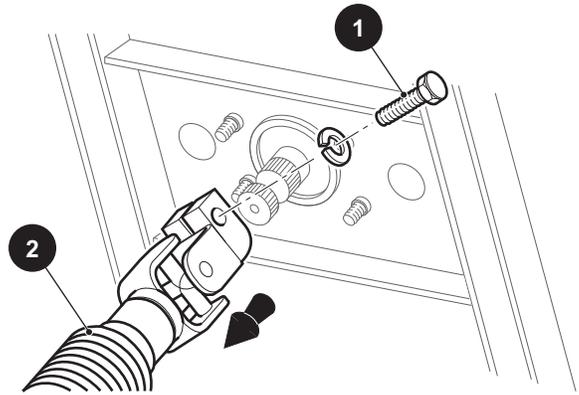
**Figure 5 Wheel Alignment**

**NOTICE:** Use a wrench on the center, flat section of the tie rod to hold the tie rod while loosening the jam nut.

**NOTICE:** The tie rod has different threads on each end. The end with the flat area has left hand threads (clockwise to loosen) while the end without the flat has conventional right hand threads (counter-clockwise to loosen).

To adjust wheel alignment, loosen tie rod jam nuts (1) and turn tie rod (2) until correct alignment is achieved (Figure 5). Tighten jam nuts (1) to the torque value specified below.

Item	Torque Specification
1	35 - 45 ft. lbs. (47 - 61Nm)



**Figure 6 Disconnect Intermediate Shaft to Center Steering Wheel**

Test drive vehicle to confirm steering wheel is correctly centered. If it is not centered, remove bolt (1) to disconnect intermediate shaft (2) from steering shaft and center steering wheel (Figure 6).

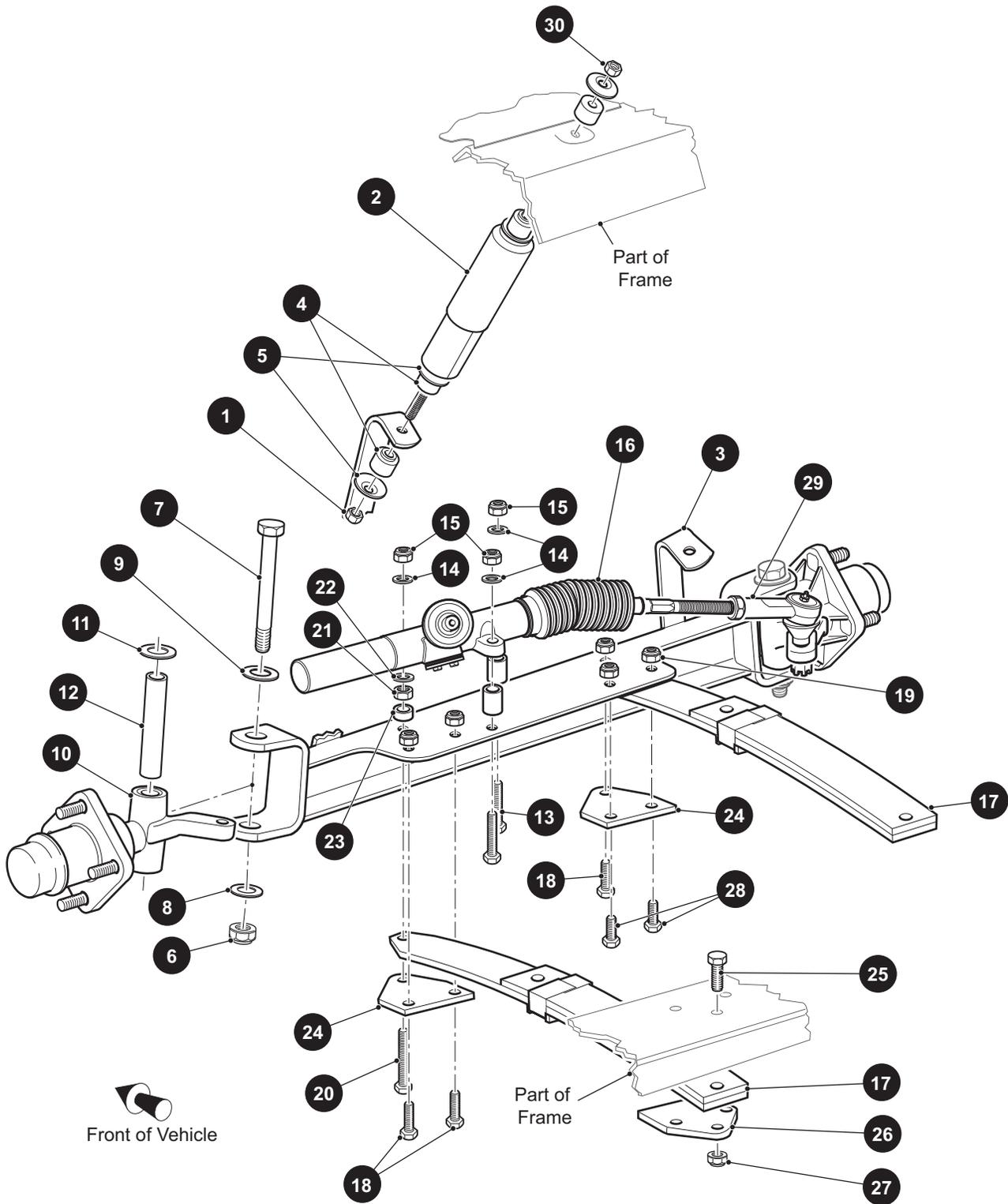
Reconnect intermediate shaft and tighten bolt (1) to the torque value specified below.

Item	Torque Specification
1	13 - 18 ft. lbs. (18 - 24 Nm)

# FRONT SUSPENSION AND STEERING

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

## FRONT SUSPENSION



\*NOTE: Tie Rod Not Shown for Clarity

Figure 7 Front Suspension Components

# FRONT SUSPENSION AND STEERING

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

## Front Shock Absorber Replacement

### Tool List Quantity

Wrench, 9/16" ..... 1

Remove the nut (1) from the bottom of the shock absorber (2) at the front axle (3) (Figure 7).

Compress shock absorber to clear the mounting bracket.

Loosen the nut (30) securing the top of the shock absorber to the vehicle frame, then rotate the shock absorber while holding the nut in place with a wrench.

Remove the shock absorber.

Install the new shock absorber in the reverse order of removal. The mounting nuts should be tightened until the rubber bushings (4) expand to the diameter of the shock absorber washers (5).

## Front Axle Replacement

### Tool List Quantity

Ratchet ..... 1

Socket, 3/4" ..... 1

Wrench, 9/16" ..... 1

Wrench, 3/4" ..... 1

Plastic Faced Hammer ..... 1

Shop Towels ..... AR

Wire ..... AR

Wrench, 5/8" ..... 1

Wrench, 11/16" ..... 1

Socket, 9/16" ..... 1

Socket, 5/8" ..... 1

Torque Wrench, ft. lbs. .... 1

Loosen front wheel lug nuts. Lift and support the front of the vehicle as instructed in the SAFETY section. Observe all warnings.

Remove the lug nuts and the front wheels.

Remove hardware (1, 4, 5) securing the shock absorber (2) to front axle (3) (Figure 7).

On driver side, remove the lock nut (6) and washer (8) from the bolt (7). Discard the nut. Remove the bolt (7) and washer (9) from the spindle (10) and separate the spindle from the axle (3).

Remove the thrust washer (11) and king pin tube (12) from the spindle. Wrap a towel around the spindle and let the spindle rest on the ground.

Repeat the procedure on the passenger side allowing the rack ball joint (29) to rest on the front spring to support spindle.

**⚠ WARNING** *To decrease the risk of possible injury from falling steering components, secure the rack and pinion unit (16) to the front springs with wire. This will decrease the intermediate shaft connecting the rack*

*and pinion unit to the steering column from pulling apart due to the weight of the steering system.*

**NOTICE:** *The intermediate shaft is assembled with the universal joints set 90° out of phase with each other.*

Remove the hardware (13, 14, 15) securing the rack and pinion unit (16) to the front axle. Discard the lock nuts (15). Move the rack and pinion unit back to rest on top of the front springs (17).

Secure the rack and pinion unit to the spring with wire to decrease the risk of pulling apart intermediate shaft.

Remove three bolts (18), two bolts (28), spring plate (24) and five lock nuts (19) securing axle (3) to the springs. Discard the lock nuts (15, 19). At the bolt (20) securing front of the left spring (17), note the location of the washer (22) and remove it from the end of the bolt.

Remove the nut (21), bolt (20), spring plate (24) and spacer (23). Retain for assembly at their original locations.

**⚠ CAUTION** *To decrease the risk of stress and possible damage to the rack and pinion unit, the axle (3) must first be mounted to the springs with the hardware (20 - 23) installed in its original location (Figure 7).*

To decrease the risk of damage to the bellows (16), the two bolts (28) must be installed in their original location.

Install front axle (3) in the reverse order of removal using new lock nuts (15, 19). All hardware (18 - 24, 28) must be installed in its original location (Figure 7).

Assemble the leaf spring, rack and pinion unit hardware (13 - 15, 18 - 21, 28) as shown in (Figure 7). Tighten nuts (15, 19, 21) to the torque value specified below.

Item	Torque Specification
15, 19, 21	35 - 50 ft. lbs. (47 - 68 Nm)

Install thrust washers (11), king pin tubes (12), spindles, washers (9) and bolts (7). Tighten new lock nuts (6) to the torque value specified below.

Item	Torque Specification
6	56 - 70 ft. lbs. (75 - 95 Nm)

Check that the spindle turns freely on the king pin tube after tightening.

Tighten the shock absorber mounting hardware until the rubber bushings expand to the diameter of the shock absorber washer.

Install front wheels per the WHEELS AND TIRES section and lower vehicle per the SAFETY section.

# FRONT SUSPENSION AND STEERING

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

Check the front wheel alignment and adjust if necessary. See *Wheel Alignment*.

## Front Spring Replacement

Tool List	Quantity
Jack Stands.....	4
Ratchet.....	1
Socket, 3/4".....	1
Socket, 5/8".....	1
Wrench, 5/8".....	1
Torque Wrench ft. lbs. ....	1
Measuring Tape.....	1

**NOTICE:** Failure of a single spring will result in over-stressing the other spring; therefore, replace front springs as a set. The following procedure will replace one spring at a time.

Loosen the front wheel lug nuts.

Lift and support the front of the vehicle as instructed in the SAFETY section. Observe all warnings.

Remove front wheels.

To detach driver side spring:

Loosen the two rack and pinion unit lock nuts (15) (one near the bellows and one on the rear side of the rack and pinion unit) until only one thread is engaged (Figure 7).

Remove the lock nut (15) and washer (14) from the bolt (20). Discard lock nut. The rack and pinion unit is now loose.

Remove the two bolts (18) and lock nuts (19) securing the driver side spring to the axle. Discard the lock nuts (19).

Hold the nut (21) with a wrench and loosen the bolt (20). Note the location of the washer (22) and thread the long bolt out as far as possible to remove the washer, nut and spacer (23).

Remove the bolt and spring plate (24) from the axle and spring. Retain items (20 - 24) for installing at their original locations.

Pull the driver side of the floor mat out of plastic trim retainer and away from floor. Locate and remove the hardware (25 - 27) securing rear of the spring (17) to the vehicle frame. Discard the lock nuts (27).

**CAUTION** To decrease the risk of stress and possible damage to the rack and pinion unit, the driver side spring must be mounted to the axle with the hardware (20 - 23) installed in its original location (Figure 7).

Install driver side spring in the reverse order of removal. Install the bolt (20), spring plate (24), spacer (23), nut (21) and washer (22) in their original locations.

Use new lock nuts (15, 19, 27) to secure the rack and pinion unit (16), two bolts (18) and rear bolts (25).

To detach passenger side spring:

Remove the hardware (18, 19, 24, 28) securing the front of the passenger side leaf spring (17) to the axle (3). Discard lock nuts (19) (Figure 7).

Pull the passenger side of the floor mat out of the plastic trim retainer and away from the floor. Locate and remove the hardware (25 - 27) securing the rear of the spring (17) to the vehicle frame. Discard the lock nuts (27).

Install the spring in the reverse order of removal using new lock nuts (19, 27).

**NOTICE:** After the springs are replaced, the axle will need to be aligned to the frame. Unless the axle has been replaced, wheel alignment will not be affected; however, it is always good practice to check wheel alignment any time the front-end components are replaced or adjusted.

When the front springs are replaced, the front axle must be aligned to the frame.

The distance from the center bolt at the rear left spring to the center bolt at the front right spring, must be an equal distance as the center bolt at the rear right spring to center bolt at the front left spring (Figure 8).

Tighten the nuts (21, 19, 27) securing the spring (18).

Tighten the rack and pinion unit hardware (15) to the torque value specified below.

Item	Torque Specification
15	35 - 50 ft. lbs (47 - 68 Nm)
21, 19, 27	35 - 50 ft. lbs. (47 - 68 Nm)

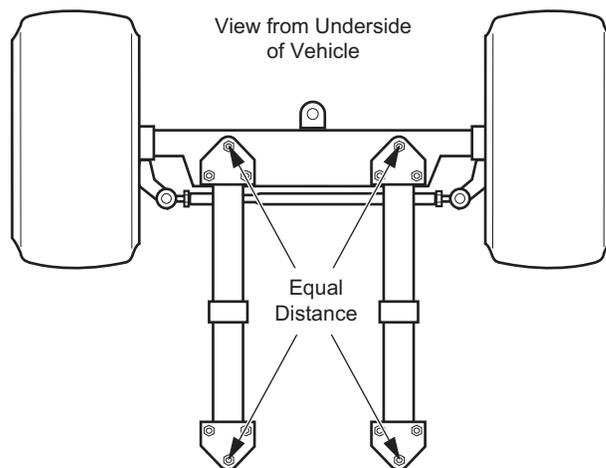


Figure 8 Front Axle Alignment

# FRONT SUSPENSION AND STEERING

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

Replace the upper portion of the floor mat in the plastic trim retainers. Install the front wheels per the WHEELS AND TIRES section and lower the vehicle per the SAFETY section.

Check the front wheel alignment. Adjust if necessary. See *Wheel Alignment*.

## Hub Replacement

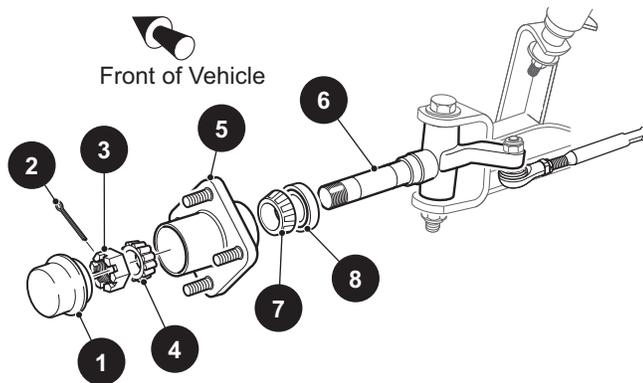
Tool List	Quantity
Socket, 3/4"	1
Ratchet	1
Straight Blade Screwdriver	1
Ball Peen Hammer	1
Needle Nose Pliers	1
Socket, 1 1/2"	1
Wheel Bearing Grease	AR
Seal Driver	1

Loosen the front wheel lug nuts.

Lift and support the front of the vehicle as instructed in the SAFETY section. Observe all warnings.

Remove the lug nuts and front wheels from the hubs.

Remove the dust cap (1), cotter pin (2) and castellated nut (3) (Figure 9).



**Figure 9 Hub Replacement**

While holding outer wheel bearing (4) in place, slide the hub (5) from the spindle (6) and discard.

Clean the spindle and the new hub thoroughly with solvent.

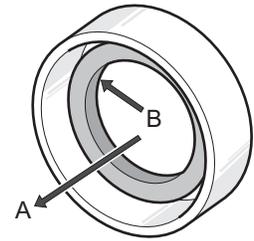
Pack the new bearings with grease. See *Wheel Bearing Packing*.

Apply a light coat of grease to the inner race and place the inner wheel bearing (7) in the hub.

Orient the new grease seal (8) so the flange side of the seal is facing into the bore. Tap gently into place until the seal is flush with end of the hub.

Lubricate the lips of the seal and spindle with grease (Figure 10).

- A - Install this side of seal into housing
- B - Lubricate lip of seal



**Figure 10 Seal Installation**

Place the new hub onto the spindle and fill the area between the two wheel bearings 1/2 - 3/4 full with grease. Apply a light coating of grease to the outer bearing race.

Install the outer wheel bearing (4) and secure the hub loosely with the castellated nut. Place the wheel onto the hub and hand tighten the lug nuts.

Adjust the bearing. See *Wheel Bearing Adjustment*.

Replace the dust cap (1).

Lower vehicle per the SAFETY section. Tighten the front wheel(s) per WHEELS AND TIRES section.

## Wheel Bearing and Race Replacement

Tool List	Quantity
Non-Ferrous Punch	1
Ball Peen Hammer	1
Bearing Driver	1

Remove the hub (1) from the spindle (Figure 11). See *Hub Replacement*.

Remove the grease seal (3), inner wheel bearing (4) and bearing races (5) by tapping (through the other side of hub) the bearing race with a hammer and soft non-ferrous punch. Tap race in a circular pattern while moving from side to side to avoid damaging the bore of the hub.

Clean the outer wheel bearing (6), inner wheel bearing (4), hub and dust cap (7) in solvent and dry thoroughly. Inspect for signs of damage. Pitting or a blue coloration of the rollers indicates bearing replacement is required. If the roller portion of the bearing is to be replaced, the race must also be replaced.

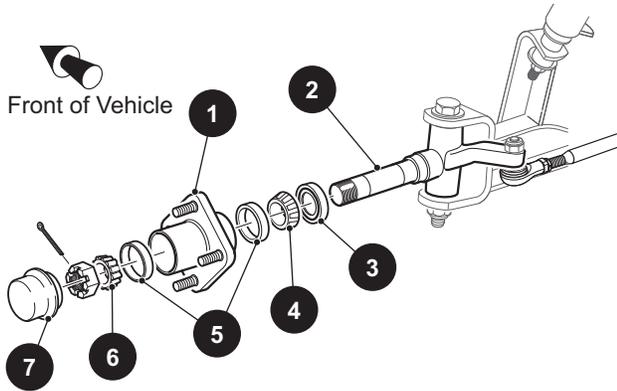
To install the race (5).

Make sure the bore of hub (1) is clean. Place the new race over the bore of the hub. Tap the race evenly with a hammer and bearing driver to drive the race fully into the bore. Repeat on the other side of the hub.

Clean the spindle (2) and pack the new bearings with grease. See *Wheel Bearing Packing*.

# FRONT SUSPENSION AND STEERING

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.



**Figure 11 Wheel Bearing Replacement**

Install the inner wheel bearing (4) and the new grease seal in the hub. Mount the hub to the spindle. To adjust the wheel bearing. See *Wheel Bearing Adjustment*.

Replace the dust cap (7).

Lower vehicle per the SAFETY section. Tighten the front wheel(s) per the WHEELS AND TIRES section.

# FRONT SUSPENSION AND STEERING

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

## STEERING

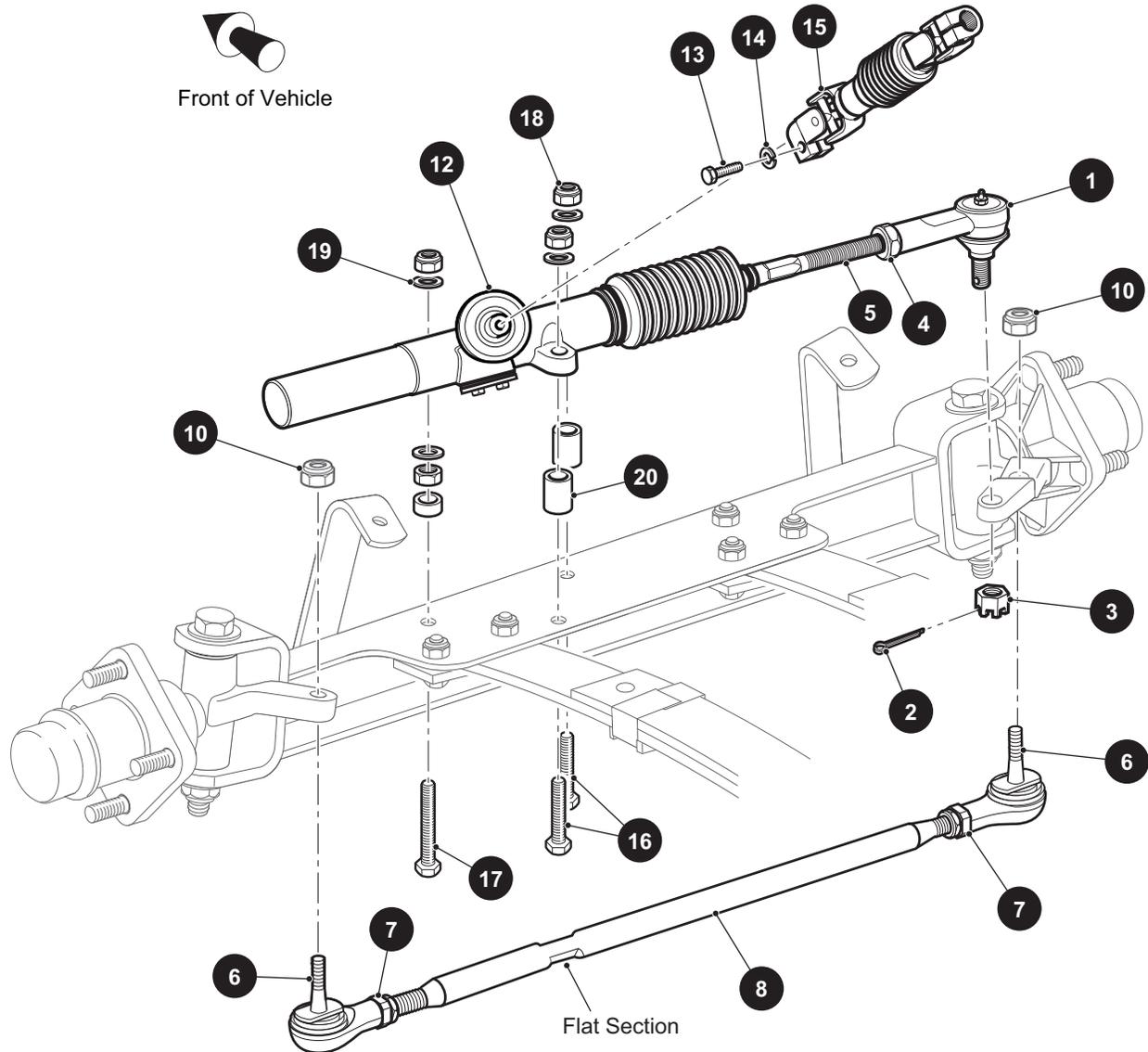


Figure 12 Steering Components

### Rack Ball Joint Replacement

#### Tool List

	Quantity
Needle Nose Pliers .....	1
Wrench, 11/16" .....	1
Ball Joint Separator .....	1
Plastic Faced Hammer .....	1
Measuring Tape .....	1
Wrench, 3/4" .....	1
Torque Wrench, ft. lbs.....	1
Socket, 11/16".....	1

To remove the rack ball joint (1), loosen the lug nuts on passenger side front wheel. Lift and support the front of

the vehicle per SAFETY section (Figure 12).

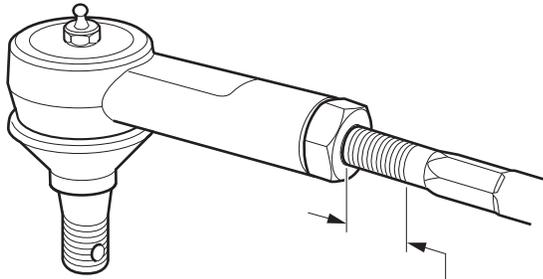
Remove the passenger side front wheel and turn steering wheel fully to the left.

Remove the cotter pin (2) and loosen the castellated nut (3) until the rack ball joint (1) threads are protected. Using a ball joint separator as a lever, apply pressure to the ball joint and tap the nut with a plastic faced hammer to release the ball joint from the spindle arm. Remove the nut from the ball joint and the spindle arm.

Measure the length of the exposed threads past the jam nut. Adjust the jam nut to the same location on the new ball joint (Figure 13).

# FRONT SUSPENSION AND STEERING

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.



Measure exposed thread length.  
Use measured length to position new ball joint at same location.

**Figure 13 Rack Ball Joint Installation**

Loosen the jam nut (4) and remove the ball joint from the rack extension (5).

Using the measurement made earlier, thread the jam nut (4) and the new ball joint (1) onto the rack extension. Set the jam nut (4) finger tight against the ball joint (1).

Attach the ball joint (1) to the spindle arm. Tighten the castellated nut (3) to the torque value specified below. Check to see if a cotter pin (2) can be inserted through the ball joint stud. If the hole does not line up with the slots in the nut, continue to tighten until a new cotter pin (2) can be installed through the nut and stud.

Item	Torque Specification
4	35 - 45 ft. lbs. (47 - 61 Nm)
3	36 - 50 ft. lbs. (49 - 68 Nm)

**CAUTION** After replacing or servicing steering components, verify that a 1/8" gap exists between large hex of the rack extension and the rack and pinion unit when the steering is turned fully to the right (Figure 20).

Check for proper rack extension-to-rack and pinion unit clearance before tightening the jam nut (4) to the torque value specified below.

Item	Torque Specification
4	35 - 45 ft. lbs. (47 - 61 Nm)

See *Checking/Adjusting Rack Extension-to-Rack and Pinion Unit Clearance*.

Install the passenger side front wheel per the WHEELS AND TIRES section. Lower vehicle per the SAFETY section.

Check the front wheel alignment and adjust if necessary. See *Wheel Alignment*.

## Tie Rod Inspection/Replacement

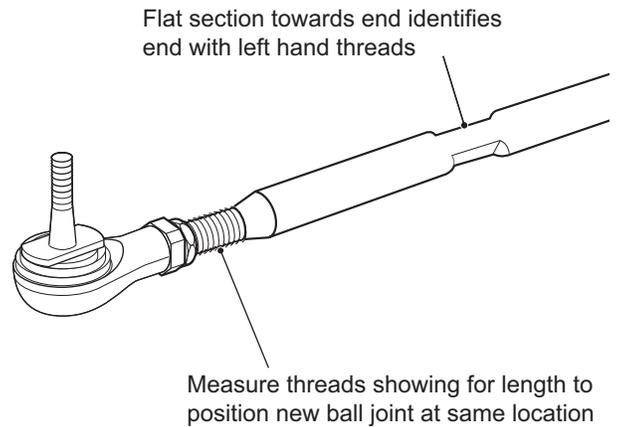
Tool List	Quantity
Measuring Tape .....	1
Wrench, 3/4" .....	1
Wrench, 9/16" .....	1
Needle Nose Pliers .....	1
Wrench, 11/16" .....	1
Ball Joint Separator .....	1
Plastic Faced Hammer .....	1
Socket, 11/16" .....	1
Torque Wrench, ft. lbs. ....	1
Crowfoot Socket, 3/4" .....	1

Grasp the tie rod (8) at the ball joints (6) and check for any vertical motion which would indicate a worn condition and necessitate replacement (Figure 12).

To remove the tie rod, loosen the front wheel lug nuts. Lift and support the front of the vehicle per the SAFETY section.

Remove the lug nuts and the front wheel.

Measure the exposed thread length at the jam nuts (7). Use this dimension to position the rod ends on the new tie rod.



**Figure 14 Tie Rod Replacement**

**NOTICE:** The tie rod has different threads on each end. The end with the flat area has left hand threads (clockwise to loosen) while the end without the flat has conventional right hand threads (counter-clockwise to loosen).

Loosen the lock nut (10) until the tie rod ball joint (6) threads are protected. Using a ball joint separator as a lever, apply pressure to the ball joint and tap the nut with a plastic faced hammer to release the tie rod from the spindle arm. Remove the nut (10) to drop the tie rod from the spindle arm.

Remove the ball joint (6) from the tie rod tube.

# FRONT SUSPENSION AND STEERING

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

**NOTICE:** Use the measurement taken earlier to the position the rod end on the tie rod tube.

The rod ends should have an equal amount of thread exposed.

Install the rod end in the spindle and secure with a lock nut (10). Tighten the lock nut to the torque value specified below.

Item	Torque Specification
10	35 - 50 ft. lbs. (47 - 68 Nm)

Install the front wheel(s) per the WHEELS AND TIRES section. Lower the vehicle per the SAFETY section.

A worn tie rod is likely to have caused incorrect wheel alignment. Check the front wheel alignment and adjust if necessary. See *Wheel Alignment*.

Tighten the jam nut (7) to torque value specified below.

Item	Torque Specification
7	36 - 40 ft. lbs. (49 - 54 Nm)

## Bellows Replacement

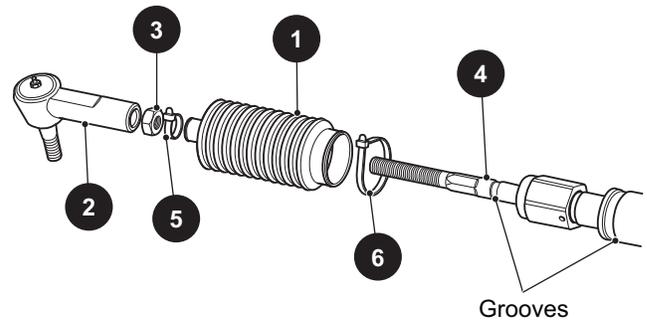
Tool List	Quantity
Needle Nose Pliers.....	1
Wrench, 11/16".....	1
Ball Joint Separator.....	1
Plastic Faced Hammer.....	1
Measuring Tape.....	1
Wrench, 3/4".....	1
Wire Cutters.....	1
Wire Tie, 8" Long.....	1
Torque Wrench, ft. lbs.....	1
Socket, 11/16".....	1

To replace bellows (1) (Figure 15), loosen passenger side front wheel. Lift and support the front of the vehicle per the SAFETY section.

Remove passenger side front wheel and turn steering wheel fully to the left.

Remove the ball joint (2) and jam nut (3) from the rack extension (4). See *Rack Ball Joint Replacement*.

Cut the wire ties (5, 6) and slide the bellows off the rack extension. Install the new bellows, align the small end over the groove in the rack extension and secure with new wire tie (5). Leave the large end of the bellows loose until rack extension-to-rack and pinion unit clearance is checked or adjusted.



**Figure 15 Bellows Replacement**

Install the jam nut (3) and ball joint (2) from the rack extension (4). See *Rack Ball Joint Replacement*.

**CAUTION** After replacing or servicing steering components, always verify that a 1/8" gap exists between large hex of the rack extension and the rack and pinion unit when the steering is turned fully to the right forcing passenger spindle arm against front axle.

Check for proper rack extension-to-rack and pinion unit clearance before tightening jam nut (3) to the torque value specified below.

Item	Torque Specification
3	35 - 45 ft. lbs. (47 - 61 Nm)

See *Checking/Adjusting Rack Extension-to-Rack and Pinion Unit Clearance*.

Install passenger side front wheel per the WHEELS AND TIRES section. Lower vehicle per the SAFETY section.

Check front wheel alignment and adjust if necessary. See *Wheel Alignment*.

## Pinion Seal Replacement

Tool List	Quantity
Vice.....	1
Straight Blade Screwdriver, Small.....	1
Ball Peen Hammer.....	1
Sandpaper, 600 Grit.....	AR
Shop Towel.....	AR
Wheel Bearing Grease.....	AR
Socket, 1 1/2".....	1

**CAUTION** To avoid damage to the aluminum rack and pinion unit, secure unit in vice by the mounting ears only.

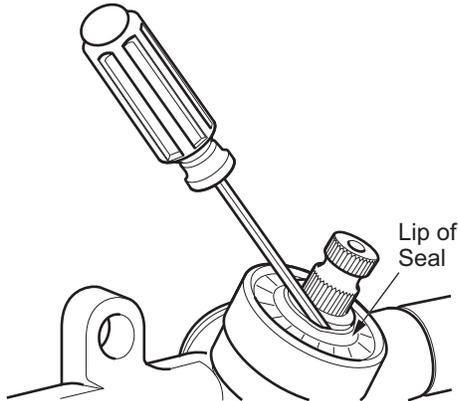
To access the pinion seal, remove the rack and pinion unit from the vehicle. See *Rack and Pinion Unit Replace-*

# FRONT SUSPENSION AND STEERING

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

ment. Anchor in vice by clamping on the mounting ears of the rack and pinion unit.

Slide a small straight blade screwdriver between lip of seal and pinion and pry top portion of seal up to remove (Figure 16).



**Figure 16 Pinion Seal Replacement**

Use the screwdriver to lift the inner portion of the seal up and off the pinion.

Check the pinion surface for roughness, and sand lightly if needed.

**NOTICE: Wipe bore clean and lubricate pinion and lip of seal with grease. The bore has a positive stop to correctly locate the seal during installation.**

Place the seal over the pinion and tap carefully with socket and hammer to start the seal straight in bore. Drive the seal fully into the bore until it stops, wipe clean of any excess grease.

Attach the rack and pinion unit to the front axle. See *Rack and Pinion Unit Replacement*.

## Spindle Replacement

Tool List	Quantity
Needle Nose Pliers.....	1
Wrench, 11/16" .....	1
Ball Joint Separator .....	1
Plastic Faced Hammer .....	1
Wrench, 3/4" .....	1
Socket, 3/4" .....	1
Socket, 11/16" .....	1
Torque Wrench, ft. lbs. ....	1

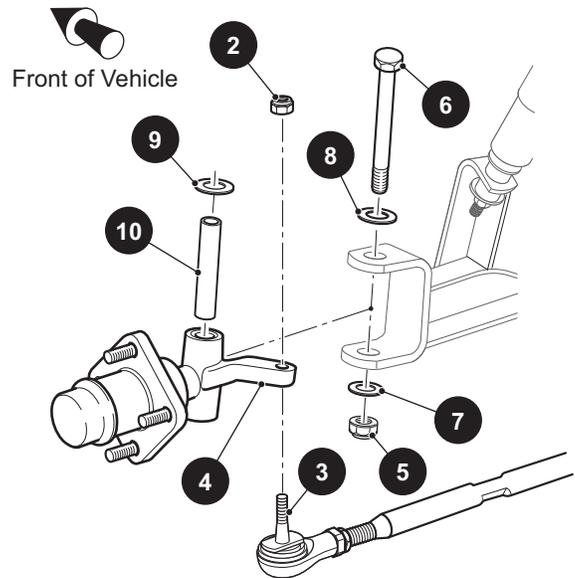
**CAUTION** The spindle bearings are designed to be used "dry". Lubrication attracts dirt and will ruin the bearings. Do not apply grease to the spindle bearings.

Loosen the front wheel lug nuts. Lift and support the front of the vehicle per the SAFETY section. Remove the lug nuts and the front wheel.

To remove the tie rod, loosen the lock nut (2) until the tie rod ball joint (3) threads are protected (Figure 17). Using a ball joint separator as a lever, apply pressure to the ball joint and tap the nut with plastic faced hammer to release tie rod from spindle arm (4). Remove the nut from the tie rod and the tie rod from the spindle arm.

Remove the lock nut (5) and washer (7) from the bolt (6). Discard the nut. Pull the bolt (6) and washer (8) from the spindle and separate the spindle from the axle. Remove the thrust washer (9) and king pin tube (10) from the spindle.

Install the spindle in the reverse order of removal.



**Figure 17 Spindle Replacement**

**NOTICE: The thrust washer (9) is located on top of the spindle between the spindle and the front axle.**

Tighten the new lock nut (2, 5) to the torque value specified below. Check that the spindle turns freely on the king pin tube after tightening.

Item	Torque Specification
2	35 - 50 ft. lbs. (47 - 68 Nm)
5	56 - 70 ft. lbs. (76 - 95 Nm)

# FRONT SUSPENSION AND STEERING

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

Install the front wheels per the WHEELS AND TIRES section. Lower the vehicle per the SAFETY section.

Check the front wheel alignment and adjust if necessary. See *Wheel Alignment*.

## Rack and Pinion Unit Disassembly and Inspection

Tool List	Quantity
Vice.....	1
Socket, 3/8".....	1
Ratchet.....	1
Wrench, 11/16".....	1
Wrench, 3/4".....	1
Wire Cutter.....	1
Retaining Ring Pliers.....	1
Shop Towel.....	AR
CITGO Lithoplex MP No. 2 grease.....	AR
Wire Tie, 8" Long.....	1
Wire Tie, 10" Long.....	1
Torque Wrench, in. lbs.....	1

**NOTICE:** The rack and pinion gears are not serviceable items. If they are found to be damaged or excessively worn, a new rack and pinion unit must be installed.

**CAUTION** To avoid damage to the aluminum rack and pinion unit, secure the unit in vice by the mounting ears only.

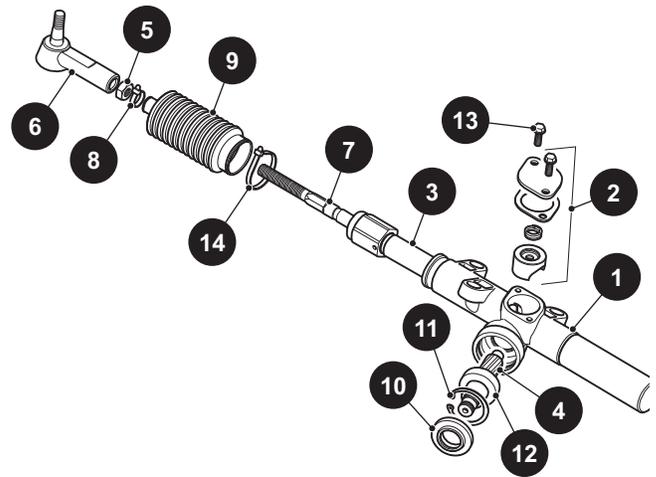
Remove the rack and pinion unit from the vehicle. Anchor the unit in vice by clamping on the mounting ears of the unit.

Disassemble the rack and pinion unit (1) by removing screws (13) and tensioner (2) to relieve pressure on rack (3) and pinion (4) (Figure 18).

Loosen the jam nut (5) and remove the ball joint (6) from the rack extension (7). Cut the wire ties (8, 14) securing the bellows (9) off of the rack extension. Pull the rack (3) from the unit (1).

Remove the pinion seal (10). See *Pinion Seal Replacement*.

Remove the internal retaining ring (11) from the rack and pinion unit, pull out the pinion (4) and ball bearing (12) as an assembly.



**Figure 18 Rack and Pinion Unit Disassembly**

Clean the rack, pinion and housing. Inspect the gear teeth, bearing surfaces and the grease seal surfaces of the unit for excessive wear or damage. If any damage or excessive wear is found, the rack and pinion unit **must** be replaced as an assembly. See *Rack and Pinion Unit Replacement*.

If the rack and pinion is still serviceable, clean the components thoroughly and lubricate with CITGO Lithoplex MP No.2 grease.

Assemble the rack and pinion unit by installing the pinion in the reverse order of removal. Make sure to lubricate the pinion seal lip prior to installing the seal. See *Pinion Seal Replacement*.

Insert the rack into the rack and pinion unit. Turn the pinion clockwise to help pull the rack in, if necessary. Install the bellows. Secure to the rack extension with wire tie (8).

**Do not** secure the large end of bellows to rack and pinion unit until instructed to do so after setting proper rack extension-to-rack and pinion unit clearance. Install tensioner and tighten bolts (13) to the torque value specified below.

Item	Torque Specification
13	100 - 120 in. lbs. (11 - 14 Nm)

Thread the jam nut and the rack ball joint to the original location on the rack extension. Set the jam nut hand tight.

Install the rack and pinion unit on the vehicle. See *Rack and Pinion Unit Replacement*.

# FRONT SUSPENSION AND STEERING

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

**CAUTION** After replacing or servicing steering components, always verify that a 1/8" gap exists between large hex of rack extension and rack and pinion unit when steering is turned fully to the right forcing passenger spindle arm against front axle.

Set the proper rack extension-to-rack and pinion unit clearance. See *Checking/Adjusting Rack Extension-to-Rack and Pinion Unit Clearance*.

## Rack and Pinion Unit Replacement

Tool List	Quantity
Socket, 13 mm .....	1
Ratchet .....	1
Needle Nose Pliers.....	1
Wrench, 11/16" .....	1
Ball Joint Separator .....	1
Plastic Faced Hammer .....	1
Wrench, 5/8" .....	1
Socket, 5/8" .....	1
Ratchet .....	1
Torque Wrench, ft. lbs. ....	1
Socket, 11/16" .....	1
Torque Wrench, in. lbs.....	1

To remove the rack and pinion unit (12) (Figure 12), loosen the front wheel lug nuts.

Lift and support the front of the vehicle per the SAFETY section. Remove the lug nuts and the front wheels.

Remove bolt (13) and washer (14) securing the intermediate shaft (15) to the rack and pinion unit (12).

Remove the cotter pin (2) and loosen the castellated nut (3) until the rack ball joint (1) threads are protected. Using a ball joint separator as a lever, apply pressure to the ball joint and tap the nut with plastic faced hammer to release the ball joint from the passenger side spindle arm.

Remove the nut from the ball joint and the ball joint from the spindle arm.

Remove the three lock nuts (18) securing the rack and pinion unit to the front axle. Discard nuts.

Remove the rack and pinion unit from the vehicle. Retain washers (19), spacers (20) and the two bolts (16) for assembly.

Replace the rack and pinion unit in the reverse order of removal.

Install the new lock nuts (18) and tighten to the torque value specified below.

Item	Torque Specification
18	35 - 50 ft. lbs. (47 - 68 Nm)

Tighten castellated nut (3) to torque mentioned and continue to tighten as needed to insert new cotter pin.

Tighten bolt (13) securing intermediate shaft to pinion to the torque value specified below.

Item	Torque Specification
3	36 - 50 ft. lbs. (49 - 68 Nm)
13	13 - 18 ft. lbs. (18 - 24 Nm)

**CAUTION** After replacing or servicing steering components, always verify that a 1/8" gap exists between large hex of rack extension and rack and pinion unit when steering is turned fully to the right forcing passenger spindle arm against front axle.

Set the proper rack extension-to-rack and pinion unit clearance. See *Checking/Adjusting Rack Extension-to-Rack and Pinion Unit Clearance*.

Install the front wheels per the WHEELS AND TIRES section.

Lower the vehicle per the SAFETY section.

Check the front wheel alignment and adjust if necessary. See *Wheel Alignment*.

## Checking/Adjusting Rack Extension-to-Rack and Pinion Unit Clearance

Tool List	Quantity
Wrench, 11/16" .....	1
Wrench, 3/4" .....	1
Wrench, 1/2" .....	1
Wire Cutter.....	1
Washer, 1/8" Thick.....	1
Crowfoot Socket, 3/4" .....	1
Torque Wrench, ft. lbs. ....	1
Wire Tie, 10" long.....	1

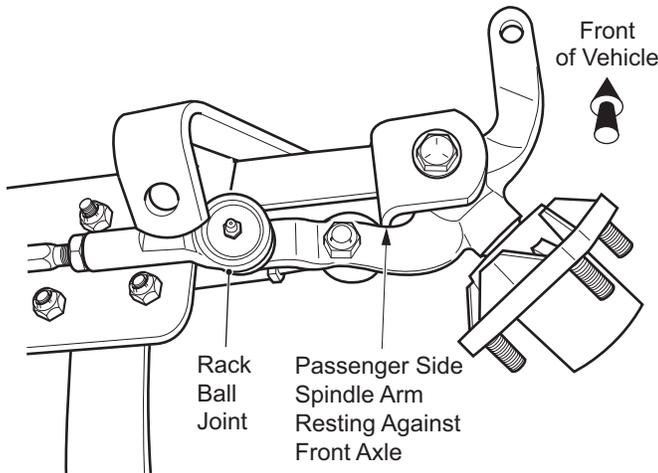
Check for proper rack extension-to-rack and pinion unit clearance by first turning steering wheel fully to the right.

The rear spindle arm on the passenger side **must rest against** the front axle (Figure 19).

If it does not, all adjustment is made at the rack ball joint (6) (Figure 18). Loosen the jam nut (5) at the rack ball joint and use a wrench to thread the shaft of the rack extension (7) further into the rack ball joint. This will provide more travel for the steering wheel to be turned to the right.

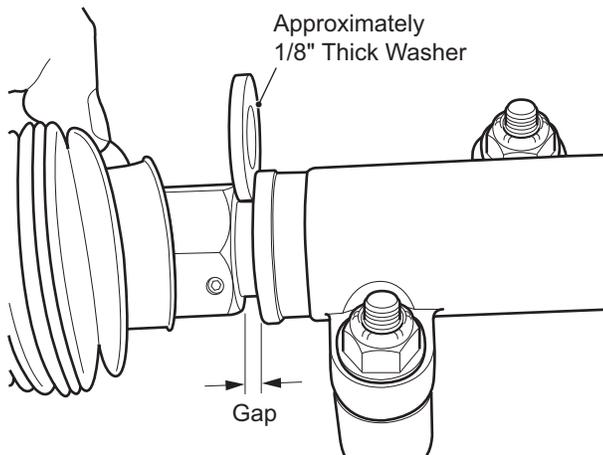
# FRONT SUSPENSION AND STEERING

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.



**Figure 19 Spindle Contact with Front Axle**

With the spindle arm resting against the front axle, cut the wire tie (14) securing the bellows (9) to the rack and pinion unit (1). Slide the bellows away from the rack and pinion unit to expose the large hex of rack extension. A 1/8" gap should exist between the large hex and the end of the rack and pinion unit.



**Figure 20 Checking Gap**

Adjust using a 1/8" thick washer as a gauge, by turning shaft of rack extension with wrench to create the 1/8" gap.

Tighten the jam nut (5) to the torque value specified below.

Item	Torque Specification
5	35 - 45 ft. lbs. (47 - 61 Nm)

Secure the bellows to the rack and pinion unit with new wire tie (14).

## Steering Wheel Replacement

### Tool List

	Quantity
Socket, 15/16"	1
Ratchet, 1/2" drive	1
Plastic Faced Hammer	1
Ball Peen Hammer	1
Anti-seize Compound	1
Torque Wrench, ft. lbs.	1

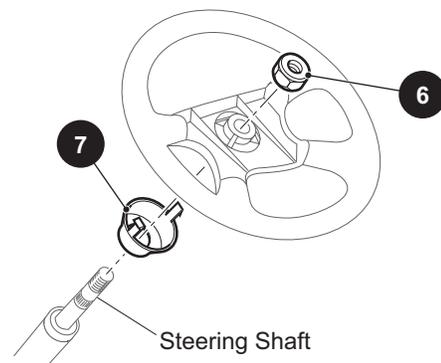
**NOTICE:** To maintain correct orientation when replacing the steering wheel, turn the wheels straight ahead.

**CAUTION** To decrease the risk of damage to the clipboard, perform the following removal procedure. Do not use a screwdriver to push or pry the retaining tabs.

From the front side of the steering wheel (4), remove the clipboard (5) by pulling straight up on the bottom of the clipboard to release the two bottom retaining tabs. Then, using thumb for leverage as shown, reach from behind steering wheel with fingertips to first pull down, and then push up to release the two top clipboard retaining tabs (Figure 21).

**Figure 21 Clipboard Removal**

Loosen the steering wheel retaining nut (6) two to three turns (Figure 21). DO NOT REMOVE NUT AT THIS TIME. Apply upward pressure to the steering wheel. Place a plastic faced hammer against the steering wheel nut and strike plastic faced hammer sharply with a ball peen hammer.



**Figure 22 Steering Wheel Replacement**

**CAUTION** Do not strike steering nut or end of steering shaft directly with ball peen hammer. Internal damage to rack and pinion unit can result.

When steering wheel is loosened, remove retaining nut and remove steering wheel.

Prior to replacement, assemble the replacement steering wheel by aligning the retaining tabs on the rear collar hub

# FRONT SUSPENSION AND STEERING

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

(7) with slots in back of steering wheel. Squeeze tabs to allow insertion of hub. **Do not force.** Squeeze hub on top and bottom to fully seat.

Replace steering wheel by lightly coating the splines of the steering shaft with a commercially available anti-seize compound. With the vehicle wheels in the straight ahead position, align the steering wheel on the steering shaft and slide wheel on shaft. Tighten the steering wheel nut torque value below.

Item	Torque Specification
6	15 - 20 ft. lbs. (20 - 27 Nm)

Inspect the four retaining tabs on the clipboard (5) for white stress lines (Figure 21). If stress lines are present, replace clipboard. Install by carefully pressing the top two, then the bottom two retaining tabs into the matching slots in steering wheel.

## Steering Shaft and Column Replacement

Tool List	Quantity
Ratchet .....	1
Socket, 3/4" .....	1
Socket, 13 mm .....	1
Ratchet .....	1
Socket, 9/16" .....	1
O-ring Pliers .....	1
Bearing Separator .....	1
Gear Puller .....	1
Arbor Press .....	1
Bearing Driver Set .....	1
Torque Wrench, ft. lbs. ....	1
Torque Wrench, in. lbs. ....	1
Wheel Bearing Grease .....	AR

To remove the steering shaft (4) (Figure 22), remove the steering wheel. See *Steering Wheel Replacement*.

Loosen the lug nuts on the front wheels. Lift and support the front of the vehicle per the SAFETY section.

Remove the lug nuts and the front wheels.

Remove the bolt (1) and washer (2) that secure the intermediate shaft (3) to the steering shaft (4).

Remove the four bolts (5) and washers (6) that secure the steering column (7) to the chassis and remove the column.

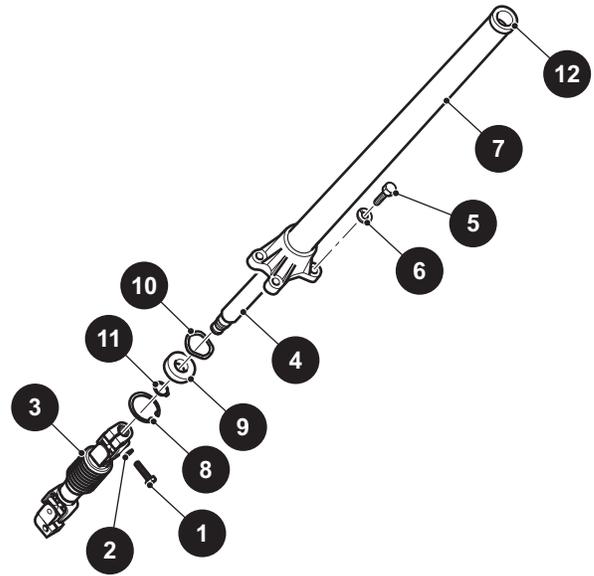


Figure 23 Steering Shaft and Column

Remove the large retaining ring (8) on the bottom end of the column and pull the shaft and bearing (9) out as an assembly. Slide the wave washer (10) out of the bottom end of the steering column. Retain the wave washer for reuse.

Remove the small retaining ring (11) and press the bearing from the steering shaft.

To assemble steering shaft, press the new bearing onto shaft until it stops against shoulder. With the small retaining ring oriented with the arch up, slide the ring onto the shaft as far as possible using O-ring pliers (Figure 23).

Use fingers to push the retaining ring fully into groove. Slide the wave washer into the base of the steering column.

To install the steering shaft and the bearing assembly, apply wheel bearing grease to the lip of the seal in the bushing (12) at the top of the column and press the steering shaft and the bearing assembly into the column base.

Secure with a large retaining ring making sure it is fully seated in the groove of column.

Place the steering column on the vehicle and tighten the column bolts (5) to the torque value specified below.

Item	Torque Specification
5	25 - 35 ft. lbs. (34 - 47 Nm)

Tighten the bolt (1) securing the intermediate shaft to the

# FRONT SUSPENSION AND STEERING

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

steering shaft to the torque value specified below.

Item	Torque Specification
1	13 - 18 ft. lbs. (18 - 24 Nm)

Install the front wheel(s) per the WHEELS AND TIRES section. Lower vehicle per the SAFETY section.

Install the steering wheel. See *Steering Wheel Replacement*.

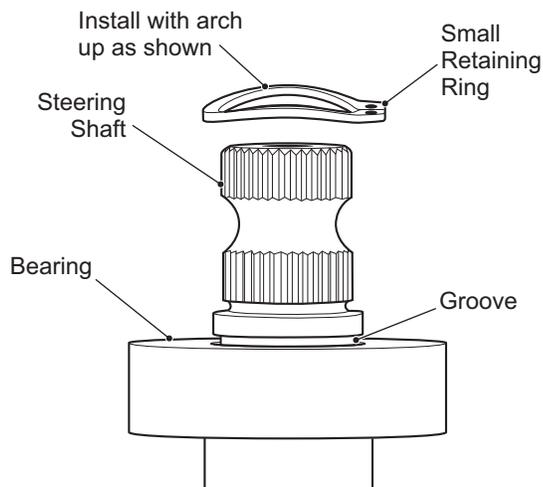


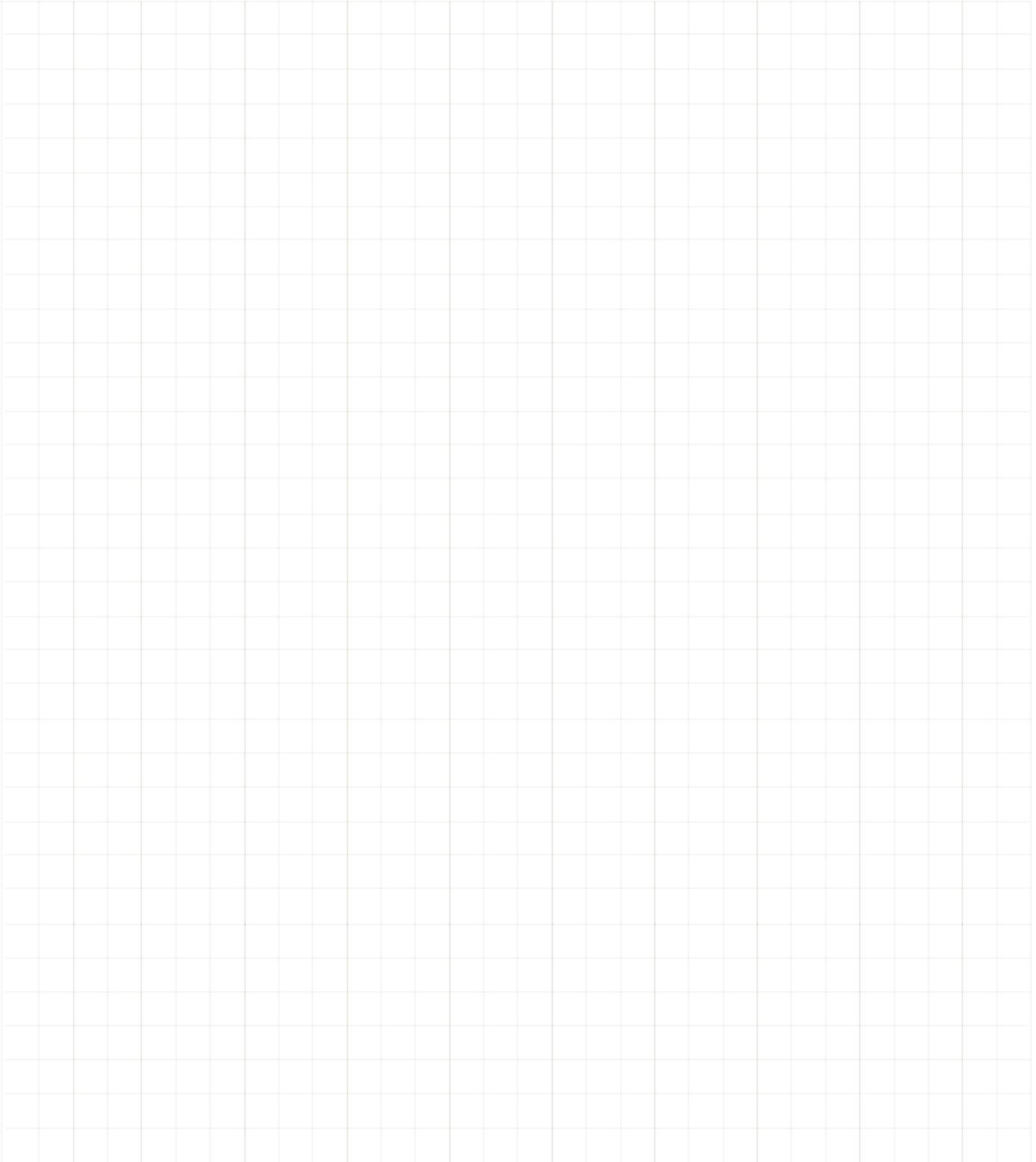
Figure 24 Small Retaining Ring Orientation

**NOTICE:** Apply grease to the splines.

# FRONT SUSPENSION AND STEERING

*Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.*

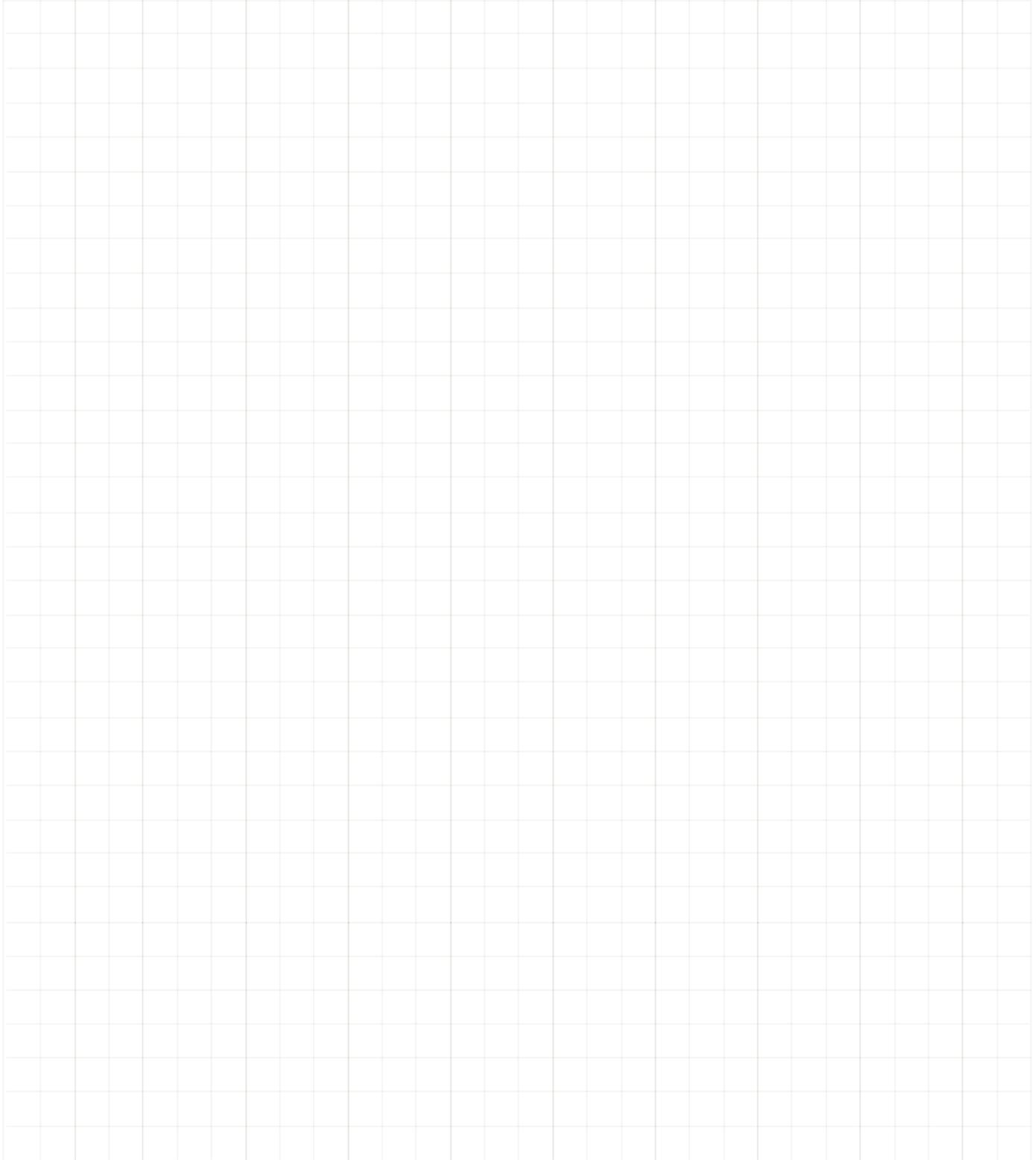
## Notes:

A large grid of graph paper for taking notes, consisting of 20 columns and 30 rows of small squares.

# FRONT SUSPENSION AND STEERING

*Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.*

## Notes:

A large grid of graph paper for taking notes, consisting of 20 columns and 30 rows of small squares.

## ELECTRONIC SPEED CONTROL

### SPEED SENSOR

The speed sensor senses the rotation of the motor's armature shaft gear. As the gear rotates by the speed sensor, electrical impulses are converted to a signal that the controller uses to determine motor speed.

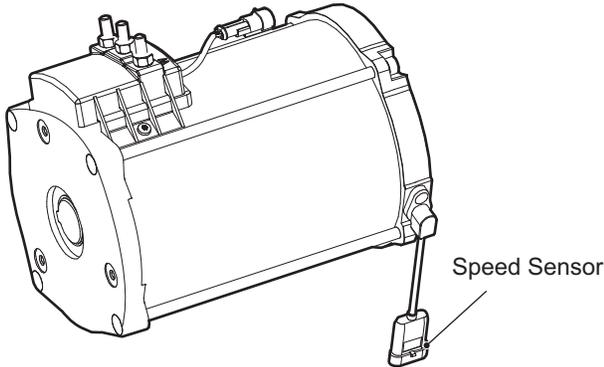


Figure 1 Speed Sensor

### CONTROLLER

The controller is a solid state unit that activates a solenoid and controls the function of the vehicle by responding to inputs from the throttle position sensor, motor speed sensor and other units.

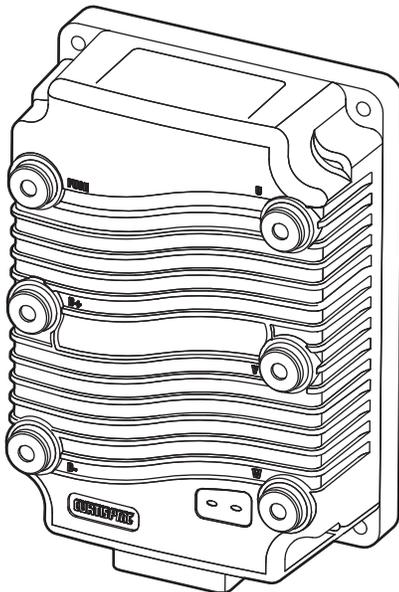


Figure 2 Controller

The main wire harness, throttle position sensor, and speed sensor are connected to the controller through a 35-pin plug. The throttle position sensor is connected to the controller through a 4-pin plug on the main wire har-

ness. The speed sensor is connected to the controller through a 4-pin plug on the main wire harness.

The controller is wired to the batteries and develops a regulated power supply for the throttle position sensor.

As the pedal is pressed, the magnitude of deflection in the throttle position sensor varies the voltage, which in turn is fed back to the controller. The controller interprets the change in voltage and supplies the appropriate power to the motor.

The throttle position sensor unit and the controller are both solid state units that contain no user serviceable parts. The testing procedures are designed to test the basic functionality of the wiring has been confirmed, the remaining tests are used to identify which of the components (controller or throttle position sensor) must be replaced.

### CONTROLLER REPLACEMENT

Tool List	Quantity
Socket, 7/16" .....	1
Socket, 13/32" .....	1
Ratchet.....	1
Extension, 6" .....	1
Wrench, 7/16" .....	1
Wrench, 13/32" .....	1
Insulated Wrench, 1/2" .....	1
Torque Wrench, ft. lbs. ....	1

#### **⚠ WARNING**

*To decrease the risk of electrical shock, the BL- wire must be removed before discharging the controller by shorting the B+ and*

*B- terminals of the controller with a large screwdriver. Be sure to hold screwdriver by the insulated portion.*

**NOTICE:** Note the location of the wiring before disconnecting from controller.

Use an insulated wrench to the remove the BL- wire from the battery.

Remove the bolts (2) and lock washers (3). Disconnect the cables and connectors from controller.

Note the location of all cable, wire and connector connections so they can be connected correctly on replacement controller.

Remove bolts (4) and lock nuts (6) and remove the controller (1) from the battery tray (Figure 3).

Install the new controller and reconnect wiring. Tighten lock nut (6) and bolt (2) to the torque values specified below.

# ELECTRONIC SPEED CONTROL

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

Item	Torque Specification
2, 6	50 - 55 in. lbs. (5.6 - 6.2 Nm)

Reconnect the BL- battery cable. Tighten the battery hardware to a torque value specified below.

Item	Torque Specification
Battery Hardware	90 - 110 in. lbs. (10 - 12.4 Nm)

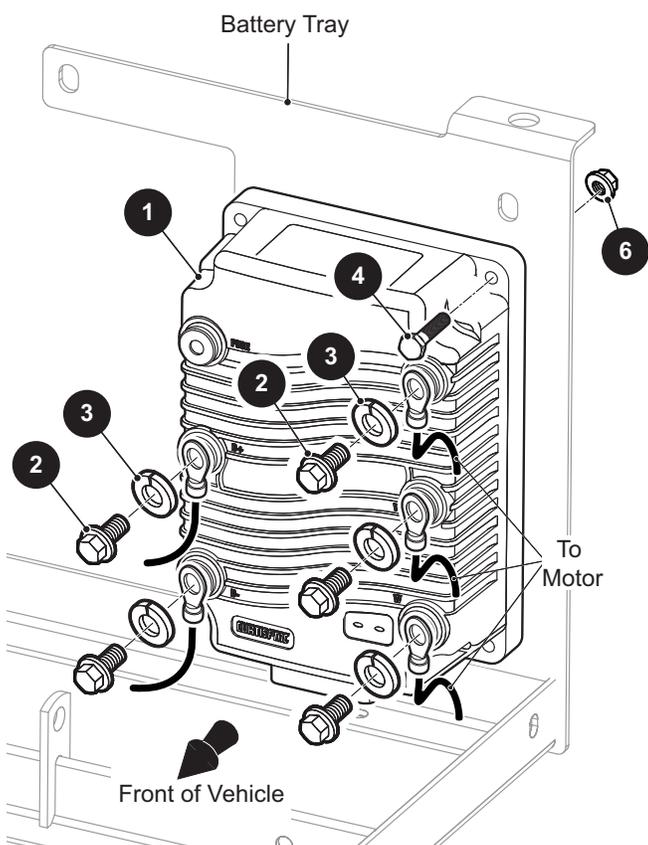


Figure 3 Controller Replacement

## SOLENOID REPLACEMENT

Tool List	Quantity
Socket, 7/16" .....	1
Socket, 3/8" .....	1
Ratchet .....	1
Insulated Wrench, 1/2" .....	1
Torque Wrench, ft. lbs.....	1

**⚠ WARNING** To decrease the risk of electrical shock, the BL- wire must be removed before discharging the controller by shorting the B+ and B- terminals of the controller with a large screwdriver. Be sure to hold screwdriver by the insulated portion.

**NOTICE:** Note the location of the wiring before disconnecting from the solenoid, to ensure correct connections when reassembling.

Use an insulated wrench to remove the BL- wire from the battery.

Remove the nuts (3) and washers (2). Disconnect the wires from the solenoid. Note all wire connections so they can be connected correctly on the replacement solenoid.

Remove the nuts (4), washer (5) and bolts (6) and remove the solenoid (1) from the vehicle.

Mount the new solenoid and reconnect the wiring.

Tighten the nuts (3, 4) to the torque value specified below.

Item	Torque Specification
3	55 in. lbs. (6.2 Nm)
4	50 - 55 in. lbs. (5.6 - 6.2 Nm)

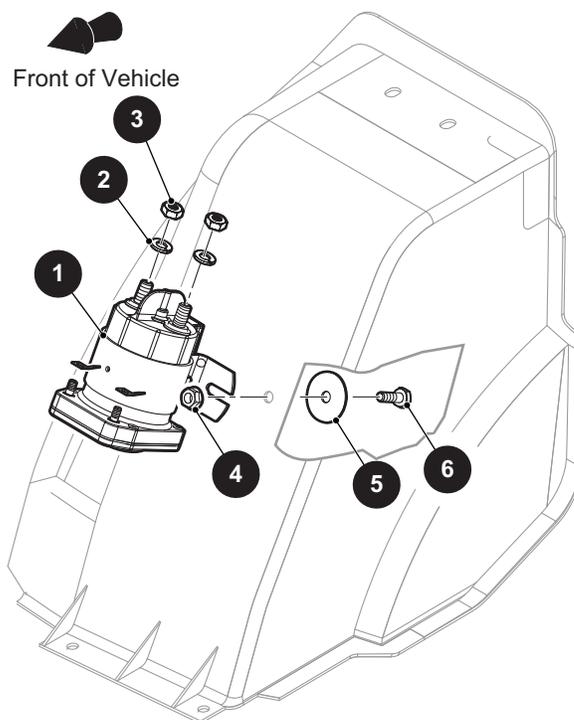


Figure 4 Solenoid Replacement

# MOTOR

## GENERAL

### CAUTION

**Do not hold vehicle on a hill using the accelerator, which is known as a “stalled” condition. Leaving motor in a stalled condition for more than 3-4 seconds can cause permanent damage to the motor.**

Disassembly of the motor is not recommended. Neither the motor housing nor armature are available as service items, therefore in the unlikely event of a failure in either of these components, the entire motor must be replaced.

## Motor Replacement

### WARNING

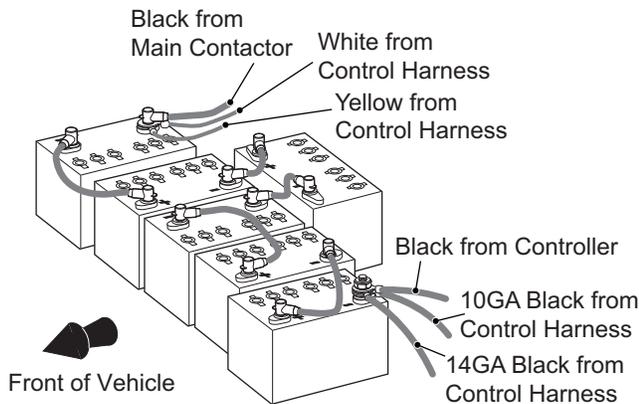
**To prevent shorting motor wires and causing an explosion, disconnect the negative (-) battery cable with an insulated wrench before attempting to remove wires from the motor (see procedures in SAFETY section of this manual).**

before attempting to remove wires from the motor (see procedures in SAFETY section of this manual).

### Tool List

### Quantity

Wrench, 10mm .....	1
Insulated Wrench, 9/16" .....	1
Socket, 9/16" .....	1
Chalk or Paint Pen .....	1
Socket, 10mm .....	1
Ratchet .....	1
Torque Wrench, in. lbs. ....	1

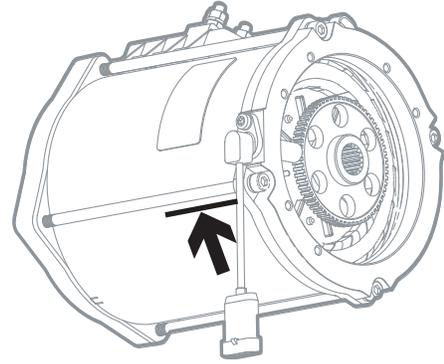


**Figure 1 Disconnect Battery Cable**

Use an insulated wrench to disconnect the negative (-) battery cable from the battery (Figure 1).

Mark both the axle and motor housings to assist with realignment during reassembly of motor to rear axle (Figure 2).

Disconnect the motor wires from the controller terminals U, V and W.



**Figure 2 Mark Axle and Motor**

### CAUTION

**Be careful not to damage the splines when removing and reassembling the motor to the rear axle housing.**

Remove the connector at the speed sensor (9) (Figure 4).

Remove the six bolts (7) that secure the motor (1) to the axle housing and carefully slide the motor straight out from the axle splines.

Remove the bolts (5), washers (4) and end cap (3) from the motor (1). Retain the end cap (3) for reuse.

Clean the motor coupler with compressed air. Use a scraper to remove any rust deposits if present.

Install the motor in the reverse order of removal.

Apply a small quantity of molybdenum grease or generous amount of silver grade anti-seize grease to the female portion of the spline.

Carefully mate the motor spline with the input shaft of the axle. Align the orientation marks and install the mounting hardware. Finger tighten bolts (7) in a cross sequence pattern (Figure 4).

Continue to tighten bolts (7) to torque value specified below.

Item	Torque Specification
7	72 - 78 in. lbs. (8 - 9 Nm)

# MOTOR

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

Install the end cap (3) to the motor (1) as shown in Figure 4. Install three bolts (5) and washers (4) to secure in place. Tighten the bolts (5) to torque value specified below.

Item	Torque Specification
5	72 - 78 in. lbs. (8 - 9 Nm)

Connect motor wires to controller (Figure 3).

Motor Terminal	Wire Marker	From Controller
U	U	U
V	V	V
W	W	W

Figure 3 Motor Wiring

## Motor Tests

The armature and motor housing are not available as individual parts. No testing is recommended to determine the specific area of failure.

If a test of the power wiring system indicates the system is operating correctly, but the vehicle does not run or runs poorly, perform the AC Motor Bench Test on page 54 before connecting a new controller.

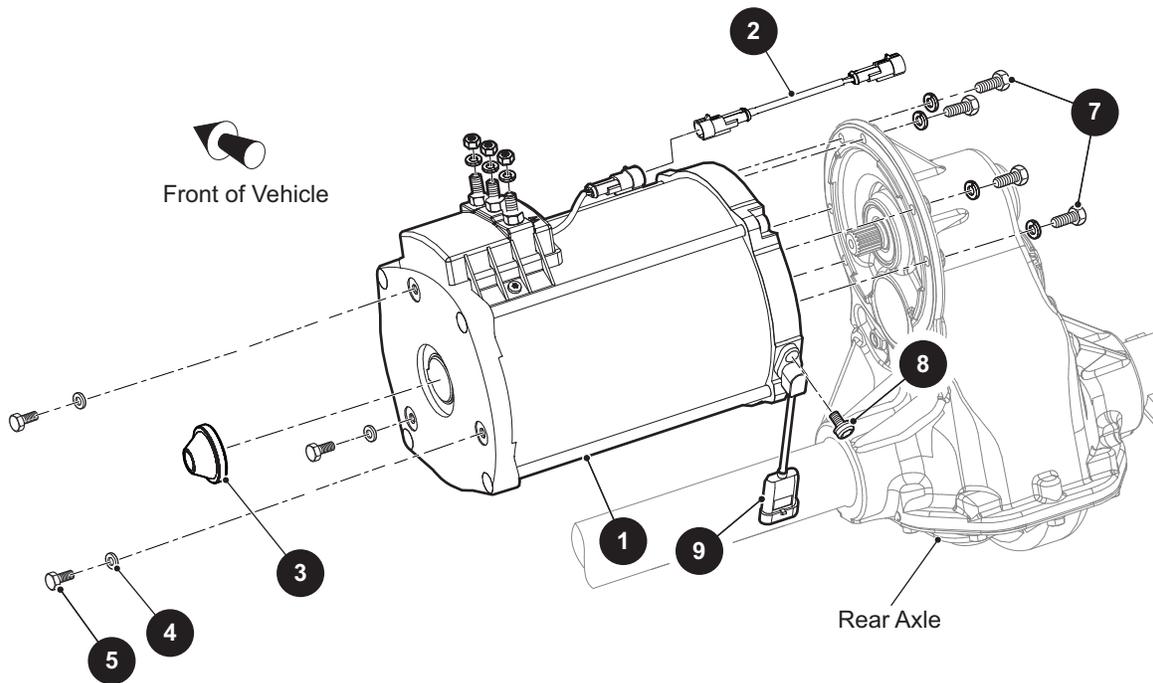


Figure 4 Motor Components

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

## Speed Sensor Removal

### ⚠ WARNING

Disconnect the negative (BL-) battery cable with an insulated wrench before attempting to disconnect wires from the motor (see safety procedures in SAFETY section).

Tool List	Quantity
Ratchet.....	1
Wheel Chocks .....	4
Socket, 9/16" .....	1
Phillips Screwdriver .....	1
Phillips Screwdriver Bit.....	1

1. Make sure that the key switch is turned to the OFF position and the key is removed from the switch.
2. Chock the rear wheels of the vehicle.
3. Raise and remove the seat bottom.
4. Remove the rear access panel. See the BODY section of this manual.
5. Clean all dirt and debris from the motor.
6. Unplug the speed sensor connector from the wire harness.

## Speed Sensor Installation

1. Inspect the speed sensor (1). Make sure the o-ring is seated in the groove before installing in the motor.
2. Insert the speed sensor (1) into the opening in the motor. Align the hole in the speed sensor with the screw hole in the motor and push down firmly to seat the o-ring.
3. Install the torx head screw (2). Tighten the torx head screw to the torque value specified below.

Item	Torque Specification
2	27 - 31 in. lbs. (3 - 3.5 Nm)

4. Plug the connector from the speed sensor into the wire harness. Make sure the speed sensor wire is not pulled tight, there must be slack in the wires.
5. Install the access cover. See the BODY section.

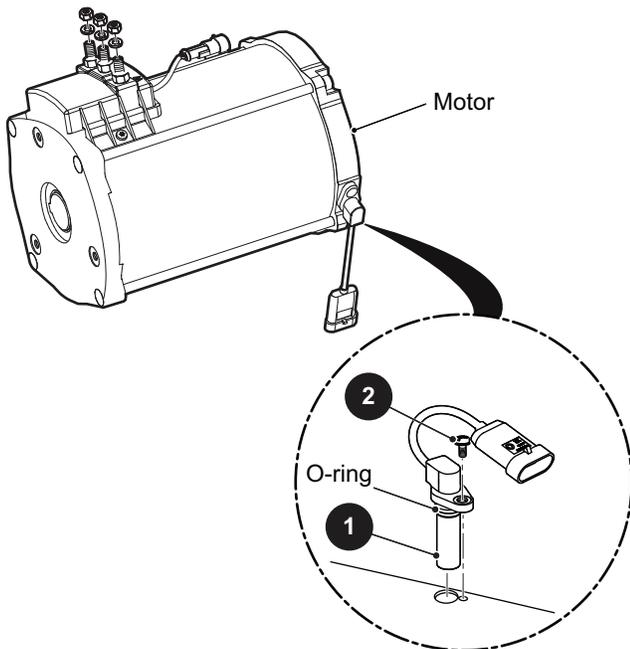


Figure 5 Speed Sensor Removal

7. Remove the torx head screw (2) that secures the speed sensor (1) to the motor. Pull the speed sensor (1) up until it is clear of the motor.

# MOTOR

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

## AC Motor Bench Test

Set a standard digital volt/ohm meter to the diode test position. Make sure the audible alarm can be heard.

1. Place one meter probe on the U-terminal and the other probe on the W-terminal. Full continuity should be observed (Figure 6).



Figure 6 U and W terminal

2. Now place one meter probe on the V-terminal and the other probe on the W-terminal. Full continuity should be observed (Figure 7).

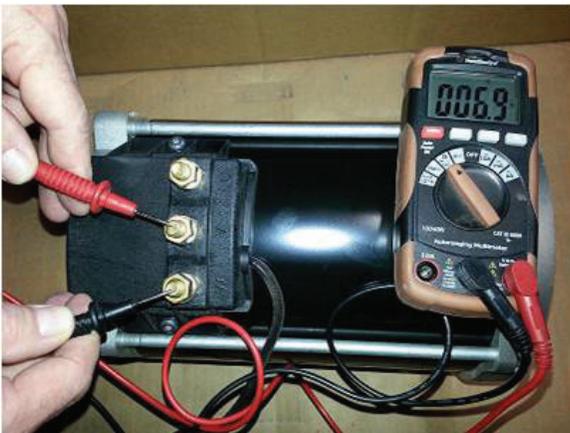


Figure 7 V and W terminal

3. Then place one meter probe on the U-terminal and the other probe on the V-terminal. Full continuity should be observed (Figure 8).

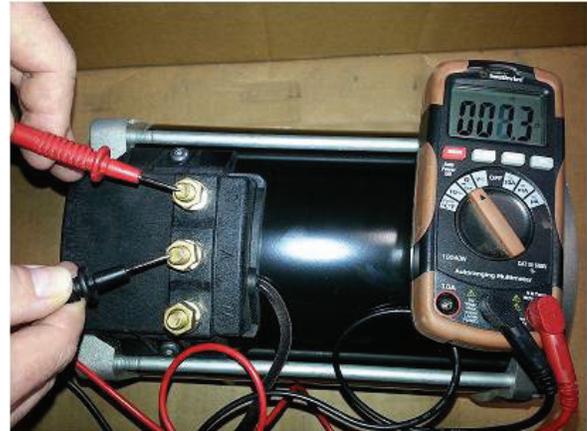


Figure 8 U and V terminal

**NOTICE:** If continuity is not observed between terminals; an open motor field condition may exist. Disassemble the motor to visually confirm.

4. Place one meter probe on any of the three motor terminals. The other meter probe should be placed on the motor case. No continuity should be observed (Figure 9).

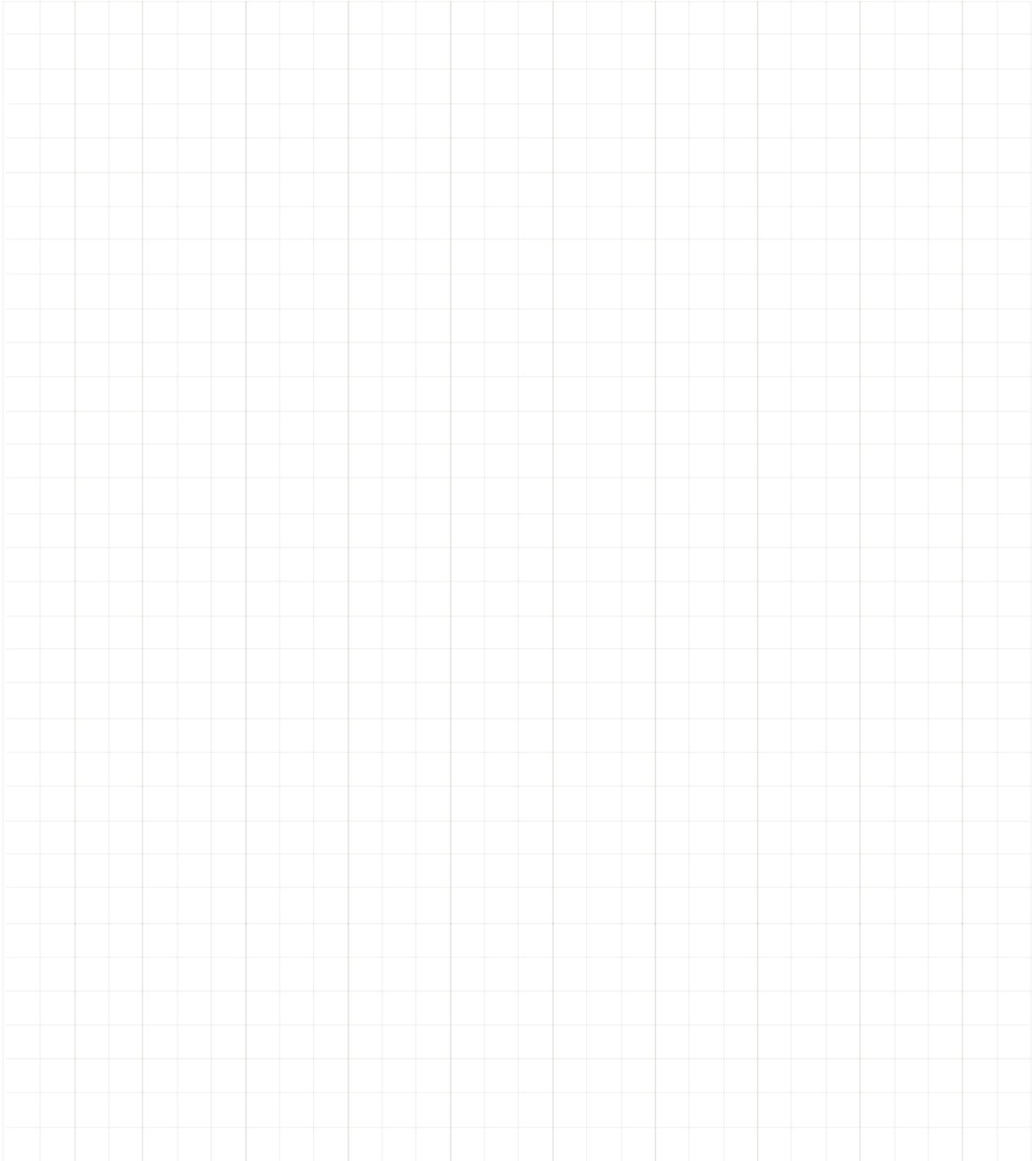
**NOTICE:** If continuity is observed between the case and terminals; a field to motor case short exists.



Figure 9 Terminal and Motor case

*Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.*

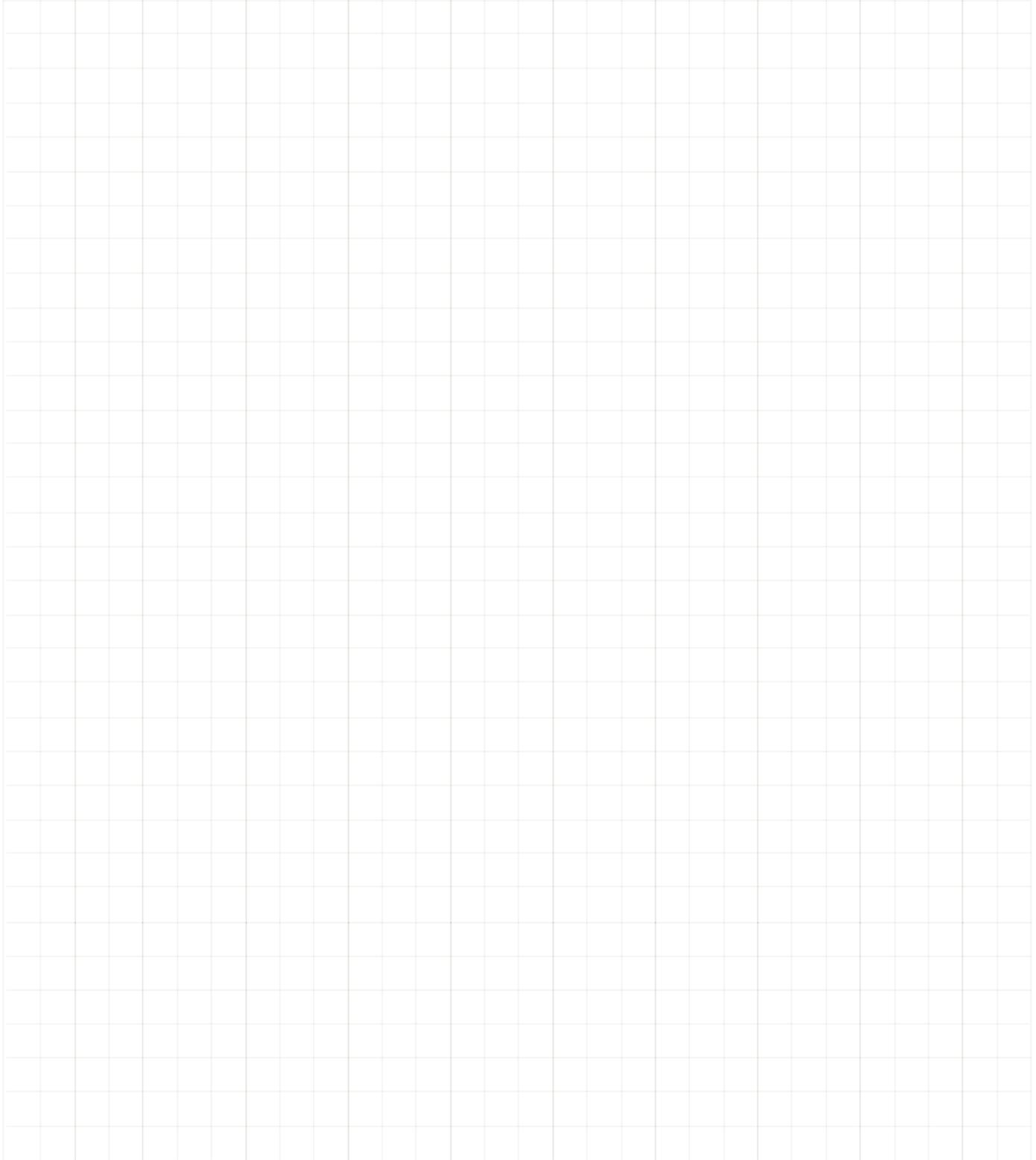
## Notes:

A large grid of graph paper, consisting of 20 columns and 30 rows of small squares, intended for taking notes.

# MOTOR

*Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.*

## Notes:

A large grid of graph paper for taking notes, consisting of 20 columns and 30 rows of small squares.

## BATTERY CHARGER

### CHARGER DESCRIPTION

For complete instructions on the on-board and portable chargers, refer to APPENDIX A section.

The Delta Q charger supplied with this vehicle is an automatic charger that is designed specifically for charging electric vehicle batteries.

For operating, maintenance and fault testing of the charger, refer to information from the charger manufacturer. A copy of this information is included with the charger and in APPENDIX A in this manual.

#### **⚠ WARNING**

**Use charger only on 72 volt battery systems. Other usage can cause personal injury and damage.**

**Lead acid batteries can generate explosive hydrogen gas during normal operation. Keep sparks, flames, and smoking materials away from batteries. Provide adequate ventilation during charging.**

**Never charge a frozen battery.**

**Study all battery manufacturers specific precautions such as recommended rates of charge and removing or not removing cell caps while charging.**

### PORTABLE CHARGER OPTION

#### **⚠ DANGER**

**To decrease the risk of electrical shock, connect the charger power cord to an outlet that has been properly installed and grounded in accordance with all local codes and ordinances.**

**A grounded outlet is required to decrease the risk of electric shock – do not use ground adapters or modify plug.**

**Do not touch the uninsulated portion of the output connector or the uninsulated battery terminal.**

**Disconnect the DC supply before making or breaking the connections to the battery while charging.**

**Do not open or disassemble the charger.**

**Do not operate the charger if the AC supply cord is damaged or if the charger has received a sharp blow, been dropped, or**

**otherwise damaged in any way. Refer to all repair work to qualified personnel.**

**The charger is not for use by children.**

Portable chargers are shipped with the vehicle. Prior to vehicle or charger operation, chargers must be removed and mounted on a platform above the ground to permit maximum air flow around and underneath the charger. For optimum performance and shortest charge times, put the charger in an area with adequate ventilation. Install the charger in an area that is free of dirt, mud, or dust since accumulations within the charger vents will decrease their heat dissipating qualities. The chargers status display must be visible to the user.

Optimal cooling occurs when the charger is placed on a horizontal surface with the fins vertical. More airflow from below the charger helps cool the fins.

If the charger is operated in an outdoor location, rain and sun protection must be provided.

As the charger may get hot during operation, the charger must be placed such that risk of contact by people is decreased.

Provide Protection From Elements



Locations outside the US and Canada: Reference appropriate local electrical code and charger manufacturer recommendations for AC power requirements

**Figure 1 Charger**

The charger can remain connected to the AC outlet. To charge the vehicle, refer to the instruction labels on the charger. Insert the polarized DC plug completely into the vehicle receptacle. The charger will automatically start a few seconds after the plug is connected. The charger will automatically stop when the batteries are fully charged, and the DC plug can be removed from the vehicle.

# BATTERY CHARGER

*Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.*

**NOTICE:** *Routing the DC cord through the steering wheel when charging the batteries, serves as a good reminder to store the cord out of the way when charging is complete. The DC plug can be damaged by driving over or catching the cord on the vehicle when driving away.*

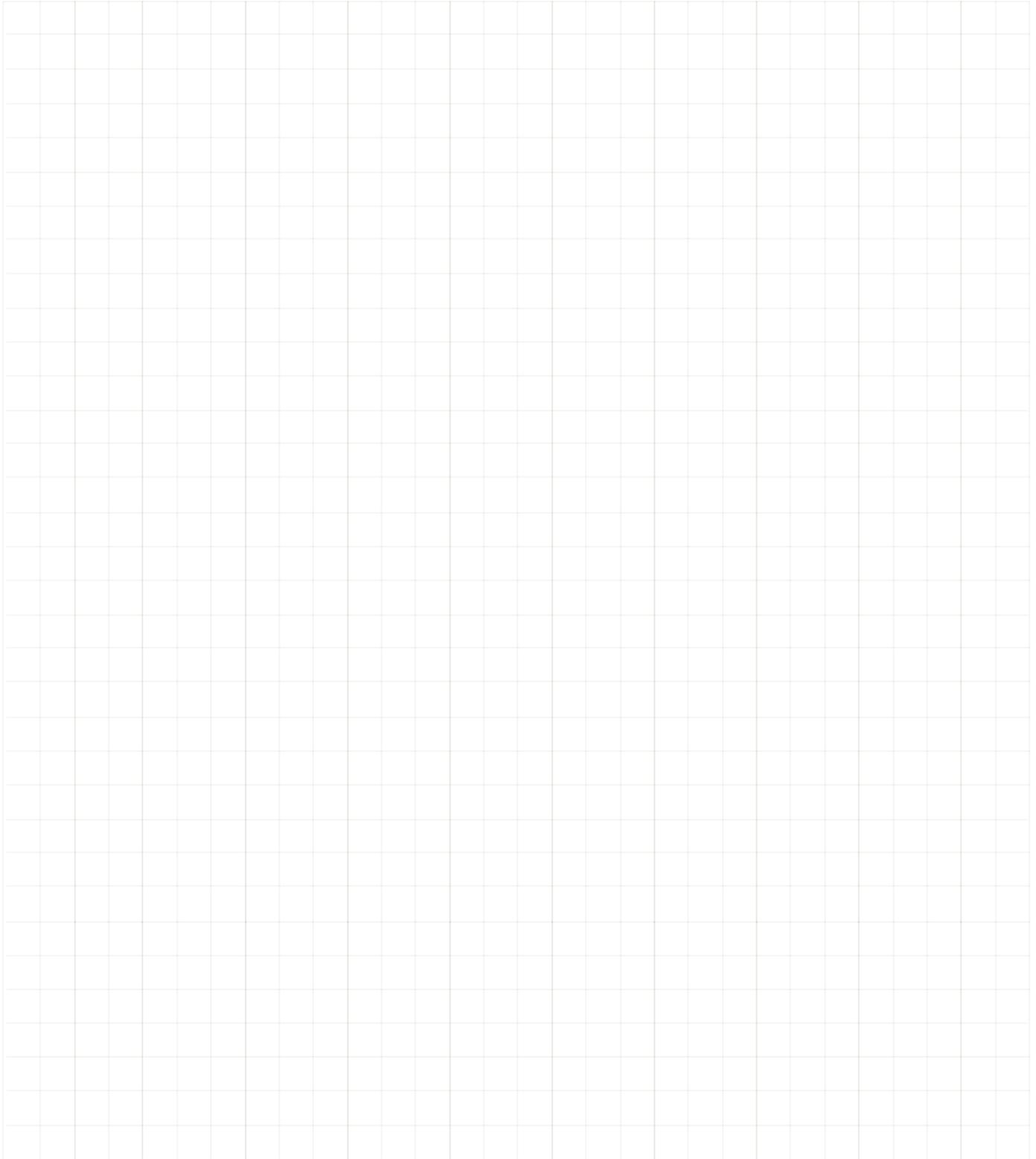
 **WARNING**

*An ungrounded electrical device can become a physical hazard that could result in an electrical shock or electrocution.*

# BATTERY CHARGER

*Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.*

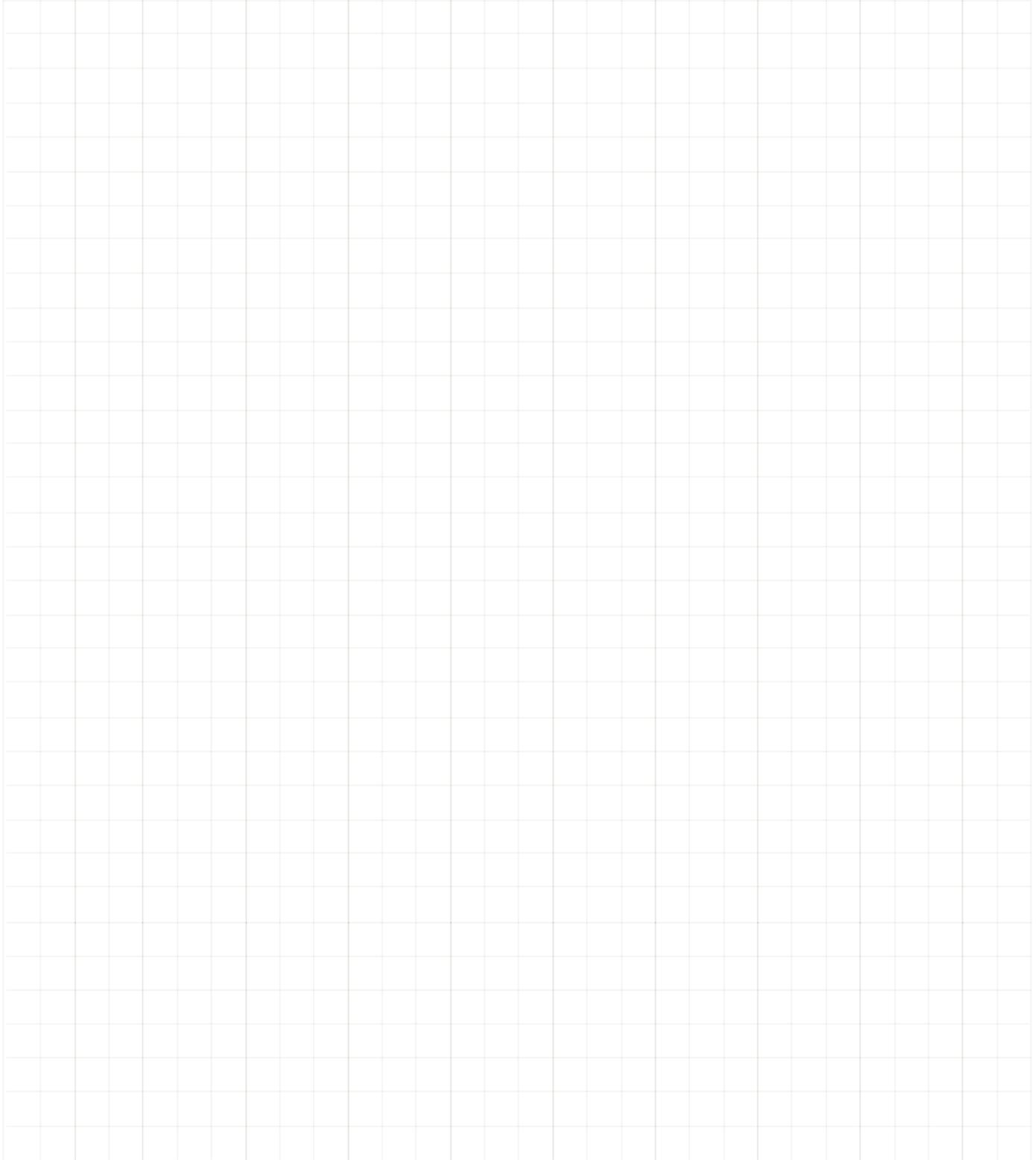
## Notes:

A large grid area for taking notes, consisting of 20 columns and 30 rows of small squares.

# BATTERY CHARGER

*Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.*

## Notes:

A large grid of graph paper for taking notes, consisting of 20 columns and 30 rows of small squares.

# BATTERIES AND CHARGING

## SAFETY

**NOTICE:** Always observe the following warnings when working on or near batteries:



**WARNING** To decrease the risk of battery explosion that could result in severe personal injury or death, keep all smoking materials, open flames or sparks away from the batteries.

Hydrogen gas is formed when charging batteries; do not charge batteries without adequate ventilation. A 4% concentration of hydrogen gas is explosive.

Ensure the key switch is off and all electrical accessories are turned off before starting work on vehicle.

Never disconnect a circuit under load at a battery terminal.

### SAFETY FIRST



**BEND KNEES WHEN LIFTING**

Batteries are heavy; use proper lifting techniques when moving them. Always lift the battery with a commercially available battery lifting device.

Use care not to tip batteries when removing or installing them; spilled electrolyte can

cause burns and damage.

The electrolyte in a storage battery is an acid solution which can cause severe burns to the skin and eyes. Treat all electrolyte spills to the body and eyes with extended flushing with clear water. Contact a physician immediately.



Always wear a safety shield or approved safety goggles when adding water or charging batteries.

Any electrolyte spills should be neutralized with a solution of 1/4 cup (60 ml) sodium bicarbonate (baking soda) dissolved in 1-1/2 gallons (6 liters) of water, and flushed with water.

Overfilling batteries may result in electrolyte being expelled from the battery during the charge cycle. Expelled electrolyte may cause damage to the vehicle and storage facility.

Aerosol containers of battery terminal protectant must be used with caution. Insulate metal container to decrease the risk of can from contacting battery terminals, which could result in an explosion.



Wrap wrenches with vinyl tape to decrease the risk of the possibility of a dropped

wrench from shorting out a battery, which could result in an explosion.

## BATTERY

A battery is defined as two dissimilar metals immersed in an acid. If the acid is absent or if the metals are not dissimilar, a battery has not been created. The batteries most commonly used in these vehicles are lead acid.

A battery does not store electricity, but is able to produce electricity as the result of a chemical reaction which releases stored chemical energy in the form of electrical energy. The chemical reaction takes place faster in warm conditions and slower in cold conditions. Temperature is important when conducting tests on a battery and test results must be corrected to compensate for temperature differences.

As a battery ages, it still performs adequately except that its capacity diminishes. Capacity describes the time that a battery can continue to provide its design amperes from a full charge.

A battery has a maximum life. Good maintenance will maximize the available life and minimize the factors that can decrease the life of the battery.

## BATTERY MAINTENANCE

Tool List	Quantity
Insulated Wrench, 9/16" .....	1
Battery Carrier.....	1
Hydrometer .....	1
Battery Maintenance Kit (P/N 25587G01).....	1
Battery Protective Spray .....	1

### At Each Charging Cycle



**WARNING** To decrease the risk of fire, never connect the battery charger to a vehicle that is to be unattended for longer than the normal charging cycle. Overcharging can damage the batteries and result in overheating. Check the charger after 24 hours and disconnect after the charge cycle is complete.

Before charging the batteries, inspect the plug of the battery charger and vehicle receptacle housing for dirt or debris.

Charge the batteries after each days use.

### Monthly

- Inspect all wiring for fraying, loose terminations, corrosion or deterioration of insulation.

# BATTERIES AND CHARGING

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

- Check that the electrolyte level is correct and add suitable water as required.
- Clean the batteries and wire terminations.

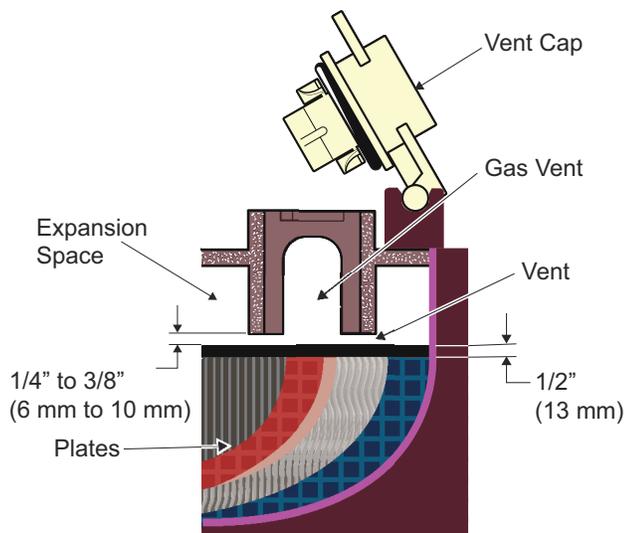
## Electrolyte Level and Water

The correct level of the electrolyte is 1/2" (13 mm) above the plates in each cell (Figure 1).

This level will leave approximately 1/4" - 3/8" (6 - 10 mm) of space between the electrolyte and the vent tube. The electrolyte level is important since any portion of the plates exposed to air will be ruined beyond repair. Of equal importance is too much water which will result in electrolyte being forced out of the battery due to gassing and the increase in volume of the electrolyte that results from the charging cycle.



**Do not overfill batteries. The charging cycle will expel electrolyte and result in component damage.**



Electrolyte level should be at least 1/2" (13 mm) above plates and 1/4" to 3/8" (6 to 10 mm) below vent.

**Figure 1 Correct Electrolyte Level**

A battery being charged will gas with the majority of the gassing taking place at the end of the charging cycle. This gas is hydrogen, which is lighter than air. Water and sulfuric acid droplets will be carried out of the battery vents by the hydrogen gas; however, this loss is minimal. If the battery electrolyte level is too high, the electrolyte will block the vent tube and the gas will force it out of the vent tube and battery cap. The water will evaporate but the sulfuric acid will remain where it can damage vehicle components and the storage facility floor. Sulfuric acid loss will weaken the concentration of acid within the electrolyte and

decrease the life of the battery.

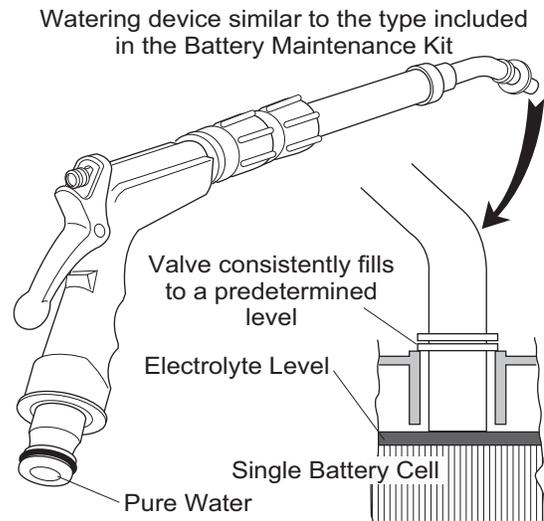
Over the life of the battery, a considerable amount of water is consumed. It is important that the water used be pure and free of contaminants that could decrease the life of the battery by reducing the chemical reaction. The water must be distilled or purified by an efficient filtration system. Water that is not distilled should be analyzed and if required, filtration installed to permit the water to meet the requirements of the water purity table (Figure 2).

Impurity	Parts Per Million
Color.....	Clear
Suspended.....	Trace
Total Solids.....	100
Calcium & Magnesium Oxides.....	40
Iron.....	5
Ammonia.....	8
Organic & Volatile Matter.....	50
Nitrites.....	5
Nitrates.....	10
Chloride.....	5

**Figure 2 Water Purity Table**

Even if the water is colorless, odorless and tasteless, it should be analyzed to ensure it does not exceed the impurity levels specified in the table.

Automatic watering devices such as the one included in the Battery Maintenance Kit (P/N 25587G01) can be used with an approved water source (Figure 3). These watering devices are fast and accurate to use and maintain the correct electrolyte level within the battery cells.



**Figure 3 Automatic Watering pump**

# BATTERIES AND CHARGING

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

**NOTICE:** The watering device should only be used if the electrolyte level is less than 1/2" (13 mm) above top of plates.

## Cleaning Batteries

When cleaning the outside of the batteries and terminals, do not use a water hose without first spraying with a solution of sodium bicarbonate (baking soda) and water to neutralize any acid deposits.

Use of a water hose without first neutralizing any acid, will move acid from the top of the batteries to another area of the vehicle or storage facility where it will attack the metal structure or the concrete/asphalt floor. After hosing down the batteries, a residue will be left on the batteries which is conductive and will contribute to the discharge of the batteries.

### CAUTION

To decrease the risk of battery damage, be sure that all battery caps are tightly installed.

The correct cleaning technique is to spray the top and sides of the batteries with a solution of sodium bicarbonate (baking soda) and water. This solution is best applied with a garden type sprayer equipped with a non-metallic spray wand. The solution should consist of 1/4 cup (60 ml) of sodium bicarbonate (baking soda) mixed with 1-1/2 gallons (6 liters) of clear water (Figure 4). In addition to the batteries, special attention should be paid to metallic components adjacent to the batteries which should also be sprayed with the sodium bicarbonate (baking soda) solution.

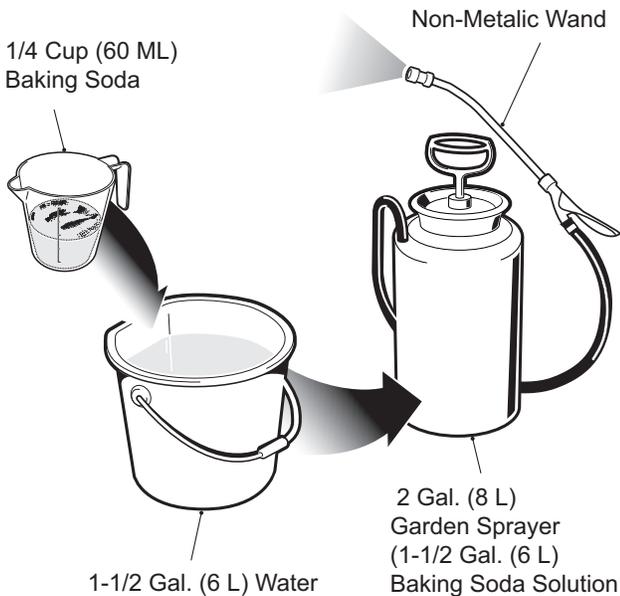


Figure 4 Preparing Acid Neutralizing Solution

Allow the solution to sit for at least three minutes; use a soft bristle brush or cloth to wipe the tops of the batteries to remove any residue that could cause the self discharge of the battery. Rinse the entire area with low pressure clear water. All of the items required for complete battery cleaning and watering are included in the Battery Maintenance Kit (P/N 25587G01).

Clean batteries once a month, or more often under extreme conditions.

## Battery Removal and Installation

### Tool List

### Quantity

Insulated Wrench, 9/16"	1
Socket, 9/16"	1
Ratchet	1
Battery Carrier	1
Torque Wrench, in. lbs.	1
Torque Wrench, ft. lbs.	1

**NOTICE:** Hardware that is removed must always be installed in its original position unless otherwise specified. If torque values are not specified, refer to the Torque Specifications table in the GENERAL INFORMATION AND ROUTINE MAINTENANCE section.

### CAUTION

Before any electrical service is performed, the run/tow switch must be placed in the TOW position.

If a power wire (battery, motor or controller) is disconnected for any reason, the run/tow switch must be left in the TOW position for at least 30 seconds after the circuit is restored.

Remove battery hold downs and cables. Lift out batteries with a commercially available lifting device.

If the batteries have been cleaned and any acid in the battery rack area neutralized as recommended, no corrosion to the battery racks or surrounding area should be present. Any corrosion found should be immediately removed with a putty knife and a wire brush. The area should be washed with a solution of sodium bicarbonate (baking soda) and water, thoroughly dried and then primed/painted with a corrosion resistant paint.

The batteries should be placed into the battery racks and the battery hold downs tightened to torque specified below; tight enough to decrease the risk of movement but not tight enough to distort battery cases.

Item	Torque Specification
Battery Hold down Nut	45 - 55 in. lbs. (5 - 6 Nm)

# BATTERIES AND CHARGING

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

Inspect all wires and terminals. Clean any corrosion from the battery terminals or the wire terminals with a solution of sodium bicarbonate (baking soda) and brush clean if required.

## ⚠ WARNING

To decrease the risk of battery explosion, care must be used with aerosol containers of battery terminal protectant.

**Insulate the aerosol container to decrease the risk of the metal can contacting the battery terminals, which could result in an explosion.**

Connect the battery wires as shown (Figure 5). Ensure that all battery terminals are installed with crimp facing up.

Tighten the battery post hardware to torque value specified below.

Item	Torque Specification
Battery Post Hardware	90 - 100 in. lbs. (6 - 8 Nm)

Do not over tighten the terminal nut, causing a “mushroom” effect on the battery post and preventing the terminal nut from being properly tightened. Protect the battery terminals and battery wire terminals with a commercially available protective coating.

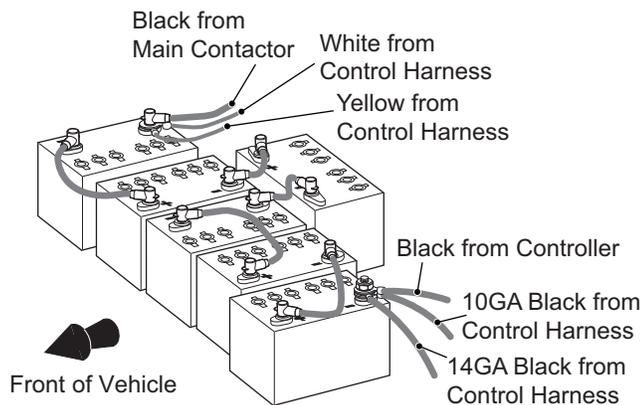


Figure 5 Battery Connections

## Prolonged Storage

### ⚠ CAUTION

Disconnect battery charger, controller and other electronic devices since they will contribute to the premature discharge of batteries.

During storage periods, the batteries need proper maintenance to decrease the risk of discharge.

In high temperatures the chemical reaction is faster, while low temperatures cause the chemical reaction to slow down. A vehicle that is stored at 90° F (32° C) will lose .002 of specific gravity each day. If a fully charged battery has a specific gravity of 1.275, and the battery is allowed to sit unused, it will become partially discharged. When it reaches 1.240, which it will do in less than twenty days, it should be recharged.

If a battery is left in a discharged state, sulfating occurs on and within the plates. This condition is not reversible and permanently damages the battery. To decrease the risk of damage, recharge the battery as necessary.

A hydrometer (P/N 50900G1) can be used to determine the specific gravity and therefore the state of charge of a battery.

In winter conditions, the battery must be fully charged to decrease the risk of the possibility of freezing (Figure 6). A fully charged battery will not freeze in temperatures above -75° F (-60° C). Although the chemical reaction is slowed in cold temperatures, the battery must be stored fully charged, and disconnected from any circuit that could discharge the battery. For portable chargers, disconnect the charging plug from the vehicle receptacle. For on-board chargers, disconnect the charging harness from the batteries.

The batteries must be cleaned and all deposits neutralized and removed from the battery case to decrease the risk of self discharge. The batteries should be tested or recharged at thirty day minimum intervals.

# BATTERIES AND CHARGING

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

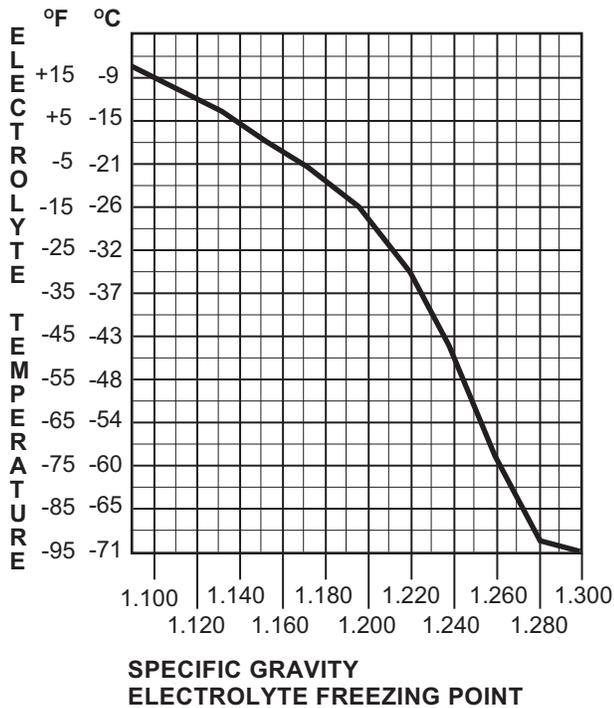


Figure 6 Freezing Point of Electrolyte

## Battery Charging

For complete instructions on the on-board and portable chargers refer to APPENDIX A section.

The battery charger is designed to fully charge the battery set. If the batteries are severely deep cycled, some automatic battery chargers contain an electronic module that may not activate and the battery charger will not function. Automatic chargers will determine the correct duration of charge to the battery set and will shut off when the battery set is fully charged. Always refer to the instructions of the specific charger being used.

Before charging, the following should be observed:

### CAUTION

**Do not overfill batteries. The charging cycle will expel electrolyte and result in component damage.**

- The electrolyte level in all cells must be at the recommended level and cover the plates.
- Charging must take place in an area that is well ventilated and capable of removing the hydrogen gas that is generated by the charging process. A minimum of five air exchanges per hour is recommended.
- The charging connector components must be in good condition and free from dirt or debris.

- The charger connector must be fully inserted into the vehicle receptacle.
- The charger connector/cord set must be protected from damage and located in an area to decrease the risk of injury that may result from personnel tripping over the cord set.
- The charger is automatically turned off during the connect/disconnect cycle and therefore no electrical arc is generated at the DC plug/receptacle contacts.

**NOTICE:** In some portable chargers, there will be a rattle present in the body of the charger DC plug. This rattle is caused by an internal magnet contained within the charger plug. The magnet is part of the interlock system that prevents the vehicle from being driven when the charger plug is inserted in the vehicle charging receptacle.

## AC Voltage

Battery charger output is directly related to the input voltage. If vehicle is receiving an incomplete charge in a normally adequate time period, low AC voltage could be the cause and the power supply should be checked.

## FAULT TESTING

In general, fault testing will be done for two distinct reasons:

- A battery that performs poorly and is outside of the manufacturers specification should be identified in order to replace it under the terms of the manufacturer's warranty. Different manufacturers have different requirements. Consult the battery manufacturer or the manufacturer's representative for specific requirements.
- The second reason is to determine why a vehicle is not performing adequately. A vehicle that runs slowly or a vehicle that is unable to operate for the time required are examples of performance problems.

A new battery must mature before it will develop its maximum capacity. Maturing may take up to 100 charge/discharge cycles. After the maturing phase is complete, battery capacity will start to diminish. The only way to determine the capacity of a battery is to perform a load test using a discharge machine following manufacturer's recommendations.

A cost effective way to identify a poorly performing battery is to use a hydrometer to identify a battery in a set with a lower than normal specific gravity. Once the problematic cell or cells are identified, the suspect battery can be removed and replaced. At this point there is nothing that can be done to salvage the battery; however, the individual battery should be replaced with a good battery of the same brand, type and approximate age.

# BATTERIES AND CHARGING

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

## Hydrometer

A hydrometer (P/N 50900G1) is used to test the state of charge of a battery cell (Figure 7). This is done by measuring the density of the electrolyte, which is accomplished by measuring the specific gravity of the electrolyte. The greater the concentration of sulfuric acid, the more dense the electrolyte becomes. The higher the density, the higher the state of charge.

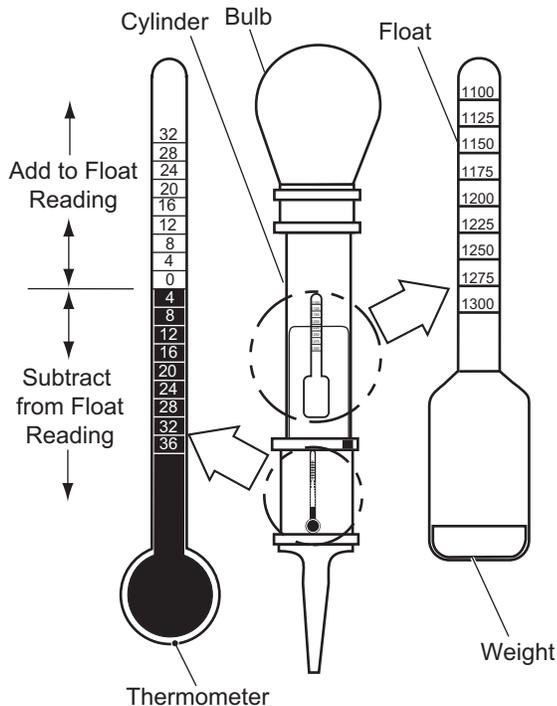


Figure 7 Hydrometer

**WARNING** To decrease the risk of battery explosion, never insert a metal thermometer into a battery. Use a hydrometer with a built in thermometer that is designed for testing batteries.

Specific gravity is the measurement of a liquid that is compared to a baseline. The baseline is water which is assigned a base number of 1.000. The concentration of sulfuric acid to water in a battery is 1.280 which means that the electrolyte weighs 1.280 times the weight of the same volume of water. A fully charged battery will test at 1.275 - 1.280 while a discharged battery will read in the 1.140 range.

**NOTICE:** Do not perform a hydrometer test on a battery that has just been watered. The battery must go through at least one charge and discharge cycle in order to permit the water to adequately mix with the electrolyte.

The temperature of the electrolyte is important since the hydrometer reading must be corrected to 80° F (27° C). High quality hydrometers are equipped with an internal thermometer that will measure the temperature of the electrolyte and include a conversion scale to correct the float reading. It is important to recognize that the electrolyte temperature is significantly different from the ambient temperature if the vehicle has been operated.

## Using A Hydrometer

1. Draw electrolyte into the hydrometer several times to permit the thermometer to adjust to the electrolyte temperature and note the reading. Examine the color of the electrolyte. A brown or gray coloration indicates a problem with the battery and is a sign that the battery is nearing the end of its life.
2. Draw the minimum quantity of electrolyte into the hydrometer to permit the float to float freely without contacting the top or bottom of the cylinder.
3. Hold the hydrometer in a vertical position at eye level and note the reading where the electrolyte meets the scale on the float.
4. Add or subtract four points (.004) to the reading for every 10° F (6°C) the electrolyte temperature is above or below 80° F (27° C). Adjust the reading to conform with the electrolyte temperature, e.g., if the reading indicates a specific gravity of 1.250 and the electrolyte temperature is 90° F (32° C), **add** four points (.004) to the 1.250 which gives a corrected reading of 1.254. Similarly if the temperature was 70° F (21° C), **subtract** four points (.004) from the 1.250 to give a corrected reading of 1.246 (Figure 8).
5. Test each cell and note the readings (corrected to 80° F or 27° C). A variation of fifty points between any two cell readings (example 1.250 - 1.200) indicates a problem with the low reading cell(s).

As a battery ages the specific gravity of the electrolyte will decrease at full charge. This is not a reason to replace the battery, providing all cells are within fifty points of each other.

Since the hydrometer test is in response to a vehicle exhibiting a performance problem, recharge and repeat test. If results indicate a weak cell, the battery or batteries should be removed and replaced with a good battery of the same brand, type and approximate age.

# BATTERIES AND CHARGING

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

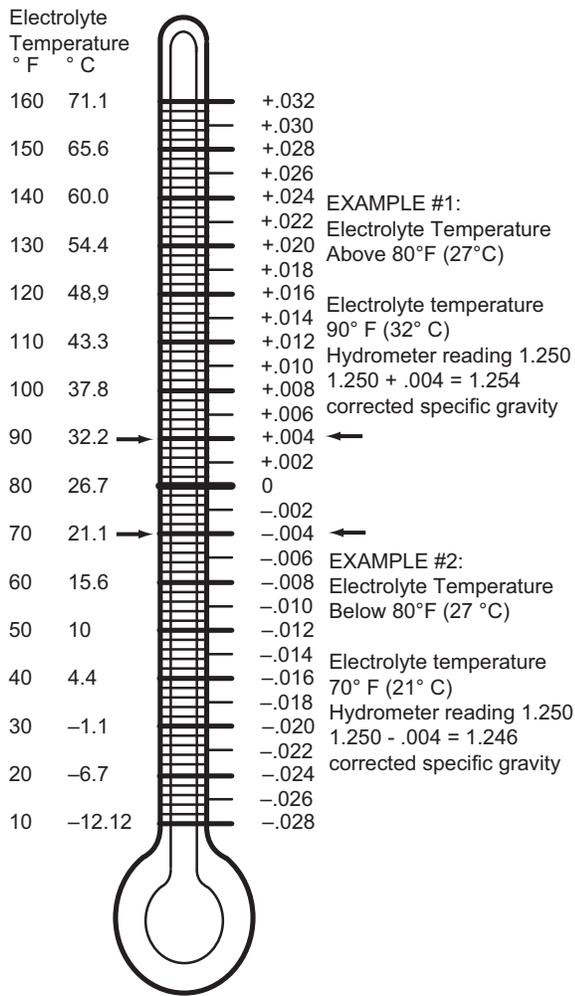
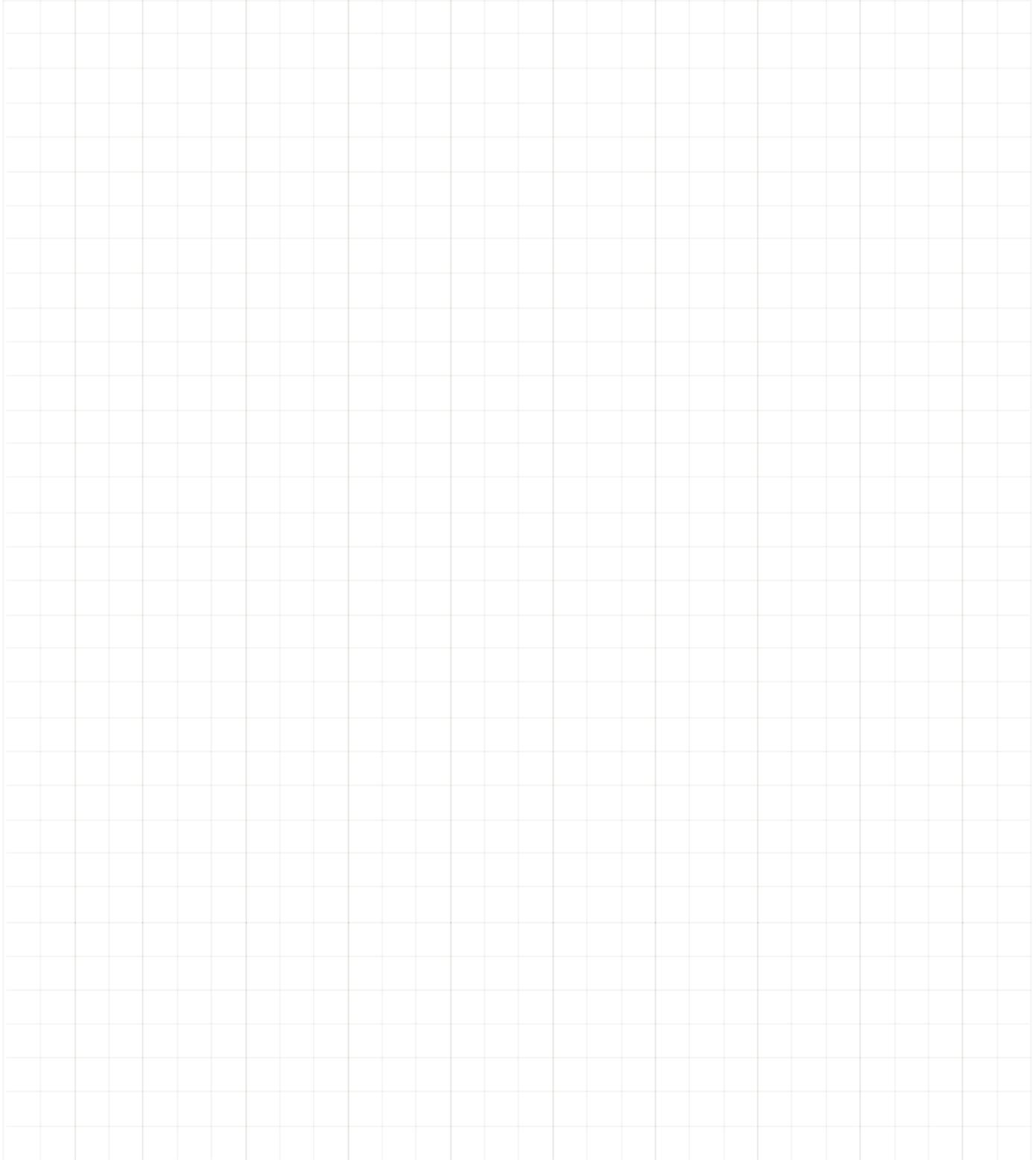


Figure 8 Hydrometer Temperature Correction

# BATTERIES AND CHARGING

*Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.*

## Notes:

A large grid of graph paper for taking notes, consisting of 20 columns and 30 rows of small squares.

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

# ELECTRICAL SYSTEM

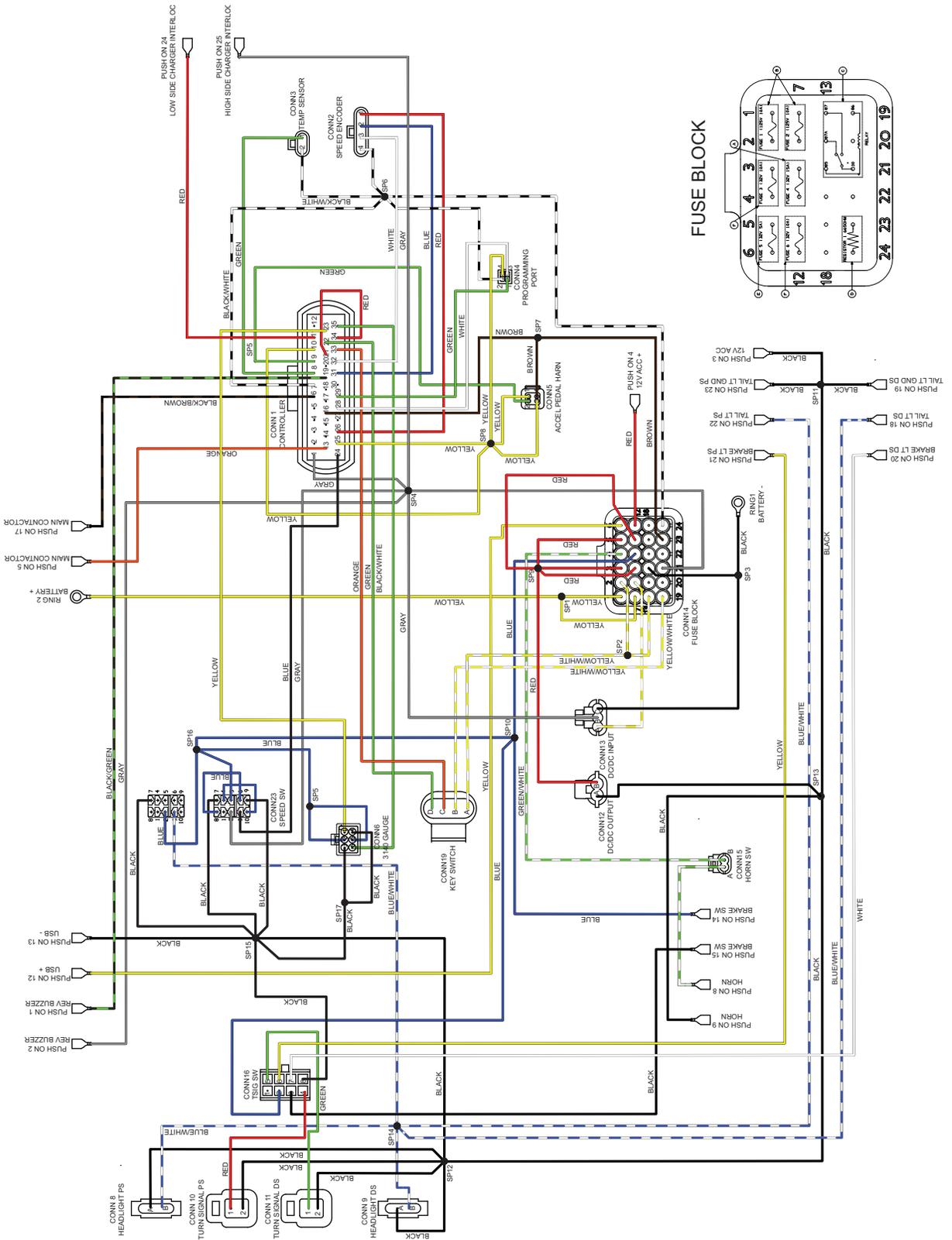


Figure 1 Wiring Diagram

# ELECTRICAL SYSTEM

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

## AWG TO METRIC CONVERSIONS

AWG	METRIC (MM2)
24	0.25
22	0.34
20	0.50
18	0.75
16	1.50
14	2.50
12	4.00
10	6.00
8	10.00
6	16
4	25
2	35
0	55
2/0	70

## VOLTAGE TEST FOR BATTERIES

### ⚠ WARNING

**Hydrogen gas formed during battery charging is explosive and can cause personal injury or death. Prevent electrical spark or open flame near battery.**

**NOTICE: If the temperature of the battery or the ambient temperature is below 60°F (15.55°C), the capacity of the battery will be less and require more time to charge.**

A cold battery will build up voltage and more rapidly reduce the charging rate.

Batteries that are new or have been stored must be fully charged before being tested or placed in vehicle.

### ⚠ CAUTION

**Do not overcharge battery.**

Battery voltage can be checked using a voltmeter. Attach the negative (-) lead of the DVOM to the ground terminal of the battery. Then attach positive (+) lead to the positive battery terminal. The voltage reading obtained should be 12 volts or above. If the reading is below 8 volts, the battery required either charging or replacement.

## MAIN HARNESS

### Power Supply

#### Tool List

Qty.

DVOM ..... 1

1. Check for loose or bare wires

Check for loose wires at each terminal connection. Check for worn insulation or bare wires touching the frame.

### ⚠ CAUTION

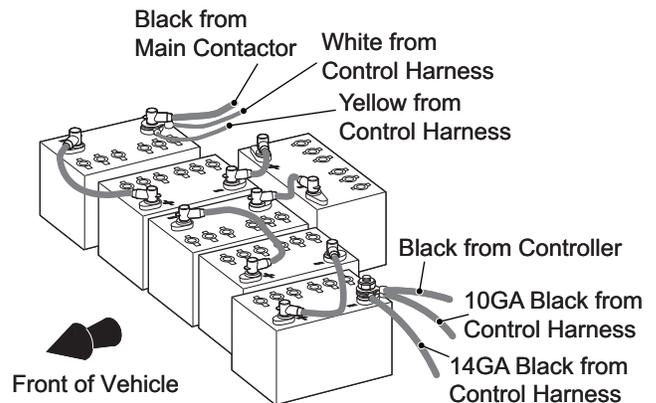
**Bare wires may cause a short circuit.**

If any DVOM readings indicate a faulty wire, it is recommended that the condition of the terminals and wire junction be examined. A faulty wire must be replaced. See "Faulty Wire Replacement".

2. Check condition of the 72V batteries set.

Check for adequate battery volts (nominal 12 VDC) by setting DVOM to 30 VDC range and place the red probe (+) on the battery post with the white (WHT) wire attached. Place the black probe (-) on the battery post with the black (BLK) wire attached. A reading of 11 VDC or greater indicates adequately battery condition. No reading indicates (a) a poor connection between the probes and the battery terminals; (b) a faulty DVOM. A voltage reading below 7 volts indicates poor battery condition and the vehicle should be recharged before proceeding with the test.

**NOTICE: Due to the resistance of the wires involved within the harness, voltage readings may be somewhat lower than battery voltage. A reading of 1 volt below battery voltage is acceptable.**



**Figure 3 Battery Connections**

# ELECTRICAL SYSTEM

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

## 3. Check fuse

Set key switch of the vehicle to the off position. Set the DVOM to the resistance setting. Place the red probe (+) on one terminal of the fuse then the black probe (-) on the other terminal. Any reading above 1 Ohm indicates a faulty fuse; replace with a good fuse of the same amperage and voltage rating.



**Use of incorrect fuse rating can damage electrical components.**

## Accessory Wiring

After determining that the fuse is good, continue checking the circuit using the procedures previously used to check the power supply, i.e. loose or rusted connections, bare wires, continuity of the wiring from terminal to terminal, operating condition of switch, etc.

Use the wiring schematic to check for correct wiring and wire routing. If there is power at the fuse end of the wire, there must also be power at the other end of the wire at the switch or electrical accessory, and eventually at the ground connection. Electricity must flow from the fuse panel through the full length of the circuit to the ground connection. Any interruption of electricity flow must be corrected, whether by repairing or replacing the wire, the switch or accessory.

## Faulty Wire Replacement

A faulty wire should be replaced with one of the same gauge and color, wired between the correct components, and secured to the harness bundle with a wire tie. The faulty wire should be cut back close to the harness and the ends protected with vinyl electrical tape.

## Headlight Replacement

**NOTICE: Following procedure is applicable for vehicles with halogen headlights.**

For vehicles equipped with halogen headlights mounted in the cowl, disconnect the wire harness connector from the bulb (1) Rotate the bulb (1) counterclockwise one quarter turn to unlock it and pull out away from the housing (Figure 4).

.Install the new bulb (1) by inserting it into the housing and rotating it clockwise one quarter turn. Reconnect the wire harness.

**NOTICE: Following procedure is applicable for vehicles with LED headlights.**

assembly must be replaced. Replacement for the single LED headlight failed is not possible. Refer to Service Parts Manual for the part number of the LED headlight.

To replace the LED headlight assembly (4), locate the nuts (2) in back of the headlight assembly, underneath the cowl that secures the front part of the light to the rear housing.

Remove the nuts allowing the LED headlight assembly (4) to be removed from the outside of the cowl.

Disconnect the wires.

Replace with a new LED headlight assembly and assemble in the reverse order of removal.

### Tool List

### Quantity.

Wrench, 10 mm ..... 1

LED headlights are designed for longevity and do not fail often. In case of failure, however, the complete headlight



*Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.*

## FAULT DIAGNOSIS

### General

In order to effectively fault diagnose the circuits that include the horn, lighting, brake/turn signals and gauge, the technician must be able to use the wiring diagram and a DVOM.

The wiring diagram shows the path followed by a voltage or signal from its origination point to its destination. Each wire is indicated by color.

The technician should use simple logic fault diagnosing in order to reduce the number of steps required to isolate the problem.

**Example 1:** If the vehicle will not start and none of the lights function (or burn dimly) the battery should be tested before trying to fault diagnose the lighting circuit.

**Example 2:** If a problem occurs in the lighting circuit that results in only one of the headlights not working, there is no reason to check battery wiring or the fuse since it is obvious that voltage is present. Since bulbs will burn out over time, the obvious place to start is at the headlight that is not functioning. If power is present at the connector and the ground wiring is satisfactory, the only possibilities that exist are a burned out bulb or a poor contact between the connectors and the headlight.

If power is not present but the other headlight functions, a wiring problem is indicated between the two headlights.

### Testing Battery Voltage

It is important to determine the condition of the battery set before proceeding with any electrical fault diagnosing. An open voltage test is of little use since a battery that has deteriorated to the point of needing replacement can still show eight volts in an open voltage test. If there is any doubt as to the adequacy of the battery set, charge the batteries and perform a load test using a discharge machine following manufacturer's instructions. If batteries are satisfactory, recharge battery set.

With the adequacy of the batteries confirmed, use a DVOM connected directly to the battery terminal posts to determine the open voltage of the set. In the following tests, this voltage level will be used as a reference. Some loss due to resistance of wires and connectors may be indicated by readings that could be up to one volt less than the reference voltage. No reading indicates an "open" condition and the battery wires should be inspected for a broken or disconnected wire or component.

### Continuity Check

#### **WARNING**

***To prevent possible injury or death resulting from a battery explosion, use an insulated wrench and remove the BL- wire***

***from the battery to disconnect electrical power to vehicle.***

Turn the key switch to OFF before disconnecting power by removing the BL- connection to the battery. Always use insulated wrenches when working on batteries. To check for continuity, set the DVOM to the K $\Omega$  setting and select Continuity. The meter will give an audible signal when it detects continuity. If the meter does not have a continuity setting, set it to K $\Omega$ , the meter will indicate "0" when it detects continuity.

# ELECTRICAL SYSTEM

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

## Testing a Switch for Continuity

Place one probe on one contact of the switch. Place the second probe on the second terminal of the switch (Figure 6).

Actuating a normally open (NO) switch will cause the DVOM to show “0” or give an audible indication when the switch is operated. A normally closed (NC) switch will cause the meter to show “0” or give an audible indication when the probes are attached without activating switch. The audible indicator will stop and the meter display will indicate a value greater than “0” when the switch is activated.

The change in display or audible indicator shows that the switch is functioning.

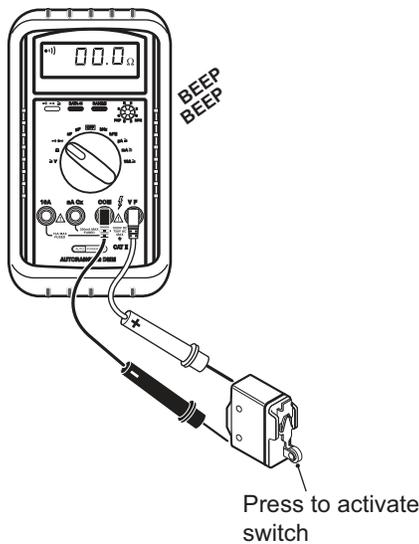


Figure 6 Continuity Check of Switch

## Testing a Solenoid for Continuity

Place one probe on one of the large terminals and the other probe on the second large terminal (Figure 7). If the meter shows “0” or gives an audible indication, the solenoid terminals are “welded” closed and the solenoid must be replaced.

If the continuity test indicates that contacts are not “welded” and the wiring to the solenoid coil is good, the coil has failed and the solenoid must be replaced.

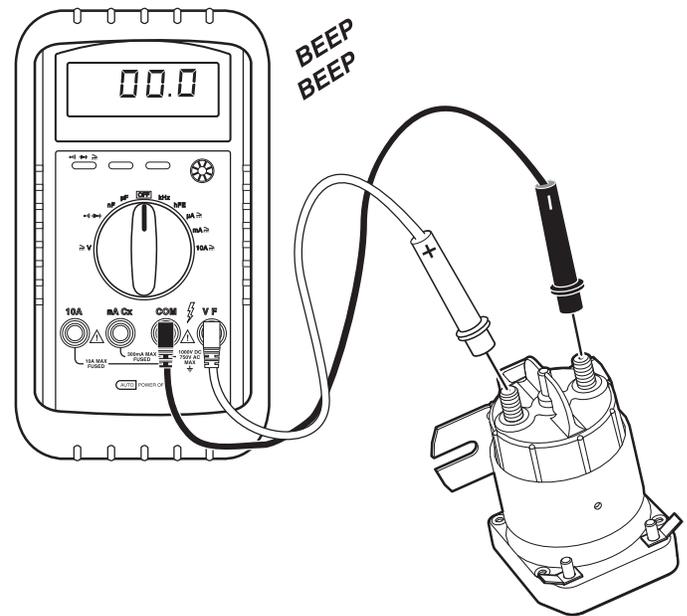


Figure 7 Continuity Check of Solenoid

## BRAKES

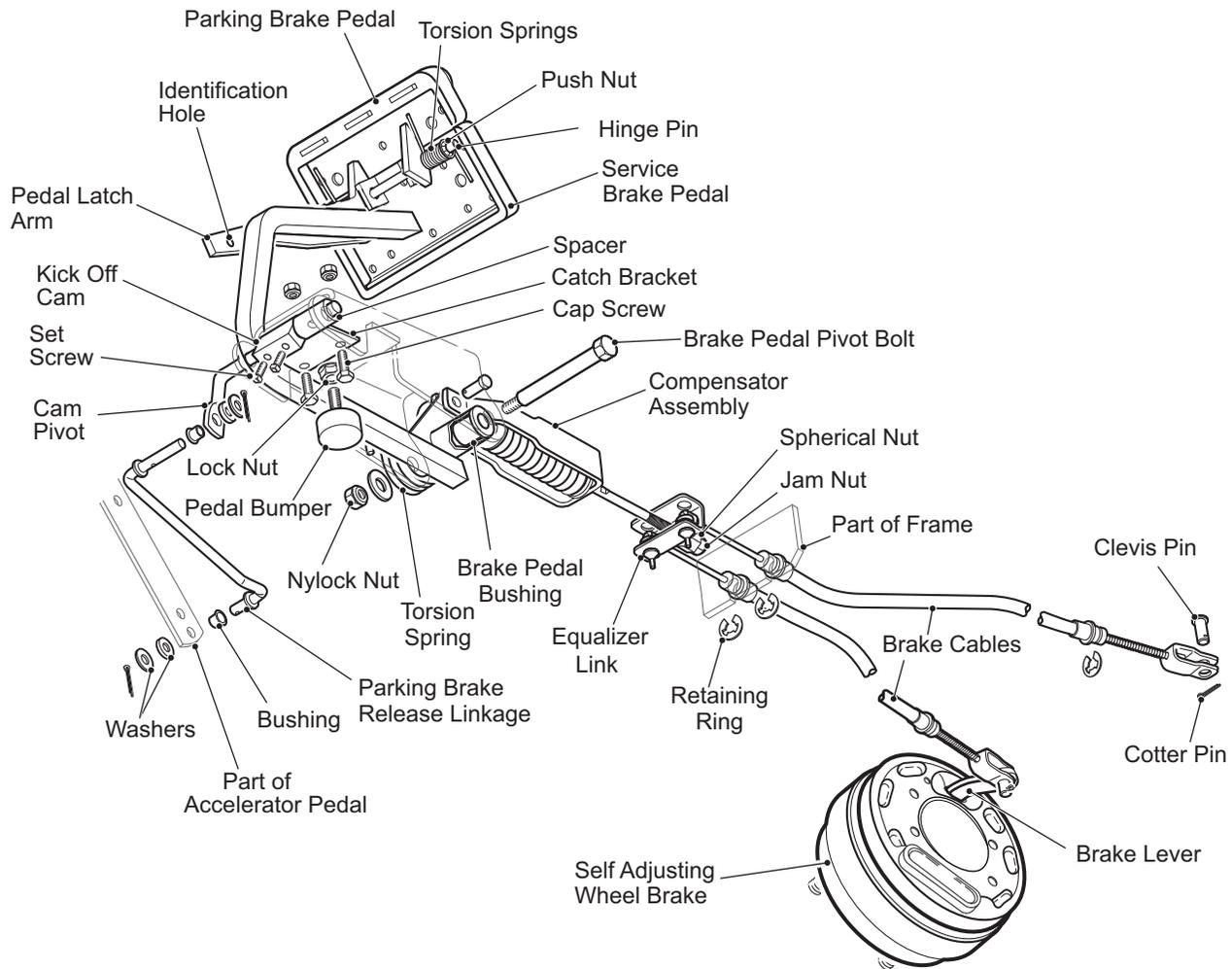


Figure 1 Mechanical Brake System

## BRAKE SYSTEM OVERVIEW

### General Description

This vehicle is equipped with a mechanically activated rear drum brake system. The brake system consists of a service brake and parking brake pedal, parking brake release linkage, compensator assembly, equalizer link, brake cables and self adjusting wheel brake assemblies (Figure 1).

Mechanical brakes depend on the travel of the brake cables to move the brake shoes against the brake drums. The travel of the brake cables is governed by the brake pedal. If the cables cannot travel far enough to absorb the slack (free travel) in the system and still apply the shoes to the drums, the braking effort at the wheel brake will not be adequate. The self adjusting mechanism in the wheel brakes requires enough cable travel at the wheel brake to work reliably. When the brake is

released, there must be slack in the system so the brakes will release fully and the adjusters will function. Free pedal travel, pedal force, shoe to drum clearance and braking capability are closely related. It is very important to maintain the proper relationships to assure braking performance and the best wheel brake adjustment.

### How the Brake Works

Pressing the service brake pedal pulls the compensator assembly and equalizer link, which are connected to the brake cables (Figure 1). The first part of the pedal travel removes slack from the system. Continued motion of the brake pedal pulls both the left and right brake cables. Each brake cable pulls a brake lever which pushes the rear brake shoe against the brake drum. When the rear shoe contacts the brake drum, it can no longer move rearward. Additional pedal (and cable) travel causes the actuator bracket (moving anchor) to move and applies

# BRAKES

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

force to the front shoe, pushing it against the brake drum. The force applied to the front and rear shoes is approximately equal. As the shoes contact the moving brake drum, the shoes try to move in the direction of drum rotation. This movement results in the typical brake shoe wear patterns.

## Equalizer Link

The equalizer link balances braking between the driver and passenger sides of the vehicle. Variations in wheel brake adjustment, cable friction and manufacturing tolerances may cause the equalizer to be slightly misaligned. This misalignment is normal.

## Automatic Adjuster Mechanism

### CAUTION

**Never manually adjust the brakes at the star wheel. Doing so will cause permanent damage to the adjuster assembly and result in a gradual loss of brakes.**

The wheel brakes are equipped with an automatic adjuster mechanism that is designed to compensate for brake shoe wear and eliminate the need for manual brake shoe adjustment. The brake adjuster is activated by movement of the lever attached to the brake cable.

## How the Park Brake Works

The park brake is operated by a smaller pedal which extends across the top of the service brake pedal. It is spring loaded and attached to the service brake pedal with a hinge pin (Figure 2).

Pressing the park brake pedal moves the latch arm against the catch bracket attached to the chassis. As the park brake is pressed, the brake is applied until the notch in the latch arm engages with the catch bracket. The brake pedal is held in the applied (down) position by the catch bracket.

The latch arm is held in position by the tension in the brake linkage. The parking brake can be released by two methods:

1. Pressing the brake, which permits the spring loaded park brake pedal to return to its original position, disengages the latch arm from the catch bracket. This is the preferred method because it minimizes wear on components.
2. Pressing the accelerator pedal rotates the kick-off cam and forces the pedal latch arm to move away from the catch bracket. The spring loaded park brake pedal returns to its original position, releasing the brake.

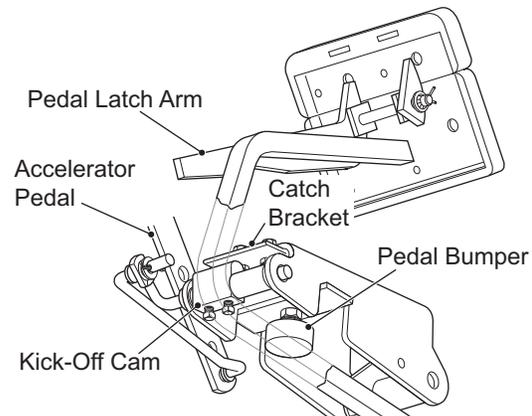
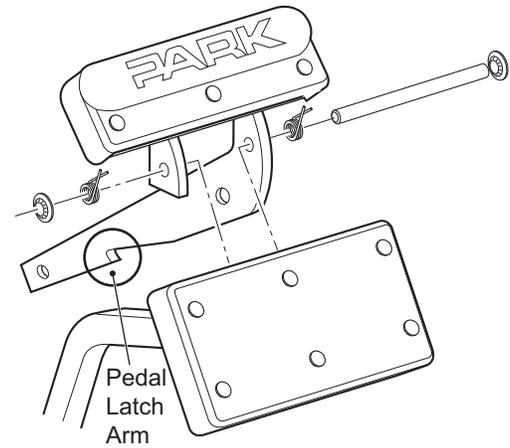


Figure 2 Parking Brake and Kick-Off Mechanism

## Kick-Off Actuating Linkage

The kick-off actuating linkage may require periodic adjustment to compensate for the normal wear. Replacement of any linkage components will also require an adjustment.

## Compensator Assembly

The compensator assembly contains a spring, which is compressed until the stop tube within the spring is engaged and the linkage becomes solid (Figure 3). The brake compensator assembly applies a spring load to the park brake system and insures that the park brake remains under tension whenever it is engaged.

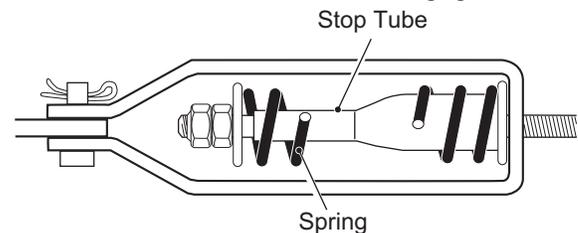


Figure 3 Compensator Assembly

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

## FAULT TESTING FLOWCHART

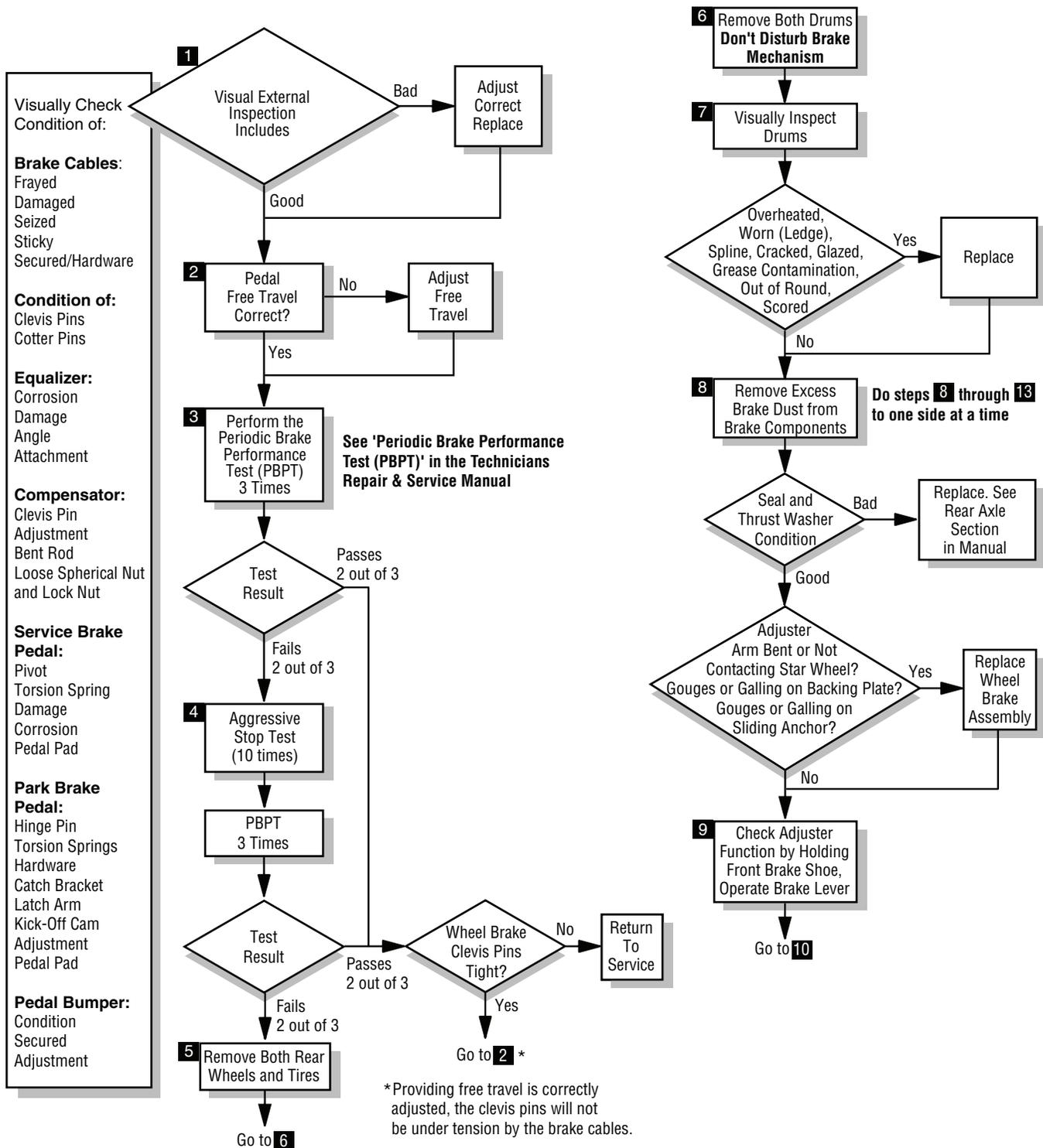
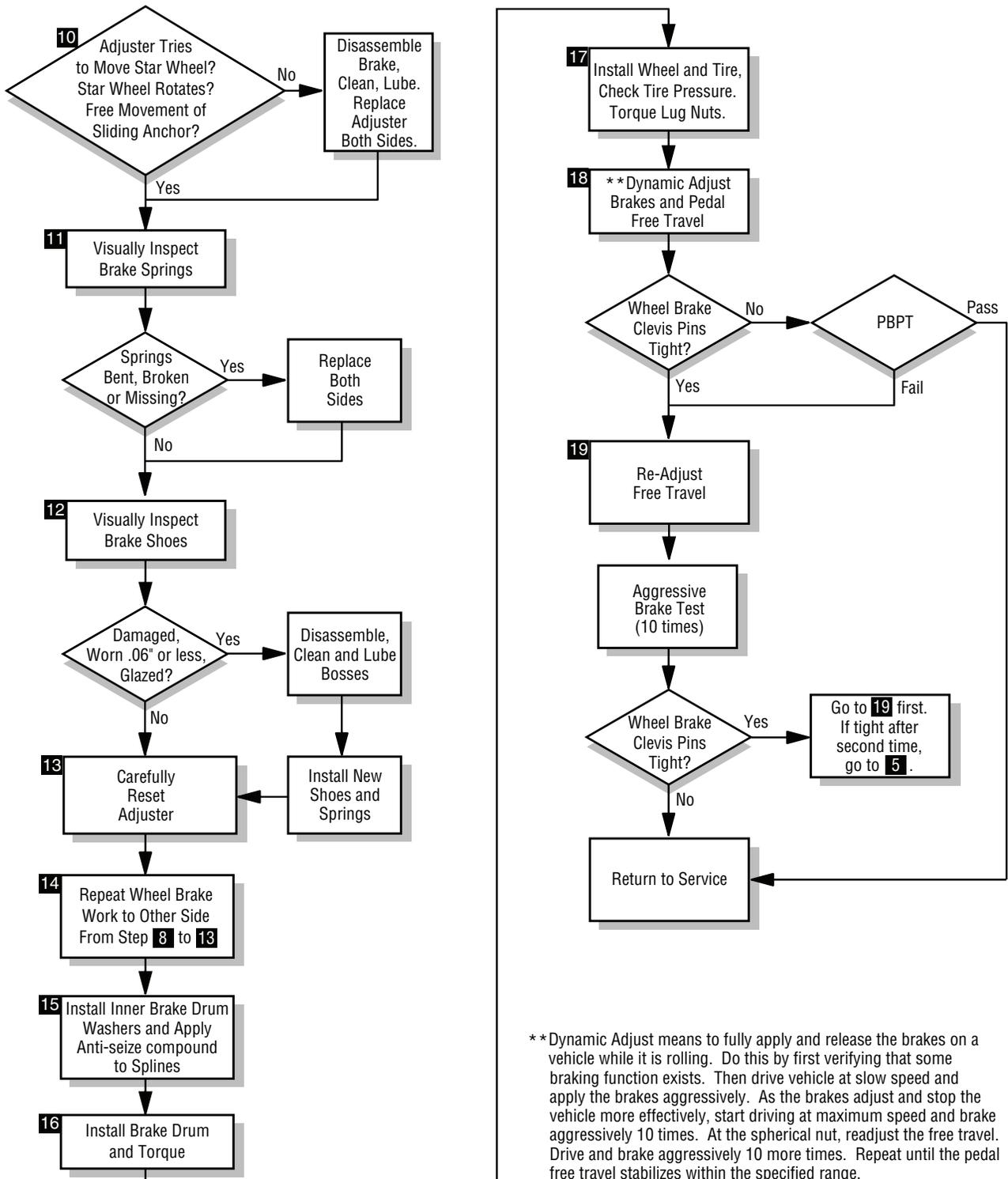


Figure 4 Fault Testing Flowchart

# BRAKES

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.



\*\*Dynamic Adjust means to fully apply and release the brakes on a vehicle while it is rolling. Do this by first verifying that some braking function exists. Then drive vehicle at slow speed and apply the brakes aggressively. As the brakes adjust and stop the vehicle more effectively, start driving at maximum speed and brake aggressively 10 times. At the spherical nut, readjust the free travel. Drive and brake aggressively 10 more times. Repeat until the pedal free travel stabilizes within the specified range.

Figure 5 Fault Testing Flowchart (Continued)

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

## FAULT TESTING TABLE

thorough visual inspection, Daily Brake Performance Test has been performed (Figure 6).

Refer to the following fault diagnosis table only after the

Condition	Possible Cause	Correction
<b>Fails Brake Performance Test by stopping in a longer distance than normal</b>	Wheel brake failure due to severely worn or damaged components	Replace all severely worn or damaged components
	Brake pedal not returning	Check for binding of brake pedal
	Brake not adjusting	Check brake pedal free travel Check brake cables Check brake adjusters Check pedal pivot
	Brake shoes wet	Check again when shoes are dry
	Brake cables damaged or sticky	Check brake cable and replace if sticky or damaged
	Brake shoes severely worn	Replace
	Brake shoes glazed	Sand shoes with emery cloth provided that shoes have .06" (1.5 mm) min. material
	System not adjusted properly	Check and adjust per manual
	End of brake cable loose from anchor brackets Cracked brake drum	Check and repair Replace
<b>In excess of 1-1/8" (2.9 cm) free pedal travel (Soft Pedal)</b>	Low pedal force at parking brake latch	Adjust per manual
	Brake cables damaged	Replace
	Brake return bumper out of adjustment	Adjust per manual
	End of brake cable loose from anchor brackets	Check and repair
	Wheel brake failure due to severely worn or damaged components	Replace all severely worn or damaged components
	System not adjusted properly	Adjust per manual
<b>Less than 7/8" (2.2 cm) free pedal travel (Hard Pedal)</b>	High pedal force at parking brake latch	Adjust per manual
	Brake cables damaged or sticky	Check brake cable and replace if sticky or damaged
	System not adjusted properly	Check and adjust per manual
	Wheel brake failure due to severely worn or damaged components	Replace all severely worn or damaged components
<b>Neither wheel locks when parking brake is latched. (Note: At full speed the wheels may not lock, but should brake aggressively).</b>	Incorrect compensator spring adjustment	Return to factory specification
	Excessive brake pedal free travel	Adjust per manual
<b>Unequal braking (one wheel locks while other rotates)</b>	Wheel not locking is not adjusting	Check brake operation of wheel that is <b>not</b> locking
	Sticky/dragging cable	Check for brake lever return Check that brake levers return at equal rate - (Indication of dragging cable)
	Cracked brake drum	Replace
	Brake shoes wet or glazed	Check again when shoes are dry
	Rusted or sticky brake pivot hardware	Replace

Figure 6 Fault Testing Table

# BRAKES

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

Condition	Possible Cause	Correction
<b>Neither wheel locks</b>	Brake system requires complete adjustment	Adjust entire system
	Brake pedal not returning	Check for binding of brake pedal Check brake pedal free travel
<b>Grabbing brakes (oversensitive)</b>	Moisture has caused surface rust on drums	Apply moderate force to pedal while at maximum level ground speed to remove rust until condition is relieved.
	Brake Pivot binding	Check and replace poor components
<b>parking brake hard to latch</b>	Inadequate free play	Adjust pedal free travel at spherical nut and check that wheel brake actuators are returning fully
	Sticky/dragging cable	Check for brake lever return Check that brake levers return at equal rate - (Indication of dragging cable)
	Dragging shoes	Check wheel brakes
<b>parking brake will not stay latched</b>	Excessive wear	Check for worn latch mechanism

Figure 6 Fault Testing Table (Continued)

## FAULT DIAGNOSIS AND INSPECTION

### New Vehicles

A new vehicle will undergo an initial break-in of components including brake cables and brake shoes. In this break-in period, it is not uncommon for the brake pedal free travel (and the effort required to latch the parking brake) to change. The timing of this change varies with terrain and the driving habits of the operator(s). When this occurs, the brake linkage should be adjusted. See *Adjusting Brake Pedal Free Travel*. After the initial break-in period, no further adjustments are necessary until routine maintenance is scheduled.

### Fault Diagnosis and Inspection Procedures

To find the problem in the mechanical brake system, inspect the brake pedal and linkage to find worn or damaged parts per the Fault Testing Flowchart. Then, do the Brake Performance Test to evaluate the brake system performance. Based on the results of the inspection and tests, refer to the Fault Diagnosis Table (Figure 5) to evaluate symptoms and repairs. If necessary, disassemble the wheel brake to locate and correct internal faults.

For removal or replacement of parts and adjustments referred to in this section of the manual are described in detail under *MAINTENANCE AND REPAIRS*.



**Satisfactory brake performance does not eliminate the need for routine brake testing and inspection as indicated in the PERIODIC**

**SERVICE SCHEDULE section. Correct brake operation depends on maintenance.**

### Brake Pedal and Linkage Inspection

1. **Inspect brake pedal return bumper.**  
Ensure that the brake pedal is contacting the return bumper when released, that the bumper is in good condition and that a 1/4" - 3/8" (6 - 9.5 mm) gap exists between the pedal arm and the setscrew heads of the kick-off cam (Figure 7). Replace or adjust the pedal bumper if required. See *Pedal Bumper Adjustment*.

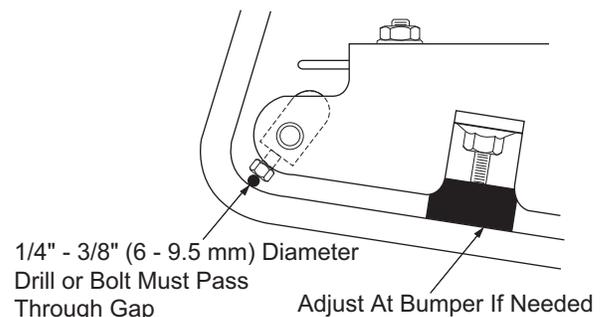
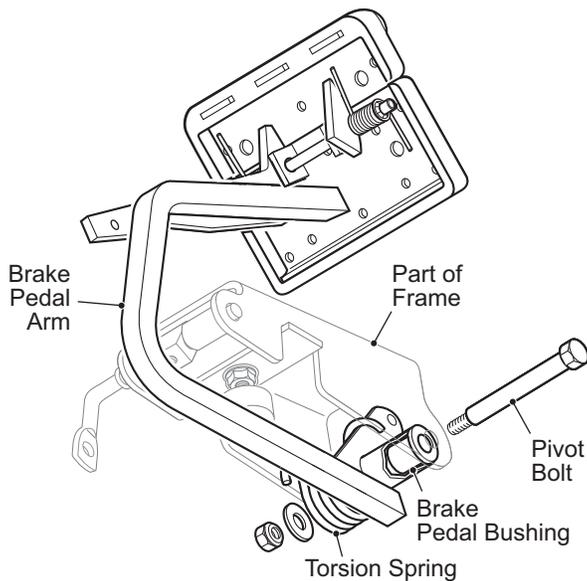


Figure 7 Brake Pedal Bumper Inspection

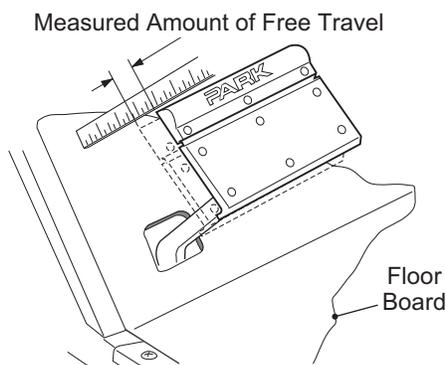
2. **Check brake pedal return.**  
Apply the brake pedal and release. Check that the brake pedal arm rests against the return bumper when released. Check that the torsion spring is hooked around both the pedal and the frame and is in good condition. If the pedal does not return fully or is sluggish, the brake pedal bushings and pivot bolt should be inspected (Figure 8). Replace pedal, spring, bushings and bolt as required. See *Brake Pedal Removal and Installation*.

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.



**Figure 8 Brake Pedal Inspection**

- 3. Check the brake pedal free travel.**  
 Brake pedal free travel refers to the distance the pedal moves from rest, to the point at which the brake shoes first contact the brake drums. This should not be confused with the light resistance that is felt as the brake pedal is pressed enough to remove slack from the compensator and cables. Too much pedal free travel may indicate wheel brakes not adjusting, wear in the cables and linkages or initial break-in of components. Not enough free travel can indicate improper adjustment of the wheel brake or the brake linkage. Either condition can prevent the brakes from adjusting properly.

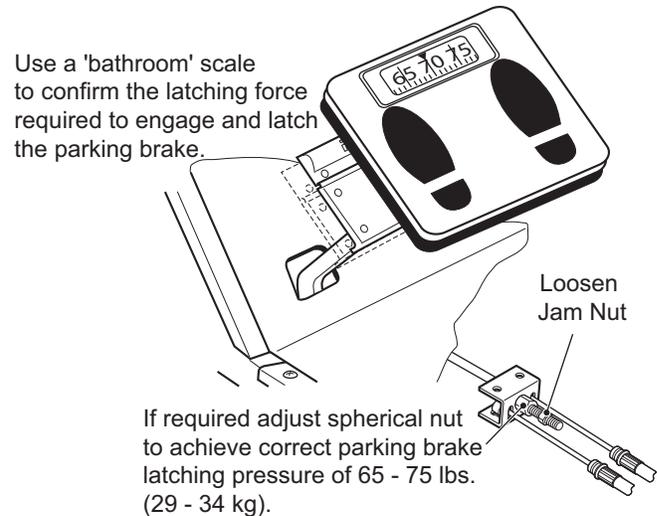


**Figure 9 Check for Excessive Free Travel**

The correct brake pedal free travel should be set to 7/8" - 1 1/8" (2.2 - 2.9 cm) (Figure 9).

The park brake lock force may be checked for verification after setting brake pedal free travel. The recommended method of checking park brake lock force is to place a 'bathroom' scale on the brake pedal. Use both feet, press

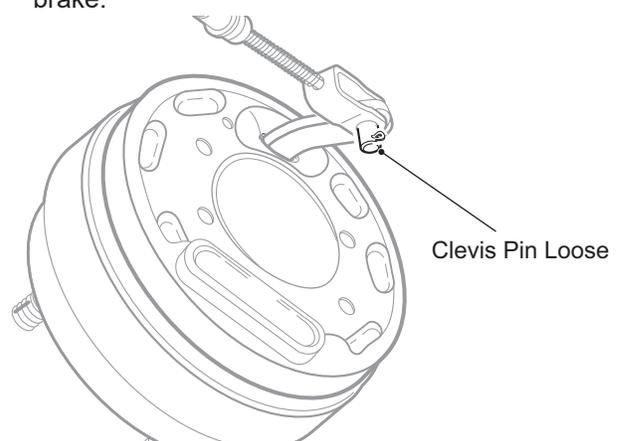
the scale down evenly against the park brake pedal until it latches. The park brake must lock between 65 and 75 lbs. (29 - 34 kg) indicated on the scale (Figure 10). If necessary, adjust the spherical nut to achieve correct latching pressure.



**Figure 10 Checking Park Brake Latching Pressure**

Adjust brake pedal free travel as described See *MAINTENANCE AND REPAIRS* if required.

- 4. Inspect the brake cables.**  
 Inspect for damage to the outer cable, wear of the inner cable or no free motion when the pedal is applied and released. Inspect the brake cable supports to make sure the cables are correctly secured. If any of these conditions are found, replace both cables and equalizer.
- 5. Check the clevis pins.**  
 Check the clevis pins that secure the brake cables to the brake lever. When the brake pedal is released (Figure 11). If the clevis pins are not loose, but brake pedal free travel is correctly adjusted and the brake cables move freely, the problem is likely in the wheel brake.

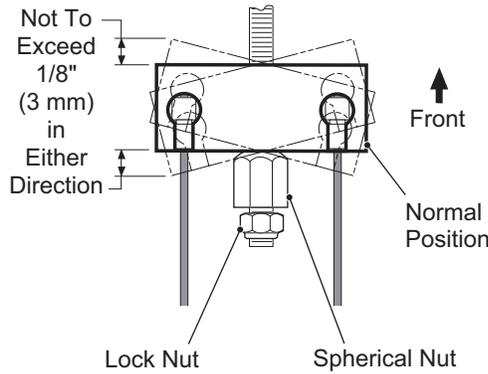


**Figure 11 Check Clevis Pins**

# BRAKES

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

- Inspect the brake cable equalizer linkage.**  
 Inspect for corrosion, damage, wear or excessive misalignment (Figure 12). Replace the cable if corrosion, damage, or wear is found.
- Inspect the compensator assembly.**  
 Inspect for damage, corrosion or wear; replace the complete assembly if present. In general, adjustment will not be necessary, as the spring assembly is factory calibrated. With the park brake disengaged, check that the compensator spring length is 3-15/16" (10 cm) (Figure 12). If an adjustment is required, it should be made at the nuts at the spring facing the front of the vehicle. Tighten the jam nut firmly after adjusting.



View From Below

NOTE: This dimension is factory pre-set with the parking brake disengaged and is not to be changed.

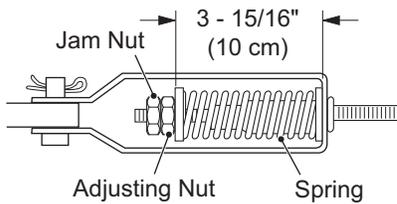


Figure 12 Equalizer and Compensator

- Inspect park brake pedal hinge.**  
 Check for broken springs, and correct retention of the hinge pin. Operate park brake pedal to confirm smooth operation of the hinge mechanism (Figure 13).

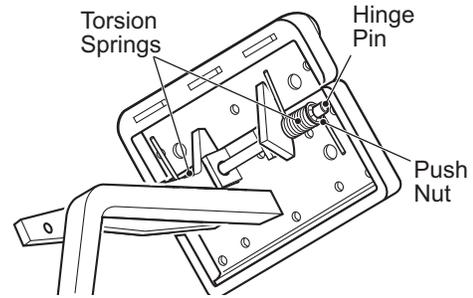


Figure 13 Parking Brake Pedal Hinge Inspection

- Check the condition and operation of the park brake latching mechanism.**  
 The park brake should latch firmly and release as soon as the accelerator pedal is pressed.

**WARNING**

To prevent serious injury or death from the use of worn park brake components, do not attempt to renew worn components. The park brake latch arm, kick-off cam and catch bracket are hardened parts. Do not grind or file them, as doing so will cause the parts to lose their hardness properties. Always use new parts.

- Inspect catch bracket and latch arm.**  
 Replace if indication of wear or damage are found (Figure 14).
- Inspect the park brake kick-off cam.**  
 Look for wear and for correct adjustment. With the park brake engaged and fully latched, there must be no gap between the top of the cam and the latch arm. Adjust the kick-off cam if required (Figure 14). Correct setscrews must be used to hold the kick-off cam to the pivot rod. Use of longer screws prevents correct adjustment of pedal bumper (pedal travel) and may prevent the brakes from adjusting properly.
- Inspect kick-off cam linkage and bushings.**  
 Check for wear and damage. The kick-off cam pivot and bushings must move freely and be free of corrosion. The kick-off cam should rotate when the accelerator pedal is pressed.

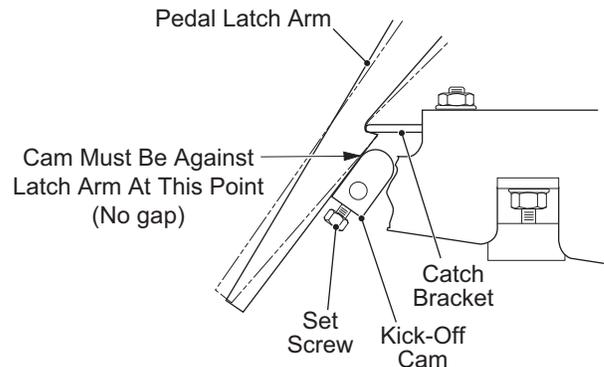


Figure 14 Kick-Off Cam Inspection

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

## Daily Brake Performance Test

**NOTICE:** To ensure correct braking performance, all maintenance, inspections and procedures must be performed as indicated in the **PERIODIC SERVICE SCHEDULE** section. A Daily Brake Performance Test must be performed, and the entire brake system must be serviced in accordance with the Periodic Service Schedule. The brake system must be bled whenever any part of the brake system has been replaced.

Press the brake pedal. The pedal should have some initial free play, and then become resistant. This indicates proper performance.

If the brake pedal has a soft feel or loses resistance, perform a brake system inspection, See Brake System Inspection.

## Wheel Brake Inspection

### ⚠ WARNING

**Wear a dust mask and eye protection whenever working on wheel brakes.**

**Do not use pressurized air to blow dust from brake assemblies.**

**Replace both brake shoes on both wheels if one or more shoes are worn below .06" (1.5mm) thickness at any point.**

### ⚠ CAUTION

**Do NOT touch any of the wheel brake mechanism except as instructed.**

**Do NOT use a commercial brake cleaner unless the entire brake has been disassembled.**

1. Remove the brake drums.  
Do not disturb adjuster mechanisms. Remove excess dust and dirt from the drum with a brush.

### ⚠ WARNING

**The drum must not be machined to remove grooves in the friction surface. Machining the drum makes the wall thin and can cause the drum to fail. Drum failure causes a loss of braking capacity, which can cause severe injury or death.**

2. Inspect the brake drum.  
Look for a blue coloration or blistered paint indicates that the drum has overheated. Check for grooves in the friction surface. Check for an area worn below the rest of the friction surface indicating excessive wear. Inspect the splines for galling, wear and corrosion. If any of these problems are present, the drum must be replaced.
3. Remove any accumulated brake dust from the wheel brake assembly with a brush.

4. Visually inspect the axle seal for oil leakage, and the condition of the thrust washer. If oil is present, see REAR AXLE section.
5. Verify the inner brake drum washer is present and check its condition. Replace if damaged or missing.

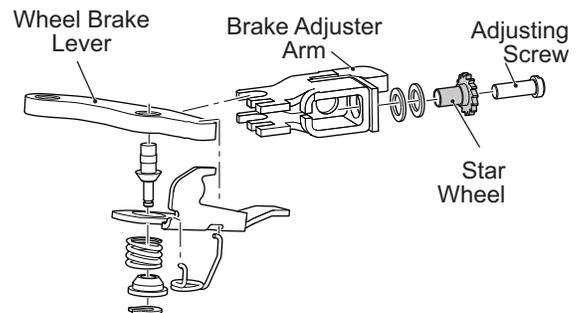
### ⚠ WARNING

**If one wheel brake assembly is replaced, the one on the other side must also be replaced.**

### ⚠ CAUTION

**Be careful when you handle the adjuster arm. Excessive force will damage the adjuster and both wheel brake assemblies will need to be replaced.**

6. Visually check the condition and operation of the adjuster mechanism.
  - Inspect the brake lever for damage or wear. Test the adjuster function as follows:
  - Push the front brake shoe in the direction of the rear of the vehicle and hold in position.
  - Operate the brake lever.
  - Observe the brake adjuster arm and note if the arm engages the star wheel and tries to rotate it (Figure 15).



**Figure 15 Adjuster Mechanism**

If the adjuster arm **engages and turns** the star wheel, proceed. If the arm **fails to engage** the star wheel, it has been damaged and both wheel brake assemblies must be replaced.

If the adjuster arm engages the star wheel but **fails to rotate it**, the adjuster assemblies must be replaced with new color-coded adjusters. Note the location of the two Teflon coated washers (Figure 15).

7. Check the condition and operation of the moving anchor assembly (Figure 15).  
Operate the brake lever to check for free motion. The adjuster assembly and brake lever should move smoothly from front to back on the backing plate. If the moving anchor assembly is damaged or jams against the backing plate, replace both wheel brake assemblies.

# BRAKES

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

## ⚠ WARNING

**A backing plate assembly that shows any indication of galling or gouging is not repairable and must be replaced with a new wheel brake assembly. Always replace wheel brake assemblies in pairs.**

8. Inspect the backing plate. Inspect for gouges, galling or other damage, particularly where the backing plate is contacted by the brake shoes and by the moving anchor assembly. Replace both backing plates if any gouges or galling is found.
9. Measure the brake shoe thickness. Measure at the most worn area. Brake shoe thickness must never be less than .06" (1.5 mm) at any point on the shoe. It is normal for the shoes to show more wear at the leading and trailing edges (Figure 16). If the brake shoe thickness is approaching .06" (1.5 mm), the shoes should be replaced. The brake shoe springs and brake adjusters be replaced when installing new brake shoes.
10. Inspect the brake shoe springs. Be sure that they are not broken or damaged and are correctly installed. The springs must be inserted with the light spring at the bottom. The long hook is installed down through the rear brake shoe. The heavier top spring is installed with the spring hooks facing up. The heavy top spring is installed with both spring hooks installed down through the brake shoes (Figure 17).
11. Repeat procedure at the opposite wheel brake.
12. Check/adjust brake pedal free travel. Whenever the brake system is serviced or requires parts replaced, the brake pedal free travel must be checked and adjusted. See *Adjusting Brake Pedal Free Travel*. This includes all linkage and wheel brake components.

The pattern of normal brake shoe wear is shown in quadrant A, B, C & D with quadrant A showing the most wear. Quadrant B will show the second most wear.

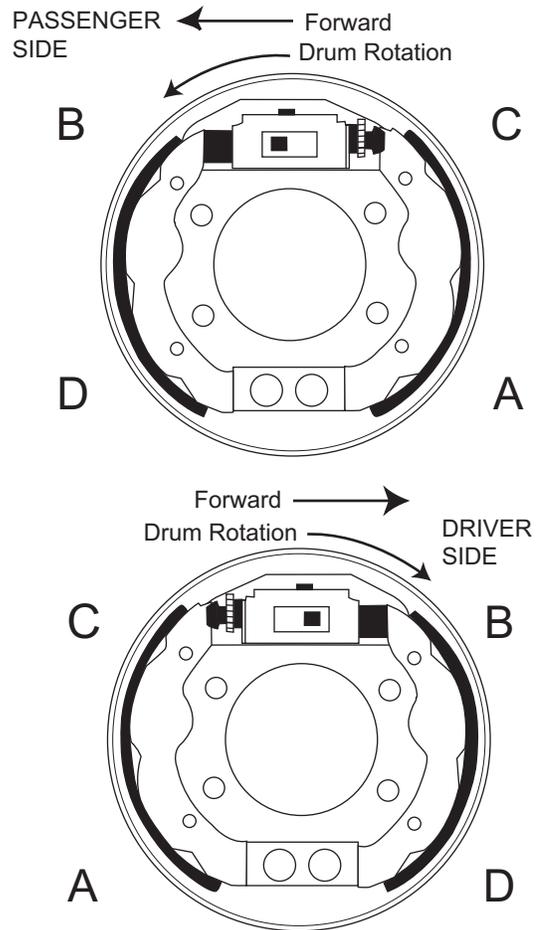


Figure 16 Brake Shoe Wear

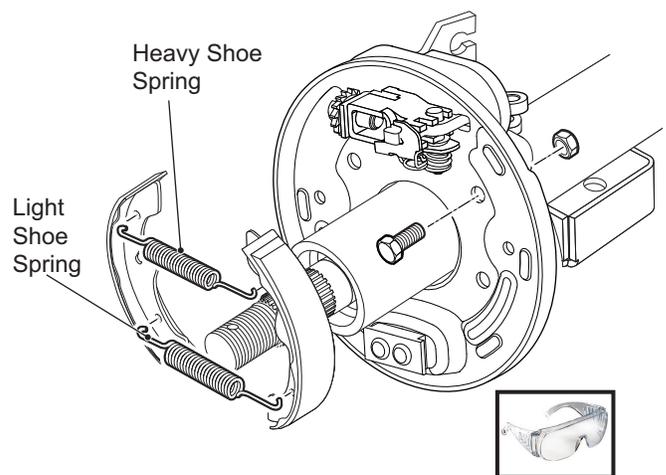


Figure 17 Orientation of Brake Shoe Springs

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

## MAINTENANCE AND REPAIRS

Tool List	Quantity
Hydraulic Floor Jack.....	1
Scale .....	1
Jack Stands.....	4
Wheel Chocks .....	4
Socket, 1/2" .....	1
Socket, 3/4" .....	1
Socket, 11/16" .....	1
Socket, 15/16" .....	1
Socket, 1 1/8" .....	1
Socket, 1/4" .....	1
Torque Wrench, ft. lbs .....	1
Torque Wrench, in. lbs.....	1
Extension, 6" .....	1
Ratchet .....	1
Open End Wrench, 1/4".....	1
Open End Wrench, 1/2".....	1
Open End Wrench, 5/8".....	1
Straight Blade Screwdriver.....	1
Straight Blade Screwdriver, Narrow .....	1
Pliers .....	1
Vernier/Dial Calipers.....	1
Plastic Tipped Hammer .....	1
Puller (P/N 15947G1).....	1
Pry Bar .....	1
Dust Mask .....	1
Emery Cloth.....	1

### Adjusting Brake Pedal Free Travel

#### CAUTION

**Brake pedal free travel must be checked and adjusted any time the brake system is serviced, or when parts are replaced.**

Brake pedal free travel refers to the distance the pedal travels from rest to the point at which the brake cables start to move the brake levers. This should not be confused with the light resistance felt as the brake pedal is pressed enough to remove slack from the compensator and cables. Correct adjustment of free travel is essential to proper brake function. Excess free travel will limit braking capability; insufficient free travel may cause the brakes to drag (not fully released). Either condition can prevent the brakes from adjusting properly.

#### WARNING

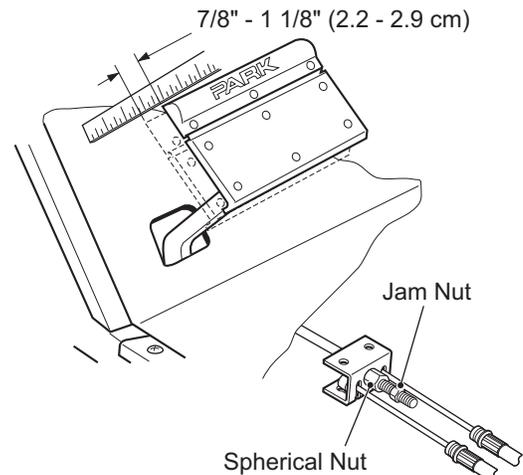
**The purpose of this procedure is to adjust the brakes and seat brake system components. The brake system cannot be effective**

**for the first few applications of the brake pedal.**

Pre-adjust service brake pedal free travel to the correct setting by loosening the jam nut and adjusting the spherical nut (Figure 18). Tighten the jam nut to the torque

value specified below.

Item	Torque Specification
Jam Nut	10 - 11 ft. lbs. (14 - 15 Nm)



**Figure 18 Free Travel Adjustment**

The correct brake pedal free travel is 7/8" - 1 1/8" (2.2 to 2.9 cm).

Press the brake pedal aggressively four to six times to establish known free travel.

#### WARNING

**All brake tests must be done in a safe location with regard for the safety of all personnel.**

In a safe location, free from people and vehicles, drive the vehicle at reduced speed and apply the brakes aggressively. As the brakes adjust and stop the vehicle effectively, start driving at maximum speed and brake aggressively 10 times.

At the spherical nut, adjust the free travel as noted above.

Drive again and brake aggressively 10 times.

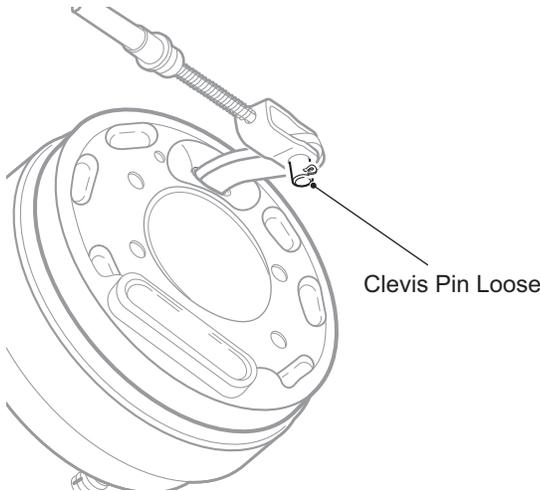
Repeat the previous step(s) until the pedal free travel does not change during the aggressive braking.

Check to see that the clevis pins attaching the brake cables to the brake levers are loose (Figure 19). If they are not loose, inspect the system again and correct as required. If the clevis pins are loose, tighten the jam nut at the spherical nut to the torque value specified below.

Item	Torque Specification
Jam Nut	10 - 11 ft. lbs. (14 - 15 Nm)

# BRAKES

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

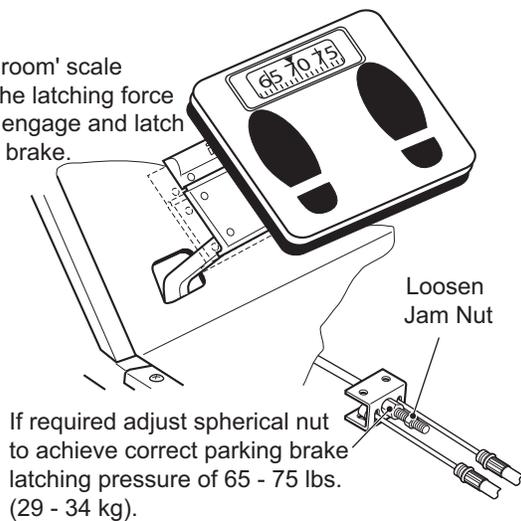


**Figure 19 Check Clevis Pins**

The park brake latching force can be checked as verification after setting brake pedal free travel. To check the park brake latching force, place a bathroom scale on the brake pedal. Use both feet to press the scale down against the park brake pedal until it latches. The park brake should latch between 65 and 75 lbs. (29 - 34 kg) indicated on the scale (Figure 20).

Perform the Brake Performance Test as described and return the vehicle to service if brake performance is satisfactory.

Use a 'bathroom' scale to confirm the latching force required to engage and latch the parking brake.

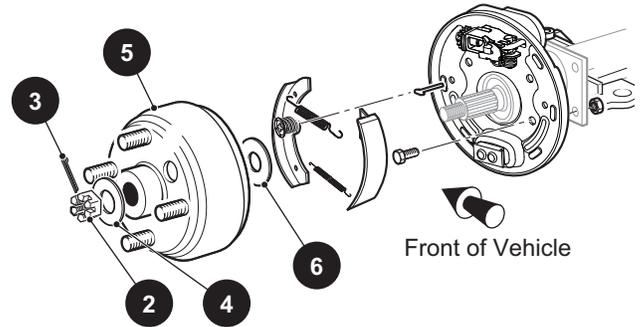


If required adjust spherical nut to achieve correct parking brake latching pressure of 65 - 75 lbs. (29 - 34 kg).

**Figure 20 Checking Parking Brake Latching Pressure**

## Brake Drum Removal and Installation

Remove the dust cap to gain access to the castellated nut (2) and the cotter pin (3) (Figure 21).



**Figure 21 Brake Assembly**

Remove the cotter pin (3) and castellated nut (2) as shown.

**NOTICE: Do not apply the brake when removing the nut as the shoes may not fully retract, preventing removal of the brake drum.**

Remove the washer (4).

Slide the brake drum (5) from the axle shaft. If required, tap the drum with a plastic faced hammer to loosen it from the axle shaft or use drum puller (P/N 15947G1).

### **CAUTION**

**Be careful when raising the adjuster arm. Excessive force will damage the adjuster and necessitate both wheel brake assemblies be replaced.**

**lies be replaced.**

If the drum does not slide from the brake assembly, the brake shoes must be retracted. Rotate the hub so that the hole is directly over the brake mechanism. Use a small straight blade screwdriver to raise the adjuster arm **just above** the star wheel.

Loosen the star wheel to retract the brake shoes and remove the brake drum.

**NOTICE: Pay particular attention to the location of the inner brake drum washer (6) inside the brake drum. It may be on the axle shaft or attached to the rear of the drum hub. This washer must be reinstalled when the brake is reassembled.**

To install the brake drum, clean the axle shaft and the splines on the brake drum to remove debris and grease.

Apply a small amount of anti-seize compound to the axle spline.

Install the inner brake drum washer (6) and slide the brake drum (5) into place (Figure 21).

Make sure the nose of drum hub is beyond the end of the axle splines. If not, remove the drum and install one additional inner brake drum washer (total of two) to obtain required spacing.

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

**CAUTION**

**Do not back off nut to install cotter pin.**

Install the remaining hardware, continue to tighten until a new cotter pin can be installed through the castellated nut and the hole in the axle. Maximum torque is 140 ft. lbs. (190 Nm). Install the hardware to the torque value specified below.

Item	Torque Specification
2	130 - 140 ft. lbs. (176 - 190 Nm)

## Wheel Brake Service

Wheel brake service consists of disassembly, cleaning, inspection, lubrication and re-assembly of the wheel brake. Worn or damaged components must be replaced.

Wheel brake service is required periodically as a preventive maintenance measure (see PERIODIC SERVICE SCHEDULE section). The wear rate of brake shoes and required service intervals will vary based on usage, terrain and other conditions.

Remove the brake drum as described in See *Brake Drum Removal and Installation*.

**WARNING**

**Wear eye protection and a mask when cleaning brake components.**

**Do not use compressed air to remove brake dust from brake assembly.**

**CAUTION**

**Do NOT use a commercial brake cleaner unless the entire brake has been disassembled.**

Remove any accumulated brake dust with a brush.

Remove the brake shoes. See *Brake Shoe Removal*.

Clean backing plate with a commercial brake cleaner. Allow to dry completely.

**CAUTION**

**Friction areas between the backing plate and the brake shoes must be lubricated. Be careful not to allow lubricant to contact**

**braking portion of the brake shoes or the friction surface of the brake drum. Use only recommended lubricants.**

Lubricate the backing plate friction points of the shoes and surfaces with Multi Purpose Grease (MPG) lubricant (Figure 22).

Install the actuator components, adjuster components and brake shoes. See *Brake Shoe Installation*. If the brake shoes and drum are not to be replaced, sand the friction surfaces lightly with emery cloth to remove any debris.

**CAUTION**

**Be sure that the adjusting screw is threaded into the star wheel nut until only 1 - 2 threads are exposed.**

**If the brake shoes are replaced, replace the brake springs and the adjuster components.**

Replace springs one side at a time, using the other side as a reference.

Install brake drum as described in *Brake Drum Removal and Installation*.

Repeat on other side of vehicle.

Adjust the brake pedal free travel. See *Adjusting Brake Pedal Free Travel*.

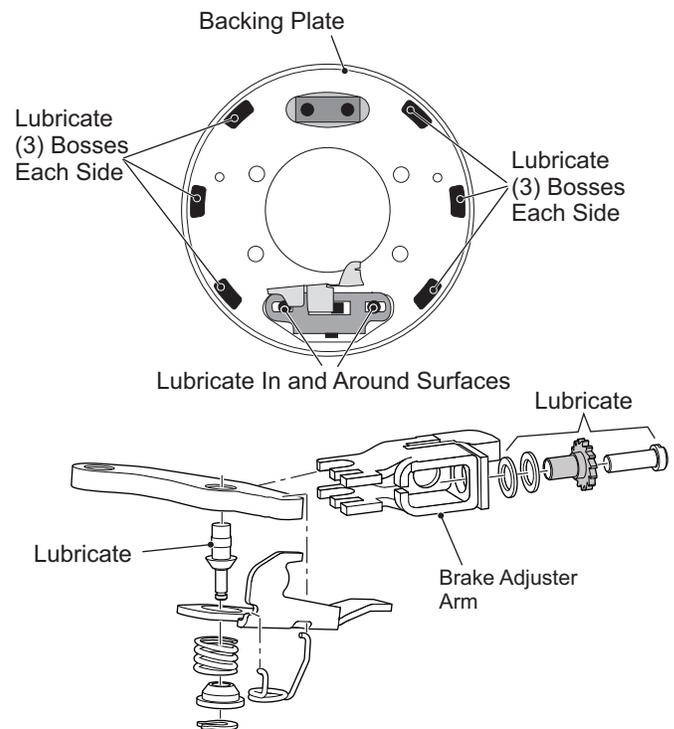


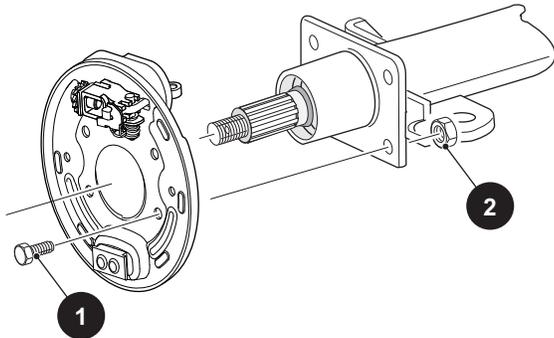
Figure 22 Wheel Brake Lubrication Points

# BRAKES

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

## Backing Plate/Entire Wheel Brake Assembly Removal and Installation

Remove four bolts (1) and lock nuts (2) securing the wheel brake backing plate to the flange on the axle tube (Figure 23).



**Figure 23 Backing Plate Removal and Installation**

Remove the clevis pin securing the brake cable to the brake lever.

Installation is reverse of removal. Connect the brake cable to the wheel brake with clevis pin (installed from the top downward) and a new cotter pin.

Install the brake assembly or backing plate to the axle tube flange. Install new hardware (lock nut should not be reused). Tighten the lock nut to the torque value specified below.

Item	Torque Specification
2	23 - 27 ft. lbs. (31 - 36.5 Nm)

## Brake Shoe Removal

**NOTICE: When brake shoes are replaced, adjusters and springs must also be replaced. Do one side at a time, using the other side for reference.**

Using pliers to compress the open end of the brake shoe retainer springs (1) (Figure 24).

While holding the tension pin (2) with a second set of pliers, turn the retainer spring 1/4 turn to align the slot in the spring retainer with the flats in the tension pin. Remove the brake shoe retainer springs.

Grasp the brake shoes (3) in the center and tilt them outwards and away from the back mounting plate. This will release the tension in the brake springs (4). Remove the brake springs and remove the brake shoes (Figure 24).

Inspect brake shoes. If a brake shoe has less than 0.060" (1.5mm) lining material thickness AT ANY POINT on either shoe, both shoes MUST be replaced.

Check for free lateral (front and back) movement of the adjusting mechanism and for free movement of the star wheel.

Remove the boot on the brake lever. Clean any accumulated brake dust from backing plate and adjuster mechanism with a brush.

If the brake is being removed for an axle bearing and seal replacement, the four bolts and nuts securing the brake assembly to the rear axle must be removed.

When reinstalling the brake mounting bolts, tighten the bolts to the torque value specified below.

Item	Torque Specification
Bolts	23 - 27 ft. lbs. (31 - 36.6 Nm)

Clean the backing plate with a commercial brake cleaner. Allow to dry completely.

Lubricate friction points of the shoes and moving anchor with Multi Purpose Grease (MPG) lubricant (Figure 22).

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

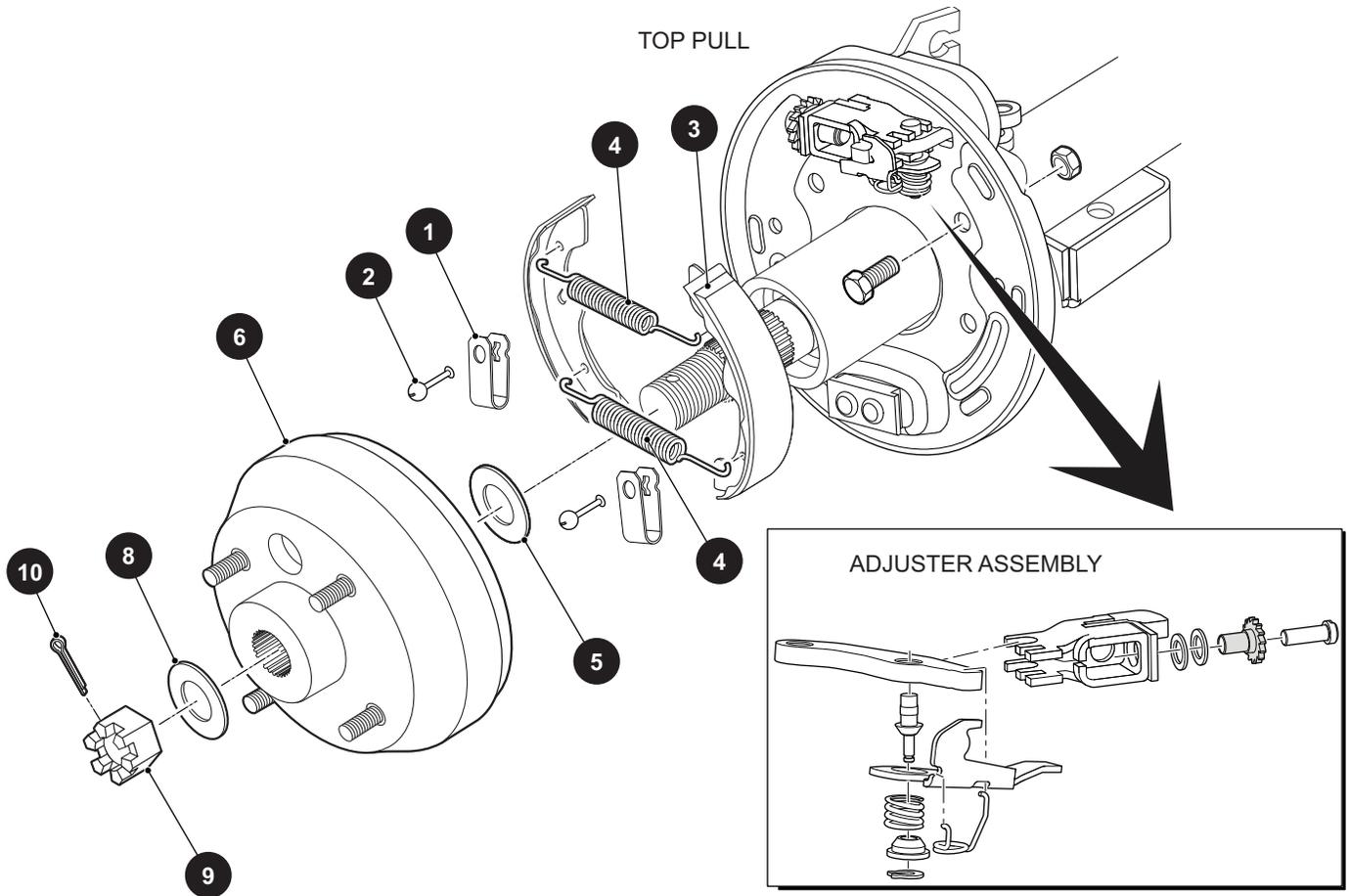


Figure 24 Brake Shoes & Springs

# BRAKES

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

## Brake Shoe Installation

The leading brake shoe (marked 17L) is angled to a narrow end and engages the backside of the adjuster (Figure 25).



**Figure 25 Brake Shoe '17L'**

The trailing brake shoe (marked 17T) is chamfered on wide end and engages the screw end of the adjuster (Figure 26).

Install the brake shoes in the reverse order of removal. Secure with brake shoe retainer springs and brake shoe return springs.

Clean the axle shaft to remove debris and grease that may have accumulated.



**Figure 26 Brake Shoe '17T'**

Insert a straight blade screwdriver between the adjusting lever and the adjusting mechanism.

Rotate the star wheel left until the shoes have retracted sufficiently to allow the installation of the brake drum.

Install washer (5), brake drum (6), washer (8) castellated nut (9).

Tighten the castellated nut to the torque value specified below.

Item	Torque Specification
9	130 - 140 ft. lbs. (176 - 190 Nm)

Continue to tighten until a new cotter pin (10) can be installed through the castellated nut and the hole in the axle. Maximum torque 140 ft. lbs. (190 Nm) (Figure 24).

Install the brake drum. See *Brake Drum Removal and Installation*.

Repeat on other side of vehicle. Adjust the brake pedal free travel. See *Adjusting Brake Pedal Free Travel*.

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

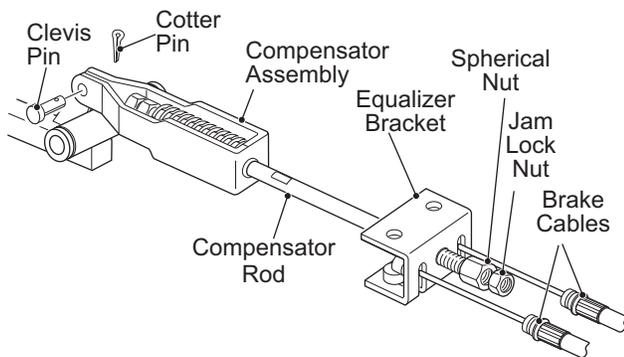
## Brake Cable and Equalizer Assembly Removal and Installation

**NOTICE:** The brake cables and equalizer are only serviceable as a complete assembly.

Remove the cotter pins and clevis pins connecting the brake cables to the brake levers. Remove the retaining rings connecting the brake cables to their brackets at the axle (rear of cable) and at the frame (front of cable). Loosen and remove the jam nut and the spherical nut on the equalizer link (Figure 27). Inspect the hardware and replace if needed. Remove the brake cable and equalizer assembly and discard.

Slide the equalizer link of the new assembly over the compensator rod. Loosely install the spherical nut and new locking jam nut. Insert the cables into the frame and axle brackets. Install new retaining rings. Connect the cables to the brake levers using new clevis pins and new cotter pins.

Adjust the brake pedal free travel. See *Adjusting Brake Pedal Free Travel*.



**Figure 27** Brake Cable, Equalizer and Compensator

## Compensator Assembly, Removal and Installation

Disconnect the compensator assembly from the brake pedal by removing the cotter pin and clevis pin (Figure 27).

Loosen and remove the jam nut and the spherical nut connecting the compensator rod to the equalizer link.

Remove the compensator assembly.

Installation is the reverse of removal. Use new cotter pins in the clevis pin.

Adjust the brake pedal free travel. See *Adjusting Brake Pedal Free Travel*.

## Brake Pedal Removal and Installation

Disconnect the compensator assembly (1) from the brake pedal by removing the cotter pin (2) and the clevis pin (3) (Figure 28).

Disconnect the wiring harness if equipped with brake lights.

Unhook the torsion spring (4) by inserting a thin blade screwdriver between the small hook and the bracket. Move hook back and to the side to release the torsion spring.

Remove the lock nut (5) and the shoulder bolt (6).

Remove the brake pedal.

Inspect the shoulder bolt for corrosion that could cause binding. Replace both bolts and bushings (7) with new ones if corrosion or wear is found.

Brake pedal installation is in the reverse order of disassembly.

Tighten the nut (5) to the torque value specified below.

Item	Torque Specification
5	25 - 29 ft. lbs. (34 - 39 Nm)

Use a new cotter pin when installing the compensator assembly.

Connect brake light wiring harness, if equipped.

Adjust the brake pedal free travel. See "Adjusting Brake Pedal Free Travel".

Check for proper brake light operation if equipped.

# BRAKES

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

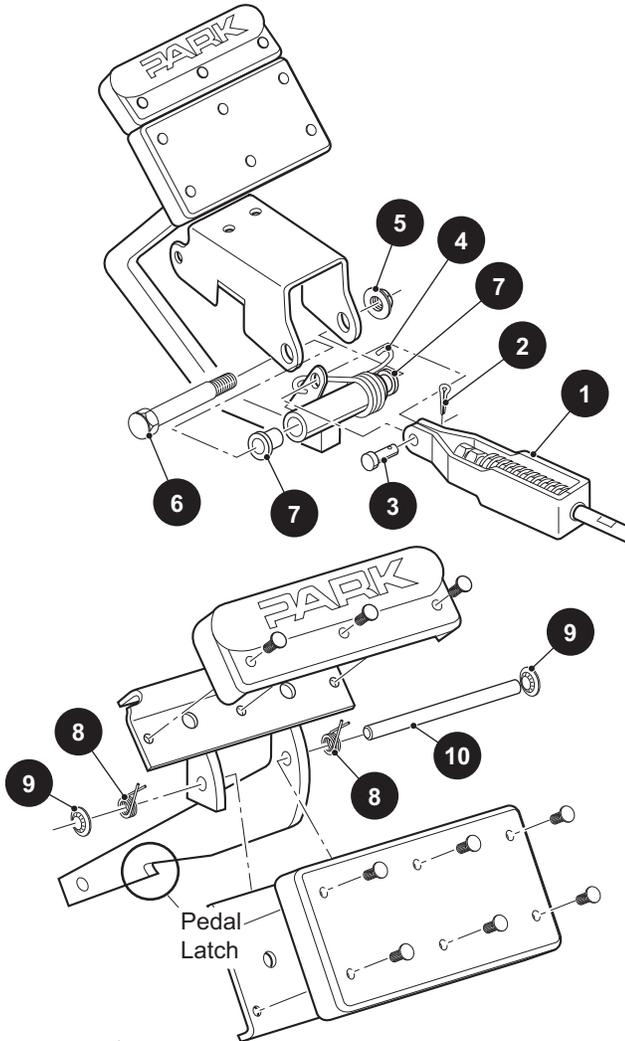


Figure 28 Brake Pedal Removal and Installation

## Park Brake Catch Bracket Removal and Installation

Remove the driver side front wheel to gain access to the brake pedal release mechanism.

### ⚠ WARNING

**To prevent serious injury death resulting from the use of worn park brake components, do not attempt to re-new worn components. The catch bracket is a hardened part. Do not grind or file it, as doing so will cause the part to lose its hardness characteristics. Always use a new catch bracket.**

Remove the two bolts (1) and nuts (2) that secure the catch bracket. Replace with a new catch bracket.

Tighten the hardware to the torque value specified below (Figure 29).

Item	Torque Specification
2	85 - 95 in. lbs. (10 - 11 Nm)

If required, adjust the kick-off cam (3). See *Park Brake Kick-Off Cam Removal, Replacement and Installation*.

Install wheel. See WHEELS AND TIRES section.

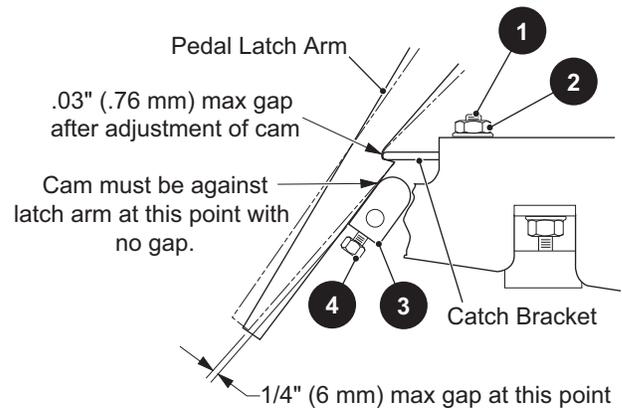


Figure 29 Catch Bracket and Latch Arm  
Park Brake Pedal Removal and Installation

Note the location and orientation of the two torsion springs (8) for reassembly purposes. Remove the push nut (9) and pin (10) (Figure 28) and remove the park brake pedal.

### ⚠ WARNING

**To prevent serious injury or death resulting from the use of worn park brake components, do not attempt to re-new worn components. The park brake latch arm is a hardened part. Do not grind or file it, as doing so will cause the part to lose its hardness characteristics. Always use a new park brake arm latch.**

Install the park brake pedal in the reverse order of removal. Use a new push nut (or push nuts).

If required, adjust the kick-off cam (3). See *Park Brake Kick-Off Cam Removal, Replacement and Installation*.

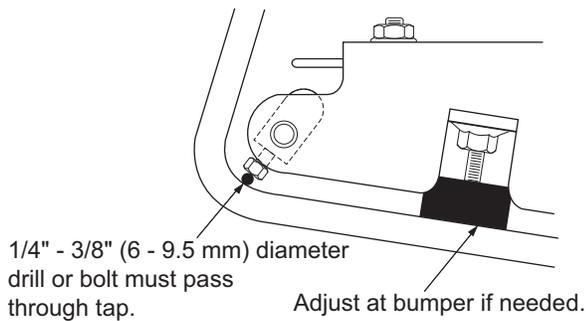
## Pedal Bumper Adjustment

Loosen the bumper lock nut and adjust the bumper by rotating it (Figure 30). The brake pedal must contact the pedal bumper when pedal is released. The dimension from the top of the pedal arm to the setscrew heads in the kick-off cam should be approximately 1/4" - 3/8" (6 - 9.5 mm).

When correctly adjusted, tighten the lock nut to the torque value specified below.

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

Item	Torque Specification
Lock Nut	12 - 14 ft. lbs. (16 - 19 Nm)



**Figure 30 Pedal Bumper Adjustment**

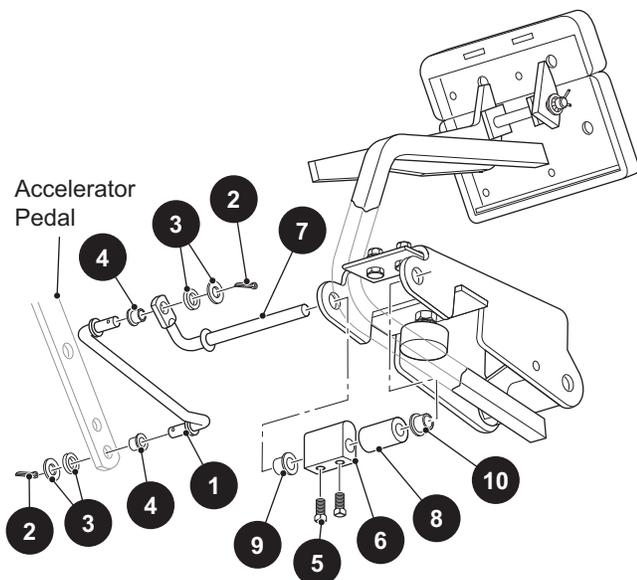
## Park Brake Release Linkage Removal and Replacement

Remove the cotter pin (2), washers (3) and bushings (4) from linkage rod (1). Remove the linkage rod (Figure 31).

Inspect the bushings (4). Replace them if signs of wear are present.

Installation is the reverse order of removal.

If required, adjust the kick-off cam (6). See *Parking Brake Kick-Off Cam Removal, Replacement and Installation*.



**Figure 31 Park Brake Release Linkage and Kick-Off Cam Removal and Installation**

## Park Brake Kick-Off Cam Removal, Replacement and Installation

Disconnect the park brake release linkage as described above. Loosen the two setscrews (5) from the cam (6) and remove the cam pivot (7), cam and spacer (8) (Figure 31).

Inspect the bushings (9, 10) and spacer (8). Replace any that show signs of wear.

Installation is the reverse order of removal.

With the park brake engaged and locked, there must be no gap between the top of the cam and the latch arm.

To adjust the kick-off cam (6), engage the park brake and loosen the two cam setscrews (5), rotate the cam until it contacts the latch arm.

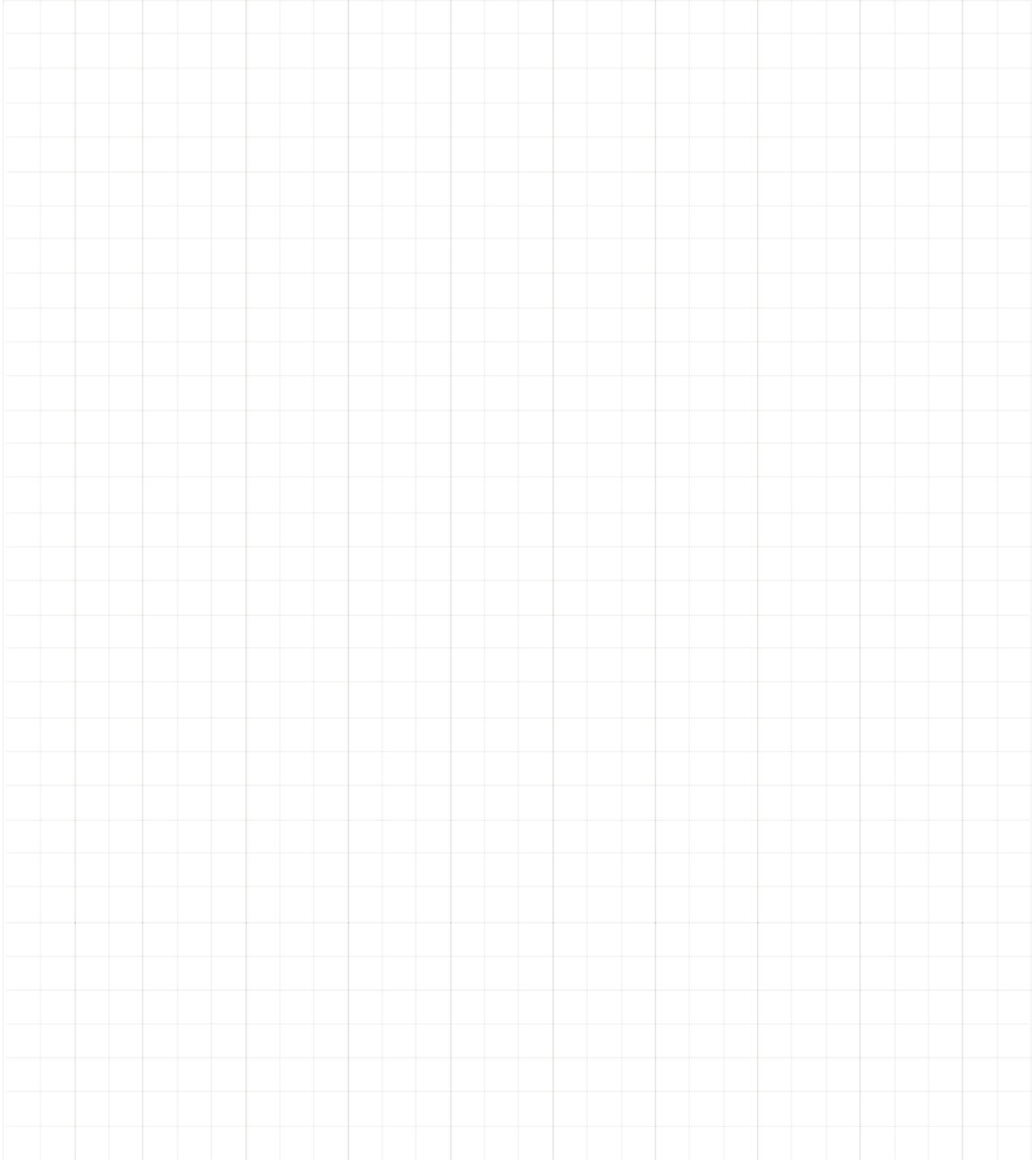
Tighten the setscrews (5) to the torque value specified below. Always use new setscrews with a locking patch.

Item	Torque Specification
5	70 - 84 in. lbs. (8 - 9.5 Nm)

# BRAKES

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

## Notes:

A large grid of graph paper for taking notes, consisting of 20 columns and 30 rows of small squares.

## REAR AXLE

For further axle information, refer to Electric Rear Axle Manual P/N 28148G01.

Refer to the REAR SUSPENSION section for procedure to remove the axle assembly from the vehicle.

### REAR AXLE MAINTENANCE

The only maintenance required for the first five years is periodic inspection of the lubricant level. The rear axle is provided with a lubricant level check/fill plug located on the bottom of the differential. Unless leakage is evident, the lubricant need only be replaced after five years.

Item	Lubricant Capacity
Standard Axle	10 - 12 oz. 30 wt.
Axle with LSD	24 - 26 oz. mobil 424 and 2 oz. friction modifier

#### Checking the Lubricant Level

Clean the area around the check/fill plug and remove plug. The correct lubricant level is just below the bottom of the threaded hole. If lubricant is low, add lubricant as required. Add lubricant slowly until lubricant starts to seep from the hole. Install the check/fill plug. In the event that the lubricant is to be replaced, the vehicle must be lifted and supported and the oil pan removed or the oil siphoned out through the check/fill hole (Figure 1).

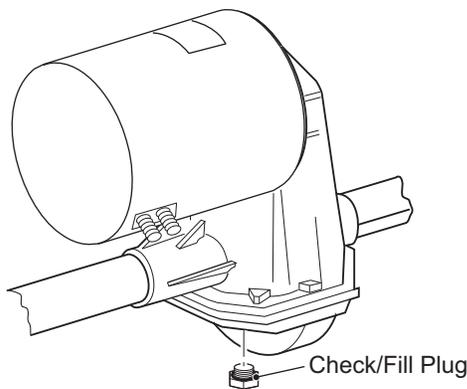


Figure 1 Add, Check and Drain Rear Axle Lubricant

### REAR AXLE DISASSEMBLY

#### CAUTION

*The rear axle is a precision assembly, and therefore any repair or replacement of parts must be done with extreme care in a clean environment. Before attempting to perform any service on the axle, read and understand all of the following text and illustrations before disassembling the unit.*

*Handle all splines with extreme care. O-rings must be removed/installed with care to decrease the risk of damage to bearings, seals and bearing bores.*

**NOTICE:** *It is recommended that whenever a bearing, seal or O-ring is removed, it be replaced with a new one regardless of mileage. Always wipe the seals and O-rings with a light oil before installing.*

#### WARNING

*To decrease the risk of personal injury, follow the lifting procedure in SAFETY section of this manual. Place wheel chocks in front and behind the front wheels and check the stability of the vehicle on the jack stands before starting any repair procedure. Never work on a vehicle that is supported by a jack alone.*

#### Axle Shaft Removal and Disassembly

Tool List	Quantity
Arbor Press .....	1
Bearing Separator .....	1
Needle Nose Pliers .....	1
Internal Snap Ring Pliers .....	1
Slide Hammer, P/N 18753G1 .....	1

For brake drum removal, Refer to BRAKES section.

Remove outer snap ring from the axle tube (Figure 2).

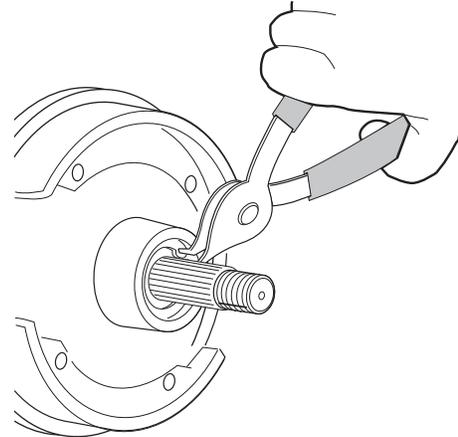
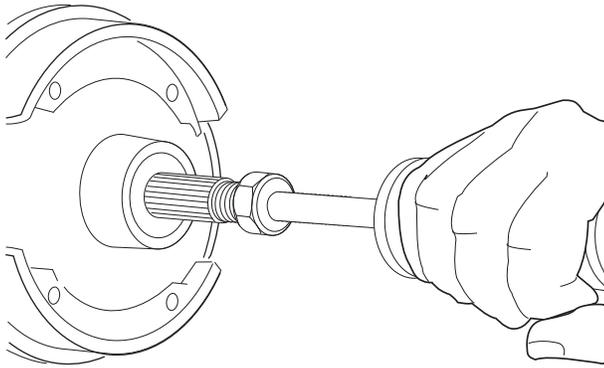


Figure 2 Removing/Installing Outer Snap Ring

# REAR AXLE

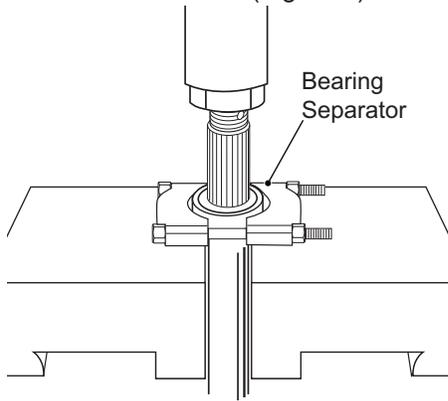
Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

Attach a slide hammer to the axle shaft thread and remove the axle and bearing from axle tube (Figure 3).

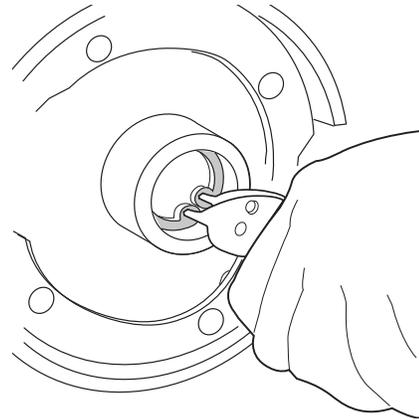


**Figure 3 Removing/Installing Axle Shaft**

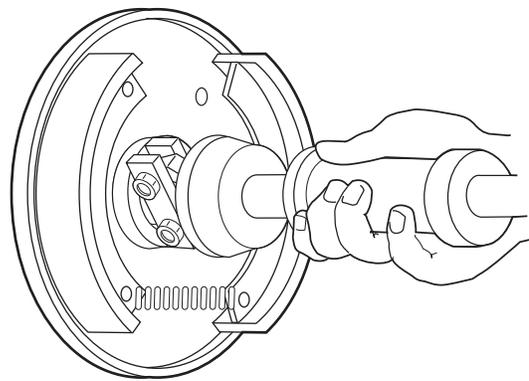
Remove the bearing by supporting the inner race of the bearing on an arbor press bed and apply pressure to the threaded end of the axle shaft (Figure 4).



**Figure 4 Pressing Bearing from Axle Shaft**



**Figure 5 Removing/Installing Inner Snap Ring**



**Figure 6 Removing Seal**

To install the seal, use the special seal installer to the seal into its correct position (Figure 7).

## Axle Shaft Seal Removal and Replacement

Tools List	Quantity
Internal Snap Ring Pliers .....	1
Seal Puller .....	1
Seal Installer, P/N 18739G1 .....	1
Ball Peen Hammer .....	1

**CAUTION**

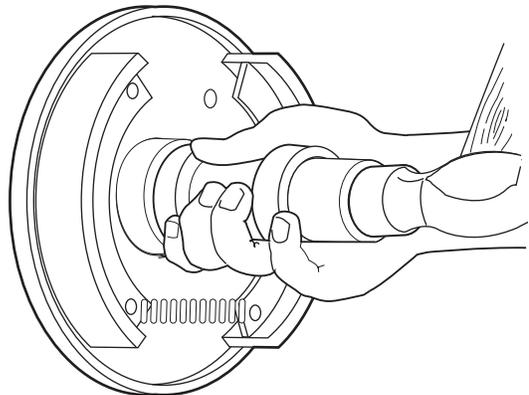
*Use care to decrease the risk of damage to the inner surface of the axle tube at the sealing area.*

Remove the inner snap ring (Figure 5). Use a puller to remove the seal (Figure 6).

**CAUTION**

*To decrease the risk of seal damage, lightly coat the axle shaft with bearing grease and support the shaft during installation.*

Install the inner snap ring (Figure 5).



**Figure 7 Installing Seal**

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

## Axle Shaft Replacement

Carefully insert the axle shaft and bearing through the oil seal. Rotate the shaft until the spline engages with the differential side gears. Install the outer snap ring.

Coat the outboard spline of the axle with a commercially available anti-seize compound. Install the brake hub and drum, thrust washer, nut and new cotter pin (Figure 8).

**NOTICE: Tighten the axle nut to torque value specified below. Continue to tighten until the slot in the nut aligns with the cotter pin hole.**

Item	Torque Specification
Axle nut	130 - 140 ft. lbs (176 - 190 Nm)

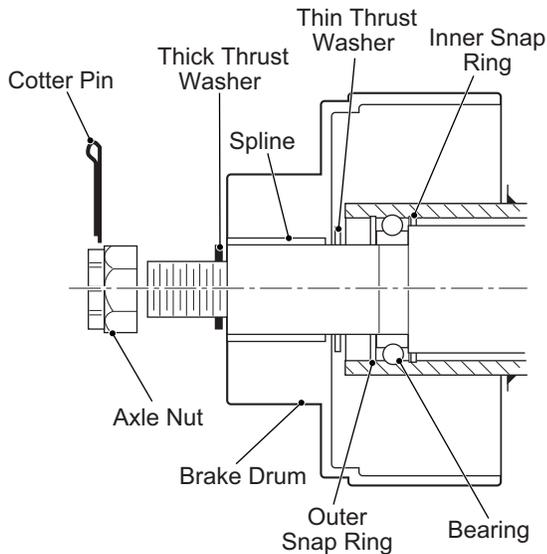


Figure 8 Cut Away of Outer Bearing and Brake Drum



## REAR SUSPENSION

### GENERAL

**⚠ WARNING** To reduce the possibility of personal injury, follow the lifting procedure. Place wheel chocks in front of and behind the front wheels and check the stability of the vehicle on the jack stands before starting any repair procedure. Never work on any vehicle that is supported by a jack alone (See LIFTING THE VEHICLE on page 8).

**NOTICE:** In the following text, there are references to removing/installing bolts etc. Additional hardware (nuts, washers, etc.) that are removed must always be installed in the original position unless otherwise stated. Non specified torques are shown in the torque table (See HARDWARE on page 4).

The rear suspension consists of the leaf springs, shocks, and the hardware that secures these items and mounts the leaf springs to the axle and to the vehicle frame. The removal of the rear axle is also covered in this section due to the nature of it being interrelated to the suspension components.

### SHOCK ABSORBER

#### Removal

Tool List	Qty.
Wrench, 1/4"	1
Wrench, 9/16"	1
Deep Socket, 9/16"	1
Ratchet	1
Floor Jack	1
Jack Stands	2
Wheel Chocks	4

1. Lift and support the rear of the vehicle and remove the rear wheels (See LIFTING THE VEHICLE on page 8) (See WHEEL AND TIRE SERVICE on page 11).
2. Remove the vinyl cap (4), hex nut (3), washer (1), and rubber bushing (2) from the lower end of the shock absorber (5) (Ref Fig. 1).
3. Remove the vinyl cap, hex nut, washer, and rubber bushing from the upper end of the shock absorber
4. Compress the shock absorber and remove it from between the frame mounting bracket (15) and the lower mounting plate (10).

#### Installation

1. Install a washer (1) with the cupped surface facing upward and the rubber bushing (2) on the top stud of the shock absorber (5) (Ref Fig. 1).

2. Install a washer with the cupped surface facing downward and the rubber bushing on the bottom stud of the shock absorber.
3. Insert the top stud into the mounting hole on the frame bracket (15) and compress the shock absorber until the bottom stud can be installed into the lower mounting plate (10).
4. Install a rubber bushing and washer with the cupped surface facing down on the upper shock absorber stud.
5. Install the hex nut (3) and tighten it until the rubber bushing expands to the same diameter as the washer.
6. Install a rubber bushing and washer with the cupped surface facing up on the lower shock absorber stud.
7. Install the hex nut and tighten it until the rubber bushing expands to the same diameter as the washer.

Removal and installation of the shock absorber is the same for both sides of the vehicle.

**⚠ WARNING** Replace any worn or damaged hardware with new parts.

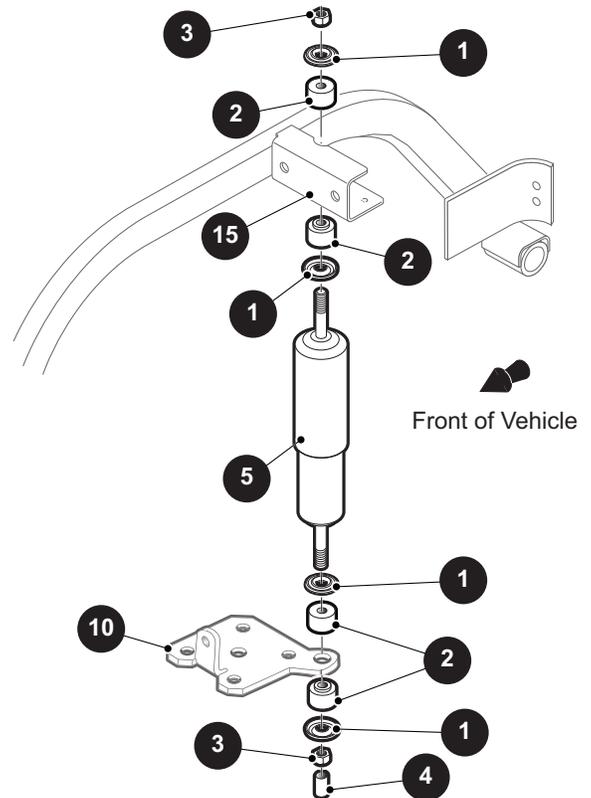


Fig. 1 Shock Absorber

# REAR SUSPENSION

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

## REAR LEAF SPRINGS

**NOTICE:** If the springs are to be replaced and the rear axle is not to be removed, it is important to remove and replace one spring at a time. Springs must be replaced in sets. Never replace just one.

**NOTICE:** Be sure to note whether the springs are mounted on top or bottom of the axle.

### Tool List

	Qty.
Wrench, 9/16" .....	1
Wrench, 3/4" .....	1
Socket, 9/16" .....	1
Ratchet .....	1
Torque Wrench, ft. lbs.....	1
Floor Jack .....	1
Jack Stands .....	4
Wheel Chocks .....	4

### Removal

1. Lift and support the rear of the vehicle and remove the rear wheels (See LIFTING THE VEHICLE on page 8) (See WHEEL AND TIRE SERVICE on page 11).
2. Remove the shock absorbers (See SHOCK ABSORBER on page 99).
3. Remove the lock nuts (11) and washers (13) from the bolts (7) and remove the bolts from the lower leaf spring mounting brackets (25) (Ref Fig. 2).
4. Remove the upper leaf spring mounting bracket (21).
5. Place a floor jack under the rear frame and lift the vehicle enough to relieve pressure from the leaf springs on the lift bracket (19) and rear axle.
6. Remove the bolts (8) and lock nuts from the lower shackles (18) at the rear of the leaf spring.
7. Remove the bushings (14) and spacers (17).
8. Remove the lock nut (9), bolt (6), and bushings (16) from the forward leaf spring mounting bracket (15) on the frame.
9. The leaf spring (20) can now be removed from the vehicle.
10. Remove the lock nut (12), bolt (8), shackles (18), bushings (14), and spacer (17) from the rear mounting bracket on the frame.

### Installation

1. Inspect all of the bushings and the hardware and replace any worn or damaged parts with new hardware.
2. Make sure that the lift bracket (19) is correctly positioned on top of the axle (Ref Fig. 2).

3. Install the large bushings (16) in the forward end of the leaf spring and place the leaf spring in the forward mounting bracket (15).
4. Install the bolt (6) and new lock nut (9) to secure the forward end of the leaf spring (20) in the bracket.
5. Install one pair of the smaller flanged bushings (14) and the spacer (17) in the rear frame mounting holes.
6. Position the shackles (18) over the bushings and install the bolt (8) and nut (12) in the upper bolt hole.
7. Install the remaining pair of smaller flanged bushings (14) and the spacer (17) in the rear of the leaf spring.
8. Position the leaf spring (20) into the shackles and install the bolt (8) and lock nut (12).
9. Align the pin on the leaf spring with the holes in the lift bracket (19) and upper leaf spring mounting plate (21).
10. Install the bolts (7) and washers (13) then secure in place with new lock nuts (11).
11. Torque all hardware to the torque values below making sure that the leaf spring pin remains aligned with the holes in the leaf spring mounting plate.

Removal and installation of the leaf spring is the same for both sides of the vehicle.

Item	Torque Specification
9	18 - 23 ft. lbs. (24.5 - 31 Nm)
11	16 - 20 ft. lbs. (21.5 - 27 Nm)
12	10 - 15 ft. lbs. (13.5 - 20 Nm)

# REAR SUSPENSION

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

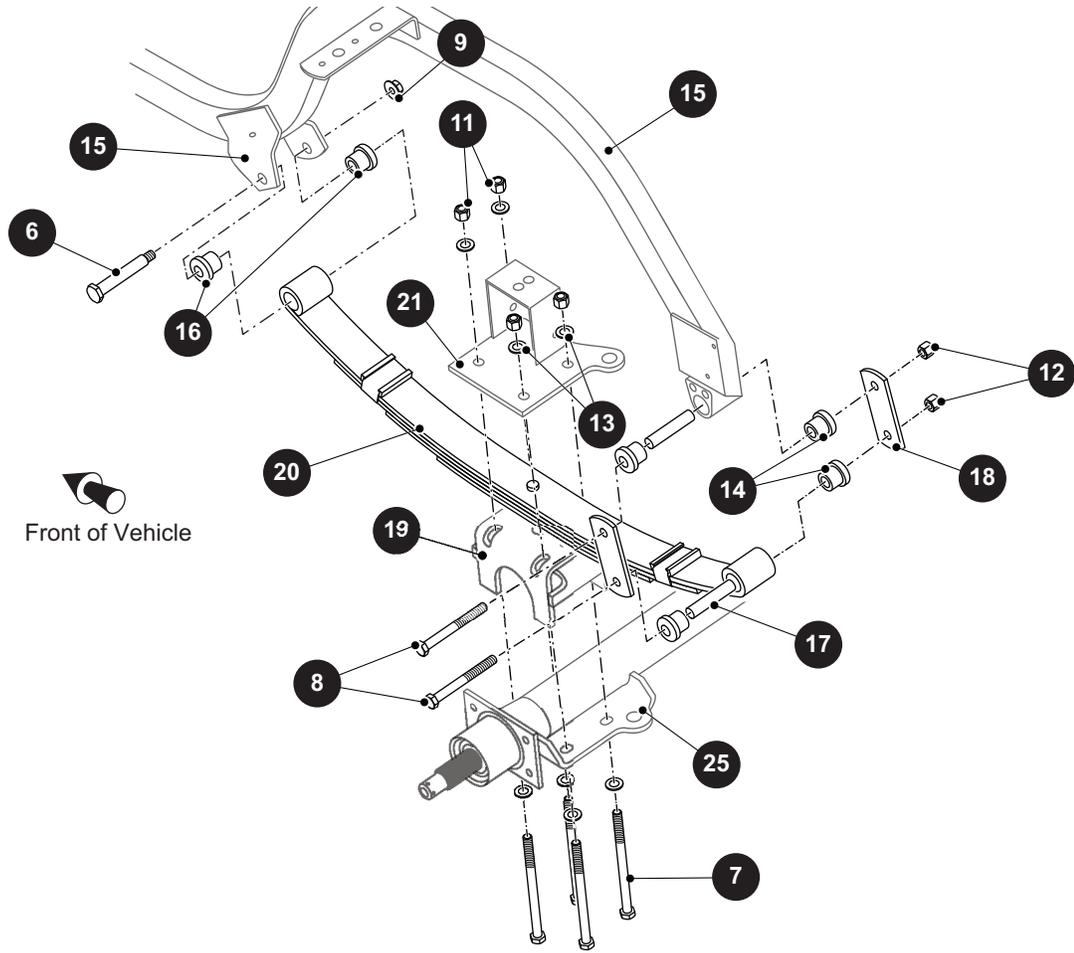


Fig. 2 Leaf Springs

# REAR SUSPENSION

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

## REAR AXLE

Tool List	Qty
Wrench, 10mm .....	1
Wrench 1/4" .....	1
Wrench, 9/16" .....	1
Insulated Wrench, 9/16" .....	1
Wrench, 3/4" .....	1
Socket, 10mm.....	1
Socket, 9/16" .....	1
Deep Socket, 9/16" .....	1
Chalk or Paint Pen.....	1
Ratchet .....	1
Torque Wrench, ft. lbs.....	1
Floor Jack .....	1
Jack Stands .....	4
Wheel Chocks .....	4

**⚠ WARNING** *To reduce the possibility of personal injury, follow the lifting procedure of this manual (See LIFTING THE VEHICLE on page 8). Place wheel chocks in front and behind the front wheels and check the stability of the vehicle on the jack stands before starting any repair procedure. Never work on any vehicle that is supported by a jack alone.*

## Removal

1. Lift and support the rear of the vehicle on the outer ends of the rear bumper (See LIFTING THE VEHICLE on page 8).
2. Remove the wheels (See WHEEL AND TIRE SERVICE on page 11).
3. Remove the motor (See Motor Removal on page 41).
4. Remove the shock absorbers (See SHOCK ABSORBER on page 99)Remove the clevis pin from both brake cables where they attach to the wheel brake levers (See Mechanical Brake System on page 77).
5. Remove the retaining rings at the axle end of the outer brake cable and move cables out of the way of the axle.
6. Place a floor jack under the center section of the rear axle and raise just enough to place a second set of jack stands under the axle tubes.
7. Remove the bolts (7) securing the axle to the leaf springs (20) (Ref Fig. 2).
8. Remove the jack stands from beneath the axle and lower the floor jack to remove the axle.

## Installation

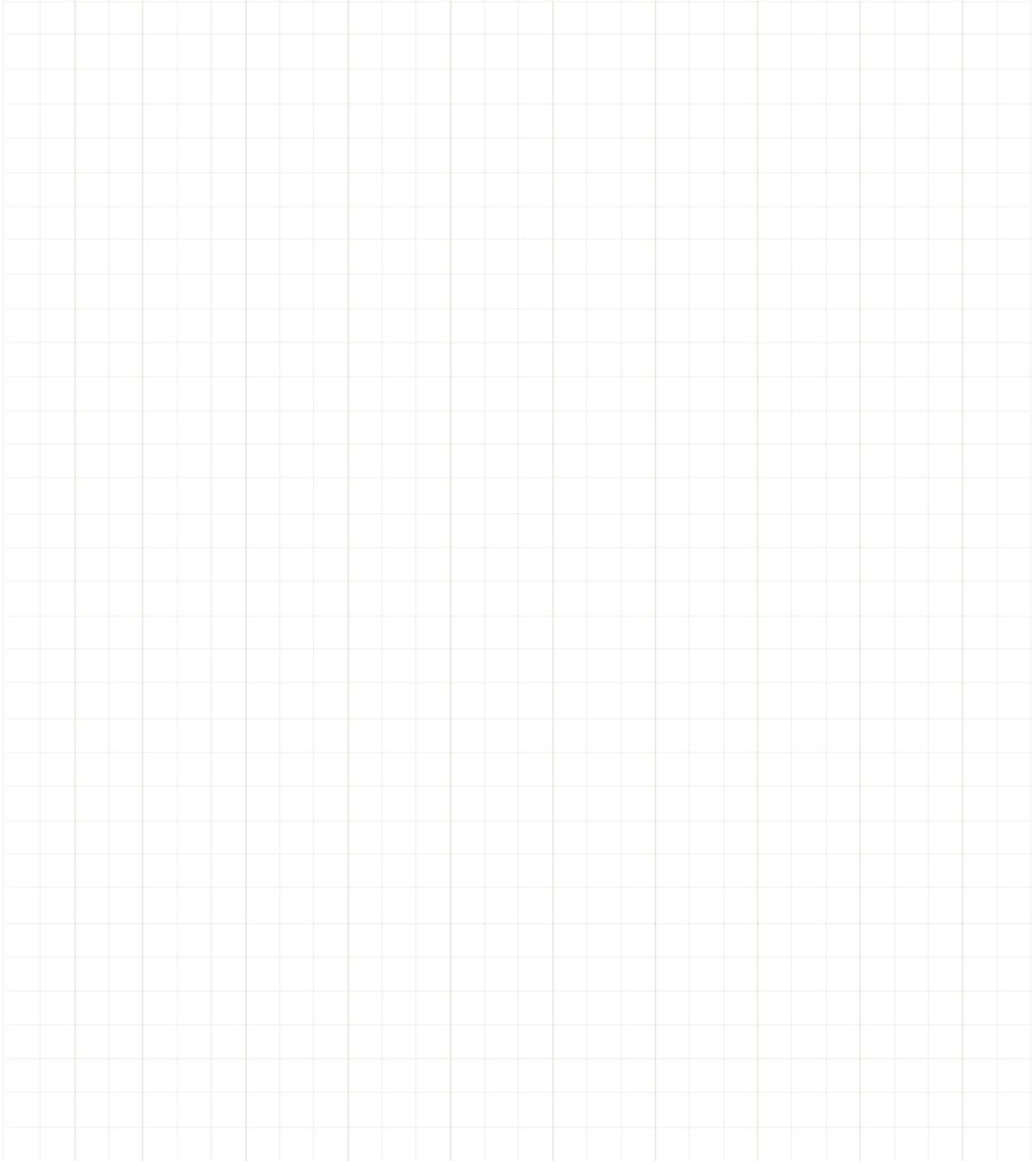
Assemble in the reverse order of removal.

Tighten all hardware to the torque values listed in the proper section (See SHOCK ABSORBER on page 99)(See REAR LEAF SPRINGS on page 100)(See Motor Installation on page 42).

# REAR SUSPENSION

*Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.*

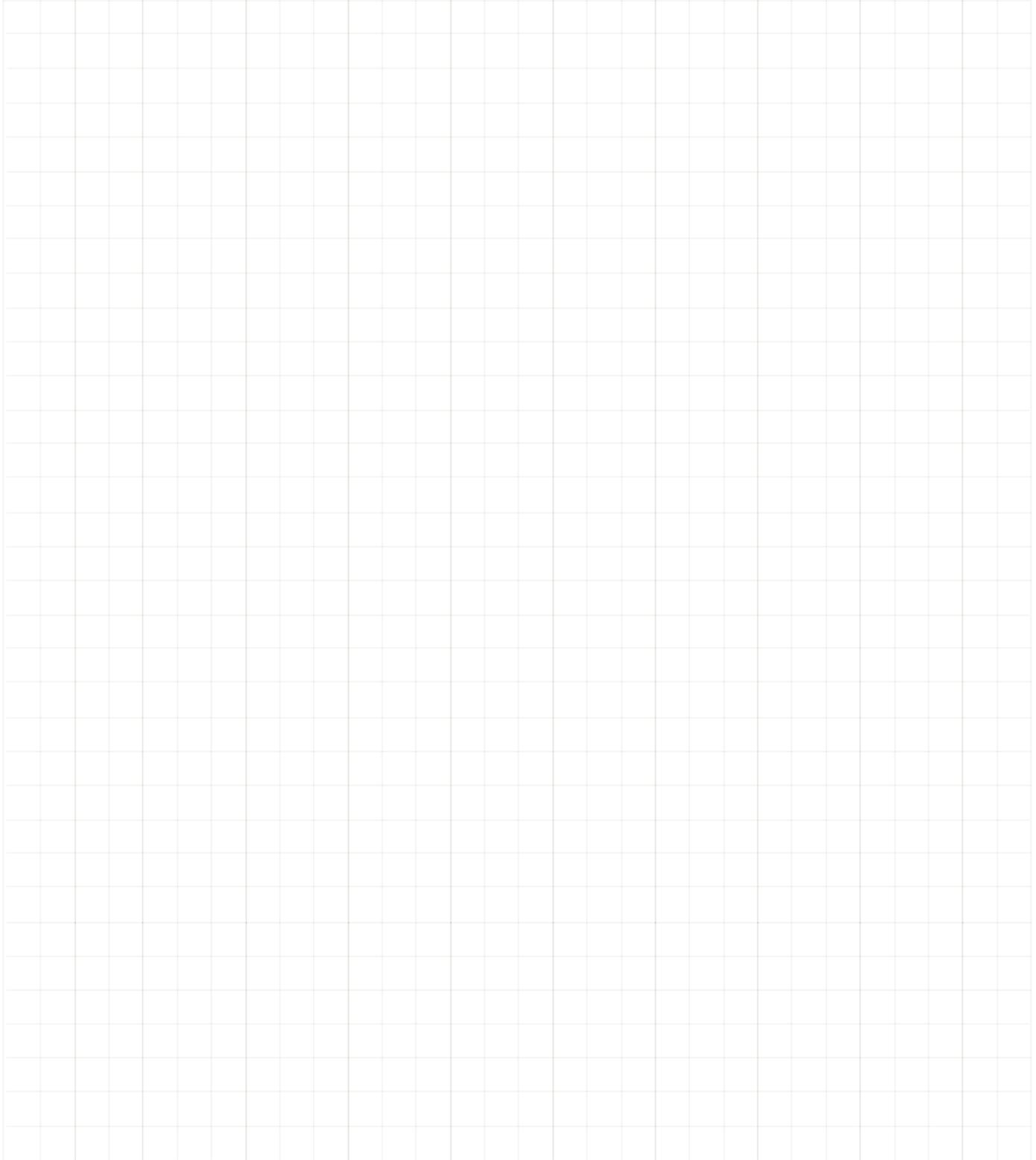
## Notes:

A large grid of graph paper for taking notes, consisting of 20 columns and 30 rows of small squares.

# REAR SUSPENSION

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

## Notes:

A large grid of graph paper for taking notes, consisting of 20 columns and 30 rows of small squares.

## WEATHER PROTECTION

### GENERAL

**⚠ WARNING** *The canopy does not provide protection from roll over or falling objects.*

*The windshield does not provide protection from tree limbs or flying objects.*

The canopy and windshield are designed for weather protection only.

Clean the windshield with water and a clean cloth. Minor scratches can be removed with a commercial plastic polish or Plexus plastic cleaner available from the service parts department.

### Transporting Vehicle

If the vehicle is to be transported on a trailer at highway speeds, the windshield and top must be removed and the seat bottoms secured. Always check that the vehicle and contents are adequately secured before transporting the vehicle.

**⚠ WARNING** *To reduce the possibility of severe injury or death while transporting vehicle:*

**Secure the vehicle and contents.**

**Never ride on vehicle being transported.**

**Always remove windshield before trailering.**

**Maximum speed with sun top installed is 50 mph (80 kph).**

### CANOPY TOP INSTALLATION

Tool List	Quantity
Rubber Mallet .....	1
Wrench, 1/2" .....	2
Wrench, 9/16" .....	2
Hex Wrench, 7/32" .....	1
Straight Blade Screwdriver .....	1

#### Front Strut

1. Remove and discard the four bolts from the front cowl (See Detail A).
2. Upper Hole: Install the front strut (2) with bolt (15) and two lock washers (14) on the outside of strut, a spacer (13) between the front cowl and strut. Finger tighten hardware to allow for adjustment.

3. Lower Hole: Secure the strut with bolt (15) and lock washer (14) on the outside of strut, and two washers (12) between the front cowl and strut as shown. Finger tighten hardware to allow for adjustment.

Tighten the hardware to the torque values specified below.

Item	Torque Specification
15	13 - 15 ft. lbs. (17 - 20 Nm)

#### Rear Support

1. Using a plastic faced hammer, tap end caps (5) into the top of the rear struts (3, 4) (See Detail D).
2. At driver side of vehicle, align the holes in the rear strut (3) with the holes in the seat back support bracket, being sure that the open end of the strut faces the rear of the vehicle (See Detail A).
3. Insert bolt (6) and washer (7) through the seat back support bracket. Place nylon washer (8) between seat back support bracket and rear strut. Secure with washer (7) and lock nut (9) at outer side of rear strut as shown. Finger tighten hardware to allow for adjustment.
4. Repeat procedure with rear strut (4) at passenger side of vehicle.

#### Canopy Top

1. Place sun top onto struts.
2. At Front: Secure sun top loosely with bolts (11), washers (18), spacers (20), washers (18) and lock nuts (19). Finger tighten hardware to allow for adjustment (See Detail C).
3. At Rear: Insert bolts (10), washers (18), spacers (20), washers (18) and lock nuts (19) (See Detail D). Finger tighten hardware to allow for adjustment.

Tighten the hardware to the torque values specified below.

Item	Torque Specification
6, 10, 11, 15	13 - 15 ft. lbs. (17 - 20 Nm)

# WEATHER PROTECTION

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

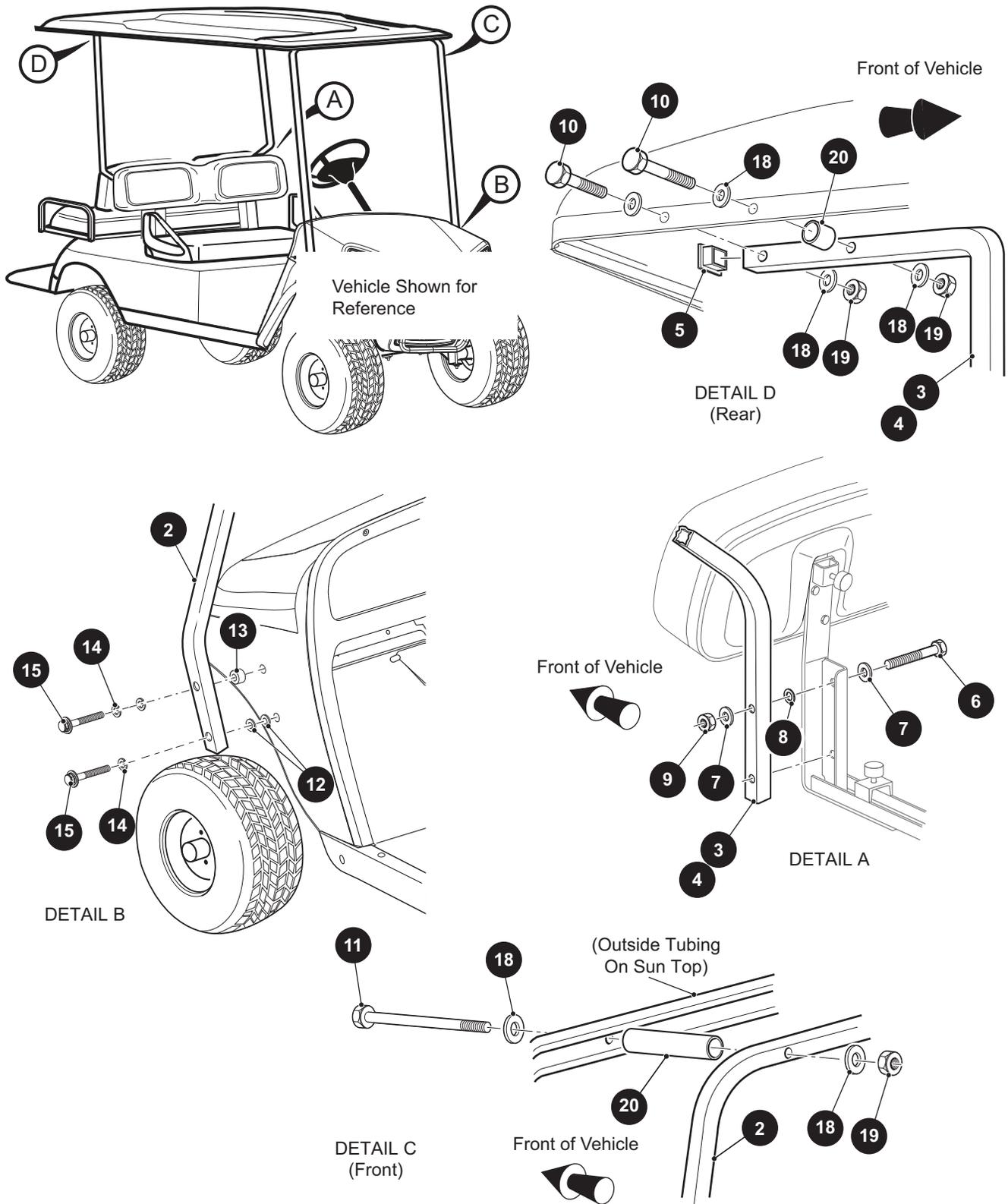


Figure 1 Canopy Top

# WEATHER PROTECTION

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

## SPLIT WINDSHIELD INSTALLATION

Tool List	Quantity
Plastic faced mallet .....	1
Wrench, 7/16".....	1
Phillips screwdriver.....	1

1. Remove protective covering from the windshield (2).
2. Install sash (3) on each side of the lower section of windshield. Using a plastic faced mallet, gently tap sash to ensure windshield seats properly (See Detail A).



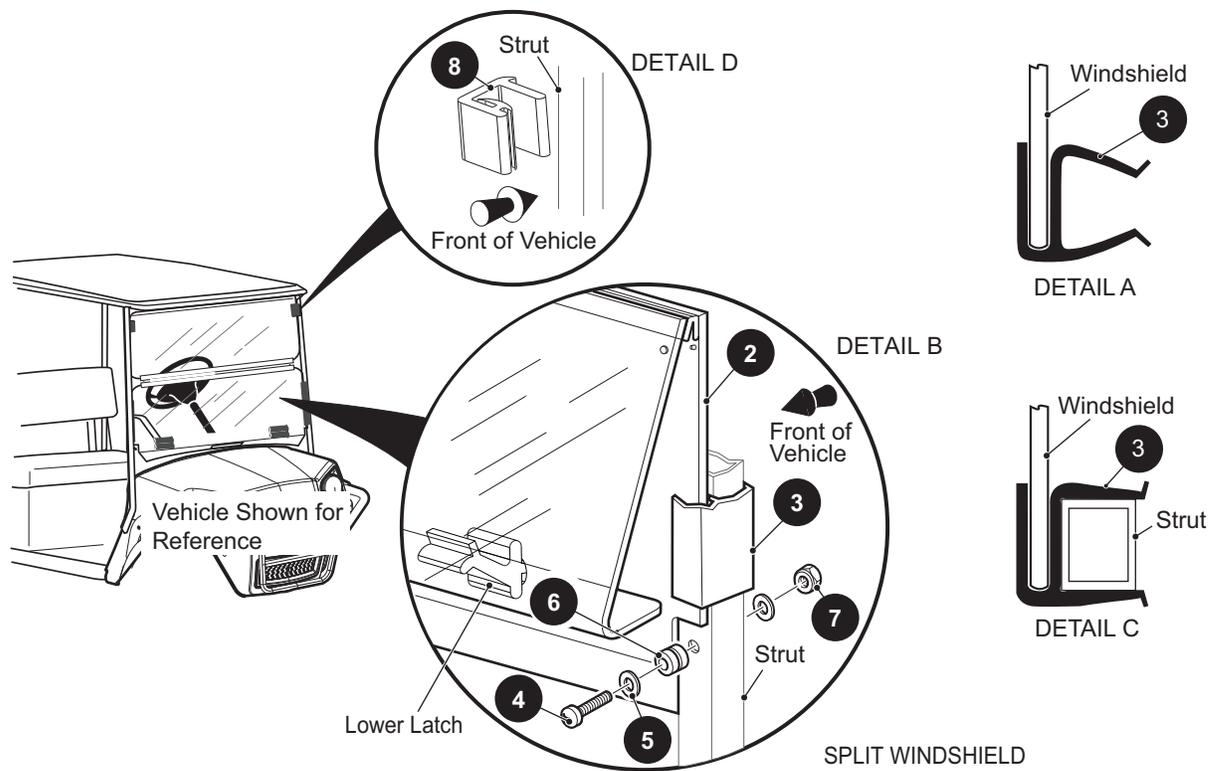
**Take care not to warp windshield when raising and lowering the top section of windshield.**

3. To secure windshield when lowered, press edge of windshield firmly into lower latches (See Detail B).
4. Insert bolt (4) through washer (5), rubber grommet (6) and existing hole in front strut. Secure with washer (5) and lock nut (7) (See Detail B). **Do not over-tighten or squeeze grommet.**
5. Place bottom section of windshield on rubber grommets and press the sash, starting at the bottom, onto the front strut so that it snaps into place (See Details B and C). Repeat for opposite side of windshield.
6. Swing the top section of windshield up and secure by hooking the upper round latch (8) on each side of strut to the upper windshield. Using a plastic faced mallet, gently tap the latch (8) to ensure windshield seats properly (See Detail D).

Figure 1 Split Windshield

# WEATHER PROTECTION

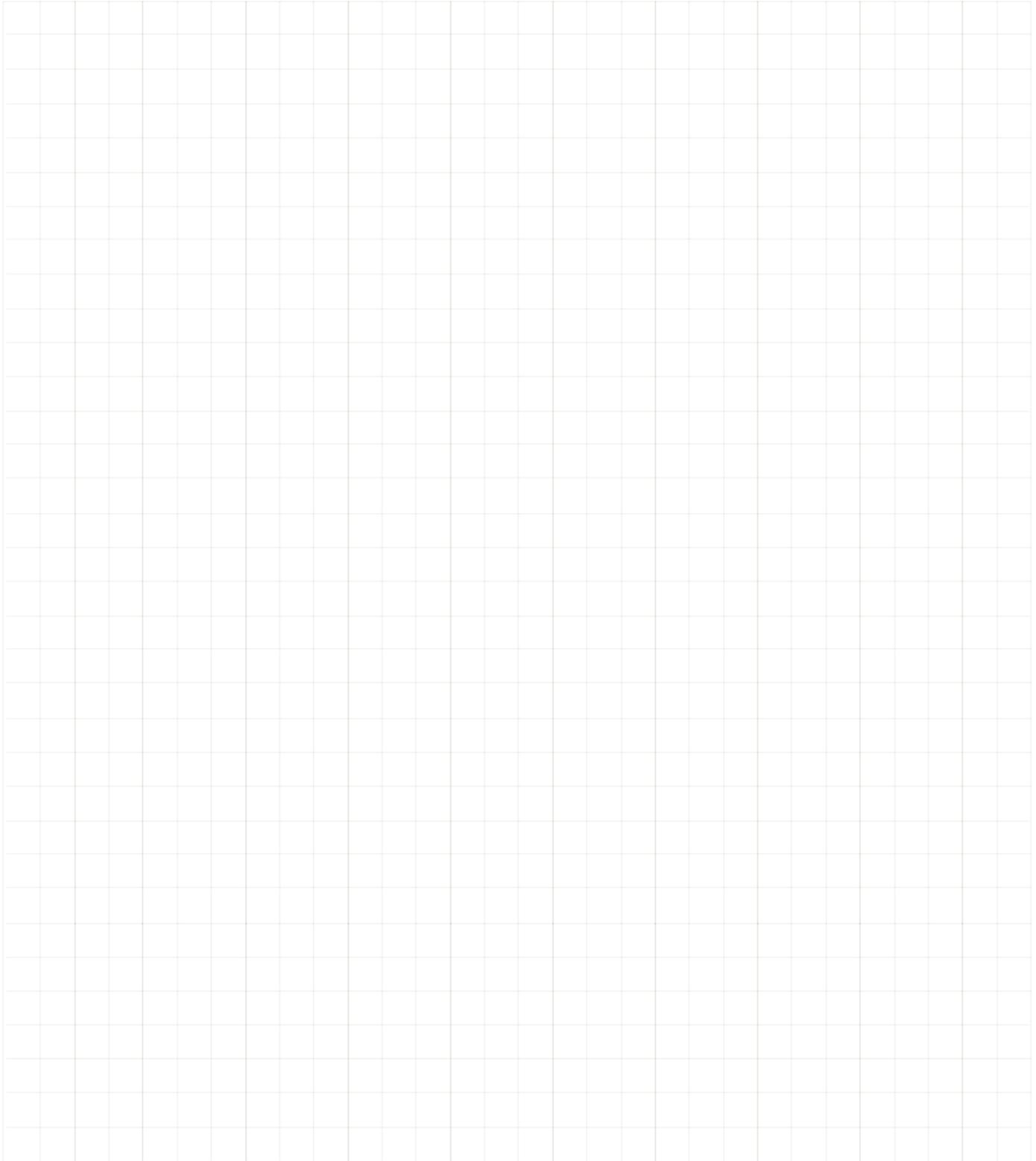
Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.



# WEATHER PROTECTION

*Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.*

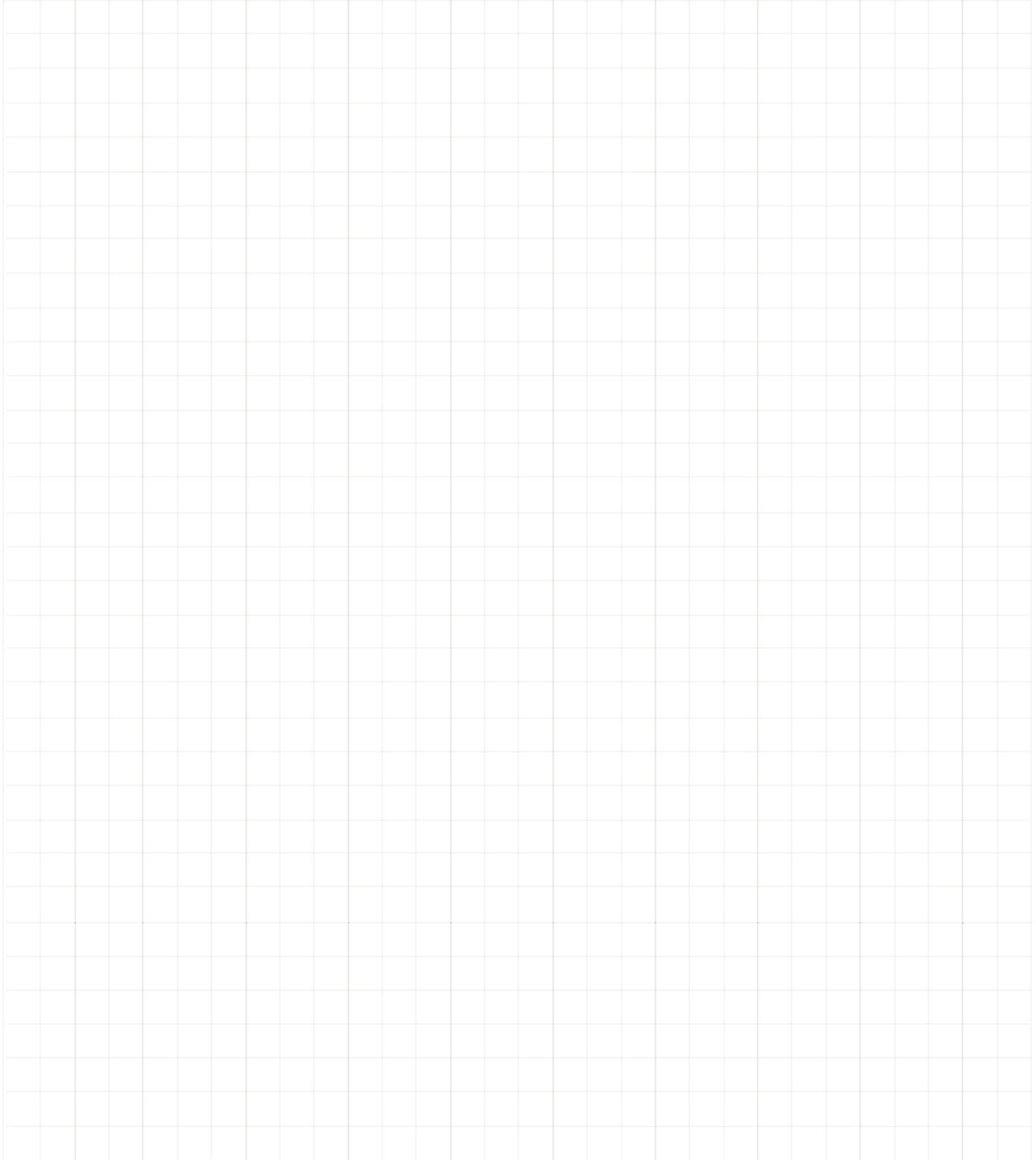
## Notes:

A large grid of graph paper for taking notes, consisting of 20 columns and 30 rows of small squares.

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## HANDHELD DIAGNOSTICS

### CURTIS HANDHELD 1313

The Curtis handheld Programmer is used for programming, testing, fault testing, tuning, diagnosing and parameter adjustments of speed controller and auxiliary devices.



Figure 1 Curtis Handheld Programmer

The manufacturer utilizes a 'Molex to Tyco' adaptor connected to the power cord to connect to the vehicle diagnostic port provided under the seat.

**⚠ WARNING** Plug the Curtis handheld programmer into Curtis programmer port only. If plugged into the wrong port, voltage from other interface circuits may result in permanent damage to the programmer.

The main menu appears after the data is uploaded from the controller unit.

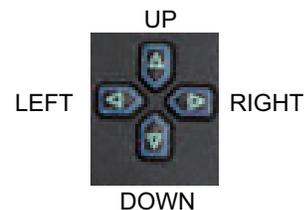
#### Primary Connection: 4 PIN TYCO

- Located under passenger seat
- Remove protective water cap
- Use both harness adapters
- Align white dots on connector
- Engage and twist sleeve to secure, a slight snap or click may be heard/felt



#### Navigation

With these four keys you can scroll up and down, and right and left, within the display. In the Main Menu, you can use the arrow keys to highlight one of the menus; you then open the highlighted menu using the "Select" soft-key. Within menus (other than the Main Menu), the left-arrow key is used to navigate backwards within menus (other than the Main Menu), the right-arrow key is used to navigate forwards - that is, to open highlighted sub-menus or items.



#### Changing Data Value



Press the Data Increase or Data Decrease key to change the value of the parameter.

#### Favorites



This key is an alternate way to bring up the Favorites menu. you can access the Favorites menu by selecting its icon in the Main Menu, or by using the Favorites key. To set a favorite, navigate to the menu desired and select the soft-key "add to". Use the soft key "select" to select "Favorites" and choose the soft key "add" and then "finish".

# HANDHELD DIAGNOSTICS

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## Main Menu Definitions

- **SYSTEM INFO** - The System Info menu opens directly to a detail screen providing information about the motor controller to which the programmer is connected.
- **PARAMETERS** - This is where you can adjust the settings of the control system's adjustable parameters.
- **MONITOR** - Show vehicle real-time diagnostics
- **DIAGNOSTICS** - Show active and past faults
- **PROGRAMMING** - Through the Programming menu, you can save and restore your parameter settings files (.cpf files).
- **FAVORITES** - The Favorites menu consists of the custom set of items you have created.
- **HHP SETTINGS** - This menu allows you to adjust the appearance of the screen displays and also several aspects of the handheld programmer's functionality.
- **FILE MANAGER** - With File Manager you can create, delete, move, copy and paste files and folders.
- **PLOT & LOG** - Through the Plot & Log menu, you can use the Plot program to plot real-time variables, or use the Log program to create a log of variable values to view later in a spreadsheet program on your PC.

# HANDHELD DIAGNOSTICS

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Menu 1313	Submenu 1	Submenu 2	Submenu 3	Data Range	Default value
System Information	Model Number			Display the controller model number	
	Protocol Version			Display the controller protocol version	
	Serial Number			Display the controller serial number	
	Mfg Date Code			Display controller date of man	
	Hardware Version			Display the controller hardware version	
	OS Number			Display controller operating system	
	Build Number			Display controller OS build number	
	Supervisor Version			Display supervisor version	
	Supervisor Build No.			Display controller supervisor build number.	
	HW Version			Display controller HW version	
Parameters	Battery	Reset Volts Per Cell		0.900V-3.00V	2.090V
		Full Volts Per Cell		0.900V-3.00V	2.040V
		Empty Volts Per Cell		0.900V-3.00V	1.730V
		Discharge Time		0-600	25Mn
		BDI Reset Percent		0-100	75%
	Reset Controller			0 - 1	0

**Figure 2 CURTIS Hand Held Controller Main/Submenus**

# HANDHELD DIAGNOSTICS

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Menu 1313	Submenu 1	Submenu 2	Submenu 3	Data Range	Default value	
Monitor	Solenoid Coil			On - Off	On	
	Rear Node Select			On - Off	On	
	Solenoid PWM			0-100	0%	
	Rear Controller	Run/Tow Switch			On - Off	Off
		Key Switch			On - Off	Off
		Economy Mode Switch			On - Off	Off
		Forward Switch			On - Off	Off
		Reverse Switch			On - Off	Off
		Throttles	Raw Primary Throttle		0.00 - 5.00	0.73V
			Mapped Primary Throttle		0 - 1 00	0.00%
			Raw Redundant Throttle		0.00 - 5.00	0.37V
		Mapped Redundant Throttle		0 - 100	0%	
	Inputs	Throttle Command			0 - 100	0%
		Mapped Throttle			0 - 100	0%
		Throttle Pot			0.00 - 5.50	0.73V
		Pot2 Raw			0.00 - 5.50	0.37V
		Interlock			On - Off	Off
		Analog 2			0.00 - 10.00	1.24V
	Outputs	5 Volts			0.00 - 6.25	4.94V
		12 Volts			0.00 - 12.00	12.42V
		Ext Supply Current			0 - 200	63mA
		Pot Low			0.00 - 6.25	0.20V
	Battery	BDI			0 - 100	75%
		Capacitor Voltage			0.0 - 105.0	3.1V
		Keyswitch Voltage			0.0 - 105.0	77.0V
	Motor	Motor RPM			-12000 - 12000	0 RPM
		Temperature			-100 - 300	29 degree celsius
		Motor Speed A			-12000 - 12000	0 RPM
		Motor Speed B			-12000 - 12000	0 RPM

Figure 2 CURTIS Hand Held Controller Main/Submenus (Continued)

# HANDHELD DIAGNOSTICS

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Menu 1313	Submenu 1	Submenu 2	Submenu 3	Data Range	Default value	
Monitor (continued)	Controller	Current (RMS)		0.0 - 1000.0	0.1A	
		Modulation Depth		0.0 - 100	0.00%	
		Frequency		-300.0 - 300.0	0.0Hz	
		Temperature		-100 - 300	33°C	
		Regen		On - Off	On	
		Cutbacks	Motor Temp Cutback	0 - 100	100%	
			Controller Temp Cutback	0 - 100	100%	
			Under voltage Cutback	0 - 100	0%	
		Over voltage Cutback	0 - 100	100%		
	Vehicle	Vehicle Speed		-3276.8 - 3276.7	0	
		Vehicle Odometer		0.0-10000000.0	0	
		Braking Distance		0.0 - 1000000.0	0	
		Distance Since Stop		0.0 - 1000000.0		
	Diagnostics	Present Errors			Display active faults.	
Fault Histoty				Display non - active faults		
Programming	Save .cpf file					
	Restore .cpf file					
HHP Settings	Program	LCD Contract	-300		0	
		Language		English	English	
		Set Security Code		Set user lock code		
	Faults	Fault History			Display fault history of HANDHELD	
		Clear Fault History			Yes/No	
	Information	OEM Info			Display OEM information	
		*Reconfigured			Display reconfigure status	
		Model Number			Display handheld model number	
		Serial Number			Display handheld serial number	
		Manufacturing Date			Display handheld manufacture date	
		Software Version			Display handheld software version	
		Hardware Version			Display handheld hardware version	
		MC-Protocol Version			Display MC-Protocol version	
		ES-Protocol Version			Display ES-Protocol version	
		S-Protocol Version			Display S-Protocol version	
Device Type			Display device type			
File Manager				Display to create folder		
Plot & Log				Display to plot & log		

Figure 2 CURTIS Hand Held Controller Main/Submenus (Continued)

# HANDHELD DIAGNOSTICS

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## Fault Code Chart

DIAGNOSTICS: Diagnostics information can be obtained in either of two methods:

- by reading the display on a 1311 and 1313 programmer or
- by observing the fault codes issued by the Status LEDs.

The 1311 and 1313 programmer will display all faults that are currently set, as well as a history of the faults that have been set since the history log was last cleared. The 1311 and 1313 displays the faults by name.

The pair of LEDs built into the controller (one red, one yellow) produce flash codes displaying all the currently set faults in a repeating cycle. Each code has two digits. The red LED flashes once to indicate that the first digit of the code will follow; the yellow LED then flashes the appropriate number of times for the first digit. The red LED flashes twice to indicate that the second digit of the code will follow; the yellow LED flashes the appropriate number of times for the second digit.

Example: Battery Undervoltage (code 23).

In the Fault menu of the 1311 programmer, the words Undervoltage Cutback will be displayed; the real-time battery voltage is displayed in the Monitor menu ("Keyswitch Voltage").

The controller's two LEDs will display this repeating pattern:

RED	YELLOW	RED	YELLOW
*	* *	* *	* * *
(first digit)	(2)	(second digit)	(3)

The numerical codes used by the yellow LED are listed in the fault testing chart, which also lists possible fault causes and describes the conditions that set and clear each fault.

## Summary of LED Display Formats

The two LED's have four different display modes that indicate the type of information they provide.

TYPES OF LED DISPLAY	
Display	Status
Neither LED illuminated	Controller is not powered on; or vehicle has dead battery; or severe damage.
Yellow LED Flashing	Controller is operating normally.
Yellow and red LEDs both on solid	Controller is in Flash program mode.
Red LED on Solid	Watchdog failure or no software loaded. Cycle KSI to restart, and if necessary load software.
Red LED and yellow LED Flashing alternately	Controller has detected a fault. 2-digit code flashed by yellow LED identifies the specific fault; one or two flashes by red LED indicate whether first or second code digit will follow.

# HANDHELD DIAGNOSTICS

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Fault Number	Description	Condition	Relay	Warning	BMS
1-2	<b>Controller Over current</b>	Phase Current exceeded current limits	Vehicle Disabled	KSI Cycled	1.External short of phase U,V or W 2.Check wiring 3.Motor parameters are mis-tuned 4.Defective controller 5.Speed encoder noise problems
1-3	<b>Current Sensor Fault</b>	Controller current sensors have invalid offset reading	Vehicle Disabled	KSI Cycled	1.Short to car frame from phase U,V or W. 2.Controller defective
1-4	<b>Precharge Failed</b>	Capacitor bank failed to charge at KSI voltage	Vehicle Disabled	Cycle interlock	1.See handheld monitor menu - battery: capacitor voltage 2.External load on capacitor bank preventing capacitor charge 3.Check wiring 4.Check brake sensor if other faults are found
1-5	<b>Controller Sever Under temp</b>	Heat sink temperature below -40°C	Vehicle Disabled	Raise controller temp to above -40 degree Celsius and cycle KSI or interlock	1.Controller is operating in an extreme environment 2.See monitor menu - controller: temperature
1-6	<b>Controller Sever Over temp</b>	Heat sink temperature above +95°C	Vehicle Disabled	Reduce heat sink temperature below 95 degree Celsius and cycle KSI or interlock	1.Controller is operating in an extreme environment 2.See monitor menu - controller: temperature 3.Excessive load on vehicle 4.Improper mounting of controller
1-7	<b>Severe Under voltage</b>	Capacitor voltage dropped below limit	Reduced Drive torque and speed	Condition clears	1.Battery menu parameters are misadjusted 2.Non-controller system drain on batteries 3.Battery resistance too high 4.Battery disconnected while driving 5.See monitor menu - Battery: capacitor voltage 6.Blown B+ fuse or main contactor did not close

Figure 3 Fault Code Chart

# HANDHELD DIAGNOSTICS

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Fault Number	Description	Condition	Relay	Warning	BMS
1-8	<b>Severe Over voltage</b>	Capacitor bank voltage exceeded limit	Vehicle Disabled	Condition clears and KSI cycled	<ol style="list-style-type: none"> <li>1. See monitor menu-Battery: capacitor voltage</li> <li>2. Battery menu parameters are mis-adjusted</li> <li>3. Battery resistance too high for given regen current</li> <li>4. Battery disconnected while regen braking</li> </ol>
2-2	<b>Controller Over temp Cutback</b>	heat sink temp exceeded 85°C	Reduced drive and brake torque	Condition clears	<ol style="list-style-type: none"> <li>1. See monitor menu-Controller: temperature</li> <li>2. Controller is performance-limited at this temperature</li> <li>3. Controller is operating in an extreme environment</li> <li>4. Excessive load on vehicle</li> </ol>
2-3	<b>Under voltage Cutback</b>	Capacitor bank voltage dropped below limit	Reduced Drive torque and speed	Condition clears	<ol style="list-style-type: none"> <li>1. Normal operation. Fault shows that batteries need recharging</li> <li>2. Battery parameters are mis-adjusted</li> <li>3. Non-controller system drain</li> <li>4. Battery resistance too high</li> <li>5. Battery disconnected while driving</li> <li>6. See Monitor menu-Battery: capacitor voltage</li> <li>7. Blown B+ fuse or main contactor did not close</li> </ol>
2-4	<b>Over voltage Cutback</b>	Capacitor bank voltage exceeded Over voltage limit	Reduced brake torque	Condition clears	<ol style="list-style-type: none"> <li>1. Normal operation. Fault shows that the regen braking currents elevated the battery voltage during regen braking. Controller is performance limited at this voltage</li> <li>2. Battery parameters are mis-adjusted</li> <li>3. Battery resistance too high for given regen current</li> <li>4. Battery disconnected while regen braking</li> <li>5. See Monitor menu - Battery: ca (capacitor voltage)</li> </ol>
2-5	<b>+5V supply Failure</b>	+ 5 V supply (pin 26) outside the +5V + or - 10% range	None: Check VCL	Condition clears	<ol style="list-style-type: none"> <li>1. External load impedance on the + 5 V supply is too low</li> <li>2. See Monitor menu-Outputs: 5 volts and ext supply current</li> </ol>

Figure 3 Fault Code Chart (Continued)

# HANDHELD DIAGNOSTICS

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Fault Number	Description	Condition	Relay	Warning	BMS
2-6	<b>Digital Out Over current</b>	Digital output 6 (pin 19) current exceeded 15mA	None: Check VCL	Fix the over current cause and use the VCL function set dig out to turn driver on again	1.External load impedance on Digital Output 6 (pin 19) is too low
2-7	<b>Digital Out 7 Over current</b>	Digital output 7 (pin 20) current exceeded 15mA	None: Check VCL	Fix the over current cause and use the VCL function set dig Out() to turn driver on again	1.External load impedance on Digital Output 7 (pin 20) is too low
2-8	<b>Motor Temp Hot Cutback</b>	Motor temp is at or above Hot parameter setting	Reduced Drive torque and speed	Condition clears	1.Motor temperature is at or above the programmed temperature Hot setting, and the requested current is being cut back 2.Motor temperature control menu parameters are mis-tuned 3.See Monitor menu-Motor: temperature and - Inputs: analog 2 4.reduce load on motor
2-9	<b>Motor Temp Sensor Fault</b>	Motor thermistor input (pin8) is at voltage rail (0 or 10v)	Reduced speed, Motor temp cutback disabled	Condition clears	1.Motor thermistor is not connected 2.Check sensor
3-1	<b>Coil 1 Driver Open or Short - also can be Main Open or Short</b>	Driver 1 (pin6) is either open or shorted. This fault can only be set when main enable =off	Shutdown driver 1	Correct condition and cycle driver	1.Open or short on driver load 2.Dirty connector pins 3.Bad crimps or faulty wiring
3-2	<b>Coil 2 Driver Open or Short</b>	Driver 2 (pin5) is either open or shorted. This fault can only be set when main enable =off	Shutdown driver 2	Correct condition and cycle driver	1.Open or short on driver load 2.Dirty connector pins 3.Bad crimps or faulty wiring
3-3	<b>Coil 3 Driver Open or Short</b>	Driver 3 (pin4) is either open or shorted. This fault can only be set when main enable =off	Shutdown driver 3	Correct condition and cycle driver	1.Open or short on driver load 2.Dirty connector pins 3.Bad crimps or faulty wiring

Figure 3 Fault Code Chart (Continued)

# HANDHELD DIAGNOSTICS

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Fault Number	Description	Condition	Relay	Warning	BMS
3-4	<b>Coil 4 Driver Open or Short</b>	Driver 4 (pin3) is either open or shorted. This fault can only be set when main enable =off	Shutdown driver 4	Correct condition and cycle driver	1.Open or short on driver load 2.Dirty connector pins 3.Bad crimps or faulty wiring
3-5	<b>PD Open or Short</b>	The Proportional driver (pin2) is either open or shorted. This fault can only be set when main enable =off	Shutdown PD driver	Correct condition and cycle driver	1.Open or short on driver load 2.Dirty connector pins 3.Bad crimps or faulty wiring
3-6	<b>Encoder Fault</b>	Motor encoder phase failure detected.	Throttle Shutdown	KSI cycled	1.Motor encoder failure 2.Bad crimp or faulty wiring 3.See Monitor menu - Motor: motor rpm
3-7	<b>Motor Open</b>	Motor Phase U,V or W detected open	Vehicle Disabled	KSI cycled	1.Motor phase is open 2.Bad crimps or faulty wiring
3-8	<b>Main Contactor Welded</b>	Prior to main contactor closing, capacitor bank voltage was loaded for a short time and did not discharge	Vehicle Disabled	KSI cycled	1.Main contactor tips are welded closed 2.Motor phase U or V is disconnected or open 3.An alternate voltage path is providing a current to the capacitor bank (B+ connection terminal)
3-9	<b>Main Contactor Did Not Close</b>	With the main contactor commanded closed, the bank voltage (B+ connection terminal) did not charge to B+	Vehicle Disabled	KSI cycled	1.Main contactor did not close 2.Main contactor tips are oxidized, burned, or not making a good contact 3.External load on capacitor bank (B+ connection terminal) that prevents capacitor bank from charging 4.Blown B+ fuse
4-1	<b>Throttle Wiper High</b>	Throttle pot wiper (pin16) voltage is higher than high fault setting	Shutdown throttle	Condition clears	1.See Monitor menu-Inputs: throttle pot 2.Throttle pot wiper voltage too high
4-2	<b>Throttle Wiper Low</b>	Throttle pot wiper (pin16) voltage is lower than low fault setting	Shutdown throttle	Condition clears	1.See Monitor menu-Inputs: throttle pot 2.Throttle pot wiper voltage too low

Figure 3 Fault Code Chart (Continued)

# HANDHELD DIAGNOSTICS

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Fault Number	Description	Condition	Relay	Warning	BMS
4-3	<b>Pot 2 Wiper High</b>	Pot 2 wiper (pin17) voltage is higher than high fault setting	Full Brake	Condition clears	1. See Monitor menu-Inputs: pot2 raw 2. Pot2 wiper voltage too high
4-4	<b>Pot 2 Wiper Low</b>	Pot 2 wiper (pin17) voltage is lower than low fault setting	Full Throttle	Condition clears	1. See Monitor menu-Inputs: pot2 raw 2. Pot2 wiper voltage too low
4-5	<b>Pot Low Over current</b>	Pot low (pin 18) current exceeds 10mA	Shutdown Throttle and full Brake	Condition clears and KSI cycled	1. See Monitor menu-Outputs: pot low 2. Combined pot resistance connected to pot low is to low
4-6	<b>EEPROM Failure</b>	Controller operating system tried to write to EEPROM memory and failed	Vehicle Disabled	Download correct software (OS) and matching parameter default settings into the controller and c	1. Failure to write to EEPROM memory. This can be caused by EEPROM memory writes initiated by VCL, by the CAN bus, by adjusting parameters with the programmer, or by loading new software into controller
4-7	<b>HPD/ Sequencing Fault</b>	HPD sequencing fault caused incorrect sequence of KSI, interlock, direction and throttle input	Shutdown Throttle	Reapply inputs in correct sequence	1. KSI, interlock, direction and throttle inputs applied in incorrect sequence 2. Faulty wiring, crimps, or switches at KSI, interlock, direction, or throttle inputs. 3. See Monitor menu-Inputs
4-8	<b>Emer Rev HPD</b>	At the conclusion of Emergency Reverse, the fault was set because various inputs were not returned to neutral	Shutdown Throttle	If EMR_interlock=On, clear the interlock, throttle and direction inputs. If EMR_Interlock=Off, clear the throttle and direction inputs.	1. Emergency Reverse operation has concluded, but the throttle, forward and reverse inputs, and interlock have not been returned to neutral
4-9	<b>Parameter Change Fault</b>	Adjustment of a parameter setting that requires cycling of KSI	Vehicle Disabled	KSI cycled	1. This is a safety fault caused by a change in certain parameter settings so that the vehicle will not operate until KSI id cycled

Figure 3 Fault Code Chart (Continued)

# HANDHELD DIAGNOSTICS

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

Fault Number	Description	Condition	Relay	Warning	BMS
5-2	<b>Traction Throttle Mismatch</b>	Throttle input/output mismatched	Throttle Shutdown	Condition Clears	1. See Monitor menu-Inputs: Throttle 2. Check throttle return
5-3	<b>Throttle Input Out of Range</b>	Throttle input out of range	Throttle Shutdown	Condition Clears	1. See Monitor menu-Inputs: Throttle 2. Check throttle return 3. Check for water intrusion of throttle wiper
5-4	<b>Park Brake Set</b>	Park brake engaged when traction pedal was activated	Throttle Shutdown	Condition cleared	1. Park brake was engaged when throttle was activated 2. Release park brake and operate unit 3. Check park brake switch
5-5	<b>HPD/SRO Fault</b>	High pedal disable/static return to off	Vehicle Disabled	Condition cleared. Correct start sequence applied	1. Verify correct start sequence. Unit must be in neutral prior to key on
5-6	<b>Solenoid Coil Open/Short</b>	Driver does not turn OFF	Vehicle Disabled	KSI cycled	1. Open or short on driver load 2. Dirty connector pins 3. Bad crimps or faulty wiring 4. When found in history, does not necessarily indicate a problem
6-8	<b>VCL Run Time Error</b>	Runtime VCL code error condition	Vehicle Disabled	KSI cycled or install new software to match parameters	1. VCL code encountered a runtime VCL error 2. See Monitor menu -Controller: VCL error module
6-9	<b>External Supply out of Range</b>	The external 5v and 12V supply is out of range.	None: Check VCL	External supply current within range	1. External load on the 5V and 12V supplies draws either too much or too little current 2. Fault checking menu parameters Ext supply max and Ext. supply min are mis tuned 3. See Monitor menu-Outputs: ext supply current
7-1	<b>OS General</b>	Internal controller fault detected	Vehicle Disabled	KSI Cycled	1. Internal controller fault detected 2. Cycle KSI
7-2	<b>PDO Timeout</b>	Time between CAN PDO messages received exceeded the PDO timeout period	Shutdown Interlock. Set CAN NMT state to pre-operational	Cycle KSI or Cycle F&R	1. Time out period exceeded because of no inputs from throttle or controls 2. Cycle KSI and or F&R switch

Figure 3 Fault Code Chart (Continued)

# HANDHELD DIAGNOSTICS

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

Fault Number	Description	Condition	Relay	Warning	BMS
7-3	<b>Stall Detected</b>	No Motor encoder movement detected	Vehicle Disabled	Cycle KSI	1.Stalled motor 2.Motor encoder failure 3.Bad crimps or faulty wiring 4.Problems with power supply for the motor encoder 5.See Monitor menu-Motor: motor rpm
7-4	<b>Fault on Other Traction Controller</b>	Fault found on slave controller	Depends on fault	KSI cycled	1.Check slave controller faults with handheld via direct connection to slave controller
7-5	<b>Dual Severe Fault</b>	Severe fault found on slave controller	Vehicle Disabled	KSI cycled	1.Check slave controller faults with handheld via direct connection to slave controller
8-7	<b>Motor Characterization on Fault</b>	Motor Characterization failed during motor characterization process	Vehicle Disabled	KSI cycled or fault corrected	1.Motor characterization failed during MC process. See Monitor menu - Controller: motor characterization error for cause: 0=none 1=encoder signal seen, but step size not determined: set encoder step size manually 2=motor temp sensor fault 3=motor temp hot cutback fault 4=controller over temp cutback fault 5=controller under temp cutback fault 6=under voltage cutback fault 7=severe over voltage fault 8=encoder signal not seen, or one or both channels missing 9=motor parameters out of characterization range
8-9	<b>Motor Type Fault</b>	Motor type parameter value is out of range	Vehicle Disabled	KSI cycled and or correct fault	1. Motor Type parameter value is out of range 2. Check controller command on hand held
9-1	<b>VCL/OS Mismatch</b>	VCL and OS software do not match, when Ski is cycled a check is made to verify that they match and a fault is issued when they do not	Vehicle Disabled	Condition clears	1. The VCL software in the controller does not match the OS software in the controller-re-install software

Figure 3 Fault Code Chart (Continued)

# HANDHELD DIAGNOSTICS

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

Fault Number	Description	Condition	Relay	Warning	BMS
9-3	<b>Encoder LOS (limited operating strategy)</b>	Encoder fault(code36) or stall detect fault (code73) was activated and brake or interlock has been applied to activate LOS control mode, allowing limited motor control	Vehicle Disabled	KSI Cycled or Fault cleared	<ol style="list-style-type: none"> <li>1. limited Operating Strategy control mode has been activated, as a result of either an encoder fault or stall detect fault</li> <li>2. Motor encoder failure</li> <li>3. Bad crimps or faulty wiring</li> <li>4. Motor stalled</li> </ol>
9-4	<b>EMER Rev Timeout</b>	Emergency reverse was activated and ran until the EMR timeout timer expired.	Throttle Shutdown	Condition clears	<ol style="list-style-type: none"> <li>1. Emergency reverse was activated and concluded because of EMR timeout</li> <li>2. The emergency reverse input is stuck on</li> </ol>
9-8	<b>Illegal Model Number</b>	Model Number variable, cycles a check is made to confirm a legal model number is found, a fault is issued if not	Vehicle Disabled	Appropriate software downloaded	<ol style="list-style-type: none"> <li>1. Model number variable is illegal for controller type</li> <li>2. Software and hardware do not match</li> <li>3. Defective controller</li> </ol>
9-9	<b>Dual motor Parameter Mismatch</b>	Mismatch of front and rear motors	Vehicle Disabled	Condition clears	<ol style="list-style-type: none"> <li>1. Check Wires and connections</li> <li>2. Check for mechanical bind</li> <li>3. Check for high mechanical load</li> <li>4. Verify motor encoder</li> <li>5. Check faults on handheld for both controllers</li> </ol>

Figure 3 Fault Code Chart (Continued)

# HANDHELD DIAGNOSTICS

*Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.*

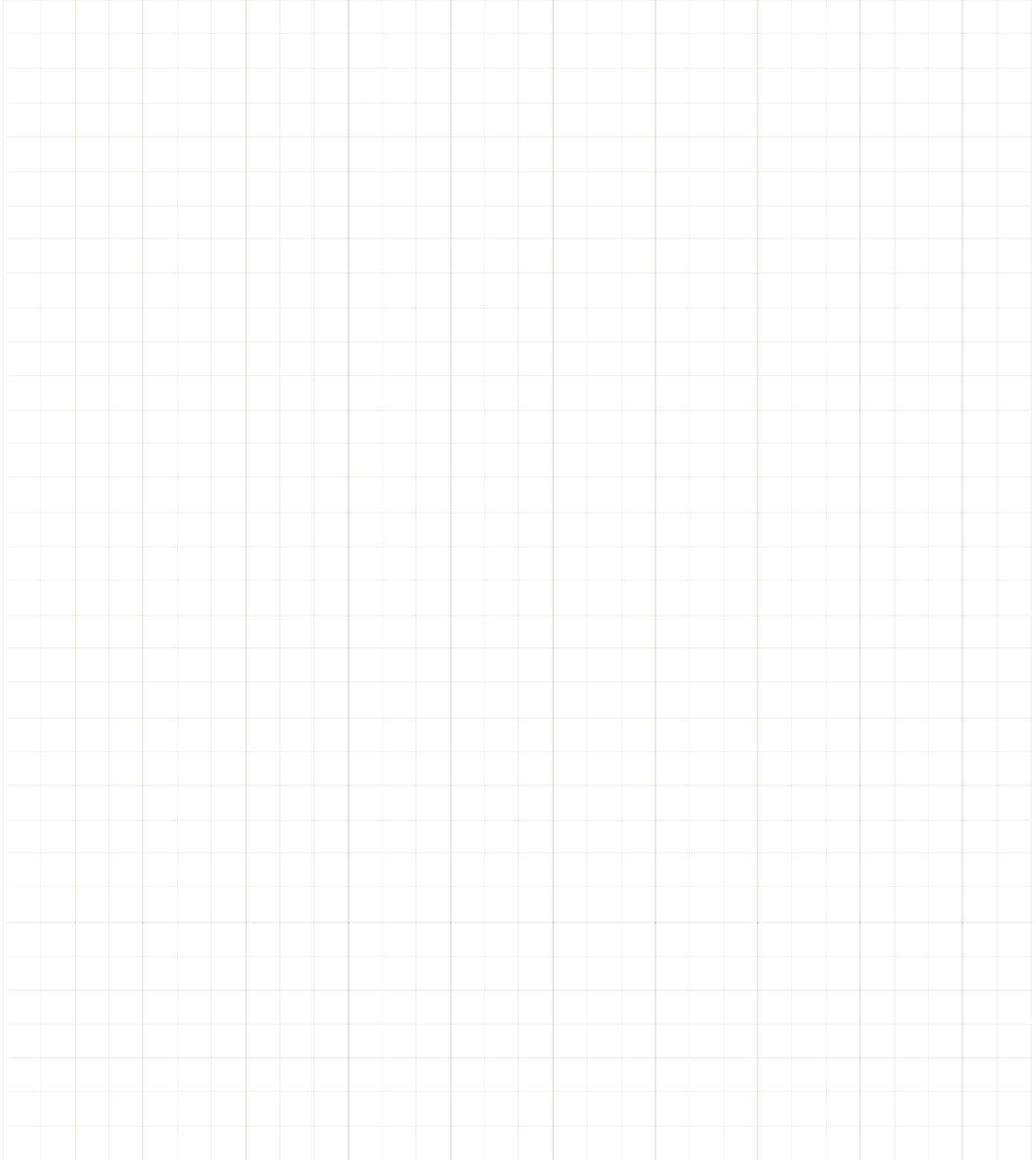
## Notes:

A large grid of graph paper for taking notes, consisting of 20 columns and 30 rows of small squares.

# HANDHELD DIAGNOSTICS

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## Notes:

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## FAULT TESTING

### ELECTRICAL SYSTEM

Condition	Possible Cause	Correction
VEHICLE WILL NOT MOVE See ELECTRONIC SPEED CONTROL section.		
VEHICLE SPEED ERRATIC	Faulty ESC system	Test and replace components as indicated by test procedure
NO REDUCED SPEED IN REVERSE	Faulty ESC system	Test and replace components as indicated by test procedure
MOTOR NOISY	Damaged bearing	Replace bearing
	Raised commutator bar(s)	Replace motor
	Loose motor mounting hardware	Tighten
BATTERIES WILL NOT CHARGE	Charger not functioning correctly	Repair or replace charger
	Vehicle charging wiring faulty	Repair or replace wiring
	Vehicle/charger connector damaged	Replace connector
	Battery case damaged	Replace battery
	Low electrolyte level	Maintain correct electrolyte level
	Battery capacity deficient	Hydrometer/load test Replace battery if required
	Damaged battery	Replace battery

### Basic Electrical Power System Troubleshooting

To diagnose electrical problems in the electrical power system, refer to the ELECTRONIC SPEED CONTROL section.

### Basic Electrical Troubleshooting for Accessories

To diagnose electrical problems in the vehicle electrical wiring system, refer to the ELECTRICAL SYSTEM section.

# FAULT TESTING

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

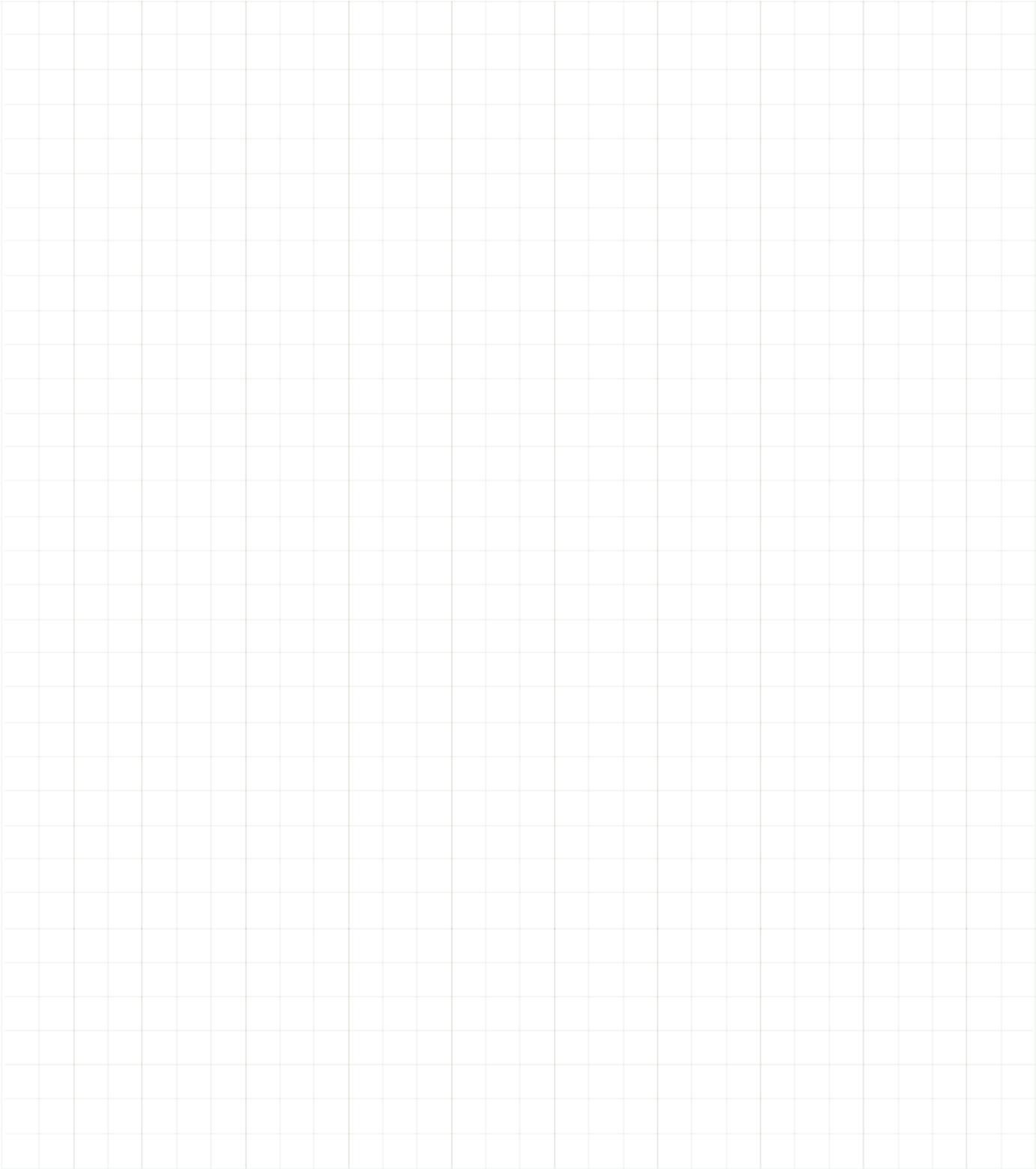
## SUSPENSION AND STEERING

Condition	Possible Cause	Correction
UNEVEN TIRE WEAR	Incorrect tire pressure	Inflate to recommended pressure
	Improper alignment (Incorrect toe in)	Align front tires
STIFF STEERING	Water has entered steering box and may freeze in cold conditions	Remove steering column, pinion and bearing and remove water before adding grease Inspect gasket for good seal
	Excessive grease in steering box has migrated into steering rack bellows or rack cover	Raise the vehicle and observe the rack bellows while moving the steering from lock to lock Any distortion of the bellows may indicate that an excess of grease has built up in the bellows Remove the bellows and remove excess grease
	Insufficient lubricant in king pins, rod ends, idler bushing or steering box	Add one pump of lubricant to each grease fitting and operate steering from lock to lock. <b>Do not over grease</b> If steering does not return to acceptable condition proceed to next step
	Bent rack	Remove rack and place on flat surface with rack teeth up If a .015" (.381 mm) feeler gauge will pass under the rack, the rack must be replaced
PLAY IN STEERING	Steering wheel loose	Inspect splines - replace steering wheel, if required Tighten steering wheel nut
	Steering components worn	Replace
	Loose wheel bearings	Adjust or replace
VIBRATION	Steering components worn	Replace
	Damaged wheel bearings	Replace
	Out of round tires, wheels or brake drums	Inspect and replace if out of round
	Loose lug nuts	Tighten to 50 - 85 ft. lbs. (68 - 115 Nm)
STEERING PULLS TO ONE SIDE	Incorrect tire pressure	Inflate to recommended pressure
	Dragging wheel brake	Service brake system
	Suspension component failure	Repair
	Improper alignment	Align

# FAULT TESTING

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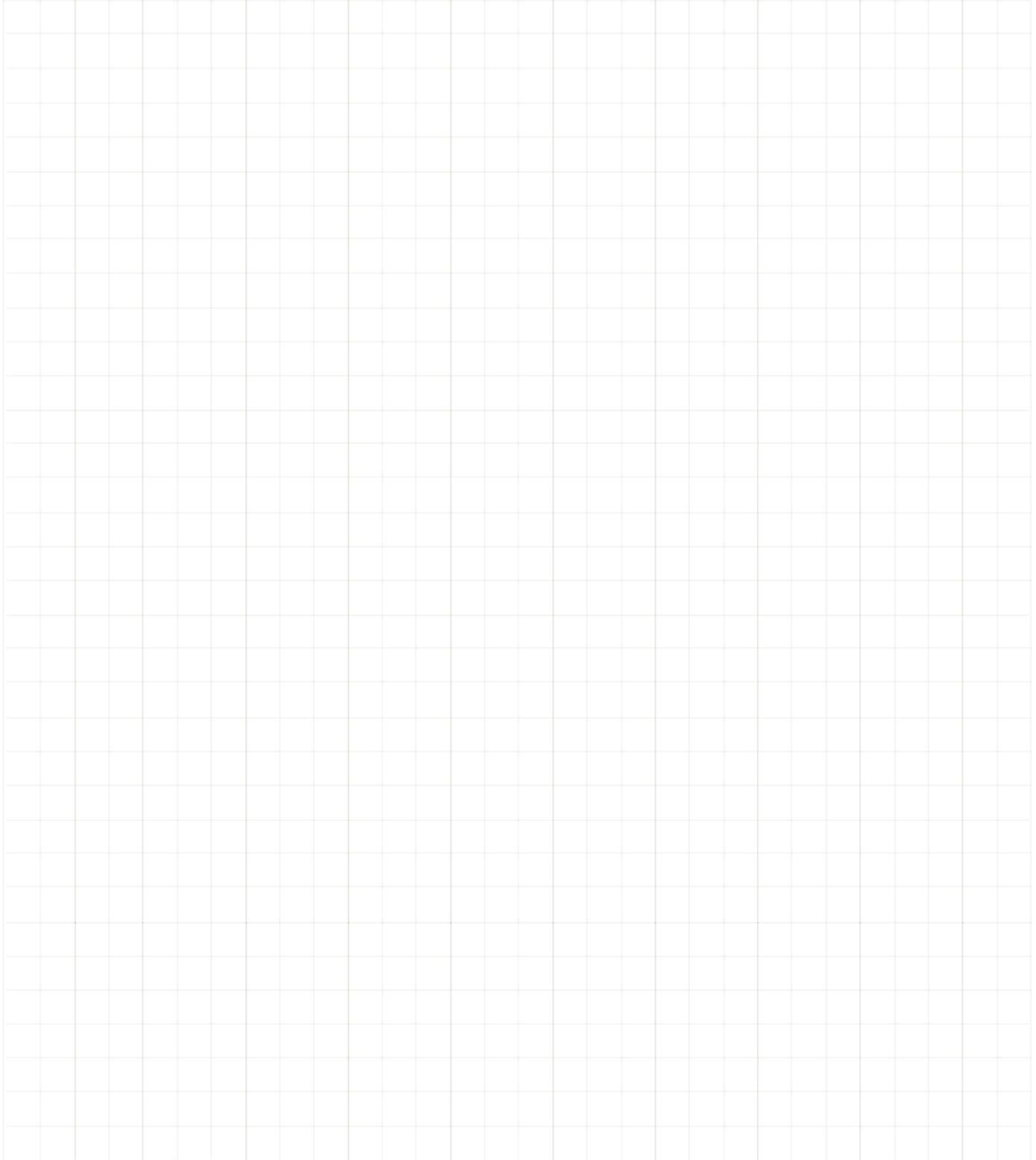
## Notes:

A large grid of graph paper, consisting of 20 columns and 30 rows of small squares, intended for taking notes.

# FAULT TESTING

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## GENERAL SPECIFICATIONS

### SHUTTLE 2+2 - VEHICLE SPECIFICATIONS

Item	Specification
Overall Length	107.5 in (273 cm)
Overall Width	49.5 in (124.5 cm)
Overall Height (No Canopy)	47.5 in (120.5 cm) (Top of steering wheel)
Overall Height (With Canopy)	77.5 in (197 cm)
Load Deck Width	40 in (101.5 cm)
Load Deck Length	32 in (84 cm)
Wheel Base	67 in (170 cm)
Front Wheel Track	34.5 in (87.5 cm)
Rear Wheel Track	38.5 in (98 cm)
Ground Clearance (at Differential)	5.75 in (14.5 cm)
Turning Radius	10.2 ft (3.1 m)
Power Source	72V DC
Motor Type	AC Induction
Horsepower (kW)	22.4 hp (16.7 kW)
Electrical System	72V
Batteries	Six, 12V Deep Cycle
Key or Pedal Start	Pedal
Battery Charger	1500 W, 72V DC
Speed Controller	350 Amp AC Controller
Speed (Level Ground)	14.5 - 19.5 mph (23.3 - 31.4 kph)
Drivetrain	Motor Shaft Direct Drive
Transaxle	Differential with helical gears
Gear Selection	Dash Mounted FNR/key switch
Rear Axle Ratio	16.99:1 (Forward)
Seating Capacity	4-Person
Dry Weight	968 lb (439 kg) (without batteries)
Curb Weight	1460 lb (662 kg)
Dash / IP Storage Capacity	1123 in <sup>3</sup> (18403 cm <sup>3</sup> )
Load Deck Capacity	250 lb (113 kg)
Vehicle Load Capacity	800 lb (363 kg)
Outside Clearance Circle	19 ft (5.8 m)
Towing Capacity	N/A
Steering	Self-compensating reduction rack and pinion
Front Suspension	Leaf springs with hydraulic shock absorbers
Brakes	Dual rear wheel mechanical self-adjusting drum
Parking Brake	Self-compensating, single point engagement
Front Tires	Desert Eagle 23/10-14 (4ply)

# GENERAL SPECIFICATIONS

*Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.*

Item	Specification
Rear Tires	Desert Eagle 23/10-14 (4ply)
Frame	Welded steel with DuraShield™ powder coat
Front Body and Finish	Injection Molded TPO
Rear Body and Finish	Injection Molded TPO

## SCHEDULED MAINTENANCE

### SCHEDULED MAINTENANCE CHART

Item	Interval (perform at interval that comes first)		Remarks	Page
	Hours	Calendar		
Overall vehicle condition	Pre-ride		Inspect.	
Batteries	Daily		Charge daily after use.	
Steering	Pre-ride		Check for smooth and free operation.	
Front suspension	Pre-ride		Inspect. Check for leaks and loose or missing hardware.	
Rear suspension	Pre-ride		Inspect. Check for leaks and loose or missing hardware.	
Tires	Pre-ride		Check condition and pressure.	26
Wheel lug nuts	Pre-ride		Check for loose or missing.	26
Accelerator	Pre-ride		Check for smooth operation.	
Brake system	Pre-ride		Check for smooth operation and acceptable stopping distance.	80
Frame hardware	Pre-ride		Check for loose or missing.	
Headlights and taillights	Pre-ride		Check operation. Replace bulbs as needed.	
Reverse warning alarm	Pre-ride		Check operation.	
Switches	Pre-ride		Check operation.	
Fluid leakages	Pre-ride		Inspect entire vehicle for leaks	
<b>s</b> Brake shoes	10	Monthly	Inspect. Replace as needed.	
Batteries	20	Monthly	Clean	
Batteries	20	Monthly	Check electrolyte level; fill with distilled water if required	
Charger receptacle	20	Monthly	Clean connections.	
Parking brake	20	Monthly	Conduct brake performance test; adjust as necessary. Check for correct hold on an incline.	
Accelerator	20	Monthly	Check for smooth operation.	
Wiring	20	Monthly	Inspect for loose connections, broken or missing insulation.	
Steering	20	Monthly	Check for excess play, loose or missing hardware.	
<b>s</b> Tie rods	20	Monthly	Check for excess play, bent rods, loose or missing hardware.	
Front suspension	20	Monthly	Inspect strut for leaks. Check hubs and kingpins, for excessive play, worn bushings, loose or missing hardware.	
Rear axle	20	Monthly	Check for leakage; add oil as required.	
Brakes	20	Monthly	Check for smooth operation and acceptable stopping distance.	80
Front wheel alignment	60	3 Months	Check for unusual tire wear.	
Rear Suspension	60	3 Months	Check for shock oil leakage, worn bushings, loose or missing hardware.	
<b>s</b> General lubrication	50	3 Months	Lubricate all fittings, pivots, cables, etc. where required.	3
Rear axle	500	5 years	Replace fluid.	
Motor coupling	20,000 Amp Hours	5 years	Add anti-seize compound (approx. 1 tbsp.)	

# SCHEDULED MAINTENANCE

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

## RECOMMENDED LUBRICANTS AND FLUIDS

Check and lubricate all components at the intervals shown in the *SCHEDULED MAINTENANCE CHART*.

Item	Capacity	Lubricants/Fluids	Notes
Rear axle oil	25 oz. (0.7 L)	Mobil 424	Part Number 603967
Rear axle oil	2.0 oz (59 mL)	Friction Modifier	Part Number 611242
Grease fittings		Universal joint grease or equivalent	Do not exceed 3 pumps of grease in each fitting.

## REPLACEMENT OF MAINTENANCE ITEMS

These items or their equivalents can be purchased through your dealer or any other qualified source.

Item	Part Number
32V, 5A Mini Fuse	636455G10
32V, 10A Mini Fuse	636455G12
32V, 15A Mini Fuse	636455G13
125V, 10A Mini Fuse	636455G05
Throttle Resistor	662004
72V Relay	633230G03
LED Headlight Assembly	651411G03
Headlight Bulb	619100

*Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.*

# APPENDIX A

## DELTA-Q USER'S GUIDE

# APPENDIX A

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.



## SAVE THESE IMPORTANT SAFETY INSTRUCTIONS



This manual contains important safety and operating instructions – read before using charger.

**Warning:** Use charger only with an algorithm selected that is appropriate to the specific battery type. Other usage may cause personal injury and damage. Lead acid batteries may generate explosive hydrogen gas during normal operation. Keep sparks, flames, and smoking materials away from batteries. Provide adequate ventilation during charging. Never charge a frozen battery. Study all battery manufacturers' specific precautions, ie. maximum charge rates and if cell caps should be removed while charging.

**Danger:** Risk of electric shock. Connect charger power cord to an outlet that has been properly installed and grounded in accordance with all local codes and ordinances. A grounded outlet is required to reduce risk of electric shock – do not use ground adapters or modify plug. Do not touch uninsulated portion of output connector or uninsulated battery terminals. Disconnect the AC supply before making or breaking the connections to the battery. Do not open or disassemble charger. Do not operate this charger if the AC supply cord is damaged or if the charger has received a sharp blow, been dropped, or otherwise damaged in any way – refer all repair work to the manufacturer, or qualified personnel. This appliance is not intended for use by persons (including children) with reduced physical, sensory or mental capabilities, or lack of experience and knowledge, unless they have been given supervision or instruction concerning use of the appliance by a person responsible for their safety. Children should be supervised to ensure that they do not play with the appliance.

## INFORMATIONS IMPORTANTES DE SÉCURITÉ



Ce manuel contient des instructions importantes concernant la sécurité et le fonctionnement.

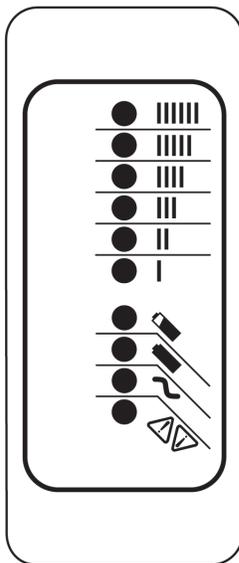
**Attention:** Utiliser le chargeur seulement avec un algorithme approprié au type spécifique de batterie. D'autres types de batteries pourraient éclater et causer des blessures ou dommages. Les batteries peuvent produire des gaz explosifs en service normal. Ne jamais fumer près de la batterie et éviter toute étincelle ou flamme nue à proximité des batteries. Fournissez une ventilation adéquate du chargement. Ne jamais charger une batterie gelée. Prendre connaissance des mesures de précaution spécifiées par le fabricant de la batterie, p. ex., vérifier s'il faut enlever les bouchons des cellules lors du chargement, et les taux de chargement.

**Danger:** Risque de chocs électriques. Ne pas toucher les parties non isolées du connecteur de sortie ou les bornes non isolées de la batterie. Toujours connecter le chargeur à une prise de courant mise à la terre. Déconnectez la source AC avant de faire ou défaire les connexions à la batterie en chargement. Ne pas utiliser le chargeur si le cordon d'alimentation AC est endommagé ou si le chargeur est abîmé suite à une chute ou autre incident. Ne pas ouvrir ni désassembler le chargeur – référer toute réparation aux personnes qualifiées. Cet appareil n'est pas destiné à un usage par des personnes (dont les enfants) avec des facultés motrices, sensorielles ou mentales réduites, ou ayant une expérience et des connaissances insuffisantes, à moins qu'elles sont sous la supervision ou reçoivent les instructions sur l'utilisation de l'appareil d'un répondant garant de leur sécurité. Les enfants devraient être surveillés afin qu'il ne jouent en aucun temps avec l'appareil.

### Operating Instructions

**CAUTION:** Charger enclosure may be hot during charging. Use hand protection if handling the charger while charging.

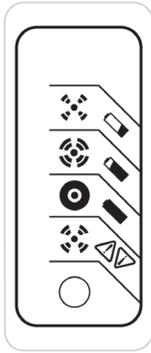
1. Extension cords must be 3-wire cord no longer than 30m(100') at 10AWG or 7.5m(25') at 16AWG per UL guidelines.
2. Only connect **ONE** QuiQ charger to a single 15A circuit or the circuit may become overloaded.
3. Charger 10-LED Display:



LED Colour	Indication (following "Power-On Self Test")
<b>Ammeter (Amber)</b>	<b>Solid:</b> Displays approximate scale of current output during bulk phase.
	<b>Flashing:</b> High internal charger temperature. Output reduced. Also displays algorithm #1-6 for 11 seconds if no battery is connected.
<b>80% Charge (Amber)</b>	<b>Solid:</b> Bulk charge phase complete, 80% charged. In Absorption phase.
	<b>Flashing:</b> With no battery connected, indicates algorithm # selected by number of flashes.
<b>100% Charge (Green)</b>	<b>Solid:</b> Charging complete. Charger in Maintenance Mode.
	<b>Flashing:</b> Absorption phase complete. In Finish phase
<b>AC On (Amber)</b>	<b>Solid:</b> AC Power good
	<b>Flashing:</b> Low AC Voltage, check voltage and extension cord length (see above for guidelines).
<b>Fault (Red)</b>	<b>Flashing:</b> Charger error. Reset charger power and refer to Troubleshooting Instructions below.

Read all of SAFETY and this section before attempting any procedure. Pay particular attention to Notices, Cautions, Warnings and Dangers.

#### 4. Optional Charger Single-LED Display (internal or external)



LED Colour	Indication (following "Power-On Self Test")	
Green	 <b>Solid:</b>	Charging complete. Charger in Maintenance Mode.
	 <b>Flashing:</b>	<i>Short:</i> <80% Charge.
		<i>Long:</i> >80% Charge. <i>When battery is not connected:</i> Algorithm Number display.
Amber	<b>Flashing:</b>	Reduced Power Mode: Low AC Voltage or High internal charger temperature.
Red	 <b>Flashing:</b>	Charger error. Reset charger power and refer to Troubleshooting Instructions below.

### Maintenance Instructions

- Do not expose charger to oil, dirt, mud or direct heavy water spray when cleaning vehicle.
- If the detachable input power supply cord set is damaged, replace with a cord that is:
  - for North America - UL or CSA listed/approved detachable cord, 3 conductor, 16AWG minimum, and rated SJT; terminating in a grounding type IEC 60320 C14 plug rated 250V, 13A minimum; or
  - for all other countries – a safety approved detachable cord, 3 conductor, 1.5mm<sup>2</sup> minimum, rated appropriately for industrial use. The cord set must be terminated on one end with a grounding type input connector appropriate for use in the country of destination and, on the other end, an output grounding type IEC 60320 C14 plug.
- The enclosure of the charger has been tested successfully to EN60529, meeting IP66. The AC supply inlet is rated to IP20, which is suitable for indoor use only. Keep all AC connections clean and dry.

### Troubleshooting Instructions

If a fault occurs, count the number of red flashes between pauses and refer to the table below:

Red Flashes	Cause	Solution
	Battery High Voltage	Check battery size and condition and reset charger (interrupt AC power for 15 seconds).
	Battery Low Voltage	Check battery size and condition and reset charger (interrupt AC power for 15 seconds).
	Charge Timeout caused by battery pack not reaching required voltage. Charger output was reduced due to high temperatures	Check connections. Operate charger at a lower ambient temperature.
	Check Battery: battery could not be trickle charged up to minimum voltage	Check for shorted or damaged cells.
	Over-Temperature: Charger shut down due to high internal temperature.	Ensure sufficient cooling air flow and reset charger (interrupt AC power for 15 seconds).
	Charger Internal Fault	Reset charger (interrupt AC power for 15 seconds). Return to qualified service depot if fault persists.

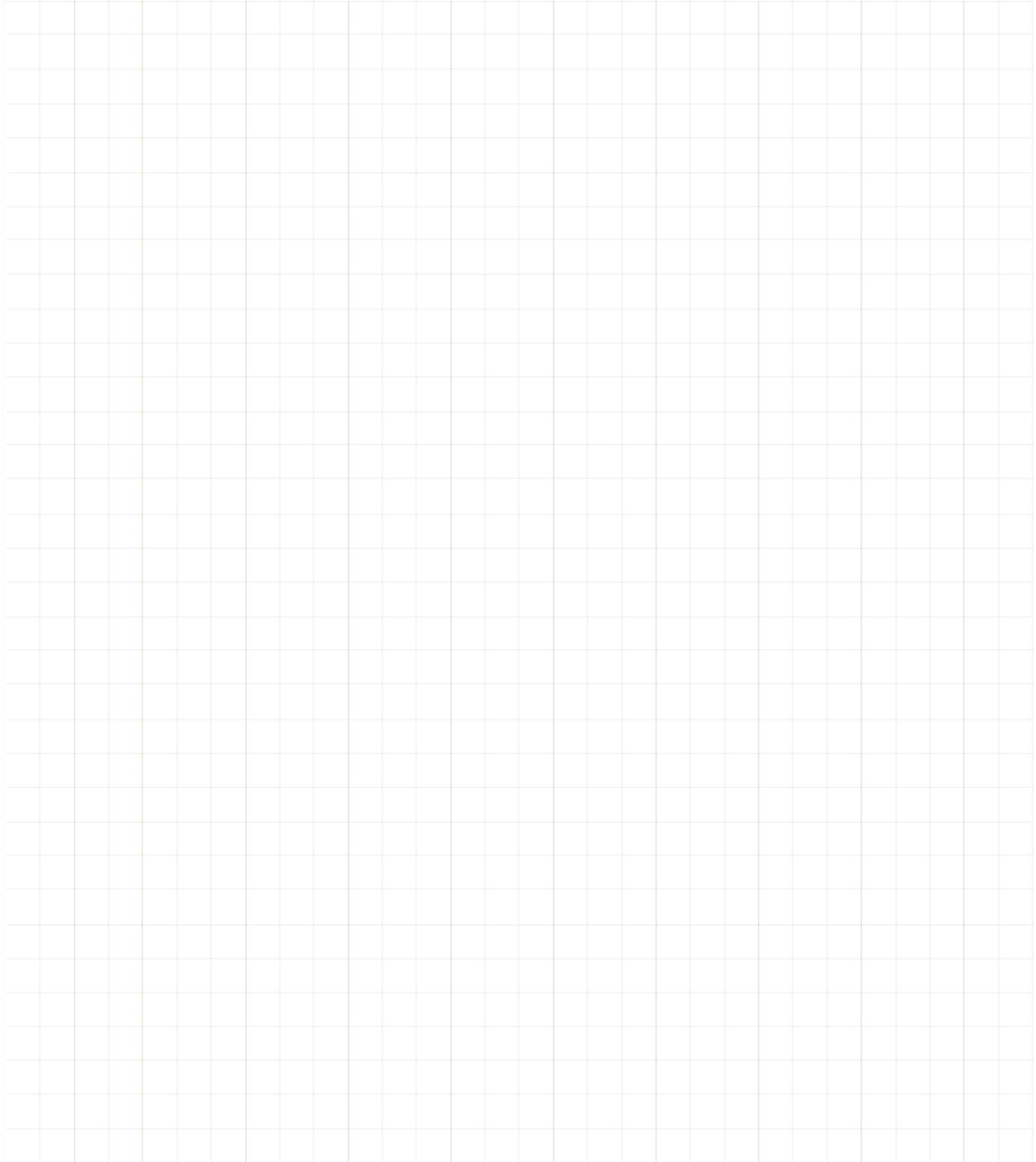
Note: This is a Class A product complying with United States Federal Communications Commission, Code of Federal Regulations; 47CFR part 15. In a domestic environment this product may cause radio interference, in which case the user may be required to take adequate measures.

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# APPENDIX A

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## Notes:

A large grid of graph paper for taking notes, consisting of 20 columns and 30 rows of small squares.

Normal use, age and wear on vehicle components can affect the safe operation and reliability of the vehicle. The recommended inspection and maintenance procedures are crucial for safety, performance, reliability and maximum longevity of your vehicle.

A damaged vehicle, or a vehicle that is not functioning properly is dangerous and must not be operated until repairs are made.

**NOTICE:** Read the following operational warnings before driving the vehicle:

**WARNING**

Before you leave the vehicle, turn the key to the OFF position and remove the key from the vehicle to prevent unauthorized use.

Drive the vehicle at appropriate speeds for the terrain and conditions. Be aware of environmental conditions that change the terrain and your ability to control the vehicle.

Do not drive on excessively steep hills. Evaluate the terrain before descending a hill. Drive slowly and deliberately. Use the brake to limit speed and maintain control. Sudden braking or turning can cause loss of vehicle control. Drive straight down the hill; do not drive across the hill.

Operate in approved areas.

Keep feet, legs, hands and arms inside vehicle at all times.

Avoid driving on terrain that is too rough for your vehicle's capabilities and your driving skills.

Before you drive in the reverse direction, make sure the area behind the vehicle is clear. Accelerate slowly and avoid making sharp turns.

Make sure the direction selector is in the correct position before you press the accelerator pedal.

Decrease speed before and during turns.

Bring the vehicle to a complete stop before you move the direction selector.

See **GENERAL SPECIFICATIONS** for the vehicle load and seat capacity.

**NOTICE:** Read the following maintenance information and warnings before servicing or repairing the vehicle:

Follow the procedures and comply with the safety information in this manual while performing vehicle service or maintenance.

Use the tools shown in the tool list and wear the specified safety equipment when performing vehicle service or maintenance.

**WARNING**

Remove all jewelry before you service the vehicle.

Do not allow loose clothing or hair to contact the moving parts.

Do not touch hot objects.

The drive wheels must be lifted and supported on jack stands before you perform any service to the powertrain while the motor is in operation.



When you service the vehicle, always wear eye protection. Be careful when working around batteries, using solvents or compressed air.

Use insulated wrenches to decrease the risk of a short-circuit if a wrench contacts the battery terminals. A short-circuit in a battery can cause an explosion.

To prevent the risk of battery explosion, keep all flammable materials, open flames or sparks away from the batteries.

Hydrogen gas is produced as batteries are charged. Charge batteries only in well-ventilated areas.

Maintain constant awareness that some components are heavy, spring loaded, corrosive, explosive, can cause high amperage or get extremely hot. Battery acid and hydrogen gas can cause bodily injury. Keep your hands, face, feet and body away from any area that can expose them to injury if an unexpected situation occurs.

# ***TRACKER***

## MANUFACTURER INFORMATION

Textron Specialized Vehicles Inc.

1451 Marvin Griffin Road

Augusta, GA, USA 30909-3852

Dealer: 800-296-4804

Consumer: 877-394-6772

[www.trackeroffroad.com](http://www.trackeroffroad.com)

Owner's Manuals and Repair Manuals are available from the manufacturer.

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