GODDARD PARK
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OWNER'S MANUAL

1999 SOLECTRIA FORCE
156V Lead Acid

1st Edition

SOLECTRIA

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I. EMERGENCY RESPONSE/SAFETY INFORMATION

If this vehicle is involved in a serious accident, a system of internal fuses are designed to protect personnel and prevent damage to vehicle components.

If the vehicle appears to be in a dormant condition, no further action is required to stabilize the vehicle other than turning off the ignition key. Note that when the ignition key is turned off, battery power to the motor controller is shut off. However, the DC-DC Converter, the Battery Charger, the Air Conditioning Controller, and the amp-hour meter and the heater continue to remain at the full pack voltage.

If the vehicle is giving off smoke and the hood can be opened safely, then perform the following steps:

1. **Disconnect the red Service Disconnect** located under the hood near the motor cooling fan on the passenger side of the vehicle (see Diagram in Owner's or Service Manual). This will shut off all high voltage supplied from the battery pack to all vehicle components – except the battery charger.

2. **Disconnect the separate black Service Disconnect** (along the fire wall in the same vicinity as the red Service Disconnect) to disconnect the battery charger from high voltage.

3. **Disconnect the main motor controller plug** mounted to the brace bar crossing the center of the motor compartment.

Once these three steps are completed, all vehicle components are now disconnected from the high-voltage battery pack.

II. INTRODUCTION

Congratulations on purchasing a new electric drive Solectria Force automobile! Solectria Corporation prides itself in building the most efficient, practical electric vehicles (EVs) available.

The Force uses a new Chevrolet Metro body, along with advanced Solectria electric drive components. The Force offers clean, energy-efficient transportation, durability and convenience. Solectria is confident the high quality workmanship and components in your new Force will provide years of trouble-free transportation and the satisfaction of driving a zero-emission vehicle.

Solectria has provided some of the key information from this manual on the inside of the sun visor on the driver's side of the vehicle. Please refer to this manual for more detailed information and explanations.

Please read this manual carefully to ensure proper operation and maintenance of the vehicle. Although the Force looks similar to a gasoline-powered vehicle and is simple to drive and maintain, it does require care and preventive maintenance. Reading this manual is essential for safe, long-lasting, and trouble-free vehicle operation.

How to Use this Manual

This Owner's Manual is divided into ten sections.

Section I	covers information for emergency response personnel.
Section II	is this introduction.
Section III	covers safety features.
Section IV	covers vehicle operation, including driving, recharging, regenerative braking and parking.

Section V	covers the drive components installed by Solectria, including the motor, motor controller, batteries, and other electronic equipment used to monitor or regulate vehicle electric energy consumption.
Section VI	provides suggestions on efficient driving.
Section VII	has information on reporting safety defects.
Section VIII	contains a detailed maintenance schedule to ensure the vehicle maintains its performance.
Section IX	contains warranty information and instructions on seeking vehicle repairs.
Section X	is a troubleshooting guide for problems or minor repairs and adjustments.
Section XI	contains vehicle diagrams.

Happy Motoring!

Solectria Corporation

P.S. We welcome comments and suggestions for improving the Force and/or this Manual. Please call or send a note on how we can better serve you.

III. SAFETY FEATURES OF THE FORCE

The Force is designed to maximize performance while maintaining a high level of safety. The Force incorporates many safety features to avoid or avert accidents as well as protect passengers in the event an accident does occur.

The Force is heavier than the original Chevrolet Metro from which it was converted, due to the substantial weight of the propulsion batteries. Solectria has deliberately and carefully located the battery boxes as low as possible on the vehicle frame (without affecting the vehicle ground clearance), for improved stability and handling of the vehicle. In addition, the batteries are placed in the vehicle to evenly distribute the vehicle weight on each wheel. The low center of gravity and even weight distribution of the batteries and vehicle also improve braking performance and vehicle stability during hard braking or in an accident, making the vehicle less likely to roll or pitch forward.

The Force is equipped with vacuum-assisted power front disc brakes, front regenerative braking, and rear power brakes, for efficient and effective braking under all road conditions. Immediately upon releasing the accelerator pedal, the motor controller applies the full regenerative braking power to the front wheels, slowing the vehicle even before the hydraulic brakes are applied. For more rapid braking, the hydraulic brakes can be applied by stepping on the brake pedal, providing maximum braking power.

The regenerative braking function can be switched off to prevent sliding under extremely slippery conditions. For more information about the regenerative braking feature, see Regenerative Braking in SECTION IV, VEHICLE OPERATION.

The battery boxes in the Force are constructed of high-strength aluminum and are secured to the vehicle frame outside the passenger compartment area, using high-strength fasteners.

The battery is made up of sealed, battery modules requiring no maintenance over their life. Because the modules are sealed, no appreciable amount of dangerous fumes or gases are emitted from the battery. The 3.3kW charging system in the vehicle, including the battery pack, was determined by Underwriters Laboratories to be suitable for UL Classification for indoor charging without mechanical building ventilation.

The battery boxes are vented to allow the release of gases that could build up in the battery boxes in the unlikely event a module seal is broken (such as in an accident). The battery boxes have high-current in-line fuses to disconnect the batteries in the event of an electrical short, accident, or other abnormality.

The Force is equipped with driver and passenger-side air bags. This system is provided by Chevrolet and is intended as a *supplemental* restraint system. Solectria strongly urges you and your passengers to always wear seat belts when driving or riding in the vehicle. Please familiarize yourself with the information provided by Chevrolet in its Metro manual regarding the operation, use and maintenance of the airbag system.

IV. VEHICLE OPERATION

The Solectria Force has been built to provide years of trouble-free driving. The Force drives and handles much like a conventional gasoline-powered vehicle. Certain aspects of the vehicle, however, will seem different to the new EV owner. This section covers the Force's day-to-day operational features which may be different from a conventional vehicle.

Vehicle Layout

While most items in the Force are similar to those in a Chevrolet Metro, there are a few items that are different.

Range/Power Selector

The range/power selector located on the console assembly between the front seats is used to select the Force's driving mode. **ALWAYS** put the selector in **NEUTRAL-START** and set the parking brake when leaving the vehicle. There are three selections for forward driving, labeled **MAX RANGE**, **NORMAL** and **POWER**, and one setting, labeled **REV** for reverse. These positions correspond to maximum current (i.e. power) available for the motor. For maximum efficiency and range, always drive in the **ECON** mode. **NORMAL** and **POWER** provide higher power levels for hard acceleration, but can substantially increase the battery load, decrease range and reduce battery life.

For maximum range, set range/power selector to **ECON**. For maximum acceleration, set range/power selector to **POWER**.

Neutral Interlock

Always start the vehicle with the selector in the **NEUTRAL-START** position. If the vehicle is started with the selector in **REV** or a forward settings, it will not operate until the selector is first placed in **NEUTRAL-START**. This safety feature helps prevent unintended vehicle operation.

Ampere-Hour Meter

The amp-hour meter, located in the instrument panel next to the speedometer, provides a highly accurate measure of electrical energy use in the vehicle.

- As you draw energy from the battery, the meter counts up and the red **OUT** light flashes, indicating energy consumption.

- As you put energy back in to the vehicle (during charging and regenerative braking), the meter counts down and the green **IN** light flashes, indicating energy storage.

The rate the lights blink corresponds to the amount of current going into or out of the battery. For the first few miles of driving with a fully charged battery, the regenerative braking effect will be reduced. As always, driving efficiently will extend range and maximize battery life.

Ammeter (Optional)
Your Force may be equipped with an ammeter, which indicates the electrical current going out of or into the battery. During rapid acceleration, as much as 300 amps may be drawn. During regenerative braking, the ammeter may go as low as -100 amps. The Force motor controller regulating battery energy will limit the current (i.e. power) available from the battery at low states-of-charge (SOC roughly less than 20%) in order to protect the battery from harmful over-discharge.

Voltmeter (Optional)
Your Force may be equipped with a voltmeter to measure the battery pack voltage. It is normal for the voltage to fluctuate up and down as battery demand changes. An increase in current demand for example when climbing up a hill, results in a decrease in battery terminal voltage. The motor controllers prevent battery terminal voltage from dropping below a minimum value by limiting current (power) output, as the battery reaches a fully discharged state. With no significant electrical load on the battery, the voltmeter can be used to provide a rough idea of battery state-of-charge.

Dual Ammeter/Voltmeter (Optional)
Your Force may be equipped with a dual ammeter and voltmeter in a single dash-mounted gauge. Please read the descriptions above for each separate meter.

State-of-Charge Meter (Optional)
Your Force may be equipped with a State-of-Charge (SOC) meter. This analog gauge, mounted on the dash, gives a visual indication of the amount of energy remaining in the batteries. It is similar to a fuel gauge on a gasoline-powered vehicle.

Battery Charging

A wonderful benefit of owning an electric vehicle is never again pulling into a gasoline station to fill the tank. Since the Force uses electricity stored in its battery as its energy source, the vehicle must instead be recharged via an extension cord and the recharging plug (located under the "gas" cap).

Charging the vehicle is simple. The Force is equipped with an on-board electronic charger. The Force charger may require 120V or 208/240V AC current, depending on charger option selected. To charge the vehicle, simply plug a heavy-duty (10 gauge or 12 gauge) grounded extension cord, such as the one provided with the vehicle, into the charge port located on the driver's side of the vehicle inside the gas cap door, and plug the other end into an appropriate electrical outlet rated for 20 amps for vehicles with 3.3 kW or 6.6 kW chargers respectively.

WARNING!

Make sure you plug into the appropriate outlet when charging. The car's charger may require 110V AC or may require 220V AC - check the label on the car's plug (found under the former gasoline fill cap). Plugging into the wrong outlet could cause serious damage. (Note: if no 220V AC is available, a Solectria 220V charger may be plugged into a 110V outlet by using the 1-foot adapter cord provided with the vehicle. However, we recommend using 220V whenever possible.

Use only heavy gauge extension cords (minimum 12 gauge) rated for the correct voltage and current (20 amps) with a grounding prong to prevent overheating of the extension cord and electrical shock. Do not remove the grounding prong from the extension cord or use an ungrounded outlet.

To avoid overloading an electrical circuit, plug the vehicle into a dedicated outlet on a circuit with no other electrical loads. Make sure the outlet is rated for the amount of current the charger draws (20 Amps).

Failure to adhere to these instructions could result in electrical shock, fire, and/or damage to the charging system and vehicle.

Call Solectria at 978-658-2231 with any questions.

Once the vehicle is plugged in, the charger turns on automatically. When the battery is charging, the green **IN** light on the amp-hour meter blinks, and the amp-hour meter counts down toward zero. To avoid ever returning to a partly or fully discharged vehicle, it is a good practice to briefly check the amp-hour meter each time you plug the vehicle in to confirm it is truly charging.

Under normal conditions, the charger will overcharge the batteries slightly, so the amp-hour meter will read between 00.00 and -05.00 when charging is complete. This is due to inefficiency of charging and is normal. Once an electrical load is applied (e.g. if he interior light turns on as the door is opened), the meter automatically resets to 00.00 to give an accurate measure of the total energy consumption from the battery.

The charger turns off automatically when the batteries are fully charged. Leaving the vehicle plugged in after charging is complete will not harm the batteries, and is recommended.

The Force's charger was tuned at the factory for the specific battery in the vehicle, according to the battery manufacturer's recommendations. This means the charging system provides the optimal battery charging sequence for efficient charging and long battery life.

As new battery technologies are developed or as charging procedures are updated by the battery manufacturers, Solectria may be able to reprogram the charging system to accommodate the new procedures. To ensure the charging system uses the proper charging profile, please notify Solectria before replacing the battery pack.

The Solectria Force is equipped with sealed, gel lead acid batteries. The vehicle should be kept plugged in whenever possible. This greatly extends battery life by ensuring the batteries stay at a high state of charge (SOC) and by preventing freezing during extended inactive periods during cold weather.

A green light on the left side of the dash marked "CHARGE COMPLETE" indicates the vehicle is fully charged.

Vehicle Starting

To turn on the Force motor controller, insert the key into the ignition and turn it forward (clockwise) to the "ON" position, as you would in a conventional gasoline vehicle. You will not hear any engine noise, but do not be alarmed, as the vehicle is silent when not moving.

Each time the controller is turned on, it performs a 1 to 2- second self-diagnostic check. Once the diagnostic is performed, the vehicle is ready to drive (see the following section, "Driving the Force").

Observe the amp-hour meter to see how much electrical energy (as measured in amp-hours) you have used from the battery. When the battery is fully charged the meter will automatically reset to 00.00 (after it has been negative).

Note: the amp-hour meter counts up as you discharge the battery, and counts down as you charge the battery.

Driving the Force

Once the vehicle is turned on, **select a driving mode** using the range/power selector. For ECON and battery life, drive in the **ECON** mode. If more power is needed, shift to **NORMAL** or **POWER**.
Note, the range/power selector may be shifted at any time, i.e., while the vehicle is moving, with your foot on or off the accelerator pedal, etc. To drive, **depress the accelerator pedal about halfway** and the vehicle will start to move.

The first half of the accelerator travel is the regenerative braking region, as explained in "Regenerative Braking", so you must depress the accelerator halfway down, through this zone, before the vehicle begins to move. Once moving, the vehicle speed is regulated by the accelerator pedal, which tells the motor controller how much power to give to the motor (or draw from the motor in regenerative braking).

You do not need to shift gears while driving, as the Force has only one forward gear. However, if you need quick acceleration for safety, flick the range/power selector to the **NORMAL** or **POWER** setting as you are driving. The vehicle speed is regulated by the degree to which you depress the accelerator pedal.

Note that as you draw more current from the battery or put more energy back into the battery, the red or green light on the amp-hour meter will flash proportionately. For extended range, as well as extended battery life, it is best to drive efficiently, by keeping the current into and out of the battery (i.e. the blink rate on the amp-hour meter) as low as reasonably possible. For more information on efficient driving, see **SECTION VI**.

Regenerative Braking

As you release the accelerator pedal past the mid-point of its travel, the motor controller switches to regenerative braking (regen) mode to slow down the vehicle while at the same time generating electricity to partly recharge the battery.

When regen braking is active, notice the green **IN** light next to the amp-hour meter blinks. This signifies the battery is recharging with electricity produced from regen braking. This recaptured energy can be used by the vehicle when more power is demanded from the battery. Regen therefore extends range and also the life of the vehicle's batteries. Regen braking uses the same motor, controller, drive train and battery used to drive the vehicle, only in reverse. The same amount of power, or torque, the motor provides to drive the vehicle can also be used to slow the vehicle down in regen mode.

Solectria limits the maximum regen power to somewhat lower than the maximum motor capability, but regen braking can still be quite powerful. To slow down smoothly during normal driving, the accelerator should be released more gently than in a conventional vehicle.

For rapid or emergency braking, full regen braking is engaged immediately upon releasing the accelerator. The standard hydraulic brakes may be applied at any time as in a conventional vehicle by use of the brake pedal.

With prudent driving and appropriate use of regen braking, frequent use of the brake pedal should not be required. The brake pedal gives fast deceleration for quick stops, but does so by quickly using up the vehicle's energy of motion through heat and brake pad wear. Since regen braking recaptures and stores some of that energy in the battery for additional use, Solectria recommends drivers maximize the use of regen braking to slow the vehicle under normal driving conditions. This may require driving style adjustments so most, if not all, deceleration is performed with regen braking.

Regen braking is connected to the rear brake lights. As the accelerator is released through the mid-point of its travel, the motor controller begins to apply regen braking and the green **IN** light by the amp-hour meter begins to blink. As you continue to release the accelerator and regen increases to a level stronger than "engine braking", the controller turns on the brake lights, indicating to other drivers that the vehicle is actively braking. The brake lights for regen are activated by a relay located under the dash that clicks as the regen lights turn on or off. Releasing the accelerator completely applies maximum regen. Regen braking can be disabled with the switch located on the floor console.

WARNING!

Under extremely slippery road conditions, such as on icy or snowy roads, set the regen braking switch to "SLIPPERY" to turn off regen braking. Regen applies braking to the front wheels only, and under slippery conditions could cause wheel lock-up and/or sliding. Use caution during *any* braking under these conditions.

Once the vehicle slows to about 3 mph, regen braking slowly releases, and the vehicle is free-rolling. Regen braking will not bring the vehicle to a complete stop, nor will it "hold" the vehicle on a hill. To ensure the vehicle stops completely and remains stopped, apply the hydraulic brakes, as in a conventional vehicle. (The parking brake can also be used to hold the vehicle on a hill.) Without the hydraulic brake on, the vehicle may roll. Solectria recommends you always keep your foot on the brake pedal when the vehicle is stopped.

Parking the Vehicle

To park the vehicle, bring it to a complete stop, place the range/power selector in **NEUTRAL-START** and ALWAYS set the parking brake.

A reminder tone will sound if you fail to set the parking brake.

When exiting the vehicle always leave the range/power selector in **NEUTRAL-START** and remove the key from the ignition. If parking on a hill, turn the wheels towards the curb to prevent the vehicle from rolling should the parking brake fail.

Range

The Force uses highly efficient components, and is designed to have the best range possible while still maintaining a safe vehicle weight. However, it has a significantly lower range than a gasoline vehicle. Thus, driving efficiently is important. The distance you can drive depends on 1) the amount of energy you have on-board, and 2) the efficiency of your driving. At a constant 45 mph and without the use of accessories, the Solectria Force will travel at least 50 miles. Highway driving, frequent stop and go driving, and use of accessories (especially heat and air conditioning) can significantly decrease the range. In addition, tire pressure should be maintained at the recommended 44 psi to maximize range.

Energy Use

The Solectria Force battery pack can provide a maximum of about 42 amp-hours of energy (according to the dash-mounted amp-hour meter) before the vehicle begins to slow down appreciably. ***Note, it is best to recharge the battery before it reaches this state of depletion.***

The Force's energy consumption can vary from 1 to 2 or more amp-hours per mile. This means the vehicle range can fluctuate between 50 and 25 miles, depending on driving habits, the terrain, use of accessories, outside and battery temperatures, etc. Once you become familiar with the vehicle's energy consumption under different conditions, you will have a better sense of how much range to expect per charge for given road conditions. Please refer to **SECTION VI, EFFICIENT DRIVING** for tips on driving more efficiently.

Comfort Controls

Heat

Press the red button on the console labeled **HEAT** to turn on the Force electric heater. You may regulate the amount of heat by adjusting the fan speed control. *Note, the heater fan must be turned on for the heater to operate.*

Air Conditioning (Optional)

Push the square black button on the dash labeled **A/C**, and turn on the fan to operate the air conditioner. Sliding the lever to "recirculate" will help the vehicle cool faster and reduces battery drain. Driving for the first few minutes with the air conditioning off and the windows open helps disperse hot air inside the vehicle quickly. Then close the windows and turn the air conditioner to bring the passenger compartment to a comfortable temperature.

Remember both the electric heating and air conditioning runs directly off the battery. Using them decreases range by 10-15% or more depending on heating or cooling usage, driving conditions, etc.

Cabin Preheat (Optional)

Your Solectria Force may be equipped with an optional cabin preheat system. This system allows you to program the vehicle's heat to turn on automatically before you use your vehicle each morning or evening during cold weather. The cabin preheat system uses power from the wall outlet--not the batteries--to heat your vehicle, so it will be warm and fully charged when you start driving. Instructions for setting the Cabin Preheat are below.

Please note:

- The vehicle must be plugged in to energize preheat display and for preheat system to operate.
- Set preheat timer for 30 minutes maximum on operation for each preheat cycle.

A. Setting Clock
   1. Press and hold TIME ADJ for 1 second or longer.
   2. Press SHIFT key repeatedly to move cursor to today's day.
   3. Press SET key. The bar (-) mark will turn on.
   4. If bar (-) marks for all days are blinking, press SET key again.
   5. Press h key to adjust hour (note 0:00 is used instead of 12:00).
   6. Press m key to adjust minute.
   7. Press WRITE key to finalize new time.

B. Setting Preheat Timer
   1. Turn Mode switch to P1.
   2. Up (on) arrow on left side of screen will be blinking.
   3. Select day for Preheat to turn on using SHIFT key.
   4. Press SET to turn on bar (-) mark under that day.
   5. SHIFT/SET keys can be used again to select more days if turn on/off times will be the same on those days (e.g., to turn on preheat from 8:00 AM till 8:30 AM Mon, Tues, Fri).
   6. Set time using h and m keys.
   7. Press WRITE key to finalize new time.
   8. Down (off) arrow on right side of screen will be blinking.
   9. Set time for preheat to turn off using h/m keys.
   10. Press WRITE key.
   11. Repeat process with up to 12 on/off times.
   12. Set mode switch to RUN.

C. Editing and Checking Preheat Times
   1. Set mode switch to P1.
   2. Press WRITE key to view first program step (time to turn on is one step, time to turn off is a second step).
   3. This time can be changed using h and m keys; day can be changed using shift and set keys.
   4. Press WRITE to move to each subsequent programming step.
   5. Set mode switch to RUN to return to the time of day.

D. Clearing All Settings and Starting Over
   1. Set mode switch to P1.
   2. Open panel door at bottom of display unit.
   3. Press recessed CLR button with pencil tip.
   4. Set mode switch back to RUN.

E. Running Preheat System
   1. Plug in vehicle.
   2 Set recirculate/fresh air control to recirculate.
   3. Slide temperature selector (red and blue) to hot (red).
   4. Setting vent selector to defrost will clear windshield when the preheat comes on, but vehicle may not get as warm.
   5. Set timer to RUN.
   6. Set both output switches to AUTO
   7. Green light on top right corner of preheat display will turn on to show unit is ready and will turn on at next programmed time.

Fuel Fired Heater (Optional)

Your Force may be equipped with an optional kerosene-fired heater that circulates antifreeze through a heater core. This allows you to warm the vehicle without using battery energy. The fuel fired heater (FFH) will not operate above if outside temperatures are above 40°F. FFH and electric (normal) heat cannot operate at the same time. Check the FFH antifreeze and fuel levels weekly. The antifreeze tank is located at the top rear passenger side of the motor compartment.

WARNING!

Use of fuel fired heater may produce toxic fumes. Do not use fuel fired heater inside an enclosed area.

A. Turning on FFH
   1. Make sure fuel tank contains fuel. It is located under the hood.
   2. Set floor console heat selector switch to "FUEL".
   3. Set dash "recirc/fresh" slider set to "recirc".
   4. Turn fan on. Switch will illuminate FUEL (amber light) -- the electric heater will illuminate the red light.
   5. When fan comes on, adjust blower speed as desired.
   6. Turning FFH off shortly before arriving at destination saves fuel.

Note, the red/blue temperature selector does not change the temperature; it is automatically controlled.

B If FFH Does Not Operate
   1. Check fuel volume and quality (is fuel still liquid or did it gel ?)
   2. Confirm all switches are in proper location according to above.
   3. Check FFH fuse located under hood near main fuse box on driver's side.

C. Refueling
   1. Turn FFH off.
   2. Open hood and remove fuel tank cap.
   3. Using funnel, fill with diesel or kerosene formulated for your region. Note, a summer blend of diesel fuel may gel in winter.
   4. Replace cap and close hood.

D. Summer Preparation
   1. Turn FFH off.
   2. Open hood and drain fuel from tank.

V. THE ELECTRIC DRIVE SYSTEM AND OTHER COMPONENTS

Drive System
The electric drive system is what makes the Force a unique vehicle. It is important to understand the basics of its operation.

Motor Controller
The "brains" of the system are housed in the highly efficient Solectria AC induction motor controller located on top of the front battery box. It controls and coordinates all electric motor functions, regenerative braking and the battery during vehicle operation.

Battery Boxes
Directly below the controller is a large black battery box housing approximately half of the batteries. The remainder of the batteries is located in a second battery box below the trunk. These two battery packs are connected in series to from the vehicle's battery pack, which stores the energy the vehicle uses.

Batteries
The Solectria Force is equipped with sealed, lead acid gel batteries. These batteries are maintenance-free and have minimal free electrolyte available for spillage in an accident. The Force battery pack voltage is nominally 156V DC.

Battery Thermal Management System
The battery boxes are equipped with Solectria's automatic battery thermal management system, which insures the battery is maintained at a suitable working temperature in cold weather.

This system is critical for maintaining vehicle range and battery life during cold weather. In addition, lead acid batteries can freeze in extremely cold temperatures, especially if they are at a low state of charge. If temperatures are below 50°F, the vehicle should be kept plugged into an AC outlet whenever possible to maintain a fully charged battery and optimal battery temperature. ***Keep the vehicle plugged in whenever it is not in use.***

Motor
The silver cylinder with cooling fins mounted under the hood is the drive motor. It propels the vehicle or slows it down during regenerative braking by converting the vehicle's energy of motion directly to electricity (as regulated by the motor controller). The motor is coupled to Solectria's direct drive gearbox via a gear linkage, and then through the axles to the front wheels. Active air cooling of the motor is provided by a thermally controlled fan.

When you depress the accelerator, an electronic signal is sent to the controller, which then converts DC current from the battery to AC current of an appropriate form to drive the motors (or vice versa during regen braking). Solectria's efficient AC motor and controller produce sufficient torque at low speed, and spin fast enough (up to 12,000 rpm) that a single gear ratio is adequate for all normal driving conditions. Therefore, the Force does not have separate gearing and does not require "shifting gears" automatically or manually. Thus, unlike most gas vehicles with multiple gearing, the speed of the Force is determined solely by the speed of the motor.

Overheat Protection
Solectria's Force drive system is highly efficient (70% and 90% overall for the motor controller and motor respectively). In spite of high efficiency, under high power requirements the motor and controller produce heat. Both controller and motor are equipped with thermally-switched cooling fans to maintain operating temperatures under heavy load.

Under extreme conditions of hot weather and extended high power demand, the controller may reach maximum operating temperature and shut down to protect its electronics. After a few minutes when the controller has cooled down, it will automatically restart and allow the vehicle to be driven.

Limp Home Mode
The Force provides consistent performance throughout most of the discharge cycle of the battery. As the battery reaches 20% state-of-charge (SOC), the motor controller begins to limit the current available from the battery. This prevents irreversible battery damage. The Force then operates with progressively diminishing performance ("limp home

mode") for 5 miles or more. Once the battery reaches approximately 10% SOC, the motor controller shuts down to protect the battery, and the vehicle can no longer move under its own power.

System Voltage

All the Force's electrical drive components (battery, motor controller, motor) and interconnecting wiring are potentially at or above the nominal battery voltage of 156V.

In addition, the battery charger, amp-hour meter shunt, DC-DC converter input cables, air conditioning motor, controller cables and heater cables, are all at the high voltage of the traction battery. Although the high voltage circuit is completely isolated from the vehicle chassis and the 12V DC system, extreme caution must be exercised when handling any high voltage component.

All servicing of high voltage components must be performed by experienced, qualified service personnel. Treat all connectors and conductors as live until they are verified to be de-energized by proper monitoring equipment. **Failure to follow these rules may result in electrical shock, fire, damage to the vehicle and other property and possibly death.** Please notify Solectria or a Solectria representative whenever you have electronic problems or traction battery problems. Do not attempt to make repairs on your own.

Power Brakes

The Force hydraulic brakes are power-assisted, using the original Chevrolet Metro power brake assembly. The vacuum for the power brake system is provided by a vacuum pump and vacuum canister located under the hood.

DC-DC Converter

The electrical accessories in the Force are powered indirectly by the main traction battery through the DC-DC converter, which provides 12V DC power for lights, radio, etc. The 12V system is chassis-grounded as in gasoline vehicles and is completely isolated from the high voltage electrical system. The electric heaters, however, operate at main battery pack voltage rather than through the DC-DC converter.

VI. EFFICIENT DRIVING

The Force is carefully designed to provide good performance in both city and highway driving. However, the tips in this section allow you to obtain the best range possible, achieve longer battery life, and conserve energy.

Cruising
For maximum efficiency, accelerate gradually to the desired cruising speed, and then try to maintain a constant speed. Stopping and starting use considerable energy even when regenerative braking is included. Anticipate the need to slow down so deceleration is gradual and stopping is averted if possible.

Maintain a slow, steady cruising speed. Data collected by Solectria show the energy consumption of the Force increases dramatically with speed. Slower cruising speeds not only save energy and extend vehicle range and battery life, but also save lives.

Energy consumption depends on your particular driving habits and driving conditions.

Acceleration
The Force provides good acceleration capability for safety and enjoyment. Although using the full acceleration does not increase wear on electronic or drive train components, it does take a toll on the batteries, and causes the vehicle to use more energy, thereby decreasing the range.

The faster the vehicle's battery is discharged, the less total energy, or amp-hours, the battery can provide. High-power and high-acceleration driving not only use up battery energy more quickly but also decrease the total amount of battery energy available. Because of this effect, "hot rodding" can decrease vehicle range by 30% or more.

To maximize range and efficiency, accelerate gently and anticipate slowdowns. Decelerating gently provides the most benefit from regenerative braking.

Driving Modes

The **ECON** setting on the range/power selector limits the current drawn from the battery by the controller. This current limit reduces the maximum motor power output, and therefore limits the effect of "jack rabbit" starting. Setting the range/power selector to **ECON** increases overall energy efficiency while lowering vehicle performance.

In **NORMAL** or **MAX POWER** modes, the vehicle's efficiency is considerably reduced. With the high power acceleration and high speed driving capacity of the Force, the vehicle may use as much as 1.5-2.0 amp-hours per mile, or up to 50% above the consumption at a more restricted, efficient **ECON** mode setting. For maximum benefit, Solectria recommends driving in **ECON** mode as much as possible.

Hill Climbing

Hill climbing is energy-intensive. However, the slower you climb, the less power required. To be efficient, Solectria recommends you climb hills slowly, if possible.

The red **OUT** light by the amp-hour meter flashes quickly when using a lot of power and slowly when using less power. The lower the power used, the more range per battery charge. As a rule, try not to let the red light blink so quickly it appears to be solidly lit for extended driving periods. This indicates excessive power use and inefficient driving! The more slowly this red light blinks, the more miles per charge.

VII. REPORTING SAFETY DEFECTS

If you believe your vehicle has a defect which could cause a crash, injury or death, immediately inform the National Highway Traffic Safety Administration (NHTSA) in addition to notifying Solectria Corporation.

If NHTSA receives similar complaints, it may open an investigation, and if it finds a safety defect exists in a group of vehicles, it may order a recall and remedy campaign. However, NHTSA cannot become involved in individual problems between you, your dealer, or Solectria.

To contact NHTSA, either call the Auto Safety Hotline at 1-800-424-9393 or 202-366-0123 or write to NHTSA, U.S. Department of Transportation, Washington DC 20590. You can also obtain other information about motor vehicle safety from the Hotline.

VIII. MAINTENANCE

The purpose of maintenance is to ensure the vehicle is safe to drive at all times and to maximize the life of all vehicle components. It is possible you may use the vehicle more or in worse conditions than anticipated by this maintenance schedule, but this schedule is adequate for normal commuting and around town driving. The schedule is specifically designed for vehicles:

o carrying passengers and cargo within the recommended limits. The limits can be found on the edge of the driver's door.

o driving on reasonable road surfaces within legal driving limits.

Based on this, there is one recommended maintenance schedule for the Force automobile. Refer to the 1999 Solectria Force Maintenance Schedule included in this section.

Specifically, six items should be performed by knowledgeable service personnel on a periodic basis. These six items are listed and described below. Please refer to the 1999 Solectria Force Service Manual for a more complete description of these tasks.

Warranty Card
For the vehicle's warranty to remain valid, the vehicle's Warranty Card must be filled in each time Scheduled Maintenance takes place. We recommend you keep the Warranty Card with the Owner's Manual in the glove box of the vehicle.

Rotate/inspect tires

For long wear and maximum tire life, rotate the tires following the instructions in the Chevrolet Metro Owner's Manual. Check the tires for uneven wear or damage. If you see irregular or premature wear, check the wheel alignment. Check for damaged wheels as well. While tires and wheels are removed for inspection, perform brake system inspection.

Change gearbox oil

Remove the belly pan. Drain the transmission. Refill with one (1) quart Dextron® III Automatic Transmission Fluid, or ATF. (Refer to the Solectria Service Manual for more specific instructions.)

Inspect gearbox oil level

Looking from inside the motor compartment or from underneath the vehicle, with the front wheels turned full left, observe the sight glass on the transmission. (It is located on the driver's side near the inner axle joint.) The fluid level should be visible near the mid-point of the window.

Inspect steering and suspension

Inspect the front and rear suspension and steering for worn, damaged or loose parts, or for lack of lubrication. Inspect the drive axle boots for cracks, holes, or leakage. Replace as necessary.

Inspect brake system

It is easiest to do this when the wheels are removed for tire rotation. Inspect lines and hoses for proper hook-up, binding, leaks, cracks, chafing, etc. Inspect disc brake pads for wear and rotors for surface condition. Also inspect drum brake linings for wear and cracks. Inspect other brake parts, including drums, wheel cylinders, parking brake etc. Check parking brake alignment. You may need to inspect the brakes more often if your driving habits or conditions result in frequent braking. (If you are careful and use the regenerative brakes whenever braking is required, it will result in less wear on the conventional brakes and less maintenance expense.) Check the brake fluid level.

Change brake fluid

Drain, refill, and bleed the brake system.

Operator Inspections

In addition to the items listed above, several inspections (including tire pressure check, windshield washer fluid level check, etc.) should be

performed by the vehicle's owner/operator on a weekly, monthly, biannual, or annual basis. These items are listed and described below.

Weekly

Check windshield washer fluid level

Check windshield washer fluid level in the windshield washer tank and add fluid if necessary.

Check hood latch operation

Pull the hood release inside the vehicle. The secondary latch should keep the hood from opening all the way. Make sure the hood closes firmly.

Monthly

Check tire pressure

Check tires for proper pressure; if low, inflate to maximum level specified on the tire sidewall. If they are worn unevenly, check four-wheel alignment.

Every 6 months

Check restraint system

Inspect belt system, including webbing, buckles, latch plates, retractors, guide loops and anchors. Have the belt assembly replaced if the webbing has been cut or otherwise damaged.

Check wiper blades

Inspect wiper blade performance during use. If wipers are not effective at clearing the windshield, replace as necessary.

Every 12 months

Lubricate key lock

Lubricate the key lock cylinders with the lubricant specified in List of Fluids and Lubricants at the end of this section.

Lubricate body

Lubricate all door hinges, rear compartment hinges, latches, and locks including interior glove box and console doors, and any moving seat hardware. Lubricate the hood safety lever pivot and latch mechanism. More frequent lubrication may be required when exposed to a corrosive environment.

Check steering column lock

While parked, and with the parking brake set, turn the key to LOCK, remove it, and ensure the steering wheel is locked. Insert key, turn to ON and ensure the steering wheel has full play.

Check parking brake performance

WARNING!

The vehicle could move during this check. Make sure there is sufficient room in front of the vehicle so if it rolls, you could stop it with the foot brake without injury to people or damage to property.

Park on a fairly steep hill, with the vehicle facing downhill. Keep your foot on the regular foot brake and set the parking brake. Place the vehicle in **NEUTRAL-START** so the motor is not applying any braking or motive Force to the vehicle. Slowly remove foot pressure from the regular brake pedal. Do this until the vehicle is held by the parking brake only. See a Chevrolet dealer immediately if the vehicle cannot be held in place with this test. Should this occur, use extreme caution and park only on level ground to prevent the vehicle from rolling unintentionally.

Car Wash Information

CAUTION!

Although the possibility is slight, there is a chance that spraying large volumes of pressurized water into the vehicle from an automatic car wash could cause short circuits resulting in damage to the auto and/or injury to yourself. In general, it is safer not to use most car wash facilities and to hand wash your Force.

LIST OF FLUIDS AND LUBRICANTS

Hydraulic Brake System	Delco Supreme 11® Brake Fluid (GM Part No. 12377967 or equivalent DOT-3 brake fluid)
Key Lock Cylinders	Lubricate with Multi Purpose Lubricant (GM Part No. 12346241)
Parking Brake Cable Guides	Chassis lubricant GM Part No. 12377985 or equivalent or lubricant meeting requirements of NLGI #2, Category LB or GC-LB
Hood and Door Hinges	Multipurpose lubricant, Superlube® (GM Part No. 12346241 or equivalent)
Air Conditioning	R134A (24 oz. system empty)
Transmission oil	Dextron® III Automatic Transmission Fluid (approximately 1 qt)
Chassis Lubrication	Chassis lubricant (GM Part No. 1052497 or equivalent) or lubricant meeting NLGI #2, Category LB or GC-LB
Front Wheel Bearings	Wheel bearing lubricant meeting the requirements of NLGI #2, Category GC or GC-LB (GM Part No. 1051344 or equivalent)
Weather-strip	Dielectric silicone grease (GM Part No. 12345579) or equivalent

Maintenance Locations
Maintenance of the vehicle body, disc and drum brakes, wheels, tires, etc. can be performed at any service station or Chevrolet dealer.

Electronic and electric drive system maintenance must be performed by Solectria or a Solectria-approved Service Provider. Presently, Solectria's main facility is located at 33 Industrial Way, Wilmington MA 01887 USA tel 978-658-2231, fax 978-658-3224.

1999 Solectria Force Maintenance Schedule

Item	Odometer (miles)																
	6,000	12,000	18,000	24,000	30,000	36,000	42,000	48,000	54,000	60,000	66,000	72,000	78,000	84,000	90,000	96,000
Rotate/inspect tires	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Change gearbox oil	x	x		x		x		x		x		x		x		x
Inspect gearbox oil level			x		x		x		x		x		x		x	
Inspect steering & suspension		x		x		x		x		x		x		x		x
Inspect brake system		x		x		x		x		x		x		x		
Change brake fluid										x						

Owner/Operator Inspections

Weekly

Check windshield washer fluid level
Check hood latch operation

Monthly

Check tire pressure

Every 6 months

Check restraint system
Check wiper blades

Once a year

Lubricate key lock
Lubricate body
Check steering column Lock
Check parking brake performance

IX. WARRANTY/REPAIR

Solectria maintains a high customer satisfaction record and we want you to be completely satisfied with your new Force automobile. It is important to understand how to operate the vehicle, and so we recommend reading the entire Owner's Manual.

In addition to the following information, please see Solectria's Vehicle Warranty Policy for full details.

Maintenance and Repairs
Maintenance and repairs can be performed by any qualified service outlet; however, ***warranty repairs must be performed by a Solectria-authorized dealer or service provider***. Please contact Solectria Customer Service if you have questions concerning an appropriate service facility.

Note: Removal and re-installation of components must be performed by a trained technician. (Most Solectria components are modular and can be removed by disconnecting a few contacts or loosening a few screws.)

If you experience problems with the Chevrolet parts in your vehicle, please contact a Chevrolet dealer in your area to arrange for warranty or non-warranty work, as appropriate.

If unsure how to proceed, please call Solectria Customer Service at 978-658-2231.

Non-Warranted Items

Antenna
Batteries
Belts
Brake drums
Brake linings
Brake pads
Brake rotors
Bulbs
Cords
Fuses
Mirrors
Plugs
Shock absorbers - rear
Springs - rear
Struts - front
Tires
Windows
Windshield wash fluid
Wiper blades

Other Exclusions

The vehicle's warranty also does not cover any damage caused by vandalism, abuse, neglect, acts of God, etc. Also, it does not cover any other item outside the manufacturer's control.

Warranty Card

For your vehicle's warranty to remain valid, your vehicle's Warranty Card must be filled in each time Scheduled Maintenance takes place. We recommend the Warranty Card be kept with the Owner's Manual in the vehicle's glove box.

Receipts concerning regular maintenance should be retained in case questions arise concerning maintenance. Solectria reserves the right to deny warranty coverage if the vehicle has not been properly maintained. However, this decision would not be based solely on the absence of maintenance records.

Contact Solectria Corporation at 978-658-2231 to effect all necessary warranty repairs. If you are not in the vicinity or are unable to bring your vehicle to our Massachusetts facility, you may use an authorized Service Provider after contacting us. Once we confirm by phone, fax or letter, have the vehicle serviced and we will reimburse the repair facility directly.

NOTE: Chevrolet dealers are probably the best source for conventional vehicle parts for the Solectria Force.

CAUTION!

Do NOT attempt to open or repair "damaged" components. Doing so will completely void the warranty on that part and may present a hazardous situation.

Before removing any item, call Solectria at 978-658-2231 with information on the problem. After receiving authorization to remove the component in question, ensure a trained person is on hand to remove the item.

When disconnecting contacts, confirm the technician knows exactly how to reconnect parts as incorrect wiring reconnections can damage components.

Service personnel should promptly package the defective or broken component and send it back to Solectria after calling Solectria Customer Service in advance at 978-658-2231 to obtain a RMA (Return Merchandise Authorization) number for tracking this return.

Transferability

The vehicle warranty is applicable to vehicles registered in the U.S. and normally operated in the U.S. It is provided to the original owner only and is not transferable without the express written authorization of Solectria.

Repair Locations

Repair of your vehicle body, suspension, disc and drum brakes, wheels, tires, etc. can be performed at any service station or Chevrolet Dealer.

Electronic and electric drive system repairs must be performed by Solectria or a Solectria-authorized Service Provider. Presently, Solectria's main facility is located at 33 Industrial Way, Wilmington MA 01887 USA, tel 978-658-2231, fax 978-658-3224.

Solectria Corporation reserves the right to make changes, improvements and alterations in vehicles it builds without incurring the obligation to make similar changes on earlier models of Solectria vehicles.

If you have questions about your warranty or repair information in general, contact Solectria for assistance at 978-658-2231.

X. TROUBLESHOOTING GUIDE

The purpose of this section is to give the owner or operator of the vehicle guidance on what to do if something is wrong.

NEVER open the motor controller, DC-DC converter, or any other sealed piece of electronic equipment. Doing so could damage the vehicle or cause severe injury to yourself and voids the warranty.

Below are some common problems and how to address them.

A. Vehicle will not start

1. First, check the amp-hour meter to make sure the vehicle has power.

2. Make sure the vehicle is unplugged - it will not start if it is plugged into a charging outlet.

3. Have you tried driving? Remember, you really don't hear anything when you turn the vehicle on.

4. Check that the key is inserted in the ignition switch and is in the "on" position. If unsure, turn everything off, wait a few seconds, insert the key, turn to "start" and release (it should now be on the "on" position), and wait 1-2 seconds.

5 Move the range/power selector to **NEUTRAL-START,** then set the range/power selector to the desired mode.

6. Release the parking brake fully.

7. The vehicle should now drive. If it still doesn't, the problem could be mechanical or electrical. Listen carefully for the whine of the motor and controller as you depress the accelerator. If the motor does not spin at all, the problem is electrical. In this case, we recommend contacting a Solectria Repair facility to check all electrical connections from battery box to motor.

CAUTION!

WORKING WITH HIGH VOLTAGE SYSTEMS IS DANGEROUS, AND CAN RESULT IN SERIOUS INJURY IF DONE IMPROPERLY. IT MUST ONLY BE ATTEMPTED BY TRAINED TECHNICIANS. PLEASE CALL SOLECTRIA AT 978-658-2231 BEFORE ATTEMPTING ANY ELECTRICAL REPAIRS.

B. Vehicle will not charge

1. If the vehicle is plugged into a wall outlet and the green **IN** light on the instrument panel is not flashing, it indicates the battery is not receiving power. Unplug the vehicle.

2. Check the outlet to make sure it is getting power with a voltmeter or by plugging in another device such as a lamp. If the circuit breaker is tripped or the fuse is blown, make sure the circuit is rated for the power the charger requires (20 amps).

3. Listen for a relay clicking when plugging the vehicle in. Listen for the charger cooling fans turning on. If either occurs (indicating the charger is receiving power) check the amp-hour meter. If the green **IN** light is not flashing, watch the numbers on the counter. If they are decreasing, the vehicle is being charged, but the green light is bad. Call Solectria for repair information.

4. If the vehicle still is not charging, call Solectria.

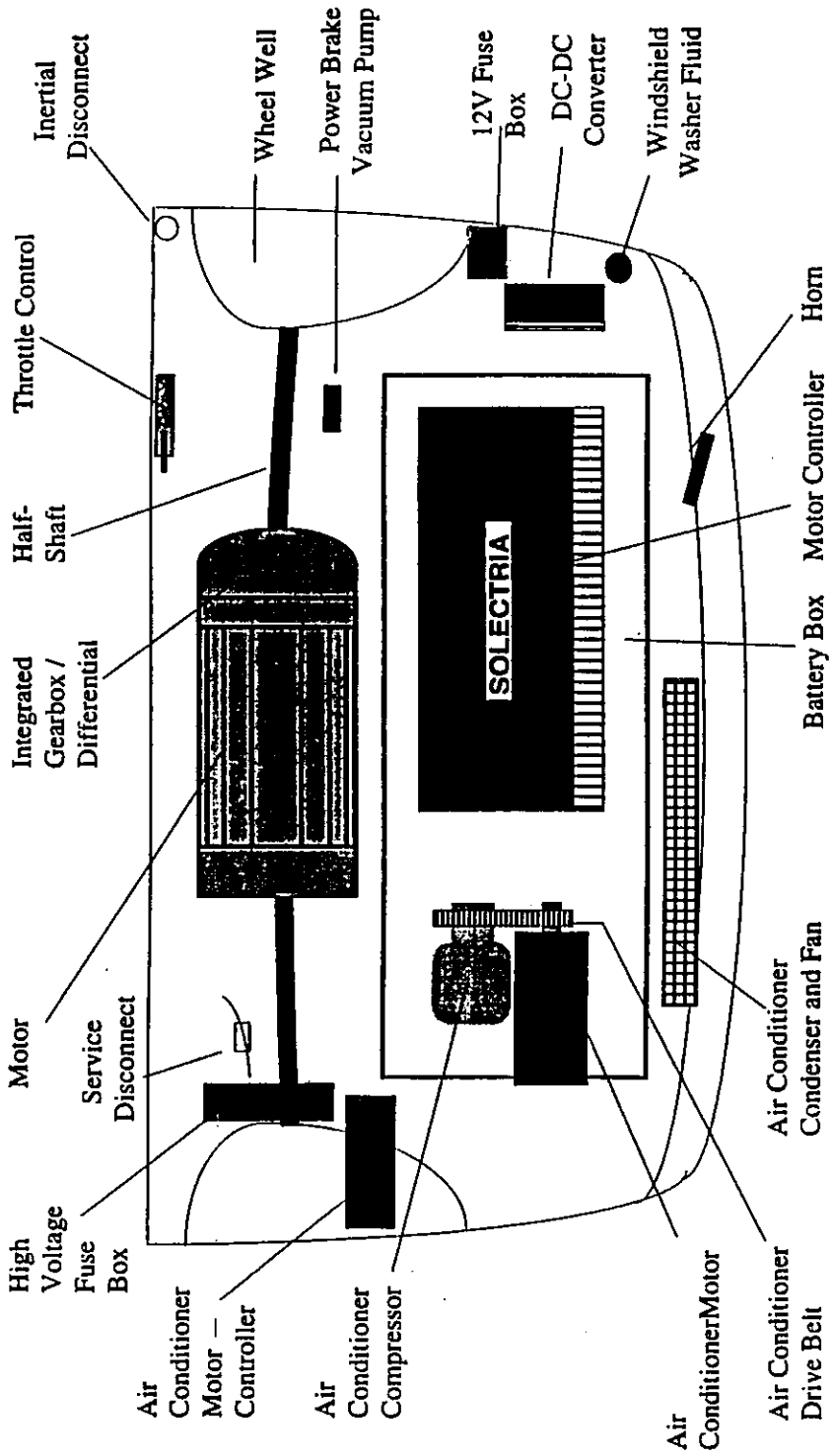
C. Batteries are not recharging or are not holding a full charge

1. This may be due to improper or insufficient charging. Call Solectria at 978-658-2231 for assistance.

2. Note: Rough driving can cause battery damage which is not visible. Internal damage may shorten battery life and reduce charging ability.

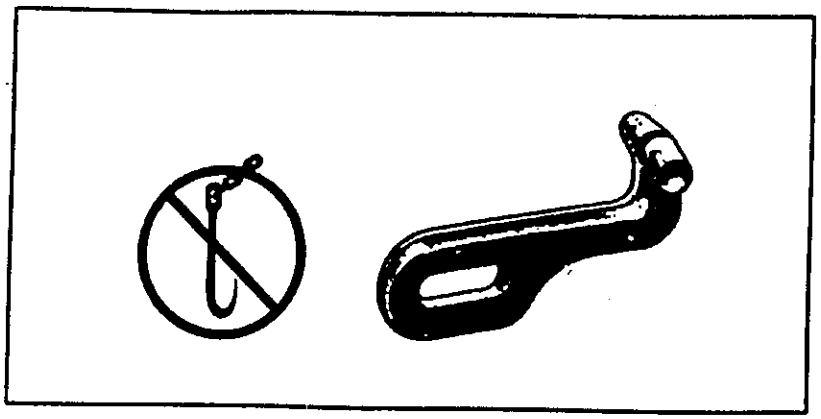
X. DIAGRAMS

1999 Solectria Force Motor Compartment

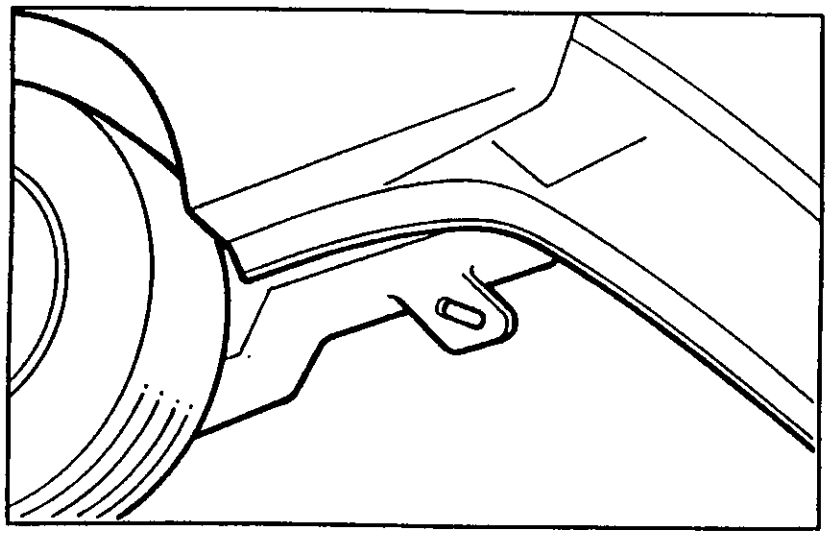


Towing Instructions for 1999 Solectria Force

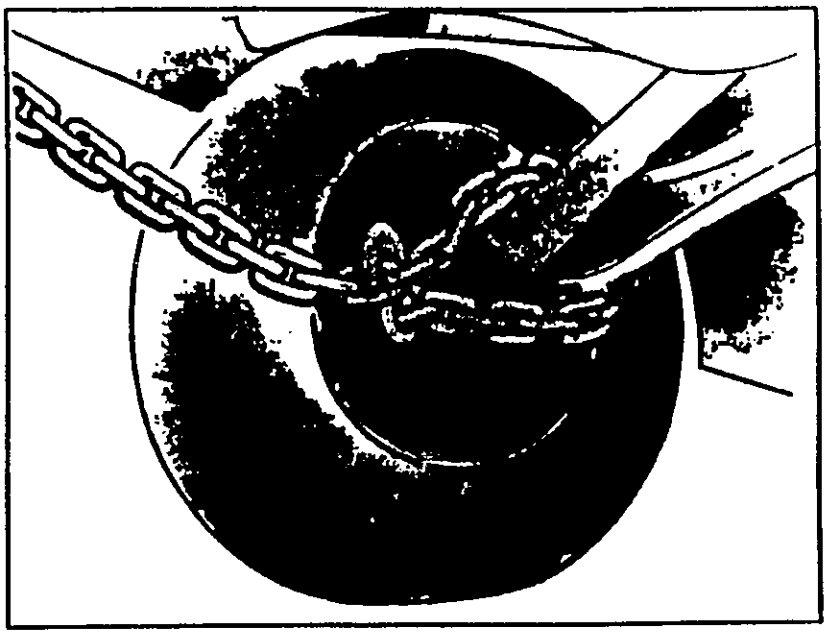
Do not attach winch cables or "J"-hooks to suspension components when towing.



Always use "T"-hooks inserted into the "T"-hook slots. See diagrams.

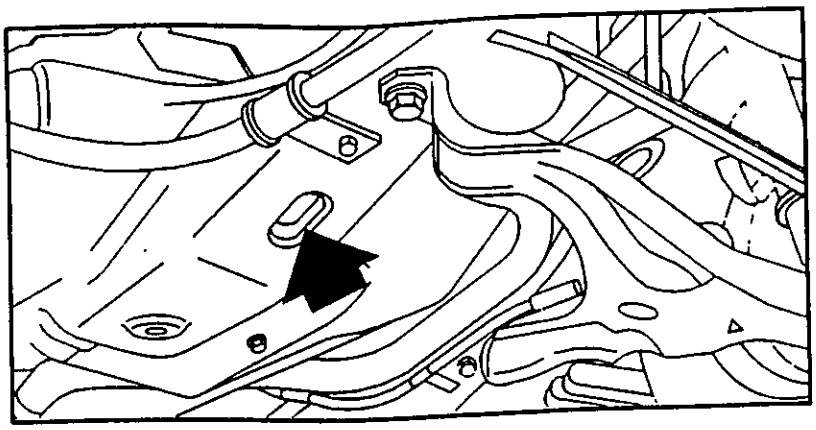


Attach T-hook chains on both sides, in the slotted holes in the brackets, just ahead of the front wheels.



Attach a separate safety chain around the outboard end of each lower control arm.

Do not wrap chain around track rods, sway bars, tie rods, or brake lines.



Attach T-hook chains to the T-hook slots in the bottom of the floor pan just ahead of the rear wheels on both sides.

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