

Hybrid Vehicle Safety Hazards

By Larry Carley c2008



There's been a lot of hoopla lately about hybrid vehicles and whether they really deliver the kind of high fuel economy numbers touted by the vehicle manufacturers. EPA mileage estimates are determined under controlled conditions and obviously vary with driving style and traffic conditions. But another issue that has received less attention isn't fuel economy, it is the risk of being shocked or electrocuted while working on these vehicles.

Hybrid vehicles use **high voltage** batteries and electric motors to achieve their fuel economy gains. The battery packs quite a wallop, 144 volts on a Honda Insight or Civic, 201 volts on a second-generation (2004) Toyota Prius (which is bumped up to 500 volts by the power inverter at the electric motors!), 275 volts on a first-generation Toyota Prius (2001-03), 288 volts on a Lexus RX400H and Toyota Highlander, and 330 volts on a Ford Escape Hybrid. This is more than enough juice to toast anyone who accidentally comes into contact with the high voltage battery, wiring or powertrain components.

HYBRID ELECTROCUTION HAZARD?

So how does a modern day hybrid vehicle compare to an electric chair? The hybrid comes in a close second. In days gone by when criminals were executed by electrocution in an electric chair, a initial jolt of 2000 to 2450 volts was applied to lower the resistance of the skin. This was followed by a sustained 8 amp current of 400 to 480 volts for 20 to 30 seconds to finish "cooking" the victim. In spite of its sometimes gruesome results (charred flesh, people bursting into flames, etc.), it was an effective means of ending a person's life. Except for the initial high voltage jolt, a hybrid electric system has the same lethal potential.



High voltage direct current is especially dangerous because it typically causes continuous muscular contractions that prevent the victim from "letting go." This increases the likelihood of deep tissue burns, organ damage and death. Alternating current, by comparison, is more like to cause heart fibrillations that may result in death. The threshold voltage where DC becomes dangerous can be as low as 55 to 60 volts, compared to 110 volts for AC. Ordinary 12 volt DC car batteries and electrical systems pose no danger, but the high voltage secondary ignition system can give you a nasty shock (though the current is usually too low to cause serious harm).

Some say the risk of electrocution has been greatly exaggerated and that hybrid vehicles are no more dangerous to work on than conventional gasoline-powered vehicles. Gasoline, after all, is a highly flammable and explosive liquid. Even so, you need to be aware of the dangers of high voltage and to treat it with respect. But many technicians have yet to see their first hybrid electric, and may not be aware of the danger. Likewise, an emergency rescue worker may inadvertently slice through a high voltage cable while trying to extract an accident victim from a damaged vehicle and end up harming himself or the person he is trying to save. That's why education is so important. People need to be aware of the danger.

One factor that increases the shock hazard to the unwary is that some hybrid vehicles are difficult to distinguish from their conventional gasoline-powered counterparts. The Toyota Prius has a fairly unique appearance as does the Honda Insight, but the hybrid Lexus RX 400H, Toyota Highlander Hybrid, Honda Civic Hybrid and Ford

Escape Hybrid all look the same as the regular gasoline-powered models. Because of this, some safety experts want hybrid vehicles to have an orange warning label on the sun visor. Sounds like a good idea to me.

HYBRID SAFETY

The high voltage components in most hybrids are color-coded **ORANGE**, and on the Toyota hybrids the battery pack relays automatically open and disconnect the battery if a collision is severe enough to deploy the airbags. But that's no protection for technicians who may have to service these vehicles.

The recommended protection is to wear Class 0 rated insulated gloves, which are rated to 1000 volts AC, and must not have any tears, pinholes or cuts. You should test the integrity of the gloves by rolling them up toward the fingers to see if they hold air. If they do not, throw the gloves away and buy new gloves. You should also use insulated tools when working on high voltage hybrid components.

Also, you must make sure the vehicle is OFF before you begin any electrical or mechanical repairs on any hybrid powertrain components.

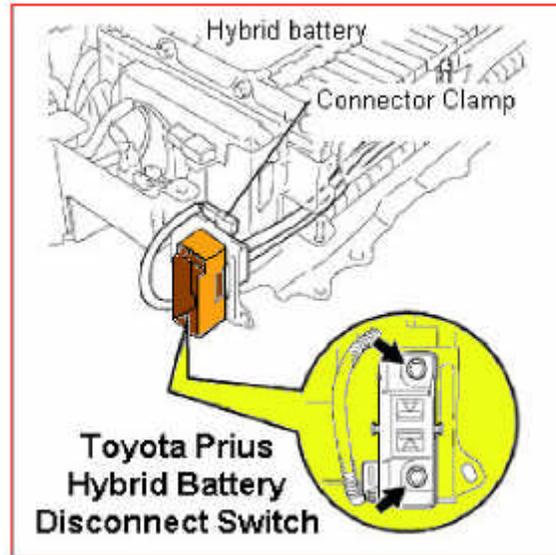
Actually, hybrid vehicles are not as dangerous to work on as they might seem at first. If the key is off and the key is out of the vehicle, the hybrid system is powered down. The battery can't shock you unless you go poking around the high voltage battery connections with bare hands or uninsulated tools. Even so, always treat the high voltage hybrid battery and electrical components with caution.

Always disconnect the high voltage hybrid battery BEFORE doing any major repair work or electrical work. See the instructions in the vehicle owner's manual or manufacturer service literature for details. Most manufacturers also recommend waiting 5 to 15 minutes before working on the vehicle after the battery has been isolated or disconnected. This gives the high voltage capacitors time to discharge so there is no residual voltage to pose a shock hazard.

HOW TO DISCONNECT THE HIGH VOLTAGE HYBRID BATTERY ON A TOYOTA PRIUS

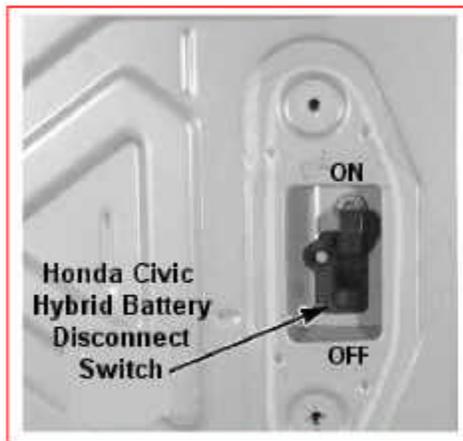
On the first generation Prius, the hybrid battery is disconnected by opening the trunk, removing the liner from the left front corner, and pulling straight back on a small orange handle to remove the plug. The plug should be removed from the car until it is time to reconnect the battery.

On a 2004 and up Prius, Toyota says to first disconnect the negative cable on the conventional 12-volt battery (which is also located in the trunk). Remove the trunk floor panel and cover, disconnect the 12-volt battery, then locate the service plug on the left side, and pull the handle down and out to remove the plug (wear insulated gloves when doing this). If you have to remove or replace the fuse, it is located right under the service plug and is held in place by two bolts. Again, wear insulated gloves. When the service plug is replaced, make sure the handle is returned to the upright position to lock the plug in place, otherwise a loose plug may set battery codes.



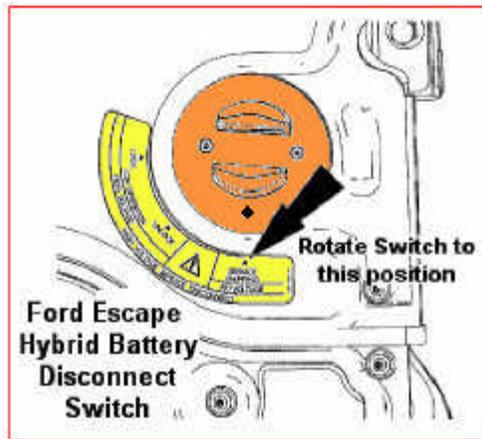
HONDA CIVIC HYBRID BATTERY DISCONNECT PROCEDURE

On a Honda Civic hybrid, the battery is disconnected by removing the rear seat back cushion, removing two screws from a small cover with the word "UP" on the cover, the flipping the power switch DOWN to the OFF position.



FORD ESCAPE HYBRID HYBRID BATTERY DISCONNECT PROCEDURE

Put the shift lever into Park and remove the ignition key. This will turn off the hybrid system, but not totally isolate the hybrid battery in the back of the vehicle. To totally isolate the high voltage hybrid battery, open the tailgate, pull back the carpeting on the floor, and locate the round disconnect switch on the top of the hybrid battery. With rubber gloves on, turn the switch COUNTERCLOCKWISE then lift out the switch plug to totally disconnect the battery.



MAKE SURE A HYBRID IS REALLY OFF BEFORE YOU WORK ON IT

If you are working on a Toyota Prius and forget to push the "Power" button to turn the car off or remove the key, the hybrid powertrain will still be hot even though the engine may not be running. At stop, the vehicle reverts to an electric-only mode of operation, shuts off the gasoline engine and makes no noise. Meanwhile, the engine control module continues to monitor the voltage of the hybrid battery, and may automatically restart the engine if the hybrid battery voltage is low and the engine needs to run to recharge it. That could mean a nasty surprise for you if you happen to be working under the hood, changing the oil or doing anything else that puts you in close proximity to belts, pulleys or high voltage components.



Most hybrids have some kind of "Ready" indicator light on the dash to let the driver know when the hybrid system is on. So always make sure the Ready light is out, the ignition is off and the key is out of the vehicle before you start any service or repair work. Removing the key from the vehicle is especially important if the vehicle has a keyless entry system and recognizes the key fob anytime it is in close proximity to the car. Keep the keyless fob at least 20 feet away to prevent any accidental starts.

Most hybrids are designed to isolate the high voltage battery if the vehicle is involved in an accident that is serious enough to deploy the air bags. On the Prius, the high voltage battery and wiring circuits are separate from the other electrical circuits in the vehicle, and do not use the body or chassis as a ground. The Prius has a ground

fault sensor that will disconnect the hybrid battery and turn on a warning light (an exclamation mark inside a triangle) if it detects any high voltage leakage to the body. A DTC P3009 fault code would indicate such a problem on the Prius.

The good news is that nobody has yet been injured or electrocuted by a hybrid electric vehicle. An extensive search of news archives failed to turn up any reports of service technicians, emergency responders or motorists being zapped by a high voltage hybrid. Let's hope it stays that way.

[Click here to view Toyota Prius Emergency Response Manual \(PDF file\)](#)

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