HYBRID SAFETY AND SERVICE PROCEDURES

Figure 90-1  Rubber lineman’s gloves protect the wearer from a shock hazard.

Figure 90-2  Wearing leather gloves over the lineman’s gloves helps protect the rubber gloves from damage.
WARNING:
Touching circuits or wires containing high voltage can cause severe burns or death.

Figure 90-3 Checking rubber lineman's gloves for pinhole leaks.

WARNING:
Cables and wiring are orange in color. High-voltage insulated safety gloves and a face shield must be worn when carrying out any diagnostics involving the high-voltage systems or components.
Figure 90-4. Be sure to only use a meter that is CAT III-rated when taking electrical voltage measurements on a hybrid electric or electric vehicle.

**FREQUENTLY ASKED QUESTION**

Is It the Voltage Rating that Determines the CAT Rating?

Yes and no. The voltages stated for the various CAT ratings are important but the potential harm to a technician due to the energy level is what is most important. For example, some CAT II rated meters may have a stated voltage higher than a meter that has a CAT III rating. Always use a meter that has a CAT III rating when working on a hybrid electric vehicle. \(\text{SEE FIGURES 90–4 AND 90–5.}\)

Figure 90-5. The meter leads should also be CAT III-rated when checking voltages on a hybrid electric vehicle.
WARNING:

Power remains in the high-voltage electrical system for up to 10 minutes after the HV battery pack is shut off. Never touch, cut, or open any orange high-voltage power cable or high-voltage component without confirming that the high-voltage has been completely discharged.

TECH TIP: Silence Is NOT Golden

Never assume the vehicle is shut off just because the engine is off. When working with a Toyota or Lexus hybrid electric vehicle, always look for the READY indicator status on the dash display. The vehicle is shut off when the READY indicator is off.

The vehicle may be powered by:

1. The electric motor only.
2. The gasoline engine only.
3. A combination of both the electric motor and the gasoline engine.

The vehicle computer determines the mode in which the vehicle operates to improve fuel economy and reduce emissions. The driver cannot manually select the mode.

- SEE FIGURE 90-6.

Figure 90-6: The Ford Escape hybrid instrument panel showing the vehicle in park and the indication is "EV" instead of 0 RPM. This means that the gasoline engine could start at any time depending on the state of charge of the high-voltage batteries and other factors.
TECH TIP: High Voltage Is Insulated from the Vehicle Body
Both positive and negative high-voltage power cables are isolated from the metal chassis, so there is no possibility of shock by touching the metal chassis. This design is called a floating ground.

A ground fault monitor continuously monitors for high-voltage leakage to the metal chassis while the vehicle is running. If a malfunction is detected, the vehicle computer will illuminate the master warning light in the instrument cluster and the hybrid warning light in the LCD display. The HV battery pack relays will automatically open to stop electricity flow in a collision sufficient to activate the SRS airbags.

CHART 90–1
As a rule of thumb, the auxiliary battery is usually a flood-type if it is located under the hood and an AGM type if it is in the trunk area.

Figure 90-7: Jump starting a 2001–2003 Toyota Prius using a 12-volt supply to boost the 12-volt auxiliary battery in the trunk.
WARNING

Even if all of the above steps are followed, there is still a risk for electrical shock at the high-voltage batteries. Always follow the vehicle manufacturer’s instructions exactly and wear high-voltage gloves and other specified personal protective equipment (PPE).

FREQUENTLY ASKED QUESTION:

When Do I Need to De-Power the High-Voltage System?

During routine service work, there is no need for a technician to de-power the high-voltage system. The only time when this process is needed is if service repairs or testing is being performed on any circuit that has an orange cable attached. These include:

• AC compressor if electrically powered
• High-voltage battery pack or electronic controllers

The electric power steering system usually operates on 12 volts or 42 volts and neither is a shock hazard. However, an arc will be maintained if a 42-volt circuit is opened. Always refer to service information when servicing the electric power steering system or any other system that may contain high voltage.
Figure 90-9 Using a warning cover over the steering wheel helps others realize that work is being performed on the high-voltage system and that no one is to attempt to start or move the vehicle.

Figure 90-10 A lock box is a safe location to keep the ignition keys of a hybrid electric vehicle while it is being serviced.

Figure 90-11 Insulated tools, such as this socket set, would provide an additional margin of safety to the service technician when working around high-voltage components and systems.
FREQUENTLY ASKED QUESTION

Will the Heat from Paint Ovens Hurt the High-Voltage Batteries?

Nickel-metal hydride (NiMH) batteries may be damaged if exposed to high temperatures, such as in a paint oven. The warning labels on hybrid vehicles specify that the battery temperature not exceed 146°F (63°C). Therefore be sure to check the temperature of any paint oven before allowing a hybrid electric vehicle into one that may be hotter than specified. Check service information for details on the vehicle being repaired.

Figure 90-12 The high-voltage wiring on this Honda hybrid is colored orange for easy identification.

TECH TIP: High-Voltage Battery SOC Considerations

NiMH batteries do not store well for long lengths of time. After a repair job, or when the HV system has been powered down by a technician and powered up again, do not be surprised if a warning lamp lights, diagnostic trouble codes are set, and the MIL is illuminated. If everything was done correctly, a couple road tests may be all that is required to reset the MIL. The HV battery indicator on the dash may also read zero charge level. After a road test, the HV battery level indicator will most likely display the proper voltage level.
Figure 90-13 A scan tool display showing two hybrid-related faults in this Ford Escape hybrid.

Figure 90-14 Always use the specified viscosity of oil in a hybrid electric vehicle not only for best fuel economy but also because of the need for fast lubrication because of the engine (idle) stop feature.

REAL WORLD FIX: A Bad Day Changing Oil
A shop owner was called by a regular customer who had just bought a Prius. The oil could be changed there. The owner opened the hood, made sure the filter was in stock (it is a standard Toyota filter used on other models), and said yes. A technician with no prior knowledge of hybrids drove the warmed-up vehicle into the service bay. The internal combustion engine never started, so the people in the service bay thought the technician had turned the engine off. They removed the drain bolt, and drained the oil into the oil drain unit. When the filter was removed, oil started to fly around the shop. The engine was in standby mode during the first part of the oil change. When the voltage level dropped, the onboard computer started the engine so that the HV battery could recharge. The technician should have removed the key to keep this from happening. Be sure that the ready light is off before changing the oil or doing any other service work that may cause personal harm or harm to the vehicle if the engine starts.
Figure 90-15. This 12 volt battery under the hood on a Ford Fusion hybrid is a flooded cell type auxiliary battery.

HV GLOVE USE 1
The cuff of the rubber glove should extend at least 1/2 inch beyond the cuff of the leather protector.

HV GLOVE USE 2
To determine correct glove size, use a soft tape to measure around the palm of the hand. A measurement of 6 inches would correspond with a glove size of 9.
HV GLOVE USE 3. The glove rating and the date of the last test should be stamped on the glove cuff.

HV GLOVE USE 4. Start with a visual inspection of the glove fingertips, making sure that no cuts or other damage is present.

HV GLOVE USE 5. The damage on this glove was easily detected with a simple visual inspection. Note that the rubber glove material can be damaged by petroleum products, detergents, certain hand soaps, and talcum powder.
HV GLOVE USE 6
Manually inflate the glove to inspect for pinhole leaks. Starting at the cuff, roll
up the glove and then open the fingers and listen carefully for deflation of the glove. If
a leak is detected, the glove must be discarded.

HV GLOVE USE 7
Petroleum on the leather protector’s surface will damage the rubber glove
underneath.

HV GLOVE USE 8
Glove powder (glove dust) should be used to absorb moisture and reduce
friction.
Put on the gloves and tighten the straps on the back of the leather protectors.

Technicians MUST wear HV gloves and leather protectors whenever working around the high-voltage areas of a hybrid electric vehicle.

HV gloves and leather protectors should be placed in a canvas storage bag when not in use. Make sure to keep the ventilation hole at the bottom of the bag.
HV GLOVE USE 1.2 Make sure that the rubber gloves are not folded when placed in the canvas bag. Folding increases mechanical stress on the rubber and can lead to premature failure of the glove fabric.