

# Enova Hybrid Systems

## Study Guide



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# Introduction

Welcome to Navistar's Enova Hybrid Systems training programs. The purpose of this course is to familiarize you with the Enova hybrid systems. The course contains four programs:

1. Product Overview
2. Hybrid System Components and Operation
3. Hybrid System Diagnostics
4. Hybrid Service Considerations

## Objectives

**Upon completion of this course, you will be able to:**

- **Identify the two types of Enova Hybrid Systems.**
- **Explain the operation of the major components of both systems.**
- **Perform basic diagnostic procedures.**
- **Perform basic service procedures.**



## Hybrid Groups

Hybrids are vehicles that use more than one source to produce, store and deliver power to increase overall efficiency.

There are two hybrid groups: full and mild. A full hybrid can operate without the primary engine to propel the vehicle, typically during launch, because its hybrid system has sufficient battery and horsepower.

In a mild hybrid, the electric motor can help accelerate or stop the vehicle, but cannot power the vehicle by itself.

## Program 1: Product Overview

Upon completion of this program, you will be able to:

- **Identify the Enova Hybrid's group, technology, architecture and configuration.**
- **Explain the differences between Enova's Charge-Depleting and Charge-Sustaining Systems.**
- **Differentiate between Regeneration and Retard/Regeneration modes.**

***The Enova Hybrid System used in the IC bus is a mild hybrid.***

## Hybrid Technologies

***The Enova Hybrid System used in the IC bus is a diesel/electric hybrid.***

Hybrids can also be assigned to one of three types of technologies: plug-in, gasoline/electric or diesel/electric.

- Plug-in hybrids use battery power only until the batteries are discharged. When this happens, the vehicle switches to engine power.

Other technologies have the ability to regenerate battery power without plugging in.

- Most consumer vehicles are gasoline/electric hybrids.
- Larger hybrid vehicles like trucks and buses require the greater power of a diesel/electric hybrid.

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## Hybrid Architectures

Electric hybrids may feature series or parallel architecture.

In a series hybrid, the engine never directly powers the vehicle. Instead, the engine turns a generator. The generator either charges the batteries or powers the electric motor that drives the vehicle.

In a parallel hybrid, a primary or secondary power source can propel the vehicle, independently or in combination. A failure of the hybrid system does not put the vehicle out of service; the vehicle can still complete its mission using the engine without the assistance of the hybrid motor.

***The Enova Hybrid System utilizes a parallel hybrid architecture.***

## Parallel Hybrid Configurations

***The IC bus utilizes the Enova post-transmission system.***

A parallel hybrid can have either a pre- or post-transmission configuration.

In a pre-transmission system, the hybrid motor is built in front of the transmission. This design is often used in utility trucks that require an engine-off power take-off, or PTO.

***The Enova Hybrid System is a mild, diesel/electric, parallel, post-transmission hybrid system.***

In a post-transmission system, the electric motor is mounted behind the transmission. This system may be used in vehicles like school buses that use a normal, factory-installed transmission and make frequent stops but do not require PTO capability.

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## Hybrid Advantages

Spiraling fuel costs are shifting market demand to hybrid technology because of its advantages.

First, blending the power output from the electric motor and diesel engine improves fuel economy.

Second, burning less fuel means fewer emissions. Being environmentally friendly or “green” is also important to many communities and customers.

Third, when a hybrid vehicle coasts or slows down, it regenerates its high-voltage batteries. This regeneration mode also slows the vehicle, reducing brake wear.

## Two Enova Systems

Navistar offers two Enova hybrid systems on the IC bus. The systems differ in how they use and recharge the energy stored in their batteries. These are the charge-depleting and the charge-sustaining systems.

## **Charge-Depleting System (CDS)**

***During this initial phase, the hybrid gets an economy boost of 70 to 100 percent over a conventional vehicle.***

In a charge-depleting system or CDS, the high-voltage batteries provide stored energy that is drawn down during the driving cycle. This system typically uses a larger battery pack to store sufficient energy for the draw down. This optimizes fuel economy.

The mileage range for the system in its default setting is 40 miles. The energy draw-down works this way: the batteries are drawn to approximately a 20 percent state of charge during the initial miles of operation.

***During this recharge period and for the balance of the route, the fuel economy boost is in the 20-to-50 percent range.***

At this setting, when the battery reaches the 20 percent state of charge, the hybrid system begins to recharge the batteries.

The draw-down can be tailored to fit individual needs. For example, setting the system to draw down more quickly increases miles per gallon but shortens vehicle range. Conversely, setting it to draw down more slowly produces a greater mileage range but reduces fuel economy.

A 220-volt charging receptacle is located on the passenger side of the bus. A weatherproof Ground Fault Control Interrupt or GFCI, charging cord is provided for charging the hybrid battery pack.

***The feature code for the Enova post-transmission, charge-depleting, parallel, mild hybrid system is 10AHJ.***

***In the charge-sustaining system, battery charge is sustained through power regeneration. Power regeneration is the process of generating power via the hybrid system's electric motor.***

## **Charge-Sustaining System (CSS)**

The second type of Enova hybrid system is the charge-sustaining system, or CSS. This type of system maintains the battery pack state of charge within a specific range over the entire drive cycle. In the CSS, the battery charge is maintained by the on-board equipment and is not normally recharged from the grid. Fuel economy improvement for the charge-sustaining system is 20 to 50 percent, depending on the drive cycle.

The feature code for the Enova post-transmission, charge-sustaining, parallel, mild hybrid system is 10AHH.

Power regeneration occurs when the hybrid system is operating in either regeneration or retard/regeneration mode.

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## Regeneration Mode

The regeneration mode occurs when the driver applies the brake to slow the vehicle. Typically, when the brake pedal of a conventional vehicle is depressed, the resulting kinetic energy is dissipated as heat. However, the hybrid system captures some of this energy and stores it in the battery pack. In this way, the electric motor functions as a generator and is used with the brakes to slow the vehicle.

The hybrid system's Control Electronics Unit or CEU, uses a brake pressure sensor to control the amount of regenerative braking torque applied by the motor.

The vehicle braking system is not altered by the hybrid system, so the brakes continue to function normally if the hybrid system is switched off.

***The hybrid system enters into the regeneration mode only when the battery state of charge is below a predetermined value, as measured by the Battery Management System, and when the brakes are applied.***

## Retard/Regeneration Mode

***Power regeneration in retard/regeneration mode is not as great as in regeneration mode when the brakes are applied.***

Retard/regeneration mode occurs when the vehicle is coasting without brake application. The CEU constantly monitors power demand by the driver. When the driver lifts his or her foot off the accelerator, the CEU commands the motor/generator to regenerate the batteries. This in turn, slows the vehicle.

The hybrid system enters into the retard/regeneration mode only when the battery state of charge is below a predetermined value, as measured by the Battery Management System; the driver is NOT depressing the accelerator; and the motor/generator is running between 1200 and 2000 rpm.

While several components of the hybrid system drive train are similar to those of a conventional vehicle, others are different. The components of the Enova hybrid system are the electric motor, Control Electronics Unit (CEU), battery packs, hybrid cooling system, brake pressure sensor, and operator interface panel.

## Electric Motor

The Enova hybrid systems use a three-phase induction electric motor. In both CDS and CSS, the motor is mounted to the frame between the transmission and drive axle, and connected to drive shafts at each end.

During acceleration, the electric motor draws energy – in the form of high-voltage alternating current, or AC – from the batteries. This energy is produced by converting direct current, or DC voltage to AC for use by the motor.

During deceleration, the motor acts as a generator by allowing the wheels to turn it. In this way, the motor generates energy – in the form of AC – which is then converted to DC to charge the batteries.

# Program 2: Hybrid System Components and Operation

Upon completion of this section, you will be able to

- Identify each major component and describe its function.

***The electric motor uses advanced electronics that allow it to act as both a motor and generator.***

***In the Charge-Depleting System, or CDS, the CEU also contains the charger module for recharging the battery packs.***

## **Control Electronics Unit (CEU)**

The job of inverting, rectifying, converting, and managing AC and DC voltages between the motor/generator and the hybrid battery packs belongs to the CEU. The CEU is typically located in the undercarriage on the driver side of the bus.

During acceleration, the CEU converts DC electricity from the battery packs to AC electricity that drives the electric motor.

During deceleration, the CEU converts AC power from the electric motor to DC energy, which recharges the battery packs during regenerative braking.

## **Battery Packs**

There are two types of battery packs used in Enova hybrid systems. Depending upon the system, there are either two separately mounted battery packs or two battery packs mounted within a single cage. When combined, the battery packs produce 330 volts DC.

To recharge the battery packs, connect the vehicle to a 220-volt AC outlet using the GFCI-equipped charge cable supplied by Enova. When not in use, the vehicle should be connected to the charge cable.

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## Hybrid Cooling System

Hybrid systems produce a high level of heat during operation.

The components of the cooling system are the coolant circulation pump, the radiator, and the coolant reservoir.

### Coolant Pump

The coolant pump circulates coolant through the hybrid cooling circuit.

### Radiator

The radiator dissipates heat from the coolant.

### Coolant Reservoir

The coolant reservoir holds coolant and supplies it to the pump as needed. The reservoir is typically located under the hood on the driver's side.

***The Enova hybrid system has a self-contained cooling system to circulate coolant and remove heat from hybrid system components.***

## Brake Pressure Sensor

***The CEU controls the amount of regenerative braking torque the motor applies.***

The CSS is equipped with a brake pressure sensor. When the driver presses the brake pedal, the sensor identifies the amount of braking pressure and sends that value to the CEU. Based on that value, the CEU controls the amount of regenerative braking torque the motor applies.

On a bus equipped with air brakes, the sensor is located on a delivery port of the treadle valve to the secondary (steer axle) brakes. On a bus equipped with hydraulic brakes, the sensor is “teed” into the primary (steer axle) brake line between the Full Power Brake Hydraulic Compact Unit and the wheel ends.

The brake pressure sensor also works with the Anti-lock Brake System (ABS) by communicating the event to the CEU. The CEU disables the system regenerative braking during an ABS event.

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## Operator Interface Panel (OIP)

The only features of the Enova hybrid system that are accessible to the bus driver are located on the OIP, which is also called the Hybrid System Interface panel. The OIP includes the hybrid enable switch, status indicator lamps, and only for a bus equipped with the charge-depleting system, a charging indicator lamp.

### Hybrid Enable Switch

The hybrid enable switch is connected to the vehicle ignition key.

The hybrid enable switch allows the hybrid system to be turned on and off whenever the ignition switch is on. During normal day-to-day operation, the hybrid enable switch should be in the ON position. When the switch is on, the green indicator lamp is illuminated.

There are only two conditions under which the hybrid enable switch should be turned off:

- When a fault has occurred in the hybrid system
- When the vehicle is being serviced or repaired by authorized service personnel

***During normal day-to-day operation, the hybrid enable switch should be in the ON position. When the switch is on, the green indicator lamp is illuminated.***

## Status Indicator Lamps

***It's important to note that the operator should wait until the Service HEV Soon lamp turns off and the green Ready lamp is on before shifting the vehicle into gear.***

The hybrid status indicator lamps are located on the operator interface panel. These lamps allow the operator to monitor the status of the hybrid system. Status indicator lamps are the Ready lamp and the Service HEV Soon lamp.

When the vehicle is started, both indicator lamps are illuminated for approximately three seconds. During normal operation, the Service HEV Soon lamp turns off after this initial period and the Ready lamp remains illuminated.

It's important to note that the operator should wait until the Service HEV Soon lamp turns off and the green Ready lamp is on before shifting the vehicle into gear.

## Ready Lamp Operation

A steady-on green Ready lamp indicates normal operation of the hybrid system. If the green Ready lamp flashes on and off, the system has entered into a performance-limiting mode. While the vehicle continues to operate safely in this mode, the amount of assistance provided by the electric motor is limited and the vehicle relies more on the engine for power.

In the performance-limiting mode, the operator may notice that either the green Ready lamp flashes alternately with the Service HEV Soon lamp or the Service HEV Soon lamp flashes by itself with a steady-on green Ready lamp.

The operator should report the flashing lamp to service personnel upon returning to the depot.

***If the green Ready lamp flashes on and off, the system has entered into a performance-limiting mode. While the vehicle continues to operate safely in this mode, the amount of assistance provided by the electric motor is limited.***

## Service HEV Soon Lamp

***In the event of a system fault, the hybrid system automatically disables itself.***

If the Service HEV Soon lamp illuminates steady-on, a hybrid system fault has occurred. In the event of a system fault, the hybrid system automatically disables itself. When this occurs, the electric motor does not assist the engine with acceleration. The operator should move the hybrid enable switch to the OFF position when it is safe and convenient to do so. The vehicle continues to operate safely with the Service HEV Soon lamp on.

## Charging Indicator

The operator interface panel of a bus equipped with a charge-depleting system also includes a charging indicator.

The charge lamp illuminates steady-on when the following two conditions are met:

- The ignition switch or the hybrid enable switch is in the OFF position.
- The charge cable is attached to the vehicle and the battery packs are recharging.

If the charge lamp illuminates steady-on when the vehicle is operating, the hybrid system is no longer running in charge-depleting mode. It has changed to charge-sustaining mode. This indicates the battery State of Charge or SOC, is less than 25 percent. The vehicle returns to charge-depleting mode when the battery SOC moves above 50 percent.

If the charge lamp flashes on and off while the vehicle is operating, the SOC level of the battery packs is below 15 percent. This indicates the vehicle is in charge-sustaining mode and the battery packs need to be recharged. The vehicle continues to operate safely, but assistance from the electric motor is limited. The operator should recharge the vehicle upon return to the depot.

***If the charge lamp illuminates steady-on when the vehicle is operating, the hybrid system is no longer running in charge-depleting mode. It has changed to charge-sustaining mode.***



## Fault Codes

In Program 2, we learned that the hybrid system has entered into the performance-limiting mode when the green Ready lamp flashes alternately with the Service HEV Soon lamp or if the Service HEV Soon lamp flashes by itself with a steady-on green Ready lamp.

If the Service HEV Soon lamp illuminates steady-on, a hybrid system fault has occurred and the fault code has been logged by the CEU. Fault code diagnostics are performed using the Panther Diagnostic Software (PDS).

## Program 3: Hybrid System Diagnostics

**Upon completion of this section, you will be able to**

- **Explain the effects of fault classes on vehicle operation.**
- **Demonstrate how to launch Panther™ Diagnostic Software, or PDS™.**
- **Locate and interpret PDS data fields for a hybrid vehicle.**

## Fault Classes

The Enova hybrid system classifies fault codes into three classes: 0, 1 and 2. Each fault class describes a different response by the hybrid system to the fault detected by the CEU.

### Fault Class 0

***When the CEU detects a Class 0 fault, the battery contactors open automatically, shutting down the hybrid system.***

When the CEU detects a Class 0 fault, the battery contactors open automatically, shutting down the hybrid system.

### Fault Class 1

When the CEU detects a Class 1 fault, the hybrid system automatically disables itself until the fault has cleared.

### Fault Class 2

When the CEU detects a Class 2 fault, the hybrid system automatically limits its motor output power.

For a list of all fault codes by fault class, refer to *Troubleshooting Panther™ Faults for Enova Hybrid System Vehicles*. Two copies of this manual – for dealer and customer – are delivered with each vehicle.

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## Diagnostic Tools

When the servicing dealer receives an Enova hybrid bus and completes the required hands-on training, the dealership receives a copy of Panther Diagnostic Software and a dedicated Enova RS232 Diagnostic Interface Cable or DIC, for use with the EZ Tech electronic service tool.

## Diagnostic Procedures

This section describes how to use PDS for basic diagnostic procedures on a vehicle equipped with an Enova hybrid system.

Use the following seven-step procedure to run PDS on your EZ Tech.



### **NOTE**

**Use only the Enova RS232 DIC to connect to the hybrid system.**

## **Step 1: Run Panther Diagnostic Software**

To permanently install the PDS software on your EZ Tech, insert the software DVD into the EZ Tech, click the PDS icon and follow the installation prompts.

## **Step 2: Attach Interface Cable**

Connect the Enova RS232 DIC to either the COM1 or COM2 port on your EZ Tech. Connect the other end to the 25-pin hybrid diagnostic port located under the middle of the dash.

## **Step 3: Open PDS**

Open PDS by double-clicking the PDS 232 Enova icon.

When the dialog box opens, select COMM from the menu bar and then select Preferences from the drop down menu.

## **Step 4: Select Settings**

When the set-up file is displayed, select these settings:

- COM port on your EZ Tech
- Display temperature scale
- Speed units
- Default directory for data saving file

- First two letters for default saving file name

When you have completed these selections, click Save, then click Exit.

### **Step 5: Set COM Preferences**

To set the communication mode, click COMM from the menu bar and select Real Time Data, or click COM on the button menu bar.

### **Step 6: Power Up**

Turn on the hybrid system by turning the vehicle ignition on, or plug in the AC charging connector to activate the vehicle onboard charger.

When power up is successful, the MCU Real Time Display window opens.

### **Step 7: Verify Power Up**

As the system powers up, make sure the number in the Pkg field continues to increase. This field, located in the upper portion of the far right column of the readout, displays the quantity of RS232 data packages received from the Motor Control Unit, or MCU. If the number displayed does not increase during power up, the RS232 DIC is not communicating correctly.

***If the number displayed does not increase during power up, the RS232 DIC is not communicating correctly.***

If this occurs, check the cable to ensure proper connection.

## PDS™ Parameters

When you have established successful communication, you're ready to begin basic troubleshooting with PDS. In this section, we will review several data fields on the MCU Real-Time Display readout where you can find information related to the hybrid system.

### Faults

First, locate the Faults Info field in the lower portion of the third column of the readout. Faults Info shows the fault class in bit format, or as a fault class 0, 1 or 2.

The text box at the bottom of the readout displays the specific fault in text. Refer to *Troubleshooting Panther Faults for Enova Hybrid System Vehicles* for a description of the fault code and recommended repairs.

### HVDC Input

In the upper left section of the readout is the HVDC Input field. HVDC stands for High Voltage Direct Current.

This field shows several parameters related to the hybrid battery packs, including the propulsion battery pack voltage, battery current, battery power, and the isolation voltage.

***Refer to  
Troubleshooting  
Panther Faults  
for Enova Hybrid  
System Vehicles  
for a description  
of the fault code  
and recommended  
repairs.***

## **CEU Temp °C**

The CEU Temp field on the left side of the readout displays the CEU cold-plate temperature in degrees Celsius.

## **Mot Temp °F**

The Mot Temp field displays the motor temperature in degrees Fahrenheit.

## **Charger Fields**

Charger fields are located on the lower left portion of the readout. These fields display:

- Auxiliary Battery Voltage
- Charger Status
- Charger Temperature
- Input AC Voltage and Current
- Charge Command

## Motor

The Motor section in the second column of the readout shows the following data:

- Motor Phase Current
- RPM
- Vehicle Speed
- Enable Status, identified as either Speed Lim, IGBT Bias or IGBT Enable
- Torque Command or CMD
- Modified APS (Accelerator Position Sensor) request to the ECU
- Brake Input Voltage
- De-Rating Ratio

## Logic I/O Status

The Logic I/O Status in the top middle of the readout shows the status of six basic logic inputs and outputs. When the More button is selected, a new window opens that shows all logic statuses.

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## ECU

The three systems controllers – Engine Control Module or ECM, Transmission Control Module or TCM and hybrid ECU – communicate with each other over the Controller Area Network or CAN.

***The three systems controllers communicate with each other over the Controller Area Network or CAN.***

The ECU section in the third column of the readout shows data received via the J1939 communication link. The APS field is the actual APS request by the driver, which comes from the J1939 data transmitted by the ECM.

Other data fields are straight from the J1939 data transmitted by the ECM.

## TCM

The TCM field is located in the fourth column of the readout. Data from the TCM are transmitted via the J1939 communication link.

## Valence BMS

A significant amount of the PDS readout features information about the high-voltage batteries. This information is located in the Battery Management Section or BMS, in the lower portion of the readout fourth column.

The Valence BMS section displays these fields:

- State of Charge
- BMS Mode
- Contactor Status
- Contactor Open Request
- Pack Voltage
- Pack Current
- Maximum Cell Voltage
- Minimum Cell Voltage
- Discharge Current Limit
- Regenerative Current Limit
- Maximum and Minimum Module Temperatures

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## Motoring Mode

Information regarding Motoring Mode is located on the lower left of the readout, just above the Faults text box. During Motoring mode, data that are related to the Charging Mode are grayed out. These include:

- Charge Mode from BMS
- Charge Current Set Point
- Charge Volt Set Point
- End of Charge Flag (signals that charging has terminated)

## BMS Faults

Clicking the BMS Faults button in the bottom middle of the readout displays a new dialog box with reporting options for BMS faults.



## Program 4: Hybrid Service Considerations



### SHOCK HAZARD

All field service repairs are limited to only the removal and replacement of subsystem components. Components of Enova subsystems are to be opened only by Enova technicians. Failure to follow this warning could result in personal injury or death to you or other service personnel or damage to the vehicle, equipment, or components.

Upon completion of this section, you will be able to identify these special considerations for the pre-service checklist:

- High-voltage battery pack
- Electric motor
- Control Electronics Unit (CEU)
- Hybrid cooling system



### SHOCK HAZARD

A cable wrapped in orange loom identifies it as one that carries high voltage. Do not touch or cut these cables. Only authorized service personnel who have successfully completed High-Voltage Safety training should touch these cables. Failure to follow this warning could result in personal injury or death to you or other service personnel or damage to the vehicle, equipment, or components.

***After a fault has been isolated to a hybrid subsystem, you must perform two steps to ensure safety before you begin any service procedure.***



### **SHOCK HAZARD**

**Under no circumstance should the service disconnect switch be treated as an emergency switch. This switch is not intended to be used in situations where cable damage is extensive enough to cause a short circuit. This switch was designed as a secondary measure to remove battery voltage during service or transport. Failure to follow this warning could result in personal injury or death to you or other service personnel or damage to the vehicle, equipment, or components.**

## **Pre-Service Checklist**

### **Step 1: Ignition Switch**

Turn the ignition switch to the OFF position. Remove the key and place it in a safe location to which only you have access. Removing the key ensures that the hybrid system is shut down.

### **Step 2: Service Disconnect Switch – Procedures**

Turn off the service disconnect switch on each battery pack. This causes contactors inside each pack to remain open and assures that high voltage from the battery packs is isolated.

The type of disconnect switch your vehicle is equipped with determines which of the following procedures you will follow.

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## **Service Disconnect Switch - No Cover Plate**

If the disconnect switch does not have a cover plate, rotate the service disconnect switch to the OFF position. Open the locking device incorporated in the knob and install a padlock.

If there is a second battery pack, perform the same procedure to its disconnect switch. This causes contactors inside each pack to remain open and isolates the high voltage within the battery pack.

## **Service Disconnect Switch - With Cover Plate**

If the battery pack is equipped with a service disconnect switch cover plate, remove the cover plate. Rotate the service disconnect switch counter-clockwise and remove the orange knob. If there is a second battery pack, perform the same procedure for its disconnect switch. Place the knobs in a safe location to which only you have access.

***After the high voltage has been isolated to the battery packs, it is safe to perform service to the hybrid system.***

## Electric Motor Assembly

### **CAUTION**

**When replacing the Electric Motor Assembly or EMA, never disconnect the high-voltage cable from the motor side. Failure to follow this caution could result in equipment or component damage.**

### Disconnecting the High-Voltage Cable

***Disconnect the high-voltage cable from the EMA at the CEU.***

Disconnect the high-voltage cable from the EMA at the CEU.

### CEU Assembly

To replace the CEU assembly, remove the harness guard bracket to access the cable connectors.

Disconnect all wiring cables connected to the CEU assembly.

## Cooling System

### **CAUTION**

**Do not operate the cooling system without the proper level of coolant in the system. Failure to follow this caution could result in coolant pump failure.**

### Overview

The hybrid cooling system is a standard, gravity-based cooling system. The system must be periodically maintained and inspected to ensure the proper operation of hybrid components.

Preventative maintenance specifies that coolant be changed annually. When removing coolant, always remove the lower hoses first, then the higher, elevated ones. Residual coolant may remain in the system.

***Preventative maintenance specifies that coolant be changed annually. When removing coolant, always remove the lower hoses first, then the higher, elevated ones.***

### Coolant Level

Check the coolant reservoir periodically to verify proper coolant level. Under normal conditions, the coolant level should be at the FULL mark.

## Refilling the System

Each time the system is opened, use the following procedure to refill the cooling system:

1. Verify that all hoses are properly connected and all hose clamps are tightened.
2. Verify that hybrid enable and ignition switches are in the OFF position.
3. Open the vehicle hood. Remove the reservoir cap and fill the reservoir to the FULL mark with the proper type of coolant specified in ISIS.
4. Turn the ignition key to the ON position.
5. Turn the hybrid enable switch to the ON position.

At this point, the pump starts to circulate coolant through the cooling system. As the cooling system fills with coolant, the level of coolant in the reservoir drops.

1. Continue to add coolant to maintain its level at the FULL mark.
2. As the system starts priming, air purges and bubbles rise into the reservoir. Keep the pump running and wait for all the air to purge.
3. After the air has purged, add more coolant to the reservoir, if required.
4. Reinstall the cap to the reservoir.
5. Finally, verify there are no leaks in the cooling system and close the hood of the vehicle.

## **Conclusion**

This concludes the Enova Hybrid Systems training series. To receive credit for completing each program, you are required to take a post-test via the LMS.

