

Advanced Automotive Electricity & Electronics

Chapter 28 Hybrid Safety & Service Procedures

Opening Your Class

KEY ELEMENT	EXAMPLES
Introduce Content	This course or class covers operation and service of Advanced Automotive Electricity & Electronics . It correlates material to task lists specified by ASE and NATEF.
Motivate Learners	Explain how the knowledge of how something works translates into the ability to use that knowledge to figure why the engine does not work correctly and how this saves diagnosis time, which translates into more money.
State the learning objectives for the chapter or course you are about to cover and explain this is what they should be able to do as a result of attending this session or class.	Explain learning objectives to students as listed on NEXT SLIDE. <ol style="list-style-type: none">1. Safely de-power a hybrid electric vehicle.2. Safely perform high-voltage disconnects.3. Understand the unique service issues related to HEV high-voltage systems.4. Correctly use appropriate personal protective equipment (PPE).5. Perform routine vehicle service procedure on a hybrid electric vehicle.6. Explain hazards while driving, moving, and hoisting a hybrid electric vehicle.
Establish the Mood or Climate	Provide a WELCOME , Avoid put downs and bad jokes.
Complete Essentials	Restrooms, breaks, registration, tests, etc.
Clarify and Establish Knowledge Base	Do a round robin of the class by going around the room and having each student give their backgrounds, years of experience, family, hobbies, career goals, or anything they want to share.

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1. SLIDE 1 CH28 HYBRID SAFETY & SERVICE PROCEDURES

0. SLIDE 0 **EXPLAIN** FREQUENTLY ASKED QUESTION

2. SLIDE 2 **EXPLAIN** High-Voltage Safety

3. SLIDE 3 **EXPLAIN WARNING**

4. SLIDE 4 **EXPLAIN** High-Voltage Safety Equipment

5. SLIDE 5 **EXPLAIN NOTE**

6. SLIDE 6 **EXPLAIN** Figure 28-1 Rubber lineman's gloves protect the wearer from a shock hazard.

7. SLIDE 7 **EXPLAIN** Figure 28-2 Wearing leather gloves over the lineman's gloves helps protect the rubber gloves from damage

8. SLIDE 8 **EXPLAIN** FIGURE 28-3 Checking rubber lineman's gloves for pinhole leaks.

DISCUSSION: Have students talk about importance of using leather gloves over insulated gloves. Remind them that when purchasing leather gloves, they must be large enough to fit over insulated safety gloves. What should be done before each use of gloves?

FIGURES 28-1 to 28-3

9. SLIDE 9 **EXPLAIN** HIGH VOLTAGE EQUIPMENT

10. SLIDE 10 **EXPLAIN WARNING**

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QUESTION



QUESTION



QUESTION

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SAFETY Have students talk about need for safety precautions when working around & with hybrid electric vehicles. Both hybrid electric vehicles & all-electric vehicles use high-voltage circuits that cannot be touched without protection.

DEMONSTRATION: Show students materials necessary to create a "High Voltage: DO NOT TOUCH" sign that can be placed on roof of HEV that is being stored.

11. SLIDES 11-12 **EXPLAIN** HIGH VOLTAGE EQUIPMENT

13. SLIDE 13 **EXPLAIN** FREQUENTLY ASKED QUESTION

DISCUSSION: Discuss auxiliary batteries. Where are flood-type and AGM type batteries located? **CHART 28-1**

14. SLIDE 14 **EXPLAIN** FIGURE 28-4 Be sure to only use meter that is CAT III-rated when taking electrical voltage measurements on hybrid electric or electric vehicle.

15. SLIDE 15 **EXPLAIN** FIGURE 28-5 The meter leads should also be CAT III-rated when checking voltages on a hybrid electric vehicle.

16. SLIDE 16 **EXPLAIN** NOTE

DISCUSSION: Discuss CAT III-rated DMM. Why is a CAT III-certified DMM required for taking measurements on HEVs? **FIGURES 28-4 & 5**

DEMONSTRATION: Using a CAT III DMM, show students how to check a floating ground to identify a high-voltage leak. **FIGURES 28-4 & 5**

DISCUSSION: Discuss identifying colors used for high voltage cables. What does blue or yellow plastic conduit mean? What does orange plastic conduit mean?

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DISCUSSION: Discuss insulation testers (Fluke 1587). When is an electrical insulation tester used?

HANDS-ON TASK: Have the students wear insulated and leather gloves while trying to take a voltage reading using a CAT III DMM. Ask students to share their experience with the task.

ON-VEHICLE NATEF TASK: Identify location of hybrid vehicle high-voltage circuit disconnect (service plug) location and safety precautions.

17. SLIDE 17 **EXPLAIN** Electric Shock Potential

18. SLIDE 18 **EXPLAIN TECH TIP**

DEMONSTRATION: DEMO de-powering procedure on a Hybrid Electric Vehicle

Use a cooking timer with a bell alarm or some other audible signal as a way to know when the 10-minute waiting period for HV battery shutdown has passed.

DISCUSSION: Have students talk about when high voltage system needs to be de-powered & when it doesn't. When servicing a system that may contain high voltage, how can you be sure of whether or not it needs to be de-powered?

HANDS-ON TASK: Supervise students as they de-power vehicle.

19. SLIDE 19 **EXPLAIN FIGURE 28.6** The Ford Escape Hybrid instrument panel showing the vehicle in park and the tachometer on "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.

20. SLIDE 20 **EXPLAIN TECH TIP**

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21. SLIDE 21 **EXPLAIN** CHART 28.1 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.
22. SLIDE 22 **EXPLAIN** Electric Shock Potential
23. SLIDE 23 **EXPLAIN WARNING**

24. SLIDE 24 **EXPLAIN** De-Powering the High-Voltage System

25. SLIDE 25 **EXPLAIN** FREQUENTLY ASKED QUESTION
26. SLIDE 26 **EXPLAIN** De-Powering the High-Voltage System

27. SLIDE 27 **EXPLAIN WARNING**

28. SLIDE 28 **EXPLAIN** De-Powering the High-Voltage System
29. SLIDE 29 **EXPLAIN CAUTION**
30. SLIDE 30 **EXPLAIN** Collision and Repair Industry Issues
31. SLIDE 31 **EXPLAIN NOTE**
32. SLIDE 32 **EXPLAIN** Figure 28-7 Jump starting a 2001–2003 Toyota Prius using a 12-volt supply to boost the 12-volt auxiliary battery in the trunk.
33. SLIDE 33 **EXPLAIN** Figure 28-8 The underhood 12-volt jump-start terminal on this 2004+_ Toyota Prius has a red plastic cover with a “+” sign. The positive booster cable clamp will attach directly to the vertical metal bracket

DEMONSTRATION: Show students jump starting procedures on HEV. Review safety procedures for connecting & disconnecting jumper cables. Can jump box or jumper cable from another vehicle be used on high-voltage HV battery

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Ch 28 Hybrid Safety & Service Procedures pack? FIGURES 28-7 & 8

34. SLIDE 34 **EXPLAIN** Moving and Towing a Hybrid
35. SLIDE 35 **EXPLAIN** FIGURE 28-9 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.
36. SLIDE 36 **EXPLAIN** FIGURE 28-10 lock box is a safe location to keep the ignition keys of a hybrid electric vehicle while it is being serviced.
37. SLIDE 37 **EXPLAIN** FREQUENTLY ASKED QUESTION

DEMONSTRATION: Show procedure for moving & storing HEV waiting for parts to arrive.

HANDS-ON TASK: Have the students describe safety precautions that should be taken to work on HEVs. Grade them on thoroughness and a clear understanding of dangers that HEVs present and how those dangers can be addressed.

HANDS-ON TASK: Review importance of separating the keys from a hybrid vehicle to prevent an accidental start-up that could lead to personal injury. Have students create a metal lock box or research the cost of purchasing one.

ON-VEHICLE NATEF TASK: Identify high-voltage circuits of hybrid electric vehicles and related safety precautions.

ON-VEHICLE NATEF TASK: Identify hybrid vehicle A/C system electrical circuits

38. SLIDE 38 **EXPLAIN** Removing the High-Voltage Batteries

39. SLIDE 39 EXPLAIN TECH TIP

40. SLIDE 40 **EXPLAIN** Figure 28-11 Insulated tools, such as this socket set, would provide an additional margin of safety to the service technician when working

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around high-voltage components and systems

41. SLIDE 41 **EXPLAIN** Figure 28-12 The high-voltage wiring on this Honda hybrid is colored orange for easy identification

SAFETY Gather materials necessary for the students to create a **“High voltage—Do not touch”** sign that can be placed on roof of HEV that is being stored. **FIGURES 28-10, 11, & 12**

DEMONSTRATION: Show how to **identify lift points** for HEV from on-line service information. Using a floor jack/lift, raise vehicle and have the students take note of **areas of concern** on vehicle: **FIGURE 28-12**

HANDS-ON TASK: create a **“High voltage—Do not touch”** sign that can be placed on the roof of a hybrid vehicle that is being stored..

42. SLIDES 42-44 **EXPLAIN** Routine Service Procedures

45. SLIDE 45 **EXPLAIN** Figure 28-13 scan tool display showing two hybrid-related faults in this Ford Escape hybrid.

DISCUSSION: Have the students review the **eight-step diagnosis procedure**. Is diagnosing a hybrid electric vehicle different from diagnosing any other type of vehicle?

HANDS-ON TASK: Have students **lift an HEV** supervised by the instructor

ON-VEHICLE NATEF TASK: Identify hybrid engine service precautions

46. SLIDE 46 **EXPLAIN** FIGURE 28.14 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 engine (idle) stop feature

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DISCUSSION: discuss oil changes for HEVs. Why do most hybrid electric vehicles require either **SAE 0W-20** or **SAE 5W-20**? **FIGURE 28-14**

47. SLIDE 47 EXPLAIN REAL WORLD FIX

DISCUSSION: Have students talk about **cooling system service** for HEVs. What considerations for servicing an HEV cooling system may differ from those for servicing ICE cooling system?

DISCUSSION: Have the students discuss servicing the **air conditioning of an HEV**. What does the service technician need to know about the air conditioning compressor on HEV

DISCUSSION: Have the students talk about the **regenerative braking system** and base brakes used on hybrid electric cars. Why do base brakes on HEVs often get stuck or function incorrectly?

ON-VEHICLE NATEF TASK: Describe the operation of **HEV regenerative braking system**

DISCUSSION: Have the students discuss **rolling resistance**. How does replacing tires affect fuel economy?

48. SLIDE 48 **EXPLAIN** Routine Service Procedures

49. SLIDE 49 **EXPLAIN** Figure 28-15 This 12 volt battery under the hood on a Ford Fusion hybrid is a flooded cell type auxiliary battery

DISCUSSION: Have the students talk about **auxiliary battery service**. What is the proper charger to use when recharging an AGM battery? Can this charger also be used on regular lead acid battery? **FIGURE 28-15**

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QUESTION

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50. SLIDE 50 **EXPLAIN** Routine Service Procedures

51. SLIDE 51 **EXPLAIN NOTE**

52. SLIDES 52-63 **OPTIONAL EXPLAIN HV GLOVE USE 1-12**

DEMONSTRATION: Show the students how to **inspect, test, and store HV safety gloves and leather protectors.**

DISCUSSION: Have the students discuss the storage and **care of safety gloves.** What kinds of materials and products can damage rubber gloves?