

STRANDS AND STANDARDS

ELECTRIC VEHICLE SAFETY AND TECHNOLOGY



Course Description

Electric Vehicles present unique challenges when servicing. This course addresses safety mechanisms in place, the electrical principles involved, and other emerging technologies in the transportation sector.

Intended Grade Level	10-12
Units of Credit	0.5
Core Code	40.09.00.00.027
Concurrent Enrollment Core Code	40.09.00.13.027
Prerequisite	ASE Electrical/Electronics
Skill Certification Test Number	
Test Weight	
License Area of Concentration	CTE and/or Secondary Education 6-12
Required Endorsement(s)	
Endorsement 1	Automotive Service
Endorsement 2	N/A
Endorsement 3	N/A

STRAND 1

Safety

Students will understand and demonstrate electric vehicle and shop safety.

Standard 1

Personal Protective Equipment (PPE)

Students will learn safe working habits and procedures and pass an electric vehicle and technology safety test with 100% accuracy.

- Personal safety
- Tool and equipment safety
- Workplace safety
- Understand the proper use of personal protective equipment (PPE)
- Know appropriate gloves for high voltage applications
- Know the appropriate glove validation procedures and tests (leak check, expiration, etc.)
- Identify proper footwear for high voltage applications
- Identify proper eyewear and/or face shields for high voltage applications. Resources: Light Duty Hybrid/Electric Vehicle Specialist ASE L3 https://www.ase.com/uploads/L3Studyguide2021_210112_141628.pdf

Standard 2

Safe Work Area

Comply with safety rules for working with electric and hybrid vehicles. Identify an appropriate work area of high voltage vehicles.

- Demonstrate proper use of cones, barriers, and ground markings for high voltage service of vehicles.
- Describe a proper location for storage of vehicle keys for preventing accidental vehicle startup.
- Demonstrate proper use of emergency response equipment (insulated rescue hook, etc.)
- Identify proper lift points on an electric or hybrid vehicle.
- Identify proper towing points and procedures on an electric or hybrid vehicle.

Standard 3

High Voltage Safety & Identification

Students will be able to identify safety concerns and high voltage warning labels when working with hybrid or electric vehicles.

- Identify high voltage wiring in an electric or hybrid vehicle (wire color variations and meanings)
- Identify the purpose and location of high voltage service disconnect.
- Understand proper fire response in a case of an emergency.
- Explain potential hazards of traditional firefighting techniques for high voltage vehicles.
- Understand and explain proper procedures in the event of an accidental electric shock.

Performance Skills

- Pass the electric vehicle safety test with 100% accuracy.
- Demonstrate proper use of cones, barriers, and ground markings for high voltage service of vehicles.
- Demonstrate proper use of emergency response equipment (insulated rescue hook, etc.)
- Demonstrate a proper high voltage glove inspection.
- Demonstrate proper lift procedures for electric and hybrid vehicles.

STRAND 2

Tools

Students will be able to identify and understand tools related to high voltage vehicles.

Standard 1

Safety Kit

Students will be able to identify tools used in a high voltage service and safety kit.

- Understand and identify glove use associated with hybrid electric vehicle (HEV) service and repair.
- Understand the purpose and use of cotton-lined, insulated rubber, and leather outer-protective gloves.
- Understand how to test and inspect gloves, including expiration dates and test for leaks.
- Understand expiration time on glove inspection and read their stamped date.
- Understand leak tests on glove inspections (roll up method, pump method, etc.)
- Understand and identify purpose and use of an insulated safety hook and its location.
- Understand and identify cones and safety barriers.
- Understand and identify approved eye protection used for servicing and repair of hybrid electric vehicles.

Standard 2

Key Storage

Students will be able to understand and identify proper key storage and lockout options.

- Understand and identify location and purpose of lockboxes and lockout options.
- Understand and identify the purpose of key isolation.

Standard 3

Insulated Tools

Students will be able to understand and identify tools related to hybrid electric vehicle (HEV) service.

- Understand and identify classification and rating of high voltage tools.
- Understand and identify purpose and use of coated tools.
- Understand and identify purpose and use of composite tools.
- Understand and maintain HEV tools.

Standard 4

Diagnosing & Testing Equipment

Students will be able to understand and identify use of diagnostic and testing equipment for hybrid electric vehicle (HEV) service.

- Understand and use scan tools for diagnostic requirements.
- Understand and identify use and storage of Digital Multimeters (class 3 meter and leads).
- Understand and identify purpose of Isolation Testers rated for HEV service in Mega Ohms.

Standard 5

Service Information

Students will be able to use and access hybrid electric vehicle (HEV) service information using online resources.

- Properly use online service information that relates to HEV service.

Standard 6

Cooling Systems Tools

Students will be able to understand and identify the use of cooling system tools specific to hybrid electric vehicle (HEV) service.

- Understand and identify how to properly fill and bleed cooling systems.
- Understand and identify coolant concentration using a hydrometer and refractometer.

Performance Skills

- Demonstrate proper lockout procedures (vehicle key location).
- Identify proper tool usage for HEVs.
- Demonstrate proper Digital Multimeter (DMM) settings and usage (range selection).

STRAND 3

Battery Systems

Students will be able to identify the types of batteries used in electric and hybrid vehicles.

Standard 1

Low Voltage Auxiliary

Students will be able to inspect and test the low voltage battery system.

- Confirm proper battery capacity, size, type, and application for vehicle.
- Maintain or restore electronic memory functions as recommended by manufacturer.
- Inspect and clean low voltage battery, cable, connectors, clamps, and hold downs.

Standard 2

High Voltage Battery

Students will be able to identify the types of high voltage batteries used in hybrid electric vehicles (HEV).

- Understand the composition of materials used in high voltage batteries.
- Understand the chemistry of various high voltage batteries (nickel metal hydride, lithium ion, lithium polymer, etc.)
- Understand the series and parallel method used to produce high voltage battery modules.

Standard 3

Jump Starts

Students will be able to properly and safely jump start the low voltage auxiliary battery on a hybrid or electric vehicle (HEV).

- Demonstrate or describe the appropriate procedures for jump starting the low voltage auxiliary battery on an HEV.

Standard 4

State of Charge

Students will be able to perform a battery state of charge test and determine needed action.

- Demonstrate the proper procedure for measuring the battery state of charge using a Digital Multimeter (DMM) on the low voltage Auxiliary battery.
- Demonstrate the proper procedure for measuring the high voltage system using a scan tool.

Standard 5

Cooling

Students will be able to understand the different cooling systems used in cooling the high voltage battery and components.

- Identify and inspect the coolant level for the high voltage system.
- Inspect the battery cooling system for leaks.

Standard 6

Loss of Isolation

Students will be able to describe the conditions that cause a loss of isolation on hybrid/electric vehicles (HEV).

- Understand the safety concerns related to loss of isolation (electrocution, fire, etc.)

Performance Skills

- Perform a high voltage system coolant fluid check
- Retrieve/diagnose Diagnostic Trouble Codes (DTCs) related to the high voltage system concerns.
- Jump start a low voltage system in an HEV.
- Remove and replace an auxiliary battery.
- Locate or replace a high voltage battery air filter.
- Perform high voltage service disconnection procedure.

STRAND 4**Internal Combustion**

Students will be able to identify the role of an internal combustion engine in a hybrid electric vehicle (HEV).

Standard 1

Retrieve & Diagnose Diagnostic Trouble Codes (DTCs)

Students will be able to retrieve and diagnose the DTCs on an HEV.

- Demonstrate the procedure for retrieving and diagnosing DTCs using a scan tool on an HEV.

Standard 2

Modes & Shutdown

Students will be able to identify the different modes of operations found on an electric/hybrid vehicle (HEV).

- Understand the meaning of ready mode and the consequences of servicing an HEV without placing it in shutdown mode.

Standard 3

Cooling System Differentiations

Students will be able to identify the different types of cooling systems found on a hybrid/electric vehicle (HEV).

- Describe the purpose of the cooling system for high voltage system components.

Standard 4

Start & Stop Technology

Students will be able to identify the components and advantages of a vehicle with start and stop technology.

- Identify the components used in a start and stop vehicle (manufacture-specific components).
- Inspect belts and tensioners on a belt alternator starter (BAS) system.

Standard 5

No Start Diagnosis

Students will be able to identify leading causes for no start conditions in a hybrid vehicle.

- List the leading causes for a no start condition (crank no start, or no crank, no start, etc.)
- Retrieve diagnostic trouble codes (DTCs) associated with no start conditions.

Performance Skills

- Perform an oil change on a hybrid vehicle.
- Retrieve and diagnose DTCs related to hybrid vehicles.
- Perform belt inspection with a groove gauge tool.
- Optional enrichment activity: perform a compression test.

STRAND 5

Drive Systems

Students will be able to identify and describe hybrid electric vehicle (HEV) drive system components.

Standard 1

Transmission Service Procedures for Fluid Inspection

Students will be able to identify and describe fluid service and inspection in hybrid electric vehicles (HEV).

- Identify and describe procedures for servicing and inspecting HEV drive systems.
- Identify and describe fluid considerations for HEV drive systems.
- Identify specific fluid components related to HEVs (manufacturer-specific fluids).

Standard 2

Types

Students will be able to identify and describe basic drive system layouts.

- Identify and describe the difference between drive types 1, 2, and 3 (identified in the ASE L3 blueprint; see resource below)
- Identify and describe what a Plug in Hybrid Electric Vehicle (PHEV) is.
- Identify what a Battery Electric Vehicle (BEV) is.
- Identify and describe a Fuel Cell Electric Vehicle (Hydrogen cell)
- Identify and describe the Belt Alternator Starter (BAS) system. Resources: Light Duty Hybrid/Electric Vehicle Specialist ASE L3

Standard 3

Retrieve & Diagnose Diagnostic Trouble Codes (DTCs)

Students will be able to identify and describe how to retrieve and diagnose DTCs.

- Identify and describe how to retrieve DTCs related to HEVs
- Identify and describe how to find and use diagnostic flowcharts.
- Identify and describe needed diagnostic steps based on diagnostic trouble codes.

Standard 4

Harnesses & Terminal Inspection

Students will be able to identify and describe problems caused by damaged and failed harnesses and connectors.

- Identify and describe proper terminal inspection procedures.
- Identify and describe wiring harness inspection procedures.
- Identify and describe wiring harness isolation testing procedures.

Standard 5

Regenerative Braking Systems & Drive Modes

Students will be able to identify and describe regenerative braking and charging systems.

- Identify and describe procedures to deactivate the brake system self-test.
- Identify and describe operations and methods of regenerative braking.

- Identify and describe drive modes used in hybrid vehicles.
- Identify and describe power flow used in hybrid vehicles.
- Identify and describe placing vehicles in various service modes (place in run, service, etc.).

Performance Skills

- Verify fluid levels for transmission.
- Identify various types of drive systems (type 1, type 2, type 3, etc.).
- Retrieve & diagnose DTCs related to drive systems.
- Visually inspect harness & terminal conditions.
- Place vehicle in various service modes (place in run, service, etc.).

STRAND 6

Power Electronics

Students will be able to identify the high voltage systems and components on a hybrid or electric vehicle (HEV).

Standard 1

Alternating Current/Direct Current (AC/DC) Differentiation

Students will be able to describe the difference between AC and DC voltage.

- Describe alternating current.
- Describe direct current.

Standard 2

Inverters (AC to DC)

- Describe the purpose of the high voltage AC to DC inverter on an HEV.
- Describe the purpose of the high voltage AC to DC inverter on an HEV.

Standard 3

Converters (DC to DC)

Students will be able to describe the purpose of the high voltage DC to DC converter on an HEV.

- Describe the purpose of the high voltage DC to DC converters on an HEV.

Standard 4

Retrieve & Diagnose Diagnostic Trouble Codes (DTCs)

Students will be able to retrieve and diagnose DTCs related to the high voltage system components.

- Retrieve and diagnose DTCs related to the high voltage system components.

Standard 5

Cable Routing Identification

Students will be able to identify the high voltage cable routing between high voltage systems found on a hybrid and electric vehicle.

- Identify the high voltage cable routing between high voltage systems found on an HEV.
- Understand the dangers and hazards associated with high voltage wiring.

Standard 6

Motor Control

Students will be able to describe the various types of electrical motors used on an HEV.

- Describe the various types of electrical motors used on an HEV (type 1, type 2, type 3, etc.)

Standard 7

Change Control

Students will be able to describe the operational characteristics of the change controller.

- Describe the purpose and operation of the characteristics of the change controller (heat management, current flow, etc.)
- Verify charger interface and operation.

Standard 8

Contactors

Students will be able to describe the operational characteristics of high voltage contactors and their role in isolating the high voltage battery.

- Describe the operational characteristics of high voltage contactors and their role in isolating the high voltage battery.

Standard 9

On-Vehicle Charging

Students will be able to describe on-vehicle charging of high voltage batteries on HEVs.

- Describe the standards found in SAE standard J1772
- Describe the process and disadvantages for fast charging an electric vehicle with a DC fast charger (cost, availability, safety, etc.)
- Identify the various types of electric vehicle chargers used (Level 1 (120volt), Level 2 (240volt), Level 3 (DC Fast Charge)).
- Describe the purpose and process for battery conditioning prior to charging (manufacturer's recommended procedure).
- Performance Skills
- Retrieve & Diagnose DTCs related to electric propulsion vehicles.
- Identify various types of motor used in hybrid and electric vehicles.
- Identify AC/DC related components.
- Optional enrichment activity: safely connect a charger to an electric vehicle.

STRAND 7**Hybrid Supporting Systems**

Students will be able to identify and understand the hybrid supporting systems.

Standard 1

Heating, Ventilation, and Air Conditioning (HVAC)

Students will be able to identify the unique components found on a hybrid or electric vehicle (HEV) for the HVAC system.

- Identify the unique characteristics of the oil found in A/C refrigerant for HEVs (non-conductive oil, etc.)
- Identify the characteristics of the heating system found on an HEV.
- Describe the role of the HVAC system related to high voltage battery conditioning and temperature in hot and cold climates.

Standard 2

Electric Steering Systems

Students will be able to describe the operation and components related to the electric steering system.

- Describe the operation and components related to the electric steering system.
- Describe voltages used in steering systems (12v, 42v, etc.)

Standard 3

Information Management

Students will be able to describe the interface options available to the driver related to the HEV systems operation.

- Navigate the HEV information system related to the battery management system.
- Navigate the HEV information system related to vehicle range ability

Standard 4

Charging Infrastructure

Students will be able to identify and understand charging systems and requirements, electricity generation, infrastructure requirements, as well as limitations and locations of charging stations.

- Identify and describe ability to find local charging stations.
- Identify and describe how electricity is generated and where.
- Identify and understand charge times.

Performance Skills

- Remove and replace the cabin air filter
- Navigate an information system (battery maintenance, power flow, etc.)
- Electric Vehicle Safety & Technology Workplace Skills
- Students will participate in personal and leadership development activities through SkillsUSA or another appropriate career and technical student organization.
- Understand when it is appropriate to listen and to speak
- Understand and follow verbal and written instructions for classroom and laboratory activities.
- Identify and understand different roles when working with a team.
- Analyze the cause of a problem
- Develop a solution to address a problem.
- Implement a plan in addressing a problem.
- Evaluate the effectiveness of a plan in addressing a problem.
- Set and meet goals on attendance and punctuality.
- Prioritize, plan, and manage work to complete assignments and projects on time.
- Use an achievement chart for activities and behaviors in class that encourages a personal evaluation of classroom performance.
- File a regular written report on progress toward completion of assignments and projects.
- Be familiar with the course disclosure statement and all requirements for successful completion of the course.
- Demonstrate workplace ethics (fairness, honesty, discipline, etc.)

Skill Certification Test Points by Strand

Test Name	Test #	Number of Test Points by Strand										Total Points	Total Questions	
		1	2	3	4	5	6	7	8	9	10			