Electrical Systems B (2020)

Course Plan

Course Details

Certification: Emergency Vehicle Technician 2

CTS Guide: Emergency Vehicle Technician (2020)

Description: This course provides an overview of the knowledge and skills needed to repair low-voltage electrical systems, and inspect, maintain, and repair electronic controls and instrumentation in emergency vehicles

Designed For: The SFT-certified Emergency Vehicle Technician (EVT) 1 advancing to EVT 2 or anyone seeking an overview of electronic controls and instrumentation

Prerequisites: Emergency Vehicle Technician 1B: Electrical Systems A

Standard: Complete all activities and formative tests.

Complete all summative tests with a minimum score of 80%.

Hours: Lecture: 19:00

Activities: 15:00

Testing: 2:00

Hours (Total): 36:00

Maximum Class Size: 20

Instructor Level: Primary

Instructor/Student Ratio: 1/20

Restrictions: Increasing class size requires an additional qualified instructor

SFT Designation: CFSTES

Instructor Resources

To teach this course, instructors need:

- *Medium/Heavy Duty Truck Electricity and Electronics* (1st edition)
  - Classroom manual and shop manual
  - Author: Sulev Oun
  - ISBN 13: 978-0827370067
  - One copy of each item per student + a personal copy for the instructor
- Student Supplement
  - Provided by California Fire Mechanics Academy, Inc.
- Personal protective equipment (PPE)

Online Instructor Resources

The following instructor resources are available online at https://osfm.fire.ca.gov/divisions/state-fire-training/cfstes-professional-certification/:

- Activity 2-2: Testing Electrical Systems and Electronic Controls

Student Resources

To participate in this course, students need:

- *Medium/Heavy Duty Truck Electricity and Electronics* (1st edition)
  - Classroom manual and shop manual
  - Author: Sulev Oun
  - ISBN 13: 978-0827370067
  - Provided by instructor for in-class use
- Student Supplement
  - Provided by California Fire Mechanics Academy, Inc.
- Personal protective equipment (PPE)
  - Student must bring to class
- Digital multimeter (DVOM)
  - Student must bring to class

Facilities, Equipment, and Personnel

The following facilities, equipment, or personnel are required to deliver this course:

Facilities

- Standard classroom equipped for 20 students
- Projector with appropriate laptop connections
- Wifi/Internet access
- Outdoor space for emergency response vehicle with a clear perimeter for student activities

Equipment

- Emergency response vehicle
- Schematics
    - Digital or physical
    - Must correspond to an onsite emergency response vehicle
- Low-voltage electrical systems (test, calibration, and diagnostic equipment, and tools)
    - Digital voltmeter (DVOM)
    - Ammeter
    - Battery testers
    - Power probes / powered test lights
    - Test lights
    - Test leads
    - Digital storage oscilloscopes (DSO)
    - Scanners
    - Relay substitution device
    - Soldering equipment
    - Crimping equipment
    - Remote start switches
    - Remote power supplies
    - Wire strippers
- Electronic controls and instrumentation (test, calibration, and diagnostic equipment, and tools)
    - Working alternator model
    - Working starter model
    - Working multiplex model
- Activity 2-1
    - Four different solenoids (at least four sets of each)
    - DVOM
    - Power Probe™ or jumper test lead
- Activity 2-2: Testing Electrical Systems and Electronic Controls
    - DVOM
    - Ammeter
    - Fuse-resistance chart

Unit 1: Introduction

Topic 1-1: Orientation and Administration

Terminal Learning Objective

At the end of this topic, a student will be able to identify facility and classroom requirements and identify course objectives, events, requirements, assignments, activities, resources, evaluation methods, and participation requirements in the course syllabus.

Enabling Learning Objectives

1. Identify facility requirements
    - Restroom locations
    - Food locations
    - Smoking locations
    - Emergency procedures
2. Identify classroom requirements
    - Start and end times
    - Breaks
    - Electronic device policies
    - Special needs and accommodations
    - Other requirements as applicable
3. Review course syllabus
    - Course objectives
    - Calendar of events
    - Course requirements
    - Student evaluation process
    - Assignments
    - Activities
    - Required student resources
    - Class participation requirements

Discussion Questions

1. What is a formative test? What is a summative test?

Activities

1. To be determined by the instructor.

Topic 1-2: Emergency Vehicle Technician Certification Process

Terminal Learning Objective

At the end of this topic, a student will be able to identify different levels in the Emergency Vehicle Technician certification track, the courses and requirements for State Fire Training (SFT) Emergency Vehicle Technician (EVT) certification, and can describe the task book and testing process.

Enabling Learning Objectives

1. Identify the different levels of certification in the Emergency Vehicle Technician (EVT) certification track
   - EVT 1
   - EVT 2
   - EVT 3
2. Identify the SFT courses required for EVT 1
   - State Fire Training
     - Emergency Vehicle Technician 1A: Chassis, Cab, Body, Tank and Accessories (2020)
     - Emergency Vehicle Technician 1B: Electrical Systems A (2020)
     - Emergency Vehicle Technician 1C: Pumps and Accessories (2020)
3. Identify the SFT courses required for EVT 2
   - State Fire Training
     - Emergency Vehicle Technician 2A: Electrical Systems B (2020)
4. Identify the SFT courses required for EVT 3
   - State Fire Training
     - Emergency Vehicle Technician 3A: Human Resource Management / Fleet Specifications and Records (2020)
5. Identify additional requirements for Emergency Vehicle Technician 1
   - Experience (one of the following)
     - Have a minimum of two (2) years full-time, paid experience in a California fire department, public agency, or private industry as an automotive or truck mechanic, with one (1) year of which must be related to the maintenance of emergency response vehicles; or
     - Have a minimum of three (3) years full-time, paid experience in a California fire department, public agency, or private industry as a truck mechanic with no emergency response vehicles required; or
     - Have a minimum of four (4) years volunteer time or paid part-time, paid experience in a California fire department, public agency, or private industry as a truck mechanic with primary duties performing as a truck mechanic.
6. Identify additional requirements for Emergency Vehicle Technician 2
   - Experience (one of the following)
     - Have a minimum of three (3) years full-time, paid experience in a California fire department, public agency, or private industry as an automotive or truck mechanic, with one (1) year of which must be related to the maintenance of emergency response vehicles; or
     - Have a minimum of four (4) years full-time, paid experience in a California fire department, public agency, or private industry as a truck mechanic with no emergency response vehicles required; or
     - Have a minimum of five (5) years volunteer time or paid part-time, paid experience in a California fire department, public agency, or private industry as a truck mechanic with primary duties performing as a truck mechanic.

7. Identify additional requirements for Emergency Vehicle Technician 3
    - Have a minimum of four (4) years full-time, paid experience in a California fire department, public agency, or private industry as an automotive or truck mechanic, with one (1) year of which must be related to the maintenance of emergency response vehicles; or
    - Have a minimum of five (5) years full-time, paid experience in a California fire department, public agency, or private industry as a truck mechanic with no emergency response vehicles required; or
    - Have a minimum of six (6) years volunteer time or paid part-time, paid experience in a California fire department, public agency, or private industry as a truck mechanic with primary duties performing as a truck mechanic.
8. The following requirements are required for each EVT 1, EVT 2, and EVT 3
    - Code of Federal Regulations (CFR) 396.25: Department of Transportation Brake Inspector Qualification
    - Successful completion of the CFMA Certification Exam or CFMA Recertification Exam for the respective SFT Level of Certification. This exam is administered by the California Fire Mechanics Academy (CFMA).
    - EVT 1 Requires the following ASE Certifications:
      National Institute for Auto Service Excellence (ASE)
        - Gasoline Engines [T1]
        - Diesel Engines [T2]
        - Drive Train [T3]
        - Brakes [T4]
        - Suspension and Steering [T5]
        - Preventative Maintenance Inspections [T8]
    - EVT 2 and EVT 3 Requires the following ASE Certifications:
      National Institute for Auto Service Excellence (ASE)
        - Gasoline Engines (T1)
        - Diesel Engines (T2)
        - Drive Train (T3)
        - Brakes (T4)
        - Suspension and Steering (T5)
        - Electrical / Electronic Systems (T6)
        - Heating, Ventilation and Air Conditioning (HVAC) (T7)
        - Preventative Maintenance Inspections (T8)
9. Describe the task book process
    - Complete all prerequisites and course work
    - Complete all job performance requirements included in the task book
    - Must have identified evaluator verify individual task completion via signature
    - Submit application and fees
        - A candidate may apply for the EVT 1, EVT 2, and EVT 3 task books at the same time (three applications and three fees)

    - Shall not submit the EVT 2 task book until he or she receives EVT 1 certification (a prerequisite for EVT 2)
    - Shall not submit the EVT 3 task book until he or she receives EVT 2 certification (a prerequisite for EVT 3)
  - Must have Fire Chief or authorized representative verify task book completion via signature
  - Must be employed by a California Fire Agency or be in a position as a volunteer or paid part-time, in a California fire department, or public agency, or private industry as a truck mechanic with primary duties performing as a truck mechanic as noted above for experience.
  - This experience must be documented prior to submitting completed task book to State Fire Training
10. Complete Continuing Education
  - Persons with EVT Certification are required to renew their certification every five years. The recertification requires that the applicant completes 36 hours of approved continuing education (CE) and meet all prerequisites stated for Recertification Requirements. All recertification applications must be postmarked on or before the certification expiration date. If the certified EVT did not meet all recertification requirements by the expiration date, the EVT Certification is considered to be lapsed.
  - If the EVT Certification lapsed, the applicant will be required to complete 36 hours of CE in addition to the completion of additional CE hours. If the certification lapsed less than 6 months, you can regain EVT Certification by completing an additional 8 hours of approved CE. If the certification lapsed between 6 months and less than 12 months, you can regain EVT Certification by completing an additional 16 hours of approved CE. If the certification lapsed between 12 months and less than 18 months, you can regain EVT Certification by completing an additional 24 hours of approved CE.
  - For expiration, greater than 18 months, the applicant will need to reapply for initial EVT 1 certification which includes successful completion of the EVT certification exam and completion of a new Certification Task Book.
11. Complete all formative and summative tests administered during the course deliveries

Discussion Questions

1. To be determined by the instructor

Activities

1. To be determined by the instructor

Instructor Notes

1. SFT teaches most EVT 1 (inspect and maintain) and EVT 2 (repair and replace) content together because depending on the size of the agency or shop, there are different expectations of the technician.

Instructor Notes

1. SFT teaches most EVT I (inspect and maintain) and EVT II (repair and replace) content together because depending on the size of the agency or shop, there are different expectations of the technician.

Unit 2: Low-voltage Electrical Systems

Topic 2-1: Repairing Low-voltage Electrical Systems

Terminal Learning Objective

At the end of this topic, a student, given an emergency response vehicle, manufacturer specifications, an assignment or inspection report detailing a deficiency or deformation, SOPs, test, calibration, and diagnostic equipment, and tools, will be able to perform repairs on low-voltage electrical system components so that defective components are diagnosed; deformed, broken, loose, worn, or missing parts are repaired, replaced, or rebuilt to manufacturer specifications; charging systems, starting systems, lighting systems, electrical accessories, and other electrical systems are returned to operation; correct test equipment is used; hazards are avoided; correct parts are used; diagnostic checks are conducted and performance is verified; and repairs are documented in accordance with the procedures of the manufacturer and the authority having jurisdiction (AHJ)

Enabling Learning Objectives

1. Describe the theory of electricity
2. Describe the function, construction, and operation of starting motors, alternators, and accessory electric motors, relays, solenoids, and regulators
3. Describe repair and overhaul procedures
4. Describe operational, diagnostic, and performance tests
5. Describe adjustment and calibration procedures
6. Describe how to select test, calibration, and diagnostic equipment
7. Identify common defects
8. Describe electrical troubleshooting procedures
9. Identify record-keeping requirements
10. Describe the diagnostic and repair procedures of the manufacturer and the AHJ
11. Recognize, evaluate, and identify reported conditions
12. Perform required repairs to resolve deficiencies
13. Use test, calibration, and diagnostic equipment
14. Measure voltage, amperage, and resistance
15. Distinguish defects and deficiencies
16. Operate and test system
17. Perform electrical calculations
18. Complete required documentation

Discussion Questions

1. What type of electrical problems have you experienced with your fleet?
   - How did you resolve them?
2. What does a digital multimeter measure?
   - What does a DVOM not measure?
3. What high-voltage safety concerns must you address when working with electrical systems?
4. What is the difference between a relay and a solenoid?

- How would you confirm whether you had an intermittent duty or continuous duty solenoid?

Activities

1. Given at least four different solenoids, a DVOM, and a Power Probe™ or jumper test lead, have students determine the following for each solenoid:
   - Is it good?
   - How would it work?
   - Is it intermittent duty or continuous duty?

Instructor Notes

1. Topic 2-1 is a review of Emergency Vehicle Technician 1B: Electrical Systems A (units 2 and 3)

CTS Guide Reference: CTS 8-1

Topic 2-2: Testing Low-voltage Electrical Systems

Terminal Learning Objective

At the end of this topic, a student, given an emergency response vehicle, manufacturer specifications, SOPs, test, calibration, and diagnostic equipment, and tools, will be able to complete performance testing on low-voltage electrical system components including batteries, charging systems, starting systems, electrical loads, solenoids, and relay devices in accordance with NFPA 1911 so that components are performance tested to assure they are operating in accordance with manufacturer specifications and NFPA standards; performance tests are conducted to verify that repairs are completed; and all testing is documented in accordance with the procedures of the manufacturer and the authority having jurisdiction (AHJ)

Enabling Learning Objectives

1. Describe operational, diagnostic checks, and performance tests
2. Describe adjustment and calibration procedures
3. Describe how to select test, calibration, and diagnostic equipment
4. Describe how to test sensors, components, and systems
   - Chassis voltage systems
     - A relay system
     - A solenoid system
     - A lighting system
     - A starting system
     - A charging system
     - A DC motor system
     - A warning system
   - Parasitic loads
     - Vehicle-based
     - Agency/body builder-added
5. Identify common defects
6. Describe electrical troubleshooting procedures

7. Identify record-keeping requirements
8. Describe the diagnostic and repair procedures of the manufacturer and the AHJ
9. Recognize, evaluate, and identify reported conditions
10. Perform required repairs to resolve deficiencies
11. Use test, calibration, and diagnostic equipment
12. Measure voltage, amperage, and resistance
13. Distinguish defects and deficiencies
14. Operate and diagnostically check system and performance tests
15. Perform electrical calculations
16. Complete required documentation in accordance with NFPA standards and the AHJ

Discussion Questions

1. Determined by instructor

Activities

1. Activity 2-2: Testing Electrical Systems and Electronic Controls
   - Chassis Voltage Systems
   - Parasitic Loads
   - Individual Circuit Loads

Instructor Notes

1. ELO 4: Recommend using the schematics for the vehicle used for the course to demonstrate measurement location and technique.
2. ELO 9-16 – Covered by activity.

CTS Guide Reference: CTS 8-2

Unit 3: Electronic Controls and Instrumentation

Topic 3-1: Inspecting Electronic Controls and Instrumentation

Terminal Learning Objective

At the end of this topic, a student, given an emergency response vehicle, SOPs, manufacturer specifications, tools, test, calibration, and diagnostic equipment, schematics, and an inspection checklist, will be able to inspect the electronic controls and instrumentation so that the mounting security is verified; operation and condition of the electronic control system is verified to be within manufacturer specifications; all checklist items are inspected; defects and deficiencies, including broken, loose, worn, or missing parts, are identified and reported; and inspection and tests are documented in accordance with the procedures of the manufacturer and the authority having jurisdiction (AHJ)

Enabling Learning Objectives

1. Describe how the principles of magnetism apply to electronic control devices
   - Magnetic fields
   - Impacts of magnetic fields
   - Proper wire routing
2. Describe how the principles of electricity apply to electronic control devices
   - Kirchhoff’s laws

- Watt's law
- Ohm's law
- Series and parallel circuits
- Shared current paths

3. Describe the principles of circuit analysis
   - Difference in potential (flowing vs. not flowing)
   - Application of Kirchhoff's laws
   - Application of Ohm's law
   - Application of Watt's law
   - Parasitic drain
1. Describe the function, construction, operation, and requirements of:
   - Electronic engine
     - Input, output, and regulations devices
   - Transmission
     - Input, output, and regulation devices
   - Brake controls
     - Input, output, and regulation devices
2. Describe the function, construction, operation, and requirements of:
   - Instrumentation
   - Load control devices
   - Sequencers
   - Interfaces
   - Interlocks
3. Describe how to select test, calibration, and diagnostic equipment
   - Digital voltmeter (DVOM)
   - Ammeter
     - Inductive
       - Low amperage (< 100 A)
       - High amperage (</= 1,000 A)
     - Series
       - Shunt or direct wire
       - Fuse replacement ammeter
   - Battery testers
     - Carbon pile
     - Conductance / battery impedance testers
   - Power probes / powered test lights
     - Benefits
       - Ability to power a device
       - Ease of use
     - Problems
       - Excess voltage to delicate computer circuits
       - Piercing

- Test leads
    - Quality is critical
    - Various lengths and sizes
    - Coiled or extendable
    - Auxiliary meter leads
- Digital storage oscilloscopes (DSO)
- Scanners
    - Code readers
    - Manufacture specific
    - Bi-directional
    - Laptop with interface
- Relay substitution device
- Soldering equipment
    - 100W (medium sized electrical, base wiring, lighting systems, etc.)
    - Temperature controlled (< 25W) (circuit boards, power distribution systems, computers, etc.)
    - Battery powered
    - Torch (propane, mapp, etc.)
    - Rosin-core solder
- Crimping equipment
    - Correct crimper for device
    - Manufacturer specific
    - Hydraulic
    - Manual ratcheting
- Remote start switches
    - Safety concerns during use
- Remote power supplies
    - Battery chargers
    - Jump batteries (traditional and lightweight)
    - Bench test power supplies (adjustable current and voltage)
    - Auxiliary electronic control module/unit (ECM / ECU) power supply
- Wire strippers

4. Describe test, calibration, and diagnostic equipment to avoid
    - Test lights
        - Benefits
            - Ease of use
            - Very fast
        - Problems
            - Overloading sensitive electronics
            - Trigger low amperage devices
            - Piercing
            - No accurate readings

    - Safety
        - Understand impacts of misuse (energizing relays, etc.)
5. Use test, calibration, and diagnostic equipment
6. Describe how to use a DVOM and electronic readers
    - Challenges with 5-volt reference and control circuits
7. Describe how to test sensors, components, and systems
8. Describe how to interpret fault codes
    - Generic
    - Enhanced (manufacturer specific)
9. List types of defects, deficiencies, and potential problems associated with electronic controls and instrumentation
    - Open circuit
    - Short to power
    - Short to ground
    - Cross short
    - Excessive resistance
    - Shielding and cable routing
10. Determine defects and deficiencies
    - Troubleshooting
    - Design deficiencies
11. Describe how to read and interpret schematics
    - Basic schematic symbols
    - Manufacturer-specific schematic symbols
    - As-built schematics (per vehicle)
12. Read and interpret schematics
13. Identify mounting and adjustment requirements
14. Recognize and identify potential failure symptoms and conditions of electronic controls and instrumentation
    - Smoke (sight or smell)
    - Improper charging (too high or two low / AC voltage issues)
    - Failure to function
    - Onboard chargers instrumentation reading outside parameters
    - Operator error
    - Arcing and sparking
15. Describe the inspection procedures of the manufacturer and the AHJ
    - Gather tools and safety equipment
    - Secure vehicle in a safe environment
    - Set parking brake
    - Place wheel chocks
    - Inspect impact of low-voltage electrical system on electronic controls and instrumentation
        - Recognize and identify symptoms and conditions

    - Determine defects, deficiencies, and potential problems
    - Determine impact if not corrected
  - Complete manufacturer and AHJ inspection checklist
  - Perform operational tests
  - Complete checklist and inspection documentation
  - Release vehicle for in-service use or maintenance/repair
16. Recognize and identify symptoms and conditions of electronic control and instrumentation issues
17. Determine defects, deficiencies, and potential problems
18. Perform operational tests
19. Identify record-keeping requirements
20. Complete checklist and inspection documentation

Discussion Questions

1. What impact does voltage drop have on electronic control circuits?
2. What problems can using the wrong test equipment create?
3. What safety concerns are associated with using electronic control interlocks?
4. How does vehicle parasitic drain related to electronic controls?
5. How does agency/body builder based parasitic dram relate to electronic controls?

Activities

1. Determined by instructor

CTS Guide Reference: CTS 8-3

Topic 3-2: Maintaining Electronic Controls and Instrumentation

Terminal Learning Objective

At the end of this topic, a student, given an emergency response vehicle, manufacturer specifications, a maintenance schedule or assignment, a maintenance checklist, SOPs, test, calibration, and diagnostic equipment, and tools, will be able to perform maintenance on the electronic controls and instrumentation so that deformed, broken, loose, worn, or missing parts are repaired or replaced; the operational condition is preserved or restored; calibration and adjustments are performed; activities are documented; and additional repair needs are reported

Enabling Learning Objectives

1. Describe troubleshooting and adjustment methods and procedures
   - Corrosion
     - Clean
     - Correct cause (if possible)
     - Recoat or repaint (if necessary)
   - Faulty connections
     - Clean
     - Tighten
     - Rewire
     - Replace

- Low or high voltage
    - Adjust
    - Replace
    - Rebuild
    - Send for repair
- Deformed, broken, loose, worn, missing, or failed components
    - Tighten
    - Replace
    - Adjust
    - Send for repair

2. Evaluate reported conditions
3. Use test, calibration, and diagnostic equipment
4. Perform operational tests
5. Perform all required maintenance, including all items on a maintenance checklist
6. Correct deficiencies
7. Complete required documentation

Discussion Questions

1. How does the voltage drop on an electronic control system differ from the voltage drop on a 12-volt electrical chassis circuit?

Activities

1. Determined by instructor

CTS Guide Reference: CTS 8-4

Topic 3-3: Repairing Electronic Controls and Instrumentation

Terminal Learning Objective

At the end of this topic, a student, given an emergency response vehicle, manufacturer specifications, an assignment or inspection report detailing a deficiency or deformation, SOPs, test, calibration, and diagnostic equipment, and tools, will be able to perform repairs on electronic controls and instrumentation so that defective components are diagnosed; deformed, broken, loose, worn, or missing parts are repaired, replaced, or rebuilt to manufacturer specifications; engine, transmission, and brake electronic control units or electronic control modules, pump throttles and pressure control devices, and instrumentation are returned to operation; programming is correct; load control devices, sequencer, interfaces, and interlocks are operational; correct test equipment is used; correct parts are used; correct tests and programming procedures are followed; operational tests and diagnostic checks are conducted and performance is verified; and repairs are documented in accordance with the procedures of the manufacturer and the authority having jurisdiction (AHJ)

Enabling Learning Objectives

1. Describe how to select test, calibration, and diagnostic equipment
2. Describe safety procedures
    - Personnel

    - Solenoid inductive kick
    - Strobe lights
    - High-intensity discharge (HID)
  - Vehicle
    - Welding precautions on vehicle chassis
3. Identify common deficiencies and describe correct repair procedures
   - Voltage drop
   - Sensor failure
   - Circuit driver failure
   - Radio frequency effects
   - Parasitic drain
4. Identify record-keeping requirements
   - Manufacturer requirements
   - NFPA requirements
   - Agency/shop requirements
5. Describe the diagnostic and repair procedures of the manufacturer and the AHJ
6. Recognize, evaluate, and analyze reported conditions, defects, and deficiencies
7. Perform required repairs to resolve deficiencies
8. Use test, calibration, and diagnostic equipment
9. Operate and test system(s)
10. Perform calculations
11. Use correct parts
12. Complete required documentation

Discussion Questions

1. What types of in-house electrical repairs do you do?
   - What repairs do you transfer out?
2. What is parasitic drain?
3. What is the purpose of reference voltages?
   - How do they differ from signal voltages?

Activities

1. To be determined by the instructor

Instructor Notes

1. ELO 5 – Covered in detail in Topic 4-1: Testing Low-voltage Electrical Systems
2. ELO 11-17 – Covered by Activity 4-1: Testing Low-voltage Electrical Systems

CTS Guide Reference: CTS 8-5

Topic 3-4: Testing Electronic Controls and Instrumentation

Terminal Learning Objective

At the end of this topic, a student, given an emergency response vehicle, manufacturer specifications, SOPs, test, calibration, and diagnostic equipment, and tools, will be able to complete performance testing on electronic controls and instrumentation including electronic engine, pump control systems, transmission, brake controls, load control devices,

sequencers, interfaces, and interlocks, in accordance with NFPA 1911 so that components are tested to assure they are operating in accordance with manufacturer specifications and NFPA standards; performance tests are conducted to verify that repairs are completed; and all testing is documented in accordance with the procedures of the manufacturer and the authority having jurisdiction (AHJ)

Enabling Learning Objectives

1. Describe operational, diagnostic, and performance tests
2. Describe adjustment and calibration procedures
3. Describe how to select test, calibration, and diagnostic equipment
4. Describe how to test sensors, components, and systems
    - 5-volt reference circuits
        - Throttle position sensor
        - Manifold absolute pressure sensor
        - Mass airflow sensor
        - Intake air temperature sensor
        - Coolant temperature sensor
        - Oxygen sensor
5. Identify common defects
6. Describe electronic troubleshooting procedures
7. Identify record-keeping requirements
8. Describe the diagnostic and repair procedures of the manufacturer and the AHJ
9. Recognize, evaluate, and identify reported conditions
10. Perform required repairs to resolve deficiencies
11. Use test, calibration, and diagnostic equipment
12. Measure voltage, amperage, and resistance
13. Distinguish defects and deficiencies
14. Operate and test system
15. Perform electrical calculations
16. Complete required documentation in accordance with NFPA standards and the AHJ

Discussion Questions

1. What impact will a 12-volt chassis system have on a 5-volt control system?
2. What is the purpose of twisted pair cabling in an electronic control circuit?
    - What will happen if you don't properly re-twist the wires?
3. How can AC voltage end up in an electronic control circuit?

Activities

1. Activity 2-2: Testing Electrical Systems and Electronic Controls
    - 5-volt Reference Circuits

Instructor Notes

1. ELO 4: Recommend using the schematics for the vehicle used for the course to demonstrate measurement location and technique.
2. ELO 11-16 – Covered by activity.

CTS Guide Reference: CTS 8-6

Time Table

Segment	Lecture Time	Activity Time	Total Unit Time
Unit 1: Introduction			
Topic 1-1: Orientation and Administration			
Lecture	0:30		
Activity 1-1: Determined by instructor		0:00	
Topic 1-2: Emergency Vehicle Technician Certification Process			
Lecture	0:30		
Activity 1-2: Determined by instructor		0:00	
Unit 1 Totals	**1:00**	**0:00**	**1:00**
Unit 2: Low-voltage Electrical Systems			
Topic 2-1: Repairing Low-voltage Electrical Systems			
Lecture	2:00		
Activity 2-1: Solenoids		1:30	
Topic 2-2: Testing Low-voltage Electrical Systems			
Lecture	2:00		
Activity 2-2: Testing Electrical Systems and Electronic Controls		1:30	
Unit 2 Totals	**4:00**	**3:00**	**7:00**
Unit 3: Electronic Controls and Instrumentation			
Topic 3-1: Inspecting Electronic Controls and Instrumentation			
Lecture	5:00		
Activity 3-1: Determined by instructor		3:00	
Topic 3-2: Maintaining Electronic Controls and Instrumentation			
Lecture	3:00		
Activity 3-2: Determined by instructor		2:00	
Topic 3-3: Repairing Electronic Controls and Implementation			
Lecture	4:00		
Activity 3-3: Determined by instructor		4:00	
Topic 3-4: Testing Electronic Controls and Implementation			
Lecture	2:00		

Segment	Lecture Time	Activity Time	Total Unit Time
Activity 2-2: Testing Electrical Systems and Electronic Controls		3:00	
Unit 3 Totals	**14:00**	**12:00**	**26:00**
Lecture, Activity, and Unit Totals:	**19:00**	**15:00**	**34:00**

Course Totals

Segment Type	Time
Total Lecture Time (LT)	19:00
Total Activity Time (AT)	15:00
Total Testing Time (TT)	2:00
Total Course Time	**36:00**