Appendix N

TRANSPORTATION, DISTRIBUTION AND LOGISTICS
YOUTH APPRENTICESHIP

AUTO COLLISION PATHWAY
DAMAGE ANALYSIS & ELECTRICAL REPAIR (UNIT 6)

Unit 6: Auto Collision Pathway
Damage Analysis & Electrical Repair

Competency

1. Prepare vehicle for inspection

Performance Standard Condition

Competence will be demonstrated

- at the worksite

Performance Standard Criteria

Performance will be successful when learners:

- Obtain equipment & materials needed
- Review safety & service procedures
- Mask and protect edges of broken glass
- Wipe up any leaking fluids
- Identify programmable electrical/electronic components; record data for reprogramming before disconnecting battery
- With the ignition off, disconnect the battery
- Remove battery if indicated; check battery case for cracks
- Assist to attach anchoring and support devices

Learning Objectives

- Describe safety practices related to personal protection, equipment & materials for this process
- Describe the rationale for disconnecting the battery
- Explain the purpose of the Damage Report
- List the customer information required on a damage report
- Explain how to read a Damage Report
- Describe methods of determining repairability of a damaged vehicle

Comments:

Unit 6: Auto Collision Pathway
Damage Analysis & Electrical Repair

Competency

2. Assist to determine structural damage

Performance Standard Condition

Competence will be demonstrated

- at the worksite
- while assisting a worksite professional

Performance Standard Criteria

Performance will be successful when learners:

- Obtain equipment & materials needed
- Review safety & service procedures
- Determine direction and point(s) of impact
- Check alignment of doors, hood & deck lid
- Check for gaps between panels
- Verify opening and closing of doors, hood, & deck lid
- Check door handles & door locks for proper operation
- Inspect for ripples in roof, fenders, or quarter panels away from direct impact
- Check seam sealers
- Check glass and operation of windows
- Check damage to interior
- Assist to measure common structural damage points
- After inspection, cleanup work area, return tools to proper location, complete appropriate documentation

Learning Objectives

- Describe safety practices related to personal protection, equipment & materials for this process
- Describe collision information needed to help determine damage analysis
- Define factors assessed to determine structural damage
- Compare types of vehicle construction & frame designs such as space frame, unibody, body over frame, modular assembly
- Compare types of vehicle construction materials
- Review different manufacturing processes to build cars such as welding, mechanical fasteners, adhesives, etc.
- Define & locate crush zones
- Describe types of damage such as direct, indirect, pre-existing
- Explain the difference between direct and indirect damage
- Explain how to identify pre-existing damage or repairs through inspection
- Describe the different damage characteristics of space frame, unibody, and body over frame vehicles
- Identify impact energy absorbing components and their basic repair/replacement procedures
- Define dimensional frame points of reference- datum, body zero, and centerline
- Describe features of different types of frame damage such as mash/collapse, sag/kickup, sway, twist, and diamond

- Explain measurements needed in collision repair
- Describe how to take linear, angle, pressure, volume and other measurements
- Compare SAE and metric measuring systems
- Identify basic measuring tools common in collision repair
- Compare and contrast structural damage measuring systems (tram & self-centering gauges, dedicated fixture measuring systems, and universal measuring systems (mechanical, electronic, laser)
- Explain the common methods used to straighten damaged frames
- Identify steel components and their basic repair/replacement procedures
- Identify aluminum/magnesium components and their basic repair/replacement procedures

Comments:

Unit 6: Auto Collision Pathway
Damage Analysis & Electrical Repair

Competency

3. Assist to determine suspension, mechanical, and electrical damage

Performance Standard Condition

Competence will be demonstrated

- at the worksite
- while assisting a worksite professional

Performance Standard Criteria

Performance will be successful when learners:

- Obtain equipment & materials needed
- Review safety & service procedures
- Check wheels and tires including the spare
- Check under the vehicle for fluid leaks
- Inspect parts in the engine compartment for damage
- Perform a steering wheel center check
- Perform a jounce/rebound steering gear check
- Perform a strut position check
- Perform a wheel run-out check
- Select any other appropriate testing equipment to identify mechanical problems
- Assist to diagnose required mechanical/electrical repairs
- Plan for mechanical and electrical component repairs
- After inspection, cleanup work area, return tools to proper location, complete appropriate documentation

Learning Objectives

- Describe safety practices related to personal protection, equipment & materials for this process
- Define factors assessed to determine non-structural damage and component damage
- Describe different types of suspension, mechanical & electrical damage related to direct, indirect and inertia damage
- Compare structural and non-structural parts
- Identify tests and equipment to check suspension & steering problems
- Identify tests and equipment to check general electric problems
- Identify tests and equipment to check brake problems
- Identify tests and equipment to check engine cooling problems
- Identify tests and equipment to check engine performance problems
- Identify add-on accessories and modifications and their basic repair/replacement procedures

Comments:

Unit 6: Auto Collision Pathway
Damage Analysis & Electrical Repair

Competency

4. Assist to determine if refinishing is required

Performance Standard Condition

Competence will be demonstrated

- at the worksite
- while assisting a worksite professional

Performance Standard Criteria

Performance will be successful when learners:

- Obtain equipment & materials needed
- Review safety & service procedures
- Review type and condition of finish
- Look for cracked or stressed paint
- Assist to determine if refinishing is required and in what areas
- After inspection, cleanup work area, return tools to proper location, complete appropriate documentation

Learning Objectives

- Describe safety practices related to personal protection, equipment & materials for this process
- Define factors assessed to determine finish damage

Comments:

Unit 6: Auto Collision Pathway
Damage Analysis & Electrical Repair

Competency

5. Assist to plan repair work

Performance Standard Condition

Competence will be demonstrated

- at the worksite
- while assisting a worksite professional

Performance Standard Criteria

Performance will be successful when learners:

- Determine structural repair requirements
- Determine suspension, mechanical & electrical repair requirements
- Determine refinishing requirements
- Prepare a plan for work and repairs based on customer decision
- Collect necessary information to determine parts and materials required
- Locate and interpret vehicle and component identification numbers such as make, model, year, VIN, vehicle certification labels, calibration decals
- Identify and record vehicle options, including trim level, paint code, transmission, accessories, and modifications
- Determine if OEM, aftermarket, recycled, or remanufactured/rebuilt/reconditioned parts could or should be used
- Assist to order required OEM, aftermarket, recycled/used, rebuilt, reconditioned parts and materials based on estimate
- Verify availability, compatibility, and condition of parts and materials upon receipt

Learning Objectives

- Explain how damage repair estimates are determined
- Explain aspects of insurance claim estimates (e.g., deductible, total loss, betterment, depreciation, adjustments, diminished value and prior damage)
- Discuss the required authorizations needed in order to proceed with repairs
- Outline the customer claims-insurance-repair shop process for vehicle damage
- Compare flat rate and overlap labor rate when making a cost estimation
- Identify common abbreviations in collision estimating guides
- Compare manual and computerized estimating
- Identify key operating features of manual and computerized estimating systems
- Apply appropriate estimating and parts nomenclature (terminology)
- Describe contractual and warranty obligations in collision repair
- Discuss the legal obligation to restore the vehicle to manufacturer specifications
- Compare OEM, aftermarket, recycled, and remanufactured/rebuilt/reconditioned components
- Describe when to use OEM components
- Describe when to use aftermarket components
- Describe when to use recycled (used) components
- Describe when to use remanufactured/rebuilt/reconditioned components

Comments:

Unit 6: Auto Collision Pathway
Damage Analysis & Electrical Repair

Competency

6. Inspect, clean, and replace battery

Performance Standard Condition

Competence will be demonstrated

- at the worksite

Performance Standard Criteria

Performance will be successful when learners:

- Obtain equipment & materials needed
- Review safety & service procedures
- Inspect the condition of the support tray, hold-down, posts, cables and clamps

TOP

- If the battery top is dirty, test the top of the battery with a voltmeter; if leaking voltage then clean
- Clean top with baking soda & water

TERMINALS

- Perform a battery terminal test with a voltmeter with the ignition disabled
- If disconnecting battery, use a memory saver to keep programmable information intact
- Clean battery terminals by removing the cables and cleaning with baking soda & water
- Coat terminals with white grease
- Tighten fasteners to secure cable

ELECTROLYTE LEVEL

- In older NON maintenance free batteries, check electrolyte level
- Remove vent cap
- Check electrolyte level
- Fill cells to correct level with distilled water if needed

REMOVE/INSTALL

- Disconnect the cables
- Loosen the battery hold-down
- Carefully lift the battery out using a battery strap
- Gently place the battery into its try or box
- Ensure the battery fits properly
- Tighten the hold-down and reconnect the cables
- After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper location, complete appropriate documentation

Learning Objectives

- Describe safety practices related to personal protection, equipment & materials for this process
- Describe the basic parts of an automotive battery
- Explain how temperature & other factors affect battery performance
- Describe the function of a baking soda mixture for cleaning
- Explain how to clean a battery top on a NON maintenance free battery
- Explain how to perform a battery terminal test
- Discuss when to use pliers to remove battery cables

- Discuss precautions to take around battery fill openings
- Explain why only distilled water can be used in batteries
- Explain why over-tightening terminals is a problem
- Discuss how size of battery relates to motor performance & battery service life

Comments:

Unit 6: Auto Collision Pathway
Damage Analysis & Electrical Repair

Competency

7. Perform battery state-of-charge test

Performance Standard Condition

Competence will be demonstrated

- at the worksite

Performance Standard Criteria

Performance will be successful when learners:

- Obtain equipment & materials needed
- Review safety & service procedures

NON-SLA

- On NON-SLA (sealed lead acid) batteries, perform a hydrometer state of charge test
- If specific gravity is at or above acceptable level, do capacity test
- If specific gravity for all cells is below acceptable level, charge & retest battery
- If specific gravity between cells varies by more than acceptable amount, replace the battery

SLA

- Remove surface charge
- Perform open circuit voltage test
- Measure the open circuit voltage
- Refer to voltage chart to determine state of charge on battery
- After testing, prepare for service or cleanup work area, return tools to proper location, complete appropriate documentation

Learning Objectives

- Identify safety precautions when performing battery service
- Explain the operating principles of a lead-acid battery
- Compare conventional & maintenance-free batteries
- Explain how to remove surface charge from a battery
- Define specific gravity and how it indicates battery charge
- Describe how to do the hydrometer test
- Describe how to do the capacity test
- Describe how to do the open circuit voltage test
- Explain how to use the voltage chart to determine charge
- List levels which require a new battery vs. re-charging

Comments:

Unit 6: Auto Collision Pathway
Damage Analysis & Electrical Repair

Competency

8. Perform battery charge

Performance Standard Condition

Competence will be demonstrated

- at the worksite

Performance Standard Criteria

Performance will be successful when learners:

- Obtain equipment & materials needed
- Review safety & service procedures
- Disconnect the negative battery cable
- Check the battery casing for damage
- Check the water level; add water if needed
- Loosen the vent caps, if so equipped
- Attach charger clamps to battery
- Connect charger according to manufacturer instructions
- Connect the red charger lead to the positive terminal
- Connect the black charger lead to the negative terminal
- Set the charger to the appropriate current for the type of charging
- Turn charger on
- Turn charger off when charging is complete
- Remove charger clamps, negative first
- Replace vent caps if applicable
- Attach negative battery cable
- After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper location, complete appropriate documentation

Learning Objectives

- Identify safety precautions when performing battery service
- Describe how a battery charger works to charge a battery
- List battery charging precautions to prevent damage
- Compare advantages & disadvantages for slow & fast battery charging
- Describe the temperature and charging rates for slow & fast charging
- Discuss what would happen if a charger was on when it is connected to the battery

Comments:

Unit 6: Auto Collision Pathway
Damage Analysis & Electrical Repair

Competency

9. Retrieve codes and settings and disconnect the battery if needed

Performance Standard Condition

Competence will be demonstrated

- at the worksite

Performance Standard Criteria

Performance will be successful when learners:

- Obtain equipment & materials needed
- Review safety & service procedures
- Verify malfunction indicator light trouble codes using the scan tool
- Obtain the appropriate scan tool and program cartridge for the vehicle, system and/or date
- Locate the data link connector (DLC) in the vehicle
- Attach the scan tool cable into the DLC; use an adaptor if needed
- Connect the scan tool to battery power if needed
- Follow the prompts to access the trouble codes
- Consult the trouble code chart or scan tool code conversion
- Consult worksite professional to determine further tests, inspections or repairs
- Erase diagnostic trouble codes when applicable
- After servicing, cleanup work area, return tools to proper location, complete appropriate documentation

Learning Objectives

- Describe safety practices related to personal protection, equipment & materials for this process
- Discuss the purpose and operation of on-board diagnostic systems
- Explain the use of scan tools to simplify reading of trouble codes
- Compare OBD I and OBD II system capabilities and procedures
- Locate the data link connector on most makes and models of cars
- Activate on-board diagnostics and read trouble codes with and without a scan tool
- Describe how to use a trouble code chart in a service manual or code conversion by a scan tool
- Describe the importance of running all OBDII monitors for repair verification

Comments:

Unit 6: Auto Collision Pathway
Damage Analysis & Electrical Repair

Competency

10. Assist to diagnose electrical circuits, wiring, and connectors

Performance Standard Condition

Competence will be demonstrated

- at the worksite
- while assisting a worksite professional

Performance Standard Criteria

Performance will be successful when learners:

- Obtain equipment & materials needed
- Review safety & service procedures
- Locate the wiring diagram for the component of concern to see how the circuit is supposed to operate
- Identify all components, connectors, wires, related to that component
- Inspect the switches, connectors, relays, solenoid devices for proper connection and wearing, burning or pitting
- Inspect the wires for proper connection and wearing, rubbing or fraying
- Test devices & wires for voltage, voltage drop, current flow, resistance, continuity, & shorts
- Line-out parts of the circuit on the diagram that are working as each point is tested
- From the lined out circuit trace, narrow down possible causes
- Given measured and calculated values throughout a given circuit, identify some common cause that could result in the vehicle concern
- Determine additional testing or repairs required with worksite professional
- After testing, prepare for service or cleanup work area, return tools to proper location, complete appropriate documentation

Learning Objectives

- Describe safety practices related to personal protection, equipment & materials for this process
- Explain the principles of electricity
- Describe the action of basic electric circuits
- Compare voltage, current, and resistance
- Describe the principles of magnetism and magnetic fields
- Identify basic electric and electronic terms and components
- Describe fundamental electrical tests
- Identify factors that will determine how much current will flow in a circuit
- Define Ohm's Law and how to determine circuit resistance, current flow and voltage drop
- State the relationships between voltage, current & resistance in a simple circuit
- Identify sources of AC/DC voltages & their automotive applications
- Explain how to use the following testing instruments: Voltmeter, Test Light, Ammeter, & Ohmmeter
- Describe how to check for module communication errors using a scan tool
- Describe how to check voltages in electrical wiring circuits with a DMM (digital multimeter)

- Describe how to check for voltage drop and/or current flow in electrical wiring circuits and components with a DMM (digital multimeter)
- Identify series & parallel circuits as they apply to typical lighting circuits
- Describe characteristics of a series circuit
- Describe characteristics of a parallel circuit
- Describe characteristics of a series/parallel circuit
- Identify common causes of electrical circuit or component failures
- List electrical systems in a vehicle
- List types of common automotive wiring
- Explain common causes of wire damage
- Identify types of wire damage
- List common types of insulation damage
- List common types of wiring connectors used in vehicles
- Define an open circuit, short circuit, & high resistance in a circuit
- Identify the effect of an open circuited component on voltage & amperage measured at various points in the circuit
- Identify the effect of a short circuited component on voltage & amperage measured at various points in the circuit
- Identify common electrical schematic symbols
- Identify electrical components on schematic drawings
- Read & interpret electrical schematic drawings
- Describe wire repair procedures
- Explain how to terminate primary wires

Comments:

Unit 6: Auto Collision Pathway
Damage Analysis & Electrical Repair

Competency

11. Assist to inspect, test, and replace fusible links, circuit breakers, and fuses

Performance Standard Condition

Competence will be demonstrated

- at the worksite
- while assisting a worksite professional

Performance Standard Criteria

Performance will be successful when learners:

- Obtain equipment & materials needed
- Review safety & service procedures
- Inspect the fuses, breakers & links for tripping or breaks
- Check fuses with a circuit tester or multimeter
- Inspect fuse links for bubbled insulation, replace as indicated or perform continuity check
- Reset the breaker or replace the fuse as needed
- After testing, prepare for service or cleanup work area, return tools to proper location, complete appropriate documentation

Learning Objectives

- Describe safety practices related to personal protection, equipment & materials for this process
- Identify types of circuit protection devices used in an electrical circuit
- Define the functions of a fuse, fuse box, fusible link, circuit breaker
- Compare circuit breakers to fuses
- Explain the common functions & locations of fuses & breakers in a vehicle
- Describe types of circuit faults

Comments:

Unit 6: Auto Collision Pathway
Damage Analysis & Electrical Repair

Competency

12. Assist to check & repair exterior lighting & wires

Performance Standard Condition

Competence will be demonstrated

- at the worksite
- while assisting a worksite professional

Performance Standard Criteria

Performance will be successful when learners:

- Obtain equipment & materials needed
- Review safety & service procedures
- Check lights for operation
- Use wiring diagrams to check for electrical circuit problems

INSPECT

- Test the power at the bulb socket
- Check the ground circuit
- Look for any shorted or open circuits
- Check for corrosion of the connector terminals
- Check the fuse
- Check the switch

REPLACE BULB

- Remove the bulb assembly
- Remove small rings or screws
- Remove the lens
- Replace with new bulb
- Reinstall lens, screw, rings, and bulb assembly

REPAIR WIRING

- Assist to repair wiring and connections if needed
- After servicing, cleanup work area, return tools to proper location, complete appropriate documentation

Learning Objectives

- Describe safety practices related to personal protection, equipment & materials for this process
- Identify safety precautions when performing wire repair
- Explain the components & operating principles of automotive light systems
- Identify safety precautions when handling halogen bulbs
- Discuss the diagnostic questions to determine problems in light systems
- Define the functions of a switch, connector, relay, solenoid device, & wire
- List common methods of wire repair
- Describe wire size and wire gauge
- Compare & contrast types of automotive wiring

Comments:

Unit 6: Auto Collision Pathway
Damage Analysis & Electrical Repair

Competency

13. Aim headlamp assemblies and fog/driving lamps

Performance Standard Condition

Competence will be demonstrated

- at the worksite

Performance Standard Criteria

Performance will be successful when learners:

- Obtain equipment & materials needed
- Review safety & service procedures
- Use headlight aimers, aiming screen or bubble levelers according to equipment specification
- Mount headlight aimers over vehicle headlights
- Observe leveling bulbs in the aimers
- Turn headlight aiming screws as needed on the headlights to adjust beams correctly in front of the vehicle
- After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper location, complete appropriate documentation

Learning Objectives

- Describe safety practices related to personal protection, equipment & materials for this process
- Describe headlight aiming screw types and operation
- Describe how to mount and use a headlight aimer
- Describe how to load a vehicle prior to aiming headlights
- Explain the purpose of the bubble level

Comments:

Unit 6: Auto Collision Pathway
Damage Analysis & Electrical Repair

Competency
14. Check & replace horn

Performance Standard Condition

Competence will be demonstrated

- at the worksite

Performance Standard Criteria

Performance will be successful when learners:

- Obtain equipment & materials needed
- Review safety & service procedures
- Check operation of horn
- Use wiring diagrams to check for electrical circuit problems
- Test the power at the horn terminal
- Look for any shorted or open circuits
- Check for corrosion of the connector terminals
- Check the fuse
- Check the switch
- Check the relay
- Push horn while another tech reads the current between the feed wire and the horn terminal
- If current is not within specification, turn the amp screws until the readings is appropriate
- Assist to remove & replace horn if needed
- After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper location, complete appropriate documentation

Learning Objectives

- Describe safety practices related to personal protection, equipment & materials for this process
- Explain the components & operating principles of automotive horn systems
- Discuss the diagnostic questions to determine problems in horn systems
- Describe how to prevent meter damage when checking amp draw

Comments:

Unit 6: Auto Collision Pathway
Damage Analysis & Electrical Repair

Competency
15. Check & replace wiper/washer system motors & pumps

Performance Standard Condition
Competence will be demonstrated
- at the worksite

Performance Standard Criteria
Performance will be successful when learners:
- Obtain equipment & materials needed
- Review safety & service procedures
- Check wipers for cuts or splits; replace if needed
- Use wiring diagrams to check for electrical circuit problems

WIPER SYSTEM
- Check fuses & electrical connections of wiper system
- Check power to wiper motor
- Check to ensure motor is properly grounded
- Check wiper switch & circuit connections for openings

WINDSHIELD WASHER SYSTEM
- Check fuses & electrical connections of washer system
- Check power to washer motor
- Check pump operation
- Assist to replace motors or pump as needed
- After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper location, complete appropriate documentation

Learning Objectives
- Describe safety practices related to personal protection, equipment & materials for this process
- Explain the components & operating principles of automotive wiper systems
- Discuss the diagnostic questions to determine problems in wiper systems
- Explain how to remove & replace a wiper motor and washer pump

Comments:

Unit 6: Auto Collision Pathway
Damage Analysis & Electrical Repair

Competency

16. Check & replace power window system switches & motors

Performance Standard Condition

Competence will be demonstrated

- at the worksite

Performance Standard Criteria

Performance will be successful when learners:

- Obtain equipment & materials needed
- Review safety & service procedures
- Check operation of power windows
- Use wiring diagrams to check for electrical circuit problems
- Check fuse or circuit breaker for whole system
- If only one window affected, check power to switches & motor at that window
- If a humming sound, check motor gear box for stripped teeth; replace gear box
- Check fuses, switches & relays along circuit if problems still exist
- Replace bad switches or motors
- After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper location, complete appropriate documentation

Learning Objectives

- Describe safety practices related to personal protection, equipment & materials for this process
- Explain the components & operating principles of automotive power window systems
- Discuss the diagnostic questions to determine problems in power window systems

Comments:

Unit 6: Auto Collision Pathway
Damage Analysis & Electrical Repair

Competency

17. Check operation of electrically heated mirrors, windshields, back lights, panels, etc

Performance Standard Condition

Competence will be demonstrated

- at the worksite

Performance Standard Criteria

Performance will be successful when learners:

- Obtain equipment & materials needed
- Review safety & service procedures
- Check operation of heated window, mirror or panel
- Use wiring diagrams to check for electrical circuit problems
- Check fuse or circuit breaker for whole system
- Check voltage
- Test circuit for openings
- Test rear window defogger grid
- Test windshield control module
- Assist to determine needed repairs or replacements
- After testing, cleanup work area, return tools to proper location, complete appropriate documentation

Learning Objectives

- Describe safety practices related to personal protection, equipment & materials for this process
- Explain the components & operating principles of automotive electrical heated mirrors, windshields, & panel systems
- Discuss the diagnostic questions to determine problems in heated mirror, windshield, & panel systems

Comments:

Unit 6: Auto Collision Pathway
Damage Analysis & Electrical Repair

Competency
18. Inspect, remove and replace components of power antenna circuits

Performance Standard Condition
Competence will be demonstrated
- at the worksite

Performance Standard Criteria
Performance will be successful when learners:
- Obtain equipment & materials needed
- Review safety & service procedures
- Check operation of power antenna
- Use wiring diagrams to check for electrical circuit problems
- Test the power at the antenna gear
- Look for any shorted or open circuits
- Check for corrosion of the connector terminals
- Check the fuse
- Check the switch
- Check voltage to motor windings
- Replace unit if needed
- After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper location, complete appropriate documentation

Learning Objectives
- Describe safety practices related to personal protection, equipment & materials for this process
- Explain the components & operating principles of power antenna systems
- Discuss the diagnostic questions to determine problems in power antenna systems

Comments: