I-CAR®

Uniform Procedures For Collision Repair UPCR

EL01 Wire Repair

 v.4.0

1. Description

This procedure describes methods for repairing electrical wiring. Inspection and evaluation requirements are also included.

2. Purpose

The purpose of this procedure is to provide industry-accepted requirements for performing high-quality wire repairs. This procedure is intended for use by professionals who are qualified through training and experience.

3. Referenced Documents

The following documents are considered part of this procedure by reference.

3.1 Procedures

EL11 Troubleshooting
EL21 Self-Diagnostics
PS01 Personnel Safety

3.2 Other Information

Equipment-specific information
Vehicle-specific repair information

4. Equipment And Material Requirements

4.1 Equipment

The following equipment is used in this procedure:

- ❑ digital volt-ohmmeter (DVOM)
- ❑ 25–40 watt soldering gun
- ❑ butane-powered soldering iron
- ❑ clamp-on heat sinks
- ❑ wire stripping tool
- ❑ heat gun
- ❑ crimping tool
- ❑ terminal release tools
- ❑ electro-static discharge (ESD) strap

4.2 Materials

The following materials are used in this procedure:

- ❑ splice sleeves
- ❑ insulated wire
- ❑ heat-shrink tubing
- ❑ weatherproof connectors
- ❑ rosin-core solder
- ❑ dielectric grease
- ❑ wire cleaner
- ❑ petroleum jelly

5. Damage Analysis

5.1 Wire And Connector Damage

Inspect wires, terminals, and connectors for these conditions:

- ❑ bent or broken terminals or connectors
- ❑ exposed wires or terminals
- ❑ cut or pinched insulation
- ❑ corrosion
- ❑ swollen, discolored, melted, or scorched insulation
- ❑ cracked connector housings, or other insulators
- ❑ loose connections
- ❑ missing seals or connector locks
- ❑ moisture inside connectors
- ❑ wire terminals not secured in the connector

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5. Damage Analysis (cont'd)

Refer to the vehicle maker's recommendations to determine if a damaged wire can be repaired.

Note: Some vehicle makers require the use of a specific repair kit for performing wire repairs. Some vehicle makers do not recommend the repair of wiring or connectors in the airbag system.

5.2 Circuit Damage

Indications that a wire repair may be required include the following:

- ❏ blown fuse, burned fusible link, or tripped circuit breaker
- ❏ high resistance or no continuity
- ❏ faulty load
- ❏ failed voltage drop test
- ❏ improper warning lamp operation
- ❏ improper continuity (incorrect resistance) between circuits
- ❏ failed diagnostic test procedure

6. Personnel Safety

6.1 General Safety

General safety information is in **PS01**.

Before working around battery acid spills or leakage, clean the area with baking soda and water, followed by soap and water.

6.2 Safety With Soldering

To prevent injury when soldering:

- ❏ Work in a well-ventilated area.
- ❏ Avoid breathing smoke or vapors created when soldering. Use a respirator suitable for the purpose.
- ❏ Wear the proper eye and skin protection.
- ❏ Use a flameless heat source.

7. Environmental Safety

Does not apply.

8. Vehicle Protection

8.1 Electronic Parts

To protect computers and other sensitive parts from damage when making wire repairs:

- ❏ Follow the vehicle maker's recommendations for recording and resetting electronic memories.
- ❏ Ensure that the ignition switch is in the LOCK position, and the key is removed.
- ❏ Disconnect and isolate the negative battery cable.
- ❏ Disarm the passive restraint system, if working in the area of the airbag sensors, modules, or wiring. Follow the vehicle maker's recommendations.
- ❏ Carefully remove computer modules when welding or heating within 300 mm (12"), or a greater distance when recommended by the vehicle maker.
- ❏ Protect computer modules, connectors, and wiring from dirt, heat, static electricity, and moisture. Use an ESD strap when handling computers and other sensitive parts.
- ❏ Loosen or remove any wiring harnesses or electrical parts that could be damaged during the repair process.
- ❏ Use a DVOM with at least a 10 megohm internal impedance.
- ❏ Avoid touching electrical terminals.
- ❏ Do not use acid-based products for soldering.
- ❏ Always check for computer codes after any electrical repairs.

8.2 Wire Splicing

To protect the vehicle when splicing wires:

- ❏ If it is necessary to replace a length of wire, use the same, or larger diameter wire (smaller gauge number), with proper splices to maintain specified resistance over the entire repair.
- ❏ Duplicate the length of the original wire as closely as possible. Follow the vehicle maker's wire color coding whenever possible.
- ❏ Use heat sinks, when required to protect heat-sensitive parts.
- ❏ Do not use a high-wattage soldering gun for making wire repairs.
- ❏ Avoid damaging any of the other wires or insulation in a wiring harness when making a wire repair.
- ❏ Make sure each splice is at least 40 mm ($1\frac{1}{2}$") away from other splices, harness branches, or connectors.
- ❏ Use only rosin-based soldering materials. Acid-based materials will permanently damage wiring and electrical parts.

9. Repair Procedure

9.1 Solder Splice

To make a copper wire solder splice:

- ❑ 1. If it is necessary to replace a length of wire, use the same diameter or larger wire (smaller gauge number).
- ❑ 2. Duplicate the length of the original wire as closely as possible. Follow the vehicle maker's wire color coding whenever possible.
- ❑ 3. Strip the wire insulation about 20 mm ($^3/_4$") from both ends.
- ❑ 4. Inspect the wire after the insulation has been stripped, to check for damage or discoloration.
- ❑ 5. Clean the ends of the wires with wire cleaner or rosin flux.
- ❑ 6. Slip the proper diameter and length of heat-shrink tubing onto one wire.
- ❑ 7. Twist the wires together for a "western union" splice, or mesh the wires together and crimp on a splice clip.
- ❑ 8. Solder the splice with rosin-core solder. Solder should flow into the wires.
- ❑ 9. Pull on the wires lightly to ensure the splice is properly soldered and tight.
- ❑ 10. Apply dielectric grease over the repair area.
- ❑ 11. Slide heat-shrink tubing over the splice and apply heat to tighten the shrink tubing around the splice. Or tightly wrap the splice with the proper electrical tape.
- ❑ 12. Perform a wiggle test on the joint. See **11.2**.

9.2 Splice Sleeve With Sealant

Some electrical joints require a waterproof splice using a splice sleeve containing a sealant. Select an area to make the splice that will allow the application of heat without damaging the surrounding areas.

To make a waterproof wire splice:

- ❑ 1. Use a solderless splice sleeve containing a sealant. Select the proper size sleeve for the wire size. Follow the vehicle maker's recommendations.
- ❑ 2. Strip the wire insulation about 20 mm ($^3/_4$") from both ends. Do not nick or damage the conductor.
- ❑ 3. Clean the ends of the wires with wire cleaner.
- ❑ 4. Insert the wires into the ends of the sleeve.
- ❑ 5. Crimp the ends of the sleeve, if required for the type of sleeve used. Use special wire-crimping tools, if required by the vehicle maker.
- ❑ 6. Pull on the wires lightly to ensure the splice is tight.
- ❑ 7. Starting at the center of the connector, apply heat to the joint until the sealant begins oozing out of each end.
- ❑ 8. Perform a wiggle test on the joint. See **11.2**.

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9.3 Shielded Cable Splice

To make a splice in shielded cable:

- ❏ 1. Cut away the outer insulation from the shielded cable on each end and discard it. Avoid cutting into the drain wire or the aluminum/mylar tape.
- ❏ 2. Unwrap the aluminum/mylar tape, but do not remove it.
- ❏ 3. Untwist the wires, and splice the wires together. See **9.1**.
- ❏ 4. Rewrap the splice with the aluminum/mylar tape. Avoid wrapping the drain wire.
- ❏ 5. Splice and solder the drain wire, and wrap it around the splice.
- ❏ 6. Tape over the splice and the drain wire to replace the outer insulation.
- ❏ 7. Perform a wiggle test on the joint. See **11.2**.

9.4 Splicing Aluminum Wire

Note: A special repair kit may be required for making repairs on aluminum wires. Follow the vehicle maker's recommendations.

To make a splice in aluminum wire:

- ❏ 1. Cut the plastic conduit open with diagonal cutters and pull out the wire that is to be spliced. Avoid damaging any of the wires when cutting open the conduit.
- ❏ 2. Cut the damaged wire from the harness. Remove as little wire as possible.
- ❏ 3. If replacement of a length of wire is required, use the same diameter or larger wire (lower gauge number).
- ❏ 4. Duplicate the length of the original wire as closely as possible. Follow the vehicle maker's wire color coding whenever possible.
- ❏ 5. Strip about 6 mm ($\frac{1}{4}$") of insulation from each wire end. Avoid damaging the aluminum wire.
- ❏ 6. Clean the ends of the wires with wire cleaner.
- ❏ 7. Apply a generous coating of petroleum jelly to the splice area to prevent corrosion. If replacing a terminal, also coat the terminal crimp area and aluminum wire with petroleum jelly.
- ❏ 8. Select the proper size splice clip.
- ❏ 9. Insert one wire end in each end of the splice clip.
- ❏ 10. Crimp the clip firmly to the wire. Do not solder the splice.
- ❏ 11. Tape or apply shrink tubing over both the splice clip and the petroleum jelly to seal out moisture and insulate the splice. Do not tape over a terminal crimp area.
- ❏ 12. Perform a wiggle test on the joint. See **11.2**.

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9.5 Wire Terminal Replacement

To replace a wire terminal:

❏ 1. Refer to the vehicle service manual for instructions on taking the connector apart. Note: Special tools, included in a connector and terminal repair kit, may be required. Follow the vehicle maker's recommendations.
❏ 2. Cut the wire close to the terminal.
❏ 3. Cut a replacement copper wire slightly longer than the original length to allow enough wire for overlapping the splice. Make sure the replacement wire is the same diameter or larger wire (lower gauge number).
Note: If the original wire is sufficiently long enough to prevent strain on the terminal, the replacement terminal may be spliced directly to the original wire, without using a replacement wire.
❏ 4. Strip about 5 mm ($^{3}/_{16}$") of insulation from the replacement wire end.
❏ 5. Reinstall any required weatherproof insulators on the wire.
❏ 6. Clean the end of the wire with wire cleaner.
❏ 7. Crimp a new terminal and insulation grip to the wire.
❏ 8. Solder the terminal crimp with rosin-core solder.
❏ 9. Splice the wires together using the proper splicing method. See **9.1**.
❏ 10. Insert the replacement terminal and wire into the connector and perform a wiggle test. See **11.2**.
❏ 11. Apply dielectric grease to the connector and reinstall.

9.6 Connector Replacement

Note: Special tools, included in a connector and terminal repair kit, may be required. Follow the vehicle maker's recommendations.

To replace a connector:

❏ 1. Follow the vehicle maker's recommendations for taking the connector apart.
❏ 2. Replace the damaged connector with an identical connector, if possible. If an exact replacement is not available, replace with a connector having at least the same number and type of terminals as the original connector. Replace a waterproof connector with another waterproof connector. The replacement connector must be the same type specified by the vehicle maker.
❏ 3. If the connector is supplied pre-wired, splice the connector lead wires using the proper splicing method. See **9.1**.

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❏ 4. If the connector body is available without pre-wired terminals, release each terminal from the damaged connector and transfer it to the correct cavity in the replacement connector. Note: When a connector with a different number of terminals than the original part is being used, select a connector having more terminal cavities than required and replace both the male and female connector parts. When building new connector sets during the repair, make every effort to maintain pin locations consistent with the original connector. If the connector body is available without pre-wired terminals, use a terminal release tool to release the terminals from the damaged connector and transfer them to the corresponding cavities in the replacement connector.

❏ 5. Apply dielectric grease to the connector. Follow the vehicle maker's recommendations.

9.7 Replacing A Fusible Link

CAUTION: Do not replace a burned fusible link until the cause of the circuit overload is isolated and repaired.

To replace a damaged fusible link:

❏ 1. Remove the fusible link by cutting the wire beyond the splice.
❏ 2. Strip about 13 mm (½") of insulation from the wire that will be protected.
❏ 3. Select a repair link of the same gauge as the damaged fusible link.
❏ 4. Slip the proper diameter and length of heat-shrink tubing onto the wire.
❏ 5. Insert the bare wires into the link splice.
❏ 6. Crimp the splice in two places.
❏ 7. Pull on the wires lightly to ensure the splice is tight.
❏ 8. Apply dielectric grease to the joints.
❏ 9. Slide the heat-shrink tubing over the splice and apply heat to tighten the shrink tubing around the splice.
❏ 10. Perform a wiggle test on the joint. See **11.2**.

10. Use Of Recycled (Salvage) Parts

10.1 Salvage Parts Requirements

Use only salvage parts that exactly duplicate the original parts.

Do not use salvage wiring harnesses or connectors having any of these defects:

- ❏ corrosion
- ❏ exposed wires
- ❏ cut or pinched insulation
- ❏ swollen, discolored, melted, or scorched insulation
- ❏ cracked connector housings
- ❏ loose terminal cavities
- ❏ missing seals or connector locks
- ❏ bent or corroded terminals

Do not use salvage airbag wiring harnesses or connectors.

11. Inspection And Testing

11.1 Inspection Of Wire Repairs

Inspect wire repairs for these conditions:

- ❏ no exposed wires or damaged insulation
- ❏ proper operation of the repaired circuit
- ❏ proper application of shrink tubing or electrical tape
- ❏ splices at least 40 mm (1½") away from other splices, harness branches, or connectors
- ❏ proper ground connections
- ❏ properly installed seals or connector locks
- ❏ proper application of petroleum jelly or dielectric grease

After repairs, inspect the vehicle for these conditions:

- ❏ proper operation of all warning lamps
- ❏ no current trouble code is displayed
- ❏ all history codes have been cleared

Correct any defects.

11.2 Wiggle Test

A wiggle test will check for a cold solder joint or other poor connection. To perform this test, wiggle the wires and connection while checking for a change in resistance or voltage drop across the connection. See **EL11**.

Correct any defects.