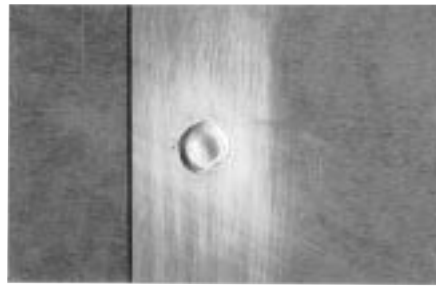
Uniform Procedures For Collision Repair

WE01A–GMA (MIG) Plug Weld

 v.2.4

1. Description

This procedure describes methods for making and evaluating gas metal arc (GMA) plug welds (MIG plug welds) on all types of automotive aluminum alloys.



2. Purpose

The purpose of this procedure is to provide industry-accepted requirements for performing high-quality GMA (MIG) plug welds on aluminum. 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

PS01 Personnel Safety

3.2 Other Information

Equipment-specific information
Vehicle-specific repair information

4. Equipment And Material Requirements

4.1 Shielding Gas

A shielding gas of 100% argon is recommended for GMA (MIG) welding automotive sheet aluminum. The flow rate is normally set at 20–50 cfh, or 3–4 psi. Welding should not be performed in a draft or wind exceeding 8 kph (5 mph).

4.2 Filler Wire

Filler wire must be compatible with the base metal alloy being joined. Follow the vehicle maker's recommendations for the specific type of filler wire.

For welding these alloy series to these alloy series → ↓	2000	5000(1)	6000
2000	4043 4145	Not Recommended	4043 4047 4145
5000(1)	Not Recommended	5356 5183	5356 5183
6000	4043 4047 4145	5356 5183	4043 5356(2)

(1) The preferred filler alloy is shown first.

(2) 6009, 6010, 6013, and 6111 alloys have a high copper content and should not be welded to another 6000 series with 5356 electrode wire.

Filler wire thickness is based on the metal thickness being welded. Use the following chart:

Metal Thickness	Filler Wire Diameter
up to 1.6 mm (1⁄16")	0.6 mm (.025")
1.6–2.4 mm (1⁄16–3⁄32")	0.8 mm (.030")
3.2 mm (1⁄8")	0.8 or 1.2 mm (.030" or 3⁄64")
4.8 mm (3⁄16")	1.2 mm (3⁄64")
6.3 mm (1⁄4")	1.2–1.6 mm (3⁄64–1⁄16")

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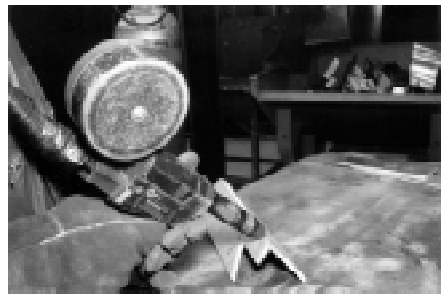

Avoid contaminating the filler wire with dirt, dust, moisture, etc. When not in use, the filler rod should be stored in its original container or a sealed, plastic bag. Store in a warm, dry area to avoid condensation.

4.3 Wire Feeder

A spool gun or push-pull wire feeder is recommended for GMA (MIG) welding automotive sheet aluminum. Change the gun, drive rolls, and cable liner if the welding machine is not dedicated to aluminum.

4.4 Transfer Mode

Either spray-arc or pulsed-spray is the preferred transfer mode for GMA (MIG) welding automotive sheet aluminum.

4.5 Polarity

Reverse polarity (electrode positive and base metal negative) is recommended for collision repair aluminum welding.

4.6 Welder Settings

Collision repair GMA (MIG) welders operate on either 110- or 220-volt, AC power. The thickness of the aluminum being welded, and the weld position, determines how much voltage and amperage are needed. Refer to the table for approximate settings.

Thickness	Position	Amperage	Voltage
1.5 mm (1⁄16")	Flat	70–110	15–20
2 mm (3⁄32")	Flat H/V/OH	90–150 110–130	18–22 18–23
3 mm (1⁄8")	Flat H/V OH	125–150 110–130 115–140	20–24 19–23 20–24
5 mm (3⁄16")	Flat H/V OH	180–210 130–175 130–190	22–26 21–25 22–26

(cont'd)

4. Equipment And Material Requirements (cont'd)

4.7 Special Equipment

Use tools and materials, such as abrasives, that are designated for use only on aluminum, to avoid surface contamination.

A stainless steel wire brush, dedicated for use on aluminum, is recommended for cleaning aluminum before making a weld.

A slotted "T" handle is recommended for destructively testing plug welds on aluminum.

5. Damage Analysis

Does not apply.

6. Personnel Safety

6.1 General Safety

General safety information is in **PS01**.

6.2 Electric Shock

To prevent injury from electric shock:

- ❏ Set the welding machine following the equipment maker's instructions.
- ❏ Make sure cables and wires are in good condition.
- ❏ Make sure all connections are in good condition.
- ❏ Never place the welding machine in a wet area.
- ❏ Never stand in a wet area when welding.
- ❏ Never use the top of the welding machine as a table for food, etc.
- ❏ Inspect all welding machine plugs and receptacles before each use.
- ❏ Wear dry shoes or boots.

6.3 Arc Rays

To prevent eye injuries from ultraviolet exposure:

- ❏ Use a face helmet with a filter plate and clear safety lens cover.
- ❏ Use at least a grade 10 filter when welding aluminum.
- ❏ Say "cover" before striking an arc to alert others in the area.

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6. Personnel Safety (cont'd)

6.4 Welding Fumes

To prevent injury from exposure to welding fumes:

- ❏ Wear an approved welding respirator.
- ❏ Use a welding fume extractor.
- ❏ Provide ventilation with a fan or other air circulator.

6.5 Welding Sparks

To prevent burns from welding sparks:

- ❏ Wear safety glasses with side shields under the welding helmet.
- ❏ Wear protective clothing with long sleeves and no cuffs. Fasten shirt top button when welding.
- ❏ Wear leather gloves and leather cape welding sleeves.
- ❏ Do not handle metal parts until they have cooled.
- ❏ Wear high-top leather shoes or boots.
- ❏ Make sure clothing and shoes are free from oil, grease, or other flammable materials.
- ❏ Remove all flammable materials from the area to be welded.
- ❏ Do not carry matches or butane lighters in pockets.
- ❏ Do not weld near parts containing fuel, such as fuel tanks, lines, pumps, etc.
- ❏ Keep a fire extinguisher in the work area while welding.

7. Environmental Safety

Does not apply.

8. Vehicle Protection

8.1 Electronic Parts

To protect computers and other sensitive parts from damage:

- ❏ Follow the vehicle maker's recommendations for recording and resetting electronic memory settings, such as radio, seats, etc.
- ❏ Ensure that the ignition switch is in the LOCK position.
- ❏ Disconnect and isolate the negative battery cable, and disarm the passive restraint system. Follow the vehicle maker's recommendations.
- ❏ Carefully remove computer modules when welding or heating within 300 mm (12"). Some vehicle makers specify greater distances. Protect modules, connectors, and wiring from dirt, heat, static electricity, and moisture.
- ❏ Loosen or remove any wiring harnesses or electrical parts that could be damaged during the repair process.

Remove the battery if it is near an area to be welded or heated.

8.2 Sparks

To protect surfaces from welding sparks:

- ❏ Use welding blankets on surfaces that can be covered.
- ❏ Remove interior trim, headliners, upholstery, and other parts if the interior will be exposed to heat or sparks.

9. Repair Procedure

9.1 Plug Weld Procedure

To make a GMA (MIG) plug weld:

- ❏ 1. Clean the mating surfaces to remove oxides and any other residual contaminants that could adversely affect weld quality.
- ❏ 2. Refer to the vehicle maker's recommendation for the location, number, and size of plug weld holes. If no recommendations are available, punch or drill 10 mm (⅜") holes in the outer panel at the same locations used originally by the vehicle maker. When plug welds are used to join three or more panels, punch or drill holes in every piece except the base piece. Make the holes progressively smaller from the outer to the base piece.

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9. Repair Procedure (cont'd)

❑ 3. Clamp the mating surfaces tightly together.
❑ 4. Make sample test welds on scrap pieces of the same type and thickness as the parts to be welded. Make the sample welds in the same position as the welds on the vehicle. See **11.1**.
❑ 5. Visually inspect and destructively test the sample welds to verify the welder settings and the welding technique. See **11.2** and **11.3**.
❑ 6. Locate the work clamp as close to the welding site as possible.
❑ 7. Make the welds on the actual parts. Some vehicle makers recommend preheating the weld area to reduce defects caused by cold starts.
❑ 8. Dress the welds, as required. Do not reduce the thickness of the surrounding metal.

10. Use Of Recycled (Salvage) Parts

To prepare salvage parts for welding:

❑ Trim the parts to fit.
❑ Remove all heat-affected areas.
❑ Make sure the parts are not deformed along the weld joints.
❑ Make sure mating surfaces are clean.

11. Inspection And Testing

11.1 Test Welds

Make sample test welds, before welding on the vehicle, using the same thickness and alloys that will be welded on the vehicle. Make the test welds in the same position as the welds on the vehicle. Visually inspect and destructively test the sample welds before welding on the vehicle.

Make the test welds on small pieces of flat scrap aluminum, trimmed to about 75 x 125 mm (3 x 5"). Damaged parts that are to be replaced may provide scrap pieces. Punch a single 10 mm (⅜") hole in the middle near the end of one coupon. Lap the coupon with the hole about ¾ over the other coupon's length.

Note: Some vehicle makers recommend preheating the weld area to reduce defects caused by cold starts.

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11.2 Visual Inspection Of The Weld

The following visual inspection requirements for nugget height, diameter, and penetration are for 1.2 mm (3⁄64"), 5356-series aluminum. The requirements will change slightly for other aluminum alloy types and thicknesses.

The face of the plug weld must meet these requirements:

- ❏ no cracks
- ❏ crater completely filled
- ❏ no porosity, skips, or voids
- ❏ no undercut
- ❏ hole completely filled
- ❏ nugget height no greater than 3 mm (1⁄8")
- ❏ nugget diameter of 11–15 mm (7⁄16–9⁄16")

The back side of the plug weld must meet these requirements:

- ❏ no cracks
- ❏ no suck-back
- ❏ penetration diameter of 3–8 mm (1⁄8–5⁄16")
- ❏ penetration extends no more than 3 mm (1⁄8") from the bottom

Use a dye penetrant to detect cracks in the weld or base metal. If defects are detected, adjust the welder and welding technique, and repeat the test welds before welding on the vehicle.

If the vehicle maker recommends the application of a dye penetrant to welds on a vehicle, use the following procedure if a crack or other defect is detected:

- ❏ 1. Thoroughly remove the dye penetrant to avoid contaminating the surface.
- ❏ 2. Remove the defective area. Do not thin the surrounding metal.
- ❏ 3. Reweld the area.
- ❏ 4. Repeat the visual inspection.

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11.3 Destructive Test

Perform a peel test on the sample plug weld. To perform a peel test:

- ❑ 1. Secure the end of the bottom coupon in a vise and bend it over 90° so the top coupon, and the face of the weld nugget, are pointing upward.
- ❑ 2. Attach the slotted T-handle on the end of the top coupon.
- ❑ 3. Roll the top coupon with the T-handle to peel it from the bottom coupon.
- ❑ 4. There must be a tear-out hole in the bottom coupon at least 5 mm (3⁄16") in diameter.

Adjust the welder and welding technique, and repeat the test welds, if required.