



Joining and Dispense Process Control Procedure

1 Scope

Note: Nothing in this standard supercedes applicable laws and regulations.

Note: In the event of conflict between the English and domestic language, the English language shall take precedence.

1.1 Material Description. This standard defines equipment process control and product inspection requirements for producers of GM welded or mechanical clinched product.

1.2 Symbols. Not applicable.

1.3 Applicability. The requirements of this standard are applicable to joining and dispense processes utilized by a General Motors fabricating and/or assembly plant to manufacture automotive parts and assemblies (prior to paint operations).

1.4 Remarks. For clarification of this standard or editorial comments, email the GM Weld Council at weld.council@gm.com.

Proposed changes to this standard must be presented to the Global Weld Council. To suggest a change to this standard, reference the "Procedure for Weld Standard Changes" on the Global Weld Council's web page.

2 References

Note: Only the latest approved standards are applicable unless otherwise specified.

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

None

2.3 Additional References.

- Body-in-White (BIW) Manufacturing Validation Standard (MV1)
- Dispense Tool Data Sheet
- Global Launch Manual
- Global Manufacturing System (GMS) Operating Guideline
- GM Global Quality Requirements (GQR) Manual
- GM Global Safety 21 Process
- Tool and Equipment Bulletin 15-6,3
- Weld Tool Data Sheet

3 Requirements

3.1 Requirements on Test Specimens. Not applicable.

3.2 Designation of Responsibility.

3.2.1 Product Engineering. The product engineering function is responsible for defining the structural requirements of the vehicle. These requirements include the joining method, quantity, location, and product tolerances. Product acceptance criteria are to be consistent with published GM Engineering Standards.

3.2.2 Manufacturing Engineering. The manufacturing engineering function is responsible for evaluating the product design for manufacturability. Manufacturing Engineering defines the process, type of tooling, and operational sequences to manufacture the product in conformity to the released design.

3.2.3 Plant Responsibility. The plants must adhere to the product specifications approved by Product Engineering and the process requirements defined by Manufacturing Engineering. Product Engineering must approve any variance or deviation from product specifications. Variance from process requirements must be in agreement with written procedures.

3.3 Process Evaluation.

3.3.1 Tool Verification and System Qualification. The procuring manufacturing engineering function must verify that new as built tooling agrees with the tool design and/or Tool and Equipment Statement of Requirements. The applicable sections of the **Global Launch Manual** and Body-in-White (BIW) Manufacturing Validation Procedure (MV1) are to be utilized to perform the verification and qualification activities. Any tooling revisions necessitated by this procedure must be completed and tool design documents updated. Records of the verification and system qualification activity are to be maintained. Once qualified, the applicable Weld Tool Data or Dispense Tool Data Sheet and the associated robot program are to be placed under change control.

3.3.2 Tool Re-qualification. Each tool must be re-qualified whenever a change occurs in the product or process that was part of the original verification and qualification activity. Records of the re-qualification activity are to be maintained.

3.3.3 Equipment Process Monitoring. Equipment process monitoring, (i.e., predictive maintenance) consists of measuring process parameters established during tool qualification as well as visual evaluation of the equipment functional operation. Parameters identified outside prescribed limits require appropriate corrective action to restore the process to the qualified state. Equipment process monitoring requirements for the various joining and dispense processes are contained in Appendices A thru K (Tables A1 thru K1) of this standard. Tasks identified as Operator Maintenance (OM) should be considered for assignment to the production organization if practical. Equipment process monitoring activities are to be described in written procedures or standardized work.

3.3.4 Equipment Scheduled Maintenance. Each location shall have documented plans for the preventative maintenance of equipment. The equipment maintenance schedule should be consistent with the tool or equipment manufacturer's recommendations.

3.4 In-Process Inspection and Test. In-process inspection consists of evaluating the manufactured/welded product with the released design and the applicable GM Engineering Standards to identify, contain, and repair nonconforming product. In-process inspection and tests are to occur as close as practical to the point of operation. The in-process inspection and test activity for all welded parts and dispense applications must be described in written procedures or standardized work. Unless stated elsewhere, inspection and testing is to occur at evenly spaced intervals throughout the shift, (i.e., a frequency of four times per shift would equate to one check approximately every 2 h of an 8 h shift, a frequency of two times per shift would equate to one check in the first half of the shift and one check in the second half of the shift).

The purpose of the in-process inspection is to periodically verify specific quality attributes and detect deficiencies prior to product leaving the weld shop. In-process inspection is not a substitute for the required equipment maintenance or equipment process monitoring.

Nonconforming product identified during in-process inspection and test requires suspect product to be contained and repaired or an authorization allowing the product to deviate from specification. Documented corrective actions are required for nonconforming product.

3.4.1 In-Process Inspection and Test (Resistance Spot Welds and Sheet Metal Projection Welds). A deformation check of all spot welds (for all styles and all cells) is recommended to occur four times per shift at evenly spaced intervals. The minimum required frequency is one check per weld gun, metal stack-up, and weld schedule combination, sampled two times per shift.

When a weld gun installs more than one weld on the same metal stack-up or on different body styles, rotate the in-process inspection (where practical) to include the other welds and body styles.

Concurrent with the deformation checks, visually inspect the adjoining welds for conformance to the applicable product drawing and GM Engineering Standard.

This visual inspection is to identify welds containing holes or cracks, welds not installed, edge welds, welds with excessive indentation, distortion, or surface eruptions, and extra welds.

In instances where a deformation check of spot welds is not possible or the spot welds are inaccessible due to being closed out, the alternative methods of verifying or assuring weld fusion may be utilized:

- Ultrasonic weld inspection (refer to 3.6).
- Increased equipment process monitoring.
- Increased weld destruct test frequency.
- Witness coupons.

The frequency and use of an alternative method must be documented as described in 3.4.

3.4.2 In-Process Inspection and Tests (Welded Fasteners). Welded fasteners shall be verified for conformance to the visual acceptance criteria of the applicable standard a minimum of two times per shift.

Threaded welded fasteners are to be tested with a chisel notch test, click wrench procedure or portable nut retention tester. Retention of non-threaded welded fasteners is to be tested with a chisel notch test. The minimum required frequency is one fastener per weld gun and metal stack-up, sampled two times per shift.

When a weld gun welds more than one fastener on the same metal stack-up or on multiple body styles, rotate the in-process inspection (where practical) to include the other fasteners.

3.4.3 In-Process Inspection and Tests (Welded Studs). Welded studs shall be verified for conformance to the visual acceptance criteria of the applicable standard a minimum of two times per shift.

Drawn arc weld studs are to be proof tested utilizing a nondestructive bend test or click wrench style stud testing tool. The minimum required frequency is one stud per weld gun and metal stack-up, sampled two times per shift.

When a weld gun installs more than one stud on the same metal stack-up or on multiple body styles, rotate the in-process inspection (where practical) to include the other studs.

3.4.4 In-Process Inspection and Tests (Mechanical Clinches). Mechanical clinches shall be verified for conformance to the visual acceptance criteria of the applicable standard a minimum of two times per shift.

Mechanical clinches are to be tested according to the manufacturers' recommendation using a Go/No Go gauge, calipers or a scissors gauge (7.1, Glossary). The minimum required frequency is one clinch for each operation and metal stack-up, sampled two times per shift.

When one tool installs more than one clinch on the same metal stack-up or on multiple body styles, rotate the in-process inspection (where practical) to include the other clinch locations.

3.4.5 In-Process Inspection and Tests (Arc and Laser Welds). Manually installed arc welds shall be verified for conformance to the visual criteria of the applicable GM Engineering Standard and product design release information on all jobs. Automated or robotically installed arc welds, arc braze, plasma braze, laser and laser braze joints shall be verified for conformance to the visual acceptance criteria of the applicable standard a minimum of two times per shift on each body style produced.

In-process physical testing of arc welds, arc braze and laser braze joints is not required.

3.4.6 In-Process Inspection and Tests (Sealer and Adhesives). Manually applied sealer and adhesive shall be verified for conformance to the visual acceptance criteria of the product release document or the approved Product Quality Standards (PQS) on all jobs. **Note:** Bead diameters when shown are reference values only to aid in the initial set up and qualification of the process to achieve wet out.

Automated dispense operations equipped with vision monitoring require inspection of a minimum of one 25 mm portion of the bead.

3.4.7 In-Process Inspection and Tests (Self Pierce Rivets). Self Pierce Rivets (SPR) shall be verified for conformance to the visual acceptance criteria of the applicable standard a minimum of two times per shift.

3.4.8 In-Process Inspection and Tests (Clinch Studs). Clinch studs shall be verified for presence and correct part a minimum of two times per shift. Clinch stud torsional resistance is to be verified per the sample size and frequency specified for standard care fasteners in the GM Global Quality Requirements (GQR) Manual.

3.4.9 In-Process Inspection and Tests (Clinch Nuts). Clinch nuts shall be verified for presence and correct part a minimum of two times per shift. Clinch nut torsional resistance is to be verified per the sample size and frequency specified for standard care fasteners in the GM Global Quality Requirements (GQR) Manual.

3.4.10 In-Process Inspection and Tests (Fasteners). Torque controlled fasteners (with the exception of Self Piercing and Extruding Screws) inspection and process control requirements are specified in the GM Global Quality Requirements (GQR) Manual.

Self Piercing and Extruding Screws shall be verified for conformance to the visual acceptance criteria of the applicable standard a minimum of two times per shift.

3.5 Vehicle and Component Teardown - General. The purpose of the vehicle or component teardown is to verify the effectiveness of the joining and dispense related process controls, (i.e., equipment process monitoring, equipment maintenance, and in-process inspection) implemented.

Nonconforming product identified during a teardown requires suspect product to be handled in accord with the Global Quality Requirements for Corrective Action and Nonconforming Material.

3.5.1 Vehicle Teardown Frequency - Assembly Plants. At the Start of System Fill, the frequency of full body destruct/teardown is one of each new body style per month.

Once the system is running at a steady state, the weld system process capability can be assessed. Once acceptable process capability has been demonstrated and documented, the vehicle teardown frequency can then be reduced to a quarterly teardown/destruct test of each body style. Quarterly teardown means one of each body style produced be evaluated every 13 production weeks.

An acceptable process capability demonstration consists of completing three consecutive monthly teardowns that meet requirements.

3.5.2 Component Teardown Frequency - Fabricating Plants. At Start of Production, the frequency of teardown/destruct tests is to be one of each assembly per month until process capability is demonstrated and documented. Process capability consists of completing three consecutive teardown/destruct tests that meet requirements. The frequency can then be reduced to a quarterly teardown/destruct test of each assembly.

3.5.3 Teardown (Resistance Spot Welds). Prior to conducting each teardown and as part of a re-qualification activity, weld quantity and location are to be verified. Visual acceptance criteria including applicable appearance standards are also to be verified.

The teardown is an evaluation of welded product that uses any of the various methodologies (i.e., destructive hammer and chisel, peel test, mechanical spreader, cross sectioning) to measure and evaluate various product quality characteristics for conformance to requirements. Destructively tested product results in irreversible metal separation, and this product cannot be reworked or repaired.

Note: Peel testing is the preferred method of inspection for aluminum spot welds. Hammer and chisel testing is not an acceptable method of inspection for aluminum spot welds.

3.5.4 Teardown (Welded Fasteners). Prior to conducting each teardown and as part of a re-qualification activity, correct part, quantity and location are to be verified.

Welded fasteners are to be destructively tested to verify either fusion requirements or push out load strength criteria in accord with the applicable GM Engineering Standard.

3.5.5 Teardown (Welded Studs). Prior to conducting each teardown and as part of a re-qualification activity, correct part, quantity and location are to be verified.

Welded studs are to be destructively tested to verify either fusion requirements or push out load strength criteria in accord with the applicable GM Engineering Standard.

3.5.6 Teardown (Mechanical Clinches). Prior to conducting each teardown and as part of a re-qualification activity, clinch quantity, location and visual acceptance criteria are to be verified. In addition, bottom thickness and button diameters are to be measured. Clinches that are outside the acceptable ranges for these measurements are discrepant.

3.5.7 Teardown (Arc and Laser Welds). Prior to conducting each teardown and as part of a re-qualification activity, correct bead location (start and stop), visual acceptance criteria and effective bead length are to be verified.

Arc and Laser welds are to be cross sectioned to assess any internal discontinuities in the weld and to verify that the leg length, throat, and penetration requirements exceed the minimum requirements of the applicable GM Engineering Standard.

Inspection, measuring and test equipment to perform the image analysis of weld cross sections must be capable of evaluating the specified measurable criteria to an accuracy of 0.1 mm. Weld cross sections are to be viewed at 15x or less magnification.

The number of required weld cross section samples is to be determined by the specified length of the weld bead in accord with Table 1. Cross sections are not to be taken within the first 5 mm or last 5 mm of the weld.

Table 1: Weld Cross Sections

Specified Weld Bead Length (mm)	Number of Cross Sections	Location of Cross Sections
30 or less	1	Midpoint of weld
31 to 100	2	Equally spaced from each other and from the ends of the welds
100+	3	Equally spaced from each other and from the ends of the welds

3.5.8 Teardown (Sealer and Adhesives). In conjunction with each teardown and as part of a re-qualification activity, dispense material wet-out and applicable appearance standards are to be evaluated to the product release documentation or an approved Product Quality Standard (PQS).

Note: This item does not apply to adhesives used to structurally bond composites (see 3.7) or hem flange adhesives (see 3.8).

3.5.9 Teardown (Self Pierce Rivets). Prior to conducting each teardown and as part of a re-qualification activity, SPR quantity, location and visual acceptance criteria are to be verified.

At the start of production, a SPR joint for each gun and stack up is to be cross sectioned and evaluated for proper interlock and bottom thickness once per month until process stability is demonstrated. Process stability consists of completing three consecutive cross sections requirements. The frequency can then be reduced to a quarterly cross section evaluation.

3.5.10 Teardown (Fasteners). Torque controlled fasteners (with the exception of self piercing and extruding screws) do not require physical testing or evaluation during vehicle teardown.

Self piercing and extruding screws (also known as flow drilled screws) are to be verified to the visual acceptance criteria and applicable static torque requirements during each teardown.

3.6 Nondestructive Evaluation (NDE). Ultrasonic evaluation of resistance spot welds can be utilized in place of the required deformation or destruct tests provided the personnel and process have been qualified in accord with the applicable regional standard.

3.7 Bonded Composites Teardown. Bonded composite panels are to be destructively tested at the same sample size and frequency as the Vehicle Teardown – Assembly Plants (see 3.5.1). Composite bond destructs are to be performed on a cured assembly to assess conformance to specifications for correct bond location, bond line adhesion and bond line width.

3.8 Hem Flange Adhesive Teardown. A destruct test to evaluate hem flange adhesive applications is to occur quarterly on post paint bake panels.

4 Manufacturing Process

Not applicable.

5 Rules and Regulations

5.1 Legal Regulations. All materials must satisfy applicable laws, rules, regulations and recommendations valid in the country of usage.

5.2 Language. In the event of conflict between the English and domestic language, the English language shall take precedence.

5.3 Inspection and Rejection. Not applicable.

5.4 Material Safety Data Sheets/Safety Data Sheets (MSDS/SDS). Not applicable.

5.5 Safety. Welding, cutting and allied processes can be performed safely with minimal health risk, provided Safe Operating Procedures are followed and the appropriate Personal Protective Equipment is utilized (refer to the GM Global Safety 21 Process).

6 Approved Sources

Note: Section 6 does not apply to GMW15563 as the applicability of the standard is GM manufacturing facilities.

7 Notes

7.1 Glossary.

Applicable GM Engineering Standard: Product Engineering specifies the applicable product acceptance criteria as part of the design release information (i.e., Inspection Data Sheets).

Change Control: The practices that are established to prevent arbitrary or unintended modifications to a qualified process.

Check: The practice of inspecting, or examining by looking, listening or touching to determine an existing status condition. For example an air leak in a hose may be checked by sight, hearing or touch.

Chisel Notch Test: A nondestructive test applied to a welded fastener where a chisel is used to apply a load to the side of fastener being tested until either a notch is created (acceptable) or the fastener separates from the panel indicating unacceptable fusion.

Click Wrench Procedure (Threaded Fasteners): A test applied to threaded fasteners utilizing a torque wrench preset to a "click stop".

Deformation Check: Term used to describe a nondestructive test performed with a chisel (paint scrapers and putty knives are not to be used for deformation testing). For this type of test, the chisel is inserted on both sides of the spot weld being evaluated until the metal begins to plastically deform indicating weld fusion. A deformation check does not provide an evaluation of weld size. Product evaluated by a deformation check can be reworked and returned to service.

Destruct Test: An evaluation of welded product that uses any of the various methodologies (i.e., destructive hammer and chisel, peel test, mechanical spreader, cross sectioning) to measure various joining and dispense quality characteristics for conformance to requirements. Destructively tested product results in irreversible metal separation, and this product cannot be reworked or repaired.

Destructive Hammer and Chisel Test: A destruct test method that utilizes a hammer and chisel to separate two or more pieces of metal in order to pull spot weld buttons for weld size evaluation.

Equipment Maintenance: Planned tasks that are established using supplier, engineering and historical information to maximize equipment, tooling and machine productivity and function. Equipment maintenance tasks are to keep equipment and machinery in its original operational condition to the extent possible. These tasks may also be referred to as "planned maintenance" or "preventive maintenance" or "scheduled maintenance".

Equipment Process Monitoring: Proactive tasks that are used to verify and monitor that the weld and dispense operations are operating within the defined process parameters established during tool qualification. Equipment process monitoring may also be referred to as "predictive maintenance".

In-Process Inspection and Test: Product monitoring activities that occur during the normal process flow or prior to completing the finished product.

Nonconforming Product: Product that does not conform (outside of tolerance) to the engineering specification.

Operator Maintenance (OM): Predictive maintenance tasks that can be assigned to production/operations personnel with support from Engineering and Maintenance.

Peel Test: A destructive test that mechanically separates a spot welded lap joint with a peeling or rolling motion.

Portable Nut Retention Tester: A portable means of evaluating the push-out strength of pierce nuts and other threaded fasteners.

Predictive Maintenance: Refer to "equipment process monitoring".

Process Capability: The demonstrated ability of a process or system to produce a product or products that meets requirements (i.e., no nonconforming patterns) over a period of time.

Product Monitoring: The various practices used to verify that parts, assemblies, and/or completed body-in-white structures were built in agreement with the weld quality acceptance criteria specified by Product Engineering. Product monitoring can occur prior to or after all welds have been completed on the product. Product monitoring that occurs prior to all welds being installed is referred to as in-process inspection and test. Product monitoring that occurs after all welds have been installed is referred to as final inspection and test.