



Metal Bonding Structural Adhesive Acceptance Criteria and Repair Procedures - Welded Bonded, Rivet Bonded, and Bonded Structures

1 Introduction

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 Purpose. This standard provides the acceptance criteria and repair procedures for structural adhesives in automotive products for which GM is responsible for establishing or approving product design. This standard does not apply to hem flange or anti-flutter (semi-structural) adhesives.

1.2 Applicability. This standard applies to any applications where a structural adhesive is used to bond metallic automotive substrates (this includes applications with self-piercing and extruding screws).

The criteria established in this standard become mandatory when referenced in product release information. Deviations from any adhesive criteria provided in this standard must be identified in product release information or an approved Product Quality Standard (PQS) document.

1.3 Remarks.

1.3.1 Usage. Structural bonds are considered satisfactory when they carry the intended service loads for a required period. Service loads on structures containing adhesive in a vehicle are varied in both type and magnitude and cannot be addressed by this standard. Therefore, while the manufacturing acceptance criteria of this standard are consistent with service loading requirements, they have been established specifically for use in process and product monitoring. Any attempted application of this document to other uses, such as post-crash quality assessment, may lead to an erroneous result or conclusion. Discrepant adhesive applications may still contribute to the integrity of the assembly by retaining a portion of their engineering properties.

1.3.2 Clarification. For clarification of this standard or editorial comments, email the GM Global 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.

GMW15049 GMW15563

2.3 Additional References.

- GMS Operating Guidelines and Global Launch Manual, Section B4
- GM Global Quality Requirements
- Procedure for Weld Standard Changes

3 Requirements

3.1 General Acceptance Criteria.

3.1.1 Correct Material. The structural adhesive applied shall be the material specified in the design release documentation. The product is non-conforming if incorrect material is being applied.

3.1.2 Material Shelf-Life. The "shelf-life" of the material shall not exceed the requirements in the material specifications. Material in containers with "shelf life" exceeding the specifications shall be replaced. The material shall not be exposed to temperatures during storage which exceed the requirements in the material specifications. Material in the dispense system that exhibits dispense characteristics that are normal and unremarkable is not required to be purged.

3.1.3 Bond Gap. Bond gap refers to the amount of separation between the faying surfaces of a joint. The maximum recommended (PT) gap is 0.5 mm (1.4 mm for full spectrum impact resistant (IR) adhesive). Joints that exceed the desired gap should have the product and/or process adjusted to reduce the gap to the desired range.

3.1.4 Substrate Condition. Cleaning of the faying surfaces is not required unless visibly contaminated by dirt, dust, corrosion, or other foreign matter. Preparation of the faying surfaces is not required unless specified in the material specifications.

3.2 Visual Acceptance Criteria.

3.2.1 Bead Location. Bead position across the flange may be adjusted to achieve wet out and to minimize or eliminate excess material squeezed out of the joint (see Figures A3 and A4 in Appendix A). Squeeze-out of adhesive is not allowed in locating holes, fixing holes and tooling holes. For other types of holes, e.g., clearance holes, drain holes, etc., small amounts of squeeze-out can be accepted as long as functionality is not degraded and work environment and wash-off problems do not occur.

3.2.2 Voids, Skips or Interruptions. Adhesive voids, skips or interruptions in the applied bead are acceptable provided wet out requirements are achieved.

3.3 Measurable Acceptance Criteria.

3.3.1 Wet Out. Wet out is defined as the "footprint" of adhesive surface area on each of the flanges in a joint that the adhesive covers. It is required that both flange surfaces exhibit evidence of adhesive contact (flattening of the dispensed bead) after separation. The portion of the joint not achieving wet out or only exhibiting adhesive on one surface is a discontinuity and the length of the joint not wet out cannot be counted in the effective length. If the length of this discontinuity exceeds the maximum allowable length for a discontinuity (see Table 1) then the product is nonconforming.

3.3.1.1 Wet Out Width. The wet out width (see Figures A4 and A5) is to be measured on the flange surface opposing the bead application flange. If the wet out width at the narrowest place, is less than the minimum width dimension shown in the design release documentation and on the Process Data Sheet (example in Appendix A, Figure A1 and Figure A2), then the portion/length of adhesive less than the minimum width is a discontinuity and cannot be counted in the effective length. If the length of this discontinuity exceeds the maximum allowable length for a discontinuity (see Table 1) refer to Table B1 in Appendix B.

If a wet out width dimension is not defined on the design release documentation, the default wet out width requirement is a minimum 7 mm width.

3.3.1.2 Voids, Skips or Interruptions. Voids, skips or interruptions in the adhesive wet out are discontinuities and cannot be counted in the effective length. If the length of the discontinuity exceeds the maximum allowable length for a discontinuity (see Table 1) refer to Table B1 in Appendix B.

3.3.1.3 Effective Length (Le). Adhesive applications that have an effective length greater than or equal to the minimum required length are acceptable provided that the maximum allowable discontinuity value listed in Table 1 is not exceeded. Adhesive applications that do not have an effective length greater than or equal to the minimum required length are nonconforming (refer to Table B1 in Appendix B to determine if product is nonconforming). Refer to Appendix C, Figure C1 for adhesive Length Acceptability Flow Chart used with Table 1.

Table 1: Length Requirements ^{Note 1}

Specified Length (mm) L_w	Maximum Allowable Length (mm) for any Single Discontinuity (post wet out)	Length Tolerance (mm) L_t	Minimum Required Length (mm) L_r
< 30	0	presence	N/A
30 to 150	20% of L_w up to a Maximum of 15	20% of L_w	$L_w - L_t$
> 150	30		

Note 1: Effective Length is defined as $L_e = L_a - L_d$.

Where:

L_e = Effective Length

L_a = Actual Length

L_d = Combined discontinuity lengths

3.3.1.3.1 Examples. See Figure 1 and Figure 2.

L_w Specified Bond Length

L_t Length Tolerance

L_r Minimum Required Length

L_a Actual Bond Length

L_d Combined Discontinuity Length

L_e Effective Bond Length

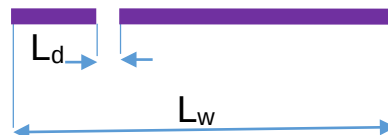


Math Data

$L_w = 100$ (as measured in math)

$L_t = 20$ (calculated from Table 1)

$L_r = 80$ ($L_w - L_t$)



Actual Physical Product

$L_a = 90$ (as measured on product)

$L_d = 5$ (as measured on product)

$L_e = 85$ ($L_a - L_d$)

✓
 $L_e \geq L_r$

Figure 1: Single "Footprint"



Math Data

$L_w = 310$ (as measured in math)

$L_t = 62$ (calculated from Table 1)

$L_r = 248$ ($L_w - L_t$)



Actual Physical Product

$L_a = 295$ (as measured on product)

$L_d = 20$ (as measured on product)

$L_e = 275$ ($L_a - L_d$)

✓
 $L_e \geq L_r$

Note: All lengths (L_x) are determined by the sums of the individual parts in the pattern.

Figure 2: Pattern "Footprint"

3.3.2 Post Cure Bond Cross Section(s). When required, the number and location of the representative cross section sample(s) are determined by the specified bond line length (L_w) as shown in Table 2.

Table 2: Cross Section Quantity and Location Requirements ^{Note 1}

Specified Bond Line Length (L_w)	Quantity of Cross Section(s)	Approximate Location of Cross-Sections
$L_w \leq 30$ mm	1	Midpoint of bond
$30 \text{ mm} < L_w \leq 100$ mm	2	Equally spaced from each other and the start and end of the bond
$L_w > 100$ mm	3	Equally spaced from each other and the start and end of the bond

Note 1: Shift cross section if approximate location falls on a weld or mechanical fastener if present.

3.3.2.1 Post-cure Bond Line Height. Bond line height refers to the thickness of the cured “ribbon” of adhesive between the faying surfaces of a joint after the full paint bake. Post-cure bond line heights greater than 0.5 mm (1.4 mm for full spectrum impact resistant (IR) adhesive) shall adjust the process -or- correct the mating parts to reduce the height to the desired range.

3.3.2.2 Post-cure Bond Line Width. Bond line width refers to the wideness of the cured “ribbon” of adhesive across the faying surfaces of a joint after the full paint bake. Post-cure bond line widths less than the design release documentation (7.0 mm when not specifically called out on the design release documentation) shall have their process wet out adjusted to bring the width to within desired range.

3.3.3 Wet Out Pattern Conformance Criteria. A pattern is a collection of adhesive “footprints” to which a tolerance is applied to meet structural requirements and for determining manufacturing acceptance of the product. The default pattern is on individual adhesive “footprints” on the structure installed at the same manufacturing plant. The wet out pattern is conforming (not discrepant per the requirements of this standard) when it meets or exceeds the default pattern tolerance or the as stated on the design release documentation. Manufacturing acceptance of product is based on all patterns conforming.

3.4 Disposition/Repair Procedure.

3.4.1 Disposition. Disposition of product nonconforming to this standard shall be handled in accordance with GM Global Quality Requirements for Corrective Action and Nonconforming Material. See Appendix B, Table B1 to determine when a discrepant adhesive bond causes the product to be nonconforming.

3.4.2 Repair Procedures. When required, nonconforming adhesive applications shall be repaired according to the procedures specifically authorized by the appropriate Product Engineer.

3.4.3 Repair Exceptions. An exception to specified product repair requirements may be permitted provided there is documented review and approval by the responsible Product Engineer allowing the suspect product to deviate from specification and/or conformance criteria.

4 Manufacturing Process

4.1 Process Control. The welding source is responsible for establishing practices and test methods to assure that the criteria of this standard are met and are consistent with the GM Joining and Dispense Process Control Procedure, GMW15563.

4.2 Adhesive Cure Control. The painting source is responsible for establishing practices and test methods to assure that the cure and/or post-cure cycle criteria are met and are consistent with the applicable material specifications.

5 Notes

5.1 Glossary.

Attribute Quality Characteristic: A product characteristic or feature that engineering requires 100% verification of conformance or error proofing. (Refer to GMW15049 *Key Characteristic Designation System*.)

Bond Line: Intermediate layer of cured adhesive used to connect substrates of similar or different materials.

Faying Surfaces: Pre-bonded pair of close fitting surfaces that are to be connected.

Footprint: Pattern left after wet out of adhesive material.

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