



Body Structure Adhesive Material Requirements

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 Purpose/Material Description. This standard is intended to cover the material and performance requirements of structural adhesive candidates that are used to bond automotive body substrates.

It is anticipated that assemblies bonded with these types of adhesives will incorporate a mechanical means of attachment (hems, fasteners, and/or welds) to facilitate fixturing prior to cure of the adhesive, generally, in the heat of the paint bake ovens, or in the case of two (2) component adhesives, the assemblies will be held in appropriate fixtures until the adhesive has attained sufficient strength for handling.

It is further anticipated that this specification shall cover "true" structural bonding applications, that is, cases where substrates are joined primarily by adhesives and the joint must maintain an acceptable strength level throughout the life of the vehicle. The adhesives covered by this standard are meant for use in the vehicle assembly plant body shops and are pumpable, other types of adhesive bonding shall be addressed in separate specifications.

1.2 Symbols. Not applicable.

1.3 Applicability.

1.3.1 Body Structure. For the attachment of body panels, reinforcements, frame members, floor pans, etc., where strength is required to augment welds, or increase vehicle durability and stiffness.

1.3.2 Closure Assemblies. Bonding of hem flanges and/or inner panel reinforcements to provide integrity and "lock-up" of the hem seam or durability and stiffness of the reinforcement to the inner panel.

1.4 Remarks.

1.4.1 Approvals. Adhesive candidates shall not be used for GM production vehicles without full approval by GM Materials Engineering. Adhesives can only be used in production (Production Approval) when there is an accompanying "AAA" number, that is, an Approved Adhesive Application (AAA) number for the intended application. The AAA number is unique to each substrate and surface treatment. The AAA number is released after all required testing to this specification has been completed for the specific combination of substrates plus surface treatments. The AAA number can be used as surrogate for multiple bond joint configurations or multiple assembly plant locations as determined by the approving GM Materials Engineer.

1.4.2 Test Data Submission. Production approval and AAA submissions shall be submitted on the standard test data template. Contact the approving GM Materials Engineer for an electronic copy of the standard test data template for submission.

1.4.3 Dispense. The adhesive system must be capable of being metered, mixed and dispensed using current GM production equipment.

1.4.4 Paint Bake. Adhesives approved to this specification shall be compatible with production paint systems and cannot be adversely affected by paint oven bake schedules.

1.4.5 Sealing. The use of a structural adhesive in an application does not automatically constitute "sealing" of that application. Each "bond" application, requiring "seal" shall be evaluated on a "case by case" basis, by the GM subject matter experts representing sealing and structural bonding disciplines.

1.4.6 Coated Substrates. Structural adhesive applications involving a substrate with a coating, shall demonstrate that the bond strength of the coating to the substrate is greater than the bond strength of the

adhesive to the coating following all test conditions required by this specification. Coatings include; ecoat or other paint coatings, laminations, plating, Plasma Vapor Deposition Coatings, etc.

2 References

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

2.1 External Standards/Specifications.

ASTM 2094	ASTM D1144	ASTM D3418	ISO 4587
ASTM D412	ASTM D1338	ASTM E502	ISO 10365
ASTM D570	ASTM D1875	ASTM E831	ISO 11343
ASTM D638	ASTM D1876	ISO 527	SAE J243
ASTM D792	ASTM D2369		

2.2 GM Standards/Specifications.

9986265	GMW3025	GMW14729	GMW15921
9986321	GMW3059	GMW15477	GMW16269
GMW8	GMW3205	GMW15481	GMW16700
GMW11	GMW3286	GMW15634	GMW16723
GMW3008	GMW14124	GMW15635	GMW16853
GMW3011	GMW14270	GMW15735	

2.3 Additional References.

- GWS-5K Standard Test Procedures, Welding Performance of Weld-Through Sealer and Adhesive, Steel available from GM Supply Power at Uniform Resource Locator (URL): <https://gmsupplypower.covisint.com/web/portal/home>: Document Library (tab): Manufacturing, Standards Mach and Equip Facilities, Global ME Body (folders).
- Standard Test Data Template (contact the approving GM Materials Engineer for an electronic copy).

3 Requirements

3.1 Classification of Type, Strengths and Performance. Adhesive systems shall be classified by type of curing mechanism, one (1) part or two (2) part and by strength as determined by lap shear and T-peel testing as described in Table 2.

3.1.1 Type One (1). One (1) component adhesives that are heat cured, typically in the first paint bake oven.

3.1.2 Type Two (2). Two (2) component adhesives that cure by the mixing of the two (2) components. Supplemental heat may be applied to speed up the cure.

3.2 Material Properties; Uncured Adhesive. See Table 1.

Table 1: Materials Properties; Uncured Adhesives ^{Note 1}

Property	Value	Test Method
Color	As specified by the GM approving Materials Engineer. Two (2) component systems shall have contrasting colors.	Visual
Moisture Absorption	< 2%	ASTM D570
Solids Content	> 99%	ASTM D2369
Viscosity Initial	Report	25 mm parallel plate rheometer, 15 °C, 0.450 mm gap, 3 s ⁻¹ shear rates, take reading at 180 s

Viscosity Aged 90 days at 35 °C	Report	25 mm parallel plate rheometer, 15 °C, 0.450 mm gap, 3 s ⁻¹ shear rates, take reading at 180 s
Density	Nominal ± 5%	ASTM D1875
Flash Point	> 200 °C	ASTM E502
Homogeneity	Material must be homogeneous and free of lumps or air bubbles	Visual
Sag Resistance	< 5 mm	SAE J243, ADS-10,
Mix Ratio ^{Note 2}	Report by weight and by volume	Visual
Working Life ^{Note 2}	Report	ASTM D1338, Method A, 23 °C, dew point > 10 °C, 10 mm diameter bead.
Time to Handling Strength ^{Note 2}	Report	ASTM D1144, 23 °C
Time to Peak Exotherm ^{Note 2}	Report	ASTM D3418
Cure Time, 23 °C ^{Note 2}	Report	ASTM D1144

Note 1: Each component of a type two (2) adhesive shall meet the requirements in Table 1, except where noted.

Note 2: These requirements are for type two (2) adhesives when mixed.

3.3 Flame Resistance (GMW16723). Materials that are self-extinguishing within 60 s when tested per GMW16723 shall be designated with the SE suffix: Self-Extinguishing (SE).

3.4 Material Properties; Cured Adhesive.

3.4.1 Type Two (2) Adhesives. Two (2) component adhesives shall meet the requirements of this specification except where noted. The supplier of two (2) component adhesives shall establish the boundaries of off-ratio mixing conditions where the cured adhesive no longer meets the requirements of this specification. These off-ratio boundaries shall be reported to the approving GM materials engineer.

3.4.2 Polymeric Substrates. Adhesives qualified for use on fiber reinforced or non-fiber reinforced substrates shall meet the requirements of GMW15921.

3.4.3 Metal Substrates. Use GM approved production substrates as specified by the approving material engineer. For example, steel grade to be used is cold roll with a thickness of 1.0 mm minimum. For oily metal, use one (1) challenging approved lubricant as specified by the approving material engineer. Degreasing and oiling according to GMW15477. Oil coating weight shall be 3 g/m² to 0.25 g/m² for corrosion protection oils/lubricants and 1.25 g/m² to 0.25 g/m² for dry lubes. Oils shall not exceed a storage time of 1 year and shall be stored in opaque and inert bins.

After application of the adhesive the oily metal panels shall be processed through pretreatment and Electrodeposition Primer (ELPO) prior to baking and exposure according to 3.6.4 and 3.7.2.4. Use any GM approved pretreatment (see GMW3011) and ELPO (see GMW3008) at target film thickness, as specified by the approving material engineer. Cyclic corrosion testing according to 3.6.4 and 3.7.2.4 is not required with oily Cold Roll Steel (CRS).

Production or AAA approval, will require testing to this specification of each unique combination of substrates, substrate plus oil, substrate plus surface treatment, etc., intended to be used in vehicle production, or as specified by the approving material engineer.

3.4.3.1 Bond Strength and Adhesion. Structural adhesive candidates shall be evaluated for strength and separation mode. Sample testing shall be done in sample "sets". Five (5) samples shall constitute a "set".

3.4.3.2 Lap Shear (see ISO 4587). All structural adhesive candidates shall be evaluated using the "lap shear" configuration.

3.4.3.2.1 Lap shear testing shall be done to establish tensile shear strength. The preferred separation mode of the adhesive shall be "cohesive" within the adhesive layer. For metal bonding, due to the high yield strengths of

adhesives, and "necking" or "stretching" of the lap shears bond area, the appearance of "bare" metal on the bond areas of the lap shears after tensile testing is not necessarily representative of unsatisfactory performance of the adhesive system.

3.4.3.2.2 In any case, the minimum required lap shear strength must be maintained, both initially, and after environmental exposure, and there may not be any evidence of "undercutting" corrosion of the bond site after environmental exposure. After environmental exposure a minimum of 80% cohesive separation within the adhesive is acceptable. A maximum of 20% other separation modes is allowed. Separation modes are defined by ISO 10365.

3.4.3.2.3 "Adhesive" separation of any "layer", e.g., paint coating, metal coating, lamination, plating, PVD, adhesion promoter, etc., in the test sample is defined as a delamination separation mode. Delamination is deemed an unacceptable separation mode.

3.4.3.2.4 Substrate coupons shall measure 25 mm x 100 mm, with a bond flat of 25 mm x 13 mm. Lap shear bond gap for metal bonding shall be 0.2 mm $\pm$ 0.05 mm unless otherwise stated in this specification.

3.4.3.2.5 Lap shears shall be tensile tested (pulled) at a rate of 10 mm/minute.

3.4.3.3 T-Peel (see ASTM D1876) Metal Bonding Only. Structural Adhesive candidates shall be evaluated using the "T-peel" configuration.

3.4.3.3.1 T-peel testing shall be done to establish tensile peel strength and separation mode of the adhesive. The acceptable separation mode of the adhesive shall be "cohesive" within the adhesive layer when evaluated initially (see 3.6.1). T-peel samples exposed to corrosion tests (see 3.6.4) and pull tested, shall exhibit 80% minimum cohesive separation within the adhesive layer and shall maintain the minimum load required by the specification. Furthermore, there shall be no evidence of "undercutting" corrosion of the bond site after environmental exposure.

3.4.3.3.2 "Adhesive" separation of any "layer", e.g., paint coating, metal coating, lamination, plating, PVD, adhesion promoter, etc., in the test sample is defined as a delamination separation mode. Delamination is deemed an unacceptable separation mode.

3.4.3.3.3 Individual sample pieces shall measure 30 mm x 200 mm, with a bond flat of 30 mm x 100 mm.

3.4.3.3.4 The bond gap shall be 0.2 mm $\pm$ 0.05 mm.

3.4.3.3.5 T-peel samples shall be tensile tested (pulled) at a rate of 50 mm/minute.

3.4.3.4 Wedge Impact Peel (see ISO 11343) Metal Bonding Only. Structural adhesive systems that are classified as, or intended to be used as, "impact resistant" or "fracture toughened" shall be evaluated by means of the ISO 11343 test method.

3.4.3.4.1 Test samples shall be of the "symmetric wedge" configuration.

3.4.3.4.2 Individual sample pieces shall measure 20 mm x 90 mm, with a bond flat of 20 mm x 30 mm.

3.4.3.4.3 The separation mode of the adhesive to the test substrate shall be 100% "cohesive" within the adhesive layer initially, and 80% cohesive following any environment.

3.4.3.4.4 "Adhesive" separation of any "layer", e.g., paint coating, metal coating, lamination, plating, PVD, adhesion promoter, etc., in the test sample is defined as a delamination separation mode. Delamination is deemed an unacceptable separation mode.

3.4.3.4.5 Test sample bond gap shall be 0.2 mm $\pm$ 0.05 mm for metal samples, and 0.8 mm $\pm$ 0.25 mm for non-metal samples.

3.4.3.4.6 Wedge impact peel samples shall be tested at a rate of 2 m/s for steel substrates and 3 m/s for aluminum substrates.

3.5 Bead Structure. The "structure" and appearance of a cured bead of the adhesive observed, and noted, to assure that there is no gassing, bubbling, or inclusions, within the cured bead when a 3.0 mm bead of adhesive is subjected to either the "minimum bake" or "over bake" schedule as described in 4.3.

3.6 Lap Shear and T-Peel Adhesive Strength and Adhesion.

3.6.1 Initial Test. Lap shear and T-peel samples shall be tested for "initial" strength levels and adhesion after adhesive cure. This testing shall be done no sooner than 16 h after completion of the cure schedule as described in 4.3.