

**ADHESIVE, WELDABLE, RIVETABLE, THERMAL CURE,
STRUCTURAL, ALUMINUM****WSS-M2G410-A****1. SCOPE**

The material defined by this specification is pumpable, one component, thermal curing, weldable or rivetable structural adhesives for aluminum.

2. APPLICATION

This specification was released originally for materials used to structurally bond body components such as top rails, rear sills, and cross members to floor pans and inners to outers in a wheel house. This adhesive can be used to bond oily, unclean mill finish and pretreated aluminum sheet, castings and extrusions for body-in white applications.

The use of pretreated aluminum sheet, castings and extrusions provide optimal adhesion performance for long term durability. Optimal adhesion strengths are achieved with adhesive bondlines of 0.25 mm. The material is cured in the electrocoat oven.

The Manufacturing Properties and Engineering Performance requirements defined in this specification are based on laboratory sample testing and define the minimum acceptance criteria for adhesive performance. The function and design requirements for the application are defined by the Sub-system Design Specification (SDS), key life test requirements, or vehicle program requirements.

Prior to use, the adhesive must be evaluated under the production parameters. The choice of substrates, stamping lubricants, stamping plant processing conditions, assembly plant processing conditions and specific design application may affect adhesive performance. Compliance with this specification does not guarantee the adhesive will function for all potential applications on a vehicle.

3. REQUIREMENTS**3.1 APPROVED SOURCES**

This specification requires the use of approved sources. Only the sources identified on the Ford Approved Source List (ASL) can be used when this specification is listed on the drawing, CAD file, or other documents. The list of approved sources is located within Ford at www.mats.ford.com or available externally through a Ford Materials Engineer.

3.2 SYSTEM COMPATIBILITY

Initial adhesive approval was based on a specific material system which included the substrate, stamping lubricants and adhesive. The material system was oven cured using specific production process parameters. Substrate choice, stamping lubricants, stamping plant processing conditions and assembly plant processing conditions may affect adhesive performance. If any of these parameters are changed, the adhesive performance must be validated using the new parameters.

Date	Action	Revisions	Rev. 04
2018 06 11	Editorial	See Summary of Revisions	B. Witkowski, NA
2017 10 19	Revised	See Summary of Revisions	B. Witkowski, NA
2003 01 23	Activated		N. Lindsay-Merte, J. Crist, NA



3.3 MATERIAL PROPERTIES

- 3.3.1 Weight Per Volume +/- 0.02
(ASTM D816)

The weight tolerance for any one supplier shall be +/- 0.02 kg/L, based on the recorded weight of their original approved production sample. Reference para 4.1.

- 3.3.2 Volatile Organic Compounds (VOC) Content +/- 10%
(EPA Method 24, Procedure B)

The VOC Content variation for any one supplier shall be +/- 10%, based on the recorded VOC Content of their original approved production sample. Reference para 4.2.

- 3.3.3 Cure Requirements Report minimum and maximum cure conditions, must meet requirements in this paragraph.

(Define the process cure window for material cure, report minimum and maximum time at temperature requirements to define performance boundaries).

Critical performance characteristics shall include, but are not limited to, the following

- Lap-Shear, para 3.5.1
- Stress Durability, para 3.5.2
- Fracture Toughness, para 3.5.4
- Fatigue, para 3.5.5
- Tensile Properties, para 3.5.7
- Peel Resistance, para 3.5.3

Minimum and maximum cure conditions to be proven by the supplier. A cured material is one which will meet all minimum properties required in this specification. The cure conditions required for this specification for e-coat bake are:

- Minimum cure 10 minutes metal temperature (maximum 20 minutes in oven) at 160 °C
- Maximum cure 30 minutes metal temperature (minimum 40 minutes in oven) at 205 °C

3.4 MANUFACTURING PROPERTIES

- 3.4.1 Rheology Report
(SAE J1524, rotational rheometer with 40 mm diameter parallel plates, 500 micron gap, 50 Pa/sec ramp, stress controlled rheometers use stress range 0 - 3500 Pa, strain controlled rheometers use strain range 0 - 100 sec⁻¹, evaluate material to highest stress or strain as the formulation will allow, report material batch/lot number, identify rheometer make and model, for each test condition report yield stress and submit plots for shear stress vs shear rate, submit plot for viscosity vs temperature at mid-range shear rate)

Initial (as received)

- Test at 23 +/- 1 °C
- Test at application temperature +/- 2 °C
- Test over range 10 to 50 °C at increments of 10 °C

Aged (age then test at 23 °C and application temperature)

- 7 days at 40 +/- 1 °C
- 90 days at 32 +/- 1 °C



- 72 hours at 45 +/- 1 °C

The rheology variation for any one supplier shall be +/- 10 %, based on the recorded rheology of the original approved production sample. The flow curves established for initial approval shall constitute the reference standard and shall be kept on file at the designated material laboratory. All samples shall produce flow curves that correspond to the reference standard when tested under the same conditions.

Final approval of material rheology for production shipments shall be made by the affected manufacturing activity. In all cases, the rheology shall be within the limits as identified on the material control plan.

3.4.2 Pumpability/Dispense Capability

Materials being considered for approval to this specification shall be evaluated for processing capability using extrusion, stream and swirl methodologies. The pumpability/dispense capability report must be approved by the affected assembly operation and Design Engineering. Results shall be made available to Materials Engineering prior to material approval and release.

Materials shall be a smooth homogenous mixture, free from entrapped air, foreign materials and properties detrimental to normal production operation. The material shall work with all the plant processes (cleaning operations, phosphating process, welding operations, etc.) and shall not deteriorate the performance of phosphating, electrocoat primer or other materials applications.

3.4.3 Differential Scanning Calorimetry

(20 +/- 1 mg sample size, 5 °C/min heating rate, 25 - 250 °C temperature range, submit Heat Flow vs. Temperature curve)

Onset of reaction	80 °C min
Glass Transition Temperature	Report

3.4.4 Sag Resistance

(FLTM BV 118-01, lab caulking gun applied 5 mm diameter bead, substrates per para 4.3, condition for 24 h at 40 °C, oven schedule per para 4.4, one panel each bake)

- | | |
|--------------|------------------------|
| • Horizontal | No measurable movement |
| • Vertical | No measurable movement |
| • Inverted | No loss of material |

3.4.5 Slump Resistance

3 mm max

- Assembly aged 30 days at 50 +/- 1 °C

Test Assembly: Two 25 x 100 mm coupons, prepared per para 4.3, with two 38 x 12 x 3 mm spacers. The spacers are placed at each end of one of the coupons, and sufficient adhesive is applied between the spacers to fill the gap. The second coupon is placed on top of the adhesive and spacers (Figure 1). Clamp the assembly with spring clips at each end. Remove excess adhesive from all exterior edges with a spatula.

Test Method:

- Prepare three assemblies per substrate and subject to exposure.
- After exposure, condition assemblies at 23 +/- 2 °C for 24 hours, then bake at minimum bake per para 4.4.



- Determine the slump by measuring adhesive loss from the bottom of the assembly.
- Photograph and record observations of any adhesive loss after exposure and after bake.
- Repeat the above procedures for maximum bake per para 4.4.

3.4.6 Bridging 3 mm max
(SAE J243 ADS-9, Section 3.3, Method D, non-flow fixture, substrates per para 4.3, photograph after exposure and after material cure, bake conditions per para 4.4)

- Assembly aged 30 days at 50 +/- 1 °C

3.4.7 Wash Resistance
(FLTM BV 116-01, Method B, 10.0 x 200.0 mm substrates, per para 4.3)

No measurable movement, displacement or wash-off.

3.4.8 Electrocoat Compatibility
(FLTM BV 119-01, use current production paints as identified by Material Engineering, substrates per para 4.3)

Shall not contaminate electrocoat primer bath or cause electrocoat film irregularities.

3.4.9 Welding Acceptance Test Must Pass
(FLTM BV 109-01, gun application, 25 coupon assemblies per condition, substrates per para 4.3)

- As prepared (fresh material)
- Assembly aged 30 days at 23 +/- 2 °C
- Assembly aged 30 days at 40 +/- 2 °C

3.4.10 Flammability with Continuous Spot Welding
(FLTM BV 114-01, substrates per para 4.3)

During welding tests, less than 5 % of the welds shall exhibit a flame and all shall be self-extinguishing within 30 seconds.

3.4.11 Rivetability

The adhesive shall not cause excess quilting as defined in Figure 2, nor cause a break through of the sheet metal or buckling of the rivet.

Original approval was based on laboratory / plant trials using hydraulic/electric and manual/robotic parameters.

New applications shall be validated using the intended production parameters.



Test Method:

Perform rivet tests using methods typical of the production application, e.g. hydraulic/electric, manual/robotic. Using 1.0 x 100 x 400 mm aluminum coupons construct an assembly as defined in Figure 3. A 3 mm bead of adhesive shall be applied 9.5 mm from edge of lower coupon prior to mating with the top coupon. Use rivet and type as specified by the application. After riveting, cure adhesive per para 4.4.

Examine the assembly. Cross section the assembly through the rivet.

A rivetability report must be approved by the affected assembly operation and Design Engineering. Results shall be made available to Materials Engineering prior to material approval and release.

3.4.12 Odor Rating 3 max
(FLTM BO 131-03, method D, cure per
FLTM BV 150-05, high and low bake per para 4.4)

3.4.13 Material Consistency

Shall be a smooth homogenous mixture, free from entrapped air, foreign materials and any properties detrimental to normal production operation.

3.4.14 Storage Stability

Heat greatly accelerates aging. The material shall be stored in closed containers away from all sources of heat. The shelf life of the material shall be 3 months from date of manufacture when stored below 32 °C. When materials are stored at temperatures below 23 °C, they shall be conditioned at room temperature 24 hours prior to application. Application properties are optimized with adequate conditioning of the material.

Ambient plant conditions may fluctuate between 7 °C and 38 °C. Materials shall be evaluated for local plant conditions to determine plant specific requirements in excess of 32 °C.

Critical performance characteristics to evaluate for shelf life stability shall include, but are not limited to, the following:

- Rheology, para 3.4.1
- Sag Resistance, para 3.4.4
- Slump Resistance, para 3.4.5
- Rivetability, para 3.4.11
- Stress Durability, para 3.5.2
- Fracture Toughness, para 3.5.4
- Fatigue, para 3.5.5
- Tensile Properties, para 3.5.7

3.5 ENGINEERING REQUIREMENTS

3.5.1 Adhesion Strength, min
(SAE J1523, substrates per para 4.3,
0.25 mm adhesive bondline thickness,
13 mm length overlap, 13 mm/min pull
rate, oven cure per para 4.4)

12.0 MPa, not to exceed
more than 30% reduction
of strength after aging or
exposure.



3.5.1.1 Normal
(Condition for 30 minutes at specified temperature prior to test)

- Test at 23 +/- 2 °C
- Test at 80 +/- 2 °C
- Test at -40 +/- 2 °C

3.5.1.2 Exposed
(Condition at 23 +/- 2 °C for 1 h,
subject to environmental cycle,
oven cure per para 4.4, test at 23 °C)

Environmental cycle:

- 40 +/- 1 °C for 7 days PLUS
38 +/- 1 °C for 98 +/- 2 % RH for 7 days PLUS
40 +/- 1 °C for 7 days PLUS
23 +/- 2 °C for 1 day

3.5.1.3 Aged
(Oven cure per 4.4, then expose per below, then condition at 23 +/- 2 °C for 24 h
after exposure, test at 23 +/- 2 °C)

3.5.1.3.1 Expose to 10 Thermal Cycles prior to evaluation

One Cycle:

90 +/- 1 °C for 4 h PLUS
38 +/- 1 °C and 98 +/- 2 % RH for 4 h PLUS
- 40 +/- 1 °C for 16 h

3.5.1.3.2 Expose to 10 Moisture Intrusion Cycles prior to evaluation

One Cycle:

16 h at 38 +/- 2 °C and 95 +/- 5 % condensing RH
4 h at -40 +/- 2 °C
4 h at 80 +/- 2 °C

Samples are to be conditioned at 23 +/- 2 °C and 50 +/- 5% RH over weekends
and holidays. Time between conditions shall not exceed 5 minutes.

3.5.1.3.2 Corrosion Environment- Expose to (CETP 00.00-L-467, 6 weeks) prior
to evaluation

3.5.2 Stress Durability
(FLTM BV 101-07, substrates per para 4.3, all coupons from one manufacturer's lot, report
thickness for each coupon and substrate yield strength for manufacturer's lot, oven cure
para 4.4, two fixtures, cyclic corrosion exposure, report data per test method)

Load condition of each tube, 2400N, all coupons tested must exceed 45 cycles without
failure.

3.5.3 Peel Resistance
(ASTM D1876, 0.25 mm adhesive bondline thickness, 76.2 mm overlap, 127 mm/min pull
rate, substrates per para 4.3, oven cure per para 4.4, condition for 30 minutes at specified
temperature prior to test)