

NAVISTAR, INC.		
Material, Parts, and Process Specifications (MPAPS)		NUMBER: MPAPS K – 6900
		<i>Former Designation: TMS-6900</i>
TITLE: Structural Adhesives – Part 1 and Part 2		CURRENT REV No.: 1709
		DATE: Sep. 2017
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<i>This specification may involve hazardous materials, equipment, and procedures. This specification does not purport to address all of the safety issues associated with its use. The user is responsible to consult appropriate safety and health practices and to determine the applicability of regulatory limits prior to use.</i>		

Part 1 – General, Property, and Performance Requirements

1.0 APPLICATION

Part 1 of this specification covers structural adhesive systems used for bonding parts in the construction of truck and tractor cabs and components, such as: hood and fender assemblies, body panels, roof components, air conditioning components, and other parts used in truck manufacture. Part 2 covers the production process requirements for structural bonding systems.

2.0 SCOPE

This specification covers the material properties, performance requirements, production quality and process control, supplier's responsibility, source approval and quality control, general information, and sources for the approved systems.

2.1 Description of Adhesive Resin Systems

2.1.1 Type I – One-part pumpable, heat cured epoxy

2.1.2 Type II – One-part extruded, heat cured epoxy with or without fiberglass layer

2.1.3 Type III – Two-part epoxy

2.1.4 Type IV – Two-part urethane

2.1.5 Type V – Two-part acrylic

2.1.6 Type VI – Two-part methacrylate

2.1.7 Type VII – Hot melt

2.2 Restricted Chemical Substances

Effective January 1, 2007, all product supplied to the requirements of this specification must comply with the requirements of the MPAPS B-50 specification.

3.0 REFERENCE DOCUMENTS

Unless otherwise specified, the latest issue of all referenced standards shall apply. The following Specifications, Standards, and Regulations are referenced in this specification.

Quality System Standard ISO 9001 or TS-16949	NAVISTAR MPAPS D-7133	ASTM E132
CFR Title 29, Part 1910	NAVISTAR TMS-9522	GM 9037P
NAVISTAR Supplier Packing and Shipping Std. D-13	NAVISTAR MPAPS P-9543	SAE J243
NAVISTAR Engineering Design Std. A-16	NAVISTAR MPAPS G-5	SAE J1523
NAVISTAR MPAPS B-50	ASTM D1002	SAE J1525
NAVISTAR MPAPS A-6	ASTM D5041	SAE J1553

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NAVISTAR MPAPS C-10
NAVISTAR MPAPS D-22
NAVISTAR MPAPS D-28
NAVISTAR MPAPS GT-24
NAVISTAR MPAPS GT-Paint

ASTM D2240
ASTM D2294
ASTM D2919
WSB-M18P11-A2

SAE J2334
ASTM B117
ASTM D638
ASTM D3163

4.0 REQUIREMENTS

Adhesive materials supplied to this specification shall bond the intended substrates to produce a permanent and structural bond. The general properties of as received materials, in the uncured state, are listed in Table 4. Adhesive materials supplied to this specification shall be compatible with all subsequent cleaning, pre-treat, and paint operations used in the Assembly Plant(s) and with current production materials for which the new adhesive approval is sought.

4.1 General Properties

Properties are provided for reference only. Properties shall be reported on submitted test reports and will be included in Table 4.

4.1.1 Uncured Properties

Specific requirements are to be determined between the material supplier, equipment supplier and the applicator.

4.1.1.2 Solids:

4.1.1.2.1 Method: SAE J243 Procedure ADS-7, Method A

4.1.1.2.1 Requirement: Report

4.1.1.3 Viscosity:

4.1.1.3.1 Method A: SAE J243, Procedure ADS-1, Agitated - Conditioning Method C, Pressure Flow Method 275 kPa (40 psi), $25 \pm 1^\circ\text{C}$ ($77 \pm 2^\circ\text{F}$), 20 g.

4.1.1.3.2 Method B: SAE J243, Procedure ADS-1, Agitated - Conditioning Method C, Test 2.2 Brookfield, spindle 7, 50 RPM

4.1.1.3.3 Requirement: Report

4.1.1.4 Aged Viscosity:

4.1.1.4.1 Method: Age sample at $43 \pm 1^\circ\text{C}$ ($110 \pm 2^\circ\text{F}$) for 72 hours. Test per corresponding method on section 4.1.3.

4.1.1.4.2 Required: Report

4.1.1.5 Process Compatibility:

Uncured adhesive shall remain in joints without flow or washout through the spray and immersion stages of pre-treat and E-coat. It shall be the supplier's responsibility to provide evidence of compatibility.

4.1.1.5.1 Method: MPAPS GT-24

4.1.1.5.2 Required: Pass

4.1.1.6 Fiberglass Constricted Layer:

If specified, die cut materials shall be supplied with a square weave fiberglass constricted layer. There shall be no loose glass fibers after the die cutting operation.

4.1.1.7 Weldability:

This requirement is only applicable when designated as a weld-through adhesive.

4.1.1.7.1 Method: SAE J243 Weld-Through Test ADS-3, Method B.

4.1.1.7.2 Required: Shall meet tensile, flashing, electrode life, and electrode pickup, as specified.

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4.1.2 Cured Material Properties

4.1.2.1 Tensile Strength-Ultimate (for materials which do not exhibit a definite yield point) or **Yield Strength** (for materials which do exhibit this property).

Will be determined by ASTM D638 using the 0.2 percent offset method. Speed of test will be as designated in the appendices of ASTM D638 or as agreed upon for new materials not listed.

4.1.2.2 Ultimate Elongation.

Will be determined by ASTM D638. Speed of test will be as designated in the appendices of ASTM D638 or as agreed upon for new material not listed.

4.1.2.3 Tensile Modulus.
ASTM D638 will determine tangent modulus of elasticity at 23°C. Speed of testing will be as designated in Table 1 of ASTM D638 or as agreed upon for materials not listed.

4.1.2.4 Poisson's Ratio

Determine per ASTM E132.

4.1.2.5 Shrinkage (Non Expanding Pumpables, Only)

4.1.2.5.1 Method: Fill a small, flat container 50 mm diameter x 6 mm height (2 in diameter x 1/4 in height) with adhesive material and subject leveled product to maximum bake temperatures for 40 minutes. Observe at room temperature.

4.1.2.5.2 Required: Shall show no visible evidence of shrinkage, cracking or overflow.

4.1.2.6 Volume Expansion/Shrinkage

4.1.2.6.1 Method: Test per GM 9037P, or WSB M-18P11-A2 on coupons prepared in 4.2.1 *Sample Preparation*. Obtain substrate test coupons that are dimensionally capable of supporting the entire part. For sheet stock, extrusions or injection-molded samples, avoid cutting from the edges of the sheet or part.

4.1.2.6.2 Required: Report only, requirements are under development.

4.2 Property and Performance Requirements

In the event of material screening the performance test matrix may be truncated to include only shear strength values for initial, 70°C or 120°C hot pull (unless otherwise instructed), -40°C cold pull, and 168-hour water immersion conditions.

4.2.1 Sample Preparation

A minimum of five samples shall be prepared for each condition tested. The surface condition tested shall be representative of production conditions and fully described in the test report. The bond line shall be between 0.25 and 1 mm (.010 and .040 inches) thick; normally metal at 0.25mm and plastic at 0.76mm (0.030 in). The overlap shall be 12.5 mm (.5 inch) for metal and 25 mm (1 inch) for plastic, unless otherwise directed. The cure conditions shall be described fully in the test report and should closely match the production cure conditions. Times and temperatures should represent actual bond line conditions rather than the reported temperatures of the heating elements or the oven air temperature. These cure conditions will be listed on the attached tables and shall be reproducible for future testing. Production cure conditions are listed in Table 3.

4.2.1.1 Steel Surface Preparation: Two sets of five samples shall be made for each condition tested. Solvent (acetone) clean samples thoroughly. The first set shall be tested clean. The second set shall have a light oil coating, as in steps 5 and 6 listed below, under *Aluminum Surface Preparation*.

4.2.1.2 Aluminum Surface Preparation: Three sets of five samples of aluminum test samples shall be made for each condition tested. Solvent (acetone) clean samples thoroughly. The first set shall be tested

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clean. The second set shall have a light oil coating, as in steps 5 and 6 listed below. The third set shall be prepared in the following manner:

- 1) Clean samples thoroughly with acetone.
- 2) Apply Mill Oil (Ashland Tectyl 900) liberally to the bonding surface.
- 3) Wipe oil off surface with a clean, soft, paper lab towel. A light oil residue should remain.
- 4) Bake samples for four (4) hours at 200°C (392°F).
- 5) Apply Drawing lubricant (Quaker 61AUS)** liberally to the bonding surface.
- 6) Wipe oil off surface with a clean, soft, paper lab towel. A light oil residue should remain.
- 7) Prepare test samples as required.

** Other lubricants will be used in production. Adhesives and lubricants shall be compatible with each other. Testing compatibility shall be the responsibility of the supplier of the new material. The Plant Metallurgist or QC Manager at the Navistar Body Plant in Springfield, Ohio maintains a list of approved lubricants.

4.2.1.3 Plastic and Painted Surface Preparation: One set of five samples shall be made for each condition tested. Freshly painted surfaces shall be aged for 72hrs at $49 \pm 3^{\circ}\text{C}$ ($120 \pm 5^{\circ}\text{F}$) prior to surface preparation. Solvent (isopropanol) clean samples thoroughly prior to bonding.

4.2.2 Lap Shear Strength

4.2.2.1 Method: Prepare samples as directed in 4.2.1 *Sample Preparation*. Test per ASTM D3163 or ASTM D1002, as appropriate. Tensile machine jaw separation rate shall be 13 mm (.5 in) per minute. Test overlap shear at the temperatures specified in Table 1A after holding at temperature for 30 minutes. Report the average of five tests and their failure modes.

4.2.2.2 Required: See Table 1A.

4.2.3 Cross Peel Test

4.2.3.1 Method: Prepare samples as indicated in 4.2.1 *Sample Preparation* except for the geometry requirements of SAE J1553, with an adhesive thickness of 0.75 mm (30 mil). Refer to table 1B for test conditions.

4.2.3.2 Required: See Table 1B for required values.

4.2.4 Cleavage Fracture Strength

4.2.4.1 Method: Prepare samples as indicated in 4.2.1 *Sample Preparation* except for the geometry requirements of ASTM D5041. Test per ASTM D5041. Test samples un-aged and after water-immersion.

4.2.4.2 Required: A minimum of 75% fiber tear is required for FRP samples. Report peak load, failure initiation energy and failure propagation energy. See Table 1A.

4.2.5 Stress Durability

4.2.5.1 Method: Test per ASTM D2919 using a fixture described in either ASTM D2294 or ASTM D2919. Prepare samples as indicated in 4.2.1 *Sample Preparation* except for the geometry requirements of ASTM D2919 or D2294. Load samples to 2 MPa (290 psi). Test samples after 6 weeks of exposure per the cycle below. Cycle may be interrupted for weekends and holidays, in which case leave the samples in humidity for that period.

- 1) 16 hours' humidity
- 2) 2 hours $-30 \pm 2^{\circ}\text{C}$ ($-22 \pm 3.6^{\circ}\text{F}$)
- 3) 2 hours at ambient conditions

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4) 2 hours 70± 2°C (158± 3.6°F)

4.2.5.2 Required: Report time to failure or residual load per Lap Shear Strength above.

4.2.6 Corrosion

4.2.6.1 Method: Expose coupons prepared as in section 4.2.1 *Sample Preparation* for shear strength test to 500 hours of ASTM B117 salt spray. Test residual load per lap shear strength above.

4.2.6.2 Required: See Table 1A.

4.2.7 Humidity

4.2.7.1 Method: Test per MPAPS GT-Paint, method 7E on coupons prepared in 4.2.1 *Sample Preparation* for shear strength test for 500 hours.

4.2.7.2 Required: See Table 1A.

4.2.8 Water Immersion

4.2.8.1 Method: Immerse coupons prepared in 4.2.1 *Sample Preparation* for shear strength test and cross peel in distilled water at 25°C (77°F) ± 2°C (3.6°F) for 500 hours.

4.2.8.2 Required: See Table 1A for shear and Table 1B for cross peel.

4.2.9 Over-bake

4.2.9.1 Method: Prepare samples for lap shear as directed in 4.2.1 *Sample Preparation* and in 4.1.2.5 *Shrinkage*. Over-bake samples in re-circulating air oven for (4) hours at maximum bake temperatures. Check hardness per ASTM D2240, and residual lap shear strength.

4.2.9.2 Required:

4.2.9.2.1 After Over-baking: ± 3 points maximum change from original hardness.

4.2.9.2.2 Over-baked material shall not darken substantially or show other evidence of degradation.

4.2.9.2.3 Shall retain 95% of original strength by lap shear.

4.2.10 Heat-Aging

4.2.10.1 Method: Prepare samples for lap shear and cross peel as directed in 4.2.1 *Sample Preparation*. Heat-Age in a re-circulating air oven for 500 hours at 90± 2°C (194± 3.6°F). Test residual strength.

4.2.10.2 Required: Retain strength as indicated in Table 1A for shear and Table 1B for cross peel.

4.2.11 Cyclic Aging

4.2.11.1 Method: Prepare samples for lap shear as directed in 4.2.1 *Sample Preparation*. Test overlap shear after 60 cycles of SAE J2334, allowing samples to return to ambient room temperature for 24 hours prior to testing.

4.2.11.2 Required: See Table 1A.

4.2.12 T-Peel (metal only)

4.2.12.1 Method: This is a modified ASTM D1876 to measure break-away force. The metal is to be bent in order to create the tabs prior to bonding. The metal surface shall be prepared as directed in 4.2.1 *Sample Preparation* with an adhesive thickness of 0.75 mm (30 mil). Refer to Table 1B for test conditions.

4.2.12.2 Required: See Table 1B.

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5.0 QUALIFICATION

Engineering qualification of sources is required in advance of production shipments. Samples shall be accompanied by test data certifying that all requirements of the specification have been met. Material and processes submitted for approval to this specification shall include the following:

- Detailed, signed test report documenting testing to this specification per MPAPS P-9543
- Test coupons or photographs showing failure modes for each test
- Complete procedure used for preparing and curing materials for test including surface preparation
- Adhesive, substrate and any chemicals used for bonding

5.1 Quality Control Plan

A Quality Control Plan for products supplied to the requirements of this specification will be established by mutual agreement between NAVISTAR and the supplier. Unless specific exception is noted, the following characteristics, where applicable*, shall be included in the plan as features for management by statistical process control.**



Viscosity or Thickness (as appropriate)

* Other characteristics for inclusion in the control plan may be specified on the engineering drawing and/or purchase order.

** See NAVISTAR Engineering Design Standard A-16

6.0 SOURCE APPROVAL AND QUALITY CONTROL

6.1 Supplier Requirements

All suppliers to NAVISTAR are required to be registered to ISO 9001 Quality System Requirements. NAVISTAR will also accept TS-16949 registration as long as the supplier can also fulfill all AIAG PPAP (Production Part Approval Process) documentation and approval requirements. Suppliers must maintain their certification with an accredited registrar and must furnish copies of registration certificates to their Corporate Buyer upon request.

6.2 Approval

Parts supplied against contracts or purchase orders citing this specification shall be equivalent in all respects to those samples which were approved by the purchaser. No changes in formulation or processing practices are permitted without approval. In the event that changes in material, properties, processing practices, construction, color, or labeling of the product are required, the supplier shall notify NAVISTAR Materials Engineering and Purchasing and Supplier Development of the proposed change(s). Test data indicating conformance to all requirements of this specification, test samples, and new or amended or updated Material Safety Data Sheet(s) (MSDS), in accordance with CFR Title 29, Part 1910 shall be submitted with the request for change.

6.3 Process Control

The supplier shall perform and report results of tests on specific lots of parts produced using ISO 9001 or TS-16949 guidelines, or provide statistical evidence of the lot having been produced in a state of statistical control and with a process capable of providing all required properties. The part supplier and the quality control manager of the using NAVISTAR plant may determine testing and reporting requirements on specific products.

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