

NAVISTAR, INC.		
Material, Parts, and Process Specifications (MPAPS)		NUMBER: MPAPS L-6039
		<i>Former Designation: TMS-6039</i>
Rubber (TSR) Molding Compounds		CURRENT REV No.: 1802
		DATE: Feb. 2018
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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>		

1.0 APPLICATION

This specification covers thermoset rubber (TSR) molding compounds used in truck applications. These TSR compounds are generally molded or extruded and may contain recycled materials. For thermoplastic elastomers (TPR/TPE/TPU), see MPAPS L-6040.

Note: Mount properties are listed in Table 8 some sections of which are in a restricted issue appendix, MPAPS L-6039-R. Contact Materials Engineering (referenced in Section 8.0) for further information.

1.1 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.

2.0 SCOPE

This specification covers the general requirements, identification, inspection, property and performance requirements, quality plan, and source approval and quality control requirements for these TSR compounds.

2.1 Rubber Compound Designation - Description

The TSR compounds covered in this specification may include several different types of polymer base, such as EPDM, NR, CSM, NBR, etc. Within each of these basic polymer groups, several different blends and curing treatments are available, and unless otherwise specified, may be used to provide the specified hardness and other material properties required for the part. A specific polymer may be specified within the material designation for the part. Upon approval of the prototype and/or PPAP samples, no changes in the polymer base, blend, curing treatment, or other processing variables shall be made without the approval of Materials Engineering and the Quality Department of the receiving plant.

2.1.1 TSR Prefix

All rubber molding compounds provided to the requirements of this specification shall be designated with the TSR prefix. A specific polymer may or may not be specified in the material designation. These materials may contain recycled rubber (post-consumer recycled material, such as automotive tires) with prior Engineering approval. If industrial recycle (pre-consumer recycled material) is included in the TSR compound, it shall be reported separately from the post-consumer recycled content.

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2.2 Suffix Designations

Additional requirements for parts made from the rubber molding compound may be specified by adding a suffix to the compound designation. The suffix requirement is in addition to the normal durometer hardness and tensile requirements of the material designation and independent of the polymer base used for the part. The suffix designation follows and is separated from the TSR prefix by a “dash”. In some cases more than one suffix requirement may be designated. An alternate method of assigning a sequential number to new compounds has been added to facilitate development of parts while parameters may yet change.

2.2.1 Suffix-H: This designates a heat- and weather-resistant TSR material. Unless otherwise specified on the Engineering drawing, product supplied shall meet the heat resistance and aged heat adhesion requirements as specified in Tables 4-9. Minimal oil resistance is expected for this type of material.

2.2.2 Suffix-O: This suffix designates a TSR compound with good oil and/or diesel fuel resistance. Unless otherwise specified on the Engineering drawing, parts supplied will meet the oil and fuel resistance requirements specified in Tables 4-9. Typical polymers that may be used for this specification include: Acrylonitrile-butadiene (nitrile or NBR) and appropriate blends.

2.2.3 Suffix-H/O: This suffix designates a heat-resistant TSR material that also exhibits good oil and diesel fuel resistance. Unless otherwise specified on the Engineering drawing, parts supplied will meet both the heat resistance and oil and fuel resistance requirements specified in Tables 4-9. Typical polymers that may be used for this specification include: Chloroprene (CR), Chlorinated Polyethylene (CPE or CM), Chloro-sulfonated Polyethylene (CSM), Epichlorohydrin copolymer (ECO), Acrylonitrile-butadiene (nitrile or NBR), Hydrogenated Nitrile (HNBR), and appropriate blends.

2.2.4 Suffix-H/C: This suffix designates a heat- and weather-resistant TSR material with good resistance to heavy-duty diesel coolants. Unless otherwise specified on the Engineering drawing, parts supplied will meet both the heat resistance and coolant resistance requirements specified in Tables 4-9. A typical polymer that may be used is EPDM. Minimal oil resistance is expected for this material.

2.2.5 Suffix-M: This suffix designates a common TSR class of materials except used in mount or isolator applications. Dynamic property requirements for these parts are generally specified separately on the Engineering drawing. Typically, the TSR material is a Natural Rubber. Natural Rubber blends with IR and SBR may be considered with prior approval. Chloroprene can be considered in a similar fashion in applications requiring high heat and oil resistance but lower flex fatigue resistance. When highly damped materials are required, butyl compounds may be specified.

2.3 Specific TSR Compound Designations

A lower case letter may be used at the end of the compound designation to specify a specific blend or composition of TSR compound. The lower case letter is added at the end, after the tensile strength number, to indicate a specific compound. For example, as indicated in Table 3, TSR65-10a designates an 8021 molding compound supplied by NRI. The specific molding compound designated by the use of the lower case letter will be indicated in Tables 4-9 or will be shown on the engineering drawing.

2.4 Explanation – Examples of Designation System

The material designation on the drawing shall consist of the TSR material prefix, followed by any suffix requirements – H, -O, -C, or -M, followed by the durometer and tensile strength specified. In some cases, a specific compound identifier (lower case letter) may be used to differentiate compound variations. A specific polymer base material may also be identified in the specification as well.

2.4.1 Designation on Drawings: Rubber per MPAPS L- 6039, TSR60-10

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2.4.1.1 This designation identifies a basic TSR elastomer, without a specific polymer base identified, with a durometer hardness of 60 and a tensile strength of 10 MPa.

2.4.2 Designation on Drawings: EPDM per MPAPS L-6039 TSR-H70-8a

2.4.2.1 This designation requires an EPDM compound meeting the heat resistance requirement with a durometer of 70 and a tensile of 8 MPa. This is also a specific compound variation as designated by the lower case letter “a.” The specific material description is shown on the Engineering drawing.

2.4.3 Designation on Drawings: Natural Rubber per MPAPS L-6039 TSR-M50-25b

2.4.3.1 This is an engine mount material made from Natural Rubber with a durometer of 50 and a tensile strength of 25 MPa. A specific compound, designated by the lower case letter “b”, will be shown on the drawing. The print also describes specific dynamic and static spring rates for this part.

2.4.4 Designation on Drawings: TSR-0020 per MPAPS L-6039

2.4.4.1 An alternate designation, intended primarily for parts still under development that may require material property modifications prior to final production release but after the print geometry has been determined.

3.0 REFERENCE DOCUMENTS

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

Quality System Standard ISO 9001 or TS-16949	CFR Title 29, Part 1910	ASTM D 1171
NAVISTAR Eng. Design Std. A-16	ASTM D 395	ASTM D 2137
NAVISTAR Supplier Packing and Shipping Std. D-13	ASTM D 412	ASTM D 2240
NAVISTAR ISQ-001-QM	ASTM D 575	
NAVISTAR MPAPS P-9543	ASTM D 3884	
NAVISTAR MPAPS B-50	ASTM D 624	
ASTM D 5963/DIN 53516	ASTM D 1630	
NAVISTAR MPAPS L-6040	ASTM B 117	
NAVISTAR MPAPS B-1	ASTM D 5992	

4.0 GENERAL REQUIREMENTS

All materials covered by this specification shall meet the requirements specified herein and shall be molded or extruded, using good industry practices.

4.1 Finish

Unless otherwise specified on the engineering drawing, the finish for molded parts shall be uniform as produced from polished steel tools. The mold will be polished to a surface finish of 800 nm or better. Extruded products shall have a smooth, clean surface, free from any foreign matter. Extruded finish will be equivalent to Rubber Manufacturer’s Association (RMA) F2 for mold finish.

4.2 Flash

Unless otherwise specified on the engineering drawing, the parts shall have a maximum flash allowance of 0.80 mm (RMA T.80mm). Mounts and other parts deemed non-cosmetic and so indicated on the engineering print may have a flash allowance of 2.35mm (RMA T2.35).

4.3 Dimensional Tolerances

Part tolerances are shown in Table 1. Unless otherwise specified on the drawing, these tolerances are applicable and supersede the standard tolerances shown in the title block on the Engineering drawing.

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TABLE 1 - STANDARD DIMENSIONAL TOLERANCE TABLE

Dimension - inch	Tolerance – inch	Dimension – mm	Tolerance -mm
0 - 1.00	.015	0 – 25	.40
1.0 - 4.00	.025	25 - 100	.50
4.00 - 6.30	.032	100 - 160	.80
6.30 & over	0.50%	160 & over	0.50%

4.4 As-Received: Property And Performance Requirements

Test samples should be taken from finished parts. Samples from finished parts are preferred even when the referenced test method is for slab samples. Values shown in Tables 3 through 8, are min values unless shown as a range. Requirements shown in the tables are based upon following methods:

4.4.1 Hardness: ASTM D 2240 – Type A. All values are ± 5 points from specified value unless the part is specified as a mount or isolator. If the part is specified as a mount or isolator with static and dynamic properties required, then the hardness may vary to meet these dynamic requirements and the hardness is considered a reference value.

4.4.2 Tensile Strength: ASTM D 412, Die C. Reported as MPa.

4.4.3 Elongation: ASTM D 412, Die C. Reported as % elongation.

4.4.4 Tear Resistance: ASTM D 624, Die B. Reported as kN/m.

4.4.5 Compression Set: ASTM D 395, Method B, 22 hours. Reported as maximum % set.

4.4.6 Low Temperature Brittleness: ASTM D 2137, Method A, Non-Brittle at -40°C (-40°F) unless otherwise designated.

4.4.7 Ozone Resistance: ASTM D 1171, Method B, Expose samples to 70 hours of 100 mPa (0.0000145 psi) ozone partial pressure at 38°C (100°F).

4.4.8 Adhesion: ASTM D429, Method A. This test applies to any bonded assembly. All fracture modes are to be cohesive fractures or fracture through the substrate. The Qualification Test Report will include the fracture loads reported as MPa values, tested at standard lab conditions. Any adhesive failure modes shall be noted and explained in the report

4.4.9 Abrasion Resistance:

4.4.9.1 Method 1: Pico Abrasion per ASTM D 2228. 4.5 kg load, 80 revolutions at 1 Hz. Calculate and report standard and Pico index.

4.4.9.2 Method 2: Rotary Drum Abrader per ASTM D 5963 or DIN 53516. Report Method and average volume of material loss in mm³. Specified as a maximum allowed.

4.4.9.3 Method 3: NBS Abrasion per ASTM D 1630. Report abrasive index.

4.4.9.4 Method 4: Rotary Platform, Double Head (Taber) per ASTM D 3884. H18 wheel, 1000 grms, 1000 cycles. Report weight loss.

4.4.10 Staining Resistance: This requirement is *temporarily* ASTM D 925 Method B to be consistent with ASTM D 2000 classifications.

4.4.11 Low Friction: This requires an inherent low friction modifier to the rubber compound. Coatings are not acceptable. Performance requirements have not been determined at this time. Material supplied to this requirement shall meet the function requirements of the part with this characteristic.

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4.5 Property And Performance Requirements – Aged Properties

Test samples shall be taken from finish parts whenever possible. See Tables 3-8 for specific testing requirements based upon the indicated test methods.

4.5.1 Heat Resistance: ASTM D 573 or ASTM D 865, see Table 2 for the test times and temperatures.

4.5.2 Oil Resistance: ASTM D 471, No. 3 oil, see Table 2 for the times and temperatures designated. Note: Use the current, designated replacement for ASTM #3 oil and please note that not all of the listed temperatures are appropriate for this fluid.

4.5.3 Fuel Resistance ASTM D 471, No. 2 Diesel - 168 hours at 25°C

4.5.4 Coolant Resistance ASTM D 471, 50/50 Ethylene Glycol and water per MPAPS B-1 Type III - 168 hours at boiling point with reflux.

4.5.5 Salt Spray/Adhesion ASTM B 117 salt spray test for 100 hours. Test per **4.4.8 Adhesion**.

4.5.6 Heat Aged/Adhesion Age test samples for the time, temperature and method specified in **4.5.1 Heat Resistance**. Perform test as per **4.4.8 Adhesion**.

4.5.7 Non Blooming: Parts evaluated after heat age shall not exhibit unacceptable surface bloom as judged by Navistar Industrial Design.

TABLE 2 – HEAT RESISTANCE TEST REQUIREMENTS
DESIGNATION/DURATION/TEMPERATURE

Test Designation	Duration [hours]	Temperature [°C]
A	70	70
B	70	100
C	70	125
D	168	150
E	168	175
F	250	200
G	250	225
H	250	250
J	250	275

4.6 Property And Performance Requirements – Mechanical Properties

The need for these tests, and details of the specific tests to be performed, will be indicated on the Engineering drawing for the part or assembly. Additional details of the testing may be included in the Engineering Validation Plan for these parts. Unless otherwise specified all tests shall be performed on finished parts. Test fixtures, replicating, as closely possible, the production usage and intent shall be built. Details of the test fixtures, which may include engineering drawings and/or pictures, shall be included in the supplier's qualification report (see Section 5.1).

4.6.1 Static Properties - Compression Deflection: ASTM D 575 (Test Method A or B shall be referenced in the table or inferred from the requirements), except that a finished part shall be used. The direction (see 4.6.4) and amount of deflection shall be indicated on the engineering drawing. Test temperatures shall be assumed to be standard lab conditions (25°C) unless otherwise indicated.

4.6.2 Dynamic Spring Rate and Damping: ASTM D 5992. The engineering drawing will indicate:

4.6.2.1 The set-up procedure or test configuration including the part numbers of other components required to complete the test set-up configuration.

4.6.2.2 Direction of test (see 4.6.4).

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4.6.2.3 Preload.

4.6.2.4 Amplitude (listed as double amplitude value).

4.6.2.5 Frequency.

4.6.2.6 Temperature of test - shall be assumed to be standard lab conditions (25°C) unless otherwise indicated.

4.6.2.7 Spring rate required with tolerance (if a tolerance is not noted it shall be assumed to be $\pm 15\%$).

4.6.2.8 Damping required with tolerance

4.6.3 Fatigue: ASTM D 5992 except as required for durability cycle. The engineering print or this specification shall indicate the following:

4.6.3.1 The set-up procedure or test configuration including the part numbers of other components required to complete the test set-up configuration. This could be a referenced International test report that contains test cycle parameters.

4.6.3.2 Direction of test (see 4.6.4).

4.6.3.3 Preload⁽¹⁾.

4.6.3.4 Amplitude⁽¹⁾ (listed as double amplitude value).

4.6.3.5 Frequency⁽¹⁾ – whether set as a single frequency or a more elaborate block cycle program may be varied to keep the part tested from being overheated due to mechanical work. External cooling is often required to increase test frequency. The general intent of the test is to be maintained but realistic failure modes are essential to a good test and control of test frequencies is essential to accomplish this.

4.6.3.6 Duration of test⁽¹⁾.

4.6.3.7 Temperature of test - shall be assumed to be standard lab conditions (25°C) unless otherwise indicated.

4.6.3.8 Spring rate required with failure tolerance and criteria⁽²⁾ (tolerance is $\pm 20\%$ if not otherwise indicated).

⁽¹⁾ *In many cases this procedure may be described in a block cycle requiring multiple/different inputs. In such case a separate reference on the Engineering drawing should be made to the Engineering validation test plan and the required test profile fully described in that document.*

⁽²⁾ *Exceeding the failure tolerance is the criteria used to determine component failure unless indicated otherwise.*

4.6.4 Direction of test: The direction of test should be defined on the engineering print whenever possible. The following conventions shall be used within this specification only and are not to be confused with other conventions used in other contexts:

Y direction – is generally defined as vertical or axial

X direction – is radial, longitudinal or fore-aft.

Z direction – is lateral or side to side.

Rotational moments may be defined as well. If defined in context with vehicle movements then the in vehicle orientation should be defined on the engineering print.

4.7 Recycled Content

The minimum and maximum amounts, by weight percent, of post-consumer recycled rubber content allowed in the TSR compound will be included in the Supplier's qualification report. If industrial recycled content (Pre-consumer recyclate) is included in the TSR compound, the min and max amounts allowed shall also be included in the qualification report.

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5.0 QUALITY

All material produced to this specification shall be clean and free of dirt, grease, and contamination. All rubber debris from cutting and processing shall be removed. Parts shall be free of voids.

5.1 Qualification

Materials submitted for approval to this specification shall include the following:

5.1.1 A detailed, signed test report documenting testing to this specification per MPAPS P-9543.

5.1.2 The complete procedure used for preparing and curing materials for test, especially surface preparation (when appropriate) and condition of the test materials.

5.1.3 A complete description, including engineering prints and pictures of any non-standard test fixtures used.

5.1.4 Adhesive, substrate and any chemicals used for bonding where appropriate.

5.2 Submission The material test report shall be submitted to:

Manager of Materials Engineering
Materials Engineering and Technology Dept.
10400 W. North Avenue
Melrose Park, IL 60160

5.3 Approval A report from Navistar will be issued approving new materials to this specification. Formal approval is not granted until this report has been published and the new material is listed in this specification. However, the approval report may be used as authorization for usage of that approved material/process prior to a change to this specification.

6.0 SOURCE APPROVAL AND QUALITY CONTROL

6.1 Supplier Requirements

All suppliers to NAVISTAR are subject to the requirements defined in ISQ-001-QM- NAVISTAR *Integrated Supplier Quality Requirements*. Suppliers must be compliant with ISO 9001 or TS 16949 and fulfill all AIAG PPAP (Production Part Approval Process) documentation and all approval requirements as indicated in NAVISTAR ISQ-001-QM.

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 Integrated Supplier Quality (ISQ) of the proposed change(s) by contacting their Navistar Supplier Quality representative or sending an email to ISQ@navistar.com. Test data indicating conformance to all requirements of this specification, test samples, and new or amended or updated SDS Safety Data Sheet(s) (formerly MSDS) in accordance with CFR Title 29, Part 1910, shall be submitted with the request for change.

6.3 Process Control

The supplier shall either 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 plant metallurgist and/or the quality control manager of the using NAVISTAR plant may determine testing and reporting requirements on specific products.

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