

NAVISTAR, INC.		
Material, Parts, and Process Specifications (MPAPS)		NUMBER: MPAPS A-1044
		Former Designation: TMS-1044
TITLE: Tapered Leaf and Main Support Member Suspension Springs		CURRENT REV No.: 1404
		DATE: April 2014
WRITTEN/EDITED BY: Materials Engineering	APPROVED BY: Materials Engineering	SUPERSEDES: Rev. 1312 – December 2013
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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>		
Change Notice: Changed to new MPAPS format; depth of decarburization determination method updated; editorial changes.		

1.0 APPLICATION

This specification covers steel tapered leaf suspension springs and Main Support Member (MSM) suspension springs.

2.0 SCOPE

This specification covers requirements for material, dimensional tolerances, KCC, heat treatment, microstructure, post-hardening treatments, validation, source approval/quality control, shipping, and identification.

2.1 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.

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 <i>ISO 9001 or TS-16949</i>	NAVISTAR TMS-4516	ASTM E 112
CFR Title 29, Part 1910	NAVISTAR CEMS GT-4D	ASTM E 1382
NAVISTAR Engineering Design Std. A-16	NAVISTAR CEMS GT-5A	ASTM E1077
NAVISTAR Manufacturing Std. MS-D-13	NAVISTAR CEMS GT-7D	SAE J400
NAVISTAR MPAPS A-0, Part I	NAVISTAR CEMS GT-14C	SAE J422
NAVISTAR MPAPS A-0, Part III	ASTM A 29	SAE J510
NAVISTAR CEMS A-39	NAVISTAR MPAPS B-50	SAE J788

4.0 REQUIREMENTS

4.1 Material

Open hearth, basic oxygen or electric furnace, ingot cast or strand cast, steel may be used. Unless otherwise specified, the general requirements for steel as described in ASTM A 29 shall be applicable. Steel supplied shall be fully killed, made to fine grain practice, and shall meet the minimum Steel Cleanliness Requirements for Quality Level I per MPAPS A-0, Part I.

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4.2 Chemical Composition

TAPERED LEAF SPRINGS

Carbon	0.66% max
Silicon	0.35% max
Phosphorus	0.040% max
Sulfur	0.050% max
Alloy elements as required	

MAIN SUPPORT MEMBER SPRINGS

Carbon	0.65% max
Silicon	0.35% max
Phosphorus	0.025% max
Sulfur	0.035% max
Alloy elements as required	

4.3 Heat Treatment

Springs shall be hardened and tempered at 425°C (800°F) minimum. Material type to be specified in the drawing notes.

4.3.1 Tapered Leaf & Monoleaf Springs: Brinell hardness shall be 401-444 HBW3000 for **Type I** material (5160 or equivalent alloys), and 415-461 HBW3000 for **Type II** material (6150 or equivalent alloys). High Brinell hardness acceptable for premium springs is 444-495 HBW3000 for **Type III** material. Other proprietary alloys may be allowed on an exception basis. To obtain the hardness reading, a light grind of the surface on the compression side of the leaf is permissible. Note: Please see Materials Engineering and the Suspension Technical Specialist for details on alternative alloys and for approval to use materials with Type III hardness or greater. Care must be taken to avoid stress corrosion cracking &/or hydrogen assisted cracking. Three elements must be present to have stress corrosion cracking or hydrogen assisted cracking. They are: 1) high mean stress, 2) high material hardness & 3) a corrosive environment.

4.3.2 Main Support Member Springs: Brinell hardness shall be 401-444 HBW3000 for **Type I** material (5160 or equivalent alloys), and 415-461 HBW3000 for **Type II** material (6150 or equivalent alloys). High Brinell hardness acceptable for premium springs is 444-495 HBW3000 for **Type III** material. Other proprietary alloys may be allowed on an exception basis. Note: Please see Materials Engineering and the Suspension Technical Specialist for details on alternative alloys and for approval to use materials with Type III hardness or greater. Care must be taken to avoid stress corrosion cracking &/or hydrogen assisted cracking. To obtain the hardness reading, a light grind of the surface on the compression side of the leaf is permissible.

4.4 Hardenability

Steel shall be selected to meet the minimum harden ability, based on the thickness of the hot rolled bar

Table 1. Minimum Hardenability

Thickness		Steel Code*
mm	in	
9.8 and Under	0.386 and Under	C47-66E6 (52)-22 (52)
Over 9.8	Over 0.386	C47-66E8 (52)-32 (58)

* Per Navistar MPAPS A-0, Part III. See General Information for suggested steels.

4.5 Dimensional Tolerances

4.5.1 Thickness and Width

Shall be as specified in SAE J510, Leaf Springs for Motor Vehicle Suspension. In addition, SAE J788, Design and Application of Leaf Springs, shall govern areas not covered in J510, and shall supersede drawing tolerances where conflicts exist. Note that Sections over 1.5" are not covered by J510.

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4.5.2 Secondary Leaf

All springs with more than one leaf must have intimate contact between leafs at the center clamp area and at the eye or tip. This includes main support members with a redundancy leaf.

4.5.3 Camber Height

The leaf spring drawing must specify the method being employed to manage camber height variation and vertical rate variation and any sorting to manage that variation (either Method A or Method B per section 4.5.2.1). Options include:

- A. Method A- Sorted by free camber height.
- B. Method B- Sorted by loaded camber height.
- C. Method C- Alternative sorting including a secondary operation to correct or pre-set loaded camber prior to sorting.

Note: Pre-setting may be preferred as it reduces both the geometric and vertical rate variations. This is particularly recommended for “softer” springs (rated spring load < ~5,400 lb.). Typical range of uncorrected camber variation and the calculations involved is explained in section 4.5.2.2.

4.5.3.1 Camber Sorting Methods

Method A- The standard camber height sorting Method A is recommended for front and rear springs coupled with axle ratings **greater than 12,000 lb.** (rated spring load > ~5,400 lb.) or for applications that are insensitive to ride height variation or leaning. Springs are non-corrected and sorted in free-state (“**free-camber sorted**”). Sort into two or more categories and identify the category with stripes on the front spring eye/wrap per the chart below. A typical industry standard for free height tolerance on a non-corrected spring is 12.8mm or +/-6.4mm. A table such as the one below must be published on the drawing to define the free camber height range for each stripe marking condition.

Method A Used for Variation Management- Free Camber Sorted		
Number of Vertical Stripes	Mark ID (on front of spring eye or wrap)	Free Height Tolerance, H (mm)
1	I	$-6.4 \leq H \leq 0$
2	II	$0 < H \leq +6.4$
Springs with $H < -6.4$ or $H > 6.4$ are to be rejected		

Method B- A more stringent camber height sorting method B is recommended for front and rear springs coupled with axle ratings of **12,000 lb or less** (rated spring load $\leq$ ~5,400 lb). Springs are sorted in the 1g loaded-state (“**loaded-camber sorted**”). This is being practiced on our ProStar front springs. Sort into two or more categories and identify the category with stripes on the front spring eye/wrap. A table such as the one above must be published on the drawing to define the loaded camber height range for each stripe marking condition.

Alternative Method- An alternative (“Method C”) camber height sorting method may be approved by the Suspension Technical Specialist on a case-by-case basis and must be clearly specified with a table on the drawing. For example springs may be corrected or pre-set to achieve the desired tolerance. This is being practiced on our TerraStar front springs. A typical industry standard for the loaded height tolerance on a corrected spring is 8mm or +/-4mm. A table such as the one below must be published on

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the drawing to define the loaded camber height range for each stripe marking condition. Please note that correcting or pre-setting springs may impact the fatigue life of the spring. As such careful validation is required prior to adopting this capability.

Method C Example (Loaded Camber Sorted)		
Number of Vertical Stripes	Mark ID (on front of spring eye or wrap)	Loaded Height Tolerance, H (mm)
1	I	$-4.0 \leq H \leq 0$
2	II	$0 < H \leq +4.0$
Springs with $H < -4.0$ or $H > 4.0$ are to be rejected		

4.5.3.2 Camber Height Variation Calculation

- To define the 1g loaded camber range use the following equations:
 - Maximum loaded camber $= x_{max} = f + \Delta f - P/(k + \Delta k)$
 - Minimum loaded camber $= x_{min} = f - \Delta f - P/(k - \Delta k)$
 - Loaded camber range $= R = x_{max} - x_{min}$
 - Where:
 - x = Loaded camber (mm or in)
 - R = Loaded camber range (mm or in)
 - f = Free camber (mm or in)
 - Δf = Free camber tolerance typically $= \pm 6.4$ mm or ± 0.25 in. for uncorrected spring
 - P = 1g rated spring load (lb or N)
 - k = Vertical spring rate (lb/in or N/mm)
 - Δk = Vertical rate tolerance typically $= \pm 7\% * k$

Example:

- Let $f = 4.04$ in
- $\Delta f = \pm 0.25$ in
- Let $P = 5,350$ lb
- Let $k = 1,425$ lb/in
- Thus $\Delta k = \pm 100$ lb/in

$$x_{max} = f + \Delta f - P/(k + \Delta k) = 0.78 \text{ in}$$

$$x_{min} = f - \Delta f - P/(k - \Delta k) = -0.25 \text{ in}$$

$$R = 0.78 \text{ in} - (-0.25 \text{ in}) = 1.03 \text{ in}$$

- Another Way To Calculate Loaded Camber Range:
 - Loaded camber range $= R = [\text{Free Camber Tolerance}] + [\text{Rate Tolerance}]$
 - For an uncorrected spring $R = [0.5 \text{ in.}] + [(P/(0.93 * k)) - (P/(1.07 * k))]$

Example:

- Let $P = 5,350$ lb
- Let $k = 1,425$ lb/in

$$R = [0.5 \text{ in}] + [(P/(0.93 * k)) - (P/(1.07 * k))] = 1.03 \text{ in}$$

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