

NAVISTAR, INC.		
Material, Parts, and Process Specifications (MPAPS)		NUMBER: MPAPS- A-10, PART III
		Former Designation: CEMS A-10, PART III
TITLE:	Seamless Mechanical Steel Tubing	CURRENT REV No.: 1506
		DATE: June 2015
WRITTEN/EDITED BY: W. Cook	APPROVED BY: R. Goluch	SUPERSEDES: October 2001
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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: Reformatted as MPAPS, Editorial Changes, Added Appendix		

1.0 APPLICATION

This specification is in three parts:

- Part I - Electric Resistance Welded Mechanical Steel Tubing
- Part II - Cold Drawn Butt Welded Mechanical Steel Tubing
- Part III - Seamless Mechanical Steel Tubing

International specifications covering other steel tubular products used by the Company are as follows:

- | | |
|---------------------------|------------|
| Welded and Seamless Steel | MPAPS A-18 |
| Structural Steel Tubing | MPAPS A-38 |
| Fluid Line Steel Tubing | MPAPS A-45 |

2.0 SCOPE

This part of the specification covers the requirement for seamless mechanical tubing used in the Company's products. Unless otherwise specified herein, ASTM A519 shall apply.

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 standards, specifications and regulations are referenced in this specification.

- | | |
|--|---------------------|
| Quality System Standard ISO 9001 or TS-16949 | NAVISTAR MPAPS B-50 |
| CFR Title 29, Part 1910 | ASTM A370 |
| NAVISTAR Manufacturing Std. MS-D-13 | ASTM A1040 |
| NAVISTAR Engineering Design Std A-16 | ASTM A519 |

4.0 REQUIREMENTS

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4.1 Classification

Seamless tubing is produced as either hot finished or cold drawn as shown in Table I. Hot finished tubing may be turned or ground to closer dimensional tolerances.

TABLE I
GRADE CLASSIFICATION*

International Grade	Obsolete Grade	Description	General Size Availability**	
			Inches	Millimeters
HR	HF	Hot Finished	2.0 thru 12.0 OD 0.095 Wall Thickness	51 thru 305 OD 2.41 thru 50.8 Wall Thickness
CD	--	Cold Drawn (Drawn Simultaneously Through a Die and Over a Mandrel)	0.125 thru 12.0 OD 0.222 thru 2.0 Wall Thickness	3.18 thru 305 OD 0.56 thru 50.8 Wall Thickness
EBS	--	Any MD Tubing Grade Covered in MPAPS A-10, Parts I, II, and III.		
CDT	--	Any SD or MD Tubing Grade Covered in MPAPS A-10, Parts I, II, and III.		
CDM	--	Any MD Tubing Grade Covered in MPAPSS A-10, Parts I, II, and III		

* If no grade is specified, Grade CD tubing will be furnished

** For specific size availability for each grade, see "Appendix – General Information," MPAPS A-10 Part II.

4.1.1 Permissible Alternates

When a certain grade is specified on a drawing, it may be desirable for manufacturing to use another grade. The permissible alternates for each grade are shown in Table II.

TABLE II
PERMISSIBLE ALTERNATES

Specified Grade	Permissible Alternates
EBS	Any MD Tubing Grade covered in MPAPS A-10, Parts I, II, and III
HR	CD
CDT	Any SD or MD Tubing Grade covered in MPAPS A-10, Parts I, II, and III
CDM	Any MD Tubing Grade covered in MPAPS A-10, Parts I, II, and III
CD	None

4.2 Grades EBS, CDT, and CDM

4.2.1 Grades EBS, CDT and CDM are codes which allow manufacturing to select a tubing grade covered in Parts I, II, or III, e.g., Grade H-F, Part I, which will satisfy both engineering and manufacturing requirements. See "Dimensional Tolerances" for diameter and wall thickness tolerances and "Appendix – General Information" for discussion of these grades.

4.2.2 When a coded grade is specified on the engineering drawing, the selection of the appropriate tubing within the code should be made by agreement between supplier and Navistar Engineering. Navistar Engineering should consider cost, inventory, processing, and so forth, to determine which tubing grade can be used to best advantage. The drawings and engineering specifications for individual parts should show only the coded grade.

4.2.3 Outside suppliers furnishing finished parts may consider any tubing grade covered within the coded grade shown on the drawing.

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4.2.4 Outside suppliers of semi-finished parts requiring welding, heat treating, or machining in International plants, must obtain approval of the specific tubing grade and steel from Navistar Engineering

4.3 Chemical Composition

When no steel designation is specified, the plant metallurgist of the originating plant will select the grade of steel from those listed in Tables III, IV, or V. Tubing purchased to any ASME grade will meet the requirements for chemical composition shown in the latest issue of the AISI Steel Products Manual titled, "Steel Specialty Tubular Products." The carbon and alloy steels normally used for seamless mechanical tubing are shown in Tables I, II, and III, of "Appendix – General Information," although other carbon and alloy steels can be used.

4.4 Mechanical Properties

The expected minimum mechanical properties shown in Tables III, IV, or V can be specified as minimum requirements by the purchaser. Cold drawn seamless tubing subject to additional cold working after drawing such as bending, upsetting, or ballizing will be ordered stress relieved. This is the responsibility of the using manufacturing plant. Stress relieving will be done at 800 to 1000° F (425 to 540° C). If there is no cold working after drawing, stress relieving is not required unless specified on the engineering drawing. Other thermal treatments such as annealing or normalizing may be specified where desired. When no heat-treating is specified for cold drawn seamless tubing, it will be furnished unannealed. See "Designation on Drawings and Purchase Orders" or "Appendix- General Information".

**TABLE III
HOT FINISHED TUBING
EXPECTED MINIMUM MECHANICAL PROPERTIES**

SAE Steel Designation	Yield Strength		Tensile Strength		Elongation Percent in 2 Inches (50 mm)	Hardness, Rockwell B
	psi	MPa	psi	MPa		
1010	30 000	207	47 000	324	30	54
1015	30 000	207	48 000	331	28	55
1018	35 000	241	55 000	379	25	60
1020	32 000	221	50 000	345	25	57
1025	35 000	241	55 000	379	25	60
1026	35 000	241	60 000	414	22	67
1030	37 000	255	60 000	414	22	68
1035	40 000	276	65 000	448	20	72
1040	42 000	290	70 000	483	17	77
1045	45 000	310	75 000	517	15	80
1050	50 000	345	80 000	552	10	85
1118	35 000	241	50 000	345	25	55
1137	40 000	276	70 000	483	20	75
1141	50 000	345	80 000	552	10	85
1145	45 000	310	75 000	517	15	80

**TABLE IV
COLD DRAWN, UNANNEALED OR STRESS RELIEVED
AT 800 TO 1000° F (425 to 540° C) TUBING***

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EXPECTED MINIMUM MECHANICAL PROPERTIES

SAE Steel Design-Nation	Wall Thickness incl		Yield Strength		Tensile Strength		Elongation Percent in 2 inches (50 mm)	Hardness, Rockwell B
	inches	millimeters	Psi	MPa	psi	MPa		
1010	0.500 and Under Over 0.500	12.70 and Under Over 12.70	50 000 40 000	345 276	65 000 55 000	448 379	6 12	73 63
1015	0.500 and Under Over 0.500	12.70 and Under Over 12.70	55 000 45 000	379 310	67 000 58 000	462 400	6 12	75 68
1018	0.500 and Under Over 0.500	12.70 and Under Over 12.70	65 000 55 000	448 279	75 000 68 000	517 469	5 8	80 75
1020	0.500 and Under Over 0.500	12.70 and Under Over 12.70	60 000 50 000	414 345	70 000 65 000	483 448	5 10	75 72
1025	0.500 and Under Over 0.500	12.70 and Under Over 12.70	65 000 55 000	448 279	75 000 68 000	517 483	5 8	80 75
1026	0.500 and Under Over 0.500	12.70 and Under Over 12.70	68 000 57 000	469 393	78 000 70 000	538 483	5 8	83 76
1030	0.500 and Under Over 0.500	12.70 and Under Over 12.70	70 000 60 000	483 414	80 000 72 000	552 496	5 8	84 79
1035	0.500 and Under Over 0.500	12.70 and Under Over 12.70	75 000 65 000	517 448	85 000 75 000	586 517	5 8	88 80
1040	0.500 and Under Over 0.500	12.70 and Under Over 12.70	78 000 67 000	538 462	88 000 77 000	607 531	5 7	89 84
1045	0.500 and Under Over 0.500	12.70 and Under Over 12.70	80 000 70 000	552 483	90 000 80 000	621 552	5 8	90 85
1050	0.500 and Under Over 0.500	12.70 and Under Over 12.70	85 000 70 000	586 483	100 000 82 000	689 565	5 6	95 86
1118	0.500 and Under Over 0.500	12.70 and Under Over 12.70	60 000 55 000	414 379	75 000 70 000	517 483	5 8	80 75
11L17, 11L18, 12L14, 1215	0.400 and Under	10.16 and Under	55 000	379	67 000	462	6	75
1137	0.500 and Under Over 0.500	12.70 and Under Over 12.70	78 000 60 000	538 414	88 000 75 000	607 517	5 8	89 80
1141	0.500 and Under Over 0.500	12.70 and Under Over 12.70	80 000 65 000	552 448	90 000 85 000	621 586	5 7	90 88
1144	0.400 and Under	10.16 and Under	90 000	621	105 000	724	8	95
1145	0.500 and Under Over 0.500	12.70 and Under Over 12.70	80 000 65 000	552 448	90 000 85 000	621 586	5 7	90 88

* Tubing listed from 1035 to 1145, inclusive, should into be specified unannealed. When added cold work is to be performed such as bending, expanding, etc., thermal treatment may be required which may reduce mechanical properties. In such cases, the supplier should be consulted.

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TABLE V
COLD DRAWN TUBING, EXPECTED MINIMUM MECHANICAL PROPERTIES

SAE Steel Desig- Nation	Yield Strength		Tensile Strength		Elongation Percent in 2 inches (50 mm)	Hardness, Rockwell B
	psi	MPa	psi	MPa		
Soft Annealed						
1010	26 000	179	44 000	303	32	50
1015	27 000	186	46 000	317	31	50
1018	30 000	207	50 000	345	25	55
1020	28 000	193	48 000	331	30	50
1025	30 000	207	53 000	365	25	57
1026	31 000	214	56 000	386	25	62
1030	32 000	221	56 000	386	25	65
1035	33 000	228	60 000	414	25	67
1040	34 000	234	62 000	427	23	70
1045	35 000	241	65 000	448	20	72
1050	38 000	262	68 000	469	18	74
1118	30 000	207	50 000	345	25	55
1137	35 000	241	65 000	448	22	72
1141	38 000	262	68 000	469	18	74
1145	35 000	241	65 000	448	20	72
Normalized						
1010	30 000	207	47 000	324	32	54
1015	32 000	221	51 000	352	27	59
1018	35 000	241	55 000	379	22	60
1020	34 000	234	55 000	379	22	60
1025	36 000	248	55 000	379	22	60
1026	36 000	248	60 000	414	21	67
1030	38 000	262	60 000	414	21	68
1035	40 000	276	65 000	448	20	72
1040	44 000	303	70 000	483	17	77
1045	48 000	331	75 000	517	15	80
1050	50 000	345	78 000	538	12	82
1118	35 000	241	55 000	379	20	60
1137	43 000	296	70 000	483	15	75
1141	50 000	345	78 000	538	12	82
1145	48 000	331	75 000	517	15	80

4.4.1 Hydraulic Cylinder Tubing

This tubing is intended for use in hydraulic cylinders subjected to high pressure and where assembly welding is involved. Grade CD will be used for this tubing made from 1015 through 1026 steel unless otherwise specified. All tubing subject to cold working after drawing such as ballizing will be ordered stress relieved. This is the responsibility of the using manufacturing plant. Stress relieving will be done at 800 to 1000° F (425 TO 540° C) in a controlled atmosphere. If there is no cold work after drawing, stress relieving is not required. Tubing should be purchased unannealed wherever possible. Tubing surfaces will be free from all blue or black oxides or any surface condition which might interfere with welding.

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4.5 Dimensional Tolerances

Tubing purchased to this specification will conform to the requirements for dimensional tolerances shown in the following tables. Dimensions of cold drawn seamless mechanical tubing may be specified by any two of the three following dimensions: outside diameter, inside diameter, or wall thickness, but it is preferable to specify outside and inside diameters. Hot rolled tubing will be specified to outside diameter and wall thickness. The outside diameter tolerances in Tables VI, VII, and VIIA will be used in conjunction with the appropriate wall thickness tolerances in Table VIII when tubing is specified to OD and wall thickness. Cold drawn tubing may be ordered to OD and ID in which case only the diameter tolerances in Table VII and VIIA apply.

**TABLE VI – HOT ROLLED TUBING
OUTSIDE DIAMETER TOLERANCES, PLUS OR MINUS**

Outside Diameter, incl.		As Rolled or Annealed		Oil Quenched and Tempered		Water Quenched and Tempered	
in	mm	in	mm	in	mm	in	Mm
up to 1.999	up to 50.77	0.015	0.38	0.025	0.64	0.037	0.94
2.000 to 2.499	50.80 to 63.47	0.017	0.43	0.027	0.68	0.040	1.01
2.500 to 2.999	63.50 to 76.17	0.019	0.48	0.029	0.74	0.043	1.09
3.000 to 3.499	76.20 to 88.87	0.021	0.53	0.032	0.81	0.047	1.19
3.500 to 3.999	88.90 to 101.57	0.023	0.58	0.035	0.90	0.051	1.30
4.000 to 4.499	101.60 to 114.27	0.025	0.64	0.038	0.96	0.055	1.40
4.500 to 4.999	114.30 to 126.97	0.027	0.68	0.041	1.04	0.059	1.50
5.000 to 5.499	127.00 to 139.67	0.029	0.74	0.044	1.12	0.063	1.60
5.500 to 5.999	139.70 to 152.37	0.031	0.79	0.047	1.19	0.068	1.73
6.000 to 6.499	152.40 to 165.07	0.033	0.84	0.050	1.27	0.073	1.85
6.500 to 6.999	165.10 to 177.77	0.035	0.90	0.053	1.35	0.078	1.98
7.000 to 7.499	177.80 to 190.47	0.037	0.94	0.056	1.42	0.083	2.11
7.500 to 7.999	190.50 to 203.17	0.040	1.01	0.060	1.52	0.088	2.24
8.000 to 8.499	203.20 to 215.87	0.043	1.09	0.064	1.62	0.093	2.36
8.500 to 8.999	215.90 to 228.57	0.045	1.14	0.068	1.73	0.100	2.54
9.000 to 9.499	228.60 to 241.27	0.045	1.14	0.072	1.83	0.107	2.72
9.500 to 9.999	241.30 to 253.97	0.045	1.14	0.076	1.93	0.115	2.92
10.000 to 10.750	254.00 to 273.05	0.045	1.14	0.080	2.03	0.125	3.18

4.5.1 Tolerances For Grades EBS, CDT, and CDM

Tolerances for coded Grades EBS, CDT, and CDM will conform to those shown for Grade CD, cold drawn seamless tubing, except as follows:

Grade EBS: Grade HR outside diameter and wall thickness tolerances for tubing with 2.00 in (50 mm) nominal OD and over; also for tubing with less than 2.00 inch nominal OD but with nominal wall thicknesses greater than 0.095 in (2.41 mm).

NOTE: These tolerances are only for design and manufacturing purposes. The tubing grade ordered which meets the requirements of one of the coded grades will comply with the tolerances for the ordered grade. For example, Grade H-F, part I, meets Grade EBS requirements, therefore, Grade H-F tolerances apply.

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