

NAVISTAR, INC.		
Material, Parts, and Process Specifications (MPAPS)		NUMBER: MPAPS C-3
		Former Designation: CEMS C-3
TITLE: Wrought Copper Base Alloys		CURRENT REV No.: 1512
		DATE: Dec. 2015
WRITTEN/EDITED BY: J. Goldschmidt	APPROVED BY: R. Goluch	SUPERSEDES: Rev. April 2003
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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: Combined with CEMS C-3 appendix and updated to MPAPS format.		

1.0 APPLICATION

Copper products are used in many applications where advantage is taken of its strength, good machinability, and corrosion resistance. Copper alloys are classified by chemical composition and strength or temper designation.

2.0 SCOPE

This specification covers the requirements for wrought copper base alloys used in the Company's products.

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 ISO 9001 or TS-16949	NAVISTAR MPAPS B-50	ASTM DS-56K
CFR Title 29, Part 1910	ASTM E 8	SAE HS-1086
NAVISTAR Manufacturing Std. MS-D-13	ASTM E 18	
NAVISTAR Engineering Design Std. A-16	SAE J 463	

4.0 REQUIREMENTS

Material purchased to this specification will meet the requirements for chemical composition shown in Table I. Table I is based upon the standard designation system devised by the Copper Development Association (CDA), and paralleled in SAE Standard J463. ***For convenience a list of obsolete designations, which may appear on existing drawings, and their counterparts in the new system is provided in Table IV.***

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TABLE I - CHEMICAL COMPOSITION

UNS ⁽²⁾ Alloy Number	Copper	Lead	Phosphorus	Iron	Tin	Zinc	Alumi- num	Manga- nese	Silicon	Total Other Elements
C11000	99.90*	-	-	-	-	-	-	-	-	-
C12200	99.90*	-	0.015-0.040	-	-	-	-	-	-	-
C23000	84.0-86.0	0.05	-	0.05	-	bal	-	-	-	0.20
C26000	68.5-71.5	0.07	-	0.05	-	bal	-	-	-	0.30
C26800	64.0-68.5	0.15	-	0.05	-	bal	-	-	-	0.30
C33500	62.0-65.0	0.25-0.70	-	0.15	-	bal	-	-	-	0.40
C34500	62.0-65.0	1.5-2.5	-	0.15	-	bal	-	-	-	0.40
C35000	60.0-63.0	0.8-2.0	-	0.15	-	bal	-	-	-	0.40
C36000	60.0-63.0	2.5-3.7	-	0.35	-	bal	-	-	-	0.50
C37700	58.0-61.0	1.5-2.5	-	0.30	-	bal	-	-	-	0.50
C38500	55.0-59.0	2.5-3.5	-	0.35	-	bal	-	-	-	0.50
C51000	99.5**	0.05	0.03-0.35	0.10	4.2-5.8	0.30	-	-	-	0.50
C54400	99.5**	3.5-4.5	0.01-0.50	0.10	3.5-4.5	1.5-4.5	-	-	-	0.50
C62400	99.5 min ⁽¹⁾	-	-	2.0-4.5	0.20	-	10.0-11.5	0.30	0.25	0.50
C65100	99.5 min ⁽¹⁾	0.05	-	0.80	-	1.5 max	-	0.70	0.8-2.0	0.50

* Copper + Silver, % min

** Copper + Tin + Phosphorus, % min

*** Copper + Tin + Phosphorus + Lead + Zinc, % min

⁽¹⁾ Copper + Elements with specified limits

⁽²⁾ Copper Alloy UNS numbers have been adopted for use by the Copper Association. See SAE HS-1086 and/or ASTM DS-56K.

4.1 MECHANICAL PROPERTIES AND DIMENSIONAL TOLERANCES

Materials supplied to this specification will comply with the limits for mechanical properties and dimensional tolerances established in SAE J463 from which Tables II and III are extracted.

TABLE II - MECHANICAL PROPERTIES

UNS Alloy Number	Product Form or Shape	Section Size		Temper	Tensile Strength		Elong- ation, % min	Hardness Rockwell 30T (Typical)
		inches	mm		ksi	MPa		
C11000	flat products	all	all	quarter hard	32-40	221-276	-	49 max
				half hard	37-46	255-317		43-57
				hard	43-52	296-359		54-62
				spring	50-58	345-400		60-66
				extra spring	52 min	359 min		61 min
	rod	all	all	soft	37 max	255 max	25	-
		thru 0.250	thru 6.35	hard	50 min	345 min	-	-
		0.251 thru 0.375	6.38 thru 9.53		45 min	310 min	10	
		0.376 thru 1.000	9.55 thru 25.40		40 min	276 min	12	
		1.001 thru 2.000	25.43 thru 50.80		35 min	241 min	15	
		2.001 thru 3.000	50.83 thru 76.20		33 min	228 min	15	

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TABLE II - MECHANICAL PROPERTIES (Continued)

UNS Alloy Number	Product Form or Shape	Section Size		Temper	Tensile Strength		Elongation, % min	Hardness Rockwell 30T (Typical)
		inches	mm		ksi	MPa		
C12200	tube	all	all	annealed	30 min	207 min		
				light drawn	36-47	238-324		30-60
				drawn (general purpose)	36 min	248 min		30 min
		thru 1.00 OD x 0.020 thru 0.120 wall	thru 25.4 OD x 0.51 thru 3.05 wall	hard drawn	45 min	310 min	-	55 min
		1.01 thru 2.00 OD x 0.035 thru 0.180 wall	25.7 thru 50.8 OD x 0.89 thru 4.57 wall					
		2.01 thru 4.00 OD x 0.060 thru 0.250 wall	51.1 thru 101.6 OD x 1.52 thru 6.35 wall					
C23000	tube	all	all	soft annealed	-	-	-	36 max
		thru 0.045 wall	thru 1.14 wall	light annealed	-	-	-	39 max
		over 0.045 wall	over 1.14 wall		-	-	-	-
		all	all	light drawn	44-58	303-400	-	43-75
				drawn (general purpose)	44 min	303 min	-	43 min
		thru 1.00 OD x 0.020 thru 0.120 wall	thru 25.4 OD x 0.51 thru 3.05 wall	hard drawn	57 min	393 min	-	65 min
		1.01 thru 2.00 OD x 0.035 thru 0.180 wall	25.7 thru 50.8 OD x 0.89 thru 4.57 wall					
		2.01 thru 4.00 OD x 0.060 thru 0.250 wall	51.1 thru 101.6 OD x 1.52 thru 6.35 wall					
C26000	flat products	0.012 thru 0.028	0.30 thru 0.71	quarter hard	49-59	338-407	-	43-57
		over 0.028	over 0.71				-	46-60
		0.012 thru 0.028	0.30 thru 0.71				-	56-66
		over 0.028	over 0.71	half hard	57-67	393-462	-	58-68
		0.012 thru 0.028	0.30 thru 0.71				-	65-70
		over 0.028	over 0.71				-	67-72
		0.012 thru 0.028	0.30 thru 0.71	three-quarter hard	64-74	441-510	-	70-73
		over 0.028	over 0.71				-	71-74
		0.012 thru 0.028	0.30 thru 0.71				-	74-76
		over 0.028	over 0.71	extra hard	83-92	572-634	-	75-77
		over 0.012	over 0.30				-	76-78
		over 0.012	over 0.30				-	77-79
C26000	tube	thru 0.30 wall	thru 0.76 wall	soft annealed	-	-	-	40 max
		over 0.030 wall	over 0.76 wall					43 max
		thru 0.030 wall	thru 0.76 wall	light annealed	-	-	-	60 max
		over 0.030 wall	over 0.76 wall					55 max
		all	all	drawn (general purpose)	54 min	372 min	-	53 min
		thru 1.00 OD x 0.020 thru 0.180 wall	thru 25.4 OD x 0.51 thru 3.05 wall	hard drawn	66 min	455 min	-	70 min
		1.01 thru 2.00 OD x 0.035 thru 0.180 wall	25.7 thru 50.8 OD x 0.89 thru 4.57 wall					
		2.01 thru 4.00 OD x 0.060 thru 0.250 wall	51.1 thru 101.6 OD x 1.52 thru 6.35 wall					

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TABLE II - MECHANICAL PROPERTIES (Continued)

UNS Alloy Number	Product Form or Shape	Section Size		Temper	Tensile Strength		Elongation, % min	Hardness Rockwell 30T (Typical)
		inches	mm					
C26800	flat products	0.012 thru 0.028	0.30 thru 0.71	quarter hard	49-59	338-407	-	43-57
		over 0.028	over 0.71					46-60
		0.012 thru 0.028	0.30 thru 0.71	half hard	55-65	379-448	-	54-64
		over 0.028	over 0.71					56-66
		0.012 thru 0.028	0.30 thru 0.71	three-quarter hard	62-72	427-496	-	65-69
		over 0.028	over 0.71					67-71
		0.012 thru 0.028	0.30 thru 0.71	hard	68-78	469-538	-	68-72
		over 0.028	over 0.71					69-73
		0.012 thru 0.028	0.30 thru 0.71	extra hard	79-89	545-614	-	73-75
		over 0.028	over 0.71					74-76
		0.012 thru 0.028	0.30 thru 0.71	spring	86-95	593-655	-	75-77
		over 0.028	over 0.71					76-78
		0.012 thru 0.028	0.30 thru 0.71	extra spring	90-99	621-683	-	76-78
		over 0.028	over 0.71					77-79
C33500 C34500 C35000	rod	thru 0.50	thru 12.7	soft	46 min	317 min	20	46 max
		0.51 thru 1.00	13.0 thru 25.4		44 min	303 min	25	
		over 1.00	over 25.4		40 min	276 min	30	
		thru 0.50	13.0 thru 25.4	quarter hard	52 min	359 min	10	50-67
		0.51 thru 1.00	over 25.4		50 min	245 min	15	43-63
		over 1.00	13.0 thru 25.4		42 min	290 min	20	40-60
		thru 0.50	over 25.4	half hard	57 min	393 min	7	57-70
		0.51 thru 1.00	13.0 thru 25.4		55 min	379 min	10	53-67
		over 1.00	over 25.4		50 min	345 min	15	43-60
C36000	flat products	thru 1.00 x 6.00 wide	thru 25.4 x 152.4 wide	soft	44 min	303 min	20	-
		thru 0.50 x 1.00 wide	thru 12.7 x 25.4 wide	half hard	50 min	345 min	10	-
	rod	thru 1.00	thru 25.4	soft	48 min	331 min	15	23-46
		1.01 thru 2.00	25.7 thru 50.8		44 min	303 min	20	
		over 2.00	over 50.8		40 min	276 min	25	
		thru 0.50	thru 12.7	half hard	57 min	393 min	7	-
		0.51 thru 1.00	13.0 thru 25.4		55 min	379 min	10	56-70
		1.01 thru 2.00	25.7 thru 50.8		50 min	345 min	15	49-63
		2.01 thru 3.00	51.1 thru 76.2		45 min	310 min	20	45-63
		3.01 thru 4.00	76.5 thru 101.6					43-56
		over 4.00	over 101.6					33 min
		0.06 thru 0.19	1.5 thru 4.8	hard	80 min	552 min	-	-
		0.20 thru 0.50	5.1 thru 12.7		70 min	483 min	4	
		0.51 thru 0.75	13.0 thru 19.1		65 min	448 min	6	
C37700	forgings	-	-	-	45 min	310 min	30	36-50
C38500	shapes	all	all	as extruded	48 min	331 min	15	44 min
C51000	rod	thru 0.25	thru 6.4	soft	40-58	276-400	-	-
				hard	80-128	552-883	-	-
		0.026 thru 0.063	0.66 thru 1.60	spring	115 min	793 min	-	-
		0.064 thru 0.125	1.62 thru 3.18		110 min	758 min	-	-
		0.13 thru 0.25	3.3 thru 6.4		105 min	724 min	-	-

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