

NAVISTAR, INC.		
Material, Parts, and Process Specifications (MPAPS)	NUMBER: MPAPS C-8	
	Former Designation: CEMS C-8	
TITLE: Aluminum Alloy Castings	CURRENT REV. No: 1604	DATE: APRIL 2016
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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: Added 384.0F; Editorial Changes		

1.0 SCOPE

This specification covers the chemical composition limits and mechanical properties for the most frequently used grades of aluminum alloy castings for engine and truck components.

2.0 INTRODUCTION

Aluminum alloy castings are light weight and offer a good combination of strength, corrosion resistance and machinability. They are suitable for many surface treatments like polishing and/or anodizing to provide good cosmetic appearance.

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.

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4.0 REFERENCE DOCUMENTS

This standard, unless otherwise specified, shall be used in conjunction with the latest issue of all referenced standards. The following standards, specifications and regulations are referenced in this specification.

Quality System Standard <i>ISO 9001 or TS-16949</i>	ASTM B85/B85M
NAVISTAR Manufacturing Standard MS-D-13	ASTM B108/B108M
NAVISTAR Engineering Procedural Standard EPS-143	ASTM B26/B26M
NAVISTAR Engineering Procedural Standard EPS-91	SAE J452
NAVISTAR MPAPS B-50	ASTM B917/B917M
CFR Title 29, Part 1910	ASTM E23
ASTM B505	ASTM B557
ASTM B769	ASTM E10
MIL I 17563C	

5.0 CLASSIFICATION

Aluminum alloys are classified on the basis of chemical composition. Specification of aluminum alloys further requires the identification of the casting process and post casting heat treatment. Navistar also classifies cast aluminum parts by function: Structural, Fluid Transport, and General Purpose (non-structural).

5.1 Chemical Composition

Proprietary trade names used by specific companies should not be used in a specifying an alloy. Use the designation and defined chemistry as ascribed to each alloy by a national or international standardization organization. Examples of standardization organizations that may be referenced include The Aluminum Association, ASTM, ISO, DIN and JIS.

5.2. The Casting Process: S, P or D.

5.2.1 The letter S is used mainly for parts made in bonded sand molds. Other casting process that employ sand or plaster as mold medium- Evaporative Pattern Casting (EPC), Shell Mold Casting, Plaster Casting etc..., should also use this letter but must also be identified in a separate note on the drawing.

5.2.2 The letter P is used for parts made in metallic permanent molds using gravity or low pressure feed systems (170kPa/ 25psi or less). Semi-permanent mold castings employing the sand cores are included in this process designation. Note that some international standardization organizations use the letter "K" to describe this type of casting process.

5.2.3 The letter D is used for parts made by injecting molten metal into a die- mold under considerable pressure.

5.2.4 When exotic casting/processing methods like centrifugal casting, squeeze casting or semisolid-metal processing are employed, use the letter above that best describes the mold to be used (S or P) and describe the actual casting process in a separate note.

5.3 Post Casting Heat treatment (temper)

Identify along with casting process per The Aluminum Association temper designation system

5.4. Casting Class

Indicated for all castings as described in section 7.3.

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6.0 GENERAL REQUIREMENTS

6.1 Chemical Composition Requirements

Alloy designations and chemical composition limits are shown in Table I (refer to the applicable ASTM standard - ASTM B85/B85M for die castings, ASTM B26/B26M for sand castings, and ASTM B108/B108M for permanent or semi-permanent mold castings). Alloy designations and compositions compiled by other standardization bodies which are not listed in Table 1, may be specified in the callout in conjunction with the governing standard as indicated in section 10.0.

6.2 Mechanical Properties

Heat treatment of sand and permanent mold castings shall be specified by the addition of a suffix to the alloy designation as shown in Table II. The letter "F" indicates that castings are to be supplied "as cast" without any heat treatment. Die castings are not heat treated.

6.2.1 Mechanical properties of separately cast test bars representing sand and permanent mold castings shall conform to the requirements listed in Table III. Property requirements of test bars machined from castings shall be not less than 75% of the tensile and yield strength values shown and not less than 25% of the elongation values specified, except for permanent mold castings of alloys 354.0, C355.0, A356.0, A357.0, and 359.0 for which the tensile strength and elongation of test specimens cut from castings shall be in accordance with the values listed in Table III. When the strength of particular areas of the casting is critical, the locations where test bars may be obtained will be shown on the drawing and test bars machined from these locations can be used to verify that requirements are met.

6.2.2 Die castings purchased to this specification will not depend on mechanical properties unless specified on the engineering drawing and guaranteed by the manufacturer. For typical properties of die castings, see Table II in MPAPS C-8 Appendix.

6.3 Identification

Where space permits, the NAVISTAR part number and vendor's identification will be shown.. When a date code is required by the controlling engineering department on castings, it will be specified on the engineering drawing. Engineering Procedural Standard EPS-91* covers requirements for date codes. The company trademark per Engineering Procedural Standard EPS-143* may also be cast or stamped on each casting at a location shown on the engineering drawing Packaging and identification for shipment to Navistar facilities will be in accordance with Manufacturing Standard MS-D-13*.

*Navistar EPS-143, EPS-91, and can be obtained from Corporate Technical Standards, 2601 Navistar Dr., Lisle IL 60532. MS-D-13, Supplier Packing and Shipping Standard, can be obtained at www.navistarsupplier.com

7.0 QUALITY

7.1 Casting Soundness

Castings must be clean, sound and free from harmful porosity and segregation or other injurious defects. Unless otherwise specified on the drawing, sand and permanent mold castings shall meet the discontinuity requirements for a Grade C casting in ASTM B26 and B108 respectively. Die castings shall have no worse than a Level 2 discontinuity in any category per ASTM E505 except by agreement between the producer and Navistar Engineering. When the soundness of particular areas of the casting is critical, the locations will be shown on the drawing with specific discontinuity type and level requirements. Sand and permanent

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mold castings may be required to meet the discontinuity requirements for a Grade B casting on the print. When a non-critical area of a component cannot realistically meet the Grade C general requirement, it shall be documented on the print, annotating the location and the discontinuity types and achievable severity levels to be allowed. The specification of a maximum pore/ hole/ defect size may also be indicated on a drawing by agreement.

7.2 Repair

The only repair allowed to castings without written approval from engineering is impregnation. All other repair procedures (welding, sealing, straightening, heat treatment, etc.) require written approval from the responsible design engineer and materials engineering. Impregnation of castings to seal voids which cause leaking is allowed per MIL-I-17563C, unless otherwise stated on the print. The impregnant shall be Class 1 (suitable for service temperatures up to 300°F). Higher temperature applications will call out the requirements for the impregnant on the drawing. A casting is allowed to be impregnated up to two times to meet leaking requirements.

7.3 Casting Class:

All castings shall be placed into one of the classes below and the class denoted on the drawing. Castings which have a critical dFMEA failure mode severity of 9 or 10, and/or any component identified on "Critical Cast Component List" provided in Section A0 at the end of this specification, shall be reviewed by the responsible design SMT and Materials Engineering and assigned a Class of F, S, or M. and shall be identified as a "Critical Casting" by notation on the drawing. All other castings shall be placed into Class G.

Class F: components which require a validation and verification plan for fluid transport properties

Class S: components which require a validation and verification plan for structural support properties

Class M: components which require a validation and verification plan for a mix of fluid transport and structural support properties

Class G: components which have general validation and verification plan requirements

A validation and verification plan shall be executed during the total product lifecycle of all castings per their classification as indicated in Section A1 below. Evaluation of castings against criteria listed here and to other specified requirements shall be conducted during initial part development (DVP&R), production part approval (PPAP) and full production (Ongoing Control Plan).

Castings regarded as critical by Engineering shall include on the drawing a note indicating the class the casting falls under. See Section 10.0 for an example. Unless otherwise noted on the drawing, required properties for critical castings are the same as those defined in this specification.

8.0 METHODS OF TEST

Test Specimens, Test Methods and Number of Tests shall be per ASTM B26/B26M, B85/B85M, and B108/B108M respectively unless otherwise noted above or on the drawing.

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9.0 SOURCE APPROVAL AND QUALITY CONTROL

9.1 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.

9.2 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.

9.3 Process Control

The supplier shall either 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.

10.0 DESIGNATION ON DRAWINGS AND PURCHASE ORDERS

Material designations on drawings and purchase orders will include the Aluminum Association alloy number or other standard designation (include reference industry standard), casting process(S, P or D) with temper designation, (see Table II), and casting class as defined in Section 7.3.

Examples: Alum Alloy 319.0 SF, Class F, MPAPS C-8
Alum Alloy 380.0 DF, Class G, MPAPS C-8
Alum Alloy A356.0 PT6, Class S, MPAPS C-8
Alum Alloy, ADC12 per JIS H5302, DF, Class G, MPAPS C-8

11.0 PACKING AND SHIPPING

Packing, shipping, and identification will be in accordance with Manufacturing Standard MS-D-13.

12.0 TECHNICAL INFORMATION

For further information related to the technical content of this specification, contact:	Suppliers may purchase controlled copies of this specification by contacting:
Materials Engineering and Technology Dept. 10400 W. North Avenue Melrose Park, IL 60160 E-mail: MaterialsEngineering@Navistar.com	IHS Global Inc. 15 Inverness Way East Englewood CO 80112-5776 Phone: 1-800-854-7179 E-mail: Automotive@IHS.com Website: http://global.ihs.com

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TABLE I - CHEMICAL REQUIREMENTS

Alloy Designation	Casting Process *	Maximum Percent Unless Stated Otherwise (Balance Aluminum)										Other Elements	
		Copper	Iron	Silicon	Manganese	Magnesium	Zinc	-	Titanium	Nickel		Each	Total
32M**	P	0.8-1.5	0.7	11.0-13.0	0.30	0.8-1.3	0.30	-	0.20	1.3	-	-	-
A332.0**	P	0.5-1.5	1.2	11.0-13.0	0.35	0.7-1.3	0.35	-	0.25	2.0-3.0	0.05	-	-
F332.0**	P	2.0-4.0	1.2	8.5-10.5	0.50	0.5-1.5	1.0	-	0.25	0.50	-	0.50	0.50
Z332.0**	P	1.5-3.0	1.2	11.0-13.0	0.50	0.5-1.5	1.0	-	0.25	0.5-1.5	-	0.50	0.50
201.0	S	4.0-5.2	0.15	0.10	0.20-0.50	0.15-0.55	--		0.15-0.35	--	0.05	0.10	0.10
204.0	S&P	4.2-5.0	0.35	0.20	0.10	0.15-0.35	0.10	Sn, 0.05	0.15-0.30	0.05	0.05	0.15	0.15
206.0	S&P	4.2-5.0	0.15	0.10	0.20-0.50	0.15-0.35	0.10		0.15-0.30	0.05	0.05	0.15	0.15
242.0	S&P	3.7-4.5	1.0	0.7	0.35	1.2-1.8	0.35	Cr, 0.25	0.25	1.7-2.3	0.05	0.15	0.15
295.0	S	4.0-5.0	1.0	0.7-1.5	0.35	0.03	0.35		0.25	--	0.05	0.15	0.15
319.0	S&P	3.0-4.0	1.0	5.5-6.5	0.50	0.10	1.0	-	0.25	0.35	-	0.50	0.50
328.0	S	1.0-2.0	1.0	7.5-8.5	0.20-0.6	0.20-0.6	1.5	Cr, 0.35	0.25	0.25		0.50	0.50
333.0	P	3.0-4.0	1.0	8.0-10.0	0.50	0.05-0.50	1.0	-	0.25	0.50	-	0.50	0.50
354.0	P	1.6-2.0	0.20	8.6-9.4	0.10	0.40-0.6	0.10		0.20	--	0.05	0.15	0.15
355.0	S&P	1.0-1.5	0.6 ⁽¹⁾	4.5-5.5	0.50 ⁽¹⁾	0.40-0.60	0.35	Cr, 0.25	0.25	-	0.05	0.15	0.15
C355.0	S&P	1.0-1.5	0.2	4.5-5.5	0.10	0.40-0.60	0.10	-	0.20	-	0.05	0.15	0.15
356.0	S&P	0.25	0.6 ⁽¹⁾	6.5-7.5	0.35 ⁽¹⁾	0.20-0.45	0.35	-	0.25	-	0.05	0.15	0.15
A356.0	S&P	0.20	0.2	6.5-7.5	0.10	0.25-0.45	0.10	-	0.20	-	0.05	0.15	0.15
357.0	P	0.05	0.15	6.5-7.5	0.03	0.45-0.60	0.05	-	0.20	-	0.05	0.15	0.15
A357.0	P	0.20	0.20	6.5-7.5	0.10	0.40-0.7	0.10	--	0.04-0.20	--	0.05 ⁽³⁾	0.15	0.15
359.0	P	0.20	0.20	8.5-9.5	0.10	0.50-0.7	0.10	--	0.20	--	0.05	0.15	0.15
360.0	D	0.60	2.0	9.0-10.0	0.35	0.40-0.60	0.50	Sn, 0.15	-	0.50	-	0.25	0.25
A360.0	D	0.60	1.30	9.0-10.0	0.35	0.40-0.60	0.50	Sn, 0.15	-	0.50	-	0.25	0.25
380.0	D	3.0-4.0	2.0	7.5-9.5	0.50	0.10	3.0	Sn, 0.35	-	0.50	-	0.50	0.50
A380.0	D	3.0-4.0	1.3	7.5-9.5	0.50	0.10	3.0	Sn, 0.35	-	0.50	-	0.50	0.50
383.0	D	2.0-3.0	1.3	9.5-11.5	0.50	0.10	3.0	Sn, 0.15	-	0.30	-	0.50	0.50
384.0	D	3.0-4.5	1.3	10.5-12.0	0.50	0.10	3.0	Sn 0.35		0.50		0.50	0.50
ADC12 ⁽⁴⁾	D	1.5-3.5	1.3	9.6-12.0	0.50	0.30	1.0	Sn 0.20, Pb 0.20	0.30	0.50			
443.0	S&P	0.6	0.8	4.5-6.0	0.50	0.05	0.50	Cr, 0.25	0.25			0.35	0.35
520.0	S	0.25	0.30	0.25	0.15	9.5-10.6	0.15	-	0.25	-	0.05	0.15	0.15
535.0	S&P	0.05	0.15	0.15	0.10-0.25	6.2-7.5	-	⁽²⁾	0.10-0.25	-	0.05	0.15	0.15
710.0	S	0.35-0.65	0.50	0.15	0.05	0.6-0.8	6.0-7.0		0.25	-	0.05	0.15	0.15
A712.0	S	0.25	0.50	0.30	0.10	0.50-0.65	5.0-6.5	Cr, 0.4-0.6	0.25	-	0.05	0.20	0.20
771.0	S	0.10	0.15	0.15	0.10	0.8-1.0	6.5-7.5	Cr, 0.06-0.20	0.10-0.20	-	0.05	0.15	0.15

⁽¹⁾ If iron exceeds 0.45%, Manganese to be not less than half the iron content.

⁽²⁾ Beryllium, 0.003-0.007; Boron, 0.005 max.

⁽³⁾ Beryllium, 0.04-0.07

⁽⁴⁾ Per JIS H5302

* D = die; P = permanent mold; S = sand

** Piston alloys; 32M is a Navistar designation.

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