

NAVISTAR, INC.		
Material, Parts, and Process Specifications (MPAPS)		NUMBER: MPAPS E-9
		Former Designation: <i>CEMS E-9</i>
TITLE: Compacted Graphite Iron Castings		CURRENT REV No.: 1606
		DATE: June 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>		

1.0 APPLICATION

Compacted graphite iron is a cast iron with the graphite in compacted (vermicular or worm-like) shapes and essentially free of flake graphite. It is similar to ductile (nodular) iron in chemistry except for a lower magnesium or cerium content. Mechanical properties are intermediate to gray iron and ductile iron. CGI has better strength and stiffness than gray iron, and better castability, machinability, and thermal conductivity than ductile iron.

2.0 SCOPE

This specification describes the chemistry, microstructure and mechanical property requirements for castings made of compacted graphite iron (CGI) used in the Corporation'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 standards, specifications and regulations are referenced in this specification.

Quality System Standard *ISO 9001 or TS-16949*
NAVISTAR Manufacturing Standard MS-D-13
NAVISTAR Eng. Proc. Std EPS-91
NAVISTAR Eng. Proc. Std EPS-143

CFR Title 29, Part 1910
ASTM A 48
ASTM A 247
ASTM A 842
ASTM E 10
ASTM E 18
MPAPS B-50
ASTM E 8

4.0 REQUIREMENTS

4.1 CLASSIFICATION

This specification covers five grades of CGI, meeting the requirements as designated in Table I below.

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TABLE I –MECHANICAL PROPERTIES AND MICROSTRUCTURE REQUIREMENTS ⁽¹⁾

Navistar Grade ⁽²⁾	Tensile Strength (min.)		Yield Strength (min.)		Elongation % (min.)	Typical Matrix Microstructure ⁽⁴⁾	Brinell Hardness	
	MPa	ksi	MPa	ksi			HBW	BID ⁽³⁾
250	250	36.3	175	25.4	3.0	Ferritic	121-179	4.5 min
300	300	43.5	210	30.5	1.5	Ferritic/Pearlitic	143-207	5.0-4.2
350	350	50.8	245	35.5	1.0	Ferritic/Pearlitic	163-229	4.7-4.0
400	400	58.0	280	40.6	1.0	Pearlitic/Ferritic	207-255	4.2-3.8
450	450	65.3	315	45.7	1.0	Pearlitic	217-269	4.1-3.7

⁽¹⁾ Refer to Section 6.4 for designation of critical sections of castings.

⁽²⁾ Grade designations are approximately equivalent to ASTM A 842 grade designations.

⁽³⁾ BID (Brinell impression diameter) is the diameter (mm) of the impression of a 10-mm ball at a 3000-kg load.

⁽⁴⁾ Refer to Section 6.2 for specific requirements.

4.2 Chemical Composition

The chemical composition of CGI castings will be selected to produce the desired mechanical properties, but may be specified by agreement between the supplier and the controlling Engineering Dept. CGI can be alloyed with various elements to optimize properties.** Table II gives a typical composition for CGI castings.

TABLE II – TYPICAL CHEMICAL COMPOSITION (%) **

Carbon Equivalent*	Carbon	Silicon	Sulfur	Manganese	Phosphorus
4.20-4.60	3.5-3.8	2.0-2.6	<0.025	0.20-0.50	<0.050

*Carbon equivalent is defined as: $\% \text{ total C} + \frac{\% \text{ Si} + \% \text{ P}}{3}$

****NOTE:** Casting composition will be limited to a maximum of 0.015% Ti and 0.10% Cr for maximum machinability.

4.3 Microstructure Requirements

4.3.1 Metallographic examination of graphite morphology will be performed on a casting, on a test lug from the casting, or on a separately cast test coupon or test bar (see ASTM A 842, Fig. 1), as specified on the engineering drawing or per agreement between supplier and controlling Engineering Dept. Test bars or coupons will be representative of the cast metal.

4.3.2 Graphite morphology will be evaluated per ASTM A 247. The microstructure of all grades will contain 80% minimum Type IV graphite (CGI shape) per Plate 1, ASTM A 247, with the remaining graphite being of Types I or II (nodules). Flake graphite (Type VII) is not permitted.

4.3.3 The matrix microstructure will consist of ferrite or pearlite, or a combination of these depending on the required mechanical properties, and will be substantially free of primary cementite. For areas designated as critical sections of the casting, the matrix microstructure for Grade 400 must consist of 80% minimum pearlite, and 90% minimum pearlite for Grade 450 (assumes pearlite + ferrite = 100%).

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