

NAVISTAR, INC.		
Material, Parts, and Process Specifications (MPAPS)		NUMBER: MPAPS E-6
		Former Designation: <i>CEMS E-6</i>
Gray Iron Castings		CURRENT REV No.: 1608
		DATE: Aug. 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

Gray iron has a wide range of strength and hardness with a high level of fluidity. It is the most castable and the lowest cost of the common cast metal materials.

2.0 SCOPE

This specification covers the requirements for gray iron castings 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 Specifications, Standards, and Regulations are referenced in this specification.

Quality System Standard ISO 9001 or TS-16949	NAVISTAR EPS-91	ASTM E10
CFR Title 29, Part 1910	NAVISTAR EPS-143	ASTM E18
NAVISTAR Supplier Packing and Shipping Std. D-13	ASTM A48	ASTM E140
NAVISTAR Engineering Design Standard A-16	ASTM A247	AWS D11.2
NAVISTAR MPAPS B-50	ASTM E8	ASTM A159
SAE J419		

4.0 CLASSIFICATION OR GRADE

This specification covers five structural gray iron grades. Gray iron is classified by its strength, hardness and microstructure. For control purposes the iron grades described in this specification are classified by the strength developed in sections with thickness from 0.25 to 1.5 inch (see Section 5.2 and Table IV). The obsolete gray iron numbers that these five grades replace are also shown in Table I below:

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AUGUST 2016



Documents

Page 1 of 13
Document Sharing Hub

NUMBER: MPAPS E-6	TITLE: Gray Iron Castings	REVISION: 1608
-----------------------------	-------------------------------------	--------------------------

TABLE I – GRADE CLASSIFICATION

Navistar Designation			
Grade	Obsolete Gray Iron Numbers ⁽¹⁾	Grade	Obsolete Gray Iron Numbers ⁽¹⁾
25-S	15, 20, 21	35-S	30, 56, 57, 60, 61, 66, 70, 71
30-S	22	40-S	45, 90, 91, 93, 95
32-S *	23, 63, 65, 72	WI **	41, 42, 43

* Not to be specified for new design. Use Grade 30-S or 35-S as required.

** White iron

⁽¹⁾ All Navistar Engine Division flywheels not covered by current designations will be supplied to Grade 35-S.

5.0 REQUIREMENTS

5.1 Chemical Composition

The primary intent of this specification is to require hardness and microstructure rather than chemistry but the chemical requirements shown in Table II are considered necessary to control those properties.

TABLE II – CHEMICAL COMPOSITION

Navistar Grade	Chemical Composition, percent			
	Carbon Equivalent* Max	Sulfur, max	Phosphorus, max	Manganese, min
25-S thru 40-S	4.30**	0.16	0.20	1.7 x % Sulfur +0.20

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

** Not required for Grade 25-S; however, the use of high carbon equivalent 25-S in heavy sections is not recommended.

5.1.1 Alloy Requirements - New Design

5.1.1.1 Specific Alloy Additions: Castings that require specific alloy additions for heat resistance or other special properties will be designated by the Suffix “A”. Example: Grade 35-SA. The alloy content will be shown on the engineering drawing.

5.1.1.2 Wear Resistance: Castings in which wear resistance is the primary requirement will be designated by the Suffix “WR”. Example: Grade 40-WR.

5.1.1.3 Optional Additions: In most cases structural strength is the primary engineering concern. Alloy additions to meet strength requirements are optional with the producer and should not be specified on the drawing.

5.1.2 Alloy Requirements - Existing Design

5.1.2.1 Mandatory Alloy Content: A number of existing drawings specify obsolete grades with mandatory alloy content. For the particular categories of castings listed in Table III, the mandatory requirements will continue to apply until the drawing is reviewed and updated. It should be emphasized that for new designs

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AUGUST 2016



Documents

Page 2 of 13

Document Sharing Hub

NUMBER: MPAPS E-6	TITLE: Gray Iron Castings	REVISION: 1608
-----------------------------	-------------------------------------	--------------------------

involving these categories of castings, the application should be carefully reviewed to determine if the mandatory alloy content is necessary.

5.1.2.2 Non-mandatory Alloy Additions: For casting categories not listed in Table III where structural strength is the primary engineering concern, mandatory alloy content of the obsolete grade will not apply. A current grade meeting mechanical property requirements may be substituted. Example: Old - Gray Iron No. 61; New - Grade 35-S.

5.1.2.3 Obsolete Grade 65 Hydraulic Castings: Hydraulic castings formerly specified as Gray Iron No. 65, require pressure tightness and minimum porosity for surface finish. Mandatory alloy content is no longer required, but initial samples should be inspected to insure that the soundness requirements will be met.

TABLE III – ALLOY REQUIREMENTS FOR EXISTING CASTINGS

Navistar Grade *	Obsolete Gray Iron No.	Specific Castings Categories	Alloy Content, Percent		
			Nickel and/or Copper	Chromium	Molybdenum
35-SA	61	exhaust manifolds, brake drums, diesel cylinder heads	1.25 ± 0.20	0.65 ± 0.15	-
35-SA	71	manifold heat control valves	-	0.75 ± 0.15	-
40-SA	93	exhaust manifolds	0.30 ± 0.10	0.25 ± 0.15	0.60 ± 0.10

*For proper specification of the “A” suffix refer to the preceding paragraphs covering alloy requirements for new and existing designs.

5.2 Mechanical Properties

5.2.1 Castings - As Cast

Finished machined castings purchased to this specification will meet the as cast mechanical property requirements shown in Tables IV and IVa, unless otherwise specified. Since foundry hardness measurements are normally made on as-cast surfaces, foundry personnel as well as designers must be alert to the section thickness breakpoints in Tables IV and IVa.

5.2.2 Castings - Critical Sections

When sections of a casting are deemed critical for reasons of stress, function or reliability, the controlling engineering department should designate the location of the critical section or sections on the drawing. If widely different solidification and cooling rates are anticipated or experienced in the casting and the foundry anticipates or finds that it cannot meet the hardness or strength requirements throughout the casting, the foundry will request the engineering department concerned to designate the location of a critical section or sections on the drawing. The amount of allowable deviation from the specified mechanical properties in non-critical areas will be subject to agreement between the foundry and the controlling engineering department. The purpose of these procedures is to clearly establish that the hardness and strength determinations be made in critical areas.

5.2.3 Castings – Tension Test Specimens (if required)

If test specimens for tension testing are required, conventional machined tension test specimens are preferred and will conform to the dimensions specified for cast iron specimens in ASTM A48.

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AUGUST 2016



Documents

Page 3 of 13
Document Sharing Hub

NUMBER: MPAPS E-6	TITLE: Gray Iron Castings	REVISION: 1608
-----------------------------	-------------------------------------	--------------------------

TABLE IV - MECHANICAL PROPERTIES OF FINISHED UN-HEAT TREATED CASTINGS

Navistar Grade	Section Thickness, inches *																	
	thru 0.25			0.26 thru 0.50			0.51 thru 0.75			0.76 thru 1.00			1.01 thru 1.50			greater than 1.50 ⁽²⁾		
	tensile strength min	hardness BHN		tensile strength min	hardness BHN		tensile strength min	hardness BHN		tensile strength min	hardness BHN		tensile strength min	hardness BHN		tensile strength min	hardness BHN	
	psi	min	max	psi	min	max	psi	min	max	psi	min	max	psi	min	max	psi	min	max
25-S	32000	197	241	25000	170	229	22000	159	229	not recommended			not recommended			not recommended		
30-S	36000	212	248	30000	192	241	27000	179	229	24000	167	229	20000	149	229	not recommended		
32-S**	38000	217	255	32000	197	241	29000	187	235	26000	174	229	22000	159	229	18500	140	229
35-S	41500	229	262	35000	207	248	32000	197	241	29000	187	235	25000	170	229	21500	156	229
40-S	46500	241	277	40000	223	255	37000	217	248	34000	201	248	30000	192	241	27000	179	229
WI	-	375	-	-	375	-	-	352	-	-	352	-	-	352	-	-	352 ⁽¹⁾	-

TABLE IVa - METRIC EQUIVALENT OF TABLE IV

Navistar Grade	Section Thickness, millimeters																	
	thru 6.47			6.48 thru 12.82			12.83 thru 19.17			19.8 thru 25.52			25.53 thru 38.22			greater than 38.22 ⁽²⁾		
	tensile strength min	hardness BHN		tensile strength min	Hardness BHN		tensile strength min	hardness BHN		tensile strength min	hardness BHN		tensile strength min	hardness BHN		tensile strength min	hardness BHN	
	MPa	min	max	MPa	min	max	MPa	min	max	MPa	min	max	MPa	min	max	MPa	min	max
25-S	221	197	241	172	170	229	152	159	229	not recommended			not recommended			not recommended		
30-S	248	212	248	207	192	241	186	179	229	165	167	229	138	149	229	not recommended		
32-S**	262	217	255	221	197	241	200	187	235	179	174	229	152	159	229	128	140	229
35-S	286	229	262	241	207	248	221	197	241	200	187	235	172	170	229	148	156	229
40-S	321	241	277	276	223	255	255	217	248	234	201	248	207	192	241	186	179	229
WI	-	375	-	-	375	-	-	352	-	-	352	-	-	352	-	-	352 ⁽¹⁾	-

* Properties are based upon the thickest section of each classification.

** Grade 32-S: Not to be used for new design.

⁽¹⁾ Applicable to 2 inch (50 mm) thickness.

⁽²⁾ Based on 2.50 inch (63.50 mm) section thickness.

5.3 Metallurgical Requirements

An essentially pearlitic matrix is desired in all as cast gray iron castings. This requires a combined carbon content between approximately 0.50 and 0.80 percent. If part sampling is required, the microstructure location will be agreed upon by the controlling design engineering department and the foundry and will be clearly identified on the drawing. All castings purchased to this specification will conform to the following requirements for microstructure:

5.3.1 In castings whose primary requirement is resistance to wear (WR Grades), the matrix may contain small, well distributed free cementite islands in an amount not to exceed 10 percent of the area of the specimen examined. Exceptions to the above are:

5.3.1.1 Alloyed irons which have over 0.60 percent chromium content are permitted to have higher than 10 percent free cementite.

5.3.1.2 Chromium-molybdenum alloyed iron with 0.40 percent minimum molybdenum content may have fine pearlitic matrices with fine, small cementite particles interspersed through the matrices and outlining the grain boundaries.

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AUGUST 2016



Documents
Page 4 of 13
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