

NAVISTAR, INC.		
Material, Parts, and Process Specifications (MPAPS)		NUMBER: MPAPS H-1
		Former Designation: CEMS H-1
TITLE: Powder Metal Structural Parts		CURRENT REV No.: 1406
		DATE: JUNE 2014
WRITTEN/EDITED BY: Materials Engineering	APPROVED BY: Materials Engineering	SUPERSEDES: CEMS H-1 - August 2008
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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: Changed to new MPAPS format; editorial changes.		

1.0 APPLICATION

Powder metal (P/M) structural parts covered herein refer to machine components whose load carrying capability, strength, and density are the major design factors. For applications involving combined functions such as structural and self-lubrication or wear, a Materials Engineer should be consulted.

1.1 Part Development and Specification (Structural Application)

1.1.1 A complete material specification for a P/M part cannot be written at the proposal stage. The engineer must refer to the design guide in "Appendix - General Information" for detailed recommendations regarding the development of an effective material specification.

1.1.2 The design engineer should make a tentative material choice in cooperation with a P/M parts supplier and/or Materials Engineer using the materials listed in Table I. This table, based upon MPIF Standard 35, describes materials in terms of composition and strength. Since limits for the other mechanical properties cannot initially be specified, some typical mechanical properties for test bars are shown in "Appendix - General Information" as a guide. Additional mechanical properties and design information are found in other MPIF or ASTM specifications. See "Mechanical Property Requirements", Section 6.2.

1.1.3 Prototype parts will be "de-rated" to assist in the development of minimum engineering properties for the specification of the proposed parts. In some cases, the de-rating will be done by specifying prototype parts with a lower strength value than the minimum specified for production parts. In other cases, the de-rating will be done by specifying prototype material density lower than the minimum proposed for production parts.

2.0 SCOPE

This specification covers the Corporation's requirements for structural parts produced from powdered metals. The term "P/M parts" is used throughout this specification as the designation for powdered metal parts.

Note: Requirements for all powdered metal bearings and bushings with low to medium density, in which porosity and self-lubrication are paramount, are classified as porous sintered metal bearings and are covered in CEMS C-5, Bearing and Bushing Alloys.

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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	MPIF Standard 35
CFR Title 29, Part 1910	MPIF Standard 40
NAVISTAR Manufacturing Std. MS-D-13	MPIF Standard 41
NAVISTAR MPAPS B-50	ASTM B 962
NAVISTAR CEMS C-5	ASTM B 963
NAVISTAR CEMS HT-1	

4.0 REQUIREMENTS

Materials covered by this specification are identified, as shown in Table I, by a designation code which is based on the Metal Powder Industries Federation (MPIF) system. The P/M code is based on chemistry and minimum strength value. The prefix letters F, FC, FD, FL, FN, and FX designate iron, carbon and alloy steels, and prefix letters SS designate stainless steels, and are followed by four digit numbers. In ferrous materials the first two digits of the four digit code indicate the percentage of the major alloying constituent present. Combined carbon is designated by the last two numbers in the four-digit series. The three digit numbers in the stainless steel series (SS) indicate the type of stainless steel. The suffix letters indicate the minimum yield strength value in the as-sintered condition or the minimum tensile strength value in the heat treated condition. P/M prototype parts must comply with the appropriate requirements listed in Section 6.1, "Qualification".

4.1 New Materials

New or other P/M materials not included in Table I, for which the MPIF has assigned a material code, will be identified by that code. Refer to the latest issue of MPIF Standard 35.

5.0 QUALITY

Parts will be clean and free from scale, defects, flaws or any condition that would adversely affect performance. To properly evaluate and check P/M parts, it is necessary that performance tests on prototype parts be supplemented by controlled tests made in the laboratory to establish minimum acceptable mechanical property requirements of the parts. These tests will be completely described on the drawing* in terms of the test method, minimum load requirements, location of load application, or other test limits as necessary.

*Common practice is to specify a minimum crush load or breaking strength on the drawing for each part.

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5.1 Impregnation

Impregnation is prohibited unless it is specified on the drawing. No oil of any kind for any purpose will be permitted unless specified on the engineering drawing. When impregnation is required, only the vacuum method will be allowed and the impregnant (oil) will be identified on the drawing.

5.2 Dimensional Tolerances

The dimensions will be within limits for commercial practice of the P/M industry. Dimensional tolerances, when critical, will be specified on the drawing. Specific tolerances are subject to agreement between the purchaser and the supplier.

5.3 Inspection

The inspection of P/M parts involves the performance of all material property tests described herein and those tests described on the engineering drawing, as well as inspection for size and shape. Sampling details will be as agreed upon by the purchaser and supplier.

6.0 QUALIFICATION

Production material can be furnished under this specification only after engineering qualification unless waived by the controlling engineering department. When requested by the appropriate purchasing department, the supplier will be required to furnish prototype samples to the controlling engineering department. The density of prototype parts will be $0.1 \pm 0.03 \text{ g/cm}^3$ lower than the minimum for the range specified, unless otherwise specified. Whenever possible, prototype parts will be processed with production dies. Where high cost makes this impractical, the controlling engineering department may approve the testing of prototype parts machined from P/M slugs. Final approval will be granted only after receipt of acceptable production parts.

The prototype parts will be individually identified and will be accompanied by the following information:

1. Certification that all dimensions of each part are as specified.
2. Total weight of each part.
3. Actual density of each part.
4. Apparent hardness of each part.
5. Total weight, break strength, microstructure and chemical composition for each of five randomly selected parts representing the shipment.
6. Results of all tests specified on the drawing.

After final qualification of prototype parts, the engineering drawings should be reviewed to determine if any changes are necessary. Confirm correctness of the material description including the identification of impregnation material if used. Add all specialized inspection requirements such as fracture tests, density, hardness and microstructure, with critical locations for testing indicated on the drawings. Include a detailed description of necessary test fixtures. Future changes in formulation or processing will require engineering approval.

7.0 METHODS OF TEST

7.1 Density

Test per ASTM B 328. For complex shapes with possible density variations, the section to be inspected will be designated on the engineering drawing.

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7.2 Hardness

The reported apparent hardness will be an average of not less than six individual readings.

7.3 Special Tests

Radial Crush, Gear Tooth Fracture, Transverse Fracture - Conduct these tests according to CEMS Test Method HT-1. For any other special test, see the engineering drawing.

8.0 SOURCE APPROVAL AND QUALITY CONTROL

8.1 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.

8.2 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.

8.3 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.

9.0 SHIPPING AND HANDLING

Shipping and identification shall be in accordance with NAVISTAR Manufacturing Standard MS-D-13. Parts shall be packaged so as to avoid any damage in shipment detrimental to the appearance of the part.

10.0 DESIGNATION ON DRAWINGS

Material designation on drawings will include the material designation code, break strength and any other specific requirements not included in this specification.

Examples: F-0000-15 MPAPS H-1, Min Apparent Hardness R_F 40
Radial Crush Strength - 350 lbf (1.6 kN) min,
Vacuum impregnate with ____ oil.

FN-0200-25 MPAPS H-1, Carburize - Surface File Hard
Fracture Strength 9500 lbf (42.3 kN) min tested as shown.

FN-0208-130HT MPAPS H-1, Min Apparent Hardness RC 35, Min Part Weight - 180 g
Microstructure will be essentially uniform tempered martensite.
Fracture Strength 4000 lbf (17.8 kN) min tested as shown.

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10.0 TECHNICAL INFORMATION

For further information related to the technical content of this specification, contact:	Suppliers may purchase controlled copies of this specification by contacting:
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TABLE I - CLASSIFICATION, MINIMUM STRENGTH and CHEMICAL COMPOSITION

Material Designation Code ⁽¹⁾	Obsolete CEMS H-1 Designation	Minimum Strength, ksi		Chemical Composition, percent ⁽²⁾				Typical Values ^{(3),(4)}	
		Yield Strength	Tensile Strength	Carbon	Copper	Nickel	Other	Apparent Hardness	Density Mg/m ³
F-0000-10	---	10	--	0.0-0.3	-	-	-	40 HR _F	6.1
F-0000-15	F-0000-R	15	--	0.0-0.3	-	-	-	60 HR _F	6.7
	F-0000-X								
----	F-0000-S	--	--	0.0-0.3	-	-	-	-	6.8-7.2
F-0000-20	F-0000-T	20	--	0.0-0.3	-	-	-	80 HR _F	7.3
F-0005-15	---	15	--	0.3-0.6	-	-	-	25 HR _B	6.1
F-0005-20	F-0005-R	20	--	0.3-0.6	-	-	-	40 HR _B	6.6
	F-0005-X		--	0.3-0.6	-	-	-		
F-0005-25	F-0005-S	25	50	0.3-0.6	-	-	-	55 HR _B	6.9
F-0005-50HT	--	-	60	0.3-0.6	-	-	-	20 HR _C	6.6
F-0005-60HT	--	-	70	0.3-0.6	-	-	-	22 HR _C	6.8
F-0005-70HT	--	-	-	0.3-0.6	-	-	-	25 HR _C	7.0
F-0008-20	--	20	-	0.6-0.9	-	-	-	35 HR _B	5.8
F-0008-25	--	25	-	0.6-0.9	-	-	-	50 HR _B	6.2
F-0008-30	F-0008-R	30	-	0.6-0.9	-	-	-	60 HR _B	6.6
	F-0008-X								
F-0008-35	F-0008-S	35	-	0.6-0.9	-	-	-	70 HR _B	7.0
F-0008-55HT	--	-	55	0.6-0.9	-	-	-	22HR _C	
F-0008-65HT	--	-	65	0.6-0.9	-	-	-	28 HR _C	6.3
F-0008-75HT	--	-	75	0.6-0.9	-	-	-	32 HR _C	6.6
F-0008-85HT	--	-	85	0.6-0.9	-	-	-	35 HR _C	7.1
FC-0200-15		15	-	0.0-0.3	1.5-3.9	-	-	11 HR _B	6.0
FC-0200-18		18	-	0.0-0.3	1.5-3.9	-	-	18 HR _B	6.3
FC-0200-21	--	21	-	0.0-0.3	1.5-3.9	-	-	26 HR _B	6.6
FC-0200-24	--	24	-	0.0-0.3	1.5-3.9	-	-	36 HR _B	6.9
FC-0205-30		30	-	0.3-0.6	1.5-3.9	-	-	37 HR _B	6.0
FC-0205-35		35	-	0.3-0.6	1.5-3.9	-	-	48 HR _B	6.3
FC-0205-40	FC-0205-R	40	-	0.3-0.6	1.5-3.9	-	-	60 HR _B	6.7
	FC-0205-X								
FC-0205-45	FC-0205-S	45		0.3-0.6	1.5-3.9	-	-	72 HR _B	7.1
FC-0205-60HT	--	-	60	0.3-0.6	1.5-3.9	-	-	19 HR _C	6.2
FC-0205-70HT	--	--	70	0.3-0.6	1.5-3.9	-	-	25 HR _C	6.5
FC-0205-80HT	--		80	0.3-0.6	1.5-3.9	-	-	31 HR _C	6.8
FC-0205-90HT	--		90	0.3-0.6	1.5-3.9	-	-	36 HR _C	7.0
FC-0208-30	---	30		0.6-0.9	1.5-3.9	-	-	50 HR _B	5.8
FC-0208-40	FC-0208-P ⁽⁵⁾	40		0.6-0.9	1.5-3.9	-	-	61 HR _B	6.3
FC-0208-50	FC-0208-R	50	-	0.6-0.9	1.5-3.9	-	-	73 HR _B	6.7
---	FC-0208-X	---	---	0.6-0.9	1.5-3.9	-	-		6.6-7.0
FC-0208-60	FC-0208-S	60	-	0.6-0.9	1.5-3.9	-	-	84 HR _B	7.2

(1), (2), (3), (4), (5), (6), See end of table for footnotes.

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