

Material, Parts, and Process Specifications (MPAPS)		NUMBER: MPAPS P-9605	
		Former Designation: TMS-9605	
TITLE: Engineering Weight Calculations		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

This specification establishes procedures to be used for engineering weight calculations and provides values for density to be used in performing weight calculations for individual parts. This specification is applicable to all new design parts and all parts undergoing engineering review for modification or change. In accordance with Unigraphics Standard-UG Common and DCP-Proc-003, a value for weight is to be recorded in the drawing title block for all newly released parts. This specification forms a part of the Navistar Engineering Design Release System and is to be applied to all new Design Releases.

2.0 SCOPE

This Specification describes the units of measurement and the required precision of measurement to be used in engineering weight calculations and provides density values for the materials commonly used in engineering design. The units for the system of measurement are SI units.

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.

NAVISTAR Engineering Procedural Std. EPS-156
 NAVISTAR Unigraphics Std. UG Common
 NAVISTAR DCP Std. DCP-Proc-003
 ASTM SI10

4.0 CALCULATION PROCEDURE and UNITS OF MEASURE

The SI system is the primary unit and shall be used for all individual part volume and weight calculations. Refer to Engineering Procedural Std. EPS-156 or ASTM SI10.

4.1 Conversion to Inch-pound Units

The conversion from SI units to inch-pound units is inexact, and each conversion introduces a small error. To minimize errors, all individual part values should be calculated in SI units. The accumulation or summation of individual part weights to provide subassembly, unit code, or vehicle weight values, should be made using SI units. The conversion of SI units to inch-pound units should be performed only after the summation of part weight in SI units has been completed. The accumulated weight values can then be converted to inch-pound units as needed for GVW reports, axle ratings, and/or subassembly or unit code weight values.

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4.2 Volume Calculations

All Unigraphics Design System calculations of volume should be in SI units. The preferred unit for volume calculations is the cubic meter (m^3), however cubic centimeters (cm^3) may also be used as needed for convenience with the reported density values. Material thickness should be reported in millimeters (mm) and area reported as either square meters (m^2) or as square centimeters (cm^2). The product of thickness and area (=volume) should be reported in m^3 or in cm^3 .

4.3 Density Values

The preferred unit for density values is Megagrams per cubic meter (Mg/m^3). The density value in Mg/m^3 is exactly the same as the density value in g/cm^3 . Therefore, the product of volume, in m^3 or in cm^3 , and density (Mg/m^3) provides the part weight in megagrams or grams.

4.4 Weight Values

Part weight values calculated in either megagrams or grams should be reported in kilograms (kg).

4.5 Precision of Measurement (Calculation)

4.5.1 Part Weight

Part weight will be reported in kilograms, kg, to two decimal places [x.xx kg]. Parts weighing less than 0.01 kg will be counted as insignificant.

Exception: The weight of small standard parts used repetitively, such as fasteners, washers, rivets, etc., will be reported as kg/100pcs.

4.5.2 Volume

Volume calculations are performed within the Unigraphics design program. The precision of dimensions used for volume calculations will be in accordance with Standard Engineering Design practices.

4.5.3 Density Values

Density values should be reported as Mg/m^3 to two decimal places. [x.xx] (g/cm^3)

5.0 DENSITY VALUES of COMMON ENGINEERING MATERIALS

Density values to be used in primary weight calculations are shown in this section. The appendix to this specification provides a list of density values for materials by individual material specification. In addition to Mg/m^3 , the appendix includes density values in lbs/in^3 , kg/m^3 , or as specific gravity values. In some cases (i.e. paints or fuels) unit weight is expressed as kg/l . (lbs/gal). Additional material property data and more accurate density values for individual grades or types of material may be found in the Navistar Materials Database.

5.1 Carbon Steel, Bare-Uncoated

Material Specification - MPAPS/CEMS and TMS/MPAPS	Density Value
A-0, Part I; A-0, Part II; A-0, Part III; A-1; A-2; A-6, Part I; A-8; A-9; A-10, Part I; A-10, Part II; A-10, Part III; A-18; A-31, Part I; A-31, Part II; A-35; A-38; A-43; A-44; A-45, Part I; A-45, Part II; and A-45, Part III; E-2; A-1001; 1002; 1003; A-1011; A-1013; 1021; 1022; A-1026; 1029; A-1031; 1033; 1034; A-1037; 1041; F-1042; A-1044; 1051; F-1053; F-1054; A-1055; A-1056; F-1058, Type I; F-1061, Type I; F-1062; 3000.	7.83 Mg/m^3

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5.2 Coated Steel and Alloy Steel Products

Material Specification - MPAPS/CEMS and TMS/MPAPS	Density Value
Zinc Coated Steel: A-6, Part II, A-33; A-34;	7.80 Mg/m ³
Aluminized Steel: A-6, Part II, F-1058, Type II; and F-1061, Type II.	7.82 Mg/m ³
Terne Coated Steel: A-6, Part II	7.89 Mg/m ³

5.3 Cast Iron Products

Material Specification - MPAPS/CEMS and TMS/MPAPS	Density Value
Structural: E-6, E-2014	7.19 Mg/m ³
Special wear resistant and high alloy	Contact materials engineering for value

5.4 Nodular Iron Products

Material Specification - MPAPS/CEMS and TMS/MPAPS	Density Value
Structural: E-10, 2008, 2009	7.03 Mg/m ³
Special wear resistant and high alloy	Contact materials engineering for value

5.5 Malleable Iron Products

Material Specification - MPAPS/CEMS	Density Value
Structural: E-7	7.22 Mg/m ³
Special wear resistant and high alloy	Contact materials engineering for value

5.6 Cast Steel Products

Material Specification - MPAPS/CEMS	Density Value
E-2	7.83 Mg/m ³

5.7 Cast Aluminum Products

Material Specification - MPAPS/CEMS and TMS/MPAPS	Density Value
C-8, C-3102	2.66 Mg/m ³

5.8 Wrought Aluminum Products

Material Specification - MPAPS/CEMS	Density Value
C-10	2.71 Mg/m ³

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5.9 Brass and Bronze Cast Products

Material Specification - MPAPS/CEMS	Density Value
C-2	8.58 Mg/m ³

5.10 Wrought Copper Products

Material Specification - MPAPS/CEMS and TMS/MPAPS	Density Value
C-3, C-3100	8.91 Mg/m ³

5.11 Zinc Cast Products

Material Specification - MPAPS/CEMS and TMS/MPAPS	Density Value
C-14	6.64 Mg/m ³

5.12 Plastic Parts (D-28)*

Material Specification - MPAPS/CEMS	Density Value
D-28	1.40 Mg/m ³

* The density value for plastic parts varies significantly as the type of reinforcements/fillers change and the amount (%) of fillers increase. For parts specified by a TMS/MPAPS number, an appropriate density value may be found in the appendix. For materials not listed in the appendix, an appropriate density value may be found in the Navistar Materials Database. For other cases contact the appropriate materials engineer.

5.13 FRP Plastic Parts (D-22)*

Many FRP plastic parts are specified by a TMS/MPAPS number. Specific density values for individual materials may be found in the appendix. For materials not listed in the appendix, contact the appropriate Materials Engineer.

5.14 Rubber Parts

Rubber parts are generally specified by a TMS/MPAPS number. An appropriate density value may be listed in the appendix. For tires, a weight value will be provided by the supplier for each part number.

5.15 Rubber/Elastomeric Hoses

Part weight data on specific hose assemblies will be provided for each part number by the supplier. For bulk hoses in which each part number represents one foot of hose, a value of weight per foot of hose may be provided in the appropriate TMS/MPAPS specification listed in the appendix.

5.16 Insulation

Insulation is generally specified by a TMS/MPAPS number. An appropriate density value may be listed in the appendix. For complex purchased parts, weight data will be provided by the supplier for each part number.

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5.17 Glass

The density of glass varies between 2.40 – 2.80 Mg/m³. However, safety glazing is generally a composite material, which includes a bonded inner layer. Weight data will be provided by the supplier for each part number.

5.18 Carpeting

Carpeting is generally specified by TMS/MPAPS number. An appropriate density value may be shown in the appendix. For carpet purchased as a finished part, weight data will be provided by the supplier for each part number.

5.19 Fabrics

Fabrics are generally specified by TMS/MPAPS number. An appropriate density value may be shown in the appendix. In cases where fabrics are used as a component in composite trim panels, weight data will be provided by the supplier for finished parts by part number.

5.20 Diesel Engine Fuel

Material Specification - MPAPS/CEMS	Density Value
Grade 1 – Winter grade: B-32	0.816 Mg/m ³
Grade 2B – Summer grade: B-32	0.842 Mg/m ³

5.21 Diesel Engine Oils

Material Specification - MPAPS/CEMS	Density Value
15W-40: B-21	0.885 Mg/m ³
30W: B-21	0.885 Mg/m ³
10W-30: B-21	0.885 Mg/m ³

5.22 Hydraulic Fluids

Material Specification - TMS/MPAPS	Density Value
Manual - 80W90: B-6803	0.880 Mg/m ³
Automatic: B-6812	0.861 Mg/m ³

5.22 Power Steering Fluid

Material Specification - TMS/MPAPS	Density Value
B-6810	0.879 Mg/m ³
B-6811	0.879 Mg/m ³

6.0 CALCULATION OF WEIGHT VALUES FOR ENGINEERING PARTS

The weight of Engineering designed parts will be calculated by multiplying the volume of the part by its density. This calculation will take place within the Unigraphics design program and the resultant weight value stored in the part number Table of Attributes in the Engineering Attribute Database (EADB).

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7.0 PROVISION of WEIGHT VALUES for SUPPLIER PARTS

The weight of supplier parts will be provided by the supplier and entered into the part number Table of Attributes in the Engineering Attribute Database (EADB), when the Navistar part number for that part is released.

8.0 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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