



Malleable Cast Iron

1 Scope

This material specification applies to malleable iron casting used in automotive and other allied industries.

This standard specifies mechanical properties from separately cast-to-shape test samples. Mechanical properties may also be specified from test bars excised from specific control locations in product castings. Microstructure features shall only be evaluated at specific control locations in the product castings. Criteria for separately cast test samples and/or control locations for mechanical property and metallographic criteria shall be agreed to by the purchaser and supplier and identified on the engineering drawing.

1.1 Material Description. Malleable iron is cast as a graphite free structure, i.e., the total carbon content is present in the combined form as cementite (Fe_3C). Subsequent heat treatment precipitates out the graphite in the form of irregular nodules, known as temper carbon. The letter "W" indicates whiteheart malleable iron and the letter "B" indicates blackheart malleable iron. Whiteheart and blackheart denote the fracture appearance of the finished iron but also reflect the conditions under which the high temperature anneal (during which the temper carbon nodules are formed) are carried out. Whiteheart iron involves controlled decarburization of the iron in addition to the transformation of iron carbide into temper carbon nodules and matrix structure. Typically whiteheart iron is higher in sulphur and carbon and lower in silicon content than blackheart iron. Whiteheart irons are not made in North America, but are utilized in other countries for castings destined for welded assemblies. See Table 1 for GMW1 material identification.

Table 1: Material Identification

Global Grade ^{Note 1}	Minimum Tensile Strength of Cast to Shape Bars (N/mm ²)
GMW1M-IR-C-MB300-8	300
GMW1M-IR-C-MB350-10	350
GMW1M-IR-C-MB450-6	450
GMW1M-IR-C-MB550-4	550
GMW1M-IR-C-MB600-3	600
GMW1M-IR-C-MB650-2	650
GMW1M-IR-C-MB700-2	700
GMW1M-IR-C-MW350-4	350
GMW1M-IR-C-MW400-5	400
GMW1M-IR-C-MW450-7	450
GMW1M-IR-C-MWS380-12	380

Note 1: See coding system, Section 8.

1.2 Symbols. Not applicable.

1.3 Applicability. Malleable cast iron has a range of applications including wheel hubs, differential housings, differential carriers, connecting rods, diesel pistons and gears.

2 References

Note: Only the latest approved standards are applicable unless otherwise specified.

2.1 External Standards/Specifications.

ASTM E322	ISO 5922	ISO 6892
ASTM E1019	ISO 6506	

2.2 GM Standards/Specifications.

GMW3059

3 Requirements

3.1 Requirements on Delivery.

3.1.1 Chemical Requirements. The chemical composition, section size, and casting cooling rate are all interrelated, thus the chemical compositions shown in Table 2 and Table 3 are typical and shall be considered secondary to the mechanical properties. If a mandatory composition is required, the composition shall be agreed upon between the supplier and the purchaser and this shall be stated on the engineering drawing.

3.1.1.1 The composition listed in Table 2 and Table 3 reflects finished castings. Spectrographic analyses shall be taken from chilled samples. When using optical emission spectroscopy to analyze a finished casting for chemical composition, a piece of the casting shall be remelted and cast as a chilled spectrographic disk. For a whiteheart malleable iron casting, the remelt sample shall be taken from a location that does not include any of the decarburized surface.

3.1.1.2 Spectrometric analysis of chemistry shall be measured in accordance with procedures, master samples and calibration per ASTM E322. Carbon levels shall be measured in accordance with standard procedures, master samples and calibration per ASTM E1019.

Table 2: Whiteheart Malleable Iron (Typical Chemical Composition)

Element	Unit	Grade	
		MW350-4, MW400-5, MW450-7	MWS380-12 ^{Note 1}
Carbon	% by mass	3.1 to 3.4	2.9 to 3.1
Silicon		0.4 to 0.8	0.25 to 0.8
Manganese		0.4 to 0.6	0.5 to 0.8
Phosphorus		0.1 max.	0.1 max.
Sulphur		0.2 max.	0.2 max.
Chromium		0.1 max.	0.1 max.

max = maximum

Note 1: All grades of whiteheart malleable iron can be welded provided correct procedures are employed. Where strength and avoidance of post-weld heat treatment are required, grade MWS380 is preferred.

Table 3: Blackheart Malleable Iron (Typical Chemical Composition)

Element	Unit	Grade						
		MB300-8	MB350-10	MB450-6	MB550-4	MB600-3	MB650-2	MB700-2
Carbon	% by mass	2.45 to 2.75						
Silicon		1.25 to 1.55						
Manganese		0.30 to 0.60						
Phosphorus		0.05 max.						
Sulphur		0.12 max.						
Chromium		0.06 max.						

max = maximum

3.1.2 Mechanical Requirements. The minimum mechanical properties associated with each grade of whiteheart and blackheart malleable iron are listed in Table 4 and Table 5, respectively. The mechanical properties are the primary requirement in grading and classifying malleable irons for use as automotive castings. The properties of the metal are measured from cast-to-shape test pieces described in ISO 5922. Such test pieces shall be poured from the same batch of metal and heat treated in the same manner as the castings they represent. The tensile test shall be performed in the manner described in ISO 5922. Properties of test pieces machined from castings will vary from those determined by the cast-to-shape test pieces due to differences in solidification, cooling rate and rim conditions. The final sampling plan shall have agreement between the purchaser and the supplier. The validity of tests and applicability of any retests shall be in accordance with ISO 5922.

3.1.2.1 Hardness. Brinell hardness shall be taken in accordance with ISO 6506. The material hardness requirements described in Table 4 and Table 5 shall be met on both the cast-to-shape test piece and its represented castings. Since casting hardness will vary throughout the part due to differences in section size and cooling rates, the specific test location on the casting shall have agreement between the purchaser and the supplier and shall be identified on the engineering drawing.

3.1.2.2 Tensile Strength. Cast-to-shape test pieces, which represent the quality of the material and melt from which the casting is poured, shall conform to the tensile property requirements listed in Table 4 and Table 5. The standard dimensions and testing procedure for test pieces are described in the ISO 5922 and ISO 6892 specification. The manufacturer shall maintain sufficient controls and documentation to assure the purchaser that properties determined from the cast-to-shape test pieces are representative of the castings shipped. The relationships of global grades to tensile strength of international standard grades may be found in Appendix A, Table A1.

3.1.2.3 Yield Strength. The yield strength shall be determined by the 0.2% offset method. Other methods may be used by mutual consent of the purchaser and supplier.

3.1.2.4 Percent Elongation. The percent elongation calculation will be based on the ISO 5922 standard in which the original gauge length is 3 times that of the gauge diameter.

Table 4: Tensile Properties, Hardness and Typical Matrix Microstructure of Whiteheart Malleable Irons

Property	Units ^{Note 1}	Grade			
		MW350-4	MWS380-12	MW400-5	MW450-7
Minimum tensile strength ^{Note 2}	N/mm ²	350	380	400	450
Minimum yield strength ^{Note 2, Note 3}	N/mm ²	-	200	220	260
Minimum elongation ^{Note 2}	%	4	12	5	7
Maximum hardness	HBW	230	200	220	220
Typical matrix microstructure	-	Lamellar pearlite, decarburized case	Lamellar pearlite, deep decarburized case	Lamellar pearlite, decarburized case	Spheroidized pearlite, decarburized case

Note 1: Conversion - 1 N/mm² = 145 psi; 1 N/mm² = 1 MPa.

Note 2: Mechanical property data represented in this chart is based on 12 mm diameter cast-to-shape test pieces. For other size pieces ISO 5922 shall be consulted.

Note 3: Yield Strength is determined at a 0.2% offset.