

MIL-I-24137(SHIPS)
23 April 1965
SUPERSEDING
MIL-I-17166A(SHIPS)
10 April 1953
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22 March 1955

MILITARY SPECIFICATION
IRON CASTINGS,
NODULAR GRAPHITIC (DUCTILE IRON) AND NODULAR GRAPHITIC
(CORROSION RESISTING, AUSTENITIC, LOW MAGNETIC PERMEABILITY)
(FOR SHIPBOARD APPLICATION)

1. SCOPE

1.1 **Scope.** - This specification covers nodular graphitic cast iron (ductile iron), annealed castings and nodular graphitic austenitic cast iron for shipboard applications (see 6.3).

1.2 **Classification.** - Nodular graphitic cast iron shall be of the following classes, as specified (see 6.1):

Class A - Nodular graphitic iron (ductile iron).
Class B - Ductile Ni-resist (austenitic).
Class C - 22 percent nickel ductile iron (austenitic).

2. APPLICABLE DOCUMENTS

2.1 The following documents of the issue in effect on date of invitation for bids or request for proposal, form a part of the specification to the extent specified herein.

SPECIFICATION

MILITARY

MIL-I-17214 - Indicator, Permeability; Low-Mu (Go-No-Go).

STANDARDS

FEDERAL

FED-STD-151 - Metals; Test Methods.

MILITARY

MIL-STD-105 - Sampling Procedures and tables for Inspection by Attributes.

MIL-STD-278 - Welding and Allied Processes for Machinery for Ships of the United States Navy.

(Copies of specifications, standards, drawings, and publications required by the suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

2.2 **Other publications.** - The following document forms a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

FSC MECA

MIL-I-24120(SWDS)

OFFICIAL CLASSIFICATION COMMITTEE

Uniform Freight Classification Rules

(Application for copies should be addressed to the Official Classification Committee, 1 Park Avenue at 33rd Street, New York, N. Y. 10016.)

3. REQUIREMENTS

3.1 Material. - The raw materials used shall be such as to produce castings conforming to this specification.

3.2 Manufacture. - The castings shall be made by any commercial process which will produce castings conforming to this specification.

3.3 Chemical composition. - Nodular graphitic iron castings, classes A, B, and C, shall conform to the chemical composition specified in table I.

Table I - Chemical composition.

Class	Total Carbon	Silicon	Manganese	Phosphorus (Max)	Nickel	Copper (Max)	Chromium	Carbon- ^{1/} Equivalent (Max)
	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent
A	3.0 Min.	2.5 Max. ^{2/}	-	0.08 ^{2/}	-	-	-	4.3
B	2.4-3.0	1.8-3.2	0.8-1.5	0.20	18.0-22.0	0.50	1.7-2.4	-
C	2.7-3.1	2.0-3.0	1.9-2.5	0.15	20.0-23.0	0.50	0.50 Max.	-

^{1/} Applies to castings having sections 2 inches and over thick. Carbon equivalent is total carbon plus 1/3 silicon.

^{2/} For each reduction of .01 percent phosphorus below the .08 percent maximum specified, an increase of .08 percent silicon above the 2.50 percent maximum specified to a maximum of 2.75 percent will be permitted.

3.4 Mechanical properties. - Nodular graphitic cast iron and austenitic nodular graphitic cast iron shall conform to the mechanical properties specified in table II.

Table II - Mechanical properties.

	Class A	Class B	Class C
Tensile strength, P.S.I. min	60,000	55,000	50,000
Yield strength 0.2 percent offset, P.S.I. min.	45,000	30,000	25,000
Elongation in 2 inches, percent, min.	15	7.0	20.0
Brinell hardness (3000 Kg load, 10 mm. penetrator), max.	190	190	175

3.5 Heat treatment. -

3.5.1 Class A castings. - Class A castings shall be ferritizing annealed. Heat treating cycle shall be chosen by the contractor but castings shall be heat treated in such a manner as to produce material of the utmost uniformity which will conform to this specification. Heat treatment shall be performed on the whole casting and never on a part only.

3.5.2 Class B and C castings. - Class B and C castings unless heat treated for solution of carbides, shall be stress relieved. Stress relief shall consist of holding at 1160° to 1200°F. for one hour per inch of maximum thickness with a minimum hold of one hour at temperature and furnace cool. Heat treatment shall be performed on the whole casting and never on a part only.

3.6 Cleaning. - Castings shall have heads and gates removed, shall be thoroughly cleaned and all sand, scale, fins, excessive rough spots, and so forth, removed before final inspection. Padding added by the foundry to provide directional solidification shall be removed unless provisions are made in the contract or order to permit such padding to remain for removal by subsequent machining operation. When heads, gates and padding are removed by gas cutting or scarfing, the removal shall be performed before the final heat treatment and in such a manner as not to impair the casting. Gas cutting or scarfing shall be followed by cutting, chipping or grinding operation as necessary to provide the specified contour.

3.7 Repair. - The removal of defects by machining, chipping, or grinding without subsequent repair by welding is permissible in cases where the wall thickness or net remaining cross section is not reduced below that required by design, and provided the resultant cavity is blended with the casting surface. In such cases, the contractor shall submit the necessary stress calculations to the contracting agency for approval. Any evidence of unauthorized repair, or repairs which do not conform to MIL-STD-278 or other instructions issued by the bureau agency concerned will be considered as cause for rejection.

3.7.1 Minor repairs. - Minor weld repairs may be made to correct surface defects at the discretion of the manufacturer, provided the depth of the defect when prepared for welding does not exceed 20 percent of the wall thickness at that point or one inch, whichever is the less, and individual repair areas do not involve more than 10 percent of the cast surface. Heat treatment when required shall be performed after welding. The area to be welded shall be proven free of defects by magnetic particle testing prior to repair welding.

3.7.2 Major repairs. - Major repairs shall include all repairs not within the limits specified in 3.7.1. Major repairs shall be to an approved welding procedure. The procedure shall state chemical composition of the casting, electrode, nondestructive testing after defect removal, but before weld repair, and final nondestructive testing after weld repair.

3.8 Microstructure. - When specified (see 6.1), metallographic examination shall be made. Microstructure for class A castings at 50 diameters shall show a matrix having a minimum of 90 percent ferrite and no primary carbides. Graphite shall appear as rounded particles commonly described as spheroidal, spherulitic or nodular. The microstructure for class B and class C castings at 50 diameters shall show a matrix having little or no primary carbides. Primary carbides if present, shall be small and randomly distributed. Graphite shall appear as rounded particles.

3.9 Magnetic permeability. - Unless otherwise specified (see 6.1), the magnetic permeability of the class B and class C heat treated castings as offered for inspection shall not exceed 1.2 when tested with a permeability indicator conforming to MIL-I-17214. Any casting having a permeability in excess of 2.0 after machining shall be replaced by the contractor.

3.10 Marking. - The castings shall be identified with the manufacturer's name or trademark and a serial number which will positively identify the casting to pattern and part number, melt from which they were poured and the lot with which they were heat treated. Markings shall be placed in a location such that they are not machined off in finishing and in an area that is stressed least in service.

3.11 Dimensions. - The responsibility of furnishing castings that can be laid out and machined to the finished dimensions, within the specified tolerances as shown on the blue prints or drawings, and that will conform to such gauges as may be specified in individual cases, shall rest with the supplier. Sufficient stock shall be allowed for shrinkage and, where required, for finishing; but castings of excessive size and weight shall not be furnished.

3.12 Soundness. - Castings shall be of uniform quality and condition, free from shrinks, cold shuts, cracks, harmful porosity, and other defects which make the castings unsuitable for the intended use. Runners, risers, fins, and other cast-on pieces shall be removed.

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4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. - Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the supplier may utilize his own facilities or any commercial laboratory acceptable to the Government. The Government reserves the right to perform any of the inspections set forth in the specification; where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Sampling. -

4.2.1 Lot. - For purposes of inspections and tests, lots are defined as follows:

- (a) **Chemical or spectrographic analysis.** - Each melt of steel is a lot; also, a ladle of a number of smaller melts is a lot.
- (b) **Mechanical tests.** - All castings produced from one heat or melt, heat treated under similar conditions in the same heat treating charge shall constitute a lot.

4.2.2 Sampling for chemical analysis. - One sample shall be obtained from each lot. Drilling for analysis shall be taken from broken test specimens or from random castings. If practicable, castings shall be drilled in such a manner as not to impair their usefulness. For carbon determinations, a chilled pencil type specimen shall be cast for each lot.

4.2.3 Visual and dimensional examination. - Sample castings shall be selected from each lot in accordance with MIL-STD-105 at inspection level S-2 for visual examination and inspection level S-1 for dimensional examination. The Acceptable Quality Level shall be 1.0 percent major and 4.0 percent minor for visual examination. Examination of packing and marking requirements not covered by referenced specifications shall be in accordance with MIL-STD-105 using an AQL of 4.0 percent major and 10 percent minor defective.

4.2.3.1 Each of the sample castings selected in accordance with 4.2.3 shall be examined to verify conformance to all of the requirements which do not involve tests. Examination shall be conducted as specified in table III. Any casting having one or more defects shall be subject to rejection.

Table III - Classification of defects in accordance with MIL-STD-105

Categories	Defects
Critical:	None defined.
Major:	
101	Castings not class specified.
102	Castings not cleaned; heads and gates not removed; sand, scale, fins, burrs, rough spots not removed.
103	Padding not removed (unless exception made).
104	Removal of heads and gates by gas cutting or scarfing not accomplished prior to final heat treatment.
105	Specified contour not obtained by cutting, chipping, grinding after gas cutting or scarfing.
106	Evidence of unauthorized weld repairs.
107	Castings not sound; not uniform; not free of tears, cracks, porosity, sand inclusions, blow holes, shrinkage cavities, cold shuts, unfused chaplets or chills.
108	Castings not machinable to finished dimensions without straightening.
Minor:	
201	Polished castings weighing less than 50 pounds not protected as specified.
202	Castings not secured as specified.

Table III - Classification of defects in accordance with MIL-STD-105-Continued

Categories	Defects
Minor; Contd:	
203	Closure of shipping containers incorrect.
204	Strapping missing when required.
205	Strapping not of specified type and class, or incorrectly applied.
206	Gross weight of containers and hardware exceeds limit specified.
207	Identifying markings not provided; not permanent; not legible; not located as specified; data incomplete, incorrect.

4.3 Test procedures. -**4.3.1 Tension tests. -**

4.3.1.1 Test specimens shall be taken from separately cast "Y" blocks of the form and dimensions shown on figure 1. The size of coupon cast to represent the casting shall be specified by the bureau or agency concerned. If the size is not specified, the size of the test block shall be related to the thickest section of the casting. At the option of the producer, the 1-inch keel block casting shown on figure 3 may be used in lieu of the 1-inch "Y" block. When agreed upon by the Government and contractor, castings may be used as test samples. Test samples shall be heat-treated with the lot of castings represented.

4.3.1.2 Test samples shall be poured with the approximate last castings of the lot. When castings are used for test samples the same principle as to time of pouring shall be observed.

4.3.1.3 Test specimens obtained from test blocks sectioned as shown on figure 2 shall be machined to the form of type R1 of method 211.1 of FED-STD-151. In cases where castings are sectioned to obtain test specimens, the location from which test specimens are to be taken and the type of test specimen to be used shall be specified by the bureau or agency concerned.

4.3.1.4 One tension test shall be conducted for each lot in accordance with method 211.1 of FED-STD-151.

4.3.2 **Metallographic tests.** - When specified in the contract or order, one metallographic test shall be made for each lot after heat treatment. Except for light section castings, portions of test blocks, the ends of tension test specimens, or sections of castings (when castings are used as test samples) may be used for metallographic examination. In the case of light section castings when the as-cast structure can be expected to differ from the as-cast structure of the test blocks, metallographic samples shall be taken from a portion of the gate, a light section from or adjacent to the casting, or from a cast-on test coupon attached as agreed upon by the manufacturer and the bureau or agency concerned (see 6.2).

4.3.3 **Hardness.** - Unless otherwise specified in the contract or order, each casting shall be tested for hardness. As far as practicable, test shall be made on light sections of the casting.

4.4 Rejection and retest. -

4.4.1 If a test specimen fails to conform to this specification, the lot represented by the specimen shall be subject to rejection. If failure is due to improper heat-treatment, the lot may be reheat-treated and re-submitted. Only one such reheat-treatment shall be permitted.

4.4.2 Retests shall be permitted in accordance with FED-STD-151.

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5. PREPARATION FOR DELIVERY

5.1 Domestic shipment and early equipment use. -

5.1.1 Castings. -

5.1.1.1 Preservation and packaging. - Preservation and packaging shall be sufficient to afford adequate protection against corrosion, deterioration and physical damage during shipment from the supply source to the using activity and until early installation.

5.1.1.2 Packing. - Packing shall be accomplished in a manner which will insure acceptance by common carrier and will afford protection against physical or mechanical damage during direct shipment from the supply source to the using activity for early installation. The shipping containers or method of packing shall conform to the Uniform Freight Classification Rules and Regulations or other carrier regulations as applicable to the mode of transportation.

5.1.1.3 Marking. - Shipment marking information shall be provided on interior packages and exterior shipping containers in accordance with the supplier's commercial practice. The information shall include nomenclature, Federal stock number or supplier's part number, contract or order number, supplier's name and destination.

5.2 Domestic shipment and storage or overseas shipment. - The requirements and levels of preservation, packaging, packing and marking for shipment shall be specified by the procuring activity (see 6.1).

(5.2.1 The following provides various levels of protection during domestic shipment and storage or overseas shipment, which may be required when procurement is made.

5.2.1.1 Preservation and packaging. -

5.2.1.1.1 Level A. -

5.2.1.1.1.1 Castings. -

5.2.1.1.1.2 Small polished castings weighing less than 50 pounds each shall be packaged in accordance with method I of MIL-P-116.

5.2.1.1.2 Level C. - Preservation and packaging shall be sufficient to afford adequate protection against corrosion, deterioration and physical damage during shipment from the supply source to the using activity for early installation. This level may conform to the supplier's commercial practice when such meets the requirements of this level.

5.2.1.2 Packing. - Shipping containers shall be of similar construction, uniform size and shall contain the same number of castings of one size, melt or lot number. Containers shall be designed to fit the contents in a compact manner.

5.2.1.2.1 Levels A and B. - Casting having projections which may be damaged in handling or shipment shall be packed individually, or in multiple units with adequate blocking, bracing, and cushioning in unsheathed crates conforming to PPP-C-850 and appendix thereto. Castings shall be securely bolted, blocked, braced, or strapped to prevent shifting and damage within the crates. The gross weight of the crates shall not exceed 500 pounds unless individual castings exceed this weight.

5.2.1.2.1.1 Castings weighing more than 200 pounds each and not subject to damage in shipment may be shipped unpacked.

5.2.1.3 Marking. - In addition to any special marking required by the contract or order, shipment shall be marked in accordance with MIL-STD-129.)

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6. NOTES

6.1 Ordering data. - Procurement documents should specify the following:

- (a) Title, number, and date of this specification.
- (b) Class required (see 1.2).
- (c) Whether metallographic examination is required (see 3.8).
- (d) Whether magnetic permeability test is waived (see 3.9).
- (e) Dimensions of castings required (see 3.10).
- (f) Hardness test, if not required (see 4.3.3).
- (g) Preservation, packaging, packing or marking requirements other than those required by paragraph 5.1 (see 5.2).

6.2 Light section castings which are subject to chill will show a white structure whereas the test blocks which are of heavier cross section will not be chilled.

6.3 Intended use. -

Class A nodular graphitic iron (ductile iron) is intended for annealed castings for shock resisting applications, such as, required for shipboard electric equipment, engine blocks, pumps, compressors, gears, hydraulic equipment, valves, and staging clamps.

Class B ductile Ni-resist (austenitic) and class C 22 percent nickel ductile iron (austenitic) is intended for corrosion resisting, heat resisting, and nonmagnetic application, such as required for shipboard machinery and propellers.

Preparing activity:
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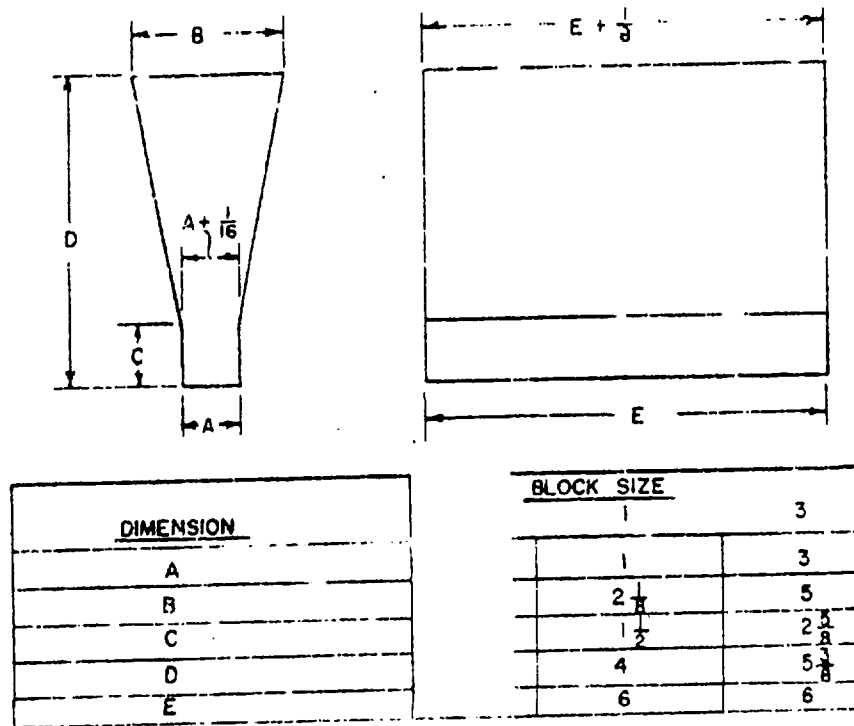


Figure 1 - Dimensions of blocks.

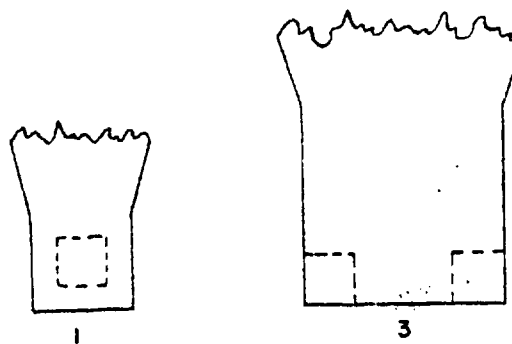
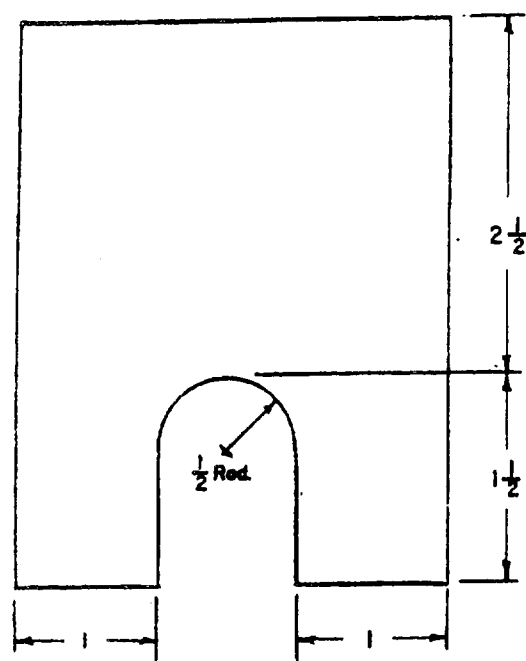


Figure 2 - Location of test specimens.

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NOTE: LENGTH SHALL BE 6 in

Figure 3 - Keel block.

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