INTERIM MILITARY SPECIFICATION

STEEL CASTINGS, HADFIELD MANGANESE

(LOW MAGNETIC PERMEABILITY)

1. SCOPE

1.1 Scope. - This specification covers Hadfield manganese steel castings for use in ship nonmagnetic applications.

1.2 Classification. - Hadfield manganese steel castings shall be furnished in the following types as specified (see 6.1):

Type A - Rough ground or pickled.
Type B - Galvanized.

2. APPLICABLE SPECIFICATIONS, STANDARDS, DRAWINGS, AND PUBLICATIONS

2.1 The following specifications and standards, of the issue in effect on date of invitation for bids, form a part of this specification:

SPECIFICATIONS

FEDERAL
QQ-S-781 - Strapping, Flat, Steel.

MILITARY
JAN-P-100 - Packaging and Packing for Overseas Shipment - General Specification.
JAN-P-106 - Packaging and Packing for Overseas Shipment - Boxes, Wood, Nailed.
JAN-P-125 - Packaging and Packing for Overseas Shipment - Barrier-Materials, Waterproof, Flexible.
JAN-P-132 - Packaging and Packing for Overseas Shipment - Crates, Unsheathed, Wood, Nailed (for Maximum Net Load of 2,500 Pounds).

NAVY DEPARTMENT
General Specifications for Inspection of Material, and
Appendix II - Metals:
Part A - Definitions and Tests.
Part F - Radiography,
Section F-1 - Definitions and Radiographic Requirements.
46Z3 - Zinc-Coating (Hot-Dip Galvanizing).

STANDARDS

MILITARY
MIL-STD-23 - Nondestructive Testing Symbols.
MIL-STD-129 - Marking of Shipments.

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

3. REQUIREMENTS

3.1 Material - The material shall be such as to produce castings in compliance with this specification.

3.2 Chemical composition.- Hadfield manganese steel castings shall conform to the chemical composition shown in table I.

Table I - Chemical composition.

Types	Carbon (max.)	Manganese	Silicon	Phosphorous (max.)	Chromium (max.)[1]	Nickel (max.)[1]	Molybdenum (max.)[1]
	Percent	Percent	Percent	Percent	Percent	Percent	Percent
A and B	1.00 - 1.35	12.00 - 14.00	0.40 - 1.00	0.060	0.75	1.00	0.50

[1]Unless otherwise specified in the contract or order, the limits shown for chromium, nickel, and molybdenum are permissible residual elements and shall not be added.

3.3 Mechanical properties. - Hadfield manganese steel castings shall conform to the mechanical properties shown in table II.

Table II - Mechanical properties.

Types	Tensile strength (min.)	Yield[1] strength (min.)	Elongation in 2 inches (min.)
	P.s.i.	P.s.i.	Percent
A and B	100,000	45,000	25.0

[1]0.2 percent offset.

3.4 Manufacture. -

3.4.1 Melting practice. - Unless otherwise specified in the contract or order, Hadfield manganese steel castings shall be made by an electric furnace process.

3.4.2 Heat treatment. - Unless otherwise specified in the contract or order, castings shall be heat treated at a minimum of 1850° Fahrenheit (F.), and preferably at 1900°F. for a minimum of 2 hours or for 1 hour per inch of casting section thickness, whichever is greater. Castings shall be cooled by water quenching. Holding at temperatures above and below those specified in addition to holding at specified temperature will be permissible.

3.5 Cleaning. - Castings shall have heads and gates removed, shall be thoroughly cleaned, and all sand, scale, fins, excessive rough spots, et cetera (etc.) removed by mechanical means, 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 operations. Heads, gates and padding may be removed by gas or arc cutting or scarfing, providing sufficient metal for subsequent removal by grinding or machining to eliminate any detrimental effect from the heat of cutting is left on the casting. Gas or arc cutting or scarfing shall be followed by mechanical cutting or grinding operations as necessary to provide the specified contour to the satisfaction of the Government inspector.

3.6 Finish. -

3.6.1 Removal of magnetic skin. - Casting shall be free of magnetic skin which shall be removed either by surface grinding, machining or by pickling (see 6.3). The pickling time shall be such that sound areas of the casting will not be damaged. If skin removal is incomplete by pickling, the remainder shall be removed by grinding.

3.6.2 Zinc coating (type B only). - Type B castings shall be zinc-coated by the hot-dip (galvanized) process in accordance with Specification 46Z3. The zinc coating shall be applied after removal of magnetic skin (see 4.5.3).

3.7 Internal chills and chaplets. - Internal chills shall not be used. Chaplets shall be used only where unavoidable and shall be prepared either from austenitic stainless steel or from austenitic manganese alloy steel materials.

3.8 Magnetic permeability. -

3.8.1 The magnetic permeability of the castings shall not exceed 1.20 when tested with a permeability indicator.

3.8.2 When specified (see 6.1), the inherent magnetic permeability of the interior metal of each prototype casting shall be determined from a magnetic permeability test block cast for the purpose. Test specimens shall not exceed a magnetic permeability of 1.05 at a field strength of 200 oersteds.

3.9 Bend (type B only). - Coated bend test specimens shall withstand the bend test specified in 4.5.3.

3.10 Radiographic examination. - When specified (see 6.1), radiographic examination of prototype castings shall be performed in those locations on each prototype as indicated on appropriately marked drawings (see Standard MIL-STD-23) to determine suitable foundry practices for each pattern. Final practices shall be subject to review by the Government inspector or bureau or agency concerned. When specified (see 6.1), radiographic examination of castings from production shall be performed. The acceptability of castings with defects found by radiographic examination shall be judged by comparison with the Radiographic Standards for Steel Castings (see 6.2).

3.11 Repair of defects. - Castings shall not be repaired, plugged or welded without permission from the Government inspector; such permission will be given only for welding to be completed after final heat-treatment and when the defects, after being thoroughly cleaned out to sound metal are judged not to affect the strength, use, or machinability of the castings. Welding of defects of a serious nature, will not be permitted unless satisfactory to the bureau or agency concerned.

3.11.1 When welding is authorized, austenitic molybdenum-manganese or nickel-manganese type electrodes approved by the bureau or agency concerned shall be used.

3.12 Straightness. - When necessary, the contractor is authorized to straighten distorted castings after heat treatment. The responsibility for furnishing heat-treated castings that can be machined to the finished dimensions, within the tolerances given, without further straightening shall rest with the contractor. Layout points, when required, shall be shown as such on the applicable drawings and shall be suitably incorporated in the castings. Castings of excessive oversize or overweight with regard to dimensions shown on the drawings shall not be furnished.

3.13 Marking. - Castings shall be positively identifiable upon receipt with respect to pattern or part number, the melt from which they were poured and the lot with which they were heat-treated. Where practicable, all marks shall be placed in such a location that they shall not be machined off in finishing to the required dimensions. In the case of small castings where individual marking and stamping is impracticable, castings from the same pattern and heat may be wired together or placed in a container with a metal tag on which the correct identifying melt and lot numbers have been stamped. Where the production of a particular foundry is such that it is not practicable to identify individual castings by melt, castings shall be divided into lots as determined by regular production time intervals.

3.14 Workmanship. - Castings shall be of uniform quality and condition, free from harmful defects such as injurious blowholes, porosity, hard spots, shrinkage defects, cracks, or other injurious defects.

4. SAMPLING, INSPECTION, AND TEST PROCEDURES

4.1 Inspection procedures. - For Naval purchases the general inspection procedures shall be in accordance with General Specifications for Inspection of Material.

4.2 Lot. - A lot shall consist of castings made from the same melt or the same pouring of a ladle containing a number of smaller melts, heat-treated in the same furnace charge and offered for inspection at one time. When individual castings cannot be identified by melt and have been heat-treated in continuous heat-treating equipment, a lot shall consist of castings, the product of each 4 hours of continuous operation of each furnace offered for inspection at one time.

4.3 Sampling procedures. -

4.3.1 Sampling for chemical analysis. -

4.3.1.1 Where material can be identified by melt, one sample shall be obtained from each melt.

4.3.1.2 Where material cannot be identified by melt, two separate representative samples shall be obtained from each lot. The samples shall be selected in a manner estimated to disclose any nonuniformity of material within the lot and shall be tested individually.

4.3.1.3 Drillings for analysis shall be taken from broken test specimens, from castings selected by the Government inspector or a test bar cast for the purpose from each melt. If practicable, castings shall be drilled in such a manner as not to impair their usefulness. Samples shall be forwarded by the inspector to a Government laboratory designated by the bureau or agency concerned.

4.3.2 Sampling for tension tests. -

4.3.2.1 Where practicable, sufficient test coupons shall be cast with and gated to the castings to represent the lot or the particular casting. Care shall be taken that the test bar mold is gated in such a manner that its feeding does not detract from the soundness of the casting. When this impracticable, coupons from which specimens can be machined may be cast attached to the castings. The Government inspector may, upon request, permit separate coupons to be cast from the same melt as the castings they represent. In all cases separately cast coupons shall be identified by the Government inspector. When integrally cast coupons are used, they shall not be detached completely from the casting until it has received its final heat-treatment and has been properly identified by the Government inspector.

4.3.2.2 Unless otherwise specified in the contract or order, for castings estimated to weigh 500 pounds or more in the rough, at least one tension test specimen shall be taken to represent each casting.

4.3.2.3 Unless otherwise specified in the contract or order, for castings estimated to weigh less than 500 pounds in the rough, at least two tension test specimens shall be taken to represent each lot.

4.3.2.4 The responsibility for furnishing sufficient test coupons shall rest with the contractor. Coupons shall be heat-treated with the castings which they represent and shall be positively identified therewith to the satisfaction of the Government inspector. Chilling of test coupons shall constitute cause for rejection of the castings which they represent. When the manufacturer so desires, extra castings may be made in order to provide for test specimens.

4 3.2.5 Reduced sampling for tension tests. - When specified in the contract or order or detail specification, reduced sampling shall apply after acceptance of 5 consecutive lots, or castings weighing 500 pounds or more in the rough. Sampling schedules shall be as follows:

The next ten production heats, cast one test bar for every other heat.
The next 25 production heats, cast one test bar for every fifth heat.
Subsequent production heats, cast one test bar for every tenth heat.
Rejection of a lot on a reduced sampling plan requires the reinitiation for subsequent heats of the sampling sequence required before reduced samplings was authorized.

4.3.3 Sampling for bend test (type B only). - Sufficient separately cast specimens shall be provided to perform the galvanized bar bend specified in 4.5.3.

4.3.4 Sampling for magnetic permeability test. - If specified, a magnetic permeability test block one foot long and having the maximum cross-section of the casting it represents shall be cast from the same melt with the prototype casting from each pattern. This block shall be separately cast and shall be heat-treated with the casting it represents. The permeability specimen shall be taken from the middle of the block (see 3.8.2 and 4.5.4).

4.3.5 Sampling for radiographic inspection. - When required, one casting from each twelve made from each pattern shall be selected for radiographic examination, except in cases where revisions in foundry practice have been necessary. If any radiograph of a production casting fails to pass inspection, that casting shall be subject to repair or discard according to the judgment of the Government inspector and all eleven pieces cast from that pattern immediately prior to the casting yielding the failed radiograph shall be subject to radiographic inspection In the instance of the failure to pass inspection by one of the regular radiographs from production, the foundry practice for that pattern shall be reviewed and the next three castings from that pattern shall all receive radiographic examination. If these castings then pass the radiographic standards, radiographic examination of production from this pattern shall again be on the basis of one of each 12.

4.4 Inspection. - Unless otherwise specified in the contract or order, castings shall be surface inspected by the Government inspector after heat-treatment and final cleaning and/or galvanizing to determine compliance with this specification which do not require tests.

4.5 Test procedures. -

4.5.1 Chemical analysis. - The sample obtained in accordance with 4.3.1 shall be forwarded to a Government laboratory designated by the bureau or agency concerned for chemical analysis. If the sample fails to conform to this specification all castings from that melt shall be rejected. (In the analysis of these drillings it should be noted that analytical procedures used in determining manganese contents of the order of 1.0 percent manganese are not suitable nor accurate for the analysis of the manganese content in Hadfield's manganese steel.)

4.5.2 Tension tests. - Tension test specimens shall conform to the design and dimensions specified in General Specifications for Inspection of Material, Appendix II, Part A for type I specimens. The shouldered round test specimen as shown on figure 1 for use with split shouldered grips will be acceptable.

4.5.3 Bend test type B (zinc-coated) castings. - Unless otherwise specified in the contract or order, two bend test specimens shall be prepared in accordance with General Specifications for Inspection of Material, Appendix II, Part A from a separately cast bar which shall receive the same surface pretreatment and zinc coating as the castings it represents. One specimen shall be prepared and bent with the zinc-coated surface in compression, through an angle sufficient to develop cracks in the uncoated metal surface. The second specimen shall be prepared and bent with the zinc-coated surface in tension through an angle sufficient to develop cracks in the coated metal surface that penetrates into the basis metal. The bend test shall be considered satisfactory if the angle through which the coated specimen (tension face specimen) bends before the development of cracks into the basis metal, is within 15 degrees of the angle of bend that the uncoated (compression face specimen) withstands before the development of surface cracks.

4.5.4 Magnetic permeability tests. - The magnetic permeability test specimen shall be machined from the block specified in 4 to the following dimensions: 1/2 inch diameter by 3 inches long. It shall be forwarded to the Engineering Experiment Station, Annapolis, Maryland, for test (see 3.8.2).

4.5.5 Radiographic examination. - Radiographic examination, if required, shall be performed under the supervision of the Government inspector. Radiographic examination shall be in accordance with General Specifications for Inspection of Material, Appendix II, Part F, Section F-1, and Radiographic Standards.

4.6 Rejection. - If any test specimen representing a lot fails to conform to this specification, the entire lot shall be rejected. If a test specimen representing a single casting fails, that casting shall be rejected. Injurious defects in castings revealed subsequent to acceptance shall be considered cause for rejection. Where the magnetic permeability is not met on first inspection, a second heat-treatment and/or additional surface preparation will be permitted. If permeability or dimensional tolerances are then not satisfactory, the casting shall be rejected. Castings which exhibit serious defects which are not repairable by welding or have been unsatisfactorily welded in such a manner as to preclude further satisfactory welding shall be rejected. Castings or lots which have been rejected for failure to meet mechanical requirements may be reheat-treated and resubmitted once for inspection.

5. PREPARATION FOR DELIVERY

5.1 Packing for domestic and overseas shipment. -

5.1.1 Large castings. - Large castings having projections which may be damaged in handling or shipping shall be securely packed in substantial wood crates conforming to Specification JAN-P-132.

5.1.2 Small castings. - Small rough castings shall be packed in nailed wood boxes conforming to style 2, 2-1/2 or 3 of Specification JAN-P-106. Small polished castings shall be wrapped with paper conforming to Specification JAN-P-125. Tape shall be used to hold the paper in place on the casting. Small polished castings shall be packed in nailed wood boxes conforming to style 2, 2-1/2 or 3 of Specification JAN-P-106.

5.1.3 Castings shall be blocked and/or braced in accordance with Specification JAN-P-100.

5.1.4 Shipping containers shall be strapped in accordance with the applicable container specification using type 1, class A or B, 5/8 inch or 3/4 inch by 0.020 inch thick strapping conforming to Specification QQ-S-781.

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

6. NOTES

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

(a) Title, number, and date of this specification.
(b) Type of casting required (see 1.2).
(c) Whether magnetic permeability test specimens are required (see 3.8.2).
(d) When radiographic examination is required (see 3.10).

6.2 Radiographic standards for steel castings are not at present available for general distribution. They may be examined at the following offices:

Inspectors of Naval Material.
Inspectors of Machinery, U.S.N.
Supervisors of Shipbuilding, U.S.N. and Naval Inspectors of Ordnance.
Commanders, Naval Shipyards.

6.3 Pickling. - A 1:1 hydrochloric acid solution at approximately 165°F. has been found very effective. Conventional pickling such as 15 minutes in inhibited 8 percent hydrofluoric acid in the temperature range of 150° - 180°F. is also recommended. Sulfuric acid pickling tends to leave a smut on the work which must be fluxed off prior to galvanizing.

Notice. - When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data, is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.