

MIL-S-15464B(SHIPS)  
15 June 1953  
SUPERSEDING  
MIL-S-15464A  
21 November 1951

## MILITARY SPECIFICATION

### STEEL, ALLOY, CHROMIUM-MOLYBDENUM; CASTINGS

#### 1. SCOPE

1.1 Scope. - This specification covers heat treated alloy steel castings suitable for Naval use at temperatures not in excess of 1050° Fahrenheit (F).

1.2 Classification. - Alloy steel castings shall be of the following classes, as specified (see 6.2):

Class 1 - 1-1/4 percent chromium - 1/2 percent molybdenum.

Class 2 - 2-1/4 percent chromium - 1 percent molybdenum.

Class 3 - 1-1/4 percent chromium - 1/2 percent molybdenum - vanadium.

#### 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

NN-B-621 - Boxes, Wood, Nailed and Lock-Corner.

###### MILITARY

JAN-P-106 - Packaging and Packing for Overseas Shipment -  
Boxes; Wood, Nailed.

JAN-P-132 - Packaging and Packing for Overseas Shipment -  
Crates; Unsheathed, Wood; Nailed (for Maximum  
Net Load of 2,500 Pounds).

MIL-L-10547 - Liners, Case, Waterproof.

###### 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.

Appendix VII, Welding,

Section C-3 - Welding of Cast Steels.

##### STANDARDS

###### MILITARY

MIL-STD-23 - Nondestructive Testing Symbols.

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

MIL-STD-129 - Marking of Shipments.

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BUREAU OF SHIPS  
Radiographic Standards for Steel Castings.

(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 used shall be such as to produce castings in full compliance with the chemical and mechanical requirements of this specification.

3.2 Processing. - Unless otherwise specified in the contract or order or in detail specifications, steel castings shall be made by one or more of the following processes:

Electric (arc or induction).  
Open-hearth.

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### 3.3 Chemical composition.- The chemical composition shall conform to table I.

Table I - Chemical composition.

Class	Carbon (max.)	Manganese (max.)	Phosphorus (max.)	Sulfur (max.)	Silicon	Molyb- denum	Copper (max.)	Nickel (max.)	Chromium (max.)	Vanadium
	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent
1	0.20	0.50-0.80	0.05	0.05	0.20-0.60	0.40-0.60	0.50	0.50	1.00-1.50	----
2	.18	.40-.70	.05	.05	.20-.60	.80-1.10	.50	.50	2.00-2.75	----
3	.18	.40-.70	.05	.06	0.60(max.)	.40-.60	.50	.50	1.00-1.50	0.15-0.25

The limits shown for copper and nickel are permissible residual elements and shall not be added.

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3.4 Mechanical properties. - The mechanical properties of the castings shall conform to table II.

Table II - Mechanical properties.

: Tensile	: Yield	: Elongation	: Reduction
: strength	: point	: in 2 inches	: in area
: (min.)	: (min.)	: (min.)	: (min.)
: P. S. I.	: P. S. I.	: Percent	: Percent
: 70,000	: 40,000	: 20	: 35

3.5 Heat treatment. -

3.5.1 Unless otherwise specified in the contract or order or in detail specifications, castings shall be heat treated by one of the following methods:

Normalize and temper.

Anneal, normalize and temper.

When selecting the desired heat treatment, due consideration shall be given to the composition and complexity of design in order to prevent the formation of heat-treating cracks. When required by the contract, order, or applicable drawings, castings which are subjected to heavy dynamic or fatigue stresses shall be given a homogenization heat treatment prior to receiving the heat treatment necessary to produce the required mechanical properties. Castings shall not be quenched in, or sprayed with liquid or be subjected to a mechanical air blast without the approval of the bureau or agency concerned. Castings which have been cold straightened or formed shall be given a stress relief heat treatment in accordance with 3.5.6. Castings may be straightened at temperatures within the stress relief temperature range specified in 3.5.6 without further heat treatment.

3.5.2 Annealing. - To anneal, castings shall be uniformly heated at a controlled rate to a temperature between 50 and 150°F. above the upper critical point, and shall be held at this temperature until all parts of each casting in the charge have reached this temperature above the critical point. The castings shall be cooled slowly in the furnace until the temperature has fallen to 750°F., after which the cooling rate of the furnace may be accelerated. When the temperature of the hottest part of the charge has fallen to 500°F. above the ambient temperature, the castings may be removed from the furnace and cooled in still air. When permitted by the Government inspector, the cooling rate of castings in which dimensional stability is not a controlling factor may be accelerated when the temperature has fallen to 1,000°F.

3.5.3 Normalizing. - The castings shall be heated to and held as specified in 3.5.2 at a temperature of at least 100°F. above the upper critical point. Castings shall then be removed from the furnace and permitted to cool through the critical range in air.

3.5.4 Heating and quenching. - When quenching is permitted, castings shall be uniformly heated to and held at a temperature sufficiently above the upper critical point for a time sufficient to insure that all sections are in proper condition for quenching, and then rapidly cooled in a suitable quenching medium. The heating and quenching may be preceded by a homogenizing, normalizing, tempering or annealing operation or suitable combination thereof, depending on the character and condition of the material and the particular properties required.

3.5.5 Tempering. - Castings which have been normalized or quenched (see 3.5.1) shall be given a tempering heat treatment by heating uniformly at a controlled rate to a temperature of 1,100 to 1,300°F. The temperature of the charge shall remain within this range for a period sufficient to insure that all sections have been uniformly heated at the required temperature. The castings shall be cooled at a rate appropriate for the composition, shape and size. Mechanical properties of normalized or quenched castings shall be determined after tempering.

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3.5.6 Stress relief heat treatment. - Castings shall be treated by a method identical with the tempering heat treatment specified in 3.5.5. For steel which has been quenched or normalized and tempered to obtain required mechanical properties, the stress relieving temperature subsequently applied shall be at least 50 but not more than 100°F. below the tempering temperature applied except that, if the manufacturer desires to determine mechanical properties after stress relief, the stress relief may be at the tempering temperature. Redetermination of mechanical properties will not be required after stress relief. (For stress relief of welded castings, see General Specifications for Inspection of Material, Appendix VII, Section C-3.)

3.5.7 Homogenization. - When homogenization is required, (see 6.2), the castings shall be heated at a controlled rate to temperature of 1,850 to 2,350°F. and shall be held at the homogenization temperature a sufficient length of time to minimize harmful heterogeneity by diffusion. The castings shall then be withdrawn to cool through the critical range. Homogenization shall be followed by annealing, normalizing, and tempering, or, if permitted, quenching and tempering.

3.5.8 Heat treating equipment. - Continuous or automatic heat treating equipment may be used, provided such equipment reproduces the heat treatment cycles specified herein.

3.5.9 Pyrometric control. - Adequate pyrometric equipment shall be employed to indicate the temperature of the casting during the heating and cooling cycles of the heat treatment. A heat-treatment record shall be available to show that the heat-treatment requirements have been carried out.

3.6 Cleaning. - Castings shall have heads and gates removed, and shall be thoroughly cleaned, all sand, scale, fins and excessive rough spots being 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. 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 operations as necessary to provide the specified contour to the satisfaction of the Government Inspector.

3.7 Repair of defects. - Unless otherwise specified by the bureau or agency concerned, welding shall be used to repair defects.

3.7.1 Repair by welding. - Welding shall not be performed on castings before the specified heat treatment has been applied except as specified herein. Welding of minor defects in heat-treated castings in accordance with General Specifications for Inspection of Material, Appendix VII, Section C-3, or other instructions issued by the bureau or agency concerned, will be permitted. In the case of normalized castings, welding may be performed after normalizing but before tempering. In the case of castings which are to be quenched and tempered, welding may be performed after a normalizing heat treatment. Welding of defects other than minor defects shall not be performed without the approval of the Government inspector. Authorized repairing shall be accomplished in accordance with General Specifications for Inspection of Material, Appendix VII, Section C-3, or other instructions issued by the bureau or agency concerned.

3.7.1.1 The term "minor defect" shall include undersize areas resulting from oxygen cutting, grinding or chipping, surface sand, or slag defects, or slight surface defects, provided that the depth of the defect when prepared for repair welding does not exceed 20 percent of the wall thickness at that point, or 1 inch, whichever is less, and provided that it has no other dimension greater than four times the wall thickness, or greater than 6 inches, whichever is less.

3.7.1.2 Major defects include all defects not falling within the limits specified in 3.7.1.1.

3.7.1.3 Each request for permission to repair defects by welding shall be accompanied by an analysis of the casting to aid in the determination of proper welding procedure. In considering requests for authority to repair defects, radiography or other nondestructive tests may be required to determine the extent of the defects, the completeness of their removal, and the effectiveness of repairs.

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3.7.2 Any evidence of unauthorized repair, or repairs which do not conform to General Specifications for Inspection of Material, Appendix VII, Section C-3 or other instructions issued by the bureau or agency concerned, will be considered as cause for rejection.

3.8 Soundness. - Castings shall be of uniform quality and condition, free from harmful defects such as injurious tears, cracks, porosity, sand inclusions, blowholes, shrinkage cavities, cold shuts and unfused chaplets or chills as determined by visual examination and applicable nondestructive tests, including radiographic examination and magnetic particle inspection. The acceptability of discontinuities in castings for specific applications shall be determined by comparison with suitable standards furnished or approved by the bureau or agency concerned. Repair of defects by approved welding processes and by qualified welders will be permitted, when performed in accordance with procedures specified in 3.7.

3.8.1 Radiographic examination. -

3.8.1.1 Castings shall be radiographically examined as specified in 4.6, except when specifically waived by the bureau or agency concerned and such waiver is made known in invitations to bid and is included in the contract, order (see 6.2) or applicable drawings.

3.8.1.2 Marking of drawings by design agents. - All drawings detailing steel castings shall be submitted in duplicate to the bureau or agency concerned for determination of necessity for radiographic inspection and addition of radiographic location markings, including the classification of the castings for application of radiographic standards. Radiographic markings in accordance with Standard MIL-STD-23 will be placed on these drawings by the bureau or agency concerned and one copy returned to the design agent, who shall incorporate these markings on tracings in such a manner that they will appear on all subsequent copies. Where radiographic markings may obscure details on the drawings, a separate drawing shall be prepared showing the necessary design details and on which the markings shall be incorporated. Such supplementary drawings shall be positively identified with the drawing on which the part is detailed.

3.8.1.3 The Government inspector may require radiographic examination of additional locations to investigate the extent of defects revealed by the original radiographic examination, by surface inspection, by machining, or by pressure or other tests.

3.8.2 Magnetic particle inspection. -

3.8.2.1 Castings shall be subject to magnetic particle inspection to detect the presence of surface hot tears and cracks except when specifically waived by the bureau or agency concerned and such waiver is made known in invitation to bid and is included in the contract or order (see 6.2) or applicable drawings.

3.8.2.2 Magnetic particle examination shall be performed on castings in those locations indicated on suitably marked drawings or supplementary position charts.

3.8.2.3 Marking of drawings by design agents. - Drawings detailing steel castings shall be submitted in duplicate to the bureau or agency concerned for determination of necessity for magnetic particle inspection and addition of magnetic particle location markings. The magnetic particle markings in accordance with Standard MIL-STD-23 will be placed on these drawings by the bureau or agency concerned and one copy returned to the design agent who shall incorporate these markings on tracings in such a manner that they will appear on all subsequent copies. Copies of drawings forwarded for radiographic markings in accordance with 3.8.1 will suffice for this purpose.

3.8.2.4 Where practicable, magnetic particle inspection shall be performed on the rough casting to determine the presence of defects which may cause rejection of the part if discovered on finish-machined surfaces. When surface discontinuities are discovered, the interpretation or extent of which is doubtful these indications shall be investigated by shallow chipping or grinding, or other suitable means. If the cavity resulting from the complete removal of the defect is not greater than 10 percent of the required wall thickness or not greater than 1/4 inch, whichever dimension is the smaller, this cavity may be blended with the casting surface and no repairs will be required.



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3.9 Straightness. - 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.

3.10 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.

3.11 Workmanship. - The workmanship shall be first class in every respect.

#### 4. SAMPLING, INSPECTION, AND TEST PROCEDURES

4.1 Lot. - A lot shall consist of castings of one class 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 of one class, the product of each 4 hours of continuous operation of each furnace offered for inspection at one time.

##### 4.2 Sampling for chemical analysis. -

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

4.2.2 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 non-uniformity of material within the lot and shall be tested individually.

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

##### 4.3 Sampling for mechanical tests. -

4.3.1 Where practicable, sufficient test coupons shall be cast with and gated to the castings to represent the lot or the particular casting. Care should 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 is 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 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.

4.3.3 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.

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4.3.4 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.

4.4 Sampling for radiographic and magnetic particle inspection. - When required (see 3.8 and 6.2), castings selected in accordance with 4.5 shall be subjected to radiographic and magnetic particle inspection. If none of the castings in the sample are defective, the lot shall be accepted. If any casting in the sample is found defective, it shall be rejected, and the remainder of the lot shall be subjected to radiographic and magnetic particle inspection. Any additional castings found defective shall also be rejected.

4.5 Sampling for visual and dimensional inspection. - From each lot of castings (see 4.1), a random sample shall be selected by the Government inspector for inspection of visual and dimensional characteristics with lot acceptance based on table III in accordance with Standard MIL-STD-105.

Table III - Sampling for visual and dimensional inspection - AQL (approx.)=1.0 percent defective.

Number of castings in inspection lot	Number of castings in sample	Acceptance number (defectives)	Rejection number (defectives)
Under 16	All	---	---
16 to 25	15	0	1
26 to 40	25	0	1
41 to 110	35	1	2
111 to 180	50	1	2
181 to 500	75	2	3
501 to 800	110	3	4
801 and over	150	4	5

4.5.1 Visual and dimensional inspection. - Each of the sample castings selected in accordance with table III shall be visually and dimensionally inspected by the Government inspector as to surface indications of defects and rough dimensions after heat treatment and final cleaning to verify compliance with this specification. Any casting in the sample containing one or more defects shall be rejected, and if the number of defective castings in the sample exceeds the acceptance number for that sample, the lot represented by the sample shall be rejected. Rejected lots may be offered again for Government inspection provided the contractor has removed all nonconforming castings. The Government inspector shall again select and examine samples from such rejected lots in accordance with table III to verify compliance with this specification.

4.6 Radiographic examination. - Radiographic examination shall be performed under the supervision of the Government inspector in accordance with General Specifications for Inspection of Material, Appendix II, Part F, Section F-1 on castings in those locations indicated on suitably marked drawings. If the radiographic classification does not appear on the drawings, examination shall be in accordance with Radiographic Standards for Steel Castings (see 6.3). The acceptability of castings with discontinuities found by radiographic examination shall be judged by comparison with Radiographic Standards for Steel Castings (see 6.3).

4.7 Mechanical tests. -

4.7.1 Tension test specimens shall conform to the dimensions of type 1 of General Specifications for Inspection of Material, Appendix II, Part A.



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4.7.2 When any test specimen shows defective machining or obvious lack of continuity of metal, it may be discarded and replaced by another specimen selected by the Government inspector. The nature of the flaw or lack of continuity of the metal, when deemed characteristic of the material under inspection, shall be taken into consideration when determining the acceptability of the casting or castings. If the percentage of elongation of any tension test specimen is less than that specified, and any part of the fracture is outside of the gage length, or within the gage length and less than 25 percent of the gage length from either datum point, as indicated by scribe marks made on the specimen before testing, the results may be disregarded and another specimen tested.

4.8 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. Castings or lots which have been rejected for failure to meet mechanical requirements may be reheat-treated and resubmitted one time only for inspection.

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

## 5. PREPARATION FOR DELIVERY

### 5.1 Packaging. -

5.1.1 Small polished castings. - Small polished castings weighing less than 50 pounds each shall be individually wrapped with a minimum of 2 thicknesses of 40 pounds minimum basis weight kraft paper or equivalent.

5.1.2 Other castings. - Castings, other than those specified in 5.1.1, will require no packaging.

### 5.2 Packing. -

#### 5.2.1 For domestic shipment. -

5.2.1.1 Small rough castings. - Small rough castings weighing less than 150 pounds each shall be packed individually or in multiple units with adequate blocking or bracing in nailed wood boxes conforming to Specification NN-B-621. Bundles shall be metal strapped. The gross weight of nailed wood boxes shall not exceed 250 pounds and of bundles, 500 pounds.

5.2.1.2 Small polished castings. - Small polished castings weighing less than 150 pounds each, including those packaged as specified in 5.1.1, shall be packed individually or in multiple units with adequate blocking or bracing in nailed wood boxes as specified in 5.2.1.1.

#### 5.2.1.3 Large castings. -

5.2.1.3.1 Large castings weighing more than 150 pounds each and having projections or surface finish which may be damaged in handling or shipping shall be packed individually or in multiple units with adequate blocking and bracing in an unsheathed crate conforming to Specification JAN-P-132 or in nailed wood boxes conforming to Specification NN-B-621. No strapping will be required. The castings shall be securely bolted, blocked, braced, or strapped to prevent shifting or damage within the crate or box. The gross weight shall not exceed 500 pounds, unless individual castings exceed this weight.

5.2.1.3.2 Large castings weighing more than 150 pounds each and not subject to damage in shipment may be shipped unpacked.

#### 5.2.2 For overseas shipment. -

5.2.2.1 Small rough castings. - Small rough castings weighing less than 150 pounds each shall be packed as specified in 5.2.1.1, except that the gross weight of nailed wood shall not exceed 150 pounds and of bundles, 250 pounds. Wood boxes shall conform to Specification JAN-P-106 and appendix thereto.

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5.2.2.2 Small polished castings. - Small polished castings weighing less than 150 pounds, each, including those packaged as specified in 5.1.1, shall be packed as specified in 5.2.1.2, except that the gross weight shall not exceed 150 pounds. Shipping containers in which packaged castings are packed (see 5.1.1), shall be lined with a sealed waterproof case liner conforming to Specification MIL-L-10547 and appendix thereto. Wood boxes shall conform to Specification JAN-P-106 and appendix thereto.

5.2.2.3 Large castings. - Large castings weighing more than 150 pounds shall be packed as specified in 5.2.1.3 except the nailed wood boxes shall conform to Specification JAN-P-106. Shipping containers shall be closed and strapped in accordance with the applicable container specification.

5.2.3 For domestic or overseas shipment. - Where practicable, shipping containers of similar construction shall be of 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.

5.3 Marking. - In addition to any special marking required by the contract or order, each package and shipping container shall be marked in accordance with Standard MIL-STD-129. The nomenclature shall be "Steel, Alloy, Chromium-Molybdenum, Castings "

## 6. NOTES

6.1 Intended use. - Class 1 steel castings are intended for use with superheated steam at temperatures of 850 to 950°F. Class 2 and class 3 steel castings are intended for use with superheat steam at temperatures of 950 to 1,050°F. Unless class 2 or class 3 is specifically required, either class may be used in the temperature range specified.

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

- (a) Title, number, and date of this specification.
- (b) Class required (see 1.2).
- (c) That all patterns furnished by the Government shall be properly cared for by the contractor, and when being returned to the Government shall be suitably boxed or crated by the contractor to prevent damage or breakage in transit. Before shipment from the foundry, patterns should be inspected by the Government inspector and report made by him if the patterns are found in an unsatisfactory condition.
- (d) Whether the patterns are to be furnished by the Government or are to be supplied by the contractor.
- (e) Whether homogenization heat treatment is required, and the homogenization temperature (see 3.5.7).
- (f) When radiographic examination and magnetic particle inspection are not required (see 3.8.1.1 and 3.8.2.1).
- (g) Whether preparation for domestic or overseas shipment is required (see 5.2 and 5.3).

6.3 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.  
Commander, Naval Shipyards.

6.4 The conditions under which pilot castings should be furnished, inspected, and subjected to destructive tests for complete exploration, when such pilot castings are considered necessary to insure obtaining satisfactory castings and to expedite delivery should be specified in the contract or order.

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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.

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Other interest:

None



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