INCH-POUND
MIL-C-24679(SH)
6 May 1988
SUPERSEDING
MIL-C-15726E(SHIPS)
(IN PART)
20 August 1965
(See 6.3)

MILITARY SPECIFICATION

COPPER-NICKEL ALLOY FORGINGS AND FORGING STOCK

This specification is approved for use within the Naval Sea Systems Command, Department of the Navy, and is available for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers copper-nickel alloy forgings (including bar and rod) and forging stock for use in applications involving seawater exposure.

1.2 Classification. Copper-nickel alloy shall be furnished in the following alloys, as specified (see 6.2.1):

Alloy C70600 (formerly 90-10)
Alloy C71500 (formerly 70-30)

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specification and standards. The following specification and standards form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of these documents shall be those listed in the issue of the Department of Defense Index of Specifications and Standards (DoDISS) and supplement thereto, cited in the solicitation.

SPECIFICATION

MILITARY
MIL-C-3993 - Copper and Copper-Base Alloy Mill Products; Packaging of.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Naval Sea Systems Command, SEA 55Z3, Department of the Navy, Washington, DC 20362-5101 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A AREA FORG

STANDARDS

FEDERAL

FED-STD-151 - Metals; Test Methods.

MILITARY

MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes.
MIL-STD-271 - Requirements for Nondestructive Testing Methods.
MIL-STD-792 - Identification Marking Requirements for Special Purpose Components.

(Copies of specifications and standards required by contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting activity.)

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted shall be those listed in the issue of the DoDISS specified in the solicitation. Unless otherwise specified, the issues of documents not listed in the DoDISS shall be the issue of the nongovernment documents which is current on the date of the solicitation.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

E 8 - Standard Test Methods of Tension Testing of Metallic Materials. (DoD adopted)
E 75 - Standard Methods for Chemical Analysis of Copper-Nickel and Copper-Nickel-Zinc Alloys.
E 478 - Standard Methods for Chemical Analysis of Copper Alloys.

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.)

(Nongovernment standards and other publications are normally available from the organizations which prepare or which distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.3 Order of precedence. In the event of a conflict between the text of this specification and the references cited herein (except for associated detail specifications, specification sheets or MS standards), the text of this specification shall take precedence. Nothing in this specification, however, shall supersede applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Materials and manufacture. The materials shall be of such quality and purity that the finished product shall have the properties and characteristics prescribed herein. The materials shall be produced by hot compressive forming and shall be sufficiently worked to produce material conforming to this specification. Unless otherwise specified (see 6.2.1), forgings shall be furnished in the hot forged condition.

3.1.1 Recovered materials. Unless otherwise specified herein, all equipment and material used in the products covered by this specification shall be new and may be processed using recovered materials to the maximum extent practicable without jeopardizing the specified requirements. The term "recovered materials" means materials which have been collected or recovered from solid waste and reprocessed to become a source of raw materials, as opposed to virgin raw materials.

3.2 Chemical composition. The material shall conform to the requirements of table I.

TABLE I. Chemical requirements.

Composition	Copper alloy number	
	C71500	C70600
Copper plus sum of named elements (minimum)	99.50	99.50
Copper and silver (minimum)	65.0	86.5
Nickel and cobalt	29.0-33.0	9.0-11.0
Zinc (maximum)	0.50	0.50
Iron	0.40-1.0	1.00-1.8
Lead (maximum)	0.02	0.02
Manganese (maximum)	1.0	1.0
Phosphorous (maximum)	0.02	0.02
Sulfur (maximum)	0.02	0.02
Carbon (maximum)	0.05	0.05

3.3 Mechanical properties. Forgings shall conform to the mechanical property requirements shown in table II. Mechanical properties are not required for forging stock, but the stock shall meet the requirements after proper working and heat treatment.

TABLE II. Mechanical properties.

Size of heaviest forged section (inches)	C71500		C70600	
	Hot finished up to 6, inclusive	Hot finished over 6 and annealed, all sizes	Hot finished up to 6, inclusive	Hot finished over 6 and annealed, all sizes
Minimum tensile strength (kilopounds per square inch (ksi))	50	45	45	40
Minimum yield strength (0.5 percent extension under load (ksi))	20	18	18	15
Minimum elongation in 2 inches or four times diameter (percent)	30	30	30	30

3.4 Forging sketch. When specified in the contract or order, a forging sketch shall be prepared (see 6.2.2).

3.5 Dimensions. The shape and dimensions of the finished forging shall be as specified (see 6.2.1) and shall be in the form of a drawing which shall include dimensional tolerances (see 6.2.2). Forging stock dimensions shall be as specified (see 6.2.1).

3.6 Soundness. Material shall be of uniform quality and condition and free of defects harmful to its intended use, such as seams, pipe, cracks, laps, excessive scale, fins, porosity, and segregation, as determined by the specified examination and nondestructive tests (see 4.4 and 4.5). When specified (see 6.2.1), forgings shall be ultrasonically and liquid penetrant inspected to demonstrate their soundness. Surface imperfections such as handling marks, straightening marks, and light mandrel and die marks will not be considered injurious defects.

3.7 Identification.

3.7.1 Individual forgings and forging stock shall be marked with the following:

(a) Producer's name or trademark.
(b) This specification number.
(c) Heat number or heat treat lot number.

3.7.2 The method and location of marking shall be in accordance with MIL-STD-792. Forging stock shall be marked with low stress die stamps or vibroetching.

3.7.3 Where individual forgings cannot be marked in accordance with 3.7.1 and 3.7.2, they may be bundled or boxed, and each bundle or box shall be marked with a metal or oil-proof tag containing the information specified in 3.7.1.

3.8 Cleanliness.

3.8.1 Contaminants. Contaminants such as sulfur or sulfur-bearing compounds from lubricants used in forming, machining, or other processing, or from marking materials used for in-process identification, shall be removed prior to any heat treatment of the material.

3.8.2 Mercury. During the manufacturing processes, examinations, and tests, the material shall not come into direct contact with mercury or any of its compounds, nor with any mercury-containing device employing a single boundary of containment.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by 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.

4.1.1 Responsibility for compliance. All items must meet all requirements of sections 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of assuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling in quality conformance does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to acceptance of defective material.

4.1.2 Certificate of quality conformance. When specified in the contract or order, a certificate of quality conformance shall be prepared for each lot of material offered for acceptance (see 6.2.2).

4.2 Lot.

4.2.1 Forgings weighing 250 pounds and less, as shipped. A lot shall consist of all forgings forged from the same heat (or from a lot in which the chemical analysis for each heat can be reported), heat treated at the same time, of the same design, and not exceeding 2000 pounds in as-shipped weight.

4.2.2 Forgings weighing over 250 pounds, as shipped. A lot shall consist of each individual forging.

4.2.3 Forging stock. A lot shall consist of metal from one heat or one lot in which the chemical analysis for each heat can be ascertained. For continuous cast material, an inspection lot shall be the product of one cast billet, or from a single melt charge whose weight shall not exceed 5000 pounds that has been continuously processed and subject to inspection at one time.

4.3 Sampling.

4.3.1 Sampling for chemical analysis.

4.3.1.1 Batch melted material. For batch melted material, one sample shall be taken from each melt preferably at the time of pouring.

4.3.1.2 Continuously cast material. For continuously cast material, samples shall be taken at the beginning of the pour and at the end of the pour. If the cast lasts more than 1 hour, an additional sample shall be taken for each hour or portion thereof of pour. The results of analyses for all melts included in an inspection lot shall be prepared (see 6.2.2).

4.3.2 Mechanical properties.

4.3.2.1 Forgings weighing 250 pounds and less, as shipped. Unless otherwise specified (see 6.2.1), forgings weighing 250 pounds or less shall have two forgings sampled when there are up to 1200 forgings in the lot. When there are over 1200 forgings in the lot, the sample size shall be as specified (see 6.2.1).

4.3.2.2 Forgings weighing over 250 pounds, as shipped. Forgings weighing over 250 pounds shall be sampled individually.

4.3.2.3 Source of specimens. Mechanical property specimens shall be taken from integral prolongations by trepanning, or extra forgings may be provided by the forger. Forgings under 3-1/2 inches in cross-section may utilize separately forged test bars, provided the wall thickness and amount of working are equivalent to the forgings being supplied. Extra forgings may be provided for samples when forgings are over 3-1/2 inches in cross-section, provided samples cannot be taken from prolongations or by trepanning.

4.3.3 Visual and dimensional.

4.3.3.1 Forgings weighing 250 pounds and less. Samples shall be selected in accordance with MIL-STD-105, general inspection level II, acceptable quality level (AQL) of 1.5.

4.3.3.2 Forgings weighing over 250 pounds. Each forging shall be visually and dimensionally examined.

4.3.4 Sampling for nondestructive inspection. When specified (see 3.6), each piece shall be inspected.

4.4 Test procedures.

4.4.1 Chemical analysis. The sample selected in accordance with 4.3.1 shall be analyzed by the wet chemical or spectrographic methods to determine conformance to table I. In the case of dispute, analysis shall be in accordance with ASTM E 75 with copper analysis to ASTM E 478.

4.4.2 Mechanical property tests. Mechanical property tests shall be performed in accordance with ASTM E 8. Yield strength shall be determined at 0.5 percent extension under load. The longitudinal axis of tensile specimens shall be parallel to the major direction of metal flow in the forgings.

4.5 Examination.

4.5.1 Visual and dimensional. Each piece of material sampled shall be examined for conformance to 3.5 through 3.7.

4.5.2 Nondestructive test. Items selected in accordance with 4.3.4 shall be inspected in accordance with MIL-STD-271 to the requirements specified in 4.5.2.1 through 4.5.2.5.

4.5.2.1 Ultrasonic inspection. Flat forgings, such as disk or pancake, shall be ultrasonically inspected by the longitudinal wave technique. Cylindrical forgings, such as ring or hollow round, shall be ultrasonically inspected by the shear wave and the longitudinal wave techniques. The forgings shall be inspected for 100 percent volume as shown on the forging sketch.

4.5.2.2 Calibration.

4.5.2.2.1 Longitudinal wave. The longitudinal wave test shall be calibrated on a flat-bottomed reference hole of a diameter as shown in table III. The hole may be drilled either into the piece to be tested or into a separate defect-free specimen of the same size, shape, material, and condition. For material up to 1-1/2 inches thick, holes shall be drilled to mid-section. For material over 1-1/2 inches thick, holes shall be drilled not less than 3/4 inch deep and not more than mid-section. Holes shall be normal to the surface. The ultrasonic test instrument shall be adjusted so that the response from the reference hole shall be not less than 25 percent and not more than 100 percent of screen height.

TABLE III. Ultrasonic testing reference hole.

Material thickness (inches)	Hole diameter (inch)
Up to and including 6	1/8
Over 6 and including 16	1/4
Over 16	As agreed upon

4.5.2.2.2 Shear wave. The shear wave test shall be calibrated on two notches, one cut into the inside surface and one cut into the outside surface. The notches shall be cut axially either into the piece to be examined or into a separate defect-free specimen of the same size, shape, material, and condition. The depth of the notches shall be 5 percent of the material thickness or 1/4 inch, whichever is less, and their length shall be not more than 1 inch. The notch producing the smaller amplitude response shall be used as the evaluation reference.

4.5.2.3 Recalibration. Recalibration shall be performed following any realignment of the search unit with respect to the material, or any change in the search unit, couplant, instrument settings, or scanning speed from that used for calibration. Recalibration shall also be performed at least once during each 8-hour shift.

4.5.2.4 Procedure. The angle used on ring and hollow forgings shall assure reflection from the internal surface. The search unit shall be fitted with a shoe or wedge machined to fit the curvature of the piece being inspected. The forgings shall also be inspected with a longitudinal wave test from the external circumferential and end surfaces.

4.5.2.5 Acceptance criteria.

4.5.2.5.1 Longitudinal wave. Any material which produces indications equ to or larger than the response from the reference hole, or which produces a complete loss of back reflection, shall be rejected.

4.5.2.5.2 Shear wave. Any material which produces indications equal to or larger than the response from the reference notch shall be rejected.

4.5.3 Liquid penetrant inspection. Liquid penetrant indications shall meet the following criteria:

(a) Linear indications: None shall be allowed.
(b) Rounded indications:

(1) Linear: Lines of four or more separated from each other by less than 1/16 inch shall not be allowed.
(2) Nonlinear: Evaluated as shown in table IV.

(Rounded indications are indications that are circular or elliptical with the long axis less than twice as long as the other axis and with no sharp corners. Material exhibiting rounded indications in excess of those specified in table IV shall be rejected.)

TABLE IV. Allowable nonlinear rounded indications.

Maximum size (inch)	Cumulative number per square inch
Up to 1/32, inclusive	20
Over 1/32 to 1/16, inclusive	10
Over 1/16	0

4.6 Rejection and retests. If any lot fails to meet any of the requirements of this specification, the lot represented by the sample shall be rejected subject to the retest provisions of FED-STD-151.

4.7 Inspection of packaging. Sample packages and packs, and the inspection of the preservation-packaging, packing and marking for shipment and storage shall be in accordance with the requirements of section 5 and the documents specified therein.

5. PACKAGING

(The packaging requirements specified herein apply only for direct Government acquisition.)

5.1 Packaging, packing, and marking. The material shall be packaged to level A or C; packed to level A, B, or C, as specified (see 6.2.1); and marked in accordance with MIL-C-3993.

6. NOTES

6.1 Intended use. Copper-nickel forgings are intended for use in mechanical systems and piping systems exposed to seawater and other corrosive environments where a low strength material will suffice.

6.2 Ordering data.

6.2.1 Acquisition requirements. Acquisition documents should specify the following:

(a) Title, number, and date of this specification.
(b) Alloy required (see 1.2).
(c) Whether forgings are to be in the hot forged condition (see 3.1).
(d) Shape and dimensions of forgings (see 3.5).
(e) Shape and dimensions of finished forging and dimensions of forging stock (see 3.5).
(f) If forgings are to be ultrasonically and liquid penetrant inspected (see 3.6).

(g) Sampling for mechanical property tests, if other than as specified (see 4.3.2.1).
(h) Level of packaging and packing (see 5.1).

6.2.2 Data requirements. When this specification is used in an acquisition and data are required to be delivered, the data requirements identified below shall be developed as specified by an approved Data Item Description (DD Form 1664) and delivered in accordance with the approved Contract Data Requirements List (CDRL), incorporated into the contract. When the provisions of DoD FAR Supplement, Part 27, Sub-Part 27.475-1 (DD Form 1423) are invoked and the DD Form 1423 is not used, the data specified below shall be delivered by the contractor in accordance with the contract or purchase order requirements. Deliverable data required by this specification is cited in the following paragraphs.

Paragraph no.	Data requirement title	Applicable DID no.	Option
3.4, 3.5	Manufacturer's forging sketch	DI-FORG-80412	----
4.1.2	Certification data/report	UDI-A-23264	----
4.3.1.2	Certification data for level I material	UDI-T-23191	----

(Data item descriptions related to this specification, and identified in section 6 will be approved and listed as such in DoD 5010.12-L., AMSDL. Copies of data item descriptions required by the contractors in connection with specific acquisition functions should be obtained from the Naval Publications and Forms Center or as directed by the contracting officer.)

6.2.2.1 The data requirements of 6.2.2 and any task in sections 3, 4, or 5 of this specification required to be performed to meet a data requirement may be waived by the contracting/acquisition activity upon certification by the offeror that identical data were submitted by the offeror and accepted by the Government under a previous contract for identical item acquired to this specification. This does not apply to specific data which may be required for each contract regardless of whether an identical item has been supplied previously (for example, test reports).

6.3 Supersession data. This specification supersedes that portion of MIL-C-15726E(SHIPS) which pertains to the acquisition of copper-nickel forgings. Cu-Ni sheet, plate, strip, bar and rod should be acquired to MIL-C-15726F(SH).

6.4 Subject term (key word) listing.

Liquid penetrant inspection
Ultrasonic inspection

Preparing activity:
Navy - SH
(Project FORG-N143)

INSTRUCTIONS: In a continuing effort to make our standardization documents better, the DoD provides this form for use in submitting comments and suggestions for improvements. All users of military standardization documents are invited to provide suggestions. This form may be detached, folded along the lines indicated, taped along the loose edge *(DO NOT STAPLE)*, and mailed. In block 5, be as specific as possible about particular problem areas such as wording which required interpretation, was too rigid, restrictive, loose, ambiguous, or was incompatible, and give proposed wording changes which would alleviate the problems. Enter in block 6 any remarks not related to a specific paragraph of the document. If block 7 is filled out, an acknowledgement will be mailed to you within 30 days to let you know that your comments were received and are being considered.

NOTE: This form may not be used to request copies of documents, nor to request waivers, deviations, or clarification of specification requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document*(s)* or to amend contractual requirements.

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STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions – Reverse Side)

1. DOCUMENT NUMBER	2. DOCUMENT TITLE
MIL-C-24679(SH)	COPPER-NICKEL ALLOY FORGINGS AND FORGING STOCK

3a. NAME OF SUBMITTING ORGANIZATION	4. TYPE OF ORGANIZATION *(Mark one)*
	☐ VENDOR
b. ADDRESS *(Street, City, State, ZIP Code)*	☐ USER
	☐ MANUFACTURER
	☐ OTHER *(Specify)*:

5. PROBLEM AREAS

a. Paragraph Number and Wording:

b. Recommended Wording:

c. Reason/Rationale for Recommendation:

6. REMARKS

7a. NAME OF SUBMITTER *(Last, First, MI)* – Optional	b. WORK TELEPHONE NUMBER *(Include Area Code)* – Optional
c. MAILING ADDRESS *(Street, City, State, ZIP Code)* – Optional	8. DATE OF SUBMISSION *(YYMMDD)*

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(TO DETACH THIS FORM, CUT ALONG THIS LINE.)