

MIL-T-22214B(SH)  
16 March 1987  
SUPERSEDING  
MIL-T-22214A(SHIPS)  
4 October 1968  
(See 6.5)

## MILITARY SPECIFICATION

### TUBE, CONDENSER AND HEAT EXCHANGER WITH INTEGRAL FINS (UNS ALLOY NOS. C71500, C70600, C12200)

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 integral finned tubes with plain ends of copper nickel alloy and copper for use in heat exchangers and condensers.

1.2 Classification. Tubes shall be furnished in the following alloys, classes and tempers, as specified (see 6.2.1).

##### Alloy:

Copper alloy UNS No. C71500  
Copper alloy UNS No. C70600  
Copper alloy UNS No. C12200

##### Class:

A - Critical application (see 6.3)  
B - Noncritical application

##### Temper:

As-finned  
Annealed

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 5523, 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.

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## 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.

## STANDARDS

## MILITARY

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

MIL-STD-271 - Nondestructive Testing Requirements for Metals.

(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 document forms 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)

B 359 - Standard Specification for Copper and Copper-Alloy Seamless  
Condenser and Heat Exchanger Tubes with Integral Fins.  
(DoD adopted)

(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.

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## 3. REQUIREMENTS

3.1 General. Copper alloy finned condenser and heat exchanger tubes shall be in accordance with ASTM B 359 except as specified herein.

3.2 Pressure resistance. The pressure resistance for class A and B tube shall be as specified in 3.2.1 and 3.2.2.

3.2.1 Class A tube. Class A tube shall withstand the hydrostatic pressure test specified in 4.3.2.1.

3.2.2 Class B tube. Class B tube shall withstand the air pressure test specified in 4.3.2.2.

3.3 Surface and internal discontinuities. For class A applications and when specified for class B applications (see 6.2.1), the tube shall pass the ultrasonic inspection as specified in 4.3.3. The inspection shall be conducted on finned tubing.

3.4 Number of fins. Unless otherwise specified (see 6.2.1), the tube shall have nineteen fins with a tolerance of up to one fin per inch as averaged over any 12-inch length.

3.5 Fin height. Unless otherwise specified (see 6.2.1), the fin height shall be 0.050 inch, minimum.

3.6 Dimensions and weights. Unless otherwise specified (see 6.2.1), the nominal dimensions and weights of the tube shall be as specified in table I. The weight variation of tubes shall be not more than 5 percent of that specified in table I.

TABLE I. Dimensions and weights of integral finned condenser tube (minimum wall).

Nominal		Approximate weight per foot	Plain section		Finned section	
Outside diameter	Wall		Outside diameter	Specified minimum wall	Root diameter	Specified minimum wall
Inch	Inch	Pounds	Inch	Inch	Inch	Inch
1/2	0.032	0.267	0.500	0.049	0.375	0.032
1/2	.042	.291	.500	.058	.375	.042
1/2	.049	.320	.500	.065	.375	.049
5/8	0.028	0.320	0.625	0.042	0.500	0.023
5/8	.035	.356	.625	.049	.500	.023
5/8	.042	.391	.625	----	----	----

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TABLE I. Dimensions and weights of integral finned condenser tube (minimum wall). - Continued

Nominal		Approximate weight per foot	Plain section		Finned section	
Outside diameter	Wall		Outside diameter	Specified minimum wall	Root diameter	Specified minimum wall
Inch	Inch	Pounds	Inch	Inch	Inch	Inch
5/8	.049	.424	.625	.065	.500	.049
5/8	.058	.466	.625	.072	.500	.058
5/8	.065	.487	.625	.083	.500	.065
3/4	.028	.401	.750	.049	.625	.028
3/4	.035	.448	.750	.052	.625	.033
3/4	.042	.493	.750	.058	.625	.042
3/4	.049	.548	.750	.065	.625	.049
3/4	.058	.593	.750	.075	.625	.058
3/4	.065	.632	.750	.053	.625	.058
3/4	.072	.697	.750	.086	.625	.072
3/4	.083	.864	.750	.095	.625	.083
3/4	.095	----	.750	.109	.625	.095
7/8	.035	.541	.875	.052	.750	.035
7/8	.042	.597	.875	.058	.750	.042
7/8	.049	.655	.875	.063	.750	.049
7/8	.058	.721	.875	.075	.750	.058
7/8	.065	.761	.875	.083	.750	.065
7/8	.072	.853	.875	.086	.750	.072
7/8	.083	.934	.875	.095	.750	.083
1	.042	.699	1.000	.058	.875	.042
1	.049	.781	1.000	.065	.875	.049
1	.058	.847	1.000	.075	.875	.058
1	.065	.908	1.000	.083	.875	.085
1	.072	1.006	1.000	.086	.875	.072
1	.083	1.106	1.000	.095	.875	.083

3.6.1 When specified (see 6.2.1), the inside diameter shall conform to the specified requirements.

3.7 Tolerances. Tube tolerances shall be as specified in 3.7.1, 3.7.2 and 3.7.3.

3.7.1 Root diameter. A tolerance of plus 0.007 inch and minus 0.003 inch on the root diameter shall be permitted.

3.7.2 Straightness. The straightness tolerances of table II shall apply to as-finned tube only.

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TABLE II. Permissible variations in straightness of tube.

Length (feet)	Maximum curvature (depth of arc) (inch)
Over 3 to 6 inclusive	3/16
Over 6 to 8 inclusive	5/16
Over 8 to 10 inclusive	1/2
Over 10	1/2 inch in any 10 foot portion of the total length

3.7.3 Outside diameter of plain sections. The tolerances for outside diameter of the plain sections as shown in ASTM B 359 shall be all negative; for example, a plus tolerance of 0.000 inches.

3.8 Finish. Annealed tubes shall be bright annealed or acid cleaned.

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

4.2 Sampling. Sampling shall be as specified in 4.2.2 and 4.2.3.

4.2.1 Lot. For sampling purposes, a lot shall consist of a maximum of 600 tubes or 5,000 pounds, whichever constitutes the greater weight.

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4.2.2 Visual and dimensional examination. From each lot, a representative sample of tubes shall be selected for visual and dimensional examination in accordance with MIL-STD-105, inspection level II. The acceptable quality level shall be 1.5 percent defective.

4.2.3 Mechanical, chemical and grain size tests. Samples shall be selected in accordance with table III for the chemical analysis, flattening, flaring and grain size tests as specified in ASTM B 359. If tubes can be shown to be from one heat, only one chemical analysis is required.

TABLE III. Sampling for mechanical, chemical and grain size tests.

Number of pieces in lot	Number of samples to be tested
1	1
2 - 64	2
65 - 160	3
161 - 400	4
401 - 2500	6

4.3 Examinations and tests. The condenser and heat exchanger tubes shall be subjected to the examination as specified in 4.3.1 and tests as specified in 4.3.2 through 4.4.

4.3.1 Visual and dimensional examination (except wall thickness at fins). Each sample tube selected in accordance with 4.2.2 shall be visually and dimensionally examined to verify conformance to this specification. Tubes selected for visual or dimensional examination containing one or more defects shall be cause for rejection. If the number of defective tubes in any sample exceeds the acceptance number for that sample, this shall be cause for rejection of the lot represented by the sample.

4.3.2 Pressure test. The pressure test for tubes shall be as specified in 4.3.2.1 and 4.3.2.2.

4.3.2.1 Class A tube. Class A tube shall be tested in the condition in which it is delivered and shall be subjected to the hydrostatic test as specified in ASTM B 359.

4.3.2.2 Class B tube. Class B tube shall be subjected to the air pressure test as specified in ASTM B 359.

4.3.3 Ultrasonic inspection. The ultrasonic inspection shall be made in accordance with applicable sections of MIL-STD-271, except as modified herein.

4.3.3.1 Shear wave test. Tube, as specified in 3.3, shall be ultrasonically inspected by the shear wave (angle-beam) technique. This test shall be conducted in two opposite circumferential directions and one longitudinal direction.

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4.3.3.1.1 Calibration. Tube required to be tested shall be tested at a frequency and wave angle that shall detect inside and outside surface discontinuities and subsurface defects. The calibration standard shall be made from defect free tube or pipe of the same type, wall thickness, and outside diameter as the tube to be tested. The standard shall contain two longitudinal notches and two transverse notches, one of each type on the inside surface (except for tube less than 1/2 inch outside diameter) and one of each type on the outside surface sufficiently separated that readily distinguishable, individual indications are obtained from each notch. The notches shall have depth equal to 5 percent of the wall thickness or 0.005 inch, whichever is greater. The notch length shall not exceed 1/2 inch for wall thicknesses 0.065 inch and less, and shall not exceed 1 inch for wall thicknesses greater than 0.065 inch. The notch which produces the smaller indication shall be adopted as the calibration standard. Ultrasonic instrument settings shall be made such that the indication from the calibration standard is at least 50 percent but less than 100 percent of full screen height when the indication is displaced at least 1/2 the full screen width from the indication of the front surface or of the initial ultrasonic pulse, whichever is closer to the calibration indications. These settings shall be made under identical conditions of scanning speed, couplant, and search unit alignment with respect to the tube, and using the same search unit as will be used in acceptance testing of the tubes.

4.3.3.1.2 Recalibration. During acceptance testing, any realignment of the search unit with respect to the tube, or any change in search unit, couplant, instrument settings, or scanning speed from that used for calibration shall require recalibration.

4.3.3.1.3 Testing (scanning). The tube, the search unit or both the tube and the search unit shall be moved uniformly during testing in such a manner that the search unit motion, relative to the tube, describes a helix concentric with the tube so that each pass of the scanning crystal overlaps the previous pass not less than 1/2 inch when testing to a 1/2 inch calibration notch and not less than 1/4 inch when testing to a 1 inch calibration notch.

4.3.3.1.4 Rejection. Any tube which produces an indication equal to or greater than 100 percent of the indication from the calibration standard shall not be offered for delivery.

4.4 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. Material shall be packaged level A or C, packed level A, B, or C, and marked in accordance with MIL-C-3993 (see 6.2.1).

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## 6. NOTES

6.1 Intended use. These tubes are intended for high flux density heat transfer tubes in condensers and other types of heat exchangers.

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, class and temper (see 1.2).
- (c) Whether ultrasonic inspection is required for class B tubing (see 3.3).
- (d) Number of fins per inch when other than specified (see 3.4).
- (e) Height of fin required when other than specified (see 3.5).
- (f) Size required (outside diameter and wall thickness) (see 3.6).
- (g) Whether inside diameter shall be supplied in a specific size and tolerance (see 3.6.1).
- (h) Length of tube and length of plain ends required (see ASTM B 359).
- (i) Quantity of tube required.
- (j) Level of packaging, packing and marking required (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 27.410-6 (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 are cited in the following paragraph.

<u>Paragraph no.</u>	<u>Data requirement title</u>	<u>Applicable DID no.</u>	<u>Option</u>
4.1.2	Certification data/report	UDI-A-23264	----

(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 Tube for class A critical application should be ordered in the annealed temper.

6.4 Subject term (key word) listing.

Annealed  
Copper alloy  
Copper nickel alloy  
Finned  
Heat exchanger tube  
Condenser tube

6.5 Changes from previous issue. Asterisks are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

Preparing activity:  
Navy - SH  
(Project 4710-N842)

## STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions - Reverse Side)

1. DOCUMENT NUMBER MIL-T-22214B(SH)		2. DOCUMENT TITLE TUBE, CONDENSER AND HEAT EXCHANGER WITH INTEGRAL FINS	
3a. NAME OF SUBMITTING ORGANIZATION		4. TYPE OF ORGANIZATION (Mark one)	
b. ADDRESS (Street, City, State, ZIP Code)		<input type="checkbox"/> VENDOR	
		<input type="checkbox"/> USER	
		<input type="checkbox"/> MANUFACTURER	
		<input type="checkbox"/> 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)	

DO NOT DETACH THIS FORM. USE AGAIN FOR THE NEXT PROPOSAL.