The Engineering Society For Advancing Mobility Land Sea Air and Space®
INTERNATIONAL
400 Commonwealth Drive. Warrendale, PA 15096-0001

AEROSPACE MATERIAL SPECIFICATION

SAE AMS 4553A

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Superseding AMS 4553

Submitted for recognition as an American National Standard

BRASS TUBING, SEAMLESS
85Cu - 15Zn

UNS C23000

1. SCOPE:

1.1 Form: This specification covers one grade of brass in the form of seamless tubing.

1.2 Application: Primarily for parts requiring resistance to corrosion by salt, water, salt air, or gases.

1.3 Classification: Tubing is classified by types as follows:

Type I - Nominal working pressure 100 psi (689 kPa)
Type II - Nominal working pressure 200 psi (1379 kPa)
Type III - Nominal working pressure 300 psi (2068 kPa)
Type IV - Nominal working pressure 450 psi (3103 kPa)

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order.

2.1 SAE Publications: Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

2.1.1 Aerospace Material Specifications:

AMS 2223 - Tolerances, Copper and Copper Alloy Seamless Tubing
MAM 2223 - Tolerances, Metric, Copper and Copper Alloy Seamless Tubing

2.2 ASTM Publications: Available from ASTM, 1916 Race Street, Philadelphia, PA 19103-1187.

ASTM B 153 - Expansion (Pin Test) of Copper and Copper Alloy Pipe and Tubing
ASTM B 154 - Mercurous Nitrate Test for Copper and Copper Alloys
ASTM B 251 - General Requirements for Wrought Seamless Copper and Copper-Alloy Tube
ASTM B 251M - General Requirements for Wrought Seamless Copper and Copper-Alloy Tube (Metric)
ASTM E 8 - Tension Testing of Metallic Materials
ASTM E 8M - Tension Testing of Metallic Materials (Metric)
ASTM E 18 - Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials
ASTM E 243 - Electromagnetic (Eddy-Current) Testing of Seamless Copper and Copper Alloy Tubes
ASTM E 478 - Chemical Analysis of Copper Alloys

2.3 U.S. Government Publications: Available from Standarization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

2.3.1 Military Specifications:

MIL-C-3993 - Copper and Copper-Base Alloy Mill Products, Packaging of

3. TECHNICAL REQUIREMENTS:

3.1 Composition: Shall conform to the following percentages by weight, determined by wet chemical methods in accordance with ASTM E 478, by spectrochemical methods, or by other analytical methods acceptable to purchaser:

	min	max
Copper	84.0	86.0
Lead	--	0.05
Iron	--	0.05
Zinc + Sum of Named Elements (3.1.1)	99.8	
Zinc (3.1.2)	remainder	

3.1.1 Applicable only when zinc is determined by direct analysis.

3.1.2 Applicable when zinc is not determined by direct analysis. The reported (certified) value is the difference between the sum of all other specified elements and 100%, and will therefore include unnamed elements. Limits for unnamed elements may be established by agreement between purchaser and manufacturer or supplier.

3.2 Condition: Fully recrystallized in the soft annealed (061) temper (See 8.1). Tubing shall be acid cleaned after final annealing, if required.

3.3 Fabrication: Tubing shall be produced by a seamless process.

3.4 Properties: Shall conform to the following requirements:

3.4.1 Tensile Properties: Shall be as follows, determined in accordance with ASTM E 8 or ASTM E 8M:

Tensile Strength, minimum	40,000 psi (276 MPa)
Yield Strength, 0.5% extension under load, minimum	12,000 psi (83 MPa)
Elongation in 8 inches (203.2 mm), minimum	30%

3.4.1.1 Tensile specimens shall be of the full section of tube and shall conform to the requirements of test specimens section of ASTM E 8 or ASTM E 8M, unless the limitations of the testing machine preclude the use of such a specimen.

3.4.2 Hardness: Should be not higher than the following, determined in accordance with ASTM E 18 but tubing shall not be rejected on the basis of hardness if the tensile property requirements of 3.4.1 are met:

Wall Thickness		
Inches	Millimeters	Hardness
Up to 0.045, excl.	Up to 1.14, excl.	36 HR30T
0.045 and over	1.14 and over	75 HRF

3.4.3 Embrittlement: Specimens of tubing, nominally 6 inches (152 mm) in length or twice the diameter, whichever is greater, shall withstand, without cracking, the mercurous nitrate test performed in accordance with ASTM B 154, Procedure A.

3.4.4 Flarability (Expansion Test): Tube specimens selected for test shall withstand 20% expansion of tube original outside diameter when tested in accordance with ASTM B 153.

3.4.5 Hydrostatic Pressure: Tubing shall withstand an internal hydrostatic pressure (P) based on the following equation, without developing leaks and without an increase in mean diameter of more than 0.2%. The tube need not be tested at a pressure of over 1000 psi (6.90 MPa).

$$P = \frac{2\,St}{D - 0.8t}$$

where: P = Internal pressure at minimum yield, psi (MPa)
S = Allowable yield stress (7000 psi [48.3] MPa)
t = Wall thickness, inches (mm)
D = Nominal OD, inches (mm)

3.5 Quality:

3.5.1 Visual Imperfections: Tubing, as received by purchaser, shall be uniform in quality and condition and shall have a finish conforming to the best practice for high quality aircraft tubing. It shall be smooth and free from heavy scale, oxide, burrs, seams, tears, grooves, laminations, slivers, pits, and other surface imperfections detrimental to usage of the tubing.

3.5.2 Surface Imperfections: Slight surface imperfections such as handling marks, straightening marks, light mandrel and die marks, shallow pits and scale patterns are acceptable provided the imperfections are removable within the tolerances specified for wall thickness.

3.5.3 Cleanliness: Tubing shall be free from grease or other foreign matter. Metallic flakes or particles shall not be collected by a clean white cloth when it is drawn through the length of the bore of a test sample. Discoloration of the cloth, without the presence of grit or flakes, is acceptable.

3.5.4 Non-Destructive Test: Tubing under 2.5 inches (64 mm) in OD tested in accordance with ASTM E 243 is not acceptable if a discontinuity indication exceeds the discontinuity indication of a single artificial defect as defined in ASTM E 243 and the appendix thereto.

3.6 Tolerances: Shall be as follows:

3.6.1 Diameter, Wall Thickness, and Length: In accordance with AMS 2223 or MAM 2223.

3.6.2 Weight: For any lot of tubing, the tolerance for overweight shall be is 10%, maximum. For calculating weight, the density shall be 0.316 pounds per cubic inch (8.75 kg/m^3).

3.7 Sizes and Weights: Shall be as shown in Tables I through IV.

TABLE I

SIZES AND WEIGHTS - TYPE I TUBING

Nominal OD Inches	Wall Thickness Inch, min	Nominal ID Inches	Nominal Weight pounds/foot
2.875	0.065	2.745	2.176
3.500	0.065	3.370	2.660
4.000	0.065	3.870	3.047
4.500	0.065	4.370	3.434
5.563	0.068	5.427	4.451
6.625	0.081	6.463	6.315
8.625	0.105	8.145	10.657
10.750	0.131	10.488	16.573

TABLE I (SI)

SIZES AND WEIGHTS - TYPE I TUBING

Nominal OD Millimeters	Wall Thickness mm, min	Nominal ID Millimeters	Nominal Weight kg/m
73.02	1.65	69.72	3.24
88.90	1.65	85.60	3.96
101.60	1.65	98.30	4.53
114.30	1.65	111.00	5.11
141.30	1.73	137.85	6.62
168.28	2.06	164.16	9.40
219.08	2.67	206.88	15.86
273.05	3.33	266.40	24.66

TABLE II

SIZES AND WEIGHTS - TYPE II TUBING

Nominal OD Inches	Wall Thickness Inch, min	Nominal ID Inches	Nominal Weight pounds/foot
1.900	0.065	1.770	1.421
2.375	0.065	2.245	1.789
2.875	0.068	2.739	2.274
3.500	0.083	3.334	3.378
4.000	0.095	3.810	4.420
4.500	0.107	4.286	5.600
5.563	0.132	5.299	8.540
6.625	0.158	6.309	12.172
8.625	0.205	8.215	20.563
10.750	0.256	10.238	32.004

TABLE II (SI)

SIZES AND WEIGHTS - TYPE II TUBING

Nominal OD Millimeters	Wall Thickness mm, min	Nominal ID Millimeters	Nominal Weight kg/m
48.26	1.65	44.96	2.11
60.32	1.65	57.02	2.66
73.02	1.73	69.57	3.38
88.90	2.11	84.68	5.03
101.60	2.41	96.77	6.58
114.30	2.72	108.86	8.33
141.30	3.35	134.59	12.71
168.28	4.01	160.25	18.11
219.08	5.21	208.66	30.60
273.05	6.50	260.04	47.63

TABLE III

SIZES AND WEIGHTS - TYPE III TUBING

Nominal OD Inches	Wall Thickness Inch, min	Nominal ID Inches	Nominal Weight pounds/foot
1.375	0.065	1.245	0.968
1.660	0.065	1.530	1.235
1.900	0.066	1.768	1.442
2.375	0.083	2.209	2.266
2.875	0.100	2.675	3.306
3.500	0.122	3.256	4.910
4.000	0.140	3.720	6.436
4.500	0.157	4.186	8.123
5.563	0.194	5.175	12.408
6.625	0.231	6.163	17.596
8.625	0.301	8.023	29.848
10.750	0.375	10.000	46.349

TABLE III (SI)

SIZES AND WEIGHTS - TYPE III TUBING

Nominal OD Millimeters	Wall Thickness mm, min	Nominal ID Millimeters	Nominal Weight kg/m
34.92	1.65	31.62	1.44
42.16	1.65	38.86	1.84
48.26	1.68	44.91	2.15
60.32	2.11	56.11	3.37
73.02	2.54	67.94	4.92
88.90	3.10	82.70	7.31
101.60	3.56	94.49	9.58
114.30	3.99	106.32	12.09
141.30	4.93	131.44	18.47
168.28	5.87	156.54	26.19
219.08	7.64	203.78	44.42
273.05	9.52	254.00	68.97

TABLE IV

SIZES AND WEIGHTS - TYPE IV TUBING

Nominal OD Inches	Wall Thickness Inch, min	Nominal ID Inches	Nominal Weight pounds/foot
0.405	0.062	0.281	0.253
0.540	0.065	0.410	0.368
0.675	0.065	0.545	0.472
0.840	0.065	0.710	0.600
1.050	0.065	0.920	0.763
1.315	0.066	1.183	0.982
1.660	0.084	1.492	1.377
1.900	0.096	1.709	2.053
2.375	0.120	2.135	3.224
2.875	0.145	2.585	4.716
3.500	0.177	3.146	7.006
4.000	0.202	3.596	9.139
4.500	0.228	4.044	11.603
5.563	0.281	5.001	17.681
6.625	0.335	5.955	25.102
8.625	0.436	7.753	42.534
10.750	0.544	9.662	66.142

TABLE IV (SI)

SIZES AND WEIGHTS - TYPE IV TUBING

Nominal OD Millimeters	Wall Thickness mm, min	Nominal ID Millimeters	Nominal Weight kg/m
10.29	1.57	7.14	0.38
13.72	1.65	10.41	0.55
17.14	1.65	13.84	0.70
21.34	1.65	18.03	0.89
26.67	1.65	23.37	1.14
33.40	1.68	30.05	1.46
42.16	2.13	37.90	2.35
48.26	2.44	43.41	3.06
60.32	3.65	54.23	4.80
73.02	3.68	65.66	7.02
88.90	4.50	79.91	10.43
101.60	5.13	91.34	13.60
114.30	5.79	102.72	17.27
141.30	7.14	127.02	26.31
168.28	8.51	151.26	37.36
219.08	11.07	196.93	63.30
273.05	13.82	245.41	98.43

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection: The vendor of tubing shall supply all samples for vendor's tests and shall be responsible for performing all required tests. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the tubing conforms to the requirements of this specification.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Tests for the following requirements are acceptance tests and shall be performed on each lot:

Requirement	Paragraph Reference
Composition	3.1
Tensile Properties	3.4.1
Flareability (Expansion Test)	3.4.4
Quality	3.5
Tolerances	3.6
Sizes and Weights	3.7

4.2.2 Periodic Tests: Tests for hardness (3.4.2), embrittlement (3.4.3), and hydrostatic pressure (3.4.5) are periodic tests and shall be performed at a frequency selected by the vendor unless frequency of testing is specified by purchaser.

4.3 Sampling and Testing: Shall be in accordance with ASTM B 251 or ASTM B 251M and as follows:

4.3.1 A lot shall consist of 1000 tubes or 10,000 pounds (4536 kg), whichever constitutes the greater mass of tubes of the same size, type, and temper.

4.3.2 Sample size shall be in accordance with Table V except only one test per heat is required for composition.

TABLE V

Lot Size No. of Tubes	Sample Size No. of Tubes	Rejection
1 to 50, incl	1	0
51 to 200, incl	2	0
201 to 1500, incl	3	0
Over 1500	0.2% of the lot, but not exceeding 10 pieces	0