

QQ-B-691b

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SUPERSEDING
Fed. Spec. QQ-B-691a
March 19, 1937

FEDERAL STANDARD STOCK CATALOG

Section IV

(Part 5)

FEDERAL SPECIFICATION

FOR

BRONZE; CASTINGS

This specification was approved on the above date by the Director of Procurement for the use of all departments and establishments of the Government, and shall become effective not later than July 15, 1944. It may be put into effect, however, at any earlier date after promulgation.

A. APPLICABLE SPECIFICATION.

A-1. The following Federal Specification, of the issue in effect on date of invitation for bids, shall form a part of this specification:

QQ-M-151, Metals; General Specifications for Inspection of.

B. COMPOSITION AND GRADES.

B-1. This specification covers machined solid and cored cast bronze bars for bearings and other miscellaneous bronze castings in the several compositions shown in table I. (See par. I-1 and I-2.)

B-2. *Grade.*—Bronze castings shall be of one grade only for each composition, except composition 6 which may be specified in one of two grades designated as 6 and 6X.

C. MATERIAL AND WORKMANSHIP.

C-1. *Material.*—The raw materials used shall be such as to produce castings meeting the requirements of this specification.

C-2. Workmanship.

C-2a. The castings shall be of uniform quality and condition, free from injurious blow holes, porosity, hard spots, shrinkage defects, cracks, and other harmful defects, and shall be smooth and well cleaned before inspection by sand blasting, tumbling, chipping, or other process approved by the inspector.

C-2b. Castings shall not be welded or otherwise repaired without permission from the inspector. Such permission will be given for miscellaneous castings only when the defects are small and do not adversely affect the strength, use, or machinability of the castings. Ordinarily, permission to weld or repair solid or cored bronze castings for machined bearings will not be given. Each repair shall be en-

circled with a ring of white paint prior to submission for inspection or shipment.

D. GENERAL REQUIREMENTS.

D-1. Dimensions.—

D-1a. The responsibility for furnishing castings that can be laid out and machined to the finished dimensions within the specified tolerances and that will conform to such gages as may be specified in individual cases shall rest with the contractor. Sufficient stock shall be allowed for shrinkage and, where required, for finishing, but castings of excessive size or weight shall not be furnished. (See par. E-5.)

D-1b. Cast-to-size parts shall conform to dimensions and tolerances specified by the purchaser and shall not be warped or distorted in such a manner as to affect adversely their appearance or serviceability.

E. DETAIL REQUIREMENTS.

E-1. Chemical requirements.—

E-1a. Bronze castings shall meet the chemical requirements shown in table I:

TABLE I.—Chemical requirements

Com- posi- tion No.	Copper (percent)	Tin (percent)	Lead (percent)	Zinc (percent)	Nickel (percent)	Iron, maxi- mum (per- cent)	Phos- phorus, maxi- mum (percent)	Anti- mony, maxi- mum (per- cent)
1.....	86.0-90.0	3.5-6.5	1.0-2.0	3.0-3.0	0-1.0	0.25	0.05	.....
2.....	84.0-86.0	4.0-6.0	4-6.0	4.0-6.0	0-1.0	.30	.05	.....
3.....	78.0-82.0	4.0-6.0	2.0-3.0	10.0-16.0	0-0.75	.35	.05	.....
4.....	78.0-82.0	0-3.5	(¹)	(²)	0-1.0	.40	.....	.....
5 ³	86.0-89.0	7.5-9.0	0-0.30	3.0-5.0	0-1.0	.15	.05	.....
6 ⁴	85.0-89.0	7.5-9.0	0-1.0	2.0-5.0	0-1.0	.25	.05	.....
6X.....	85.0-89.0	7.5-9.0	0-1.0	2.0-5.0	0-1.0	.25	.05	.....
7.....	73.0-80.0	5.0-7.0	15.0-20.0	0-1.25	0-1.0	.25	.05	0.75
8.....	82.0-85.0	7.0-9.0	7.0-9.0	0-0.75	0-1.0	.15	.50	.....
9.....	84.0-86.0	13.0-15.0	0-0.20	0-1.50	0-0.75	.10	.05	.....
10.....	80.0-82.0	18.0-20.0	0-0.50	0-0.25	0-0.75	.10	0.40- .60	.....
11.....	78.0-82.0	2.25-3.5	6.0-8.0	7.0-10.0	0-1.0	.40	.05	.....
12.....	81.0-85.0	6.25-7.50	6.0-8.0	2.0-4.0	0-0.50	.30	.15	.35

¹ In determining compliance with the minimum copper requirement for composition 2 castings, copper may be computed as copper plus nickel.

² Zinc and lead content of composition 4 castings at the option of the producer, providing the remaining chemical and physical requirements are met.

³ See Sect. I for details of application.

⁴ Minimum and maximum.

⁵ Phosphorus maximum of 0.50 permitted in composition 12 permanent mold castings.

E-1b. An analysis of each lot of castings shall be furnished by the contractor showing the percentages of the elements designated in table I.

E-2. Physical requirements.—

E-2a. Castings shall meet the physical requirements shown in table II.

FEDERAL STANDARD STOCK CATALOG
(Section IV, part 5)

QQ-B-691b-3
(May 1944)

E-2b. The physical properties of composition 3 castings need not be determined unless specified in the inquiry or invitation for bids and in the contract or purchase order.

E-2c. The physical properties of composition 6X castings will be determined only when required by the inspector.

TABLE II.—Physical requirements

Composition number	Tensile strength, pounds per square inch (minimum)	Elongation in 2 inches, percent (minimum)	Brinell hardness number (minimum)
1.....	34,000	22	
2.....	30,000	20	
3 ¹	28,000	15	
4.....	25,000	12	
5 ²	40,000	20	
6 ³	36,000	18	
6X ⁴	30,000	12	
7.....			
8.....	25,000	9	
9.....	30,000	1	
10.....	45,000		160
11.....	29,000	19	
12.....	30,000	12	

¹ See par. E-2b.

² See section I for details of application.

³ See par. E-2c.

⁴ Not required, but may be obtained in sound castings.

E-3. Pressure.—Castings of compositions 1, 2, 3, 5, 6, and 11 shall meet such pressure requirements as may be specified in the inquiry or invitation for bids and in the contract or purchase order. (See par. I-19.)

E-4. Metallographic requirements.—Solid and cored bronze castings for machined bearings shall meet such metallographic requirements as may be specified in the inquiry or invitation for bids and in the contract or purchase order. When metallographic requirements are specified, a specimen or specimens, or photomicrographs thereof, furnished or approved by the purchaser shall be the standard for acceptance of the castings. The number, size, and extent of blowholes, inclusions, segregations and other defects in specimens taken from the castings shall not be greater than shown by the standard.

E-5. Dimensions and tolerances of machined solid and cored cast bronze bars for bearings.—The inside and outside dimensions of machined cored bars and the outside of machined solid bars shall not vary from the specified dimensions by more than the amount shown in table III. The inside and outside surfaces of cored bars and the outside surface of solid bars shall be machined to remove surface scale and defects. The outside periphery of cored bars shall be concentric with the bore. Unless otherwise specified, cored and solid bars shall be furnished in 13-inch lengths, and the ends shall be either disk ground or machined. (See par. I-5.)

QQ-B-491b-4
(May 1944)

FEDERAL STANDARD STOCK CATALOG
(Section IV, part 5)

TABLE III.—Tolerances on diameters of machined cored and solid bars

Dimension	Permissible variation (inches)	
	Plus	Minus
Inside diameter:		
Up to 4 inches	0	$\frac{3}{32}$
4 inches and over	0	$\frac{1}{16}$
Outside diameter:		
Up to 4 inches	$\frac{3}{32}$	0
4 inches and over	$\frac{1}{16}$	0

F. METHODS OF SAMPLING, INSPECTION, AND TESTS.

F-1. Lot.—

F-1a. Unless otherwise specified and except where modified by the applicable provisions of paragraphs F-1b and F-1c, a lot shall consist of castings from the same melt.

F-1b. When castings are produced from alloyed ingot of known composition, a lot may consist of not more than 4,000 pounds of castings of the same composition from such a group of melts as designated by the inspector.

F-1c. When metallographic examination is required, a lot shall be further limited to castings of the same size and shape.

F-2. A sample for Government analysis shall be taken from tension test specimens or from a representative casting selected by the inspector from each lot. The drillings shall be taken from sound metal below the surface. The inspector shall forward for analysis not less than 3 ounces of drillings.

F-3. Tension tests.—

F-3a. Test coupons and bars.—

F-3a (1). Unless otherwise specified or permitted by the inspector, coupons from which tension test specimens can be machined shall be cast on the body of the castings they represent. Test coupons shall not be removed from castings except in the presence of the inspector or until he has marked them for future identification.

F-3a (2). When authorized, test bars shall be cast separately in sand or gated to the castings or runners. Separately cast test bars shall be poured and drawn from the sand in the presence of the inspector who will stamp the bars for future identification.

F-3a (3). The chilling of test coupons or bars shall be cause for rejection of the material represented except when the castings represented by the test bars are themselves authorized to be chill cast.

F-3b. Number of tests.—

F-3b (1). *Large castings.*—At least one tension test shall be made for each casting weighing 250 pounds or more.

F-3b (2). *Small castings.*—In the case of castings weighing less than 250 pounds, at least two tension tests shall be made for each 2,000 pounds or fraction thereof in the lot which they represent. If the lot consists of only one melt, the specimens for the tests shall be

FEDERAL STANDARD STOCK CATALOG
(Section IV, part 5)

QQ-B-491b-5
(May 1944)

so taken as to represent the first and the last metal poured of the melt. If, however, the lot has been designated as two or more melts, the specimens for the tests shall be poured from different melts.

F-3c. Test specimens.—

F-3c (1). Unless otherwise specified in the contract or purchase order, machined test specimens shall be used. In this case the test coupon or separately cast bar shall conform to the form and dimensions of either figure 10 or 10A Federal Specification QQ-M-151, and the specimen machined therefrom shall conform to the form and dimensions of type I, Federal Specification QQ-M-151.

F-3c (2). When specified in the contract or purchase order, test bars shall be cast in green sand in exact accordance with the method and to the dimensions shown in figure 11B, Federal Specification QQ-M-151. These bars shall not be machined prior to testing except to adapt the grips to the holders of the testing machine in such manner as to insure an axial load.

F-3c (3). The responsibility for furnishing sufficient test specimens shall rest with the contractor. When the contractor so desires and the size of the castings are such that suitable test specimens can be machined therefrom, extra castings may be made from the same melt to provide for test specimens in lieu of attached coupons or test bars without cost to the purchaser.

F-4. Brinell hardness tests of composition 10 castings shall be made in accordance with Federal Specification QQ-M-151 on a properly prepared surface $\frac{1}{16}$ inch below the cast surface.

F-5. Metallographic examination. — Metallographic specimens, when required, shall be not less than $\frac{1}{2}$ -inch thick and shall be cut from a representative casting and not from a test bar. At least one specimen shall be taken from the first and the last castings poured in the lot. Specimens shall be the full width or diameter of the casting except for castings which exceed $\frac{1}{2}$ -inch in diameter or wall thickness, in which case specimens shall be not less than $\frac{1}{2}$ -inch wide. The prepared surface shall lie in a plane parallel to and approximately coinciding with the longitudinal axis of the casting. The specimens shall be suitably polished and etched for microscopic examination. A solution of nitric acid or a mixture of ammonia and hydrogen peroxide has been found suitable as an etching reagent.

G. PACKING AND MARKING FOR SHIPMENT.

G-1. Packing.—

G-1a. All castings shall be separated by composition and pattern when packed for shipment.

G-1b. Large castings.—Castings weighing 250 pounds or more having projections that may be damaged in handling shall be crated.

G-1c. Small castings.—Castings weighing less than 250 pounds each shall be packed rigidly in boxes or crates or shall be banded.

G-1d. Finished or polished castings shall be so packed as to afford adequate protection to the surface.

G-1e. The crating, boxing, or banding shall be such as to insure acceptance by common or other carriers for safe transportation, at the lowest rate, to the point of delivery.

QQ-B-691b-6
(May 1944)

FEDERAL STANDARD STOCK CATALOG

(Section IV, part 5)

G-1f. When so specified in the contract or purchase order, the gross weight of individual crates, boxes or bundles shall not exceed 250 pounds.

G-2. Marking.—

G-2a. Large castings.—Unless otherwise specified, castings weighing 250 pounds or more shall be marked with the pattern or piece mark number and, when practicable, with the melt or lot number in a position on the casting where they will not be machined off in machining to finished dimensions.

G-2b. Small castings.—Unless otherwise specified, small castings shall be so marked that their identity will be clear at the point of delivery.

G-2c. Shipments shall be marked with the name of the material, class, and quantity contained therein, as defined by the contract or purchase order under which shipment is made, the name of the contractor, the number of the contract or purchase order and the gross weight.

H. REQUIREMENTS APPLICABLE TO INDIVIDUAL DEPARTMENTS.

H-1. Navy Department purchases.—For administrative reasons, Navy Department purchases, except for the Bureau of Aeronautics, will be under the issues in effect at date of invitation for bids of the following Navy Department specifications:

Specification No.	Title	Composition
46B5.....	Bronze, Phosphor; Castings.....	6, 6X
46B8.....	Bronze, Valve (Composition M); Castings.....	1
46B21.....	Bronze, for Screw Pipe Fittings (Composition S-c); Castings.....	3
46B22.....	Bronze, Bearing; Castings.....	7, 8, 9, 10
46B23.....	Bronze, Hydraulic (Ounce Metal); Castings (Os-c).....	2
46B24.....	Bronze; Castings, Ornamental.....	4
46B16.....	Metal, Gun; Castings (Composition G).....	5

I. NOTES.

I-1. This specification covers the technical requirements for castings and is not intended for the purchase of ingot. Federal Specification QQ-B-701 covers the technical requirements for corresponding classes of bronze ingot.

I-2. In the previous revision of this specification, bronze castings were designated by types; type I covering miscellaneous bronze castings and type II, solid and cored bronze castings for machined bearings.

I-3. The material covered by this specification is not intended for use in the manufacture of mail locks for the Post Office Department, and this specification is not mandatory when purchasing castings therefor.

I-4. Attention is invited to the fact that some of the alloys covered by this specification may not be considered "bronzes" in accordance with the definitions commonly accepted. These alloys have been included herein because they have some characteristics of "bronzes" and are intended for similar uses. The term "bronze" is used in referring

to all the alloys covered by this specification for convenience and, in case of some alloys, for lack of more distinctive names.

I-5. In ordering machined solid and cored cast bronze bars for bearings, all diameters shall be in even $\frac{1}{8}$ -inch steps. The following minimum wall thicknesses are recommended:

Inside diameter, inches:	Recommended minimum wall thickness, inch
Up to 1 $\frac{1}{2}$	$\frac{1}{4}$
1 $\frac{1}{2}$ to 4.....	$\frac{3}{16}$
Over 4.....	$\frac{1}{8}$

I-6. *Composition 1* is a high-grade steam or valve bronze.

I-7. *Composition 2* is a standard bronze for general service, also known as ounce metal, red brass, and hydraulic bronze.

I-8. *Composition 3* is a medium-grade bronze which may be used for standard and extra heavy water, air, or gas fittings. Ordinarily it may be purchased without physical test.

I-9. *Composition 4* is a cheap bronze which may be used for ornamental or electrical fittings, instruction and marker plates, hand wheels, brackets, and, in general, where the characteristics of a bronze are essential, but superior physical properties are relatively unimportant.

I-10. *Composition 5* is an excellent steam metal and structural bronze which may be used for expansion joints, special pipe fittings, gears, bolts and nuts, valves, pump pistons and casings, bushings, bearings, and similar applications where strength requirements combined with the necessity for castings properties and corrosion resistance of tin bronze and weight limitations make this high-tensile bronze necessary.

I-11. *Composition 6* is a leaded phosphor bronze or leaded gun metal which serves in the same way as composition 5 as a steam metal and general structural bronze. It machines more easily than composition 5 bronze and may in general be used for expansion joints, special pipe fittings, gears, valves, pump pistons and casings, bushings, bearing, and similar applications requiring good strength and resistance to seawater corrosion.

I-12. *Composition 6I* is a leaded phosphor bronze or leaded gun metal which may be made from scrap of like composition, and is intended for use where the stresses are low or where structural strength is not required.

I-13. *Composition 7* is a good bearing bronze for machinery carrying heavy loads and running at very low speeds.

I-14. *Composition 8* is a good bearing bronze for general service.

I-15. *Composition 9* is a hard bearing bronze, also known as hard gear bronze.

I-16. *Composition 10* is an extra-hard bearing bronze intended only for special application.

I-17. *Composition 11* is a bronze intended for general service similar to composition 2. Since the tin content is lower than that of some of the other compositions, consideration should be given to its use wherever practicable.

QQ-B-491b-3
(May 1944)

FEDERAL STANDARD STOCK CATALOG

(Section IV, part 5)

I-18. Composition 12 is intended for general bearing service similar to composition 8. Its properties are comparable to those of composition 8 except in resistance to pounding, in which it is inferior. Composition 12 is more readily produced from secondary materials, and its use is to be preferred for this reason.

I-19. Of the alloys used for pressure castings, the order of decreasing ability to withstand pressure and temperature generally is as follows: Classes 5, 8, 1, 2, 11, and 3.

I-20. For the information of designers, the yield strength of those alloys in this specification sometimes used as structural materials are as shown in the following table:

Composition number:	Yield strength, pounds per square inch, minimum
1.....	16,000
2.....	14,000
5.....	18,000
8.....	16,000
11.....	13,000

I-21. It is believed that this specification adequately describes the characteristics necessary to secure the desired material and that normally no samples will be necessary prior to award to determine compliance with this specification. If, for any particular purpose, samples with bids are necessary, they should be specifically asked for in the invitation for bids, and the particular purpose to be served by the bid sample should be definitely stated, the specification to apply in all other respects.

I-22. Federal specifications do not include all types, classes, grades, etc., of the commodities indicated by the titles of the specifications, or which are commercially available but are intended to cover the types, etc., which are suitable for Federal Government requirements.

I-23. An Index of Federal Specifications, and also a Quarterly Supplement-Index of Emergency Alternate Federal Specifications, may be purchased as noted in paragraph below, price to be obtained from the Superintendent of Documents.

I-24. Copies of this specification and of QQ-M-151 may be obtained upon application, accompanied by money order, coupon, or cash, to the Superintendent of Documents, Government Printing Office, Washington, D. C. Price 5 cents each.

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