MIL-HDBK-698A
1 JUNE 1971

MILITARY STANDARDIZATION HANDBOOK

COPPER AND COPPER ALLOYS

9500

DEPARTMENT OF DEFENSE
WASHINGTON, D. C.

MIL-HDBK-698A
Copper and Copper Alloys
1 June 1971

1. This standardization handbook was developed by the Department of Defense in accordance with established procedure.

2. This publication was approved on 1 June 1971 for printing and inclusion in the military standardization handbook series.

3. This handbook provides basic and fundamental information on copper and copper alloys for the guidance of engineers and designers of military materiel. The handbook is not intended to be referenced in purchase specifications except for informational purposes, nor shall it supersede any specification requirements.

4. Every effort has been made to reflect the latest information on copper and copper alloys. It is the intent to review this handbook periodically to insure its completeness and currency. Users of this document are encouraged to report any errors discovered and any recommendations for changes or inclusions to The Director, Army Materials and Mechanics Research Center, Watertown, Mass., 02172. Attn: AMXMR-MS.

PREFACE

This is one of a group of handbooks covering the metallic and nonmetallic materials used in the design and construction of military equipment, which are designated as MIL-HDBK-XXX.

The purpose of these handbooks is to provide, in condensed form, technical information and data of direct usefulness to design engineers. The data, especially selected from a very large number of industrial and government publications, have been checked for suitability for use in design. Wherever practicable, the various types, classes, and grades of materials are identified with applicable government specifications authorized for use in connection with drawings; the corresponding technical society specifications and commercial designations are shown for information.

The numerical values for properties listed in the handbook, which duplicate specification requirements, are in agreement with the values in issues of the specifications in effect during the preparation of this handbook. Because of revisions or amendments to specifications taking place after publication, the handbook values may, in some instances, differ from those shown in current specifications. In connection with procurement, it should be understood that the governing requirements are those of the specifications of the issue listed in the contract.

Current issues of specifications should be determined by consulting the latest issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplements thereto.

Appreciation is expressed to the American Society for Metals (ASM), the American Society for Testing and Materials (ASTM), and the Copper Development Association (CDA) for approval to use some of their data in the preparation of this handbook.

This revision of the handbook was prepared by the Army Materials and Mechanics Research Center.

CONTENTS

TABLES

COPPER AND COPPER ALLOYS

COPPER IN ENGINEERING DESIGN

1. GENERAL CHARACTERISTICS. Copper and copper alloys are widely used in engineering applications because of their high electrical and thermal conductivity, good workability, ease of joining, good corrosion resistant characteristics, and useful range of mechanical properties. A wide range of mechanical properties may be achieved by the proper use of alloying, thermal treatment, or cold working techniques. In addition, copper and its alloys are readily finished by plating or lacquering, and can be joined satisfactorily by conventional methods.

2. AVAILABLE CAST AND WROUGHT FORMS. Cast shapes are available, the method of casting depending upon the requirements and the economics of production. Sand castings are cheapest, but tolerances are poor. Permanent and semi-permanent mold castings have closer dimensional tolerances as do die castings. For precision castings, investment mold or lost-wax methods may be necessary. Wrought forms are available, and include plate, sheet, strip, wire, bar, tube, and extruded or rolled shapes.

3. AVAILABLE PROPERTY RANGES. Typical mechanical properties for copper and copper alloys are given in appropriate tables of this handbook. The values given therein represent reasonable approximations suitable for general engineering use. Due to commercial variations in composition, and to manufacturing limitations, these values should not be used for specification purposes. Ranges of room-temperature mechanical properties of copper alloys as specified for government use are also given and are expressed as minimum levels required. It should be noted that the specified range of mechanical properties of wrought alloys is very wide depending on composition, mechanical and thermal treatment, and cross-section size. Table I gives the mechanical property ranges of copper alloys indicated in government specifications.

4. REACTION TO TEMPERATURE CHANGES. In general, the tensile strength, yield strength, and hardness of copper alloys decrease with increasing temperature, while elongation behaves erratically; further, the properties of most alloys are substantially impaired at 500°F (260°C). However, when subjected to subzero temperatures, the tensile strength

TABLE I. MECHANICAL PROPERTY RANGES OF COPPER ALLOYS

Property	Cast	Wrought
Tensile Strength Min, ksi	21 to 155	30 to 230
Yield Strength, Min, ksi	8 to 130	11 to 165
Elongation, Percent	1 to 25	1 to 60

increases, yield strength and impact resistance tend to increase erractically, and elongation is altered slightly.

CLASSES OF COPPER AND COPPER ALLOYS

5. TYPES AVAILABLE. The metal is available in various compositions including commercially-pure copper (99.88 percent minimum), alloys for casting, and alloys for the manufacture of wrought products. Commercially-pure copper is non heat-treatable except for annealing after cold working. Some copper alloys, on the other hand, can achieve a range of mechanical properties not only by cold working, but also by solution treatment and aging.

6. COMMERCIALLY-PURE COPPER. Commercially-pure copper is metal for which the specified minimum copper content is not less than 99.88 percent, silver being counted as copper. The Government uses several types of commercially-pure wrought coppers with their copper contents varying from 99.88 to 99.96 percent. The pure metal is used in military design where high electrical or thermal conductivity, good resistance to corrosion, and ease of fabrication are important.

7. ALLOYS. Most copper alloys are composed of copper to which has been added zinc, tin, and lead. However, other alloying elements may include aluminum, beryllium, iron, manganese, nickel, phosphorus and silicon. Few of these alloys are heat treatable. Among the exceptions however, are the aluminum bronzes, copper-beryllium, copper-nickel-tin, and copper-nickel-phosphorus alloys. Casting alloys generally

contain two added elements, and many contain three. Total alloying additions may amount to about 42 percent, and the copper content may be from approximately 58 to 92 percent. Casting alloys with higher percentages of copper are used in most military designs. The majority of copper alloy castings is made by sand founding. Other methods of casting include the permanent-mold, die, centrifugal, continuous, plaster, and investment processes. All castings, with the exception of the aluminum bronzes, copper-nickel-phosphorus, and the copper-beryllium alloys, are supplied generally in the "as-cast" form. Wrought alloys are composed of from about 55 to 98 percent copper and alloying additives that individually may vary from minute traces to 40 percent. Wrought alloys are supplied principally as plate, sheet, strip, shapes, tubing, bars, rods, wire, and forgings.

Historically, copper alloys have been classified into two major categories: brasses and bronzes. Brass was defined as any copper alloy with zinc as the principal alloying element, with or without small quantities of some other elements. Bronze was originally a term for copper alloys having tin as the only or principal alloying element. Today, the term "bronze" is seldom used alone, and the terms "Phosphor Bronze" or "Tin Bronze" are used for indicating copper-tin alloys. In fact, the term "Bronze", together with a suitable modifying adjective, has in recent years been extended to apply to any of a great variety of copper alloys. Thus, chemical composition was the original criterion for classifying an alloy as a brass or bronze. However, this criterion has been ignored and many brasses are still erroneously called "bronzes", because their appearance or other properties are similar to bronzes. Also, trade names are likely to be confusing with respect to alloying elements used. For example: a copper-zinc alloy is called a bronze if it has a color resembling that of the true bronzes or copper-tin alloys; a copper-zinc-nickel alloy is called a nickel-silver because its color is silvery-white; while commercial bronze, manganese bronze, and architectural bronze are in reality brasses. Thus, it can be seen that trade names are often more descriptive of color than of composition.

8. STANDARD DESIGNATIONS FOR COPPERS AND COPPER ALLOYS. The most widely accepted alloy designation system in North America for wrought and cast copper and copper alloy products is the system administered by the Copper Development Association (CDA). Developed by the copper and brass industry in the United States, the system is now used by the U.S. Government, by the American Society for Testing and Materials (ASTM), by the Society of Automotive Engineers (SAE) and by nearly all producers of copper and copper alloy wrought and cast products in North America.

The designation system is not a specification but is rather an orderly method of defining and identifying coppers and copper alloys. It eliminates the limitations and conflicts of alloy designations previously used and at the same time provides a workable method for the identification marking of mill and foundry products.

In the CDA designation system, numbers from 100 through 799 describe wrought alloys. Cast alloys are numbered from 800 through 999. Within these two categories, the system groups the compositions into the following families of coppers and copper alloys:

COPPERS — Metal which has a designated minimum copper content of 99.3%.

HIGH COPPER ALLOYS — For the wrought products, these are alloys with a designated copper content less than 99.3% but more than 96%, and which do not fall into the other copper alloy groups. The cast alloys have a designated copper content in excess of 94%, to which silver may be added for special properties.

BRASSES — These alloys contain zinc as the principal alloying element with or without other designated alloying elements such as iron, aluminum, nickel and silicon. The wrought alloys contain three main families of brasses: copper-zinc alloys; copper-zinc-lead alloys (leaded brasses); and copper-zinc-tin alloys (tin brasses).

The cast alloys contain five main families of brasses; copper-tin-zinc alloys (red, semi-red and yellow brasses); copper-tin-zinc-lead alloys (leaded red, semi-red and yellow brasses); "manganese bronze" alloys (high strength yellow brasses); leaded "manganese bronze" alloys (leaded high strength yellow brasses); and copper-zinc-silicon alloys (silicon brasses and bronzes).

BRONZES — Broadly speaking, bronzes are copper alloys in which the major alloying element is one other than zinc or nickel. Originally "bronze" described alloys with tin as the only or principal alloying element. Today, the term bronze is seldom used by itself in a technical sense. Rather it is used with a modifying adjective. For wrought alloys, there are four main families of bronzes: copper-tin-phosphorus alloys (phosphor bronzes); copper-tin-lead-phosphorus alloys (leaded phosphor bronzes); copper-aluminum alloys (aluminum bronzes); and copper-silicon alloys (silicon bronzes).

The cast alloys have four main families of bronzes: copper-tin alloys (tin bronzes); copper-tin-lead alloys (leaded and high leaded tin bronzes); copper-tin-nickel alloys (nickel-tin bronzes); and copper-aluminum alloys (aluminum bronzes). The family of alloys known as "manganese bronzes" are not included here but in the brasses, above.

COPPER-NICKELS – Alloys with nickel as the principal alloying element, with or without other designated alloying elements present.

COPPER-NICKEL-ZINC ALLOYS – Commonly known as "nickel silvers", these are alloys which contain zinc and nickel as the principal and secondary alloying elements, with or without other designated elements present.

LEADED COPPERS – A series of cast alloys of copper with 20% or more lead, and usually a small amount of silver present, but without tin or zinc.

SPECIAL ALLOYS – Alloys whose chemical composition does not fall into any of the aforementioned categories.

9. SPECIFICATIONS AND DATA. Table II is a comprehensive listing of government standardization documents pertaining to copper. Revision symbols are given to alert the reader to the latest issue of the document available as of the date of publication of this handbook. Included in the list of documents are military and federal specifications, standards, and qualified products lists (QPLs). Tables III through X deal with cast coppers and copper alloys while Tables XI through XXI deal with the wrought material.

Table III lists the alloy numbers according to Federal Specification QQ-C-390 and cross-references the appropriate MIL specification, ASTM, SAE, AMS and CDA document number. Other information given include previous designations, casting forms available and typical applications for cast material.

Table IV gives the chemical composition of cast alloys by ASTM document number. Tables V and VI list cast alloys by CDA number and give the mechanical and physical properties. Table VII gives the chemical composition and mechanical properties of cast material according to QQ-C-390.

FORMABILITY

10. TYPES OF WORKING. Generally, two types of working are of interest: hot working and cold working. Hot working is defined as deforming a metal above its recrystallization temperature; that is, within its transformation range. Recrystallization takes place, but strain hardening does not since the crystals are in a plastic state. The converse of this is true during cold working; that is, deforming a metal plastically below its transformation temperature range (usually at room temperature) such that strain hardening occurs.

11. FACTORS AFFECTING FORMABILITY. Ductility, which is that property of a metal permitting permanent deformation before fracture by stress in tension, is the most important factor affecting formability. Copper is a ductile metal.

During hot working, copper can be reduced in cross-section to a considerable extent without intermediate annealing. Here, the degree of ductility is affected by factors such as inclusions, which may be nonmetallic oxides, dirt or carbon, or metallic inclusions of lead or bismuth. These two metals are insoluble in copper, and are a cause of hot shortness in the metal; that is, the metal would lack sufficient ductility and malleability so as to permit hot working.

In cold working, ductility depends to a large degree on composition; therefore, alloys having two microconstituents such as alpha-beta brass (that is, face-centered and body-centered cubic crystal structures) are less readily cold worked than the single phase alloys. Another important factor in cold working is the rate of strain hardening, but this may be circumvented by intermediate annealing; however, if the metal does not yield plastically before breaking, then cold reduction cannot occur.

12. HOT WORKING OPERATIONS. Commonly used hot working operations are given below:

ROLLING - Hot rolling is a mechanical method of working the metal by passing it between two rolls, while it is within the recrystallization temperature range. The most common shapes that are hot rolled are round, wedge, square and rectangular. Rods are rolled for subsequent drawing to wire. Flat products are rolled as heavy plates for subsequent finishing to thinner gages by cold rolling.

EXTRUSION - Hot extrusion of metal is a process whereby metal heated to within the recrystallization range is forced through a restricted orifice, thereby forming an elongated shape of uniform cross-section.

PIERCING - Rotary piercing is the method employed for quantity production of seamless tube. This tube has slightly higher mechanical properties than welded tube because it is homogeneous throughout.

HAMMER FORGING OR PRESS FORGING - Forging is defined as the hot shaping of metal by pressure or by repeated blows in a press or hammer, in open or closed dies. High mechanical properties are obtained by forging, and if cost is not a main factor, forgings should be considered first in designing.

BENDING AND FORMING - Bending and forming operations generally change the shape of articles without reducing their cross-sectional area. Hot bending and forming is used when sharp bends are required, as cold bending would rupture the metal through strain hardening.

13. COLD WORKING OPERATIONS. Commonly used cold working operations are given below:

ROLLING — Copper alloys that are cold rolled to finished size have more uniform dimensions and better mechanical properties than the hot rolled product. Most cold rolling is performed on sheet but some rolling of rods and shapes of various cross-sections are also accomplished. Rods are, however, usually brought to final dimensions by one or more cold drawing finishing operation.

DRAWING — Two common drawing operations within the copper industry are: (1) the process of pulling flat products (rod, wire, tube, and shapes) through a die, thus affecting a reduction in size or change in shape of the cross-section of the product and an increase in hardness of the metal; and (2) the process of making articles in a press from blanks cut from flat products in which the gage is reduced by pushing the metal between a punch and die to develop the side walls of the part.

OTHERS — Most of the copper alloys are capable of being formed by cold heading, spinning, bulging, flanging and necking.

HEAT TREATMENT

14. GENERAL. There are several thermal processes used to change the physical or mechanical properties of copper and copper alloys. Heat treating is a combination of heating and cooling operations applied to a metal or alloy in the solid state, to produce changes in physical and mechanical properties. Heat treatment data for several cast alloys is given in Table VIII.

15. ANNEALING. Annealing is a process involving heating and cooling designed to affect: (1) a softening of cold-worked structures by recrystallization or grain growth, or both; (2) a softening of age-hardened alloys by causing a nearly complete precipitation of the second phase in relatively coarse forms; (3) a softening of certain age-hardenable alloys by dissolving the second phase and cooling rapidly enough to obtain a supersaturated solution; and (4) the relief of residual stresses.

16. AGE HARDENING. Age hardening is a process of increasing the hardness and strength of a metal by the precipitation of particles of some phase from a supersaturated solid solution alloy. The hardening cycle usually consists of (1) heating or annealing at a temperature sufficiently high to maintain solid solution, (2) rapid cooling or quenching to retain the supersaturated solid solution, and (3) subsequent heating at a temperature lower than the solution anneal to affect the precipitation.

17. TEMPER. Temper is the condition, produced in a metal by mechanical or thermal treatment, having characteristic structure and mechanical properties.

ANNEALED TEMPERS — Tempers produced by annealing and usually defined by a nominal grain size or grain size range.

0.015 mm.	0.050 mm.
0.025 mm.	0.070 mm.
0.035 mm.	0.100 mm.

The most commonly specified nominal annealed tempers are listed. Certain alloys, not composed entirely of alpha grains, do not lend themselves to classification under these listed tempers. The terms "Light Anneal" and "Soft Anneal" are also commonly used. Their mechanical properties are defined by applicable specifications.

ROLLED OR DRAWN TEMPERS (Flat Products, except Bar, and Wire) — These tempers are designated by the following terms, and defined in applicable specifications:

Eighth Hard	Extra Hard
Quarter Hard	Spring
Half Hard	Rivet (wire only)
Three Quarter Hard	Screw (wire only)
Hard	

ROLLED OR DRAWN TEMPERS (Bar and Rod) — These tempers are designated by the following terms, and defined in applicable specifications:

Quarter Hard	Hard
Half Hard	Extra Hard

ROLLED OR DRAWN TEMPERS (Tube) — These tempers are designated by the following terms, and defined in applicable specifications:

Light-Drawn — Generally applied to tube where some degree of stiffness is desired without serious impairment of bending qualities.

Drawn (General Purpose) — Applicable to tube only; commonly used where there is no real requirement for high strength or hardness on the one hand, or for bending qualities on the other.

Hard-Drawn — Used where there is need for a tube as hard or as strong as is commercially feasible for the size in question.

AGED TEMPER - This temper is for age-hardenable alloys and is referenced as the T temper. The letter T is added to the temper designation to indicate that the material has been precipitation hardened.

OTHER TEMPERS — Other tempers used in this handbook are:

As-extruded — A condition of a mill product resulting from hot extrusion; soft, not drawn or rolled to size.

As-hot rolled — A condition of a mill product resulting from hot rolling; soft, not drawn or rolled to size.

As-drawn — Material brought to final dimensions by cold drawing through a die, regardless of temper or prior operations.

CORROSION

18. GENERAL. Corrosion is the deterioration or failure of metals and alloys by chemical or electrochemical processes. Copper and copper alloys are relatively resistant to corrosion but, like most metals, will deteriorate in certain environments. The relative corrosion resistance of copper and copper alloys to various liquids and gases is shown in Table IX for cast alloys. Table XI gives this information for wrought alloys. These tables should serve as a guide only. The most common processes affecting copper and its alloys are listed below.

DEZINCIFICATION — Corrosion of an alloy containing zinc (usually a brass alloy) involving loss of zinc.

DEALUMINIFICATION — A phenomenon somewhat similar to dezincification involving loss of aluminum.

DENICKELIFICATION — A common phenomenon somewhat similar to dezincification involving loss of nickel.

EROSION — The abrasion of metal or other material by liquid or gas, usually accelerated by presence of solid particles of matter in suspension, and sometimes by corrosion.

Cavitation — The damage caused to a material by a moving liquid, and associated with the formation and collapse of cavities in the liquid at the solid-liquid interface.

Impingement Attack — A type of localized corrosion caused by the striking of a liquid, containing entrained gasses, on a metal surface.

STRESS CORROSION — Spontaneous failure of metals by cracking under combined action of corrosion and stress, residual or applied. Season cracking is the spontaneous failure of some metals by cracking under the combined action of corrosion and residual stresses.

MACHINABILITY

19. GENERAL. Machinability is the quality of a metal or alloy which enables it to be readily shaped at a high speed by cutting tools, producing a smooth surface with a minimum wear of the tools. The relative machinability rating of various cast coppers and copper alloys is given in Table X. These ratings are based on copper alloy No. 360 (free cutting brass) having a rating of 100. Wrought alloys are covered in Table XII.

JOINING

20. GENERAL. Copper alloys are readily joined by various welding processes. The suitability of the various joining methods for many alloys is indicated in Table X. Wrought alloys are covered in Table XIII.

TEMPERATURE EFFECTS

21. ELEVATED AND LOW TEMPERATURES. The effects of testing temperature on wrought copper alloys are shown in Table XIV. These are important considerations in design.

OTHER PROPERTIES

22. GENERAL. Data indicating melting point, density, electrical conductivity, resistivity, thermal conductivity, modulus of elasticity and of rigidity are included in Table XV.

SPECIFICATIONS AND DATA - WROUGHT PRODUCTS

23. GENERAL. Table XVI lists wrought alloys by CDA number and gives their nominal composition. Tables XVII, XVIII and XIX cross-reference documents by Federal, Military and CDA respectively. Table XX lists mechanical properties according to CDA and Table XXI lists mechanical properties according to government specifications. Table XXII shows fabricating characteristics and typical applications according to CDA.

TOLERANCES

24. GENERAL. The tolerances for castings are usually specified in the contract or on the drawings. Tolerances for wrought products can be found in Fed. Std. No. 146 and also in CDA Publication "Standards Handbook", Part 1.

ABBREVIATIONS

25. GENERAL. The abbreviations used in this handbook are as follows:

A - Annealed
AC - As cast
AE - As extruded
AMS - Aerospace Material Specification (SAE)
AR - As received
ASTM - American Society for Testing and Materials
AT - Solution-Heat treated and precipitation hardened
BHN - Brinnel Hardness Number
CDA - Copper Development Association
CeC - Centrifugal cast
CF - Cold forming
CFA - Cold formed and aged
CHe - Cold heading
CoC - Continuous cast
Comp. - Composition
CR - Cold rolled
CYS - Compressive Yield Strength
D - Drawn
DA - Drawing anneal
EL - Elongation (in 2 inches)
ES - Endurance strength
ET - Extruded and turned
EXT - Extension Under Load
FT - Forged and turned
H - Hard
HD - Hot drawn
HR - Hot rolled
HT - Hard and precipitation hardened
IA - Intermediate anneal
J - In rolls, on bucks, reels, or spools
K - In straight lengths
ksi - Thousand pounds per square inch
LA - Light anneal
LD - Light drawn
mm - Millimeters
OFF - *Offset*
RA - Reduction in area
RB - Rockwell hardness, B scale
RC - Rockwell hardness, C scale
RF - Rockwell hardness, F scale

$R_{30}N$	- Rockwell hardness, 30N scale
$R_{15}N$	- Rockwell hardness 15T scale
$R_{30}T$	- Rockwell hardness, 30T scale
S	- Soft
SAE	- Society of Automotive Engineers
Spr	- Spring
SPS	- Standard pipe size
SS	- Shear strength
StC	- Static cast
StR	- Stress relieved
TS	- Tensile Strength
TYS	- Tensile yield strength - 0.5% extension under load
UTS	- Ultimate tensile strength
XH	- Extra hard
XHT	- Extra hard and precipitation hardened
XSpr	- Extra spring
YP	- Yield point
YS	- Yield Strength
1/8H	- Eighth hard
1/4H	- Quarter hard
1/2H	- Half hard
3/4H	- Three quarter hard
1/4HT	- Quarter hard and precipitation hardened
1/2HT	- Half hard and precipitation hardened
3/4HT	- Three quarter hard and precipitation hardened.

26. CHEMICAL SYMBOLS. The following listed chemical symbols are used in detailing chemical composition of the various alloys.

Aluminum	Al	Lithium	Li
Antimony	Sb	Magnesium	Mg
Arsenic	As	Manganese	Mn
Beryllium	Be	Mercury	Hg
Bismuth	Bi	Nickel	Ni
Boron	B	Phosphorus	P
Cadmium	Cd	Selenium	Se
Calcium	Ca	Silicon	Si
Carbon	C	Silver	Ag
Chromium	Cr	Sulfur	S
Cobalt	Co	Tellurium	Te
Columbium	Cb	Titanium	Ti
Copper	Cu	Tin	Sn
Iron	Fe	Zinc	Zn
Lead	Pb	Zirconium	Zr

TABLE II. GOVERNMENT STANDARDIZATION DOCUMENTS

MILITARY SPECIFICATIONS

Number	Title	Date
MIL-C-50C	Copper Alloy, Number 260 Cartridge Brass, 70 Percent, Sheet Strip, Plate Bar, and Discs.	2 Dec 63
MIL-W-85E	Waveguide Rigid Rectangular, General Specification For.	18 Feb 66
MIL-W-85/1A	Waveguide, Rigid, Rectangular.	18 Feb 66
MIL-F-1224A	Fitting, Tube, Brass or Bronze, Flared.	19 Aug 65
MIL-T-1368C(2)	Tube and Pipe, Nickel Copper Alloy, Seamless and Welded.	21 Feb 66
MIL-E-278B(1)	Electrode Covered Aluminum Bronze.	17 Mar 69
MIL-T-3235A	Tube, Copper, Seamless (For Torpedo Use).	12 May 61
MIL-W-3318	Wire, Copper and Wire, Steel, Copperclad W-154 and WS-24/U.	25 Oct 50
MIL-C-3383	Cup, Bullet Jacket Copper Alloy, for Small Arms Ammunition.	28 Jun 65
MIL-T-3595B	Tubing, Phosphor Bronze, (CDA No. 510) Round Seamless.	14 Jul 69
MIL-C-3993C	Copper and Copper Base Alloy Mill Products, Packaging of.	14 Sep 62
MIL-W-5086B(1)	Wire, Electric, Hook-up and Interconnecting, Polyvinyl Chloride-insulated, Copper or Copper Alloy Conductor.	18 Jun 68
MIL-W-5086/1	Wire, Electric, Hook-up and Interconnecting, Polyvinyl Chloride Insulation, Nylon Jacket, Tin-coated Copper Conductor, 600 Volt, 105 Deg. C.	19 Mar 68
MIL-W-5086/2A	Wire, Electric, Hook-up and Interconnecting, Polyvinyl Chloride Insulation, Pvc-Glass-Pvc-Nylon Tin-coated Copper Conductor, 600 Volt, 105 Deg. C.	18 Aug 69
MIL-W-5086/3	Wire, Electric, Hook-up and Interconnecting Polyvinyl Chloride Insulation, Pvc-Glass-Pvc-Nylon Tin-coated Copper Conductor, 600 Volt, 105 Deg. C.	19 Mar 68
MIL-W-5086/4	Wire, Electric, Hook-up and Interconnecting, Polyvinyl Chloride Insulation, Nylon Jacket Tin Coated Copper Conductor, 3000 Volt, 105 Deg. C.	19 Mar 68
MIL-W-5086/5A	Wire, Electric, Hook-up and Interconnecting, Polyvinyl Chloride Insulation, Polyvinylidene Fluoride Jacket Tin Coated Copper Conductor, 600 Volt, 110 Deg. C.	19 Mar 68
MIL-W-5086/6A	Wire, Electric, Hook-up and Interconnecting, Polyvinyl Chloride Insulation, Polyvinylidene Fluoride Jacket, Silver Coated Copper Alloy Conductor, 600 Volt, 110 Deg. C.	19 Mar 68
MIL-W-5086/7	Wire, Electric, Polyvinyl, Chloride Insulation, Nylon Jacket, Tin-Coated Copper Conductor, Medium Weight, 600 Volt, 105 Deg. C.	5 Nov 68

TABLE II (Contd.)

Number	Title	Date
MIL-W-5086/8	Wire, Electric, Hook-up and Interconnecting, Polyvinyl Chloride Insulation, Polyvinylidene Fluoride Jacket, Tin Coated Copper Conductor, Lightweight, 600 Volt, 110 Deg. C.	20 Nov 69
MIL-W-6712B	Wire Metallizing.	28 Mar 67
MIL-C-7078B(1) Supp 1	Cable Electric Aerospace Vehicle, General Spec For. (/1 thru /22).	5 Dec 67
MIL-B-7883B	Brazing of Steels, Copper, Copper Alloys, Nickel Alloys, Aluminum and Aluminum Alloys.	20 Feb 68
MIL-T-8231(2)	Tubes, Copper-Silicon-Bronze, Seamless For Aircraft.	14 Jun 61
MIL-C-10375B(1)	Cup, Case, Cartridge, Copper Alloy (For Small Arms Ammunition).	7 Feb 69
MIL-B-11552B	Brass Powder for Sintering.	13 Aug 65
MIL-B-12128C	Brass, Sintered, Structural Parts.	13 Aug 65
MIL-C-12166	Copper Rod For Crusher Cylinders.	14 Aug 52
MIL-E-13191B	Electrode, Welding, Covered Bronze For General Use.	26 Feb 69
MIL-W-13276A(1)	Wire, Bronze (Antenna, Wire type W-28).	4 Mar 66
MIL-C-13351A	Copper Alloy Number 377 Forgings.	13 Sep 63
MIL-S-13468(1)	Steel, Copper Alloy Clad Strip (For Small Caliber Bullet Jackets).	18 Mar 68
MIL-B-13501A	Bearing and Bushing, Brass and Bronze Machined or Formed.	15 May 67
MIL-C-14550A	Copper Plating (Electrodeposited).	14 Jul 70
MIL-T-15005E(2)	Tube, 70-30 and 90-10 Copper Nickel Alloy, Condenser and Heat Exchanger.	27 Apr 64
MIL-C-15345G(1)	Castings, Nonferrous, Centrifugal.	7 Oct 66
MIL-C-15726E(2) (Ships)	Copper-nickel Alloy, Rod, Flat Products (Flat Wire, Strip, Sheet, Bar, and Plate) and Forgings.	5 Aug 70
MIL-B-15894B	Brass, Die Castings.	21 Dec 66
MIL-B-16166A(1)	Bronze, Aluminum, Forgings, Heat Treated.	16 Apr 62
MIL-T-16420J(3) (Ships)	Tube, 70-30 and 90-10 Copper-nickel Alloy, Seamless and Welded.	10 Jul 69
MIL-B-16541B(3)	Bronze, Valve Castings.	10 Jun 68
MIL-V-16720C	Valve, Foot, Brass and Polyvinyl Chloride (For Light Oil and Water)	24 May 67
MIL-T-16992B	Tube, Aluminum-brass Arsenical (Copper Alloy No. 687), Condenser and Heat Exchanger.	5 Aug 62

TABLE II (Contd.)

Number	Title	Date
MIL-M-17163A	Nickel-copper Alloy Wrought (55-60 Percent Ni) Low Permeability.	3 Apr 59
MIL-B-17528A(1)	Bronze Castings, Tin-nickel (Navy).	4 Oct 65
MIL-V-17547(3)	Valve, Check, Bronze (Navy).	12 Sep 58
MIL-B-17910B(1)	Buckle, Brass for Belt, Coat, Man's Wool.	19 Nov 68
MIL-C-18738	Cartridge Cases, Brass (Other Than Small Arms). General Specification For .	13 Jun 55
MIL-C-18739	Cartridge Cases, Brass, Anti-aircraft, 20 millimeter, Mark 4 Mod 0.	13 Jun 55
MIL-C-18740	Cartridge Cases, Brass, 40-Millimeter.	13 Jun 55
MIL-C-18741	Cartridge Case, Brass, 3-inch Mark 7 Mod 0 (50 Caliber).	13 Jun 55
MIL-C-18742	Cartridge Case, Brass, 5-inch Mark 4 Mod 2 (25 Caliber).	13 Jun 55
MIL-C-18760	Cartridge Case, Brass 8-inch Mark 1 Mod 3 (55 Caliber).	29 Jun 55
MIL-R-18818A	Rods, Welding Aluminum Bronze, Surfacing Inert-Gas Tungten-Arc Process.	31 Jan 57
MIL-C-18821	Cartridge Cases, Brass 5-inch (38 Caliber).	29 Jun 55
MIL-C-18822	Cartridge Cases, Brass 5-inch (54 Caliber).	29 Jun 55
MIL-C-18823	Cartridge Cases, Brass 3-inch Impulse.	29 Jun 55
MIL-C-18824	Cartridge Cases, Brass 6-inch (47 Caliber).	29 Jun 55
MIL-B-18907 (Nord)	Bands, Projectile Rotating.	30 Jun 55
MIL-B-19231(1) (Nord)	Bars, Copper, Silver-bearing (For Commutators).	22 May 58
MIL-C-19310	Copper-Chromium-Alloy Castings.	25 Jan 56
MIL-C-19311A (Wep)	Copper-chromium-alloy Forgings, Wrought Rod, Bar and Strip.	7 Dec 62
MIL-R-19631B(4)	Rods, Welding, Copper and Copper Alloy.	20 May 68
MIL-B-19708(1)	Brass, High Strength, Yellow (Nickel Manganese Bronze) Castings.	8 Mar 57
MIL-C-20109(1)	Copper Pressure Cylinders and Copper Pressure Spheres, Cannon (Major and Medium), Cannon (Minor) Small Arms, and Pistol and Revolver.	6 May 52
MIL-C-20152	Copper, Silicon Alloys.	(Cancelled 11 Aug 64)
MIL-C-20159B(1) Int AMD 4 (SH)	Copper Nickel Alloy (70-30 and 90-10) Castings	13 Sep 63

TABLE II (Contd.)

Number	Title	Date
MIL-T-20168B	Tubes, Brass (Red Brass), Seamless.	19 Aug 62
MIL-T-20219B	Tubes, Brass, Voice and Pneumatic.	9 Jul 62
MIL-B-20292A(2) (MU)	Blanks, Rotating Band, for Projectiles.	10 Sep 68
MIL-B-20295	Blanks, Centrifugal Cast, Rotating Band.	21 Nov 51
MIL-B-21230A(3)	Bronze, Nickel Aluminum and Manganese-nickel Aluminum, Castings, Ship Propeller Application.	18 Mar 68
MIL-E-21659	Electrodes, Welding, Bare, Copper and Copper-Alloy.	24 Feb 59
MIL-C-21768(1)	Copper Alloy Numbers 210 (Gilding, 95%) and 220 (Commercial Bronze, 90%) Sheet and Strip.	30 Jul 63
MIL-C-22045(1)	Copper Anodes for the SD-4 Mod 1 Mechanism.	7 Dec 64
MIL-C-22087(1)	Copper Alloy Investment Castings.	16 Apr 62
MIL-E-22200/4A(1) Int Amd 3	Electrodes, Welding, Covered, Copper Nickel Alloy.	19 Apr 63
MIL-T-22214A (Ships)	Tube, Condenser and Heat Exchanger With Integral Fins (Copper Alloy Numbers 715, 706, and 122).	4 Oct 68
MIL-C-22226	Copper-nickel-manganese Alloy Bars, Plates, and Sheets, Low Magnetic Effect (For Special Purpose, Tools and Equipment).	9 Nov 59
MIL-C-22229(1)	Copper Base Alloy Castings (For Pressure Tight Application).	16 Apr 62
MIL-S-22499B	Shim Stock Laminated (Comp. 2/GG-B-613).	15 Mar 65
MIL-Q-22631B(2)	Quality Control of Metal Wrought Products Except Forgings Procured to Non-governmental Specifications.	27 May 66
MIL-W-22759C (Supp 1)	Wire, Electric, Fluorocarbon-insulated, Copper and Copper Alloy.	23 Jul 69
MIL-W-22759/1B	Wire, Electric, Fluorocarbon Insulated, Tfe and Tfe Coated Glass, Silver Coated Copper Conductor, 600 Volt.	23 Jul 69
MIL-W-22759/2B	Wire, Electric, Fluorocarbon-insulated, Tfe and Tfe-coated Glass, Nickel-coated Copper, 600 Volts.	23 Jul 69
MIL-W-22759/3B	Wire, Electric, Fluorocarbon-insulated, Tfe-glass-tfe Medium Weight, Nickel-coated Copper, 600 Volt.	23 Jul 69
MIL-W-22759/4	Wire, Electric, Fluorocarbon Insulated, Tfe Glass Fep. Medium Weight, Silver Coated Copper Conductor, 600 Volt.	23 Jul 69
MIL-W-22759/5	Wire, Electric, Fluorocarbon Insulated, Abrasion Resistant, Extruded Tfe, Silver Coated Copper Conductor, 600 Volt.	23 Jul 69

TABLE II (Contd.)

Number	Title	Date
MIL-W-22759/6	Wire, Electric, Fluorocarbon Insulated, Abrasion Resistant, Extruded Tfe, Nickel Coated Copper Conductor, 600 Volt.	23 Jul 69
MIL-W-22759/7	Wire, Electric, Fluorocarbon Insulated, Abrasion Resistant, Extruded Tfe, Medium Weight, Silver Coated Copper Conductor, 600 Volt.	23 Jul 69
MIL-W-22759/8	Wire, Electric, Fluorocarbon Insulated, Abrasion Resistant, Extruded Tfe, Medium Weight, Nickel Coated Copper Conductor, 600 Volt.	23 Jul 69
MIL-W-22759/9	Wire, Electric, Fluorocarbon-insulated, Extruded Tfe, Silver-coated Copper Conductor, 1000-Volt.	23 Jul 69
MIL-W-22759/10	Wire, Electric, Fluorocarbon-insulated, Extruded Tfe, Nickel-coated Copper Conductor, 1000-Volt.	23 Jul 69
MIL-W-22759/11	Wire, Electric, Fluorocarbon Insulated, Extruded Tfe, Silver Coated Copper Conductor, 600 Volt.	23 Jul 69
MIL-W-22759/12	Wire, Electric, Fluorocarbon-insulated, Extruded, Tfe, Nickel-coated Copper Conductor, 600-Volt.	23 Jul 69
MIL-W-22759/13C	Wire, Electric, Fluorocarbon Insulated, FEP-PVF2 Medium Weight, Tin Coated Copper, 600 Volt.	21 Sep 70
MIL-W-22759/14A	Wire, Electric, Fluorocarbon-insulated, FEP-PVF2, Lightweight, Tin-coated Copper, 600 Volt.	15 Apr 70
MIL-W-22759/15	Wire, Electric, Fluorocarbon Insulated, FEP-PVF2.	10 Nov 69
MIL-W-23068	Waveguides, Rigid, Circular.	31 Oct 61
MIL-W-23351	Waveguides, Single Ridged and Double Ridged (Bandwidth Ratios 3.6, 1 and 2.4 1 (General.	29 Jun 62
MIL-T-23520A(1)	Tube and Pipe, Nickel-copper Alloy, Seamless Air Melted.	19 May 69
MIL-B-23921(4)	Bronze, Nickel Aluminum Castings for Seawater Service.	18 Mar 68
MIL-F-23999(2)	Forgings, Closed Die, Nickel Copper Aluminum Alloy (K-Monel).	30 Nov 64
MIL-B-24059(2) (Ships)	Bronze, Nickel Aluminum, Rod, Flat Products with Finished Edges, Shapes and Forgings.	10 Nov 66
MIL-N-24106(3)	Nickel-copper Alloy Bars, Rods, and Forgings.	1 Nov 68
MIL-T-24107 (Ships)	Tube, Copper (Seamless).	10 Mar 65
MIL-T-24108 (Ships)	Tubes, Condenser and Ferrule Stock, Inhibited Admiralty Metal (Copper Alloy Numbers 443, 444, and 445). Use WW-T-756.	14 Dec 64
MIL-M-24130/3	Metallic Seal Ring, Non-Integral Nickel Copper Alloy.	1 Dec 69
MIL-F-24202	Fitting Butt Welding Seamless or Welded, 70-30 Copper-nickel Alloy, 700 Psi, 200 Deg.	14 Feb 66

TABLE II (Contd.)

Number	Title	Date
MIL-R-24243/2A Supp 1	Rivet Blind, Nonstructural Retained Mandrel, Open-end, Domed Head Nickel-Copper Alloy.	3 Jun 68
MIL-E-45829A	Electrode, Welding Copper, Silicon-Deoxydizer Solid Bore.	19 Jan 70
MIL-B-46066(1)	Bend, Rotating, Copper Alloy Centrifugal Cast (For Critical Applications).	4 Nov 63
MIL-T-46072(MR)	Tube, Round, Copper Alloy Numbers 330, 331, 332, and 370 (Leaded Brass), Seamless.	10 Dec 63
MIL-C-46087(1)	Copper Alloy Number 175 (Copper-Cobalt-beryllium) Bar and Rod.	10 Mar 66
MIL-C-50212	Cartridge Case Metal Parts Assembly, XM195. Metal Parts For.	15 Jan 69
MIL-C-60631A	Cartridge Case, Base Plug and Disc 40 MM, XM199E1.	3 Mar 69
MIL-C-81021	Copper-cobalt-beryllium Alloy (Copper Alloy No. 175) Strip.	8 Dec 66
MIL-W-81044A(3)	Wire, Electric, Crosslinked, Polyalkene Insulated Copper.	9 Sep 70
MIL-W-81044/B	Wire, Electric, Crosslinked Polyalkene Insulated, Silver-plated Copper, Abrasion Resistant. (Inactive. Use MIL-W-81044/2)	30 Mar 67
MIL-W-81044/2A	Wire, Electric, Crosslinked Polyalkene Insulated, Tin Coated Copper, Abrasion Resistant.	30 Mar 67
MIL-W-81044/3B	Wire, Electric, Crosslinked Polyalkene Insulated, Silver-plated Copper, Light Weight.	4 Jun 70
MIL-W-81044/4A	Wire, Electric, Crosslinked Polyalkene Insulated, Tin Coated Copper, Light Weight.	30 Mar 67
MIL-W-81044/5A	Wire, Electric, Crosslinked Polyalkene Insulated, Silver-plated Copper, Normal Weight 150 Deg. C. (Inactive. Use MIL-W-81044/6)	30 Mar 67
MIL-W-81044/6	Wire, Electric, Crosslinked Polyalkene Insulated, Tin-Coated Copper, Normal Weight, 150 Deg. C.	30 Mar 67
MIL-W-81044/7	Wire, Electric, Crosslinked Polyalkene Insulated, Silver-plated High Strength Copper Alloy, Normal Weight, 150 Deg. C.	30 Mar 67
MIL-W-81044/8A	Wire, Electric, Crosslinked Polyalkene Insulated, Silver-plated Copper, Medium Weight, 150 Deg. C.	4 Jun 70
MIL-W-81044/9	Wire, Electric, Crosslinked Polyalkene Insulated, Tin-coated Copper, Medium Weight, 150 Deg. C.	30 Mar 67
MIL-W-81044/10	Wire, Electric, Crosslinked Polyalkene Insulated, Silver-plated High Strength Copper Alloy, Medium Weight, 150 Deg. C.	30 Mar 67
MIL-W-81044/11A	Wire, Electric, Crosslinked Polyalkene Insulated, Silver Plated Copper, Light Weight, 150 Deg. C. (Inactive Use MIL-W-81044/12)	4 Jun 70
MIL-W-81044/12	Wire, Electric, Crosslinked Polyalkene Insulated, Tin-coated Copper, Light Weight, 150 Deg. C.	

TABLE II (Contd.)

Number	Title	Date
MIL-W-81044/13	Wire, Electric, Crosslinked Polyalkene Insulated, Silver-plated High Strength Copper Alloy, Light Weight, 150 Deg. C.	30 Mar 67
MIL-W-81044/14	Wire, Electric, Crosslinked Polyalkene Insulated, Tin-coated Copper, Medium Weight, 135 Deg. C.	17 Jul 68
MIL-W-81044/15	Wire, Electric, Crosslinked Polyalkene Insulated, Silver-plated High Strength Copper Alloy, Medium Weight, 135 Deg. C.	17 Jul 68
MIL-W-81381/1	Wire, Electric, Fluorocarbon/polyimide Insulated Light Weight, Silver Coated Copper.	17 Jul 68
MIL-W-81381/2D	Wire, Electric, Fluorocarbon/polyimide Insulated Light Weight, Nickel Coated Copper.	6 Nov 70
MIL-W-81381/3D	Wire, Electrical, Fluorocarbon/polyimide Insulated Medium Weight, Silver Coated Copper.	27 Jul 70
MIL-W-81381(4)	Wire, Electric, Polyimide-Insulated, Copper and Copper Alloy.	15 Jul 70
MIL-W-81381/4D	Wire, Electric, Fluorocarbon/polyimide Insulated Medium Weight, Nickel Coated Copper.	27 Jul 70
MIL-W-81381/5A	Wire, Electric Fluorocarbon/polyimide Insulated Light Weight, Silver Coated, High Strength Copper Alloy.	6 Nov 70
MIL-W-81381/6A	Wire Electric, Fluorocarbon/polyimide Insulated Light Weight, Nickel Coated High Strength Copper Alloy.	6 Nov 70
MIL-W-81381/7A	Wire, Electric, Fluorocarbon/polyimide Insulated Light Weight, Silver Coated Copper.	1 Jul 70
MIL-W-81381/8A	Wire, Electric, Fluorocarbon/polyimide Insulated Light Weight, Nickel Coated Copper.	1 Jul 70
MIL-W-81381/9A	Wire, Electric, Fluorocarbon/polyimide Insulated Light Weight, Silver Coated High Strength Copper Alloy.	1 Jul 70
MIL-W-81381/10A	Wire Electric, Fluorocarbon/polyimide Insulated Light Weight, Nickel Coated High Strength Copper Alloy.	1 Jul 70
MIL-W-81381/11	Wire, Electric, Fluorocarbon/polyimide Insulated Medium Weight, Silver Coated Copper.	15 Jul 70
MIL-W-81381/12	Wire, Electric, Fluorocarbon/polyimide Insulated Medium Weight, Nickel Coated Copper.	15 Jul 70
MIL-W-81381/13A	Wire, Electric, Fluorocarbon/polyimide Insulated Medium Weight, Silver Coated High Strength Copper Alloy.	23 Nov 70
MIL-W-81381/14A	Wire, Electric, Fluorocarbon/polyimide Insulated Medium Weight, Nickel Coated High Strength Copper Alloy.	23 Nov 70
MIL-C-81519	Casting, Copper Alloy (CDA No. 717) (Copper-nickel-beryllium).	10 Feb 67

TABLE II (Contd.)

FEDERAL SPECIFICATIONS

Number	Title	Date
FED-STD-146 Change 2	Tolerance For Copper and Copper Base Alloy Mill Products.	16 Jan 61
FED-STD-151B	Metal, Test Methods.	24 Nov 67
FED-STD-00153	Copper-base Alloy Castings, Chemical Composition and Mechanical Properties.	21 Apr 61
FED-STD-185	Identification Marking of Copper and Copper Base Alloy Mill Products.	8 Nov 60
QQ-A-660	Anode, Brass.	19 Feb 64
QQ-A-673A(1)	Anode, Copper.	20 Sep 68
QQ-B-575A	Braid, Wire (Copper, Tin-coated Tubular).	24 May 65
QQ-B-613C	Brass, Leaded and Nonleaded Flat Products (Plate, Bar, Sheet and Strip).	16 Feb 67
QQ-B-626C	Brass, Leaded and Nonleaded, Rod, Shaped Forgings, and Flat Products With Finished Edges (Bar and Strip).	1 Mar 67
QQ-B-637A	Brass, Naval, Rod, Wire, Shapes, Forgings and Flat Products With Finished Edges (Bar, Flat Wire, and Strip).	14 Mar 67
QQ-B-639A	Brass, Naval, Flat Products (Plate, Bar Sheet, and Strip).	14 Mar 67
QQ-B-650A(1)	Brazing Alloy, Copper, Copper-zinc, and Copper-Phosphorus.	14 Sep 61
QQ-B-675A(1)	Bronze, Aluminum Ingots (For Remelting).	17 Feb 64
QQ-B-728	Bronze Manganese, Rod, Shapes, Forgings and Flat Products (Flat Wire, Strip, Sheet, Bar, and Plate).	6 Dec 61
QQ-B-750(2)	Bronze, Phosphor, Bar, Plate, Rod, Sheet Strip, Flat Wire, and Structural and Special Shaped Sections.	28 Dec 66
QQ-B-825A	Bus Bar Copper, Aluminum or Aluminum Alloy.	12 May 64
QQ-C-390	Copper Alloy Castings (Including Cast Bar).	30 Jun 67
QQ-C-450	Copper-Aluminum Alloy (Aluminum Bronze) Plate, Sheet, Strip, and Bar (Copper Alloy Numbers 606, 612, 613, 614 and 628).	11 Sep 64
QQ-C-465	Copper, Aluminum Alloys (Aluminum Bronze) Copper Alloy Numbers 606, 614, 630 and 642, Rod, Flat Products With Finished Edges, (Flat Wire Strip and Bar) Shapes and Forgings.	16 Feb 67
QQ-C-502C(1)	Copper Rods and Shapes and Flat Products with Finished Edges (Flat Wire, Strips and Bars).	10 Sep 64
QQ-C-521D	Copper Ingot.	2 Aug 62

(TABLE II (Contd.)

Number	Title	Date
QQ-C-523	Copper Alloy Ingots, Brass (Yellow High Strength) Manganese and Manganese-Aluminum Bronze.	29 Jun 55
QQ-C-525B	Copper Alloy Ingots, Leaded and Non Leaded Tin Bronze, Red Brass and Semi-Red Brass.	11 Apr 62
QQ-C-530B	Copper-Beryllium Alloy Bar, Rod and Wire (Copper Alloy Number 172).	12 Apr 67
QQ-C-533A	Copper-Beryllium Alloy Strip (Copper Alloy Numbers 170 and 172).	3 Jun 64
QQ-C-557A	Copper-Nickel Alloy Shot.	21 Jun 63
QQ-C-571A	Copper, Phosphor (Alloying Additive).	17 Apr 67
QQ-C-576B(1)	Copper Flat Products With Slit, Slit and Edge Rolled, Sheared, Sawed or Machined Edges, Plate, Bar, Sheet and Strip.	6 Nov 64
QQ-C-581A	Copper, Silicon (Alloying Additive).	4 Apr 67
QQ-C-585A	Copper-Nickel-Zinc-Alloy Plate, Sheet Strip and Bar (Copper Alloy Numbers 735, 745, 752, 762, 766 and 770).	31 Dec 63
QQ-C-586B	Copper-Nickel-Zinc Alloy, Rod, Shapes, Flat Products with Finished Edges (Flat Wire, Strip and Bar).	30 Aug 65
QQ-C-591D(1)	Copper-Silicon Alloy, (Rod, Wire, Shapes and Flat Products (Flatwire, Strip, Sheet, Bar and Plate).	27 Sep 63
QQ-R-571C	Rod, Welding, Copper and Nickel Alloy.	10 Apr 69
QQ-W-321D	Wire, Copper Alloy.	10 May 67
QQ-W-343B	Wire Electrical and Nonelectrical, Copper (Uninsulated).	13 Jun 66
QQ-W-00343C(1)	Wire Electrical (Uninsulated).	24 Oct 68
QQ-W-345B(2)	Wire Electrical, Steel, Copper-Covered.	2 Jul 68
WW-P-351A	Pipe, Red Brass (Copper Alloy No. 230) Seamless Standard Pipe Size, Regular and Extra Strong.	6 Mar 63
WW-P-377D	Pipe, Copper, Seamless, Standard Sizes.	5 Nov 62
WW-P-460B	Pipe Fitting, Brass or Bronze (Threaded 125 Pound and 250 Pound).	17 Aug 67
WW-P-471A(2)	Pipe-fittings, Bushings, Locknuts, and Plugs Brass or Bronze, Iron or Steel, and Aluminum (Screwed) 125-150 Pounds.	26 Mar 64
WW-T-756D	Tubes, Condenser and Ferrule Stock, Inhibited Admiralty Metal (Copper Alloy Numbers 443, 444 and 445).	6 Mar 63
WW-T-775A Int Amd 1 (GSA)	Tube, Copper, Seamless (for Refrigeration and General Use).	3 May 62
WW-T-791	Tubing, Brass Seamless.	1 Aug 63

TABLE II (Contd.)

Number	Title	Date
WW-T-797C	Tube, Copper (Seamless).	12 Feb 63
WW-T-799C	Tube, Copper, Seamless (For Use With Solder-Type or Flared-Tube Fittings).	24 Apr 67
WW-U-516A	Union, Pipe, Bronze or Naval Brass, Threaded Pipe Connection, 250-pounds.	6 Apr 67
WW-V-51D	Valve, Bronze, Angle, Check and Globe, 125 and 150 Pound, Screwed and Flanged (For Land Use).	21 Nov 67
WW-V-54C Int Amd (1)	Valve, Gate, Bronze 125 + 150 Pound, Screwed and Flanged (For Land Use).	7 Oct 66

MILITARY STANDARDS

Number	Title	Date
MIL-STD-455A	Alloy Designation System for Wrought Copper and Copper Alloy.	9 Nov 64
MIL-STD-1276B	Leads Weldable, for Electronic Component Parts.	6 Mar 68
MS-16199B	Screw, Wood, Slotted, Flat Countersunk 82 Deg. Head, Copper Silicon Alloy, Nonmagnetic.	8 Mar 67
MS-16201A	Bolt, Lag, Cone Point, Countersunk Flathead, Slotted, Copper-silicon Alloy, Nonmagnetic.	19 Aug 66
MS-16205A	Bolt, Machine, Regular Semi-finished Hexagon Head, Copper-silicon Alloy (Silicon Bronze) UNC-2A, Non-M.	19 Aug 66
MS-16207C	Bolt, Square Neck, (Carriage Bolts), Round Head, UNC-2A, Copper-silicon Alloy, Nonmagnetic.	24 May 67
MS-16211A	Nut, Plain, Square, Regular, Unfinished, Copper-silicon Alloy, UNC-2B, Nonmagnetic.	19 Aug 66
MS-16216B	Screw, Wood, Slotted Round Head, Copper Silicon Alloy, Nonmagnetic.	8 Mar 67
MS-16218B	Screw, Machine, Flat Countersunk Head, Slotted, Copper-silicon Alloy, UNC-2A, Nonmagnetic.	8 Mar 67
MS-16747	Insert, Brass (For Molded Electrical Fitting).	4 Mar 59
MS-17795	Bearing, Sleeve, Plain Type, Sintered Bronze, Oil Impregnated.	14 Feb 62
MS-17796	Bearing, Sleeve, Flange Type, Sintered Bronze, Oil Impregnated.	16 Feb 62
MS-17828E	Nut, Self-locking, Hexagon, Regular-height (Non Metallic Insert) 250 Deg. F., Nickel-copper Alloy.	4 Oct 68

TABLE II (Contd.)

Number	Title	Date
MS-18114A	Wire, Electric, Extruded Tfe-fluorcarbon-insulated, Nickel-coated Copper, 1000 Volts.	7 Jun 68
MS-18116C	Bolt, Bolt-stud, Stud-Stud-bolt, Nickel-copper-aluminum Alloy, Special Requirements.	23 May 69
MS-19062A	Ball, Bearing, Non-ferrous, Brass.	17 Nov 65
MS-19063A	Ball, Bearing, Non-ferrous, Bronze.	17 Nov 65
MS-19064A	Ball, Bearing, Non-ferrous, Nickel-copper Alloy (K-monel Metal).	17 Nov 65
MS-20615D	Rivet, Solid-universal Head, Brass, Copper and Nickel-copper Alloy.	13 Jan 65
MS-21003	Terminal, Lug, Uninsulated, Rectangular Tongue, Crimp Style, Copper, Type 1, Class 1.	26 Sep 67
MS-21004B	Terminal, Lug, Uninsulated, Rectangular Tongue, Crimp Style, Copper, Type 1, Class 1.	2 Sep 69
MS-21005	Terminal Lug, Uninsulated, Rectangular Tongue, Two Stud, Crimp Style, Copper, Type 1, Class 1.	26 Sep 67
MS-21006	Terminal, Lug, Uninsulated, Flag Tongue, Crimp Style, Copper, Type 1, Class 1.	26 Sep 67
MS-21007	Terminal Lug, Uninsulated, Rectangular (Bent 90 Deg.) Crimp Style, Copper, Type 1, Class 1 (Special Applications).	26 Sep 67
MS-21008	Terminal, Lug, Uninsulated, Offset Rectangular Tongue, Crimp Style, Copper, Type 1, Class 1.	26 Sep 67
MS-21009	Terminal, Lug, Uninsulated, Rectangular Tongue, Lipped Side, Crimp Style, Copper, Type 1, Class 1.	26 Sep 67
MS-21011A	Terminal, Lug, Uninsulated, Rectangular Tongue, Reinforced Boss, Positioning Slot, Crimp Style, Copper, Type 1, Class 1.	2 Jul 68
MS-21012	Terminal Lug, Uninsulated, Rectangular Tongue, Lipped End, Crimp Style, Copper, Type 1, Class 1.	26 Sep 67
MS-21013	Terminal, Lug, Uninsulated, Rectangular Tongue, Off-center Hole, Lipped End, Crimp Style, Copper, Type 1, Class 1.	26 Sep 67
MS-21014	Terminal, Lug, Uninsulated, Rectangular Tongue, Two-barrel, Crimp Style, Copper, Type 1, Class 1.	26 Sep 67
MS-21015	Terminal, Lug, Uninsulated, Square Tongue, Lipped End, Rectangular Stud Hole, Crimp Style, Copper, Type 1, Class 1.	26 Sep 67
MS-21985C	Wire, Electric, Extruded Tfe-fluorocarbon-insulated, Silver-coated Copper, 600-Volt.	1 Jul 66
MS-25036H	Terminal, Lug, Crimp Style, Copper, Insulated, Ring-Tongue, Bell-mouthed, Type 1i, Class 1.	28 Jul 69
MS-25037D Notice 1(AS)	Crimping Tool, Hand, Class 1, for Copper Insulated Terminals, 26-10.	25 Sep 63

TABLE II (Contd.)

Number	Title	Date
MS-25181J	Splice, Electric, Permanent, Crimp Style, Copper, Insulated, Type 11, Class 1.	8 Aug 69
MS-25189C	Terminal, Lug, Flag Type Crimp Style, Copper, Class 1 (Asg).	4 Nov 68
MS-25192C	Cable, Electric, Aerospace Vehicle, 105 Deg. C., Copper Shield.	6 May 65
MS-25313C	Cable, Electric, Aerospace Vehicle, 105 Deg. C, Copper Shield, Nylon Jacket.	6 May 65
MS-25471C	Wire, Electrical-silicone-insulated, Copper, 600 Volt, 200 Deg. C, Polyester Jacket.	6 Jan 69
MS-27110C	Wire, Electrical-Silicone Insulated, Copper, 600 Volt, 200 Deg. C. Fep JACKE300661T(Asg).	6 Jan 69
MS-27958	Hinge, Butt-narrow and Broad, Template, Hardware, Builder, s, Commercial, Brass.	24 Feb 61
MS-27960	Hinge, Butt-narrow Light, Non-template, Hardware, Builder, s, Commercial, Brass.	24 Feb 61
MS-27961	Hinge, Butt-broad, Non-template, Hardware, Builder, s, Commercial Bronze.	24 Feb 61
MS-27962	Hinge, Butt-spring, Screen Door, Adjustable Hardware Builder, s, Commercial, Brass or Steel.	24 Feb 61
MS-27963	Hinge, Butt-spring, Single Acting and Double Acting, Adjustable, Hardware, Builder, s, Commercial Wrought Bronze.	24 Feb 61
MS-27964	Hinge, Butt-cabinet, Hardware, Builder, s, Commercial, Brass or Steel.	24 Feb 61
MS35198B	Screw, Machine, Flat Countersunk Head 82° Cross-recessed, Brass, Black, Oxide Finish, NC-2A-UNC-2A.	4 May 65
MS-35199A	Screw, Machine-flat Countersunk Head, 82 Deg., Cross-recessed, Brass, Black Oxide, UNF-2A.	21 Mar 63
MS-35214B	Screw, Machine-pan Head, Cross Recessed, Brass, Black Oxide, UNC-2A.	26 Aug 68
MS-35215A	Screw, Machine-pan Head, Cross-recessed, Brass, Black Oxide, UNF-2A.	17 Dec 62
MS-35273B	Screw, Machine Drilled Filister Head, Slotted, Brass, Black Oxide Finish, UNC-2A.	29 Jul 65
MS-35274B	Screw, Machine-drilled Filister Head, Slotted, Brass, Black Oxide Finish, UNF-2A.	16 Apr 65
MS-35309A	Screw, Cap, Hexagon Head (Finished Hexagon Bolt), Naval Brass, Plain Finish, UNC-2A.	30 Sep 66
MS-35310A	Screw, Cap, Hexagon Head (Finished Hexagon Bolt), Naval Brass, Plain Finish, UNF-2A.	30 Sep 66

TABLE II (Contd.)

Number	Title	Date
MS-35311	Screw, Cap, Hexagon Head (Finished Hexagon Bolt), Nickel-copper Alloy, Plain Finish, UNC-2A.	4 Mar 54
MS-35312	Screw, Cap, Hexagon Head (Finished Hexagon Bolt), Nickel-copper Alloy, Plain Finish, UNF-2A.	4 Mar 54
MS-35430B	Terminal, Lug, Solder Type, Copper Stamping, One Hole.	10 Feb 61
MS-35431A	Terminal, Lug, Solder Type, Copper Stamping, One Hole, Flat.	23 Jul 56
MS-35432A	Terminal, Lug, Solder Type, Copper Stamping, One Hole, Flat, Slitted.	23 Jul 56
MS-35433A	Terminal, Lug, Solder Type, Copper Stamping, One Hole, Center Mounting.	23 Jul 56
MS-35434A	Terminal, Lug, Solder Type, Copper Stamping, One Hole, Flag.	23 Jul 56
MS-35435C	Terminal, Lug, Solder Type, Copper Stamping, One Hole, Locating Lip.	10 Jul 64
MS-35436B	Terminal, Lug, Solder Type, Copper Stamping, Insulation Grip, One Hole.	10 Feb 61
MS-35437A	Terminal, Lug, Solder Type, Copper Stamping, Insulation Grip, One-hole, Locating.	23 Jul 56
MS-35438A	Terminal, Lug, Solder Type, Copper Stamping, Insulation Grip, One Hole, Flag.	23 Jul 56
MS-35439C	Terminal, Lug, Solder Type, Copper Stamping, Insulation Grip, Elongated Hole.	10 Jul 64
MS-35440A	Terminal, Lug, Solder Type, Copper Stamping, Insulation Grip, Slotted.	23 Jul 56
MS-35441A	Terminal, Lug, Solder Type, Copper Stamping, Insulation Grip, Slotted, Flag.	23 Jul 56
MS-35442A	Terminal, Lug, Solder Type, Copper Stamping, Insulation Grip, Slotted, 45 Deg.	23 Jul 56
MS-35443A	Terminal, Lug, Solder Type, Copper Stamping, Slotted.	23 Jul 56
MS-35444A	Terminal, Lug, Solder Type, Copper Stamping, Two Hole.	23 Jul 56
MS-35445A	Terminal, Lug, Solder Type, Copper Stamping, Two Hole, Flat, Slitted.	23 Jul 56
MS-35446B	Terminal, Lug, Solder Type, Copper Tubing, One Hole.	10 Feb 61
MS-35447B	Terminal, Lug, Solder Type, Copper Tubing, One Hole, 45 Deg.	10 Feb 61
MS-35448B	Terminal, Lug, Solder Type, Copper Tubing, One Hole, 90 Deg.	10 Feb 61
MS-35449B	Terminal, Lug, Solder Type, Copper Tubing, Two Hole.	10 Feb 61

TABLE II (Contd.)

Number	Title	Date
MS-35492D	Screw, Wood, Flat Head, Cross-recessed, Steel and Brass.	26 Nov 68
MS-35493D	Screw, Wood, Round Head, Cross-recessed, Steel and Brass.	20 May 68
MS-35494D	Screw, Wood, Flat Head, Slotted, Steel and Brass.	20 May 68
MS-35495C	Screw, Wood, Round Head, Slotted, Steel and Brass.	20 May 68
MS-35646A	Screw, Eye, Steel or Brass.	30 Dec 65
MS-35660A	Adapter, Cylinder Valve, Brass, Class 300-510, Acetylene, 300 Psi Working Pressure.	5 Sep 68
MS-35661A	Adapter, Compressed Gas Cylinder Valve Connections, Brass, Class 510-300, Acetylene, 300 Psi Working Pressure.	5 Sep 68
MS-35673A	Pin, Grooved, Headless, Longitudinal Taper Groove, Brass.	17 Mar 65
MS-35676	Pin, Grooved, Headless, Longitudinal Straight Groove, Brass.	11 Jan 56
MS-35679A	Pin, Grooved, Headless Longitudinal Center Groove, Brass.	17 Mar 65
MS-35685A	Rivet, Split, Oval Head, Brass.	14 Mar 69
MS-35769A	Gasket, Metallic-encased, Annular, Copper and Asbestos.	13 Dec 63
MS-35771B	Bearing, Sleeve, Plain, Bronze.	14 Nov 67
MS-35772	Bearing, Sleeve, Flanged, Bronze	14 Nov 67
MS-35910A	Gasket, Solid Copper, Spark Plug, (Other than Aircraft)	12 Apr 67
MS-36252A	Corrosion Test Strip Copper.	27 Nov 67
MS-36566	Connector, Elastic Tubing, Branched Brass.	20 Sep 68
MS-39087	Handle, Bow, Brass.	18 May 59
MS-39220A	Adapter, Compressed Gas Cylinder Valve Connection, Brass, Class 200-510, Acetylene 300 Psi Service Pressure.	5 Sep 68
MS-39221A	Adapter, Compressed Gas Cylinder Valve Connection, Brass, Class 510-200, Acetylene, 300 Psi Service Pressure.	5 Sep 68
MS-39222A	Adapter, Compressed Gas Cylinder Valve Connection, Brass, Class 200-520, Acetylene, 300 Psi Service Pressure.	5 Sep 68
MS-39223A	Adapter, Compressed Gas Cylinder Valve Connection, Brass, Class 520-510, Acetylene, 300 Psi Service Pressure.	5 Sep 68
MS-39272	Adapter, Compressed Gas Cylinder Valve Connections, Brass, Helium, Class 580-350, 2,500 Psi Service Pressure.	24 Nov 65
MS-39273	Adapter, Compressed Gas Cylinder Valve Connections, Brass, Helium, Class 350-580, 2,500 Psi Service Pressure.	24 Nov 65
MS-39274	Adapter, Compressed Gas Cylinder Valve Connections, Brass, Acetylene, Class 300-520, 300 Psi Service Pressure.	24 Nov 65
MS-39275	Adapter, Compressed Gas Cylinder Valve Connections, Brass, Acetylene, Class 510-520, 300 Psi Service Pressure.	24 Nov 65

TABLE II (Contd.)

Number	Title	Date
MS-51033A	Setscrew, Hexagon Socket, Flat Point Brass, Uncoated, NF-3A.	29 Jan 64
MS-51040A	Setscrew, Hexagon Socket, Cone Point, Brass, Uncoated, NF-3A.	29 Jan 64
MS-51945A	Rivet, Solid Countersunk Head, Brass or Copper.	7 Jul 70
MS-51969A	Nut, Plain, Hexagon-brass, Black Oxide, UNC-2B.	22 May 67
MS-51970	Nut, Plain, Hexagon-brass, Black Oxide, UNF-2B (Supersedes in Part MS-35690).	20 Jan 64
MS-63046	Punch, Drive Pins, Brass (Inactive After 31 Dec 61).	6 Sep 60
MS-90498	Clamp, Dead End Strain (Copper).	15 May 70

QUALIFIED PRODUCTS LIST

Number	Title	Date
QPL-684-11	Cup Bullet Jacket, Copper Alloy Clad Steel, For Small Arms.	3 Feb 70
QPL-5086/6-1	Wire, Electric Hookup and Interconnecting Polyvinylidene Fluoride Jacket, Silver Coated Copper Alloy Conductor, 600V, 110 Deg. C.	8 Jul 70
QPL-5086-25(5)	Wire, Electric, Hookup and Interconnecting PVC Insulated, Copper or Copper Alloy.	16 Jan 70
QPL-5908-5(1)	Wire, Electrical Copper and Copper Constantan, Thermocouple.	5 Jul 63
QPL-8777-12	Wire, Electrical Silicone Insulated Copper 600 Volt, 200 Deg C.	23 Sep 64
QPL-21659 Notice 1	Electrode, Bare, Welding, Copper and Copper Alloy.	12 Mar 69
QPL-22759/1-14	Wire, Electric, Fluorocarbon-Insulated Copper or Copper Alloy.	8 Dec 70
QPL-22759/2-4	Wire, Electric, Fluorocarbon Insulated Copper or Copper Alloy.	8 Dec 70
QPL-22759/3-4	Wire, Electric, Fluorocarbon Insulated Copper or Copper Alloy.	7 Dec 70
QPL-22759/4-2	Wire Electric, Fluorocarbon Insulated Copper or Copper Alloy.	30 Mar 70
QPL-22759/5-3	Wire, Electric, Fluorocarbon-Insulated Copper or Copper Alloy.	8 Dec 70
QPL-22759/6-2	Wire, Electric, Fluorocarbon-Insulated Copper or Copper Alloy.	8 Dec 70
QPL-22759/7-3	Wire, Electric, Fluorocarbon-Insulated Copper or Copper Alloy.	14 Jul 70

TABLE II (Contd.)

Number	Title	Date
QPL-22759/8-2	Wire, Electric, Fluorocarbon Insulated, Abrasion Resistant TFE, Medium Weight Nickel Coated Copper Conductor 600 Volt.	14 Jul 70
QPL-22759/9-3	Wire Electric, Fluorocarbon Insulated Copper or Copper Alloy.	23 Sep 70
QPL-22759/10-3	Wire, Electric Fluorocarbon Insulated Copper or Copper Alloy.	24 Sep 70
QPL-22759/11-2	Wire, Electric, Fluorocarbon Insulated Copper or Copper Alloy.	2 Oct 70
QPL-22759/12-2	Wire, Electric, Fluorocarbon Insulated Copper or Copper Alloy.	2 Oct 70
QPL-22759/13-1	Wire, Electric, Fluorocarbon Insulated FEP-PVF2 Medium Weight, Tin Coated Copper, 600 Volt.	8 Jul 70
QPL-22759/14-2	Wire, Electric, Fluorocarbon-Insulated FEP-PVF2 Lightweight Tin Coated Copper, 600 Volt.	12 Nov 70
QPL-22759/15-1 Notice 1	Wire, Electric, Fluorocarbon-Insulated FEP-PVF2 Lightweight, Silver Plated High Strength Copper Alloy 600 Volt.	21 Aug 70
QPL 24202-6	Fitting, Butt Welding, Seamless or Welded 70-30 Copper-Nickel Alloy 700, psi 200 Deg. F.	15 May 70
QPL-81044/1-3(1)	Wire, Electric, Crosslinked Polyalkene Insulated, Silver-plated Copper, Abrasion Resistant.	13 Nov 69
QPL-81044/2-3(1)	Wire, Electric, Crosslinked Polyalkene Insulated, Tin-coated Copper, Abrasion Resistant.	13 Nov 69
QPL-81044/3-5(1)	Wire, Electric, Crosslinked Polyalkene Insulated, Silver-plated Copper, Light Weight.	13 Nov 69
QPL-81044/4-5(1)	Wire, Electric, Crosslinked Polyalkene.	13 Nov 69
QPL-81044/5-1	Wire, Electric, Crosslinked Polyalkene Insulated Silver-plated Copper, Normal Weight. 150 Deg. C.	7 Jun 67
QPL-81044/6-1	Wire, Electric, Crosslinked Polyalkene Insulated, Tin-coated Copper, Normal Weight, 150 Deg. C.	6 Jun 67
QPL-81044/7-1	Wire, Electric, Crosslinked Polyalkene Insulated, Silver-plated High Strength Copper Alloy, Normal Weight, 150 Deg. C.	6 Jun 67
QPL-81044/8-1	Wire, Electric, Crosslinked Polyalkene Insulated, Silver-plated Copper, Medium Weight, 150 Deg. C.	6 Jun 67
QPL-81044/9-1	Wire, Electric, Crosslinked Polyalkene Insulated, Tin-coated Copper, Medium Weight, 150 Deg. C.	6 Jun 67
QPL-81044/10-1	Wire, Electric, Crosslinked Polyalkene Insulated, Silver-plated High Strength Copper Alloy, Medium Weight, 150 Deg. C.	6 Jun 67
QPL-81044/11-1	Wire, Electric, Crosslinked Polyalkene Insulated, Silver-plated Copper, Light Weight, 150 Deg. C.	6 Jun 67

TABLE II (Contd.)

Number	Title	Date
QPL-81044/12-1	Wire, Electric, Crosslinked Polyalkene Insulated, Tin-coated Copper, Light Weight, 150 Deg. C.	6 Jun 67
QPL-81044/13-1	Wire, Electric, Crosslinked Polyalkene Insulated, Silver-plated High Strength Copper Alloy, Light Weight, 150 Deg. C.	6 Jun 67
QPL-81044/14-1(1)	Wire, Electric, Crosslinked, Polyalkene Insulated, Tin Coated Copper, Medium Weight, 135 Deg. C.	13 Nov 69
QPL-81044/15-1(1)	Wire, Electric, Crosslinked Polyalkene Insulated Silver Plated High Strength Copper Alloy, Medium Weight, 135 Deg. C.	13 Nov 69
QPL-81044/16 Notice 1	Wire, Electric, Crosslinked Alkene-imide Polymer-insulated Tin-coated Copper, Normal Weight, 150 Deg. C.	28 Jan 70
QPL-81044/17 Notice 1	Wire, Electric, Crosslinked, Alkene-imide Polymer-insulated, Silver-plated, High Strength Copper Alloy, Normal Weight, 150 Deg. C.	28 Jan 70
QPL-81044/18 Notice 1	Wire, Electric, Crosslinked, Alkene-imide Polymer-insulated, Tin-coated Copper, Lightweight 150 Deg. C.	28 Jan 70
QPL-81044/19 Notice 1	Wire, Electric, Crosslinked Alkene-imide Polymer-insulated, Silver-plated High-strength Copper Alloy, Lightweight, 150 Deg. C.	29 Jan 70
QPL-81381/1-6	Wire, Electric Fluorocarbon/polyimide Insulated Light Weight, Silver Coated Copper.	28 May 70
QPL-81381/2-6	Wire, Electric, Fluorocarbon/polyimide Insulated Light Weight, Nickel-coated Copper.	28 May 70
QPL-81381/3-6	Wire, Electric, Fluorocarbon/polyimide Insulated Medium Weight, Silver-coated Copper.	28 May 70
QPL-81381/4-6	Wire, Electric, Fluorocarbon/polyimide Insulated Medium Weight, Nickel-coated Copper.	28 May 70
QPL-81381/5-3	Wire, Electric, Fluorocarbon/polymide Insulated Light Weight, Silver Coated High Strength Copper Alloy.	28 Aug 70
QPL-81381/6-3	Wire, Electric, Fluorocarbon/polyimide Insulated Light Weight, Nickel Coated High Strength Copper Alloy.	28 Aug 70
QPL-81381/7-1 Notice 1	Wire, Electric, Fluorocarbon/polyimide Insulated Lightweight, Silver Coated Copper.	21 Oct 70
QPL-81381/8-1	Wire, Electric, Fluorocarbon/polyimide Insulated Lightweight, Nickel Coated Copper.	21 Oct 70
QPL-81381/9-1 Notice 1	Wire, Electric, Fluorocarbon/polyimide, Insulated Lightweight, Silver Coated High Strength Copper Alloy.	21 Oct 70
QPL-81381/10-1 Notice 1	Wire, Electric, Fluorocarbon/polyimide Insulated Lightweight, Nickel Coated High Strength Copper Alloy.	21 Oct 70

TABLE III. QQ-C-390 - CROSS REFERENCE AND APPLICATIONS OF COPPER ALLOYS FOR CASTING

Alloy Number	Other Designations	Type of Casting			Other Specs Pertaining to the Alloy				Typical Applications
		St	Ce	Co	Military	ASTM	SAE	CDA	
A-1	Leaded Yellow Brass Naval Brass	X			-	-	-	-	For corrosion-resisting castings where strength or bearing requirements are unimportant, such as: brass hatch and door fitting and frames, fittings for mess tables and benches, skylight and chest hinges and fittings, joiner-work fittings (except hardware), fittings in general not subjected to pressure, brackets and clips, brass valves and fittings for ventilation systems (except working parts), ship trim, and brass pipe flanges.
A-2	Leaded Yellow Brass 405.2, 63-1-1-35 60-40 Yellow Brass		X	X	MIL-C-15345 Alloy 3	B-30 B-146 B-271	-	857	Bushings, hardware fittings, ornamental castings.
A-3	Leaded Yellow Brass 403, 67-1-3-29 Commercial No. 1 Yellow Brass	X	X	X	-	B-30 B-146 B-271	41	854	For castings not exposed to water or air pressure and as substitute for ferrous castings that corrode easily. Used for name and number plates, instrument cases, oil cups, distribution boxes, trimmings, and similar small castings. Machines easier than naval brass (alloy A1) but has lower mechanical properties. Maximum iron content (0.10 percent) should be specified for castings intended for use in artillery fire control instruments and magnetic compass equipment which cannot tolerate any disturbance of the magnetic field. General purpose yellow casting alloy not subject to high internal pressure, furniture hardware, ornamental castings, radiator fittings, ship trimmings, gas cocks, battery clamps, valves and fittings.
A-4	High Copper Yellow Brass, 400 72-1-3-24	X	X	X		B-30 B-146 B-271	-	852	A general purpose alloy with good machining properties. Fittings, fixtures, hardware, ornamental brass chandeliers, andirons.
A-5	Yellow Brass	X	X		MIL-C-15345 Alloy 2	-	-	-	For torpedo tubes and similar applications requiring moderate sea-water corrosion resistance and medium strength.
B-1	Leaded Semi-Red Brass, 101 80-5-2.5-125	X	X	X	MIL-B-16542	B-505	-	842	Medium grade brass for standard and extra heavy water, air, or gas fittings. Ordinarily may be purchased without mechanical property tests. Pipe fittings, elbows, tees, couplings, bushings, locknuts, plugs, unions.

TABLE III (Contd.)

Alloy Number	Other Designations	Type of Casting			Other Specs Pertaining to the Alloy				Typical Applications
		St	Ce	Co	Military	ASTM	SAE	CDA	
B-2	Leaded Semi-Red Brass, 123, Valve Composition 81-3-7-9	X	X	X	-	B-30 B-145 B-271 B-505	-	844	For general service similar to ounce metal or hydraulic bronze (see alloy B5). Used for threaded pipe, ornamental, or electrical fittings. Should be used wherever practicable because tin content is lower than some similar compositions. Not recommended for castings used in fire control instruments and magnetic compass equipment which cannot tolerate any disturbance of the magnetic field. Ordinarily may be purchased without mechanical property tests. General hardware, ornamental castings, plumbing, pressure valves and fittings.
B-4	Leaded Red Brass 120, Commercial Red Brass 83-4-6-7, 115	X	X	X	-	B-30 B-145 B-271 B-505	-	838	A general purpose free machining bronze for use in low pressure valves, plumbing supplies, and general hardware. It is not recommended for castings intended for use in artillery fire control instruments and magnetic compass equipment which cannot tolerate any disturbances of a magnetic field. Air-gas-water fittings, pump components, railroad catenary fittings.
B-5	Leaded Red Brass Composition Bronze, Ounce Metal, 85-5-5, 115	X	X	X	MIL-C-15345 Alloy 1 MIL-C-22229 Comp 2 MIL-C-22087 MIL-C-11866 Comp 25	B-30 B-62 B-145 B-271 B-505	40 (AMS 4855)	836	For general castings requiring fair strength, soundness, and machining properties, such as: pipe fittings, gasoline-line and oil-line fittings, small gears, fire equipment fittings, and ornamental fixtures. Requires less critical materials than valve bronze (see alloy D4). Valves, flanges, plumbing goods, pump castings, water pump impellers and housings, small gears.
B-6		X	X	X	-	-	-	-	Where a bronze is required, but superior mechanical properties are not essential; uses such as ornamental or electrical fittings, marker plates, hand-wheels, and brackets.
C1	Nickel Manganese Bronze	X			MIL-B-19708	-	-	868	As an alternative to manganese bronze where higher strength and improved resistance to corrosion-erosion are required. Marine fittings, marine propellers.
C2	Leaded High Strength Yellow Brass, 420 60,000 Tensile Manganese Bronze	X	X	X	-	B-30 B-132 B-147 B-271 B-505	-	864	Can be produced from secondary materials, and is easier to machine than other classes of this alloy. For uses where strength or toughness plus resistance to sea-water corrosion is required, as in shock loaded slides, bearings, worm wheels, framing, propeller blades and hubs, lever arms, gears, and liners. Do not use where stress corrosion may be a factor. Marine fittings, lever arms, brackets, light duty gears.

TABLE III (Contd.)

Alloy Number	Other Designations	Type of Casting			Other Specs Pertaining to the Alloy				Typical Applications
		St	Ce	Co	Military	ASTM	SAE	CDA	
C3	65,000 MnBR	X	X		MIL-C-15345 Alloy 4 MIL-C-22229 Comp 7 MIL-C-22087 Comp 5	B-30 B-147 B-271	43 (AMS 4860)	865	Can be produced from secondary materials. It is similar to alloy C2 in corrosion resistance, except that it is recommended where stress corrosion may be a factor. It has higher strength that alloy C2, and has similar applications.
C4	High Strength Yellow Brass, 90,000 Tensile Manganese Bronze, 423	X		X	MIL-C-22229 Comp 9 MIL-C-22087 Comp 9 MIL-C-11866 Comp 20	B-30 B-147 B-271 B-505	430A	862	For use where superior strength or toughness is required. Its resistance to corrosion by sea-water is unsatisfactory. Typical applications - gears and worm wheels. Marine castings, gun mounts, bushings and bearings.
C5	Same as C4	X	X		MIL-C-15345 Alloy 5 MIL-C-22087 Comp 7 MIL-C-22229	-	-	861	For use where superior strength, toughness, or resistance to corrosion by sea-water is required. Typical applications - slides, brackets, worm wheels and gears. Marine castings, gun mounts, bushings and bearings.
C6	100,000 Manganese Bronze	X			-	-	-	-	Alloy numbers C6 and C7. Have the highest mechanical properties of any copper-base alloy, but their resistance to salt water corrosion is unsatisfactory.
C7	High Strength Yellow Brass, 110,000 Tensile Manganese Bronze, 424	X	X	X	MIL-C-22087 Comp 9 MIL-C-22229 Comp 8 MIL-C-15345 Alloy 6 MIL-C-11866 Comp 21	B-22E B-30 B-147 B-271 B-505	430B (AMS 4862)	863	Extra heavy duty high strength alloy, large valve stems, gears, cams, slow speed heavy load bearings, screw-down nuts, hydraulic cylinder parts.
D1	Tin Bronze, 81-19 194, 80-20-0-0	X	X	X	-	B-22A B-505	(AMS 7322)	913	An extra-hard bearing bronze intended only for special applications. Piston rings, bearings, bushings, bridge plates, bells.
D2	Tin Bronze 85-14-0-1, 197	X	X	X	-	B-505	-	910	A hard bearing bronze, also known as a hard gear bronze. Piston rings and bearings.

TABLE III (Contd.)

Alloy Number	Other Designations	Type of Casting			Other Specs Pertaining to the Alloy				Typical Applications
		St	Ce	Co	Military	ASTM	SAE	CDA	
D3	Leaded Tin Bronze Leaded "G" Bronze 87-8-1-4, 230	X	X	X	MIL-C-15345 Alloy 10	B-30 B-143 B-271 B-505	621	923	A leaded gun metal used instead of alloy D5 where better machining properties and sounder castings are required. Valves, pipe fittings and high pressure steam castings; superior machinability to Copper Alloy No. 903.
D4	Navy "M" Steam Bronze, 245 86-6-1 1/2-4 1/2 86-6-2-4	X	X	X	MIL-C-15345 Alloy 9	B-30 B-61 B-143 B-271 B-505	622	922	Parts for use up to 550F. A general purpose free-machining bronze for parts requiring medium strength and resistance to salt-water corrosion. Used for low and medium pressure valves, castings for stern tube and propeller shaft sleeves, hose couplings and fittings, and cocks. Good brazing qualities make it suitable for general bearing use if the bushings are to be silver brazed to other components.
D5	Tin Bronze "G" Bronze, 88-8-0-4 225	X	X	X	MIL-C-15345 Alloy 8 MIL-C-22229 Comp 1	B-30 B-143 B-271 B-505	620	903	Excellent steam metal and high-tensile structural bronze used for expansion joints, special pipe fittings, gears, bolts and nuts, valves, pump pistons and casings, bushings, bearings, and similar applications with weight limitations requiring strength plus the corrosion resistance of tin bronze. This alloy is recommended for pipe fittings and similar parts which are to be silver brazed.
D6	Tin Bronze Gun Metal 88-10-0-2, 210	X	X	X	-	B-22 B-30 B-143 B-271 B-505	-	905	A nonleaded hard bronze with excellent wearing properties; can be silver brazed; preferred for guides, bushings operating at very high loads at low speeds, gears, and worms.
E1	High Leaded Tin Bronze, 70-5-25 71-5-24-0, Soft Bronze	X	X	X	-	B-66 B-144 B-271 B-505	-	943	Alloy numbers E1, E5, and E6. High-leaded bronze for bearings or bushings under light loads and high speeds. Suitable for bearing liners where the bearing metal must deform slightly to conform to irregular motion or imperfect fit; also effective where lubrication is difficult and for uses as bearings or railway rolling stock, traveling cranes, rock crushers, winches, and conveyors.
E2	70-14-16-0	X	X	X	-	B-505	-	940	Used for torpedo engine and tail bushings.
E3	75-5-20-0	X	X	X	-	B-67 B-505	-	941	An excellent high-leaded bronze used for full floating bushings, oil-to-liquid seals, gasoline and jet fuel pump bushings, bearings, and pressure plates.

TABLE III (Contd.)

Alloy Number	Other Designations	Type of Casting			Other Specs Pertaining to the Alloy				Typical Applications
		St	Ce	Co	Military	ASTM	SAE	CDA	
E4	76-6-17-1	X		X	-	B-67 B-505	-	(941)	A good bearing bronze for machinery carrying heavy loads and running at very low speeds.
E5	75-5-20-0	X		X	-	B-67 B-505	-		See E1.
E6	78-7-15	X	X	X	-	B-30 B-66 B-144 B-271 B-505	-	938	See E1.
E7	83-7-7-3 319	X	X	X	MIL-C-15345 Alloy 12	B-30 B-144 B-271 B-505	660	932	Alloy number E7. Used for strength, hardness, or shock resistance and for general utility bearings, ordnance bushings, and fittings similar to alloy E8. Suitable for heavily loaded true-running, finely polished bearings which are lubricated, and for members where the bearings are integral with the supporting or enclosing structure. Preferred to alloy E8 because it is readily produced from secondary materials and provides greater pressure tightness.
E8	84-8-8-0 310	X	X	X	MIL-C-15345 Alloy 11 MIL-C-22229 Comp 3	B-505	-	934	Similar to E1 and E7.
E9	85-5-9-1 326	X	X	X	-	B-30 B-144 B-271 B-505	66	935	A good general purpose bronze for applications involving high speeds at low loads - small bearings and bushings bronze backing for Babbitt lined automotive bearings.
E10	80-10-10 Bushing and Bearing Bronze 305		X	X		B-22 B-30 B-144 B-505	64 (AMS 4842)	937	Used for general bearing service, similar to E7 and E8.
F-1	88-10-5-0-0-1.5 Nickel Tin Bronze Nickel Gear Bronze	X	X	X	MIL-C-15345 Alloy 23	B-427	-	916	Used as gear material; generally chill cast with mechanical property requirements based on this method of casting.

TABLE III (Contd.)

Alloy Number	Other Designations	Type of Casting			Other Specs Pertaining to the Alloy				Typical Applications
		St	Ce	Co	Military	ASTM	SAE	CDA	
F-2	88-5-0-2-5 Nickel Tin Bronze		X	X	MIL-B-17528 Alloy 1	B-292 B-505	-	947	For expansion joints, pipe fittings, gears, bolts, nuts, valves, pump pistons, casings, bushings, and bearings requiring good strength and resistance to salt water corrosion.
F-3	87-5-1-2-5	X		X	MIL-B-17528 Alloy 2	B-292 B-505	-	948	Similar to alloy F2 but with lower strength and better machinability.
G-1	Aluminum Bronze	X	X	X	-	-	-	-	Heavy duty, dense, high-strength alloys with hardness equal to that of manganese bronze, and excellent resistance to corrosion and fatigue. Have good wearing qualities for elevated temperature uses. For gun slides and mountings, for worm wheels and gears, valve seats, bearings and bushings, propeller blades and hubs, liners, and bearing plates subjected to heavy loads. Proper precautions and controls are necessary to obtain satisfactory welds.
G-2	81-4-4-11 Aluminum Bronze 9D, 415		X	X	MIL-C-15345 Alloy 14 MIL-C-22087 Comp 8 MIL-C-22229 Comp 6	B-30 B-148 B-271 B-505	-	955	Same as G-1.
G-3	81-4-4-11 Aluminum Bronze 9D, 415	X	X	X	MIL-C-15345 MIL-C-22229 Comp 6	B-30 B-148 B-271	-	955	Same as G-1.
G-4	Aluminum Bronze	X			MIL-B-21230 MIL-C-22229 Comp 6	B-30 B-148	-	955	Similar to alloys G1, G2, and G3, but having improved welding characteristics for repair. Also for marine applications such as propellers.
G-5	Aluminum Bronze	X	X	X	MIL-C-15345 Alloy 13	B-30 B-148 B-271 B-505	-	954	Alloy numbers G5, G6, and G7. Similar to alloys G1, G2, and G3, only insofar as application is concerned. Optional properties applicable when intended for shaft sleeves in highly stressed shafting.
G-6	Aluminum Bronze 88-3-9, 415	X	X	X	MIL-C-22229 Comp 5	B-30 B-148 B-271 B-505	68A	952	

TABLE III (Contd.)

Alloy Number	Other Designations	Type of Casting			Other Specs Pertaining to the Alloy				Typical Applications
		St	Ce	Co	Military	ASTM	SAE	CDA	
G-7	Aluminum Bronze 9B, 89-1-10 415	X	X	X	MIL-C-11866 Comp 22	B-30 B-148 B-271 B-505	68B	953	See G5.
G-8	81-5-4-9-1 Alpha Nickel Aluminum Bronze 415	X	X		MIL-C-15345 Alloy 28 MIL-B-21230 Alloy 1 MIL-B-23921	-	-	958	Similar to alloys G1, G2, G3 and G4.
X-1	Silicon Brass	X	X		- MIL-C-22087 Comp 4	B-30 B-198-13A B-271 B-198-13B	-	874 875	X1 and X2 - For sound homogeneous castings of high strength, toughness and corrosion resistance, - bearings gears, impellers, rocker arms, valvestems, clamps, bells, marine fittings.
X-2	Silicon Bronze	X	X		MIL-C-22229 Comp 4	B-30 B-198 B-271	-	872	
X-3	Cu-Be Alloy	X			-	-	-	-	For pressure-tight castings and other uses requiring good casting properties, excellent machinability, and good corrosion resistance and bearing properties.
X-4	See A5				-	-	-	-	
X-5	Cu-Be Alloy 10C	X			-	-	-	820	For switches and switch gear, circuit breakers, current-carrying devices, and other uses requiring moderate strength and hardness with good electrical conductivity.
X-6	Cu-Be Alloy 20C	X			MIL-C-22087 Comp 10	-	-	825	For bushings, cams, bearings, gears, safety tools and other uses requiring good resistance to wear and corrosion coupled with high strength.
X-7	Cu-Be Alloy	X			-	-	-	827	General purpose applications requiring high hardness and maximum strength - bearings and molds for plastic parts.
X-8	Cu-Be Alloy	X			-	-	-	828	Applications requiring high tensile and yield strength plus maximum hardness - molds for plastic parts, cams, bushings, valves, pump parts, sleeves.
X-9	Cu-Ni Alloy, 70-30 Copper Nickel	X			MIL-C-20159 Type 1	B-369B		964	Pipe and tube fittings, uses requiring a high grade alloy resistant to sea water corrosion, - valves, pump bodies, flanges.

TABLE IV. ASTM - CHEMICAL COMPOSITION OF CAST ALLOYS

ASTM Meth No.	Alloy	Commercial Designation	Copper	Tin	Lead	Zinc	Nickel	Iron	Aluminum	Manganese	Silicon	Phos-phorus	Other
B-22	A	Bronze	79.0-82.0	18.0-20.0	0.25	0.25		0.25				1.0	
	B	Bronze	82.0-85.0	15.0-17.0	0.25	0.25		0.25				1.0	
	C	Bronze	78.0-82.0	9.0-11.0	8.0-11.0	0.75		0.15				0.10	
	D	Bronze	86.0-89.0	9.0-11.0	0.30	1.0-3.0	1.0	0.15				0.05	
	E	*Bronze*	*60.0-68.0*	*0.20*	*0.20*	rem	1.0	2.4-4.0	3.0-7.5	2.5-5.0			Cu+ SN+ Pb+ Ni-98.50
B-61	922	Valve Bronze	86.0-90.0	5.5-6.5	1.0-2.0	3.0-5.0	1.0	0.25				0.05	
B-62	836	Leaded Red Brass (85-5-5-5)	84.0-86.0	4.0-6.0	4.0-6.0	4.0-6.0	1.0	0.30				0.05	
B-66	944	Phosphor Bronze	rem	7.0-9.0	9.0-12.0	0.75	1.00	0.15				0.20-0.50	0.75 Antimony
	938	Hard Bronze	rem	6.0-9.0	10.0-16.0	1.25	0.50	0.20				0.05	0.75 Antimony
	945	Medium Bronze	rem	6.0-8.0	16.0-22.0	1.25							
	943	Soft Bronze	rem	4.0-6.0	23.0-27.0	1.25							
B-132	864	Manganese Bronze	56.0-62.0	1.5		rem		2.0	1.5	1.5			
	867	Manganese Bronze	55.0-60.0	1.5		rem		3.0	3.0	3.5			
B-143	905	Tin Bronze (88-10-2)	*86.0-89.0*	*9.0-11.0*	*0.30*	*1.0-3.0*	*1.0*	0.15				0.05	
	903	Tin Bronze (88-8-4)	86.0-89.0	7.5-9.0	0.30	3.0-5.0	1.0	0.15				0.05	
	922	Leaded Tin Bronze (88-6-2-4)	86.0-90.0	5.5-6.5	1.0-2.0	3.0-5.0	1.0	0.25				0.05	
	923	Leaded Tin Bronze (88-8-4)	85.0-89.0	7.5-9.0	1.0	2.5-5.0	1.0	0.25				0.05	
B-144	937	High Leaded Tin Bronze (80-10-10)	78.0-82.0	9.0-11.0	8.0-11.0	0.75	0.75	0.15				0.05	0.55 Antimony
	932	(83-7-7-3)	81.0-85.0	6.25-7.5	6.0-8.0	2.0-4.0	0.50	0.20				0.15	0.35 Antimony
	935	(85-5-9-1)	83.0-86.0	4.5-6.0	8.0-10.0	2.0	0.50	0.20				-	*0.30 Antimony*
	938	(78-7-15)	75.0-79.0	6.25-7.5	13.0-16.0	0.75	0.75	0.15				0.05	0.75 Antimony
	943	(70-5-25)	68.5-73.5	4.5-6.0	22.0-25.0	0.50	0.75	0.15				0.05	0.75 Antimony
B-145	836	Leaded Red Brass (85-5-55)	84.0-86.0	4.0-6.0	4.0-6.0	4.0-6.0	1.0	0.30				0.05	
	838	Leaded Red Brass (83-4-6-7)	82.0-83.75	3.25-4.25	5.0-7.0	5.0-8.0	1.0	0.30				0.03	
	844	Leaded Semi-Red Brass (81-3-7-9)	78.0-82.0	2.25-3.5	6.0-8.0	7.0-10.0	1.0	0.40				0.02	
	848	*Leaded Semi-Red Brass (76-3-6-15)*	*75.0-76.75*	*2.0-3.0*	5.25-6.75	13.0-17.0	1.0	0.40				0.02	
B-146	852	High Copper Yellow Brass	70.0-74.0	0.75-2.0	1.5-3.75	rem		0.60					
	854	Commercial No. 1 Brass	65.0-70.0	1.5	1.5-3.75	rem		0.75	0.30				
	857	60-40 Yellow Brass	60.0-65.00	0.5-1.5	0.75-1.5	rem		0.75	0.50				

TABLE IV (Contd.)

ASTM Meth No.	ASTM Alloy	Commercial Designation	Copper	Tin	Lead	Zinc	Nickel	Iron	Aluminum	Manganese	Silicon	Phosphorus	Other
B-147	864	Leaded Manganese Bronze	56.0-62.0	1.5	0.5-1.5	rem		2.0	1.5	1.5			
	865	No. 1 Manganese Bronze	55.0-60.0	1.0	0.40	rem	0.50	0.40-2.0	0.50-1.5	1.5			
	862	High Strength Manganese Bronze	60.0-68.0	0.20	0.20	rem		2.0-4.0	3.0-7.5	2.5-5.0			
	863	High Strength Bronze	60.0-68.0	0.20	0.20	rem		2.0-4.0	3.0-7.5	2.5-5.0			
B-148	952	Aluminum Bronze	86.0					2.5-4.0	8.5-9.5				
	953	Aluminum Bronze	86.0					0.75-1.5	9.0-11.0				
	954	Aluminum Bronze	83.0				2.5	3.0-5.0	10.0-11.5	0.50			
	955	Aluminum Bronze	78.0				3.0-5.0	3.0-5.0	10.0-11.5	3.5			
	956	Silicon-Aluminum Bronze	88.8				0.25		6.0-8.0		1.75-3.25		
	957	Manganese-Nickel Bronze	71.0		0.03		1.5-3.0	2.0-4.0	7.0-8.5	11.0-14.0	0.10		
B-149	973	Leaded Nickel Brass	53.0-58.0	1.5-3.0	8.0-11.0	rem	11.0-14.0	1.5		0.5			
	976	Leaded Nickel Bronze	63.0-67.0	3.5-4.5	3.0-5.0	rem	19.5-21.5	1.5		1.0			
	978	Leaded Nickel Bronze	64.0-67.0	4.0-5.5	1.0-2.5	rem	24.0-27.0	1.5		1.0			
B-176	858	Brass Die Castings	57.0	1.50	1.50	30.0		0.50	0.25	0.25	0.25		
	878	Brass Die Castings	80.0-83.0	0.25	0.15	rem		0.15	0.15	0.15	3.75-4.25		Magnesium 0.01
	879	Brass Die Castings	63.0-67.0	0.25	0.25	rem		0.15	0.15	0.15	0.75-1.25		
B-198	872	Silicon Bronze	99.5*	1.0	0.5	5.0		2.0	1.5	1.5	1.0-5.0		*Cu+ Named Elements
	874	Silicon Brass	99.5*		1.0	12.0-16.0					2.5-4.0		
	875	Silicon Brass	99.5*		0.5	12.0-16.0					3.0-5.0		
	876	Silicon Brass	99.5*		0.5	4.0-7.0					3.5-5.5		
B-292	947	Nickel-Tin Bronze	85.0-90.0	4.5-6.0	0.10	2.5	4.5-6.0						
	948	Nickel-Tin Bronze	84.0-89.0	4.5-6.0	1.0	2.5	4.5-6.0						
B369	962	Copper Nickel Alloy	rem		0.03		9.0-11.0	1.0-1.8			0.25		Columbium 1.0 Max
	964	Copper Nickel Alloy	rem		0.03		28.0-32.0	0.25-1.5			1.5		Columbium 1.0 Max
B427	908	Nickel Gear Bronze	Balance	11.0-13.0	0.25		0.5						Cu+ SN+Ni+P=99.5 Min
	917	Nickel Gear Bronze	Balance	11.25-12.5	0.25		1.5-2.0						
	916	Nickel Gear Bronze	Balance	9.75-10.15	0.25		1.5-2.0						
	915	Nickel Gear Bronze	Balance	9.0-11.0	2.0-3.5		2.75-4.0						
B-433	962	See B 369	84.5-87.0				9.0-11.0	1.75		0.75-1.5	0.25		Co-1.0 Max
	964	See B 369	65.0-67.0				29.5-31.5	0.25-1.0		0.75-1.5	0.3-0.7		Co-0.7-1.5
B-492		Copper-Nickel Tail-shaft Sleeves	74.0-80	0.01		0.1	18.0-22.0	0.5-1.5	0.05	0.25-1.5	0.03-0.8	0.02	

TABLE V. CDA - MECHANICAL PROPERTIES OF CAST ALLOYS

Alloy No.	Condition	TS ksi	YS ksi .5% Ext.	YS ksi .2% Off.	EL %	Hardness R	Hardness BHN 500 Kg.	Hardness BHN 3000 Kg.	Hardness SS ksi	CYS (ksi) Compressive Strength .001	CYS (ksi) Compressive Strength .01	CYS (ksi) Compressive Strength .1	Impact Izod	Impact Charpy	Prop. Limit ksi	Fatigue Strength ksi
801	AC	25	9	9	40	-	44	-	-	-	-	-	-	-	-	9
803	AC	25	9	9	40	-	44	-	-	-	-	-	-	-	-	9
805	AC	25	9	9	40	-	44	-	-	-	-	-	-	-	-	9
807	AC	25	9	9	40	-	44	-	-	-	-	-	-	-	-	9
809	AC	25	9	9	40	-	44	-	-	-	-	-	-	-	-	9
811	AC	25	9	9	40	-	44	-	-	-	-	-	-	-	-	9
813	HT. TR.	53(min)	-	36(min)	11(min)	-	89	-	-	-	-	-	-	-	-	-
814	HT. TR.	53	-	36	11	B69	-	-	-	-	-	-	-	-	-	-
815	HT. TR.	51	40	-	17	-	105	-	-	-	-	-	30	20	26	15
817	HT. TR.	92	-	68	8	-	-	217	70	-	-	80	8	12	50	17
818	AC	50	-	25	20	B55	-	-	-	-	-	-	-	-	15	-
818	HT. TR.	102	-	75	8	B96	-	-	-	-	-	-	-	-	50	-
820	AC	50	-	20	20	B55	-	-	-	-	-	-	-	-	12	-
820	HT. TR.	100	-	75	8	B95	-	195	-	-	-	-	-	-	50	-
821	HT. TR.	92	-	68	8	-	-	217	70	-	-	100	8	12	50	17
822	AC	57	-	30	20	B60	-	-	-	-	-	-	-	-	20	-
822	HT. TR.	95	-	75	8	B96	-	-	-	-	-	-	-	-	50	-
824	AC	72	-	37	20	B78	-	-	-	-	-	-	-	-	25	-
824	HT. TR.	150	-	140	1	C38	-	-	-	-	-	-	-	-	95	-
825	AC	80	-	45	20	B82	-	-	-	-	-	-	-	-	-	-
825	HT. TR.	160	-	-	1	C40	-	-	-	-	-	90	8	-	110	24
826	AC	82	-	47	20	B83	-	-	-	-	-	-	-	-	32	-
826	HT. TR.	165	-	155	1	C43	-	-	-	-	-	-	-	-	110	-
827	HT. TR.	155(min)	-	130(min)	-	C39(min)	-	-	-	-	-	-	-	-	-	-
828	AC	97	-	55	20	B85	-	-	-	-	-	-	-	-	37	-
828	HT. TR.	165	-	145	1	C45	-	-	-	-	-	-	5	-	110	-
833	AC	32	10	-	35	-	35	-	-	-	-	-	-	-	-	-
834	AC	35	10	-	30	F50	-	-	26	-	-	-	-	-	-	-
836	AC	37	17	-	30	-	60	-	-	14	-	37.5	9	11	-	11
838	AC	35	16	-	25	-	60	-	-	11.5	29	-	8	-	-	-
842	AC	28(min)	-	-	15(min)	-	-	-	-	-	-	-	-	-	-	-
844	AC	29	13	-	18	-	-	-	-	-	-	-	-	-	-	-
848	AC	36	14	-	30	-	55	-	-	12.8	-	34	-	12	-	-
852	AC	38	13	-	35	-	45	-	-	9	-	30	-	-	-	-
853	AC	35	11	-	40	F54	-	-	-	-	-	-	-	-	-	-
854	AC	34	12	-	35	-	50	-	-	9	-	28	-	-	-	-
855	AC	60	23	-	40	B55	85	-	-	-	-	-	-	-	-	-
857	AC	50	18	-	40	-	75	-	-	-	-	-	-	-	-	-
858	AC	55	-	30	15	B55	-	-	-	-	-	-	-	40 (un-notched)	-	-
861	AC	95	50	50	20	-	-	180	-	50	-	-	12	-	-	-

TABLE V (Contd.)

Alloy No.	Condition	TS ksi	YS ksi .5% Ext.	YS ksi .2% Off.	EL %	Hardness				CYS (ksi)			Impact		Prop. Limit ksi	Fatigue Strength ksi
						R	BHN 500 Kg.	BHN 3000 Kg.	SS ksi	Compressive Strength .001	.01	.1	Izod	Charpy		
862	AC	95	-	48	20	-	-	180	-	50	-	-	12	-	-	-
863	AC	119	-	83	18	-	-	225	-	60	-	100	15	12	-	25
864	AC	65	-	25	20	-	90	105	-	23	-	87	30	25	-	-
865	AC	71	-	28	30	-	100	130	-	24	-	79	-	32	-	20
867	AC	85	42	-	20	B80	-	155	-	-	-	-	-	-	-	-
868	AC	82	38	-	22	-	-	80	-	-	-	-	-	-	-	-
872	AC	55	25	-	30	-	85	-	28	18	60	-	33	-	-	-
874	AC	55	24	-	30	-	70	100	-	-	-	-	-	40	-	-
875	AC	67	30	-	21	-	115	134	-	26.5	-	75	-	32	-	22
876	AC	66	32	-	20	B76	110	135	-	-	-	60	-	-	-	-
878	AC	85	-	50	25	B85	-	-	-	-	-	-	-	70 (un-notched)	-	-
879	AC	70	-	35	25	B70	-	-	-	-	-	-	-	50(un-notched)	-	-
902	AC	38	16	-	30	-	70	-	-	-	-	-	-	-	-	25
903	AC	45	21	-	30	-	70	-	-	13	-	-	-	14	-	-
905	AC	45	22	-	25	-	75	-	-	-	40	-	10	-	-	13
907	AC	44	22	-	20	-	80	-	-	-	-	-	-	-	-	25
907	CeC	55	30	-	16	-	102	-	-	-	-	-	-	-	-	-
909	AC	40	20	-	15	-	90	-	-	-	-	-	-	-	-	-
910	AC	32	25	-	2	-	105	-	-	-	-	-	-	-	-	-
911	AC	35	25	-	2	-	-	135	-	-	-	-	-	-	16	-
913	AC	35	30	-	0.5	-	-	170	-	-	-	-	-	-	-	-
915	AC	47	26	-	20	-	80	-	-	-	-	50	12	-	15	-
916	AC	44	22	-	16	-	85	-	-	-	-	-	-	-	16	-
916	CeC	60	32	-	16	-	106	-	-	-	-	-	-	-	-	-
917	AC	44	22	-	16	-	85	-	-	-	-	-	-	-	16	-
917	CeC	60	32	-	16	-	106	-	-	-	-	-	-	-	-	-
922	AC	40	20	-	30	-	65	-	-	-	-	38	-	19	-	11
923	AC	40	20	-	25	-	70	-	-	-	-	35	12	-	-	-
925	AC	44	20	-	20	-	80	-	-	-	-	-	-	-	-	-
926	AC	44	20	-	30	F78	70	-	-	12	-	40	7	-	-	-
927	AC	42	21	-	20	-	77	-	-	-	-	-	-	-	-	-
928	AC	40	30	-	1	B80	-	-	-	-	-	-	-	-	-	-
932	AC	35	18	-	20	-	65	-	-	-	-	46	6	-	8.5	16
934	AC	32	16	-	20	-	60	-	-	-	-	48	5	-	8	15
935	AC	32	16	-	20	-	60	-	-	13	-	-	-	8	-	-
937	AC	35	18	-	20	-	60	-	18	13	-	47	5	11	8	13
938	AC	30	16	-	18	-	55	-	15	12	-	38	5	-	4	10
939	Con.Cast.	32	22	-	7	-	63	-	-	-	-	-	-	-	-	-
943	AC	27	13	-	10	-	48	-	-	11	-	23	5	-	-	-

TABLE V (Contd.)

Alloy No.	Condition	TS ksi	YS ksi .5% Ext.	YS ksi .2% Off.	EL %	Hardness R	Hardness BHN 500 Kg.	Hardness BHN 3000 Kg.	Hardness SS ksi	CYS (ksi) Compressive Strength .001	CYS (ksi) Compressive Strength .01	CYS (ksi) Compressive Strength .1	Impact Izod	Impact Charpy	Prop. Limit ksi	Fatigue Strength ksi
944	AC	32	16	-	18	-	55	-	16	-	-	44	5	-	6	11
945	AC	25	12	-	12	-	50	-	13	-	-	36	4	-	4	10
947	AC	50	23	-	35	-	85	-	38	-	-	-	85	-	14	14
947	HT. TR.	85	60	-	10	-	-	180	65	-	-	-	110	-	50	14
948	AC	50	23	-	35	-	80	-	-	-	-	-	-	-	13	12
948	HT. TR.	60	30	-	8	-	120	-	-	-	-	-	-	-	20	12
952	AC	80	27	-	35	-	-	125	40	27	-	70	35	30	12	22
953	AC	75	27	-	25	-	-	140	41	20	-	83	20	-	15	22
953	HT. TR.	85	42	-	15	-	-	174	46	35	-	90	24	-	26	27
954	AC	85	35	-	18	-	-	170	47	-	-	100	14	-	17	28
954	HT. TR.	105	54	-	8	-	-	195	50	-	-	120	14	-	28	35
955	AC	100	44	-	12	-	-	195	48	-	-	120	13	-	28	31
955	HT. TR.	120	68	-	10	-	-	230	70	-	-	150	15	-	45	38
956	AC	75	34	-	18	-	-	140	-	-	-	-	-	-	-	-
957	AC	95	45	-	26	-	-	180	-	-	-	150	25	30	22.4	33
958	AC	95	38	-	25	-	-	159	58	-	-	100	20	-	-	31
962	AC	45(min)	25(min)	-	20(min)	-	-	-	-	-	-	37	-	100	-	13
963	AC	75(min)	55(min)	-	10(min)	-	150	-	-	-	-	-	-	-	-	-
964	AC	68	37	-	28	-	-	140	-	-	-	-	-	78	-	18
966	HT. TR.	110	-	70	7	-	-	230	-	-	-	-	-	41	-	22.5
973	AC	35	17	-	20	-	55	-	-	-	-	-	-	-	-	-
974	AC	38	17	-	20	-	70	-	-	-	-	-	-	-	-	-
976	AC	40	24	-	20	-	80	-	-	-	30	57	-	11	-	15.5
978	AC	55	30	-	16	-	-	130	-	-	-	-	-	-	-	-
993	AC	95	55	-	2	-	-	200	-	-	-	-	-	4	28	-

NOTE: Creep Strength (ksi)

Alloy No.	Temperature °F 250	350	450	500	550	600	700	800
836	-	12.5	11.1	-	7.0	-	-	-
848	-	11.9	8.0	-	3.0	-	-	-
863	56.5	19.0	0.5	-	-	-	-	-
865	28.0	6.2	1.7	-	-	-	-	-
875	-	28.0	11.0	-	1.4	-	-	-
922	-	16.0	11.2	-	6.2	-	-	-
937	-	10.4	7.4	-	1.8	-	-	-
954	-	-	-	-	-	7.4	4.4	2.9
955	-	-	-	-	-	10.5	5.5	2.4
957	-	-	-	20.4	-	4.2	2.3	-
976	-	-	32.5	-	22.2	-	-	-

TABLE VI. CDA - SOME PHYSICAL PROPERTIES OF CAST ALLOYS

Alloy No.	Melting Point		Density	Thermal Conductivity	Electrical Conductivity	Modulus of Elasticity
	Liquidus °F	Solidus °F	lb/cu. in. at 68°F	Btu/sq. ft. / ft. /hr. °F at 68°F	% IACS at 68°F	(Tension)x10^6
801	1981	1948	.323	226	100	17.0
803	1981	1948	.323	226	100	17.0
805	1981	1948	.323	200	92	17.0
807	1981	1948	.323	200	92	17.0
809	1981	1948	.323	200	92	17.0
811	1981	1948	.323	200	92	17.0
813	2000	1950	.318	150	60	16.0
814	2000	1950	.318	150	60	16.0
815	1985	1967	.319	182	82	16.5
817	1955	1885	.316	109	48	17.0
818	1955	1855	.311	150	45	16.0
820	1990	1780	.311	150	45	17.0
821	1955	1885	.316	109	48	17.0
822	2040	1900	.316	106	45	16.5
824	1825	1650	.298	77	25	18.5
825	1800	1575	.292	75	18	18.5
826	1750	1575	.292	73	20	19.0
827	1750	1575	.292	75	20	19.1
828	1710	1625	.292	71	20	19.3
833	1940	1886	.318	-	32	15.0
834	1910	1870	.318	109	44	15.0
836	1850	1570	.318	41.6	15	13.5
838	1840	1550	.312	41.9	15	13.3
842	-	-	-	-	-	-
844	1940	1549	.314	41.9	16.4	13.0
848	1750	1530	.310	41.6	16.4	15.0
852	1725	1700	.307	48.5	18	11.0
853	1750	1680	.308	70	28	15.0
854	1725	1700	.305	51	19.5	12.0
855	1652	1634	.304	67	26	15.0
857	1725	1675	.304	48.5	22	14.0
858	1650	1600	.305	-	20	15.0
861	1725	1650	.288	20.5	7.5	15.0
862	1725	1650	.288	20.5	7.5	15.0
863	1693	1625	.283	20.5	8.0	14.2
864	1616	1583	.301	51	19	14.0
865	1616	1583	.301	50	22	15.0
867	1616	1583	.301	-	16.7	15.0
868	1652	1616	.290	-	9.0	15.0
872	1780	1580	.302	16.4	6.0	15.0
874	1680	1510	.300	16.0	6.7	15.4
875	1680	1510	.299	16.0	6.7	15.4
876	1780	1580	.300	16.4	6.0	17.0
878	1680	1510	.300	16.0	6.7	20.0
879	1700	1650	.308	-	15	15.0

TABLE VI (Contd.)

Alloy No.	Melting Point		Density	Thermal Conductivity	Electrical Conductivity	Modulus of Elasticity
	Liquidus °F	Solidus °F	lb/cu. in. at 68°F	Btu/sq. ft. / ft. /hr. °F at 68°F	% IACS at 68°F	(Tension)x10^6
902	1915	1608	.318	36	13	16.0
903	1832	1570	.318	43.2	12	14.0
905	1830	1570	.315	43.2	11	15.0
907	1830	1528	.317	40.8	9.6	15.0
909	1792	1505	-	-	-	16.0
910	1760	1505	-	-	9.3	16.0
911	1742	1505	-	-	8.5	15.0
913	1632	1505	-	-	7.0	16.0
915	1887	1575	.320	33.6	9.2	14.0
916	1887	1575	.320	40.8	10.0	16.0
917	1859	1563	.316	40.8	10.0	15.0
922	1810	1518	.312	40.2	14.3	14.0
923	1830	1570	.317	43.2	12	14.0
925	-	-	-	-	-	16.0
926	1800	1550	.315	-	9.0	15.0
927	1800	1550	.317	-	11.0	16.0
928	1751	1505	-	-	-	16.0
932	1790	1570	.322	33.6	12.0	14.5
934	-	-	.320	33.6	12.0	11.0
935	1830	1570	.320	41	15	14.5
937	1705	1403	.320	27.1	10	11.0
938	1730	1570	.334	30	11.5	10.5
939	1730	1570	.334	30	11.5	11.0
943	-	-	.336	36.2	9	10.5
944	1725	1450	.320	30	10	11.0
945	1725	1475	.340	30	10	10.5
947	1880	1660	.320	31.2	-	15.0
948	1880	1660	.320	22.3	12	15.0
952	1913	1907	.276	29.1	11	15.0
953	1913	1904	.272	36.3	13	16.0
954	1900	1880	.269	33.9	13	15.5
955	1930	1900	.272	24.2	8.5	16.0
956	1840	1800	.278	22.3	8.5	15.0
957	1814	1742	.272	7.0	3.1	18.0
958	1940	1910	.276	20.8	7.1	16.5
962	2100	2010	.323	26	11	18.0
963	2190	2100	.323	21	6.5	20.0
964	2260	2140	.323	17	5	21.0
966	2160	2010	.318	18	4.3	22.0
973	1904	1850	.321	16.5	5.7	16.0
974	2012	1958	.320	15.8	5.5	16.0
976	2089	2027	.321	13	5	19.0
978	2156	2084	.320	14.7	4.5	19.0
993	1970	1955	.275	25	9.0	18.0

TABLE VII. QQ-C-390 - CHEMICAL COMPOSITION AND MECHANICAL PROPERTIES OF CASTING

A1

Chemical Composition						
Cu	Sn	Pb	Zn	Ni	Fe	Al
60.0-65.5	0.5-1.5	0.75-1.5	Rem	1.0	0.75	0.5

Mechanical Properties			
Condition	UTS ksi	TYS[a] ksi	EL %
AC. StC	40	14	15

Notes: a. 0.5 percent extension under load or 0.2 percent offset method.

A2 (CDA 857)

Chemical Composition					
Cu	Sn	Pb	Zn	Fe	Al
60.0-65.5	0.5-1.5	0.75-1.5	Rem	0.75	0.5

Mechanical Properties		
Condition	UTS ksi	EL %
Ac, CoC	40	15

A3 (854)

Chemical Composition						
Cu	Sn	Pb	Zn	Ni	Fe	Al
65.0-70.0	- 1.5	1.5-3.75	Rem	1.0	0.75[a]	0.30

Mechanical Properties			
Condition	UTS ksi	TYS[b] ksi	EL %
AC, StC	30	11	20

Notes: a. When specified, maximum iron content shall not exceed 0.10 percent.
b. 0.5 percent extension under load or 0.2 percent offset method.

A4 (852)

Chemical Composition					
Cu	Sn	Pb	Zn	Ni	Al
70.0-74.0	0.75-2.0	0.5-3.75	Rem	1.0	0.60

Mechanical Properties			
Condition	UTS ksi	TYS[a] ksi	EL %
AC, StC	35	12	25

Notes: a. 0.5 percent extension under load or 0.2 percent offset method.

A5

Chemical Composition						
Cu	Sn	Pb	Zn	Ni	Fe	Al
59.0-63.0	a	a	Rem	a	a	0.5-1.0

Mechanical Properties		
Condition	UTS ksi	EL %
AC, CeC, StC	55	25

Note: a. 1.0 percent maximum total lead, nickel, iron, tin and manganese. Other elements 0.20 percent maximum.

TABLE VII (Contd.)

B1 (842)

Chemical Composition						
Cu	Sn	Pb	Zn	Ni	Fe	P
78.0-82.0	4.0-6.0	2.0-3.0	10.0-16.0	0.75	0.35	0.05

Mechanical Properties			
Condition	UTS ksi	TYS ksi	EL %
AC. StC. CeC	28		15
CoC	32	16	13

B2 (844)

Chemical Composition						
Cu	Sn	Pb	Zn	Ni	Fe	P
78.0-82.0	2.25-3.5	6.0-8.0	7.0-10.0	1.0	0.40	0.05

Mechanical Properties			
Condition	UTS ksi	TYS ksi	EL %
AC. StC. CeC	29	13	18
CoC	30	15	16

B4 (838)

Chemical Composition						
Cu	Sn	Pb	Zn	Ni	Fe	P
82.0-83.75	3.25-4.25	5.0-7.0	5.0-8.0	1.0	0.30	0.03

Mechanical Properties			
Condition	UTS ksi	TYS ksi	EL %
AC, StC. CeC	29		15
CoC	30	15	16

B5 (836)

Chemical Composition						
Cu	Sn	Pb	Zn	Ni	Fe	P
84.0-86.0[a]	4.0-6.0	4.0-6.0	4.0-6.0	1.0	0.30[b]	0.05

Mechanical Properties			
Condition	UTS ksi	TYS ksi	EL %
AC. StC. CeC	30		20
CoC	36	19	15

Notes: a. Copper plus nickel
b. When specified, maximum iron content shall not exceed 0.10 percent.

B6

Chemical Composition						
Cu	Sn	Pb	Zn	Ni	Fe	P
78.0-82.0	3.5	a	a	1.0	0.40	0.05

Mechanical Properties		
Condition	UTS ksi	EL %
AC, StC	25	12
CeC	25	10
CoC	28	15

Note: a. Lead and zinc added at option of producer, provided other chemical and mechanical requirements are met.

C1 (868)

Chemical Composition							
Cu	Sn	Pb	Zn	Ni	Fe	Al	Mn
53.5-57.0	1.0	0.20	Rem	2.5-4.0	1.0-2.5	2.0	2.5-4.0

Mechanical Properties			
Condition	UTS ksi	TYS[a] ksi	EL %
AC, StC	78	35	18

Notes: a. 0.5 percent extension under load.

TABLE VII (Contd.)

C2 (864)

Chemical Composition							
Cu	Sn	Pb	Zn	Fe	Al	Mn	Sb
56.0-62.0	1.5	1.5[a]	Rem	2.0	1.5	1.5	1.5

Mechanical Properties			
Condition	UTS ksi	TYS[b] ksi	EL %
AC, StC	60	20	15
CoC	70	25	25

Notes: a. Minimum lead is 0.5 percent.
b. 0.5 percent extension under load or 0.2 percent offset.

C3 (865)

Chemical Composition							
Cu	Sn	Pb	Zn	Ni	Fe	Al	Mn
55.0-60.0	1.0	0.40	Rem	0.50	0.40-2.0	0.5-1.5	1.5

Mechanical Properties			
Condition	UTS ksi	TYS[a] ksi	EL %
AC, StC, CeC	65	25	20

Notes: a. 0.5 percent extension under load or 0.2 percent offset.

C4 (862)

Chemical Composition							
Cu	Sn	Pb	Zn	Ni	Fe	Al	Mn
60.0-68.0	0.20	0.20	Rem	0.50	2.0-4.5	3.0-7.5	2.5-5.0

Mechanical Properties			
Condition	UTS ksi	TYS[a] ksi	EL %
AC, StC, CoC	90	45	18

Notes: a. 0.5 percent extension under load or 0.2 percent offset.

C5 (861)

Chemical Composition						
Cu	Sn	Pb	Zn	Fe	Al	Mn
66.0-68.0	0.20	0.20	Rem	2.0-4.0	4.5-5.5	3.0-5.0

Mechanical Properties			
Condition	UTS ksi	TYS[a] ksi	EL %
AC, StC, CeC	90	45	18

Notes: a. 0.5 percent extension under load or 0.2 percent offset.

C6

Chemical Composition						
Cu	Sn	Pb	Zn	Fe	Al	Mn
60.0-65.0	0.20	0.20	Rem	2.0-5.0	3.0-7.5	2.5-5.0

Mechanical Properties			
Condition	UTS ksi	TYS[a] ksi	EL %
AC, StC	100	60	12

Notes: a. 0.5 percent extension under load or 0.2 percent offset.

C7 (863)

Chemical Composition						
Cu	Sn	Pb	Zn	Fe	Al	Mn
60.0-68.0	0.20	0.20	Rem	2.0-4.0	3.0-7.5	2.5-5.0

Mechanical Properties			
Condition	UTS ksi	TYS[a] ksi	EL %
AC, StC, CeC	110	60	12
CoC	110	62	14

Notes: a. 0.5 percent extension under load.

TABLE VII (Contd.)

D1 (913)

Chemical Composition						
Cu	Sn	Pb	Zn	Ni	Fe	P
79.0-82.0	18.0-20.0	0.50	0.25	0.75	0.25	1.0[a]

Mechanical Properties	
Condition	Hardness
AC, StC, CeC, CoC	BHN 160[b]

Notes: a. For continuous castings the phosphorous limit may be 1.5 percent maximum.
b. 3,000 kg load.

D2 (910)

Chemical Composition						
Cu	Sn	Pb	Zn	Ni	Fe	P
84.0-86.0	13.0-15.0	0.20	1.5	0.75	0.10	0.05[a]

Mechanical Properties		
Condition	UTS ksi	EL %
AC, StC, CeC	30	1.0
CoC	30	

Note: a. For continuous castings the phosphorous limit may be 1.5 percent.

D3 (923)

Chemical Composition						
Cu	Sn	Pb	Zn	Ni	Fe	P
85.0-89.0	7.5-9.0	1.0	3.0-5.0	1.0	0.25	0.50[a]

Mechanical Properties			
Condition	UTS ksi	TYS ksi	EL %
AC, StC, CeC	35		18
CoC[b]	40	19	16
StC[b]	30		12

Notes: a. For continuous castings the phosphorous limit may be 1.5 percent.
b. Optional properties when required.

D4 (922)

Chemical Composition						
Cu	Sn	Pb	Zn	Ni	Fe	P
86.0-90.0	5.5-6.5	1.0-2.0	3.0-5.0	1.0	0.25	0.05[a]

Mechanical Properties			
Condition	UTS ksi	TYS ksi	EL %
AC, StC, CeC	34		22
CoC	38	19	18

Note: a. For continuous castings the phosphorous limit may be 1.5 percent maximum.

D5 (903)

Chemical Composition						
Cu	Sn	Pb	Zn	Ni	Fe	P
86.0-89.0	7.5-9.0	0.30	3.0-5.0	1.0	0.15	0.05[a]

Mechanical Properties			
Condition	UTS ksi	TYS ksi	EL %
AC, StC, CeC	40		20
CoC	40	22	18

Note: a. For continuous castings the phosphorous limit may be 1.5 percent.

D6 (905)

Chemical Composition						
Cu	Sn	Pb	Zn	Ni	Fe	P
86.0-89.0	9.0-11.0	0.30	1.0-3.0	1.0	0.15	0.05[a]

Mechanical Properties			
Condition	UTS ksi	TYS ksi	EL %
AC, StC, CeC	35		18
CoC[b]	40	25	16
StC[c]	30		12

Notes: a. For continuous castings the phosphorus limit may be 1.5 percent maximum.
b. When made from scrap, properties apply only when required.
c. Optional properties when required.

TABLE VII (Contd.)

E1 (943)

Chemical Composition							
Cu	Sn	Pb	Zn	Ni	Fe	P	Sb
68.5-72.5	4.5-6.0	23.0 26.0	0.5	0.5	0.15	0.05	0.75

Mechanical Properties				
Condition	UTS ksi	TYS ksi	El %	Hardness
Ac, StC, CeC	21		7	BHN 38[a]
CoC	21	15	7	

Note: a. 500 kg. load.

E2 (940)

Chemical Composition									
Cu	Sn	Pb	Zn	Ni	Fe	P	Sb	S	Other
69.0-72.0	12.0-14.0	14.0-16.0	0.5	0.5-1.0	0.25	0.05	0.35	0.25	0.35

Mechanical Properties	
Condition	Hardness
AC, CoC	BHN 80[a]
CC, StC, CeC	BHN 80[a]
SC, StC, CeC	BHN 50[a]

Notes: a. 500 kg. load.

E3 (941)

Chemical Composition						
Cu	Sn	Pb	Zn	Ni	Fe	P
72.0-77.0	4.5-6.0	18.0-22.0	0.5	1.0	0.20	0.05

Mechanical Properties			
Condition	UTS ksi	TYS ksi	EL %
AC, StC, CeC[a]	21		7
CoC	25	17	7

Note: a. Optional properties.

E4

Chemical Composition				
Cu	Sn	Pb	Zn	Sn
73.0-80.0	5.0-7.0	15.0-20.0	1.25	0.75

Mechanical Properties		
Condition	UTS ksi	EL %
AC, CoC	25	18

TABLE VII (Contd.)

E5

Chemical Composition							
Cu	Sn	Pb	Zn	Ni	Fe	P	Sb
74.0-77.0	5.0-6.5	18.0-21.0	0.75	1.0	0.15	0.05	0.75

Mechanical Properties		
Condition	UTS ksi	EL %
AC, StC	25	10
CoC	21	7

E6 (938)

Chemical Composition							
Cu	Sn	Pb	Zn	Ni	Fe	P	Sb
75.0-78.0	6.25-8.0	13.0-16.0	0.75	0.75	0.15	0.05	0.75

Mechanical Properties			
Condition	UTS ksi	TYS ksi	EL %
AC, StC,	20		10
CoC	21	16	7

E7 (932)

Chemical Composition							
Cu	Sn	Pb	Zn	Ni	Fe	P	Sb
81.0-85.0	6.25-7.5	6.0-8.0	2.0-4.0	0.5	0.20	0.15[a]	0.35

Mechanical Properties			
Condition	UTS ksi	TYS ksi	EL %
AC, StC, CeC	30		12
CoC	35	20	10

E8 (934)

Chemical Composition							
Cu	Sn	Pb	Zn	Ni	Fe	P	Sb
82.0-85.0	7.0-9.0	7.0-9.0	0.75	1.0	0.15	0.50	0.50

Mechanical Properties			
Condition	UTS ksi	TYS ksi	EL %
AC, StC, CeC	25		8
CoC	34	20	8

Notes: a. Maximum of 0.5 percent phosphorus permitted in permanent mold castings.

E9 (935)

Chemical Composition							
Cu	Sn	Pb	Zn	Ni	Fe	P	Sb
83.0-86.0[a]	4.5-6.0	8.0-10.0	2.0	0.50	0.20	0.05	0.30

Mechanical Properties			
Condition	UTS ksi	TYS ksi	EL %
AC, StC, CeC	25		8
CoC	30	16	12

Notes: a. Copper plus nickel.

E10 (937)

Chemical Composition							
Cu	Sn	Pb	Zn	Ni	Fe	P	Sb
78.0-82.0	9.0-11.0	8.0-11.0	0.75	0.75	0.15	0.05	0.50

Mechanical Properties			
Condition	UTS ksi	TYS ksi	EL %
CoC	35	20	6

TABLE VII (Contd.)

F1 (916)

Chemical Composition				
Cu	Sn	Pb	Ni	P
85.0-89.0	9.7-11.5	0.25	1.2-1.8	0.30[a]

Mechanical Properties				
Condition	UTS ksi	TYS[a] ksi	EL %	Hardness
AC, CeC	45	25[b]	14	BHN 80[b]
CoC	44	20	10	

Notes: a. For continuous castings the phosphorous limit may be 1.5 percent maximum.

b. 0.5 percent extension under load.

F2 (947)

Chemical Composition							
Cu	Sn	Pb	Zn	Ni	Fe	P	Others
85.0-90.0	4.5-6.0	0.10[a]	2.5	4.5-6.0	0.25	0.03	0.05

Mechanical Properties			
Condition	UTS ksi	TYS[b] ksi	EL %
AC, StC	45	20	25
H, StC	75	50	5
HT, CoC	75	50	5
AC, CoC	44	20	10
CoC	45	20	25

Notes: a. The mechanical properties of Alloy F2 in the heat-treated condition may not be attained if the lead content exceeds 0.01 percent.

b. 0.5 percent extension under load.

F3 (948)

Chemical Composition									
Cu	Sn	Pb	Zn	Ni	Fe	Mn	P	Sb	Other
84.0-89.0	4.5-6.0	1.0	2.5	4.5-6.0	0.25	0.20 max	0.03[a]	0.15 max	0.25

Mechanical Properties			
Condition	UTS ksi	TYS ksi	EL %
Ht, StC	40	20	20

Note: a. For continuous castings, the phosphorous limit may be 1.5 percent maximum.

G1

Chemical Composition					
Cu	Sn	Fe	Mn	Ni	Others
78.0 min	9.8-11.5	2.0-6.0	3.5[a]	6.0[a]	0.5

Mechanical Properties			
Condition	UTS ksi	TYS[b] ksi	EL %
AC, StC, CeC	90	40	6
HT, CeC	110	60	5

Notes: a. Manganese or nickel optional.

b. 0.5 percent extension under load

G2 (955)

Chemical Composition					
Cu	Al	Fe	Mn	Ni	Others
78.0 min	9.5-11.5	3.0-5.0	3.5	3.0-5.0	0.5

Mechanical Properties			
Condition	UTS ksi	TYS[a] ksi	EL %
Ht, CeC	110	60	5
CoC	95	42	10

Notes: a. 0.5 percent extension under load.

TABLE VII (Contd.)

G3 (955)

Chemical Composition					
Cu	Al	Fe	Mn	Ni	Others
78.0 min	10.0-11.5	3.0-5.0	3.5	3.0-5.0	0.5

Mechanical Properties				
Condition	UTS ksi	TYS[a] ksi	EL %	Hardness
AC, StC, CeC	90	40	6	BHN 190[b]
HT, StC, CeC	110	60	5	BHN 190[b]

Notes: a. 0.5 percent extension under load.
b. 3,000 kg. load.

G4 (955)

Chemical Composition						
Cu	Al	Fe	Mn	Ni	Pb	Others
78.0 min	8.5-11.0	3.0-5.0	3.5	3.0-5.5	0.3 max	0.5

Mechanical Properties			
Condition	UTS ksi	TYS[a] ksi	EL %
AC, StC	85	35	15

Notes: a. 0.5 percent extension under load.

G5 (954)

Chemical Composition					
Cu	Ni	Fe	Al	Mn	Others
83.0 min	2.5	3.0-5.0	10.0-11.5	0.5	0.50

Mechanical Properties			
Condition	UTS ksi	TYS[a] ksi	EL %
AC, StC, CeC	75	30	12
HT, CeC, StC	90	45	6
HT, CeC[b]	110	60	5
HT, CoC	95	45	10
CoC	85	32	12

Notes: a. 0.5 percent extension under load.
b. Optional properties applicable when material is intended for shaft sleeves in highly stressed shafting.

G6 (952)

Chemical Composition			
Cu	Fe	Al	Others
86.0 min	2.5-4.0	8.5-9.5	0.5

Mechanical Properties			
Condition	UTS ksi	TYS[a] ksi	EL %
AC, StC, CeC	65	25	20
CoC	68	26	20

Notes: a. 0.5 percent extension under load.

G7 (953)

Chemical Composition			
Cu	Fe	Al	Others
86.0 min	0.75-1.5	9.0-11.0	0.5

Mechanical Properties			
Condition	UTS ksi	TYS[a] ksi	EL %
AC, StC, CeC	65	25	20
HT, CeC, StC	80	40	12
CoC	70	26	25
HT, CoC	80	40	12

Note: a. 0.5 percent extension under load.

G8 (958)

Chemical Composition							
Cu	Pb	Ni	Fe	Al	Mn	Si	Others
78.0 min	0.02 max	4.0-5.5	3.0-[a] 5.0	8.5-9.5	3.5	0.10 max	0.5

Mechanical Properties			
Condition	UTS ksi	TYS ksi	EL %
AC, CeC	85	35[b]	18

Notes: a. Iron content shall not exceed nickel content.
b. 0.5 percent extension under load.

TABLE VII (Contd.)

X1 (874)

Chemical Composition								
Cu	Sn	Zn	Pb	Fe	Si	Al	Mn	Others
Rem.	1.0	12.0-16.0	0.5	2.5	2.5-5.0	1.5	1.5	0.5

Mechanical Properties			
Condition	UTS ksi	TYS[a] ksi	EL %
Ac, StC	50	21	18

Notes: a. 0.5 percent extension under load.

X2 (872)

Chemical Composition								
Cu	Sn	Zn	Pb	Fe	Si	Al	Mn	Others
Rem.	1.0	5.0	0.5	2.5	1.0-5.0	1.5	1.5	0.50

Mechanical Properties			
Condition	UTS ksi	TYS[a] ksi	EL %
AC, StC	45	18	20

Notes: a. 0.5 percent extension under load.

X3

Chemical Composition						
Cu	Sn	Zn	Pb	Ni	Fe	P
Rem.	1.0	1.0	8.0-12.0	0.75-1.5	0.10	3.0-4.0

Mechanical Properties		
Condition	UTS ksi	EL %
AC, StC	30	6

X4 (See A5) (Not in QQ-C-390)

Chemical Composition							
Cu	Sn	Zn	Pb	Ni	Fe	Al	Other
59.0-63.0	a	Rem	a	a	a	0.5-1.0	Each 0.20

Mechanical Properties		
Condition	UTS ksi	EL %
AC, StC, CeC	55	25

Notes: a. Total lead, nickel, iron, tin, and manganese, 1.0 percent maximum.

TABLE VII (Contd.)

X5 (820)

Chemical Composition										
Cu	Sn	Zn	Pb	Ni	Fe	Si	Al	Be	Co[a]	Cr
Rem	0.01	0.01	0.01	0.20	0.10	0.15	0.10	0.45-0.75	2.35-2.75	0.10

Mechanical Properties				
Condition	UTS ksi	TYS[b] ksi	EL %	Hardness RB
AC, SA	40 max	8 max	25	45[c]
AC, SA, AH	95	55	8	92

Notes: a. Nickel plus cobalt.
b. 0.2 percent offset.
c. Information only; not required.

X6 (825)

Chemical Composition										
Cu	Sn	Zn	Pb	Ni	Fe	Si	Al	Be	Co[a]	Cr
Rem	0.10	0.10	0.02	0.20	0.25	0.20-0.35	0.15	1.90-2.15	0.35-0.65	0.10

Mechanical Properties					
Condition	UTS ksi	TYS[b] ksi	EL %	Hardness RB	Hardness RC
AC, SA	55 max	20 max	30[c]	75[c]	-
AC, SA, AH	155	115	0	-	38

Notes: a. Nickel plus cobalt.
b. 0.2 percent offset.
c. Information only; not required.

X7 (827)

Chemical Composition									
Cu	Sn	Zn	Pb	Ni	Fe	Si	Al	Be	Cr
Rem	0.10	0.10	0.02	1.0-1.5	0.25	0.15	0.15	2.35-2.55	0.10

Mechanical Properties			
Condition	UTS ksi	TYS[a] ksi	EL %
AC, SA, AH	155	130	1.0

Notes a. 0.2 percent offset.

TABLE VII (Contd.)

X8 (828)

Chemical Composition									
Cu	Sn	Zn	Pb	Ni	Fe	Si	Al	Be	Co[a]
Rem	0.10	0.10	0.02	0.20	0.25	0.20-0.35	0.15	2.50-2.75	0.35-0.65

Mechanical Properties					
Condition	UTS ksi	TYS[b] ksi	EL %	Hardness RB	Hardness RC
AC, SA	75	30	5	90	-
AC, SA, AH	150	110	0	-	42

Notes: a. Nickel plus cobalt.
b. 0.2 percent offset.

X9 (964)

Chemical Composition											
Cu	Pb	Zn	Ni	Fe	Al	Mn	P	S	C	Cb	Si
Rem	0.01	1.0	28.0-32.0	0.25-0.50	0.50	1.50	0.02	0.02 max	0.15 max	0.50-1.50	0.70

Mechanical Properties			
Condition	UTS ksi	YP ksi	EL %
AC, StC	60	32	20
CoC	65	35	25

TABLE VIII. HEAT TREATMENT DATA FOR SOME CAST ALLOYS

Alloy No.	Solution Heat Treatment Temp. °F	Time at Temp. Hrs. in. of Section Thickness	Quenching Medium	Precipitation Hardening Temp °F	Time at Temperature	Quenching Medium
813	1800-1850	1	Water	900	2 Hrs.	Air
814	1830-1850	3	Water	900	2 Hrs.	Air
815	1830-1850	1	Water	900	3 Hrs.	Air
817	1650-1700	1	Water	850	3 Hrs.	Air
818	1650-1700	1	Water	900	3 Hrs.	Air
820	1650-1700	3	Water	900	3 Hrs.	Air
821	1650-1700	1	Water	850	3 Hrs.	Air
822	1650-1750	1	Water	835-850	2 Hrs.	Air
824	1450-1500	1	Water	650	3 Hrs.	Air.
825	1450-1475	1	Water	650	3 Hrs.	Air
826	1450-1475	1	Water	650	3 Hrs.	Air
827	1450-1475	3	Water	650	3 Hrs.	Air
828	1450-1500	1	Water	650	3 Hrs.	Air
947	1450	2	Water	600	5 Hrs.	Air
948	-	-	-	600	6-10 Hrs.	Air
953	1625	1	Water	-	-	-
954	1650	1	Water	-	-	-
955	1610	1	(Either)	-	-	-
966	1825	1	Water	950	3 Hrs.	Air

NOTE: Stress Relieving Temperature
Alloys - 825 Through 828 Incl. 400F
- 952 Through 958 Incl. 600F
- 993 950F
- All Others Listed Above 500F

TABLE IX. CORROSION RATINGS OF CAST COPPER AND COPPER ALLOYS IN VARIOUS CORROSIVE MEDIUMS

Corrosive medium	Copper	Tin bronze	Leaded tin bronze	High-leaded tin bronze	Leaded red brass	Leaded semi-red brass	Leaded yellow brass	Leaded high-strength yellow brass	High-strength yellow brass	Aluminum bronze	Leaded nickel brass	Leaded nickel bronze	Silicon bronze	Silicon brass
Acetate solvents	B	A	A	A	A	A	B	A	A	A	A	A	A	B
Acetic acid,														
20%	A	C	B	C	B	C	C	C	C	A	C	A	A	B
50%	A	C	B	C	B	C	C	C	C	A	C	B	A	B
Glacial	A	A	A	C	A	C	C	C	C	A	B	B	A	A
Acetone	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Acetylene[b]	C	C	C	C	C	C	C	C	C	C	C	C	C	C
Alcohols[c]	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Aluminum chloride	C	C	C	C	C	C	C	C	C	B	C	C	C	C
Aluminum sulfate	B	B	B	B	B	C	C	C	C	A	C	C	A	A
Ammonia, moist gas	C	C	C	C	C	C	C	C	C	C	C	C	C	C
Ammonia, moisture-free	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Ammonium chloride	C	C	C	C	C	C	C	C	C	C	C	C	C	C
Ammonium hydroxide	C	C	C	C	C	C	C	C	C	C	C	C	C	C
Ammonium nitrate	C	C	C	C	C	C	C	C	C	C	C	C	C	C
Ammonium sulfate	B	B	B	B	B	C	C	C	C	A	C	C	A	A
Aniline and aniline dyes	C	C	C	C	C	C	C	C	C	B	C	C	C	C
Asphalt	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Barium chloride	A	A	A	A	A	C	C	C	C	A	A	A	A	C
Barium sulfide	C	C	C	C	C	C	C	C	C	B	C	C	C	C
Beer[c]	A	A	B	B	B	C	C	C	A	A	C	A	A	B
Beet sugar syrup	A	A	B	B	B	A	A	A	B	A	A	A	B	B
Benzine	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Benzol	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Boric acid	A	A	A	A	A	A	A	B	A	A	A	A	A	A
Butane	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Calcium bisulfite	A	A	B	B	B	C	C	C	C	A	B	A	A	B
Calcium chloride(acid)	B	B	B	B	B	B	C	C	C	A	C	C	A	C
Calcium chloride (alkaline)	C	C	C	C	C	C	C	C	C	A	C	A	C	B
Calcium hydroxide	C	C	C	C	C	C	C	C	C	B	C	C	C	C
Calcium hypochlorite	C	C	B	B	B	C	C	C	C	B	C	C	C	C
Cane sugar syrups	A	A	B	A	B	A	A	A	A	A	A	A	A	B
Carbonated beverages[c]	A	C	C	C	C	C	C	C	C	A	C	C	A	C
Carbon dioxide, dry	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Carbon dioxide, moist[c]	B	B	B	C	B	C	C	C	C	A	C	A	A	B
Carbon tetrachloride, dry	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Carbon tetrachloride, moist	B	B	B	B	B	B	B	B	B	B	B	A	A	A
Chlorine, dry	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Chlorine, moist	C	C	B	B	B	C	C	C	C	C	C	C	C	C
Chromic acid	C	C	C	C	C	C	C	C	C	C	C	C	C	C
Citric acid	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Copper sulfate	B	A	A	A	A	C	C	C	C	B	B	B	A	A
Cottonseed oil[c]	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Creosote	B	B	B	B	B	C	C	C	C	A	B	B	B	B
Ethers	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Ethylene glycol	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Ferric chloride, sulfate	C	C	C	C	C	C	C	C	C	C	C	C	C	C
Ferrous chloride, sulfate	C	C	C	C	C	C	C	C	C	C	C	C	C	C

Corrosive medium	Copper	Tin bronze	Leaded tin bronze	High-leaded tin bronze	Leaded red brass	Leaded semi-red brass	Leaded yellow brass	Leaded high-strength yellow brass	High-strength yellow brass	Aluminum bronze	Leaded nickel brass	Leaded nickel bronze	Silicon bronze	Silicon brass
Formaldehyde	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Formic acid	A	A	A	A	A	B	B	B	B	A	B	B	B	C
Freon	A	A	A	A	A	A	A	A	A	A	A	A	A	B
Fuel oil	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Furfural	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Gasoline	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Gelatin[c]	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Glucose	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Glue	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Glycerin	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Hydrochloric or muriatic acid	C	C	C	C	C	C	C	C	C	B	C	C	C	C
Hydrofluoric acid	B	B	B	B	B	B	B	B	B	A	B	B	B	B
Hydrofluosilicic acid	B	B	B	B	B	C	C	C	C	B	C	C	B	C
Hydrogen	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Hydrogen peroxide	C	C	C	C	C	C	C	C	C	C	C	C	C	C
Hydrogen sulfide, dry	C	C	C	C	C	C	C	C	C	B	C	C	B	C
Hydrogen sulfide, moist	C	C	C	C	C	C	C	C	C	B	C	C	C	C
Lacquers	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Lacquer thinners	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Lactic acid	A	A	A	A	A	C	C	C	C	A	C	C	A	C
Linseed oil	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Liquors,														
Black liquor	B	B	B	B	B	C	C	C	C	B	C	C	B	B
Green liquor	C	C	C	C	C	C	C	C	C	B	C	C	C	B
White liquor	C	C	C	C	C	C	C	C	C	A	C	C	C	B
Magnesium chloride	A	A	A	A	A	C	C	C	C	A	C	C	A	B
Magnesium hydroxide	B	B	B	B	B	B	B	B	B	A	B	B	B	B
Magnesium sulfate	A	A	A	A	B	C	C	C	C	A	C	B	A	B
Mercury, mercury salts	C	C	C	C	C	C	C	C	C	C	C	C	C	C
Milk[c]	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Molasses[c]	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Natural gas	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Nickel chloride	A	A	A	A	A	C	C	C	C	A	C	C	A	C
Nickel sulfate	A	A	A	A	A	C	C	C	C	A	C	C	A	C
Nitric acid	C	C	C	C	C	C	C	C	C	C	C	C	C	C
Oleic acid	A	A	B	B	B	C	C	C	C	A	C	A	A	B
Oxalic acid	A	A	B	B	B	C	C	C	C	A	C	A	A	B
Phosphoric acid	A	A	A	A	A	C	C	C	C	A	C	A	A	A
Picric acid	C	C	C	C	C	C	C	C	C	C	C	C	C	C
Potassium chloride	A	A	A	A	A	C	C	C	C	A	C	C	A	C
Potassium cyanide	C	C	C	C	C	C	C	C	C	C	C	C	C	C
Potassium hydroxide	C	C	C	C	C	C	C	C	C	A	C	C	C	C
Potassium sulfate	A	A	A	A	A	C	C	C	C	A	C	C	A	C
Propane gas	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Sea water	A	A	A	A	A	C	C	C	C	A	C	C	B	B
Soap solutions	A	A	A	A	B	C	C	C	C	A	C	C	A	C
Sodium bicarbonate	A	A	A	A	A	A	A	A	A	A	A	A	A	B
Sodium bisulfate	C	C	C	C	C	C	C	C	C	A	C	C	C	C
Sodium carbonate	C	A	A	A	A	C	C	C	C	A	C	C	C	A

TABLE IX (Contd.)

Corrosive medium	Copper	Tin bronze	Leaded tin bronze	High-leaded tin bronze	Leaded red brass	Leaded semi-red brass	Leaded yellow brass	Leaded high-strength yellow brass	High-strength yellow brass	Aluminum bronze	Leaded nickel brass	Leaded nickel bronze	Silicon bronze	Silicon brass
Sodium chloride	A	A	A	A	A	B	C	C	C	A	C	C	A	C
Sodium cyanide	C	C	C	C	C	C	C	C	C	B	C	C	C	C
Sodium hydroxide	C	C	C	C	C	C	C	C	C	A	C	C	C	C
Sodium hypochlorite	C	C	C	C	C	C	C	C	C	C	C	C	C	C
Sodium nitrate	B	B	B	B	B	B	B	B	A	B	B	A	A	
Sodium peroxide	B	B	B	B	B	B	B	B	B	B	B	B	B	
Sodium phosphate	A	A	A	A	A	A	A	A	A	A	A	A	A	
Sodium sulfate, silicate	A	A	B	B	B	B	C	C	C	A	C	C	A	B
Sodium sulfide, thiosulfate	C	C	C	C	C	C	C	C	C	B	C	C	C	C
Stearic acid	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Sulfur, solid	C	C	C	C	C	C	C	C	C	A	C	C	C	C
Sulfur chloride	C	C	C	C	C	C	C	C	C	C	C	C	C	C
Sulfur dioxide, dry	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Sulfur dioxide, moist	A	A	A	B	B	C	C	C	C	A	C	C	A	B
Sulfur trioxide, dry	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Sulfuric acid, 78% or less	B	B	B	B	B	C	C	C	C	A	C	C	B	B
Sulfuric acid, 78% to 90%	C	C	C	C	C	C	C	C	C	B	C	C	C	C
Sulfuric acid, 90% to 95%	C	C	C	C	C	C	C	C	C	B	C	C	C	C
Sulfuric acid, Fuming	C	C	C	C	C	C	C	C	C	A	C	C	C	C
Tannic acid	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Tartaric acid	B	A	A	A	A	A	A	A	A	A	A	A	A	A
Toluene	B	B	A	A	A	B	B	B	B	B	B	B	B	A
Trichlorethylene, dry	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Trichlorethylene, moist	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Turpentine	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Varnish	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Vinegar	A	A	B	B	B	C	C	C	C	B	C	C	A	B
Water, acid mine	C	C	C	C	C	C	C	C	C	C	C	C	C	C
Water, condensate	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Water, potable	A	A	A	A	A	A	B	B	B	A	A	A	A	A
Whiskey[c]	A	A	C	C	C	C	C	C	C	A	C	C	A	C
Zinc chloride	C	C	C	C	C	C	C	C	C	B	C	C	B	C
Zinc sulfate	A	A	A	A	A	C	C	C	C	B	C	A	A	C

NOTES: a A = recommended, B = acceptable, C = not recommended

b Acetylene forms an explosive compound with copper when moist or when certain impurities are present and the gas is under pressure. Alloys containing less than 65% Cu are satisfactory under this use. When the gas is not under pressure other copper alloys are satisfactory.

c Copper and copper alloys are resistant to corrosion by most food products. Traces of copper may be dissolved and affect taste or color of the products. In such cases, copper alloys are often tin coated.

TABLE X. JOINING CHARACTERISTICS AND MACHINABILITY RATING OF CAST COPPERS AND ALLOYS

Alloy No.	Soldering	Brazing	Oxyacetylene Welding	Carbon Arc Welding	Gas Shielded Arc Welding	Coated Metal Arc Welding	Machinability Rating
801	E	E	NR	F	F	NR	10
803	E	E	NR	F	F	NR	10
805	E	E	NR	F	F	NR	10
807	E	E	NR	F	F	NR	10
809	E	E	NR	F	F	NR	10
811	E	E	NR	F	F	NR	10
813	E	G	NR	F	F	F	20
814	E	G	NR	F	F	F	20
815	G	G	NR	F	F	NR	20
817	G	G	NR	NR	F	NR	30

TABLE X (Contd.)

Alloy No.	Soldering	Brazing	Oxyacetylene Welding	Carbon Arc Welding	Gas Shielded Arc Welding	Coated Metal Arc Welding	Machinability Rating
818	G	G	NR	F	F	F	20
820	G	G	NR	F	F	F	20
821	G	G	NR	NR	F	NR	30
822	G	G	NR	F	F	F	20
824	F	F	NR	F	F	F	20
825	F	F	NR	F	F	F	20
826	F	F	NR	F	F	F	20
827	F	F	NR	F	F	F	20
828	F	F	NR	F	F	F	10
833	E	G	NR	NR	F	NR	35
834	E	E	F	NR	F	NR	60
836	E	G	NR	NR	NR	F	84
838	E	G	NR	NR	NR	F	90
842	E	G	NR	NR	NR	F	80
844	E	G	NR	NR	NR	F	90
848	E	G	NR	NR	NR	F	90
852	E	F	F	NR	NR	NR	80
853	E	E	G	F	G	NR	30
854	E	E	F	P	P	P	80
855	G	F	NR	NR	NR	NR	80
857	G	F	NR	NR	NR	NR	80
858	G	G	NR	NR	NR	NR	80
861	P	P	G	NR	F	G	30
862	P	P	G	NR	F	G	30
863	P	P	P	P	P	G	8
864	F	F	P	P	P	P	65
865	F	F	P	P	P	P	26
867	F	F	P	P	P	P	55
868	F	F	P	P	P	P	30
872	NR	F	G	P	F	F	40
874	NR	F	F	NR	F	NR	50
875	NR	F	F	NR	F	NR	50
876	NR	F	G	P	F	F	40
878	NR	F	NR	NR	NR	NR	40
879	G	G	NR	NR	NR	NR	80
902	E	G	F	F	F	F	20
903	E	G	F	F	F	F	30
905	E	G	F	F	F	F	30
907	E	G	F	F	F	F	20
909	E	G	F	F	F	F	20
910	E	G	F	F	F	F	20
911	E	G	F	F	F	F	10
913	E	G	F	F	F	F	10
915	E	G	NR	NR	NR	NR	40
916	E	G	F	F	F	F	20
917	E	G	F	F	F	F	20
922	E	E	NR	NR	NR	NR	42
923	E	G	NR	NR	NR	NR	42
925	E	G	NR	NR	NR	NR	30
926	E	G	NR	NR	NR	NR	40
927	E	G	NR	NR	NR	NR	45
928	E	G	NR	NR	NR	NR	70
932	E	G	NR	NR	NR	NR	70
934	G	G	NR	NR	NR	NR	70

TABLE X (Contd.)

Alloy No.	Soldering	Brazing	Oxyacetylene Welding	Carbon Arc Welding	Gas Shielded Arc Welding	Coated Metal Arc Welding	Machinability Rating
935	G	G	NR	NR	NR	NR	70
937	G	G	NR	NR	NR	NR	80
938	G	P	NR	NR	NR	NR	80
939	G	P	NR	NR	NR	NR	80
943	G	P	NR	NR	NR	NR	80
944	G	G	NR	NR	NR	NR	80
945	G	P	NR	NR	NR	NR	80
947	E	E	F	NR	G	G	30 As Cast - 20 HT. TR.
948	E	G	NR	NR	NR	NR	50 As Cast - 40 HT. TR.
952	G	G	NR	F	E	G	50
953	G	G	NR	F	E	G	55
954	G	G	NR	F	VG	G	60
955	G	F	NR	P	G	G	50
956	G	G	NR	F	G	F	60
957	G	G	NR	G	E	G	50
958	G	F	NR	P	G	G	50
962	E	E	NR	NR	F	G	10
963	E	E	NR	NR	F	F	15
964	E	E	NR	NR	G	G	20
966	E	E	G	F	F	F	20
973	E	E	NR	NR	NR	NR	70
974	E	E	NR	NR	NR	NR	60
976	E	E	NR	NR	NR	NR	70
978	E	E	NR	NR	NR	NR	60
993	NR	G	NR	P	G	G	20

NOTE: E = excellent, G = good, F = fair, P = poor, NR = not recommended.

TABLE XI. CORROSION RATINGS OF WROUGHT ALLOYS IN VARIOUS CORROSIVE MEDIUMS

Corrosive Medium	Coppers	More than 80% Cu	Less than 80% Cu	Special brasses	Phosphor bronzes	Aluminum bronzes	Copper silicon	Copper nickel	Nickel silver
Acetate solvents	E	E	G	E	E	E	E	E	E
Acetic acid[b]	E	E	E	P	P	E	E	E	G
Acetone	E	E	E	E	E	E	E	E	E
Acetylene[c]	P	P	c	P	P	P	P	P	P
Alcohols[a]	E	E	E	E	E	E	E	E	E
Aldehydes	E	E	F	F	E	E	E	E	E
Alkylamines	G	G	G	G	G	G	G	G	G
Alumina	E	E	E	E	E	E	E	E	E
Aluminum chloride	G	G	P	P	G	G	G	G	G
Aluminum hydroxide	E	E	E	E	E	E	E	E	E
Aluminum sulfate and alum	G	G	P	G	G	G	G	E	G
Ammonia, dry	E	E	E	E	E	E	E	E	E
Ammonia, moist	P	P	P	P	P	P	P	F	P
Ammonium chloride	P	P	P	P	P	P	P	F	P
Ammonium hydroxide	P	P	P	P	P	P	P	F	P
Ammonium nitrate	P	P	P	P	F	F	F	G	F
Ammonium sulfate	F	F	F	F	F	F	F	F	F
Aniline and aniline dyes	E	E	E	E	E	E	E	E	E
Asphalt	E	E	E	E	E	E	E	E	E
Atmosphere; industrial[d]	E	E	E	E	E	E	E	E	E
marine	E	E	E	E	E	E	E	E	E
Atmosphere: rural	E	E	E	E	E	E	E	E	E
Barium carbonate	E	E	E	E	E	E	E	E	E
Barium chloride	G	G	F	F	G	G	G	G	G
Barium hydroxide	E	E	G	E	E	E	E	E	E
Barium sulfate	E	E	E	E	E	E	E	E	E
Beer[b]	E	E	G	E	E	E	E	E	E
Beet sugar syrup[b]	E	E	G	E	E	E	E	E	E
Benzene, benzine, benzol	E	E	E	E	E	E	E	E	E
Benzoic acid	E	E	E	E	E	E	E	E	E
Black liquor, sulfate process	P	P	P	P	P	P	P	G	P

TABLE XI (Contd.)

Corrosive Medium	Coppers	More than 80% Cu	Less than 80% Cu	Special brasses	Phosphor bronzes	Aluminum bronzes	Copper silicon	Copper nickel	Nickel silver
Bleaching powder, wet	G	G	P	G	G	G	G	G	G
Borax	E	E	E	E	E	E	E	E	E
Bordeaux mixture	E	E	G	E	E	E	E	E	E
Boric acid	E	E	G	E	E	E	E	E	E
Brines	G	G	P	G	G	G	G	E	E
Bromine, dry	E	E	E	E	E	E	E	E	E
Bromine, moist	G	G	P	F	G	G	G	G	G
Butane[e]	E	E	E	E	E	E	E	E	E
Calcium bisulfate	G	G	P	G	G	G	G	G	G
Calcium chloride	G	G	F	G	G	G	G	G	G
Calcium hydroxide	E	E	G	E	E	E	E	E	E
Calcium hypochlorite	G	G	P	G	G	G	G	G	G
Cane sugar syrups	E	E	E	E	E	E	E	E	E
Carbolic acid (phenol)	F	G	P	G	G	G	G	G	G
Carbonated beverages[b, f]	E	E	E	E	E	E	E	E	E
Carbon dioxide dry	E	E	E	E	E	E	E	E	E
Carbon dioxide moist[b, f]	E	E	E	E	E	E	E	E	E
Carbon tetra-chloride (dry)	E	E	E	E	E	E	E	E	E
Carbon tetra-chloride(moist)	G	G	F	G	E	E	E	E	E
Castor oil	E	E	E	E	E	E	E	E	E
Chlorine, dry[g]	E	E	E	E	E	E	E	E	E
Chlorine, moist	F	F	P	F	F	F	F	G	F
Chloracetic acid	G	F	P	F	G	G	G	G	G
Chloroform, dry	E	E	E	E	E	E	E	E	E
Chromic acid	P	P	P	P	P	P	P	P	P
Citric acid[b]	E	E	F	E	E	E	E	E	E
Copper chloride	F	F	P	F	F	F	F	F	F
Copper nitrate	F	F	P	F	F	F	F	F	F
Copper sulfate	G	G	P	G	G	G	E	G	
Corn oil[b]	E	E	G	E	E	E	E	E	E
Cottonseed oil[b]	E	E	G	E	E	E	E	E	E
Creosote	E	E	G	E	E	E	E	E	E
Dowtherm "A"	E	E	E	E	E	E	E	E	E
Ethanol amine	G	G	G	G	G	G	G	G	G
Ethers	E	E	E	E	E	E	E	E	E
Ethyl acetate (esters)	E	E	G	E	E	E	E	E	E
Ethylene glycol	E	E	G	E	E	E	E	E	E
Ferric chloride	P	P	P	P	P	P	P	P	P
Ferric sulfate	P	P	P	P	P	P	P	P	P
Ferrous chloride	G	G	P	G	G	G	G	G	G
Ferrous sulfate	G	G	P	G	G	G	G	G	G
Formaldehyde (aldehydes)	E	E	G	E	E	E	E	E	E
Formic acid	G	G	P	F	G	G	G	G	G
Freon, dry	E	E	E	E	E	E	E	E	E
Freon, moist									
Fuel oil, light	E	E	E	E	E	E	E	E	E
Fuel oil, heavy	E	E	G	E	E	E	E	E	E
Furfural	E	E	F	E	E	E	E	E	E
Gasoline	E	E	E	E	E	E	E	E	E
Gelatine[b]	E	E	E	E	E	E	E	E	E
Glucose[b]	E	E	E	E	E	E	E	E	E
Glue	E	E	G	E	E	E	E	E	E
Glycerin	E	E	G	E	E	E	E	E	E
Hydrobromic acid	F	F	P	F	F	F	F	F	F
Hydrocarbons	E	E	E	E	E	E	E	E	E
Hydrochloric acid (muriatic)	F	F	P	F	F	F	F	F	F
Hydrocyanic acid, dry	E	E	E	E	E	E	E	E	E
Hydrocyanic acid, moist	P	P	P	P	P	P	P	P	P
Hydrofluoric acid, anhydrous	G	G	P	G	G	G	G	G	G
Hydrofluoric acid, hydrated	F	F	P	F	F	F	F	F	F
Hydrofluosilicic acid	G	G	P	G	G	G	G	G	G
Hydrogen[e]	E	E	E	E	E	E	E	E	E
Hydrogen peroxide up to 10%	G	G	F	G	G	G	G	G	G
Hydrogen peroxide over 10%	P	P	P	P	P	P	P	P	P
Hydrogen sulfide, dry	E	E	E	E	E	E	E	E	E
Hydrogen sulfide, moist	P	P	F	F	P	P	P	F	F
Kerosine	E	E	E	E	E	E	E	E	E
Ketones	E	E	E	E	E	E	E	E	E
Lacquers	E	E	E	E	E	E	E	E	E
Lacquer thinners (solvents)	E	E	E	E	E	E	E	E	E
Lactic acid[b]	E	E	F	E	E	E	E	E	E
Lime	E	E	E	E	E	E	E	E	E
Lime sulfur	P	P	F	F	P	P	P	F	F
Linseed oil	G	G	G	G	G	G	G	G	G
Lithium compounds	G	G	P	F	G	G	E	E	
Magnesium chloride	G	G	F	F	G	G	G	G	G
Magnesium hydroxide	E	E	G	E	E	E	E	E	E
Magnesium sulfate	E	E	G	E	E	E	E	E	E
Mercury or mercury salts	P	P	P	P	P	P	P	P	P
Milk[b]	E	E	G	E	E	E	E	E	E
Molasses	E	E	G	E	E	E	E	E	E
Natural Gas[e]	E	E	E	E	E	E	E	E	E
Nickel chloride	F	F	P	F	F	F	F	F	F
Nickel sulfate	F	F	P	F	F	F	F	F	F
Nitric acid	P	P	P	P	P	P	P	P	P
Oleic acid	G	G	F	G	G	G	G	G	G
Oxalic acid[h]	E	E	P	P	E	E	E	E	E
Oxygen[c]	E	E	E	E	E	E	E	E	E
Palmitic acid	G	G	F	G	G	G	G	G	G
Paraffin	E	E	E	E	E	E	E	E	E
Phosphoric acid	G	G	P	F	G	G	G	G	G
Picric acid	P	P	P	P	P	P	P	P	P
Potassium carbonate	E	G	E	E	E	E	E	E	E
Potassium chloride	G	G	P	F	G	G	G	E	E
Potassium cyanide	P	P	P	P	P	P	P	P	P
Potassium dichromate (acid)	P	P	P	P	P	P	P	P	P
Potassium hydroxide	G	G	F	G	G	G	G	E	E
Potassium sulfate	E	E	G	E	E	E	E	E	E
Propane[e]	E	E	E	E	E	E	E	E	E
Rosin	E	E	E	E	E	E	E	E	E
Sea water	G	G	F	E	G	E	G	E	E
Sewage	E	E	F	E	E	E	E	E	E
Silver salts	P	P	P	P	P	P	P	P	P
Soap solution	E	E	E	E	E	E	E	E	E
Sodium bicarbonate	E	E	G	E	E	E	E	E	E
Sodium bisulfate	G	G	F	G	G	G	G	E	E
Sodium carbonate	E	E	G	E	E	E	E	E	E
Sodium chloride	G	G	P	F	G	G	G	E	E
Sodium chromate	E	E	E	E	E	E	E	E	E
Sodium cyanide	P	P	P	P	P	P	P	P	P
Sodium dichromate(acid)	P	P	P	P	P	P	P	P	P
Sodium hydroxide	G	G	F	G	G	G	G	E	E
Sodium hypochlorite	G	G	P	G	G	G	G	G	G
Sodium nitrate	G	G	P	F	G	G	G	E	E
Sodium peroxide	F	F	P	F	F	F	F	G	G
Sodium phosphate	E	E	G	E	E	E	E	E	E
Sodium silicate	E	E	G	E	E	E	E	E	E
Sodium sulfate	E	E	G	E	E	E	E	E	E
Sodium sulfide	P	P	F	F	P	P	P	F	F
Sodium thiosulfate	P	P	F	F	P	P	P	F	F
Steam	E	E	F	E	E	E	F	E	E
Stearic acid	E	E	F	E	E	E	E	E	E
Sugar solutions	E	E	G	E	E	E	E	E	E
Sulfur, solid	G	G	E	G	G	G	G	E	G
Sulfur, molten	P	P	P	P	P	P	P	P	P
Sulfur chloride (dry)	E	E	E	E	E	E	E	E	E
Sulfur chloride (moist)	P	P	P	P	P	P	P	P	P
Sulfur dioxide (dry)	E	E	E	E	E	E	E	E	E
Sulfur dioxide (moist)	G	G	P	G	G	G	G	F	F
Sulfur trioxide (dry)	E	E	E	E	E	E	E	E	E
Sulfuric acid 80-95%[j]	G	G	P	F	G	G	G	G	G
Sulfuric acid 40-80%[j]	F	F	F	P	F	F	F	F	F
Sulfuric acid 40%[j]	G	G	P	F	G	G	G	G	G
Sulfurous acid	G	G	P	G	G	G	G	F	F
Tannic acid	E	E	E	E	E	E	E	E	E
Tartaric acid[b]	E	E	G	E	E	E	E	E	E
Toluene	E	E	E	E	E	E	E	E	E
Trichloracetic acid	G	G	P	F	G	G	G	G	G
Trichlorethylene (dry)	E	E	E	E	E	E	E	E	E
Trichlorethylene (moist)	G	G	F	G	E	E	E	E	E

TABLE XI (Contd.)

Corrosive Medium	Coppers	More than 80% Cu	Less than 80% Cu	Special brasses	Phosphor bronzes	Aluminum bronzes	Copper silicon	Copper nickel	Nickel silver
Turpentine	E	E	E	E	E	E	E	E	E
Varnish[b]	E	E	E	E	E	E	E	E	E
Vinegar[b]	E	E	P	G	E	E	E	E	G
Water, acid mine	F	F	P	F	G	F	F	P	F
Water, potable	E	E	G	E	E	E	E	E	E
Water condensate	E	E	E	E	E	E	E	E	E
Wetting agents[k]	E	E	E	E	E	E	E	E	E
Whiskey[b]	E	E	E	E	E	E	E	E	E
White water	G	G	G	E	E	E	E	E	E
Zinc chloride	G	G	P	G	G	G	G	G	G
Zinc sulfate	E	E	P	E	E	E	E	E	E

NOTES:

a This table is intended to serve only as a general guide to the behavior of copper and copper alloys in corrosive environments. It is impossible to cover in a simple tabulation the performance of a material for all possible variations of temperature, concentration, velocity, impurities, degree of aeration, and stress. It should be emphasized strongly that the table should be used with caution. The ratings shown in the tabulation are based on general performance.

The letters E, G, F, and P have the following significance: E - The metal will be suitable under most conditions of use. G - Some corrosion will take place, but the metal will perform satisfactorily under most service conditions. F - Corrosion rates will be higher than the 'G' classification, but use of the metal may be indicated by considerations other than corrosion resistance. P - Corrosion rates will be high and the metal is not recommended.

The material groups given as column headings are defined by copper, copper alloy number, or other designations as follows:

Copper - 102, 104, 105, 107, 110, 113, 114, 116, 120, 122, 127, 128, 130, 141, 145, 170, 172, 175, 187, 502
More than 80% Copper - 210, 220, 226, 230, 314
Less than 80% Copper - 240, 260, 270, 274, 280, 330, 335, 356, 360, 464, 675
Special brasses - Inhibited brass, 443, 444, 445, 687
Phosphor bronzes - 518, 521, 524, 544
Aluminum bronzes - 606, 614, 639
Copper-silicon bronzes - 651, 655
Copper-nickel alloys - 706, 710, 715
Nickel silvers - 720, 752, 757

b Copper and copper alloys are resistant to corrosion by most food products. Traces of copper may be dissolved and affect taste or color of the products. In such cases, copper alloys are often tin coated.

c Acetylene forms an explosive compound with copper when moist or when certain impurities are present and the gas is under pressure. Alloys containing less than 65% copper are satisfactory under this use. When the gas is not under pressure, other copper alloys are satisfactory.

d Precautions should be taken to avoid stress-corrosion cracking.

e At elevated temperatures, hydrogen will react with tough pitch copper, causing failure from embrittlement.

f Where air is present, corrosion rate may be increased.

g Below 300°F, corrosion rate is very low; above this temperature, corrosion is appreciable and increases rapidly as the temperature rises.

h Aeration and elevated temperature may increase corrosion rates substantially.

i Excessive oxidation may begin at lower temperatures.

j The use of high-zinc alloys should be avoided in acids because of the likelihood of rapid corrosion by dezincification. Copper, alloy no. 230 (red brass, 85%), phosphor bronzes, copper-silicon alloys, aluminum bronzes, and copper-nickels offer good resistance to corrosion by hot and cold dilute sulfuric acid and to corrosion by cold concentrated sulfuric acid. Intermediate concentrations of sulfuric acid sometimes are more corrosive to copper alloys than either concentrated or dilute acid. Concentrated sulfuric acid may be corrosive at elevated temperatures due to breakdown of acid with the formation of metallic sulfides and sulfur dioxide gas, causing localized pitting attack. Tests indicate that copper alloys may be corroded by pitting attack by 90 to 95% sulfuric acid at about 122°F, by 80% acid at about 160°F, and by 60% acid at about 212°F.

k Wetting agents may increase the corrosion rate of copper and copper alloys slightly to substantially when carbon dioxide or oxygen is present, by preventing the formation of a film on the metal surface and by combining (in some instances) with the dissolved copper to produce a green insoluble compound.

TABLE XII. WORKABILITY AND MACHINABILITY RATINGS OF SOME WROUGHT ALLOYS

Copper or Copper Alloy No.	Approximate Relative Suitability For Being Worked[a]		Hot Working Temperature °F	Annealing Temperature °F	Machinability Rating[b]
	Cold	Hot			
102	E	E	1400-1600	700-1200	20
110	E	E	1400-1600	700-1200	20
122	E	E	1400-1600	700-1200	20
170	E	G	1200-1500	1425-1475	20
172	E	G	1200-1500	1425-1475	20
175	E	G	1200-1625	-	-
210	E	G	1400-1600	800-1450	20
220	E	G	1400-1600	800-1450	20
226	E	G	1400-1650	800-1400	30
230	E	G	1450-1650	800-1350	30
240	E	F	1500-1650	800-1300	30
260	E	F	1350-1550	800-1400	30
268 & 270	E	P	-	800-1300	30
280	F	E	1150-1450	800-1100	40
314	G	P	-	800-1200	80
330	E	P	-	800-1200	60
332	F	P	-	800-1200	80
335	G	P	-	800-1300	60
340	G	P	-	800-1200	70
342 & 353	F	P	-	800-1100	90
356	P	F	1300-1450	800-1100	100
360	P	F	1300-1450	800-1100	100
365 to 368	F	E	1150-1450	800-1100	60
370	F	E	1150-1450	800-1100	70
377	P	E	1200-1500	800-1100	80
385	P	E	1150-1350	800-1100	90
442	E	F	1200-1450	800-1100	30
443 to 445	E	F	1200-1450	800-1100	30
464 to 467	F	E	1200-1500	800-1100	30
485	P	G	1200-1400	800-1100	70
505	E	G	1450-1600	900-1200	20
510	E	P	-	900-1250	20
520	G	P	-	900-1250	20
524	G	P	-	900-1250	20
544	G	-	-	900-1250	80
614	G	G	1450-1700	1125-1650	20
651	E	E	1300-1600	900-1250	30
655	E	E	1300-1600	900-1300	30
675	P	E	1150-1450	800-1100	30
687	E	F	1400-1600	800-1100	30
706	G	G	1550-1750	1100-1500	20
715	G	G	1700-1900	1200-1500	20
745	E	P	-	1100-1400	20
752	E	P	-	1100-1400	20
754	E	P	-	1100-1500	20
757	E	P	-	1100-1500	20
770	G	P	-	1100-1500	30

NOTES:

a E = excellent, G = good, F = fair, P = poor.

b Machinability rating is based on a rating of 100 for free cutting brass.

TABLE XIII. JOINING CHARACTERISTICS OF SOME WROUGHT ALLOYS

Alloy No.	Soldering	Brazing	Oxyacetylene welding	Carbonarc welding	Gas shielded arc welding	Coated metal arc welding	Resistance spot welding	Resistance seam welding	Resistance butt welding	Alloy No.	Soldering	Brazing	Oxyacetylene welding	Carbon arc welding	Gas shielded arc welding	Coated metal arc welding	Resistance spot welding	Resistance seam welding	Resistance butt welding
102	E	E	F	F	G	NR	NR	NR	G	370	E	G	NR	NR	NR	NR	NR	NR	F
110	E	G	NR	F	F	NR	NR	NR	G	377	E	G	NR	NR	NR	NR	NR	NR	F
122	E	E	G	G	E	NR	NR	NR	G	385	E	G	NR	NR	NR	NR	NR	NR	F
170	G	G	NR	NR	G	G	G	F	F	442	E	E	G	F	F	NR	G	NR	G
172	G	G	NR	NR	G	G	G	F	F	443	E	E	G	F	F	NR	G	NR	G
175	G	G	NR	NR	F	F	G	F	F	444	E	E	G	F	F	NR	G	NR	G
210	E	E	G	F	G	NR	NR	NR	G	445	E	E	G	F	F	NR	G	NR	G
220	E	E	G	F	G	NR	NR	NR	G	464	E	E	G	F	F	NR	G	F	G
226	E	E	G	F	G	NR	F	NR	G	485	E	G	NR	NR	NR	NR	NR	NR	F
230	E	E	G	F	G	NR	F	NR	G	502	E	E	F	G	G	F	NR	NR	E
240	E	E	G	F	G	NR	F	NR	G	510	E	E	F	G	G	F	G	F	E
260	E	E	G	F	F	NR	G	NR	G	521	E	E	F	G	G	F	G	F	E
268, 270 & 280	E	E	G	F	F	NR	G	NR	G	524	E	E	F	G	G	F	G	F	E
										544	E	G	NR	NR	NR	NR	NR	NR	F
314	E	G	NR	NR	NR	NR	NR	NR	F	614	NR	F	NR	G	b	G	G	G	G
330	E	G	F	F	F	NR	F	NR	F	651	E	E	G	G	E	F	E	G	E
332	E	G	NR	NR	NR	NR	NR	NR	F	655	G	E	G	G	E	F	E	E	E
335	E	G	F	F	F	NR	F	NR	F	675	E	E	G	F	F	NR	G	F	G
340	E	G	NR	NR	NR	NR	NR	NR	F	687	F	G	F	F	F	NR	G	F	G
342 & 353	E	G	NR	NR	NR	NR	NR	NR	F	706	E	E	F	NR	E	G	G	G	E
356	E	G	NR	NR	NR	NR	NR	NR	F	715	E	E	G	NR	E	E	E	E	E
360	E	G	NR	NR	NR	NR	NR	NR	F	745	E	E	G	NR	F	NR	G	F	G
365	E	G	F	F	F	NR	NR	NR	F	752	E	E	G	NR	F	NR	G	F	G
366	E	G	F	F	F	NR	NR	NR	F	754	E	E	G	NR	F	NR	G	F	G
367	E	G	F	F	F	NR	NR	NR	F	757	E	E	G	NR	F	NR	G	F	G
368	E	G	F	F	F	NR	NR	NR	F	770	E	E	G	NR	F	NR	G	F	G

NOTES: a E = excellent, G = good, F = fair, NR = not recommended.
b Consumable electrode excellent. Tungsten arc good, with AC preferred.

TABLE XIV. EFFECTS OF TESTING TEMPERATURE ON WROUGHT ALLOYS

Property	Effect of Decreasing Temperature	Effect of Increasing Temperature
Tensile strength	Considerable increase	Decrease
Yield strength	Moderate increase	Decrease
Elongation	Slight increase	Variable, but usually a considerable decrease, sometimes followed by an increase
Reduction of area	No significant trend	(Same as elongation)
Hardness	Considerable increase	Decrease
Impact strength	Slight increase or no change	Decrease
Fatigue strength	Moderate increase	
Modulus of elasticity	Slight to moderate increase	Decrease
Specific heat	Decrease	Increase
Thermal conductivity	Considerable increase	Slight decrease
Electrical resistance	Moderate decrease	Moderate increase

TABLE XV. SOME PHYSICAL PROPERTIES OF WROUGHT ALLOYS

Alloy No.	Melting Point °F		Density (lb./cu. in. at 68°F)	Electrical Conductivity (Volume Basis)-Annealed %IACS at 68°F	Electrical Resistivity (Annealed) Ohms/circ. mil/ft. at 68°F	Thermal Conductivity (Btu./sq.ft./ft./hr./°F at 68°F)	Modulus of Elasticity-Tension (10^6 psi)	Modulus of Rigidity (10^6 psi)
	Liquidus	Solidus						
102	1981	-	0.323	101	10.3	226	17	6.4
110	1981	1949	0.321-0.323	101	10.3	226	17	6.4
122	1981	-	0.323	85	12.2	196	17	6.4
170	1800	1590	0.298	22.0	46.2	62-75	18.5	7.3
172	1800	1590	0.298	22.0	46.2	62-75	18.5	7.3
175	1955	1885	0.316	45.0	22.8	120-150	19.0	7.5
210	1950	1920	0.320	56	18.5	135	17	6.4
220	1910	1870	0.318	44	23.6	109	17	6.4
226	1895	1840	0.317	40	25.9	100	17	6.4
230	1880	1810	0.316	37	28.0	92	17	6.4
240	1830	1770	0.313	32	32.4	81	16	6
260	1750	1680	0.308	28	37.0	70	16	6
268 & 270	1710	1660	0.306	27	38.4	67	15	5.6
280	1660	1650	0.303	28	37.0	71	15	5.6
314	1900	1850	0.319	42	24.7	104	17	6.4
330	1720	1660	0.307	26	39.9	67	15	5.6
332	1710	1650	0.308	26	39.9	67	15	5.6
335	1700	1650	0.306	26	39.9	67	15	5.6
340	1700	1630	0.306	26	39.9	67	15	5.6
342 & 353	1670	1630	0.306	26	39.9	67	15	5.6
356	1660	1630	0.307	26	39.9	67	14	5.3
360	1650	1630	0.307	26	39.9	67	14	5.3
365 thru 368	1650	1630	0.304	28	37.0	71	15	5.6
370	1650	1630	0.304	27	38.4	69	15	5.6
377	1640	1620	0.305	27	38.4	69	15	5.6
385	1630	1610	0.306	28	37.0	71	14	5.3
443 thru 445	1720	1650	0.308	25	41.5	64	16	6
464 thru 467	1650	1630	0.304	26	39.9	67	15	5.6
485	1650	1630	0.305	26	39.9	67	15	5.6
505	1970	1900	0.321	48	21.6	120	17	6.4
510	1920	1750	0.320	15	69.1	40	16	6
521	1880	1620	0.318	13	79.8	36	16	6
524	1830	1550	0.317	11	94.3	29	16	6
544	1830	1700	0.321	19	54.6	50	15	5.6
614	1915	1905	0.285	14	74	39	17	6.4
651	1940	1890	0.316	12	86.4	33	17	6.4
655	1880	1780	0.308	7.0	148	21	15	5.6
675	1630	1590	0.302	24	43.2	61	15	5.6
687	1780	1710	0.301	23	45.1	58	16	6
706	2100	2010	0.323	9.0	115	26	18	6.8
715	2260	2140	0.323	4.6	225	17	22	8.3
745	1870	-	0.314	9.0	115	26	17.5	6.6
752	2030	1960	0.316	6.0	173	19	18	6.8
754	1970	-	0.314	7.0	148	21	18	6.8
757	1900	-	0.314	8.0	130	23	18	6.8
770	1930	-	0.314	5.5	189	17	18	6.8

TABLE XVI. NOMINAL COMPOSITION OF WROUGHT ALLOYS.

COPPERS

Copper Number	Designation	Previous Commonly Accepted Trade Name	Composition, Percent Maximum (Unless Shown as a Range or Minimum)								
			Copper plus Silver (%min)	Silver[a] (oz/ton) min	Arsenic	Phosphorus	Tellurium	Nickel	Bismuth	Lead	Other Named Elements
101[b]	OFE	Oxygen Free Electronic	99.96	-	-	0.0003	-	-	-	0.0010	0.00040 Sulfur 0.0003 Zinc 0.0001 Mercury
102[b]	OF	Oxygen Free	99.95	-	-	-	-	-	-	-	-
104[b]	OFS	Oxygen Free with Silver	99.95	8	-	-	-	-	-	-	-
105[b]	OFS	Oxygen Free with Silver	99.95	10	-	-	-	-	-	-	-
107[b]	OFS	Oxygen Free with Silver	99.95	25	-	-	-	-	-	-	-
110[b]	ETP	Electrolytic Tough Pitch	99.90	-	-	-	-	-	-	-	-
111[b]	-	Electrolytic Tough Pitch Anneal Resistant	99.90	-	-	-	-	-	-	-	c
113[b, d]	STP	Tough Pitch with Silver	99.90	8	-	-	-	-	-	-	-
114[b, d]	STP	Tough Pitch with Silver	99.90	10	-	-	-	-	-	-	-
116[b, d]	STP	Tough Pitch with Silver	99.90	25	-	-	-	-	-	-	-
120	DLP	Phosphorus Deoxidized Low Residual Phosphorus	99.90	-	-	0.004-0.012	-	-	-	-	-
121	-	-	99.90	4	-	0.005-0.012	-	-	-	-	-
122[e]	DHP	Phosphorus Deoxidized High Residual Phosphorus	99.90	-	-	0.015-0.040	-	-	-	-	-
123	-	-	99.90	4	-	0.015-0.025	-	-	-	-	-
125[f]	FRTP	Fire Refined Tough Pitch	99.88	-	0.012	-	0.025[g]	0.050	0.003	0.004	0.003 Antimony
127[f]	FRSTP	Fire Refined Tough Pitch with Silver	99.88	8	0.012	-	0.025[g]	0.050	0.003	0.004	0.003 Antimony
128[f]	FRSTP	Fire Refined Tough Pitch with Silver	99.88	10	0.012	-	0.025[g]	0.050	0.003	0.004	0.003 Antimony
130[f]	FRSTP	Fire Refined Tough Pitch with Silver	99.88	25	0.012	-	0.025[g]	0.050	0.003	0.004	0.003 Antimony
141	ATP	Arsenical Tough Pitch	99.40	-	0.15-0.50	-	-	-	-	-	-
142	DPA	Phosphorus Deoxidized Arsenical	99.40	-	0.15-0.50	0.015-0.040	-	-	-	-	-
145[h]	DPTE	Phosphorus Deoxidized Tellurium Bearing	99.90[i]	-	-	0.004-0.012[j]	0.40-0.6	-	-	-	-
147	-	Sulfur Bearing	99.90[k]	-	-	-	-	-	-	-	0.20-0.50 Sulfur
150	-	Zirconium Copper	99.80	-	-	-	-	-	-	-	0.10-0.20 Zirconium

TABLE XVI (Contd.)

HIGH COPPER ALLOYS

Copper Alloy Number	Previous Commonly Accepted Trade Name	Composition, Percent Maximum (Unless Shown as a Range or Minimum)										
		Copper + silver + elements with specific limits (%min)[1]	Iron	Tin	Nickel	Cobalt	Chromium	Silicon	Beryllium	Lead	Cadmium	Other Named Elements
162	Cadmium Copper	99.8	0.02	-	-	-	-	-	-	-	0.7-1.2	-
164	-	99.8	0.02	0.20-0.40	-	-	-	-	-	-	0.6-0.9	-
165	-	99.8	0.02	0.50-0.7	-	-	-	-	-	-	0.6-1.0	-
170	Beryllium Copper	99.5	m	-	m	m	-	-	1.6-1.8	-	-	-
172	Beryllium Copper	99.5	m	-	m	m	-	-	1.8-2.0	-	-	-
175	Beryllium Copper	99.5	0.10	-	-	2.4-2.7	-	-	0.4-0.7	-	-	-
182	Chromium Copper	99.5	0.10	-	-	-	0.6-1.2	0.10	-	0.05	-	-
184	Chromium Copper	99.8	0.15	-	-	-	0.40-1.2	0.10	-	-	-	0.005 Arsenic 0.005 Calcium 0.05 Lithium 0.05 Phos. 0.70 Zinc
185	Chromium Copper	99.8	-	-	-	-	0.40-1.0	-	-	0.015	-	0.04 Phos. 0.08-0.12 Silver
187	-	99.9	-	-	-	-	-	-	-	0.8-1.2	-	-
189	-	99.9	-	0.6-0.9	-	-	-	0.15-0.40	-	0.02	-	0.05 Phos. 0.01 Aluminum 0.10-0.30 Manganese 0.10 Zinc
190	-	99.5	0.10	-	0.9-1.3	-	-	-	-	0.05	-	0.75 Zinc 0.15-0.35 Phos.
191	-	99.5	0.20	-	0.9-1.3	-	-	-	-	0.10	-	0.50 Zinc 0.15-0.35 Phos. 0.35-0.6 Tellurium

Copper Alloy Number	Previous Commonly Accepted Trade Name	Composition, Percent Maximum (Unless Shown as a Range or Minimum)						
		Copper	Iron	Tin	Zinc	Aluminum	Lead	Total Other Elements[n]
193		92.0-94.0	2.05-2.6	0.03	Rem.	0.02	0.03	0.05

TABLE XVI (Contd.)

COPPER-ZINC ALLOYS (BRASSES)

Copper Alloy Number	Previous Commonly Accepted Trade Name	Composition, Percent Maximum (Unless Shown as a Range or Minimum)							
		Copper	Lead	Iron	Zinc	Nickel	Aluminum	Phosphorus	Total Other Elements[n]
205	-	97.0-98.0	0.02	0.05	Rem.	-	-	-	0.05
210	Gilding, 95%	94.0-96.0	0.05	0.05	Rem.	-	-	-	0.10
220	Commercial Bronze, 90%	89.0-91.0	0.05	0.05	Rem.	-	-	-	0.10
226	Jewelry Bronze, 87-1/2%	86.0-89.0	0.05	0.05	Rem.	-	-	-	0.15
230	Red Brass, 85%	84.0-86.0[o]	0.05[o]	0.05	Rem.	-	-	-	0.15
234	-	81.0-84.0	0.05	0.05	Rem.	-	-	-	0.15
240	Low Brass, 80%	78.5-81.5	0.05	0.05	Rem.	-	-	-	0.15
250	-	74.0-76.0	0.05	0.05	Rem.	-	-	-	0.15
260	Cartridge Brass, 70%	68.5-71.5	0.07	0.05	Rem.	-	-	-	0.15
261	-	68.5-71.5	0.05	0.05	Rem.	-	-	0.02-0.05	0.15
262	-	67.0-70.0	0.07	0.05	Rem.	-	-	-	0.15
268	Yellow Brass, 66%	64.0-68.5	0.15	0.05	Rem.	-	-	-	0.15
270	Yellow Brass, 65%	63.0-68.5	0.10	0.07	Rem.	-	-	-	0.20
274	Yellow Brass, 63%	61.0-64.0	0.10	0.05	Rem.	-	-	-	0.20
280	Muntz Metal, 60%	59.0-63.0	0.30	0.07	Rem.	-	-	-	0.20
298	Brazing Alloy	49.0-52.0	0.50	0.10	Rem.	-	0.10	-	-

COPPER-ZINC-LEAD ALLOYS (LEADED BRASSES)

Copper Alloy Number	Previous Commonly Accepted Trade Name	Composition, Percent Maximum (Unless Shown as a Range or Minimum)										
		Copper	Lead	Iron	Tin	Zinc	Nickel	Aluminum	Phosphorus	Arsenic	Antimony	Total Other Elements[n]
310	Leaded Commercial Bronze (Low Lead)	89.0-91.0	0.30-0.7	0.10	-	Rem.	-	-	-	-	-	0.50
314	Leaded Commercial Bronze	87.5-90.5	1.3-2.5	0.10	-	Rem.	-	-	-	-	-	0.50
316	Leaded Commercial Bronze (Nickel Bearing)	87.5-90.5	1.3-2.5	0.10	-	Rem.	0.7-1.2	-	-	-	-	0.50
320	Leaded Red Brass	83.5-86.5	1.5-2.2	0.10	-	Rem.	-	-	-	-	-	0.50
325	-	72.0-74.5	2.5-3.0	0.10	-	Rem.	-	-	-	-	-	0.50
330	Low Leaded Brass (Tube)	65.0-68.0	0.20-0.8[p]	0.07	-	Rem.	-	-	-	-	-	0.50
331	-	65.0-68.0	0.7-1.2	0.06	-	Rem.	-	-	-	-	-	0.50
332	High Leaded Brass (Tube)	65.0-68.0	1.3-2.0	0.07	-	Rem.	-	-	-	-	-	0.50
335	Low Leaded Brass	62.5-66.5	0.30-0.8	0.10	-	Rem.	-	-	-	-	-	0.50
340	Medium Leaded Brass, 64-1/2%	62.5-66.5	0.8-1.4	0.10	-	Rem.	-	-	-	-	-	0.50
342	High Leaded Brass, 64-1/2%	62.5-66.5	1.5-2.5	0.10	-	Rem.	-	-	-	-	-	0.50
344	-	62.0-66.0	0.50-1.0	0.10	-	Rem.	-	-	-	-	-	0.50
345	Copper Alloy	62.0-64.0	1.5-2.8	0.15	-	Rem.	-	-	-	-	-	0.50
347	-	62.5-64.5	1.0-1.8	0.10	-	Rem.	-	-	-	-	-	0.50
348	-	61.5-63.5	0.40-0.8	0.10	-	Rem.	-	-	-	-	-	0.50
350	Medium Leaded Brass, 62%	61.0-64.0	0.8-1.4	0.10	-	Rem.	-	-	-	-	-	0.50
353	High Leaded Brass, 62%	59.0-64.5	1.3-2.3	0.10	-	Rem.	-	-	-	-	-	0.50
356	Extra High Leaded Brass	60.0-64.5	2.0-3.0	0.10	-	Rem.	-	-	-	-	-	0.50
360	Free Cutting Brass	60.0-63.0	2.5-3.7	0.35	-	Rem.	-	-	-	-	-	0.50
362	-	60.0-63.0	3.5-4.5	0.15	-	Rem.	-	-	-	-	-	0.50
365	Leaded Muntz Metal, Uninhibited	58.0-61.0	0.40-0.9	0.15	0.25	Rem.	-	-	-	-	-	0.10
366	Leaded Muntz Metal, Arsenical	58.0-61.0	0.40-0.9	0.15	0.25	Rem.	-	-	-	0.02-0.10	-	0.10
367	Leaded Muntz Metal, Antimonial	58.0-61.0	0.40-0.9	0.15	0.25	Rem.	-	-	-	-	0.02-0.10	0.10
368	Leaded Muntz Metal, Phosphorized	58.0-61.0	0.40-0.9	0.15	0.25	Rem.	-	-	0.02-0.10	-		0.10

TABLE XVI (Contd.)

COPPER-ZINC-LEAD ALLOYS (LEADED BRASSES) (Contd.)

Copper Alloy Number	Previous Commonly Accepted Trade Name	Composition, Percent Maximum (Unless Shown as a Range or Minimum)										
		Copper	Lead	Iron	Tin	Zinc	Nickel	Aluminum	Phosphorus	Arsenic	Antimony	Total Other Elements[n]
370	Free Cutting Muntz Metal	59.0-62.0	0.9-1.4	0.15	-	Rem.	-	-	-	-	-	0.50
371	-	58.0-62.0	0.6-1.2	0.15	-	Rem.	-	-	-	-	-	0.50
377	Forging Brass	58.0-62.0	1.5-2.5	0.30	-	Rem.	-	-	-	-	-	0.50
380	-	55.0-60.0	1.5-2.5	0.35	0.30	Rem.	-	0.50	-	-	-	0.50
385	Architectural Bronze	55.0-60.0	2.0-3.8	0.35	-	Rem.	-	-	-	-	-	0.50

COPPER-ZINC-TIN ALLOYS (TIN BRASSES)

Copper Number	Previous Commonly Accepted Trade Name	Composition, Percent Maximum (Unless Shown as a Range or Minimum)									
		Copper	Lead	Iron	Tin	Zinc	Phosphorus	Arsenic	Antimony	Manganese	Total Other Elements[n]
405	-	94.0-96.0	0.05	0.05	0.7-1.3	Rem.	-	-	-	-	0.15
408	-	94.0-96.0	0.05	0.05	1.8-2.2	Rem.	-	-	-	-	0.15
409	-	92.0-94.0	0.05	0.05	0.50-0.8	Rem.	-	-	-	-	0.15
410	-	91.0-93.0	0.05	0.05	2.0-2.8	Rem.	-	-	-	-	0.15
411	-	89.0-92.0	0.10	0.05	0.30-0.7	Rem.	-	-	-	-	0.15
413	-	89.0-93.0	0.10	0.05	0.7-1.3	Rem.	-	-	-	-	0.15
415	-	89.0-93.0	0.10	0.05	1.5-2.2	Rem.	-	-	-	-	0.15
419	-	89.0-92.0	0.10	0.05	4.8-5.5	Rem.	-	-	-	-	0.15
420	-	88.0-91.0	-	-	1.5-2.0	Rem.	0.25	-	-	-	0.15
421	-	87.5-89.0	0.05	0.05	2.2-3.0	Rem.	0.35	-	-	0.15-0.35	0.15
422	-	86.0-89.0	0.05	0.05	0.8-1.4	Rem.	0.35	-	-	-	0.15
425	-	87.0-90.0	0.05	0.05	1.5-2.5	Rem.	0.35	-	-	-	0.15
430	-	85.0-89.0	0.10	0.05	1.7-2.7	Rem.	-	-	-	-	0.15
432	-	85.0-88.0	0.05	0.05	0.40-0.6	Rem.	0.35	-	-	-	0.15
434	-	84.0-86.0	0.05	0.05	0.50-1.0	Rem.	-	-	-	-	0.15
435	-	79.0-83.0	0.10	0.05	0.6-1.2	Rem.	-	-	-	-	0.15
436	-	80.0-83.0	0.05	0.05	0.20-0.50	Rem.	-	-	-	-	0.15
438	-	79.0-82.0	0.05	0.05	1.0-1.5	Rem.	-	-	-	-	0.15
442	Admiralty Uninhibited	70.0-73.0	0.07	0.06	0.8-1.2	Rem.	-	-	-	-	0.15
443	Admiralty Arsenical	70.0-73.0	0.07	0.06	0.8-1.2	Rem.	-	0.02-0.10	-	-	0.15
444	Admiralty Antimonial	70.0-73.0	0.07	0.06	0.8-1.2	Rem.	-	-	0.02-0.10	-	0.15
445	Admiralty Phosphorized	70.0-73.0	0.07	0.06	0.8-1.2	Rem.	0.02-0.10	-	-	-	0.15
462	Naval Brass 63-1/2%	62.0-65.0	0.20	0.10	0.50-1.0	Rem.	-	-	-	-	0.10
464	Naval Brass Uninhibited	59.0-62.0	0.20	0.10	0.50-1.0	Rem.	-	-	-	-	0.10
465	Naval Brass Arsenical	59.0-62.0	0.20	0.10	0.50-1.0	Rem.	-	0.02-0.10	-	-	0.10
466	Naval Brass Antimonial	59.0-62.0	0.20	0.10	0.50-1.0	Rem.	-	-	0.02-0.10	-	0.10
467	Naval Brass Phosphorized	59.0-62.0	0.20	0.10	0.50-1.0	Rem.	0.02-0.10	-	-	-	0.10
470	Naval Brass Welding & Brazing Rod	57.0-61.0	0.05	-	0.25-1.0	Rem.	-	-	-	-	0.50[q]
472	Brazing Alloy	49.0-52.0	0.50	0.10	3.0-4.0	Rem.	-	-	-	-	-
476	-	86.0-88.0	1.8-2.2	0.05	1.8-2.2	Rem.	0.03-0.07	-	-	0.05-0.15	0.15
482	Naval Brass Medium Leaded	59.0-62.0	0.40-1.0	0.10	0.50-1.0	Rem.	-	-	-	-	0.10
485	Naval Brass High Leaded	59.0-62.0	1.3-2.2	0.10	0.50-1.0	Rem.	-	-	-	-	0.10

TABLE XVI (Contd.)

COPPER-TIN ALLOYS (PHOSPHOR BRONZES)

Copper Alloy Number	Previous Commonly Accepted Trade Name	Composition, Percent Maximum (Unless Shown as a Range or Minimum)						
		Copper + Tin + Phosphorus (% min)	Lead	Iron	Tin	Zinc	Aluminum	Phosphorus
502	-	99.5	0.05	0.10	1.0-1.5	-	-	0.04
505	Phosphor Bronze 1.25%E	99.5	0.05	0.10	1.0-1.7	0.30	-	0.03-0.35
507	-	99.5	0.05	0.10	1.5-2.0	-	-	0.30
508	-	99.5	0.05	0.10	2.6-3.4	-	-	0.01-0.07
509	-	99.5	0.05	0.10	2.5-3.8	0.30	-	0.03-0.30
510	Phosphor Bronze 5% A	99.5	0.05	0.10	3.5-5.8	0.30	-	0.03-0.35
518	Phosphor Bronze	99.5	0.02	-	4.0-6.0	-	0.01	0.10-0.35
521	Phosphor Bronze 8% C	99.5	0.05	0.10	7.0-9.0	0.20	-	0.03-0.35
524	Phosphor Bronze 10% D	99.5	0.05	0.10	9.0-11.0	0.20	-	0.03-0.35

COPPER-TIN-LEAD ALLOYS (LEADED PHOSPHOR BRONZES)

Copper Alloy Number	Previous Commonly Accepted Trade Name	Composition, Percent Maximum (Unless Shown as a Range or Minimum)					
		Copper + Tin + Phosphorus + Lead (% min)	Lead	Iron	Tin	Zinc	Phosphorus
532	Phosphor Bronze B	99.5	2.5-4.0	0.10	4.0-5.5	0.20	0.03-0.35
534	Phosphor Bronze B-1	99.5	0.8-1.2	0.10	3.5-5.8	0.30	0.03-0.35
544	Phosphor Bronze B-2	99.5[r]	3.5-4.5	0.10	3.5-4.5	1.5-4.5	0.01-0.50
546	Phosphor Bronze B-2 (P 0.50 max.)	99.5[r]	3.5-4.5	0.10	3.5-4.5	1.5-4.5	0.50

COPPER-ALUMINUM ALLOYS (ALUMINUM BRONZES)

Copper Alloy Number	Previous Commonly Accepted Trade Name	Composition, Percent Maximum (Unless Shown as a Range or Minimum)									
		Copper + Elements with specific limits (% min)[1]	Lead	Iron	Tin	Zinc	Nickel	Aluminum	Arsenic	Manganese	Silicon
606	-	99.5	-	0.50	-	-	-	4.0-7.0	-	-	-
607	-	99.5	0.01	-	1.7-2.0	-	-	2.3-2.9	-	-	-
608	-	99.5	0.10	0.10	-	-	-	5.0-6.5	0.35	-	-
610	-	99.5	0.02	-	-	0.20	-	6.0-9.0	-	-	0.10
612	-	99.5	-	0.50	-	-	-	7.0-9.0	-	-	-
613	-	99.5	-	3.5	0.20-0.50	-	-	6.0-8.0	-	-	-
614	Aluminum Bronze D	99.5	-	1.5-3.5	-	-	-	6.0-8.0	-	1.0	-
616	-	99.5	-	4.0	0.6	1.0	1.0	6.5-11.0	-	1.5	0.25
617	-	99.5	-	1.5	2.0[s]	-	2.0[s]	7.0-10.0	-	2.0[s]	-
618	-	99.5	0.02	1.5	-	0.02	-	9.0-11.0	-	-	0.10
620	-	99.5	-	3.2-3.7	-	-	-	9.8-10.5	-	-	-
622	-	99.5	0.02	3.0-4.25	-	0.02	-	11.0-12.0	-	-	0.10
623	-	99.5	-	2.0-4.0	0.20	-	-	8.0-10.0	-	-	0.25
624	-	99.5	-	2.0-4.0	0.20	-	-	10.0-11.5	-	0.30	0.25
626	-	99.7	-	2.0-4.5	-	-	3.0-4.5	9.7-10.7	-	1.5	-
628	-	99.5	-	1.5-3.5	-	-	4.0-7.0	8.0-11.0	-	0.50-2.0	-
630	-	99.5	-	2.0-4.0	0.20	-	4.0-5.5	9.0-11.0	-	1.5	0.25
637	-	99.5	0.05	0.30	0.6	1.0	0.25	6.5-8.5	0.15	-	1.2-2.2
639	-	99.5	0.05	0.10	-	-	0.25	6.5-8.0	0.15	-	1.5-3.0
642	-	99.5	-	4.0	0.6	1.0	0.25-1.0[t]	6.5-11.0	0.15	1.5	2.2[t]

COPPER-SILICON ALLOYS (SILICON BRONZES)

Copper Alloy Number	Previous Commonly Accepted Trade Name	Composition, Percent Maximum (Unless Shown as a Range or Minimum)								
		Copper + Elements with specific limits (% min)	Lead	Iron	Tin	Zinc	Nickel	Aluminum	Manganese	Silicon
647	-	99.5	0.10	0.10	-	0.50	1.6-2.2	-	-	0.40-0.8
651	Low Silicon Bronze B	99.5	0.05	0.8	-	1.5	-	-	0.7	0.8-2.0
653	-	99.7	0.05	0.8	-	-	0.6	-	-	2.0-3.0
655	High Silicon Bronze A	99.5	0.05	0.8	-	1.5	0.6	-	1.5	2.8-3.8
656	-	99.5	0.02	0.50	1.5	1.5	-	0.01	1.5	2.8-4.0
658	-	99.5	0.05	0.50	-	-	-	0.01	1.5	2.8-3.8
661	-	99.5	0.20-0.8	0.25	-	1.5	-	-	1.5	2.8-3.5

MISCELLANEOUS COPPER-ZINC ALLOYS

Copper Alloy Number	Previous Commonly Accepted Trade Name	Composition, Percent Maximum (Unless Shown as a Range or Minimum)										
		Copper	Lead	Iron	Tin	Zinc	Nickel	Aluminum	Arsenic	Manganese	Silicon	Total Other Elements[n]
665	-	80.0-82.0	0.05	0.10	-	Rem.	-	-	-	0.7-1.5	-	0.15
667	Manganese Brass	68.5-71.5	0.07	0.10	-	Rem.	-	-	-	0.8-1.5	-	0.50
670	Manganese Bronze B	63.0-68.0	0.20	2.0-4.0	0.50	Rem.	-	3.0-6.0	-	2.5-5.0	-	0.10
671	-	59.0-62.0	0.15-0.35	0.20-0.8	0.50-1.0	Rem.	-	-	-	0.05-0.25	-	0.50
673	-	58.0-63.0	0.40-3.0	0.50	0.30	Rem.	0.25	0.25	-	2.0-3.5	0.50-1.5	0.10
674	-	57.0-60.0	0.50	0.35	0.30	Rem.	0.25	0.50-2.0	-	2.0-3.5	0.50-1.5	0.10
675	Manganese Bronze A	57.0-60.0	0.20	0.8-2.0	0.50-1.5	Rem.	-	0.25	-	0.05-0.5	-	0.10
676	-	57.0-60.0	0.50-1.0	0.40-1.3	0.50-1.5	Rem.	-	-	-	0.05-0.50	-	0.30
677	-	55.5-58.0	0.50-1.0	0.7-1.5	-	Rem.	1.5-2.3	-	0.40-0.8	0.05-0.30	-	0.50
680	Bronze, Low Fuming (Nickel)	56.0-60.0	0.05	0.25-1.25	0.75-1.10	Rem.	0.20-0.8	0.01	-	0.01-0.50	0.04-0.15	0.50[q]
681	Bronze, Low Fuming	56.0-60.0	0.05	0.25-1.25	0.75-1.10	Rem.	-	0.01	-	0.01-0.50	0.04-0.15	0.50[q]
685	-	85.0-89.0	0.05	1.5-2.5	0.10	Rem.	-	3.5-4.5	-	-	-	0.10
687	Aluminum Brass Arsenical	76.0-79.0	0.07	0.06	-	Rem.	-	1.8-2.5	0.02-0.10	-	-	0.15
692	Silicon Brass	89.0-91.0	0.05	0.05	-	Rem.	-	-	-	-	0.8-1.5	0.50
694	Silicon Red Brass	80.0-83.0	0.30	0.20	-	Rem.	-	-	-	-	3.5-4.5	0.50
697	-	75.0-80.0	0.50-1.5	0.10	-	Rem.	-	-	-	0.40	2.5-3.5	0.50

COPPER-NICKEL ALLOYS

Copper Alloy Number	Previous Commonly Accepted Trade Name	Composition, Percent Maximum (Unless Shown as a Range or Minimum)					
		Copper + Elements with specific limits (% min)	Lead	Iron	Zinc	Nickel	Manganese
702	-	99.7	0.05	0.10	-	2.0-3.0	0.40
703	-	99.5	-	0.05	-	4.7-5.7	0.50
704	Copper Nickel 5%	99.6	0.05	1.3-1.7	1.0	4.8-6.2	0.30-0.8
705	Copper Nickel 7%	99.5	0.05	0.10	0.20	5.8-7.8	0.15
706	Copper Nickel 10%	99.5	0.05	1.0-1.8	1.0	9.0-11.0	1.0
707	-	99.5	-	0.50	-	9.5-10.5	0.50
708	Copper Nickel 11%	99.5	0.05	0.10	0.20	10.5-12.5	0.15
709	-	99.5	0.05	0.6	1.0	13.5-16.5	0.6
710	Copper Nickel 20%	99.5	0.05	1.0	1.0	19.0-23.0	1.0
715	Copper Nickel 30%	99.5	0.05	0.40-0.7	1.0	29.0-33.0	1.0
720	Copper Nickel 40%	99.5	0.05	1.5-2.5	0.30	40.0-43.0	0.5-1.7

COPPER-NICKEL-ZINC ALLOYS (NICKEL SILVERS)

Copper Alloy Number	Previous Commonly Accepted Trade Name	Composition, Percent Maximum (Unless Shown as a Range or Minimum)										
		Copper	Lead	Iron	Tin	Zinc	Nickel	Aluminum	Phosphorus	Manganese	Silicon	Total Other Elements[n]
732	-	70.0(min)	0.05	0.6	-	3.0-6.0	19.0-23.0	-	-	1.0	-	0.50
735	-	70.5-73.5	0.10	0.25	-	Rem.	16.5-19.5	-	-	0.50	-	0.50
736	-	70.5-73.5	0.05	0.25	-	Rem.	14.0-16.0	-	-	0.50	-	0.50
740	-	69.0-73.5	0.10	0.25	-	Rem.	9.0-11.0	-	-	0.50	-	0.50
745	Nickel Silver 65-10	63.5-68.5	0.10	0.25	-	Rem.	9.0-11.0	-	-	0.50	-	0.50
752	Nickel Silver 65-18	63.0-66.5	0.10	0.25	-	Rem.	16.5-19.5	-	-	0.50	-	0.50
754	Nickel Silver 65-15	63.5-66.5	0.10	0.25	-	Rem.	14.0-16.0	-	-	0.50	-	0.50
757	Nickel Silver 65-12	63.5-66.5	0.05	0.25	-	Rem.	11.0-13.0	-	-	0.50	-	0.50
762	-	57.0-61.0	0.10	0.25	-	Rem.	11.0-13.5	-	-	0.50	-	0.50
764	-	58.5-61.5	0.05	0.25	-	Rem.	16.5-19.5	-	-	0.50	-	0.50
766	-	55.0-58.0	0.10	0.25	-	Rem.	11.0-13.5	-	-	0.50	-	0.50
767	Nickel Silver 56.5-15	55.0-58.0	-	-	-	Rem.	14.0-16.0	-	-	0.50	-	0.50
770	Nickel Silver 55-18	53.5-56.5	0.10	0.25	-	Rem.	16.5-19.5	-	-	0.50	-	0.50
773	-	46.0-50.0	0.05	-	-	Rem.	9.0-11.0	0.01	0.25	-	0.04-0.25	0.50
774	-	43.0-47.0	0.20	-	-	Rem.	9.0-11.0	-	-	-	-	0.50
776	Nickel Silver 43.5-13	42.0-45.0	0.25	0.20	0.15	Rem.	12.0-14.0	-	-	0.25	-	0.50
782	-	63.0-67.0	1.50-2.50	0.35	-	Rem.	7.0-9.0	-	-	0.50	-	0.10
784	-	60.0-63.0	0.8-1.4	0.25	-	Rem.	9.0-11.0	-	-	0.50	-	0.50
786	-	60.0-63.0	1.20-1.80	0.35	-	Rem.	8.5-11.0	-	-	0.50	-	0.10
788	-	63.0-67.0	1.5-2.0	0.25	-	Rem.	9.0-11.0	-	-	0.50	-	0.50
790	-	63.0-67.0	1.50-2.20	0.35	-	Rem.	11.0-13.0	-	-	0.50	-	0.10
792	-	59.0-66.5	0.8-1.4	0.25	-	Rem.	11.0-13.0	-	-	0.50	-	0.50
794	-	59.0-66.5	0.8-1.2	0.25	-	Rem.	16.5-19.5	-	-	0.50	-	0.50
796	Leaded Nickel Silver, 10%	43.5-46.5	0.8-1.2	-	-	Rem.	9.0-11.0	-	-	1.5-2.5	-	0.50
798	-	45.5-48.5	1.5-2.5	0.25	-	Rem.	9.0-11.0	-	-	1.5-2.5	-	0.50

NOTES:

a. Troy ounces per avoirdupois ton.

b. These are high conductivity coppers which have in the annealed condition a minimum conductivity of 100% IACS.

c. Small amounts of Cadmium or other elements may be added by agreement to improve resistance to softening at elevated temperature.

d. This includes Low Resistance Lake Copper and Electrolytic Copper.

e. This includes Oxygen-Free Copper which contains Phosphorus in an amount agreed upon.

f. This includes High Resistance Lake Copper.

g. This includes permissible Selenium.

h. This includes Oxygen-Free Tellurium Bearing Copper which contains Phosphorus in an amount agreed upon.

i. This includes Copper plus Silver plus Tellurium.

j. Other deoxidizers may be used as agreed upon, in which case Phosphorus need not be present.

k. This includes Copper plus Silver plus Sulfur.

l. *Specific limits are defined as any numerical values, whether* maximum only, minimum only, or ranges.

m. Cobalt 0.20 minimum.
Nickel plus Cobalt plus Iron 0.60 maximum.

n. Analysis is regularly made for the elements for which specific limits are listed except Zinc. If, however, the presence of other elements is suspected or indicated in the course of routine analysis further analysis shall be made to determine that the total of these "other" elements is not in excess of the limits specified.

o. For pipe and tube, the Copper limit may be 83.0% minimum and the Lead 0.06% maximum.

p. For tube over 5 inch O.D., the Lead may be less than 0.20%.

q. Including Aluminum and Lead.

r. Including Zinc.

s. Nickel plus Tin plus Manganese, 2.0% maximum.

t. When both Nickel and Silicon are present, only one shall be in excess of 0.25 percent.

TABLE XVII. FEDERAL SPECIFICATIONS - CROSS REFERENCE, WROUGHT ALLOYS

Specification No.	Specification Title	Specification Alloy Designation	Copper or Copper Alloy No.
QQ-A-660	Anodes, Brass	-	240
QQ-A-673A(1)	Anodes, Copper	Type I Type II Type III	110 101, 102 122
QQ-B-575A	Braid, Wire (Copper, Tin Coated Tubular)	-	-
QQ-B-613C	Brass, Leaded and Nonleaded; Plate, Bar, Sheet, and Strip	Comp. 11	b 230, 240, 260, 268, 342, 353
QQ-B-626C	Brass, Leaded and Nonleaded; Rod, Shaped Forgings and Flat Products with Finished Edges (Bar and Strip)	Comp 11	c 230, 240, 260, 268, 342, 353, 360, 377
QQ-B-637A	Brass, Naval; Rod, Wire, Shaped Forgings, and Flat Products with Finished Edges (Bar, Flat Wire, and Strip)	-	462, 464, 482, 485
QQ-B-639A	Brass, Naval: Flat Products (Plate, Bar, Sheet, and Strip.)	-	462, 464, 482, 485
QQ-B-650A(1)	Brazing Alloy, Copper, Copper-Zinc, and Copper Phosphorous	Comp. A Comp. B Comp. C Comp. D	240, 260, 261, 298, 472
QQ-B-675A(1)	Bronze, Aluminum Ingots (For Remelting)	-	-
QQ-B-728	Bronze Manganese; Rod, Shapes, Forging, and Flat Products. (Flat Wire, Strip, Sheet, Bar and Plate)	ClassA ClassB	675 670
QQ-B-750(2)	Bronze, Phosphor: Bar, Plate, Rod, Sheet, Strip, Flat Wire, and Structural and Special Shaped Sections	Comp. A Comp. B Comp. D	510 544 524
QQ-B-825A	Bus Bar; Copper, Aluminum, or Aluminum-Alloy	-	d
QQ-C-450	Copper-Aluminum Alloy (Aluminum Bronze) Plate, Sheet, Strip, and Bar (Copper Alloy Numbers 606, 612, 613, 614, and 628)	-	606, 612, 613, 614, 628
QQ-C-465	Copper, Aluminum Alloys (Aluminum Bronze) (Copper Alloys Nos. 606, 614, 630 and 642) Rod Flat Products with Finished Edges (Flat Wire, Strip and Bar), Shapes and Forgings	-	-

TABLE XVII (Contd.)

Specification No.	Specification Title	Specification Alloy Designation	Copper or Copper Alloy No.
QQ-C-502C(1)	Copper Rods and Shapes; and Flat Products with Finished Edges (Flat Wire, Strips and Bars)	-	e
QQ-C-530B	Copper-Beryllium Alloy Bars, Rods, and Wire (Copper Alloy No. 172)	-	172
QQ-C-533A	Copper-Beryllium Alloy Strip (Copper Alloy Nos. 170 and 172)	-	170, 172
QQ-C-576B(1)	Copper-Plates, Rolled Bars, Sheets and Strips	-	e
QQ-C-585A	Copper-Nickel-Zinc-Alloy Plate, Sheet, Strip and Rolled Bar. (Copper Alloy Numbers 735, 745, 752, 762, 766, 770)	-	735, 745, 752, 762, 766, 770
QQ-C-586B	Copper-Nickel-Zinc-Alloy; Rod, Shapes, and Flat Products with Finished Edges (Flat Wire, Strip, and Bar)	-	745, 752, 764, 770, 792, 794
QQ-C-591D(1)	Copper-Silicon Alloy: Rod, Wire, Shapes, Forgings, and Flat Products (Flat Wire, Strip, Sheet, Bar, and Plate)	-	647, 651, 653, 655, 661, 692
QQ-R-571C	Rods, Welding, Copper and Nickel Alloy	Class FS-RCu-1 Class FS-RCuNi Class FS-RCuSn-2 Class FS-RCuSi Class FS-RCuZn-1 Class FS-RCuZn-3 Class FS-RCuZn-3	101, 102, 110 715 510, 518, 521 656 470 681 680
QQ-W-321D	Wire, Copper Alloy	-	210, 220, 230, 240, 260, 270, 274, 510, 745, 752, 757, 764, 770, 794
QQ-W-343B	Wire, Electrical and Nonelectrical, Copper ((Uninsulated)	-	101, 102, 110, 111
QQ-W-345B(2)	Wire, Electrical, Steel, Copper-covered	-	-
WW-P-351A	Pipe; Red Brass, (Copper Alloy No. 230), Seamless Standard Pipe Size, Regular and Extra Strong	-	230
WW-P-377D	Pipe, Copper, Seamless, Standard	-	101, 102, 110, 120, 122
WW-T-756D	Tube; Condenser and Ferrule Stock, Inhibited Admiralty Metal (Copper Alloy Numbers 443, 444, and 445)	-	443, 444, 445

TABLE XVII (Contd.)

Specification No.	Specification Title	Specification Alloy Designation	Copper or Copper Alloy No.
WW-T-775A	Tube, Copper, Seamless (for Refrigeration and General Use)	-	101, 102, 120, 122
WW-T-791	Tubing, Brass, Seamless	Grade 1 Grade 2 Grade 3	230 330 280
WW-T-797C	Tube, Copper, Seamless	-	120, 122
WW-T-799C	Tube, Copper, Seamless, (for Use with Solder-Type or Flared-Tube Fittings)	OF DLP	102 120

NOTES:

a The compositional limits of the referenced copper or copper alloy number may not be identical to those of the listed specification alloy. Though not directly interchangeable in these cases, such alloys may be considered to be approximately equivalent.

b The following copper alloy numbers are applicable: 260, 261, 262, 268, 270, 274, 280, 330, 331, 332, 335, 340, 342, 344, 347, 348, 350, 353, 356, 360, and 370.

c The following copper alloy numbers are applicable: 260, 261, 262, 268, 270, 274, 280, 330, 331, 332, 335, 340, 342, 344, 347, 348, 350, 353, 356, 360, 370, 462, 464, 465, 466, 467, 482, and 485.

d The following copper numbers are applicable: 101, 102, 104, 105, 107, 110, 111, 114 and 116.

e The following copper numbers are applicable: 101, 102, 104, 105, 111, 114, 116, 120, 121, 122, 123, 125, 127, 128, and 130.

TABLE XVIII. MILITARY SPECIFICATIONS - CROSS REFERENCES, WROUGHT ALLOYS

Specification No.	Specification Title	Specification Alloy Designation	Copper or Copper Alloy No.
MIL-C-50C	Copper Alloy Number 260 (Cartridge Brass, 70%), Sheet, Strip, Plate and Discs	-	260
MIL-W-85E	Waveguides, Rigid, Rectangular	-	101, 102, 120, 220
MIL-T-3235A	Tubing, Copper, Seamless (for Torpedo Use).	Type OF Type DLP Type DHP	102 120 122
MIL-W-3318	Wire, Copper, and Wire, Steel, Copperclad W-154 and WS-24/U.	-	b
MIL-C-3383A	Cups, Bullet Jacket, Gilding Metal (for small Arms Ammunition).	-	220
MIL-T-3595	Tubing, Phosphor Bronze, Round, Seamless	-	510
MIL-W-6712B	Wire, Spray Gun, Metal	-	c
MIL-T-8231(2)	Tubes, Copper-Silicon-Bronze, Seamless, for Aircraft	-	655
MIL-C-10375B"1"	Cups, Cartridge, Case Brass (for small arms ammunition)	-	260, 261
MIL-C-12166	Copper Rod for Crusher Cylinders or Pressure Cylinders	-	110, 111
MIL-E-13191B	Electrodes, Welding, Covered, Bronze; for General Use	-	655, 510
MIL-C-13351A	Copper Alloy Number 377 Forgings	377	377
MIL-B-13501A	Bearings and Bushings, Brass and Bronze, Machined or Formed	Comp. A, B Comp. C	411 510
MIL-T-15005E"2"	Tubes, 70-30 and 90-10 Copper Nickel Alloy, Condenser and Heat Exchanger	Comp. 90-10 Comp. 70-30	706 715
MIL-C-15726E"2"	Copper-Nickel Alloy Rods, and Flat Products (Flat Wire, Strip, Sheet, Bar, and Plate)	Comp. 90-10 Comp. 70-30	706 715
MIL-B-16166A(1)	Bronze, Aluminum: Forgings, Heat-Treated	Comp. 1 Comp. 2	620 630
MIL-T-16420J3	Tube, 70-30 and 90-10 Copper-Nickel Alloy, Seamless and Welded	Comp. 90-10 Comp. 70-30	706 715
MIL-R-18818A	Rods, Welding, Aluminum Bronze, Surfacing Inert-Gas Tungsten-Arc Process	Class MIL-RCuAl-A2 Class MIL-RCuAl-B	618 622
MIL-B-18907	Bands, Projectile Rotating	-	d
MIL-B-19231(1)	Bars, Copper, Silver Bearing (for Commutators)	-	116
MIL-C-19311A	Copper-Chromium-Alloy Forgings, Wrought Bar, and Strip	Comp. I Comp. II	184 185

TABLE XVIII (Contd.)

Specification No.	Specification Title	Specification Alloy Designation	Copper or Copper Alloy No.
MIL-R-19631B(4)	Rods, Welding, Copper and Copper Alloy	Type MIL-RCu-1 Type MIL-RCu-2 Type MIL-RCuNi Type MIL-RCuSi-A Type MIL-RCuSn-A Type MIL-RBCuZn-A Type MIL-RCuZn-B Type MIL-RCuZn-C Type MIL-RBCuZn-D Type MIL-RCuA-A2 Type MIL-RCuA-B	102 189 715 656, 658 518 470 680 681 773 618 622
MIL-T-20168B	Tubes, Red Brass, Seamless	-	230
MIL-T-20219B	Tubes, Brass, Voice, and Pneumatic	-	260, 261
MIL-B-20292A(2)	Blanks, Rotating Band, for Projectiles	Comp. A Comp. B	101, 102, 120, 122 220
MIL-E-21659	Electrodes, Welding, Bare, Copper and Copper Alloy	Type MIL-CuSi Type MIL-CuSn-A Type MIL-CuSu-C Type MIL-CuA1-A1 Type MIL-CuA1-A2 Type MIL-CuA1-B	656 518 521 610 618 622
MIL-C-21768(1)	Copper Alloy Numbers 210 (Gilding, 95%) and 220 (Commercial Bronze, 90%) Sheet and Strip	Alloy 210 Alloy 220	210 220
MIL-E-22200/4A/(1)	Electrodes, Welding, Covered, Copper Nickel Alloy	Type MIL-CuNi (70:30)	715
MIL-T-22214A	Tube, 70-30 and 90-10, Copper-Nickel Alloy, Condenser and Heat Exchanger with Integral Fins	Comp. 90-10 Comp. 70-30	706 715
MIL-S-22499	Shim Stock Laminated	-	260
MIL-T-46072	Tube, Round, Copper Alloy Numbers 330, 331, 332, and 370 (Leaded Brass), Seamless	Alloy No. 330 Alloy No. 331 Alloy No. 332 Alloy No. 370	330 331 332 370
MIL-C-46087(1)	Copper Alloy Number 175 (Copper-Cobalt-Beryllium) Bar and Rod	-	175
MIL-C-81021	Copper-Cobalt-Beryllium Alloy (Copper Alloy No. 175), Strip	-	175

NOTES:

a The compositional limits of the referenced copper or copper alloy number may not be identical to those of the listed specification alloy. Though not directly interchangeable in these cases, such alloys may be considered to be approximately equivalent.

b The following copper numbers are applicable: 101, 102, 104, 105, 110, 111, 114, 116, 120, 121, 122, 123, 125, 127, 128 and 130.

c The following copper and copper alloy numbers are applicable: 102, 110, 220, 268, 464, 510, and 618.

d The following copper and copper alloy numbers are applicable: 101, 102, 120, 122, 220, and 702.

TABLE XIX. CDA SPECIFICATIONS - CROSS REFERENCE, WROUGHT ALLOYS

MIL-STD-455 or CDA Copper or Copper Alloy No.	Government Specifications		ASTM	SAE	AMS
	Federal	Military			
101	QQ-A-673A(1) QQ-B-825A QQ-C-502C(1) QQ-C-576B(1) QQ-R-571C QQ-W-343B WW-P-377D WW-T-775A	MIL-W-3318A MIL-B-18907 MIL-B-20292 (comp. A) MIL-W-85E	B170, B432	-	4500 4701
102	QQ-A-673A(1) QQ-B-825A QQ-C-502C(1) QQ-C-576B(1) QQ-R-571C QQ-W-343B WW-P-377D WW-T-775A WW-T-799C	MIL-W-85E MIL-T-3235A MIL-W-3318A MIL-W-6712B MIL-B-18907 MIL-R-19631B(4) MIL-B-20292 (comp. A)	B1, B2, B3, B12, B33, B42, B48, B49, B68(OF), B75, B111, B124, B133, B152, B170, B187, B189, B272, B280, B359, B372, B395, B432, B447	CA102	-
104	QQ-B-825A QQ-C-502C(1) QQ-C-576B(1)	MIL-W-3318A	B152, B187, B188	-	-
105	(same as 104)	MIL-W-3318A	B152, B187, B188	-	-
110	QQ-A-673A(1) QQ-B-825A QQ-C-502C(1) QQ-C-576B(1) QQ-R-571C QQ-W-343B WW-P-377D	MIL-W-3318A MIL-W-6712B MIL-C-12166	B1, B2, B3, B5, B11, B12, B33, B47, B48, B49, B111, B116, B124(12), B133, B152, B187, B188, B272, B283, B298, B447	CA110	4500 4701
111	QQ-B-825A QQ-C-502C(1) QQ-C-576B(1) QQ-W-343B	MIL-W-3318A MIL-C-12166	-	CA111	-
114	QQ-B-825A QQ-C-502C(1) QQ-C-576B(1)	MIL-W-3318A	B1, B2, B3, B4, B12, B33, B47, B48, B49, B116, B124(12), B133, B152(STP), B187, B188, B189, B272, B298, B442	CA114	-
116	(same as 114)	MIL-W-3318A MIL-B-19231(1)	(same as 114)	CA120	-
120	QQ-C-502C(1) QQ-C-576B(1) WW-P-377D WW-T-775A WW-T-797C WW-T-799C	MIL-W-85E MIL-T-3235A (type DLP) MIL-W-3318A MIL-B-18907 MIL-B-20292 (comp. A)	B12, B42, B68, B75, B111, B187, B188, B280, B302, B306, B359, B372, B379, B395, B442, B447	CA120	

TABLE XIX (Contd.)

MIL-STD-455 or CDA Copper or Copper Alloy No.	Government Specifications Federal	Military	ASTM	SAE	AMS
121	QQ-C-502C(1) QQ-C-576B(1)	MIL-W-3318A	-	-	-
122	QQ-A-673A(1) QQ-C-502C(1) QQ-C-576B(1) WW-P-377D WW-T-775A WW-T-797C	MIL-T-3235A MIL-W-3318A MIL-B-18907 MIL-B-20292 (comp. A) MIL-T-22214	B4, B11, B12, B42, B68, B75, B88, B111, B124(12), B133, B152, B280, B302, B306, B359, B360, B379, B395, B442, B447	CA122	-
123	(same as 121)	MIL-W-3318A	B11, B152	-	-
125	(same as 121)	MIL-W-3318A	B4, B11, B12, B133, B152, B216		
127	(same as 121)	MIL-W-3318A	B133, B442	-	-
128	(same as 121)	MIL-W-3318A	B133, B442		
130	(same as 121)	MIL-W-3318A	B133	-	-
170	QQ-C-533A	-	B194, B196	-	-
172	QQ-C-530B QQ-C-533A	- -	B194, B196, B197	CA172	4530 4532 4650 4725
175	-	MIL-C-46087(1) MIL-C-81021	B441	-	-
184	-	MIL-C-19311 (comp. I)	-	CA184	-
185	-	MIL-C-19311 (comp. II)	-	-	-
189	-	MIL-R-19631B(4)	-	-	-
210	QQ-W-321D	MIL-C-21768(1)	B36, B134	CA210	-
220	QQ-W-321D	MIL-W-85E MIL-C-3383A MIL-W-6712B MIL-B-18907 MIL-B-20292 (comp. B) MIL-C-21768(1)	B36, B130, B131, B134, B135, B372	CAZ20	-
230	QQ-B-613C QQ-B-626C QQ-W-321D WW-P-351A WW-T-791	MIL-T-20168B	B36, B43, B111, B134, B135, B359, B395	CA230	-

TABLE XIX (Contd.)

MIL-STD-455 or CDA Copper or Copper Alloy No.	Government Specifications Federal	Military	ASTM	SAE	AMS
240	QQ-A-660 QQ-B-613 C QQ-B-626 C QQ-B-650A(1) QQ-W-321D	-	B36, B134	CA240	-
260	QQ-B-613C QQ-B-626C QQ-B-650A(1) QQ-W-321D	MIL-C-50C MIL-C-10375B(1) MIL-T-20219B MIL-S-22499	B19, B36, B129, B134, B135	CA260	4505 4507 4508
261	(same as 260)	(same as 260)	-	-	-
262	QQ-B-613C QQ-B-626C	-	-	-	-
268	QQ-B-613C QQ-B-626C	MIL-W-6712B	B36	CA268	-
270	QQ-B-613C	-	B36(8), B134, B135	CA270	4710 4712 4713
274	QQ-W-32	-	B134(8)	-	-
280	WW-T-791	-	B111, B135	-	-
298	QQ-B-650	-	-	-	-
330	WW-P-351A WW-T-791	MIL-T-46072	B135	CA330	-
331	-	MIL-T-46072	-	CA331	-
332	(same as 331)	MIL-T-46072	B135	-	4558
342	QQ-B-613 QQ-B-626	-	B121(4, 5) B135(4)	CA342	-
360	QQ-B-626C	-	B16	CA360	4610
370	(same as 331)	MIL-T-46072	B135	-	-
377	QQ-B-626C	MIL-B-13351A	B124, B283	CA377	4614
411	-	MIL-B-13501A	B508	-	-
443	WW-T-756D	-	B111, B171, B359, B395, B432	-	-
444	(same as 443)	-	B111, B171, B359, B395, B432	-	-
445	(same as 443)	-	B111, B171, B359, B395, B432	-	-

TABLE XIX (Contd.)

MIL-STD-455 or CDA Copper or Copper Alloy No.	Government Specifications Federal	Military	ASTM	SAE	AMS
462	QQ-B-637 QQ-B-639	-	B21	-	-
464	QQ-B-637(comp. 1) QQ-B-639(comp. 1)	MIL-W-6712B	B21, B124, B171, B283, B432	CA464	4611 4612
470	QQ-R-571	MIL-R-19631B(4)	-	-	-
472	QQ-B-650	-	-	-	-
482	QQ-B-637A QQ-B-639A	-	B21	-	-
485	QQ-B-637A QQ-B-639A	-	B21, B124, B283	-	-
510	QQ-B-750 QQ-R-571C QQ-W-321D	MIL-T-3595 MIL-W-6712B MIL-B-13501A MIL-E-13191B	B100, B103, B139, B159	CA510	4510 4625 4720
518	QQ-R-571C	MIL-R-19631B(4) MIL-E-21659	-	-	-
521	QQ-R-571C	MIL-E-21659	B103,.B139, B159	CA521	-
524	QQ-B-750(2)	-	B103, B139, B159	-	-
544	QQ-B-750(2)	MIL-B-13501	B139, B103	CA544	-
546	(same as 544)	-	-	-	4520
606	QQ-C-450 QQ-C-465	-	B169	-	-
610	-	MIL-E-21659	-	-	-
612	QQ-C-450	-	B169	-	-
613	QQ-C-450	-	-	-	-
614	QQ-C-450 QQ-C-465	-	B150, B169, B171, B432	CA614	-
616	QQ-C-465	-	-	-	-
618	-	MIL-W-6712B MIL-R-18818A MIL-R-19631B(4) MIL-E-21659	-	-	-
620	-	MIL-B-16166A(1)	-	-	-
622	-	MIL-R-18818A MIL-R-19631B(4) MIL-E-21659	-	-	-

TABLE XIX (Contd.)

MIL-STD-455 or CDA Copper or Copper Alloy No.	Government Specifications Federal	Military	ASTM	SAE	AMS
628	QQ-C-450	-	B171, B432	-	-
630	QQ-C-465	MIL-B-16166A(1)	B124, B150	-	-
642	QQ-C-465	-	B124, B150	-	4640
647	QQ-C-591D(1)	-	B411, B412, B422	-	-
651	QQ-C-591D(1)	-	B97, B98, B99, B315	-	-
653	QQ-C-591D(1)	-	B96, B97	-	-
655	QQ-C-591D(1)	MIL-T-8231(2) MIL-E-13191B	B96, B97, B98, B99, B100, B124, B283, B315, B432	CA655	4615 4665
656	QQ-R-571C	MIL-E-13191 MIL-R-19631B(4) MIL-E-21659	-	-	-
658	-	MIL-E-13191 MIL-R-19631B(4)	B315	-	-
661	QQ-C-591D(1)	-	-	-	-
670	QQ-B-728	-	B138	CA670	-
675	QQ-B-728	-	B124, B138, B283	CA675	-
680	QQ-R-571C	MIL-R-19631B(4)	-	-	-
681	QQ-R-571C	MIL-R-19631B(4)	-	-	-
687	-	-	B11, B359, B395	-	-
692	QQ-C-591D(1)	-	-	-	-
702	-	MIL-B-18907	-	-	-
706	-	MIL-T-15005E2 MIL-C-15726E2 MIL-T-16420J3 MIL-T-22214	B111, B151, B171, B359, B395, B402, B431, B466, B467	CA706	-
715	QQ-R-571C	MIL-T-15005E2 MIL-C-15726E2 MIL-T-16420J3 MIL-R-19631B(4) MIL-E-22200/4A	B111, B122, B151, B171, B359, B395, B402, B432, B466, B467	CA715	-
735	QQ-C-585A	MIL-T-22214	B122	-	-
745	QQ-C-585A QQ-C-586(comp. 5) QQ-W-321	-	B151, B206	-	-

TABLE XIX (Contd.)

MIL-STD-455 or CDA Copper or Copper Alloy No.	Government Specifications		ASTM	SAE	AMS
	Federal	Military			
752	QQ-C-585A QQ-C-586B QQ-W-321	-	B122, B151, B206	CA752	-
757	QQ-W-321	-	B151, B206	-	-
762	QQ-C-585A	-	B122	-	-
764	QQ-C-586B QQ-W-321	-	B151, B206	-	-
766	QQ-C-585A	-	-	-	-
770	QQ-C-585A QQ-C-586B QQ-W-321	-	B122, B151, B206	CA770	-
773	-	MIL-R-19631B(4)	-	-	-
792	QQ-C-586B	-	B151	-	-
794	QQ-C-586B QQ-W-321D	-	B151 B206	- -	- -

NOTES:

a. Specifications for a particular copper or alloy are not sorted by product form, but are merely listed by approximately equivalent composition. For product form the individual specifications should be referenced.

b. The compositional limits of the referenced specification alloy may not be identical to those of the listed copper or copper alloy number. Though not directly interchangeable in these cases, such alloys may be considered approximately equivalent.

c. When given, numbers and/or letters in parenthesis indicate the respective alloy in each specification.

d. Names given in parenthesis are sometimes used, but not recommended.

e. Commonly accepted trade name for alloys 443, 444, and 445 as a group is "Inhibited Admiralty".

TABLE XX. MECHANICAL PROPERTIES OF WROUGHT ALLOYS (CDA)

Form	Size Section (in)	Temper	TS ksi	YS ksi	RA %	EL %	Rockwell Hardness F	Rockwell Hardness B	Rockwell Hardness 30T	SS ksi	Fatigue Strength ksi	Fatigue Strength Million Cycles
Copper No. 102 (Oxygen-Free Copper)												
Flat Products	0.040	0.050 mm	32	10	-	45	40	-	-	22	-	-
		0.025 mm	34	11	-	45	45	-	-	23	11	100
		Eighth Hard	36	28	-	30	60	10	25	25	-	-
		Quarter Hard	38	30	-	25	70	25	36	25	-	-
		Half Hard	42	36	-	14	84	40	50	26	13	100
		Hard	50	45	-	6	90	50	57	28	13	100
		Spring	55	50	-	4	94	60	63	29	14	100
		Extra Spring	57	53	-	4	95	62	64	29	-	-
		As Hot Rolled	34	10	-	45	45	-	-	23	-	-
	0.250	0.050 mm	32	10	-	50	40	-	-	22	-	-
		Eighth Hard	36	28	-	40	60	10	-	25	-	-
		Quarter Hard	38	30	-	35	70	25	-	25	-	-
		Hard	50	45	-	12	90	50	-	28	-	-
		As Hot Rolled	32	10	-	50	40	-	-	22	-	-
	1.0	Hard	45	40	-	20	85	45	-	26	-	-
Rod	1.0	0.050 mm	32	10	70	55	40	-	-	22	-	-
	0.250	Hard (40%)	55	50	-	10	94	60	-	29	-	-
	1.0	Hard (35%)	48	44	55	16	87	47	-	27	17	300
	2.0	Hard (16%)	45	40	-	20	85	45	-	26	-	-
	1.0	As Hot Rolled	32	10	70	55	40	-	-	22	-	-
Wire	0.080	0.050 mm	35	-	-	35[a]	-	-	-	24	-	-
		Hard	55	-	-	1.5[b]	-	-	-	29	-	-
		Spring	66	-	-	1.5[b]	-	-	-	33	-	-
Tube	1.0 in. O.D. x 0.065	0.050 mm	32	10	-	45	40	-	-	22	-	-
		0.025 mm	34	11	-	45	45	-	-	23	-	-
		Light Drawn (15%)	40	32	-	25	77	35	45	26	-	-
		Hard Drawn (40%)	55	50	-	8	95	60	63	29	-	-
Shapes	0.500	0.050 mm	32	10	-	50	40	-	-	22	-	-
		Hard (15%)	40	32	-	30	-	35	-	26	-	-
		As Hot Rolled	32	10	-	50	40	-	-	22	-	-
		As Extruded	32	10	-	50	40	-	-	22	-	-
Copper No. 110 (Electrolytic Tough Pitch Copper)												
Flat Products	0.040	0.050 mm	32	10	-	45	40	-	-	22	-	-
		0.025 mm	34	11	-	45	45	-	-	23	11	100
		Eighth Hard	36	28	-	30	60	10	25	25	-	-
		Quarter Hard	38	30	-	25	70	25	36	25	-	-
		Half Hard	42	36	-	14	84	40	50	26	13	100
		Hard	50	45	-	6	90	50	57	28	13	100
		Spring	55	50	-	4	94	60	63	29	14	100
		Extra Spring	57	53	-	4	95	62	64	29	-	-
		As Hot Rolled	34	10	-	45	45	-	-	23	-	-
	0.250	0.050 mm	32	10	-	50	40	-	-	22	-	-
		Eighth Hard	36	28	-	40	60	10	-	25	-	-
		Quarter Hard	38	30	-	35	70	25	-	25	-	-
		Hard	50	45	-	12	90	50	-	28	-	-
		As Hot Rolled	32	10	-	50	40	-	-	22	-	-
	1.0	Hard	45	40	-	20	85	45	-	26	-	-
Rod	1.0	0.050 mm	32	10	70	55	40	-	-	22	-	-
	0.250	Hard (40%)	55	50	-	10	94	60	-	29	-	-
	1.0	Hard (35%)	48	44	55	16	87	47	-	27	17	300
	2.0	Hard (16%)	45	40	-	20	85	45	-	26	-	-
	1.0	As Hot Rolled	32	10	70	55	40	-	-	22	-	-

TABLE XX (Contd.)

Form	Size Section (in)	Temper	TS ksi	YS ksi	RA %	EL %	Rockwell Hardness F	Rockwell Hardness B	Rockwell Hardness 30T	SS ksi	Fatigue Strength ksi	Fatigue Strength Million Cycles
Copper 110 (Contd.)												
Wire	0.080	0.050 mm	35	-	-	35[a]	-	-	-	24	-	-
		Hard	55	-	-	1.5[b]	-	-	-	29	-	-
		Spring	66	-	-	1.5[b]	-	-	-	33	-	-
Tube	1.0 in. O.D. x 0.065	0.050 mm	32	10	-	45	40	-	-	22	-	-
		0.025 mm	34	11	-	45	45	-	-	23	-	-
		Light Drawn (15%)	40	32	-	25	77	35	45	26	-	-
		Hard Drawn (40%)	55	50	-	8	95	60	63	29	-	-
Shapes	0.500	0.050 mm	32	10	-	50	40	-	-	22	-	-
		Hard (15%)	40	32	-	30	-	35	-	26	-	-
		As Hot Rolled	32	10	-	50	40	-	-	22	-	-
		As Extruded	32	10	-	50	40	-	-	22	-	-
Copper Nos. 113, 114, 115 and 116 (Silver-Bearing Tough Pitch Coppers)												
Flat Prod-	0.040	0.025 mm	34	11	-	45	45	-	-	23	-	-
		Eighth Hard	36	28	-	30	60	10	25	25	-	-
		Quarter Hard	38	30	-	25	70	25	36	25	-	-
		Half Hard	42	36	-	14	84	40	50	26	-	-
		Hard	50	45	-	6	90	50	57	28	-	-
		Spring	55	50	-	4	94	60	63	29	-	-
		Extra Spring	57	53	-	4	95	62	64	29	-	-
		As Hot Rolled	34	10	-	45	45	-	-	23	-	-
	0.250	0.050 mm	32	10	-	50	40	-	-	22	-	-
		Eighth Hard	36	28	-	40	60	10	-	25	-	-
		Quarter Hard	38	30	-	35	70	25	-	25	-	-
		Hard	50	45	-	12	90	50	-	28	-	-
		As Hot Rolled	32	10	-	50	40	-	-	22	-	
	1.0	Hard	45	40	-	20	85	45	-	26	-	-
Rod	1.0	0.050 mm	32	10	70	55	40	-	-	22	-	-
	0.250	Hard (40%)	55	50	-	10	94	60	-	29	-	-
	1.0	Hard (35%)	48	44	55	16	87	47	-	27	-	-
	2.0	Hard (16%)	45	40	-	20	85	45	-	26	-	-
	1.0	As Hot Rolled	32	10	70	55	40	-	-	22	-	-
Wire	0.080	0.050 mm	35	-	-	35[a]	-	-	-	24	-	-
		Hard	55	-	-	1.5[b]	-	-	-	29	-	-
		Spring	66	-	-	1.5[b]	-	-	-	33	-	-
Shapes	0.500	0.050 mm	32	10	-	50	40	-	-	22	-	-
		Hard (15%)	40	32	-	30	-	35	-	26	-	-
		As Hot Rolled	32	10	-	50	40	-	-	22	-	-
		As Extruded	32	10	-	50	40	-	-	22	-	-
Copper No. 122 (Phosphorus Deoxidized Copper, High Residual Phosphorus)												
Flat Prod-ucts	0.040	0.050 mm	32	10	-	45	40	-	-	22	-	-
Tube	1.0 in. O.D. x 0.065	0.050 mm	32	10	-	45	40	-	-	22	11[c]	20
		0.025 mm	34	11	-	45	45	-	-	23	-	-
		Light Drawn (15%)	40	32	-	25	77	35	45	26	14[c]	20
		Hard Drawn (40%)	55	50	-	8	95	60	63	29	19[c]	20
Pipe	3/4 in. SPS	Hard (30%)	50	45	-	10	90	50	-	28	-	-

TABLE XX (Contd.)

Form	Size Section	Temper I	Temper II	TS ksi I	TS ksi II	YS ksi 0.2% Offset I	YS ksi 0.2% Offset II	EL % I	EL % II	Rockwell Hardness F I	Rockwell Hardness B I	Rockwell Hardness C II	Fatigue Strength ksi II	Fatigue Strength million cycles II
Copper Alloy No. 170 (Copper-Beryllium Alloy)														
Flat Products	Under 0.188 in.	A	AT	70	165	32	145	45	7	60	58	35	36	100
		1/4 H	1/4 HT	80	172	70	150	25	5	80	70	37	40	100
		1/2 H	1/2 HT	92	182	82	160	15	4	92	77	39	42	100
		H	HT	110	190	104	170	5	3	99	81	40	43	100
		AM	-	105	-	80	-	20	-	-	-	20	-	-
		1/4 HM	-	115	-	90	-	18	-	-	-	23	-	-
		1/2 HM	-	128	-	105	-	15	-	-	-	27	-	-
		HM	-	142	-	122	-	12	-	-	-	32	-	-
		XHM	-	168	-	148	-	6	-	-	-	36	-	-
Rod	All	A	AT	68	165	-	-	-	-	62	-	35	-	-
	Up to 3/8 in. incl.	H	HT	112	188	-	-	-	-	95	-	38	-	-
	Over 3/8 to 1 in. incl.	H	HT	105	183	-	-	-	-	95	-	37	-	-
	Over 1 in.	H	HT	100	178	-	-	-	-	95	-	36	-	-
Copper Alloy No. 172 (Copper-Beryllium Alloy)														
Flat Products	Under 0.188 in.	A	AT	70	175	32	155	45	6	60	58	38	36	100
		1/4 H	1/4 HT	80	185	70	165	25	4	80	70	40	40	100
		1/2 H	1/2 HT	92	195	82	175	15	3	92	77	41	44	100
		H	HT	110	200	104	180	5	2	99	81	42	44	100
		AM	-	105	-	82	-	20	-	-	-	20	-	-
		1/4 HM	-	115	-	92	-	17	-	-	-	23	-	-
		1/2 HM	-	128	-	105	-	15	-	-	-	27	-	-
		HM	-	142	-	122	-	12	-	-	-	32	-	-
		XHM	-	168	-	148	-	7	-	-	-	37	-	-
		XHMS	-	182	-	160	-	6	-	-	-	39	-	-
Rod	All	A	AT	68	178	25	160	48	6	62	-	38	-	-
	Up to 3/8 in. incl.	H	HT	112	200	90	182	15	3	95	-	41	-	-
	Over 3/8 to 1 in. incl.	H	HT	105	195	90	178	15	3	95	-	41	-	-
	Over 1 in.	H	HT	100	190	90	175	15	3	95	-	41	-	-
Wire		A	AT	68	178	28	160	35	3	-	-	-	-	-
		1/4 H	1/4 HT	102	190	82	175	10	2	-	-	-	-	-
		1/2 H	1/2 HT	122	200	100	185	5	1	-	-	-	-	-
		3/4 H	3/4 HT	142	210	120	190	2	1	-	-	-	-	-
		H	HT	152	212	125	195	1	1	-	-	-	-	-

Notes:

A	Solution heat treated.
H	Hard (except for tempers utilizing M designation).
T	*Precipitation heat treated.*
AM thru XHMS	Special mill processing and precipitation treatment.
I	As supplied by producer mill.
II	Properties after precipitation hardening at 600°F.

TABLE XX (Contd.)

Form	Size Section	Temper I	Temper II	TS ksi	YS ksi 0.2% Offset	EL %	Rockwell Hardness F	Rockwell Hardness B	Rockwell Hardness 30T	Fatigue Strength ksi	Fatigue Strength million cycles
Copper Alloy No. 175 (Copper-Cobalt-Beryllium Alloy)											
Flat Products	Under 0.188 in.	A	-	45	25	28	-	32	36	-	-
		AT	AT	110	90	12	-	96	80	-	-
		1/2H	-	68	60	8	-	70	64	-	-
		1/2HT	Y2HT	115	108	8	-	98	81	35	100
		H	-	78	70	5	-	83	72	-	-
		HT	HT	115	110	8	-	98	81	-	-
Rod	All	A	-	45	25	28	-	35	-	-	-
		H	-	72	65	12	-	68	-	-	-
		AT	AT	110	90	18	-	96	-	-	-
		HT	HT	115	110	14	-	98	-	-	-

Notes:
- A Solution heat treated.
- H Hard.
- T Precipitation heat treated.
- I As supplied by producer mill.
- II Properties after precipitation heat treating at 900°F.

Form	Size Section	Temper	TS ksi	YS ksi	RA %	EL %	Rockwell Hardness F	Rockwell Hardness B	Rockwell Hardness 30T	SS ksi	Fatigue Strength ksi	Fatigue Strength million cycles
Copper Alloy No. 210 (Gilding, 95%)												
Rolled Strip	0.040 in.	0.050 mm	34	10	-	45	46	-	-	-	-	-
		0.035 mm	35	11	-	45	52	-	4	28	-	-
		0.015 mm	38	14	-	42	60	-	15	30	-	-
		Quarter Hard	42	32	-	25	-	38	44	32	-	-
		Half Hard	48	40	-	12	-	52	54	34	-	-
		Hard	56	50	-	5	-	64	60	37	-	-
		Extra Hard	61	55	-	4	-	70	64	39	-	-
		Spring	64	58	-	4	-	73	66	40	-	-

TABLE XX (Contd.)

Form	Size Section (in)	Temper	TS ksi	YS ksi	RA %	EL %	Rockwell Hardness F	Rockwell Hardness B	Rockwell Hardness 30T	SS ksi	Fatigue Strength ksi	Fatigue Strength Million Cycles
Copper Alloy No. 220 (Commercial Bronze, 90%)												
Flat Products	0.040	0.050 mm	37	10	-	45	53	-	6	28	-	-
		0.035 mm	38	12	-	45	57	-	12	30	-	-
		0.025 mm	39	14	-	44	60	-	16	31	-	-
		0.015 mm	41	15	-	42	65	-	26	32	-	-
		Quarter Hard	45	35	-	25	-	42	44	33	-	-
		Half Hard	52	45	-	11	-	58	56	35	-	-
		Hard	61	54	-	5	-	70	63	38	-	-
		Extra Hard	67	58	-	4	-	75	67	40	-	-
		Spring	72	62	-	3	-	78	69	42	21	15
	0.250	0.035 mm	38	12	-	50	57	-	-	30	-	-
		Half Hard	52	45	-	15	-	58	-	35	-	-
	0.040	As Hot Rolled	39	14	-	44	60	-	-	31	-	-
	0.250	As Hot Rolled	37	10	-	45	53	-	-	28	-	-
Wire	0.080	0.035 mm	40	-	-	50	-	-	-	30	-	-
		0.015 mm	42	-	-	48	-	-	-	32	-	-
		Eighth Hard	44	-	-	27	-	-	-	33	-	-
		Quarter Hard	50	-	-	13	-	-	-	34	-	-
		Half Hard	60	-	-	6	-	-	-	37	-	-
		Hard	74	-	-	4	-	-	-	42	23	100
		Extra Hard	83	-	-	3	-	-	-	-	-	-
		Spring	90	-	-	3	-	-	-	-	-	-
Tube	1.0 in. O.D. x 0.065	0.035 mm	38	12	-	50	57	-	12	-	-	-
		Hard Drawn (35%)	60	53	-	6	-	69	62	-	-	-
Rod	0.500	0.035 mm	40	-	-	50	55	-	-	32	-	-
		Eighth Hard	45	-	-	25	-	42	-	33	-	-
Copper Alloy No. 226 (Jewelry Bronze, 87.5%)												
Flat Products	0.040	0.050 mm	39	11	-	46	55	-	-	29	-	-
		0.035 mm	40	13	-	45	59	-	-	30	-	-
		0.025 mm	42	15	-	44	64	-	-	31	-	-
		0.015 mm	44	16	-	42	68	-	-	32	-	-
		Eighth Hard	-	-	-	-	-	-	-	-	-	-
		Quarter Hard	47	37	-	25	-	47	-	34	-	-
		Half Hard	54	47	-	12	-	61	-	36	-	-
		Hard	66	56	-	5	-	73	-	40	-	-
		Extra Hard	72	60	-	4	-	78	-	42	-	-
		Spring	79	62	-	4	-	82	-	44	-	-
Wire	0.080	0.050 mm	40	-	-	44	-	-	-	29	-	-
		0.035 mm	41	18	-	42	-	-	-	30	-	-
		0.025 mm	43	-	-	40	-	-	-	31	-	-
		0.015 mm	45	18	-	38	-	-	-	32	-	-
		Eighth Hard	47	-	-	26	-	-	-	34	-	-
		Quarter Hard	56	-	-	12	-	-	-	36	-	-
		Half Hard	68	-	-	7	-	70	-	40	-	-
		Hard	83	-	-	5	-	-	-	-	-	-
		Extra Hard	89	-	-	4	-	-	-	-	-	-
		Spring	97	-	-	3	-	-	-	-	-	-
Copper Alloy No. 230 (Red Brass, 85%)												
Flat Products	0.040	0.070 mm	39	10	-	48	56	-	10	31	-	-
		0.050 mm	40	12	-	47	59	-	14	31	-	-
		0.035 mm	41	14	-	46	63	-	22	31	-	-
		0.025 mm	43	16	-	44	66	-	28	32	-	-
		0.015 mm	45	18	-	42	71	-	38	33	-	-
		Quarter Hard	50	39	-	25	-	55	54	35	-	-
		Half Hard	57	49	-	12	-	65	60	37	-	-
		Hard	70	57	-	5	-	77	68	42	-	-
		Extra Hard	78	61	-	4	-	83	72	44	-	-
		Spring	84	63	-	3	-	86	74	46	-	-

TABLE XX (Contd.)

Form	Size Section (in)	Temper	TS ksi	YS ksi	RA %	EL %	Rockwell Hardness F	Rockwell Hardness B	Rockwell Hardness 30T	SS ksi	Fatigue Strength ksi	Fatigue Strength Million Cycles
Copper Alloy No. 230 (Contd.)												
Wire	0.080	0.035 mm	41	-	-	48	-	-	-	31	-	-
		0.025 mm	43	-	-	-	-	-	-	32	-	-
		0.015 mm	45	-	-	-	-	-	-	33	-	-
		Eighth Hard	50	-	-	25	-	-	-	35	20[c]	300
		Quarter Hard	59	-	-	11	-	-	-	38	-	-
		Half Hard	72	-	-	8	-	-	-	43	-	-
		Hard	88	-	-	6	-	-	-	48	-	-
		Spring	105	-	-	-	-	-	-	54	-	-
Tube	1.0 in. O.D. x 0.065	0.050 mm	40	12	-	55	60	-	15	-	-	-
		0.015 mm	44	18	-	45	71	-	38	-	-	-
		Light Drawn (15%)	50	40	-	30	-	55	54	-	-	-
		Hard Drawn (35%)	70	58	-	8	-	77	68	-	-	-
Pipe	3/4 in. SPS	0.015 mm	44	18	-	45	71	-	-	-	-	-
Copper Alloy No. 240 (Low Brass, 80%)												
Flat Products	0.040	0.070 mm	42	12	-	52	57	-	8	-	-	-
		0.050 mm	44	14	-	50	61	-	16	32	-	-
		0.035 mm	46	15	-	48	66	-	28	-	-	-
		0.025 mm	48	17	-	47	69	-	32	-	-	-
		0.015 mm	50	20	-	46	75	-	42	33	-	-
		Quarter Hard	53	40	-	30	-	55	54	36	-	-
		Half Hard	61	50	-	18	-	70	64	39	-	-
		Hard	74	59	-	7	-	82	71	43	-	-
		Spring	91	65	-	3	-	91	77	48	24	20
Wire	0.080	0.050 mm	44	-	-	55	-	-	-	32	-	-
		0.035 mm	46	-	-	50	-	-	-	-	-	-
		0.015 mm	50	-	-	47	-	-	-	33	-	-
		Eighth Hard	56	-	-	27	-	-	-	37	-	-
		Quarter Hard	68	-	-	12	-	-	-	42	-	-
		Half Hard	82	-	-	8	-	-	-	47	-	-
		Hard	107	-	-	5	-	-	-	53	23	100
		Extra Hard	116	-	-	4	-	-	-	-	-	-
		Spring	125	-	-	3	-	-	-	60	26	100
Copper Alloy No. 260 (Cartridge Brass, 70%)												
Flat Products	0.040	0.100 mm	44	11	-	66	54	-	11	-	13	100
		0.070 mm	46	14	-	65	58	-	15	32	13	100
		0.050 mm	47	15	-	62	64	-	26	-	-	-
		0.035 mm	49	17	-	57	68	-	31	34	14	100
		0.025 mm	51	19	-	55	72	-	36	-	-	-
		0.015 mm	53	22	-	54	78	-	43	35	15	100
		Quarter Hard	54	40	-	43	-	55	54	36	-	-
		Half Hard	62	52	-	23	-	70	65	40	18	100
		Hard	76	63	-	8	-	82	73	44	21	100
		Extra Hard	86	65	-	5	-	88	76	46	-	-
		Spring	94	65	-	3	-	91	77	48	23	100
		Extra Spring	99	65	-	3	-	93	78	-	-	-
Wire	0.080	0.050 mm	48	-	-	64	-	-	-	-	-	-
		0.035 mm	50	-	-	60	-	-	-	34	-	-
		0.025 mm	52	-	-	58	-	-	-	-	-	-
		0.015 mm	54	-	-	56	-	-	-	-	-	-
		Eighth Hard	58	-	-	35	-	-	-	38	-	-
		Quarter Hard	70	-	-	20	-	-	-	-	-	-
		Extra Hard	124	-	-	4	-	-	-	-	-	-
		Spring	130	-	-	3	-	-	-	60	22	100
Tube	1.0 in. O.D. x 0.065	0.050 mm	47	15	-	65	64	-	26	-	-	-
		0.025 mm	52	20	-	55	75	-	40	-	-	-
		Hard Drawn (35%)	78	64	-	8	-	82	73	-	-	-
Rod	1.0	0.050 mm	48	16	75	65	65	-	-	34	-	-
		Eighth Hard (6%)	55	40	70	48	-	60	-	36	-	-
		Half Hard (20%)	70	52	68	30	-	80	-	42	22	50

TABLE XX (Contd.)

Form	Size Section (in)	Temper	TS ksi	YS ksi	RA %	EL %	Rockwell Hardness F	Rockwell Hardness B	Rockwell Hardness 30T	SS ksi	Fatigue Strength ksi	Fatigue Strength Million Cycles
Copper Alloy Nos. 268 and 270 (Yellow Brass)												
Flat Products	0.040	0.070 mm	46	14	-	65	58	-	15	32	12	100
		0.050 mm	47	15	-	62	64	-	26	-	-	-
		0.035 mm	49	17	-	57	68	-	31	34	-	-
		0.025 mm	51	19	-	55	72	-	36	-	-	-
		0.015 mm	53	22	-	54	78	-	43	-	-	-
		Eighth Hard	50	35	-	50	-	50	50	-	-	-
		Quarter Hard	54	40	-	43	-	55	54	36	-	-
		Half Hard	61	50	-	23	-	70	65	40	-	-
		Hard	74	60	-	8	-	80	70	43	14	100
		Extra Hard	85	62	-	5	-	87	74	45	-	-
		Spring	91	62	-	3	-	90	76	47	20	100
Rod	1.0	0.050 mm	48	16	75	65	65	-	-	34	-	-
		Eighth Hard (6%)	55	40	70	48	-	55	-	36	-	
Wire	0.080	0.035 *mm*	50	-	-	60	-	-	-	34	-	-
		Eighth Hard	58	-	-	35	-	-	-	38	-	-
		Quarter Hard	70	-	-	20	-	-	-	42	22[c]	300
		Half Hard	88	-	-	15	-	-	-	-	-	-
		Hard	110	-	-	8	-	-	-	55	-	-
		Extra Hard	120	-	-	4	-	-	-	-	-	-
		Spring	128	-	-	3	-	-	-	60	-	-
Copper Alloy No. 280 (Muntz Metal)												
Flat Products	0.040	Soft Anneal	54	21	-	45	80	-	46	40	-	-
		As Hot Rolled	54	21	-	45	85	-	49	40	-	-
		Eighth Hard	60	35	-	30	-	55	54	42	-	-
		Half Hard	70	50	-	10	-	75	67	44	-	-
Rod	1.0	Soft Anneal	54	21	60	50	80	-	-	40	-	-
		Quarter Hard	72	50	55	25	-	78	-	45	-	-
		As Extruded	52	20	70	52	78	-	-	39	-	-
Tube	1.0 in. O.D. x 0.065	Light Anneal	56	23	-	50	82	-	47	-	-	-
		Hard Drawn (30%)	74	55	-	10	-	80	-	-	-	-
Copper Alloy No. 314 (Leaded Commercial Bronze)												
Drawn Bar Rod	0.250	Half Hard	55	50	-	12	-	61	-	31	-	-
	1.0	0.050 mm	37	12	70	45	55	-	-	24	-	-
	0.250	Half Hard (37%)	60	55	-	10	-	65	-	32	-	-
	0.500	Half Hard (25%)	55	50	-	14	-	61	-	31	-	-
	1.0	Half Hard (20%)	52	45	60	18	-	58	-	30	-	-
Copper Alloy No. 330 (Low-Leaded Brass Tube)												
Tube	1.0 in. O.D. x 0.065	0.050 mm	47	15	-	60	64	-	26	-	-	-
		0.025 mm	52	20	-	50	75	-	37	-	-	-
		Hard Drawn (35%)	75	60	-	7	-	80	69	-	-	-
Copper Alloy No. 332 (High-Leaded Brass Tube)												
Tube	1.0 in. O.D. x 0.065	0.025 mm	52	20	-	50	75	-	36	-	-	-
		Hard Drawn (35%)	75	60	-	7	-	80	69	-	-	-
Copper Alloy No. 335 (Low-Leaded Brass)												
Flat Products	0.040	0.070 mm	46	14	-	65	58	-	15	32	-	-
		0.050 mm	47	15	-	62	64	-	26	-	-	-
		0.035 mm	49	17	-	57	68	-	31	34	-	-
		0.025 mm	51	19	-	55	72	-	36	-	-	-
		Quarter Hard	54	40	-	43	-	55	54	36	-	-
		Half Hard	61	50	-	23	-	70	65	40	-	-
		Hard	74	60	-	8	-	80	69	43	-	-

TABLE XX (Contd.)

Form	Size Section (in)	Temper	TS ksi	YS ksi	RA %	EL %	Rockwell Hardness F	Rockwell Hardness B	Rockwell Hardness 30T	SS ksi	Fatigue Strength ksi	Fatigue Strength Million Cycles
Copper Alloy No. 340 (Medium-Leaded Brass)												
Flat Products	0.040	0.050 mm	47	15	-	60	64	-	26	-	-	-
		0.035 mm	49	17	-	54	68	-	31	34	-	-
		0.025 mm	51	19	-	53	72	-	36	-	-	-
		Quarter Hard	54	40	-	41	-	55	54	36	-	-
		Half Hard	61	50	-	21	-	70	65	40	-	-
		Hard	74	60	-	7	-	80	69	43	-	-
Rod	1.0	0.025 mm	50	19	-	60	70	-	-	34	-	-
		Quarter Hard (10%)	55	42	-	40	-	60	-	36	-	-
Wire	0.080	0.025 mm	50	-	-	60	-	-	-	34	-	-
		Eighth Hard	58	-	-	45	-	-	-	38	-	-
		Half Hard	88	-	-	15	-	-	-	46	-	-
Copper Alloy Nos. 342 and 353 (High-Leaded Brass)												
Flat Products	0.040	0.035 mm	49	17	-	52	68	-	31	34	-	-
		Quarter Hard	54	40	-	38	-	55	54	36	-	-
		Half Hard	61	50	-	20	-	70	65	40	-	-
		Hard	74	60	-	7	-	80	69	43	-	-
		Extra Hard	85	62	-	5	-	87	74	45	-	-
Rod	1.0	Half Hard (20%)	58	45	50	25	-	75	-	-	-	-
Copper Alloy No. 356 (Extra-High-Leaded Brass)												
Flat Products	0.040	0.035 mm	49	17	-	50	68	-	31	-	-	-
		Quarter Hard	54	40	-	35	-	55	54	-	-	-
		Half Hard	61	50	-	20	-	70	65	-	-	-
		Hard	74	60	-	7	-	80	69	-	-	-
Copper Alloy No. 360 (Free-Cutting Brass)												
Flat Products	0.250	Quarter Hard (11%)	56	45	-	20	-	62	-	33	-	-
Rod	1.0	Soft Anneal	49	18	58	53	68	-	-	30	-	-
	0.250	Half Hard (25%)	68	52	48	18	-	80	-	38	-	-
	1.0	Half Hard (20%)	58	45	50	25	-	78	-	34	-	-
	2.0	Half Hard (15%)	55	44	52	32	-	75	-	32	20[d]	100
											14[d]	300
Shapes	0.500	As Extruded	49	18	-	50	68	-	-	30	-	-
		Quarter Hard (11%)	56	45	-	20	-	62	-	33	-	-
Copper Alloy Nos. 365 to 367 incl. (Leaded Muntz Metal)												
Plate	1.0	As Hot Rolled	54	20	-	45	80	-	-	40	-	-
Copper Alloy No. 370 (Free-Cutting Muntz Metal)												
Tube	1.5 in. O.D. x 0.125	Light Anneal	54	20	-	40	80	-	43	-	-	-
		Hard Drawn (35%)	80	60	-	6	-	85	74	-	-	-
	2.0 in. O.D. x 0.250	Hard Drawn (25%)	70	45	-	10	-	75	67	-	-	-
Copper Alloy No. 377 (Forging Brass)												
Rod and Shapes	1.0	As Extruded	52	20	65	45	78	-	-	-	-	-
Copper Alloy No. 385 (Architectural Bronze)												
Shapes	1.0	As Extruded	60	20	-	30	-	65	-	35	-	-

TABLE XX (Contd.)

Form	Size Section (in)	Temper	TS ksi	YS ksi	RA %	EL %	Rockwell Hardness F	Rockwell Hardness B	Rockwell Hardness 30T	SS ksi	Fatigue Strength ksi	Fatigue Strength Million Cycles
Copper Alloy Nos. 443, 444 and 445 (Inhibited Admiralty)												
Tube	1.0 in. O.D. x 0.065	0.025 mm	53	22	-	65	75	-	37	-	-	-
Plate	1.0	As Hot Rolled	48	18	-	65	70	-	-	-	-	-
Wire	0.080	0.015 mm	55	-	-	60	-	-	-	-	-	-
Copper Alloy Nos. 464 to 467 incl. (Naval Brass)												
Flat Products	0.040	Light Anneal	62	30	-	40	-	60	57	41	-	-
		Quarter Hard	70	58	-	17	-	75	68	43	-	-
	0.250	Soft Anneal	58	25	-	49	-	56	55	40	-	-
		Light Anneal	60	28	-	45	-	58	56	41	-	-
	1.0	As Hot Rolled	55	25	-	50	-	55	55	40	-	-
Rod	0.250	Soft Anneal	58	27	60	45	-	56	-	40	-	-
		Light Anneal	63	30	55	40	-	60	-	42	-	-
		Quarter Hard (10%)	70	48	50	25	-	80	-	43	-	-
		Half Hard (20%)	80	57	45	20	-	85	-	45	-	-
	1.0	Soft Anneal	57	25	60	47	-	55	-	40	-	-
		Light Anneal	63	30	55	40	-	60	-	42	-	-
		Quarter Hard (8%)	69	46	50	27	-	78	-	43	-	-
		Half Hard (20%)	75	53	45	20	-	82	-	44	-	-
	2.0	Soft Anneal	56	25	60	47	-	55	-	40	-	-
		Light Anneal	62	28	55	43	-	60	-	42	-	-
		Quarter Hard (8%)	67	40	50	35	-	75	-	43	-	-
Tube	0.375 in. O.D. x 0.097	Hard Drawn (35%)	88	66	40	18	-	95	-	-	-	-
Copper Alloy No. 485 (Leaded Naval Brass)												
Rod	1.0	Soft Anneal	57	25	-	40	-	55	-	36	-	-
		Quarter Hard (8%)	69	46	-	20	-	78	-	39	-	-
		Half Hard (20%)	75	53	-	15	-	82	-	40	-	-
Copper Alloy No. 505 (Phosphor Bronze, 1.25% E)												
Flat Products	0.040	0.025 mm	40	14	-	48	60	-	-	-	-	-
		Half Hard	55	-	-	16	-	64	60	-	-	-
		Hard	65	50	-	8	-	75	67	-	-	-
		Spring	75	-	-	4	-	79	70	-	-	-
Wire	0.080	Hard (80%)	79	-	-	1[a]	-	-	-	-	32	100
	0.460	Hard (70%)	72	-	-	4[a]	-	-	-	-	-	-
Copper Alloy No. 510 (Phosphor Bronze, 5% A)												
Flat Products	0.040	0.050 mm	47	19	-	64	73	26	-	-	-	-
		0.035 mm	49	20	-	58	75	28	-	-	-	-
		0.025 mm	50	21	-	52	77	30	-	-	-	-
		0.015 mm	53	22	-	50	79	34	-	-	-	-
		Half Hard	68	55	-	28	-	78	69	-	-	-
		Hard	81	75	-	10	-	87	75	-	25	100
		Extra Hard	92	80	-	6	-	93	78	-	-	-
		Spring	100	80	-	4	-	95	79	-	22	100
		Extra Spring	107	80	-	3	-	97	80	-	-	-
Rod	0.500	Half Hard (20%)	75	65	-	25	-	80	-	-	-	-
	1.0	Half Hard (20%)	70	58	-	25	-	78	-	-	-	-
Wire	0.080	0.035 mm	50	20	-	58	-	-	-	-	-	-
		Quarter Hard	68	60	-	24	-	-	-	-	-	-
		Half Hard	85	80	-	8	-	-	-	-	-	-
		Hard	110	-	-	5	-	-	-	-	27	100
		Extra Hard (75%)	130	-	-	3	-	-	-	-	30	100
		Spring (84%)	140	-	-	2	-	-	-	-	-	-

TABLE XX (Contd.)

Form	Size Section (in)	Temper	TS ksi	YS ksi	RA %	EL %	Rockwell Hardness F	Rockwell Hardness B	Rockwell Hardness 30T	SS ksi	Fatigue Strength ksi	Fatigue Strength Million Cycles
Copper Alloy No. 521 (Phosphor Bronze, 8% C)												
Flat Products	0.040	0.050 mm	55	-	-	70	75	-	-	-	-	-
		0.035 mm	58	-	-	65	80	-	-	-	-	-
		0.025 mm	60	24	-	63	82	50	-	-	-	-
		0.015 mm	62	-	-	60	85	-	-	-	-	-
		Half Hard	76	55	-	32	-	84	73	-	-	-
		Hard	93	72	-	10	-	93	78	-	22	100
		Extra Hard	106	80	-	4	-	96	80	-	-	-
		Spring	112	-	-	3	-	98	81	-	-	-
		Extra Spring	120	-	-	2	-	100	82	-	-	-
Rod	0.500	Half Hard (20%)	80	65	-	33	-	85	-	-	-	-
Wire	0.080	0.035 mm	60	24	-	65	-	-	-	-	-	-
		Quarter Hard	81	-	-	-	-	-	-	-	-	-
		Half Hard	105	-	-	-	-	-	-	-	-	-
		Hard	130	-	-	-	-	-	-	-	-	-
		Extra Hard	140	-	-	-	-	-	-	-	-	-
Copper Alloy No. 524 (Phosphor Bronze, 10% D)												
Flat Products	0.040	0.035 mm	66	28	-	68	-	55	-	-	-	-
		Half Hard	83	-	-	32	-	92	-	-	-	-
		Hard	100	-	-	13	-	97	-	-	-	-
		Extra Hard	115	-	-	7	-	100	-	-	-	-
		Spring	122	-	-	4	-	101	-	-	-	-
		Extra Spring	128	-	-	3	-	103	-	-	-	-
Wire	0.080	0.035 mm	66	-	-	70	-	-	-	-	-	-
		Quarter Hard	93	-	-	-	-	-	-	-	-	-
		Half Hard	118	-	-	-	-	-	-	-	-	-
		Hard	147	-	-	-	-	-	-	-	-	-
Copper Alloy No. 544 (Free-Cutting Phosphor Bronze)												
Flat Products	0.040	0.035 mm	44	19	-	50	65	-	-	-		-
		Half Hard	58	40	-	24	-	68	-	-	-	-
Rod	0.500	Hard (35%)	75	63	-	15	-	83	-	-	-	-
	1.0	Hard (25%)	68	57	-	20	-	80	-	-	-	-
Copper Alloy No. 614 (Aluminum Bronze, D)												
Flat Products	0.125	Soft	82	45	35	40	-	84	-	45	30	100
		Hard	89	60	-	32	-	87	-	-	-	-
	0.312	Soft	80	40	35	40	-	83	-	42	28	100
		Hard	85	58	-	35	-	86	-	-	-	-
	0.500	Soft	78	35	40	42	-	82	-	40	26	100
		Hard	80	54	-	38	-	85	-	-	-	-
	1.0	Soft	76	33	40	45	-	81	-	40	25	100
		Hard	78	45	-	40	-	84	-	-	-	-
Rod	0.500	Hard	85	45	55	35	-	91	-	48	-	-
	1.0	Hard	82	40	55	35	-	90	-	45	-	-
	2.0	Hard	80	35	60	35	-	88	-	40	-	-
Copper Alloy No. 651 (Low-Silicon Bronze, B)												
Rod	1.0	0.035 mm	40	15	-	50	55	-	-	-	-	-
		Hard (36%)	70	55	-	15	-	80	-	45	-	-
		Extra Hard (50%)	90	67	-	12	-	90	-	50	-	-
Wire	0.080	Eighth Hard	55	40	-	40	-	-	-	36	-	-
		Quarter Hard	65	50	-	25	-	-	-	40	-	-
		Half Hard	80	63	-	15	-	-	-	45	-	-
		Hard	100	70	-	11	-	-	-	50	25	100
		Extra Hard	105	71	-	10	-	-	-	53	28	100
	0.440	Quarter Hard (21%)	63	-	-	30	-	-	-	-	-	-
		Half Hard (37%)	80	-	-	20	-	-	-	-	-	-
		Hard (60%)	95	-	-	12	-	-	-	-	-	-

TABLE XX (Contd.)

Form	Size Section (in)	Temper	TS ksi	YS ksi	RA %	EL %	Rockwell Hardness F	Rockwell Hardness B	Rockwell Hardness 30T	SS ksi	Fatigue Strength ksi	Fatigue Strength Million Cycles
Copper Alloy No. 651 (Contd.)												
Tube	1.0 in. O.D. x 0.065	0.015 mm	45	20	-	55	68	-	-	-	-	-
		Hard Drawn (35%)	65	40	-	20	-	75	67	-	-	-
Copper Alloy No. 655 (High-Silicon Bronze, A)												
Flat-Products	0.040	0.070 mm	56	21	-	63	76	40	-	42	-	-
		0.035 mm	60	25	-	60	85	62	-	43	-	-
		0.015 mm	63	30	-	55	90	66	-	45	-	-
		Quarter Hard	68	35	-	30	-	75	67	47	-	-
		Half Hard	78	45	-	17	-	87	75	50	-	-
		Hard	94	58	-	8	-	93	78	57	-	-
		Extra Hard	104	60	-	6	-	96	80	60	-	-
		Spring	110	62	-	4	-	97	81	63	-	-
Rod	1.0	0.050 mm	58	22	80	60	-	60	-	43	-	-
		Half Hard (20%)	78	45	65	35	-	85	-	52	-	-
		Hard (36%)	92	55	62	22	-	90	-	58	-	-
		Extra Hard (50%)	108	60	60	13	-	95	-	62	-	-
Wire	0.080	0.035 mm	60	25	-	60	-	-	-	43	-	-
		Eighth Hard	70	40	-	35	-	-	-	48	-	-
		Quarter Hard	80	48	-	20	-	-	-	52	-	-
		Half Hard	98	57	-	8	-	-	-	58	-	-
		Hard	125	65	-	5	-	-	-	65	29	100
		Spring (80%)	145	70	-	3	-	-	-	70	30	100
Tube	1.0 in. O.D. x 0.065	0.050 mm	57	-	-	70	-	45	-	-	-	-
		Hard Drawn (35%)	93	-	-	22	-	92	78	-	-	-
Copper Alloy No. 675 (Manganese Bronze, A)												
Rod	1.0	Soft Anneal	65	30	-	33	-	65	-	42	-	-
		Quarter Hard (10%)	77	45	-	23	-	83	-	47	-	-
		Half Hard (20%)	84	60	-	19	-	90	-	48	-	-
	2.0	Quarter Hard (10%)	72	42	-	27	-	77	-	44	-	-
Copper Alloy No. 687 (Aluminum Brass Arsenical)												
Tube	1.0 in. O.D. x 0.065	0.025 mm	60	27	-	55	77	-	-	-	-	-
Copper Alloy No. 706 (Copper Nickel, 10%)												
Tube	1.0 in. O.D. x 0.065	0.025 mm	44	16	-	42	65	15	26	-	-	-
		Light Drawn	60	57	-	10	100	72	70	-	-	-

TABLE XX (Contd.)

Form	Size Section (in)	Temper	TS ksi	YS ksi	RA %	EL %	Rockwell Hardness F	Rockwell Hardness B	Rockwell Hardness 30T	SS ksi	Fatigue Strength ksi	Fatigue Strength Million Cycles
Copper Alloy No. 715 (Copper Nickel 30%)												
Flat Products	1.0	As Hot Rolled	55	20	-	45	-	35	-	-	-	-
Tube	1.0 in. O.D. x 0.065	0.025 mm	60	25	-	45	80	45	-	-	-	-
	4.5 in. O.D. x 0.109	0.035 mm	54	-	-	45	77	36	-	-	-	-
Rod	1.0	Half Hard (20%)	75	70	-	15	-	80	-	-	-	-
Copper Alloy No. 745 (Nickel Silver, 65-10)												
Flat Products	0.040	0.070 mm	49	18	-	49	67	22	30	-	-	-
		0.050 mm	51	19	-	46	71	28	34	-	-	-
		0.035 mm	53	20	-	43	76	35	38	41	-	-
		0.025 mm	56	23	-	40	80	42	44	-	-	-
		0.015 mm	60	28	-	36	85	52	51	-	-	-
		Eighth Hard	60	35	-	34	-	60	55	43	-	-
		Quarter Hard	65	45	-	25	-	70	63	45	-	-
		Half Hard	73	60	-	12	-	80	70	50	-	-
		Hard	86	75	-	4	-	89	76	55	-	-
		Extra Hard	95	76	-	3	-	92	78	59	-	-
Wire	0.080	0.070 mm	50	-	-	50	-	-	-	-	-	-
		0.050 mm	52	-	-	48	-	-	-	-	-	-
		0.035 mm	56	-	-	45	-	-	-	-	-	-
		0.025 mm	58	-	-	40	-	-	-	-	-	-
		0.015 mm	63	-	-	35	-	-	-	-	-	-
		Eighth Hard (10%)	65	-	-	25	-	-	-	-	-	-
		Quarter Hard (20%)	72	-	-	10	-	-	-	-	-	-
		Half Hard (37%)	85	-	-	7	-	-	-	-	-	-
		Hard (60%)	105	-	-	5	-	-	-	-	-	-
		Extra Hard (75%)	120	-	-	3	-	-	-	-	-	-
		Spring (84%)	130	-	-	1	-	-	-	-	-	-
Copper Alloy No. 752 (Nickel Silver, 65-18)												
Flat Products	0.040	0.035 mm	58	25	-	40	85	40	-	-	-	-
		0.015 mm	60	30	-	32	90	55	-	-	-	-
		Quarter Hard	65	50	-	20	-	73	65	-	-	-
		Half Hard	74	62	-	8	-	83	72	-	-	-
		Hard	85	74	-	3	-	87	75	-	-	-
Rod	0.500	0.035 mm	56	25	-	42	-	-	-	-	-	-
		Half Hard (20%)	70	60	-	20	-	78	-	-	-	-
Wire	0.080	0.035 mm	58	25	-	45	-	-	-	-	-	-
		0.015 mm	60	30	-	35	-	-	-	-	-	-
		Quarter Hard	73	65	-	16	-	-	-	-	-	-
		Half Hard	86	80	-	7	-	-	-	-	-	-
		Hard	103	90	-	3	-	-	-	-	-	-

TABLE XX (Contd.)

Form	Size Section (in)	Temper	TS ksi	YS ksi	RA %	EL %	Rockwell Hardness F	Rockwell Hardness B	Rockwell Hardness 30T	SS ksi	Fatigue Strength ksi	Fatigue Strength Million Cycles
Copper Alloy No. 754 (Nickel Silver, 65-15)												
Flat Products	0.040	0.070 mm	53	18	-	43	69	22	27	-	-	-
		0.050 mm	55	19	-	42	73	31	33	-	-	-
		0.035 mm	57	21	-	40	79	39	1	41	-	-
		0.025 mm	59	24	-	37	82	46	46	-	-	-
		0.015 mm	61	28	-	34	89	55	53	-	-	-
		Eighth Hard	60	35	-	30	-	60	55	43	-	-
		Quarter Hard	55	49	-	21	-	70	63	44	-	-
		Half Hard	74	62	-	10	-	80	70	47	-	-
		Hard	85	75	-	3	-	87	75	52	-	-
		Extra Hard	92	79	-	2	-	90	77	54	-	-
Copper Alloy No. 757 (Nickel Silver, 65-12)												
Flat Products	0.040	0.070 mm	52	18	-	48	69	22	27	-	-	-
		0.050 mm	54	19	-	45	73	30	33	-	-	-
		0.035 mm	56	21	-	42	78	37	38	41	-	-
		0.025 mm	59	24	-	38	82	45	44	-	-	-
		0.015 mm	61	28	-	35	88	55	51	-	-	-
		Eighth Hard	60	35	-	32	-	60	55	43	-	-
		Quarter Hard	65	45	-	23	-	70	63	44	-	-
		Half Hard	73	60	-	11	-	80	70	47	-	-
		Hard	85	75	-	4	-	89	75	52	-	-
		Extra Hard	93	79	-	2	-	92	77	56	-	-
Copper Alloy No. 770 (Nickel Silver, 55-18)												
Flat Products	0.040	0.035 mm	60	27	-	40	90	55	-	-	-	-
		Hard	100	85	-	3	-	91	77	-	-	-
		Extra Hard	108	90	-	2.5	-	96	80	-	-	-
		Spring	115	-	-	2.5	-	99	81	-	-	-
Wire	0.080	0.035 mm	60	-	-	40	-	-	-	-	-	-
		Spring (68%)	145	-	-	2	-	-	-	-	-	-

NOTES:

a Elongation in 10 inches.

b Elongation in 60 inches.

c Rotating beam tests on rod.

d Independent rotating beam tests, diameter of test section: 0.350 inch.

TABLE XXI. MECHANICAL PROPERTIES OF WROUGHT ALLOYS - (GOVERNMENT STANDARDIZATION DOCUMENTS)

102

CHEMICAL COMPOSITION	
Spec. No.	Cu + Ag
QQ-C-502C(1)	99.88 min.
QQ-C-576B(1)	99.92 min.
MIL-T-3235	99.95 min.
WWT-799C	99.95 min.

MECHANICAL PROPERTIES

Specification No.	Form	Alloy No. or Comp.	Temper	Thickness (in.)	UTS ksi	TYS ksi	EL %	Hardness -	Hardness -
QQ-C-502	Rod, bar	OF	S	All	37 max.	-	25	-	-
	Rod	OF	H	Up to 0.250 incl.	50	-	-	-	-
				Over 0.250-0.375 incl.	45	-	10	-	-
				Over 0.375-1.000 incl.	40	-	12	-	-
				Over 1.000-2.000 incl.	35	-	15	-	-
				Over 2.000-3.000 incl.	33	-	15	-	-
	Bar	OF	H	Over 0.188-0.375 incl.	42	-	10	-	-
				Over 0.375-0.500 incl.	40	-	12	-	-
				Over 0.500-2.000 incl.	33	-	15	-	-
				Over 2.000-4.000 incl.	32	-	15	-	-
	Shapes	OF	S	All	35 max.	-	25	-	-
			H	All	32	-	15	-	-
	Wire (flat) strip	OF	S	Up to 0.010 incl.	-	-	20	-	-
				Over 0.010-0.020 incl.	40 max.	-	25	-	-
				Over 0.020-0.050 incl.	38 max[a]	-	25[a]	RF 55[b]	RF 62[b]
				Over 0.050-0.188 incl.	37 max[a]	-	25[a]	RF 55[b]	RF 62[b]
			H	Up to 0.020 incl.	43-58	-	-	-	-
				Over 0.020-0.125 incl.	43[a]	-	10[a]	RF 85-97	
				Over 0.125-0.188 incl.	43[a]	-	12[a]	RF 80-95	
QQ-C-576	Plate, bar, sheet, strip	OF	CR, L	All	32-40	-	-	RB 39	-
			CR, 1/2H	All	37-46	-	-	RB 50	-
			CR, H	All	43-52	-	-	RB 57	-
			CR, Spr.	All	50-58	-	-	RB 64	-
			CR, E. Spr.	All	52	-	-	-	RF 92
			HR	All	30-38	-	-	-	RF 75
			HR, A	All	30-38	-	-	-	RF 65
MIL-T-3235	Tube	OF	LD	-	-	-	-	$R_{30}T$ 30-60	
			HD	-	-	-	-	$R_{30}T$ 55 min.	
WWT-799C			A, J		30			RF 50	
			A, K		30			RF 55	
			D		30			$R_{30}T$	

Notes:
a. When specified
b. Maximum

TABLE XXI (Contd.)

120

CHEMICAL COMPOSITION			
Spec. No.	Cu + Ag	P	
WW-T-799C	99.90 (min.)	0.004 - 0.012	

MECHANICAL PROPERTIES										
Specification No.	Form	Alloy No. or Comp.	Temper	Size (in.) Width	Size (in.) Thickness	UTS ksi	TYS ksi	EL %	Hardness RF	Hardness R30T
WW-T-799	Tube	-	A, J	-	-	30	-	-	50 max.	-
			A, K	-	-	30	-	-	55 max.	-
			D	-	-	30	-	-	-	30 min.

Note: Average grain size min. A, J - 0.040 mm
A, K - 0.025 mm

170

CHEMICAL COMPOSITION						
Spec. No.	Cu + Be + additive elements	Be	Fe	Ni	Co	
QQ-C-533A	99.5 min.	1.60 - 1.79	a	a	a	

MECHANICAL PROPERTIES												
Specification No.	Form	Alloy No. or Comp.	Temper	Size (in.) Width	Size (in.) Thickness	UTS ksi	TYS ksi	EL %	Hardness[b] Scale	Hardness[b] Value	Hardness[b] Scale	Hardness[b] Value
QQ-C-533	Strip		A	-	-	60-78	-	35	RB	45-78	R30T	46-67
			1/4H	-	-	75-88	-	10	RB	68-90	R30T	62-75
			1/2H	-	-	85-100	-	5	RB	88-96	R30T	74-79
			H	-	-	100-120	-	2	RB	96-102	R30R	79-83
			AT	-	-	150	120	3	RC	33	R30N	53
			1/4HT	-	-	160	125	2.5	RC	35	R30N	55
			1/2HT	-	-	170	130	1	RC	37	R30N	56
			HT	-	-	180	140	1	RC	39	R30N	59

Notes:
a. Ni and/or Co - 0.20 min., Ni + Co + Fe 0 0.60 max.
b. When specified, in lieu of tensile requirements.

TABLE XXI (Contd.)

172

CHEMICAL COMPOSITION					
Spec. No.	Cu + Be + additive elements	Be	Fe	Ni	Co
QQ-C-530B	99.5 min.	180 - 2.05	a	a	a
QQ-C-533A	99.5 min.	180 - 2.05	a	a	a

MECHANICAL PROPERTIES											
Specification No.	Form	Alloy No. or Comp.	Temper	Thickness (in.)	UTS ksi	TYS ksi	EL %	Hardness[b] RB	RC	$R_{30}T$	$R_{30}N$
QQ-C-530	Rod, bar	-	A	0.020-0.311 incl.	60-85	-	-	-	-	-	-
				Over 0.311	60-85	-	20	45-85	-	-	-
			H	0.020-0.249 incl.	95-130	-	-	-	-	-	-
				Over 0.249-0.375 incl.	95-130	-	-	92-103	-	-	-
				Over 0.375-1.000 incl.	90-120	-	-	91-102	-	-	-
				Over 1.000	85-115	-	8	88-101	-	-	-
			AT	0.020-0.249 incl.	160-190	120	3	-	-	-	-
				Over 0.249	160-190	120	3	-	34-40	-	-
			HT	0.020-0.249 incl.	185-215	130	1	-	-	-	-
				Over 0.249-0.375 0.375 incl.	185-215	130	1	-	34-40	-	-
				Over 0.375-1.000 incl.	180-210	130	1	-	38-44	-	-
				Over 1.000	175-205	130	2	-	37-43	-	-
	Wire		A	All	58-78	-	-	-	-	-	-
			1/4H	All	90-115	-	-	-	-	-	-
			1/2H	All	110-135	-	-	-	-	-	-
			3/4H	All	130-155	-	-	-	-	-	-
			H	All	140-165	-	-	-	-	-	-
			AT	All	160-190	-	-	-	-	-	-
			1/4HT	All	175-205	-	-	-	-	-	-
			1/2HT	All	185-215	-	-	-	-	-	-
			3/4HT	All	190-230	-	-	-	-	-	-
			HT	All	195-230	-	-	-	-	-	-
			XHT	Over 0.05-0.075 Incl.	140-165	-	-	-	-	-	-
				0.075-0.100 excl.	120-140	-	-	-	-	-	-
				0.100-0.144 excl.	115-130	-	-	-	-	-	-
QQ-C-533	Strip		A	All	60-78	-	35	45-78	-	46-67	-
			1/4H	All	75-88	-	10	68-90	-	62-75	-
			1/2H	All	85-100	-	5	88-96	-	74-79	-
			H	All	100-120	-	2	96-102	-	79-83	-
			AT	All	165-190	140	3	-	36	-	56
			1/4HT	All	175-200	150	2.5	-	38	-	58
			1/2HT	All	185-210	160	1	-	39	-	59
			HT	All	190-215	165	1	-	40	-	60

Notes: a. Ni and/or Co - 0.20 min., Ni + Co + Fe - 0.60 max.
b. When specified, in lieu of tensile requirements

TABLE XXI (Contd.)

175

CHEMICAL COMPOSITION					
Spec. No.	Cu + Co + Be	Be	Co	Fe	Total other elements
MIL-C-46087	99.5 min.	0.40 - 0.70	2.35 - 2.70	-	-
MIL-C-81021	99.5 min.	0.40 - 0.80	2.20 - 3.00	0.10	0.50

MECHANICAL PROPERTIES										
Specification No.	Form	Alloy No. or Comp.	Temper	Size (in.) Width	Size (in.) Thickness	UTS ksi	TYS ksi	EL %	Hardness RB	Hardness $R_{30}T$
MIL-C-46087	Bar, rod	-	A	-	-	55 max.	-	20	-	-
			H	-	-	65-80	-	10	-	-
			AT	-	-	100	-	10	-	-
			HT	-	-	110	-	8	-	-
MIL-C-81021	Strip	-	A	-	-	55 max.	20-30	20-35	20-45	29-45
			1/2H	-	-	60-75	50-70	5-10	65-76	60-67
			H	-	-	70-85	60-80	2-8	78-88	69-75
			AT	-	-	100-120	80-100	8-15	92-100	77-82
			1/2HT	-	-	110-130	95-120	5-12	95-102	79-83
			HT	-	-	110-130	95-120	5-12	95-102	79-83

210

CHEMICAL COMPOSITION					
Spec. No.	Cu	Pb	Fe	Zn.	Total other elements
QQ-W-321D	94.0 - 96.0	0.05	0.05	Rem.	0.10
MIL-C-21768	94.0 - 96.0	0.03	0.05	Rem.	0.10

MECHANICAL PROPERTIES								
Specification No.	Form	Alloy No. or Comp.	Temper	Size (in.) Width	Size (in.) Thickness	UTS ksi	TYS ksi	EL %
QQ-W-321	Wire[a] (round, hexagonal, octagonal)		1/8H	-	0.020 and over	35-45	-	-
			1/4H	-	0.020 and over	41-51	-	-
			1/2H	-	0.020 and over	49-58	-	-
			3/4H	-	0.020 and over	57-64	-	-
			H	-	0.020 and over	61-68	-	-
			XH	-	0.020 and over	66-73	-	-
			Spr[a]	-	0.020 and over	72 min.	-	-

TABLE XXI (Contd.)

210 (Contd.)

MECHANICAL PROPERTIES (Cont.)								
Specification No.	Form	Alloy No. or Comp.	Temper	Size (in.) Width	Size (in.) Thickness	UTS ksi	TYS ksi	EL %
QQ-W-321 (Cont.)	Wire[c, d] (flat)		1/4H	-	0.020 and over	37-47	-	-
			1/2H	-	0.020 and over	42-52	-	-
			3/4H	-	0.020 and over	46-56	-	-
			H	-	0.020 and over	50-59	-	-
			XH	-	0.020 and over	56-64	-	-
			Spr[a]	-	0.020 and over	60-68	-	-
			XSpr	-	0.020 and over	61 min.	-	-
MIL-C-21768	Sheet, strip		1/4H	-	All	37-47	-	-
			1/2H	-	All	42-52	-	-
			3/4H	-	All	46-56	-	-
			H	-	All	50-59	-	-
			XH	-	All	56-64	-	-
			Spr	-	All	60-68	-	-
			XSpr	-	All	61-69		

Notes:

a. Grain size requirements for annealed wire

Grain size, mm.		
Nominal	Minimum	Maximum
0.050	0.035	0.090
0.035	0.025	0.050
0.025	0.015	0.035
0.015	*	0.025

* No minimum required, but material shall be fully recrystallized.

b. Bend properties. Spring temper wire up to 0.250 inch shall withstand without cracking, being bent at room temperature through an angle of 120° around a radius equal to the diameter or distance between parallel faces of the wire.

c. Approximate Rockwell hardness for flat wire

Rolled temper	Tensile strength, ksi	Approximate Rockwell hardness* B scale	F scale	30-T scale
1/4 H	37 - 47	20 - 52	69 - 88**	29 - 51
1/2 H	42 - 52	40 - 60	82 - 95**	43 - 56
3/4 H	46 - 56	50 - 64	-	50 - 60
H	50 - 59	57 - 67	-	54 - 62
XH	56 - 64	65 - 72	-	60 - 65
Spr	60 - 68	68 - 75	-	62 - 67
XSpr	61 - 69	69 - 76	-	63 - 68

* Rockwell hardness values apply as follows: The B and F scales are used for wire 0.020 inch in thickness and over. The 30-T scale is used for wire 0.012 inch in thickness and over. Where possible, the B scale should be used.

** The Rockwell B scale is preferred for testing material in these tempers.

TABLE XXI (Contd.)

210 (Contd.)

d. Approximate Rockwell hardness for annealed flat wire

Grain size, mm., nominal	Approximate Rockwell hardness*	
	F scale	30-T scale
0.050	40 - 52**	4 max.
0.035	47 - 54**	7 max.
0.025	50 - 61**	1 - 17
0.015	54 - 64**	7 - 23

*Rockwell hardness values apply as follows: The F scale is used for wire 0.020 inch in thickness and over, and the 30-T scale is used for wire 0.015 inch in thickness and over. Where possible, the F scale should be used.

** This alloy in these several annealed tempers is too soft for Rockwell F hardness tests below 0.030 inch in thickness.

220

CHEMICAL COMPOSITION

Spec. No.	Cu	Pb	Fe	Zn	Total other elements
QQ-W-321D	89.0 - 91.0	0.05	0.05	Rem.	0.10
MIL-C-21768	89.0 - 91.0	0.05	0.05	Rem.	0.10

MECHANICAL PROPERTIES

Specification No.	Form	Alloy No. or Comp.	Temper	Size (in.) Width	Size (in.) Thickness	UTS ksi	TYS ksi	EL %
QQ-W-321	Wire [a] (round, hexagonal, octagonal)		1/8H	-	0.020 and over	38-50	-	-
			1/4H	-	0.020 and over	45-57	-	-
			1/2H	-	0.020 and over	56-67	-	-
			3/4H	-	0.020 and over	64-74	-	-
			H	-	0.020 and over	70-79	-	-
			XH	-	0.020 and over	78-86	-	-
			Spr [b]	-	0.020 and over	84 min	-	-
	Wire [c, d] (flat)		1/4H	-	0.020 and over	40-50	-	-
			1/2H	-	0.020 and over	47-57	-	-
			3/4H	-	0.020 and over	52-62	-	-
			H	-	0.020 and over	57-66	-	-
			XH	-	0.020 and over	64-72	-	-
			Spr [b]	-	0.020 and over	69-77	-	-
			XSpr	-	0.020 and over	72 min	-	-

TABLE XXI (Contd.)

220 (Contd.)

MECHANICAL PROPERTIES (Cont.)								
Specification No.	Form	Alloy No. or Comp.	Temper	Size (in.) Width	Thickness	UTS ksi	TYS ksi	EL %
MIL-C-21768	Sheet, strip		1/4H	-	-	40-50	-	-
			1/2H	-	-	47-57	-	-
			3/4H	-	-	52-62	-	-
			H	-	-	57-66	-	-
			XH	-	-	64-72	-	-
			Spr	-	-	69-77	-	-
			XSpr	-	-	72-80	-	-

Notes:

a. Grain size requirements for annealed wire

Grain size, mm.		
Nominal	Minimum	Maximum
0.050	0.035	0.090
0.035[a]	0.025	0.050
0.025[a]	0.015	0.035
0.015[a]	*	0.025

* No minimum required, but material shall be fully recrystallized.

b. Bend properties. Spring temper wire up to 0.250 inch shall withstand without cracking, being bent at room temperature through an angle of 120° around a radius equal to the diameter or distance between parallel faces of the wire.

c. Approximate Rockwell hardness for flat wire

Rolled temper	Tensile strength, ksi	Approximate Rockwell hardness*		
		B scale	F scale	30-T scale
1/4 H	40 - 50	27 - 56	70 - 90**	34 - 54
1/2 H	47 - 57	50 - 66	88 - 98**	50 - 61
3/4 H	52 - 62	59 - 71	-	56 - 64
H	57 - 66	65 - 75	-	60 - 67
XH	64 - 72	72 - 79	-	65 - 70
Spr	69 - 77	76 - 81	-	68 - 71
XSpr	72 - 80	78 - 83	-	69 - 72

* Rockwell hardness values apply as follows: The B and F scales are used for wire 0.020 inch in thickness and over. The 30-T scale is used for wire 0.012 inch in thickness and over. Where possible, the B scale should be used.

** The Rockwell B scale is preferred for testing material in these tempers.

d. Approximate Rockwell hardness for annealed flat wire

Grain size, mm., nominal	Approximate Rockwell hardness*	
	F scale	30-T scale
0.050	50 - 60	1 - 16
0.035	54 - 64	7 - 21
0.025	58 - 70	13 - 31
0.015	62 - 75	19 - 39

* Rockwell hardness values apply as follows: The F scale is used for wire 0.020 inch in thickness and over, and the 30-T scale is used for wire 0.015 inch in thickness and over. Where possible, The F scale should be used.

TABLE XXI (Contd.)

230

CHEMICAL COMPOSITION					
Spec. No.	Cu	Pb	Fe	Zn	Total other elements
QQ-B-613C	84.0 - 86.0	0.05	0.05	Rem.	0.15
QQ-B-626C	84.0 - 86.0	0.05	0.05	Rem.	0.15
QQ-W-321D	84.0 - 86.0	0.05	0.05	Rem.	0.15
WW-P-351A	83.0 - 86.0	0.06	0.05	Rem.	-
MIL-T-20168	84.0 - 86.0	0.06	0.05	Rem.	-

MECHANICAL PROPERTIES								
Specification No.	Form	Alloy No. or Comp.	Temper	Size (in.) Width	Size (in.) Thickness	UTS ksi	TYS ksi	EL %
QQ-B-613 [a]	Plate, bar sheet, strip		1/4H	All	All	44-54	-	-
			1/2H	All	All	51-61	-	-
			H	All	All	63-72	-	-
QQ-B-626 [a]	Strip		1/4H	All	All	44-54	-	-
			1/2H	All	All	51-61	-	-
			H	All	All	63-72	-	-
QQ-W-321 [a]	Wire [b] (round, hexagonal, octagonal)		1/8H	-	0.020 and over	43-57	-	-
			1/4H	-	0.020 and over	53-65	-	-
			1/2H	-	0.020 and over	66-77	-	-
			3/4H	-	0.020 and over	76-86	-	-
			H	-	0.020 and over	83-92	-	-
			XH	-	0.020 and over	94-102	-	-
			Spr [c]	-	0.020 and over	100 min	-	-
	Wire [d] (flat)		1/4H	-	0.020 and over	44-54	-	-
			1/2H	-	0.020 and over	51-61	-	-
			3/4H	-	0.020 and over	57-67	-	-
			H	-	0.020 and over	63-72	-	-
			XH	-	0.020 and over	72-80	-	-
			Spr [c]	-	0.020 and over	78-86	-	-
			XSpr	0	0.020 and over	82 min	-	-
WW-P-351	Pipe	-	A	-	-	40 [e]	12 [e]	-
MIL-T-20168	Tube	-	LA	All	All	40 [e]	12 [e]	-

TABLE XXI (Contd.)

230 (Contd.)

Notes:

a. Annealed grain size

Ordered grain size, mm.	Permissible variation in average grain size, mm.	
	Minimum	Maximum
0.070	0.050	0.100
0.050	0.035	0.070
0.035	0.025	0.050
0.025	0.015	0.035
0.015	*	0.025

* Although no minimum grain size is required, this material must be fully recrystallized.

b. Approximate Rockwell hardness for annealed flat wire

Grain size, mm., nominal	Approximate Rockwell hardness*	
	F scale	30-T scale
0.070	53 - 60	6 - 16
0.050	56 - 63	10 - 20
0.035	58 - 66	13 - 24
0.025	60 - 72	16 - 34
0.015	62 - 79	19 - 48

* Rockwell hardness values apply as follows: The F scale is used for wire 0.020 inch in thickness and over, and the 30-T scale is used for wire 0.015 inch in thickness and over. Where possible, the F scale should be used.

c. Bend properties. Spring temper wire up to 0.250 inch shall withstand without cracking, being bent at room temperature through an angle of 120° around a radius equal to the diameter or distance between parallel faces of the wire.

d. Approximate Rockwell hardness for flat wire

Rolled temper	Tensile strength, ksi	Approximate Rockwell hardness*		
		B scale	F scale	30-T scale
1/4 H	44 - 54	33 - 62	78 - 94**	38 - 58
1/2 H	51 - 61	56 - 71	92 - 102**	54 - 64
3/4 H	57 - 67	66 - 76	-	60 - 68
H	63 - 72	72 - 80	-	65 - 70
XH	72 - 80	78 - 85	-	69 - 74
Spr	78 - 86	82 - 87	-	72 - 75
XSpr	82 - 90	84 - 89	-	73 - 76

* Rockwell hardness values apply as follows: The B and F scales are used for wire 0.020 inch in thickness and over. The 30-T scale is used for wire 0.012 inch in thickness and over. Where possible, the B scale should be used.

** The Rockwell B scale is preferred for testing material in these tempers.

e. When specified.

TABLE XXI (Contd.)

240

CHEMICAL COMPOSITION					
Spec. No.	Cu	Pb	Fe	Zn	Total other elements
QQ-B-613C	78.5 - 81.5	0.05	0.05	Rem.	0.15
QQ-B-626C	78.5 - 81.5	0.05	0.05	Rem.	0.15
QQ-W-321D	78.5 - 81.5	0.05	0.05	Rem.	0.15

MECHANICAL PROPERTIES								
Specification No.	Form	Alloy No. or Comp.	Temper	Size (in.) Width	Thickness	UTS ksi	TYS ksi	EL %
QQ-B-613 [a]	Plate, bar, sheet, strip		1/4H	All	All	48-58	-	-
			1/2H	All	All	55-65	-	-
			H	All	All	68-77	-	-
QQ-B-626 [a]	Bar, strip, wire (flat)		1/4H	All	All	48-58	-	-
			1/2H	All	All	55-65	-	-
			H	All	All	68-77	-	-
QQ-W-321 [a, b]	Wire (round, hexagonal, octagonal)		1/8H	All	0.020 and over	50-65	-	-
			1/4H	All	0.020 and over	62-75	-	-
			1/2H	All	0.020 and over	78-90	-	-
			3/4H	All	0.020 and over	90-101	-	-
			H	All	0.020 and over	100-110	-	-
			XH	All	0.020 and over	112-121	-	-
			Spr [b]	All	0.020 and over	116 min	-	-
	Wire [c, d] (flat)		1/4H	-	0.020 and over	48-58	-	-
			1/2H	-	0.020 and over	55-65	-	-
			3/4H	-	0.020 and over	61-71	-	-
			H	-	0.020 and over	68-77	-	-
			XH	-	0.020 and over	78-87	-	-
			Spr [b]	-	0.020 and over	85-93	-	-
			XSpr	-	0.020 and over	89 min	-	-

Notes:

a. Grain size requirements for annealed wire, brass

Grain size, mm.		
Nominal	Minimum	Maximum
0.070	0.050	0.120
0.050	0.035	0.070
0.035	0.025	0.050
0.025	0.015	0.035
0.015	*	0.025

* No minimum required, but material shall be fully recrystallized.

TABLE XXI (Contd.)

240 (Contd.)

b. Bend properties. Spring temper wire up to 0.250 inch shall withstand without cracking, being bent at room temperature through an angle of 120° around a radius equal to the diameter or distance between parallel faces of the wire.

c. Approximate Rockwell hardness for annealed flat wire.

Grain size, mm., nominal	Approximate Rockwell hardness	
	F scale	30-T scale
0.070	53 - 64	2 - 21
0.050	57 - 67	8 - 27
0.035	61 - 72	16 - 35
0.025	63 - 77	20 - 42
0.015	66 - 83	25 - 50

d. Approximate Rockwell hardness for flat wire.

Rolled temper	Tensile strength, ksi	Approximate Rockwell hardness*		
		B scale	F scale	30-T scale
1/4 H	48 - 58	38 - 65	80 - 95**	42 - 60
1/2 H	55 - 65	59 - 73	93 - 102**	56 - 66
3/4 H	61 - 71	69 - 79	-	63 - 70
H	68 - 77	76 - 84	-	68 - 73
XH	78 - 87	83 - 89	-	72 - 76
Spr	85 - 93	87 - 92	-	75 - 78
XSpr	89 - 97	88 - 93	-	76 - 79

* Rockwell hardness values apply as follows: The B and F scales are used for wire 0.020 inch in thickness and over. The 30-T scale is used for wire 0.012 inch in thickness and over. Where possible, the B scale should be used.
** The Rockwell B scale is preferred for testing material in these tempers.

260

CHEMICAL COMPOSITION						
Spec. No.	Cu	Pb	Fe	Zn	Bi	Total other elements
QQ-B-613C	68.5 - 71.5	0.07	0.05	Rem.	0.006	0.15
QQ-B-626C	68.5 - 71.5	0.07	0.05	Rem.	*	0.15
QQ-W-321D	68.5 - 71.5	0.07	0.05	Rem.	-	0.15
MIL-C-50C	68.5 - 71.5	0.07	0.05	Rem.	-	0.15

* If bismuth is present in excess of 0.006 percent, the material shall be subject to rejection.

TABLE XXI (Contd.)

260 (Contd.)

MECHANICAL PROPERTIES								
Specification No.	Form	Alloy No. or Comp.	Temper[a, b]	Size (in.) Width	Size (in.) Thickness	UTS ksi	TYS ksi	EL %
QQ-B-613	Plate, bar, sheet, strip		1/4H	-	-	49-59	-	-
			1/2H	-	-	57-67	-	-
			H	-	-	71-81	-	-
			XH	-	-	83-92	-	-
			Spr	-	-	91-100	-	-
			XSpr	-	-	95-104	-	-
QQ-B-626	Rod		S[c]	All	All	42	-	30
			1/2H	-	Up to 1/2, incl.	57	-	15
					Over 1/2-1, incl.	55	-	20
					Over 1-2, incl.	50	-	25
					Over 2	45	-	30
			H	-	Up to 1/4, incl.	80	-	10
					Over 1/4-1/2, incl.	70	-	12
	Bar		S, Ae[c]	Up to 6	Up to 1, incl.	44	18	20
				Up to 6	Over 1	40	15	25
			1/2H	Up to 1, incl.	Up to 1/2, incl.	50	25	10
				Over 1-6, incl.	Up to 1/2, incl.	45	17	15
				Up to 2, incl.	Over 1/2-2, incl.	45	17	20
				Over 2-6, incl.	Over 1/2-2, incl.	40	15	20
				Over 2-4, incl.	Over 2	40	15	20
	Strip		1/4H	-	-	49- 59	-	-
			1/2H	-	-	57- 67	-	-
			H	-	-	71- 81	-	-
			XH	-	-	83- 92	-	-
			Spr[d]	-	-	91-100	-	-
			XSpr	-	-	95-104	-	-
			A[a, b]	-	-	-	-	-
QQ-W-321	Wire (round, hexagonal, octagonal)		1/8H	-	-	50- 65	-	-
			1/4H	-	0.020 and over	62- 77	-	-
			1/2H	-	0.020 and over	79- 94	-	-
			3/4H	-	0.020 and over	92-107	-	-
			H	-	0.020 and over	102-117	-	-
			XH	-	0.020 and over	115-129	-	-
			Spr[d]	-	0.020 and over	120 min	-	-
QQ-W-321 (Cont.)	Wire[a, b, e] (flat)		1/4H	-	0.020 and over	49- 59	-	-
			1/2H	-	0.020 and over	57- 67	-	-
			3/4H	-	0.020 and over	64- 74	-	-
			H	-	0.020 and over	71- 81	-	-
			XH	-	0.020 and over	83- 92	-	-
			Spr	-	0.020 and over	91-100	-	-
			XSpr	-	0.020 and over	95	-	-

TABLE XXI (Contd.)

260 (Contd.)

MECHANICAL PROPERTIES (Cont.)								
Specification No.	Form	Alloy No. or Comp.	Temper	Size (in.) Width	Size (in.) Thickness	UTS ksi	TYS ksi	EL %
MIL-C-50	Sheet, strip, plate, bar, disk		A-0.015-0.035 mm grain size	-	0.020-0.050, incl.	45	-	40
				-	Over 0.050-0.100, incl.	45	-	42
					Over 0.100-0.150, incl.	45	-	45
					Over 0.150	45	-	50
			A-0.050-0.100 mm grain size	-	0.020 to 0.050, incl.	44	-	45
					Over 0.050-0.100, incl.	44	-	47
					Over 0.100-0.150, incl.	44	-	50
					Over 0.150-0.250, incl.	44	-	55
					Over 0.250-0.500, incl.	43	-	55
					Over 0.500	40	-	60
			Hr	-	0.250-0.500, incl.	43	-	55
					Over 0.500	40	-	60
	Sheet, strip, plate, bar		CR, 1/4H	-	-	49-59	-	-
			CR, 1/2H	-	-	57-67	-	-
			CR, 3/4H	-	-	64-74	-	-
			CR, H	-	-	71-81	-	-
			CR, XH	-	-	83-92	-	-
			CR, Spr	-	-	91-100	-	-
			CR, XSpr	-	-	95-104	-	-

Notes:

a. Annealed temper grain size.

Ordered grain size, mm.	Permissible variation in average grain size, mm.	
	Minimum	Maximum
0.120	0.070	0.150
0.070	0.050	0.120
0.050	0.035	0.070
0.035	0.025	0.050
0.025	0.015	0.035
0.015	1/	0.025

b. Hardness requirements

Annealed temper, nominal grain size, mm.	Rockwell hardness	
	F	Superficial 30-T
0.120	50 - 62	21 max.
0.070	52 - 67	3 - 27
0.050	61 - 73	20 - 35
0.035	65 - 76	25 - 38
0.025	67 - 79	27 - 42
0.015	72 - 85	33 - 50

c. Soft temper grain size

Ordered grain size mm.	Permissible variation in average grain size, mm.	
	Minimum	Maximum
0.070	0.035	0.150
0.025	*	0.050

* Although no minimum grain size is required, this material shall be fully recrystallized.

TABLE XXI (Contd.)

260 (Contd.)

d. Bend properties. Spring temper wire up to 0.250 inch shall withstand without cracking, being bent at room temperature through an angle of 120° around a radius equal to the diameter or distance between parallel faces of the wire.

e. Approximate Rockwell hardness for flat wire.

Rolled Temper	Tensile Strength ksi	Approximate Rockwell hardness	
		B Scale	30-T Scale
1/4 H	49 - 59	40 - 65	43 - 60
1/2 H	57 - 67	60 - 77	56 - 68
3/4 H	64 - 74	72 - 82	65 - 72
H	71 - 81	79 - 86	70 - 74
XH	83 - 92	85 - 91	74 - 77
Spr	91 - 100	89 - 93	75 - 78
XSpr	95 - 104	91 - 95	77 - 79

268

CHEMICAL COMPOSITION

Spec. No.	Cu	Pb	Fe	Zn	Total other elements
QQ-B-613C	64.0 - 68.5	0.15	0.05	Rem.	0.15
QQ-B-626C	64.0 - 68.5	0.15	0.05	Rem.	0.15

MECHANICAL PROPERTIES

Specification No.	Form	Alloy No. or Comp.	Temper	Size(in.) Width	Size(in.) Thickness	UTS ksi	TYS ksi	EL %
QQ-B-613 [a]	Plate, bar, sheet, strip		1/4H	-	-	49-59	-	-
			1/2H	-	-	55-65	-	-
			H	-	-	68-78	-	-
			XH	-	-	79-89	-	-
			Spr	-	-	86-95	-	-
			XSpr	-	-	90-99	-	-
QQ-B-626 [a]	Rod		S	-	All	42	-	30
			1/2H	-	Up to 1/2, incl.	57	-	15
					Over 1/2-1, incl.	55	-	20
					Over 1-2, incl.	50	-	25
					Over 2	45	-	30
			H	-	Up to 1/4, incl.	80	-	10
					Over 1/4-1/2, incl.	70	-	12
	Bar		S, AE [b]	Up to 6, incl.	Up to 1, incl.	44	18	20
				Up to 6, incl.	Over 1	40	15	25
			1/2H	Up to 1, incl.	Up to 1/2, incl.	50	25	10
				Over 1 to 6, incl.	Up to 1/2, incl.	45	17	15
				Up to 2, incl.	Over 1/2-2, incl.	45	17	20
				Over 2 to 6, incl.	Over 1/2-2, incl.	40	15	20
				Over 2 to 4 incl.	Over 2	40	15	20

TABLE XXI (Contd.)

268 (Contd.)

MECHANICAL PROPERTIES (Cont.)								
Specification No.	Form	Alloy No. or Comp.	Temper	Size (in.) Width	Size (in.) Thickness	UTS ksi	TYS ksi	EL %
QQ-B-626 [a] (Cont.)	Strip		1/4H	-	-	49-59	-	-
			1/2H	-	-	55-65	-	-
			H	-	-	68-78	-	-
			XH	-	-	79-89	-	-
			Spr	-	-	86-95	-	-
			XSpr	-	-	90-99	-	-
			A [c]	-	-		-	-

Notes:

a. Grain size for annealed brass.

Copper alloy number	Ordered grain size, mm	Permissible variation in average grain size, mm. Minimum	Permissible variation in average grain size, mm. Maximum
268	0.120	0.070	0.150
	0.070	0.050	0.120
	0.050	0.035	0.070
	0.035	0.025	0.050
	0.025	0.015	0.035
	0.015	*	0.025

* Although no minimum grain size is required, this material must be fully recrystallized.

b. Grain size - rod and bar.

Ordered grain size mm.	Permissible variation in average grain size, mm. Minimum	Permissible variation in average grain size, mm. Maximum
0.070	0.035	0.150
0.025	*	0.050

* Although no minimum grain size is required, this material shall be fully recrystallized.

c. Hardness requirements - finished edge strip.

Annealed temper, nominal grain size, mm.	Rockwell hardness F	Rockwell hardness Superficial 30-T
0.120	50 - 62	21 max.
0.070	52 - 67	3 - 27
0.050	61 - 73	20 - 35
0.035	65 - 76	25 - 38
0.025	67 - 79	27 - 42
0.015	72 - 85	33 - 50

TABLE XXI (Contd.)

270

CHEMICAL COMPOSITION					
Spec. No.	Cu	Pb	Fe	Zn	Total other elements
QQ-W-321D	63.0 - 68.5	0.10	0.05	Rem.	0.15

MECHANICAL PROPERTIES								
Specification No.	Form	Alloy No. or Comp.	Temper	Size (inc.) Width	Size (inc.) Thickness	UTS ksi	TYS ksi	EL %
QQ-W-321	Wire [a]		1/8H	-	0.020 and over	50-65	-	-
			1/4H	-	0.020 and over	62-77	-	-
			1/2H	-	0.020 and over	79-94	-	-
			3/4H	-	0.020 and over	92-107	-	-
			H	-	0.020 and over	102-117	-	-
			XH	-	0.020 and over	115-129	-	-
			Spr [c]	-	0.020 and over	120 min	-	-
	b, d Wire (flat)		1/4H	-	0.020 and over	49-59	-	-
			1/2H	-	0.020 and over	55-65	-	-
			3/4H	-	0.020 and over	62-72	-	-
			H	-	0.020 and over	68-78	-	-
			XH	-	0.020 and over	79-89	-	-
			Spr [c]	-	0.020 and over	86-95	-	-
			XSpr [c]	-	0.020 and over	90 min	-	-

Notes:

a. Grain size requirements for annealed wire.

Nominal	Minimum	Maximum
0.120	0.070	-
0.070	0.050	0.120
0.050	0.035	0.070
0.035	0.025	0.050
0.025	0.015	0.035
0.015	*	0.025

* No minimum required but material shall be fully recrystallized.

b. Approximate Rockwell hardness for annealed flat wire.

Grain Size (mm) Nominal	Approximate Rockwell hardness*	
	F Scale	30-T Scale
0.120	50 - 62	21 max.
0.070	52 - 67	3 - 27
0.050	61 - 73	20 - 35
0.035	65 - 76	25 - 38
0.025	67 - 79	27 - 42
0.015	72 - 85	33 - 50

* Rockwell hardness values apply as follows: The F scale is used for wire 0.020 inch in thickness and over, and the 30-T scale is used for wire 0.015 inch in thickness and over. Where possible, the F scale should be used.

TABLE XXI (Contd.)

270 (Contd.)

c. Bend properties. Spring temper wire up to 0.250 inch shall withstand without cracking, being bent at room temperature through an angle of 120° around a radius equal to the diameter or distance between parallel faces of the wire.

d. Approximate Rockwell hardness for flat wire.

Rolled Temper	Tensile strength ksi	F Scale	30-T Scale
1/4 H	49 - 59	40 - 65	43 - 60
1/2 H	55 - 65	57 - 74	54 - 66
3/4 H	62 - 72	70 - 80	65 - 71
H	68 - 78	76 - 84	68 - 73
XH	79 - 89	83 - 89	73 - 76
Spr	86 - 95	87 - 92	75 - 78
XSpr	90 - 99	88 - 93	76 - 79

274

CHEMICAL COMPOSITION

Spec. No.	Cu	Pb	Fe	Zn	Total other elements
QQ-W-321D	61.0 - 64.0	0.10	0.05	Rem.	0.20

MECHANICAL PROPERTIES

Specification No.	Form	Alloy No. or Comp.	Temper	Size (in.) Width	Size (in.) Thickness	UTS ksi	TYS ksi	EL %
QQ-W-321	Wire [a] (round, hexagonal, octagonal)		1/8H	All	All	50-65	-	-
			1/4H	All	All	62-77	-	-
			1/2H	All	All	79-94	-	-
			3/4H	All	All	92-107	-	-
			H	All	All	102-117	-	-
			XH	All	All	115-129	-	-
			Spr [c]	All	All	120 min	-	-
	Wire [b,c,d] (flat)		1/4H	All	All	49-59	-	-
			1/2H	All	All	55-65	-	-
			3/4H	All	All	62-72	-	-
			H	All	All	68-78	-	-
			XH	All	All	79-89	-	-
			Spr	All	All	86-95	-	-
			XSpr	All	All	90 min	-	-

TABLE XXI (Contd.)

274 (Contd.)

Notes:

a. Grain size requirements for annealed wire.

Grain size, mm.		
Nominal	Minimum	Maximum
0.120	0.070	-
0.070	0.050	0.120
0.050	0.035	0.070
0.035	0.025	0.050
0.025	0.015	0.035
0.015	*	0.025

* No minimum required, but material shall be fully recrystallized.

b. Approximate Rockwell hardness for annealed flat wire.

Grain size, mm., nominal	Approximate Rockwell hardness*	
	F Scale	30-T Scale
0.120	50 - 62	21 max.
0.070	52 - 67	3 - 27
0.050	61 - 73	20 - 35
0.035	65 - 76	25 - 38
0.025	67 - 79	27 - 42
0.015	72 - 85	33 - 50

* Rockwell hardness values apply as follows: The F scale is used for wire 0.020 inch in thickness and over, and the 30-T scale is used for wire 0.015 inch in thickness and over. Where possible, the F scale should be used.

c. Bend properties. Spring temper wire up to 0.250 inch shall withstand without cracking, being bent *at room temperature through an angle of 120° around a radius equal to the diameter or distance* between parallel faces of the wire.

d. Approximate Rockwell hardness for flat wire.

Rolled Temper	Tensile Strength ksi	F-Scale	30-T Scale
1/4 H	49 - 59	40 - 65	43 - 60
1/2 H	55 - 65	57 - 74	54 - 66
3/4 H	62 - 72	70 - 80	65 - 71
H	68 - 78	76 - 84	68 - 73
XH	79 - 89	83 - 89	73 - 76
Spr	86 - 95	87 - 92	75 - 78
XSpr	90 - 99	88 - 93	76 - 79

TABLE XXI (Contd.)

330

CHEMICAL COMPOSITION					
Spec. No.	Cu	Pb	Fe	Zn	Total other elements
MIL-T-46072	65.0 - 68.0	0.2 - 0.8	0.07	Rem.	0.50

MECHANICAL PROPERTIES										
Specification No.	Form	Alloy No. or Comp.	Temper	Size (in.) Width	Size (in.) Thickness	UTS ksi	TYS ksi	EL %	Hardness RF	Hardness $R_{30}T$
MIL-T-46072	Tube		D	-	All	54	-	-	-	53
			HD	-	All	66	-	-	-	70
			D, StR	-	-	-	-	-	-	50
			SA	-	Up to 0.30 incl.	-	-	-	-	40 max.
					Over 0.30	-	-	-	80 max.	-
			LA	-	Up to 0.30 incl.	-	-	-	-	60 max.
					Over 0.30	-	-	-	90 max.	

331

CHEMICAL COMPOSITION					
Spec. No.	Cu	Pb	Fe	Zn	Total other elements
MIL-T-46072	65.0 - 68.0	0.7 - 1.2	0.06	Rem.	0.50

MECHANICAL PROPERTIES									
Specification No.	Form	Alloy No. or Comp.	Temper	Size (in.) Width	Size (in.) Thickness	UTS ksi	TYS ksi	EL %	Hardness $R_{30}T$
MIL-T-46072	Tube		D, SR	-	-	-	-	-	50

TABLE XXI (Contd.)

332

CHEMICAL COMPOSITION					
Spec. No.	Cu	Pb	Fe	Zn	Total other elements
MIL-T-46072	65.0 - 68.0	1.3 - 2.0	0.07	Rem.	0.50

MECHANICAL PROPERTIES										
Specification No.	Form	Alloy No. or Comp.	Temper	Size (in.) Width	Size (in.) Thickness	UTS ksi	TYS ksi	EL %	Hardness RF	Hardness $R_{30}T$
MIL-T-46072	Tube		D	-	All	54	-	-	-	53
			HR	-	All	66	-	-	-	70
			D, StR	-	-	-	-	-	-	50
			SA	-	Up to 0.30 incl.	-	-	-	-	40 max.
					Over 0.30	-	-	-	80 max.	-
			LA	-	Up to 0.30 incl.	-	-	-	-	60 max.
					Over 0.30	-	-	-	90 max.	-

342

CHEMICAL COMPOSITION					
Spec. No.	Cu	Pb	Fe	Zn	Total other elements
QQ-B-613C	60.5 - 66.5	1.3 - 2.5	0.10	Rem.	0.25
QQ-B-626C	62.5 - 66.5	1.5 - 2.5	0.10	Rem.	0.50

MECHANICAL PROPERTIES								
Specification No.	Form	Alloy No. or Comp.	Temper	Size (in.) Width	Size (in.) Thickness	*UTS* ksi	*TYS* ksi	*EL* %
QQ-B-613[a]	Plate, bar, sheet, strip		1/4H	-	-	49-59	-	-
			1/2H	-	-	55-65	-	-
			H	-	-	68-78	-	-
			XH	-	-	79-89	-	-
QQ-B-626[a]	Strip		1/4H	All	All	49-59	-	-
			1/2H	All	All	55-65	-	-
			H	All	All	68-78	-	-
			XH	All	All	79-89	-	-

TABLE XXI (Contd.)

342 (Contd.)

Note:

a. Grain size

Ordered grain size mm.	Permissible variation in average grain size, mm.	
	Minimum	Maximum
0.070	0.050	0.100
0.050	0.035	0.070
0.035	0.025	0.050
0.025	0.015	0.035

353

CHEMICAL COMPOSITION					
Spec. No.	Cu	Pb	Fe	Zn	Total other elements
QQ-B-613C	59.0 - 64.5	1.3 - 2.3	0.10	Rem	0.50
QQ-B-626C	59.0 - 64.5	1.3 - 2.3	0.10	Rem	0.50

MECHANICAL PROPERTIES								
Specification No.	Form	Alloy No. or Comp.	Temper	Size (in.) Width	Size (in.) Thickness	UTS ksi	TYS ksi	EL %
QQ-B-613	Plate,[a] bar, sheet, strip	24	1/4H	-	-	49-59	-	-
			1/2H	-	-	55-65	-	-
			H	-	-	68-78	-	-
			XH	-	-	79-89	-	-
QQ-B-626	Strip[a]	24	1/4H	All	All	49-59	-	-
			1/2H	All	All	55-65	-	-
			H	All	All	68-78	-	-
			XH	All	All	79-89	-	-

Note:

a. Grain size

Ordered grain size mm.	Permissible variation in average grain size, mm.	
	Minimum	Maximum
0.070	0.050	0.100
0.050	0.035	0.070
0.035	0.025	0.050
0.025	0.015	0.035

TABLE XXI (Contd.)

360

CHEMICAL COMPOSITION					
Spec. No.	Cu	Pb	Fe.	Zn	Total other elements
QQ-B-626C	60.0 - 63.0	2.5 - 3.7	0.35	Rem.	0.50

MECHANICAL PROPERTIES								
Specification No.	Form	Alloy No. or Comp.	Temper	Size (in.) Width	Size (in.) Thickness	UTS ksi	TYS ksi	EL %
QQ-B-626	Rod		S, AE	-	Up to 1 incl.	48	20	15
					Over 1-2 incl.	44	18	20
					Over 2	40	15	25
			1/2H	-	Up to 1/2 incl.	57	25	7
					Over 1/2-1 incl.	55	25	10
					Over 1-2 incl.	50	20	15
					Over 2	45	15	20
			H	-	1/8-3/16 incl.	80	45	-
					Over 3/16-1/2 incl.	70	35	4
					Over 1/2-3/4 incl.	65	30	6
	Bar		S, AE	Up to 6 incl.	Up to 1 incl.	44	18	20
					Over 1	40	15	25
			1/2H	Up to 1 incl.	Up to 1/2 incl.	50	25	10
				Over 1-6 incl.	Up to 1/2 incl.	45	17	15
				Up to 2 incl.	Over 1/2-2 incl.	45	17	20
				Over 2-6 incl.	Over 1/2-2 incl.	40	15	20
				Over 2-4 incl.	Over 2	40	15	20

370

CHEMICAL COMPOSITION					
Spec. No.	Cu	Pb	Fe	Zn	Total other elements
MIL-T-46072	59.0 - 62.0	0.9 - 1.4	0.15	Rem.	0.50

MECHANICAL PROPERTIES										
Specification No.	Form	Alloy No. or Comp.	Temper	Size (in.) Width	Size (in.) Thickness	UTS ksi	TYS ksi	EL %	Hardness RF	Hardness $R_{30}T$
MIL-T-46072	Tube		D	-	All	54	-	-		55
			LA	-	Up to 0.030 incl.	-	-	-		60 max.
					Over 0.030	-	-	-	90 max.	

TABLE XXI (Contd.)

377

CHEMICAL COMPOSITION					
Spec. No.	Cu	Pb	Fe	Zn	Total other elements
QQ-B-626C	58.0 - 62.0	1.5 - 2.5	0.30	Rem.	0.50
MIL-B-13351A	58.0 - 62.0	1.5 - 2.5	0.30	Rem.	0.50

MECHANICAL PROPERTIES								
Specification No.	Form	Alloy No. or Comp.	Temper		UTS ksi	TYS ksi	EL %	Hardness RB
QQ-B-626	Rod, bar		-	Mechanical properties as specified in the contract or order.				
MIL-B-13351	Forgings	-	-	Usage For time fuze rings For other applications	- -	- -	- -	55-70 40 min.

411

CHEMICAL COMPOSITION					
Spec. No.	Cu	Fe	Sn	Zn	Total other elements max.
MIL-B-13501A	88.0 - 92.0	0.1	0.25 - 0.75	Rem.	0.2

MECHANICAL PROPERTIES									
Specification No.	Form	Alloy No. or Comp.	Temper	Size (in.) Width	Size (in.) Thickness	UTS ksi	TYS ksi	EL %	Hardness
MIL-B-13501	Bushings	A	-	All	All	-	-	-	As specified in the contract or order.

443,444,445

CHEMICAL COMPOSITION						
Spec. No.	Cu	Pb	Fe	Sn	Zn	As
WW-T-756D	70.0 - 73.0	0.07	0.06	0.9 - 1.2	Rem.	0.02 - 0.10

MECHANICAL PROPERTIES								
Specification No.	Form	Alloy No. or Comp.	Temper	Size (in.) Width	Size (in.) Thickness	UTS ksi	TYS ksi	EL %
WW-T-756	Tube	Arsenical (443) Antimonial (444) Phosphorized (445)	A- 0.010-0.045mm grain size	All	All	-	-	-

TABLE XXI (Contd.)

462

CHEMICAL COMPOSITION						
Spec. No.	Cu	Pb	Fe	Sn	Zn	Total other elements
QQ-B-637A	62.0 - 65.0	0.20	0.10	0.5 - 1.0	Rem.	0.10
QQ-B-639A	62.0 - 65.0	0.20	0.10	0.50 - 1.0	Rem.	0.10

MECHANICAL PROPERTIES								
Specification No.	Form	Alloy No. or Comp.	Temper	Size (in.) Width	Size (in.) Thickness	UTS ksi	TYS ksi	EL %
QQ-B-637	Bar, rod shapes		AE	All	All	50	20	30
	Bar, rod, wire		S	All	All	48	16	30
	Rod, wire		CHe or CF	All	All	48	18	22
	Bar, rod, wire		1/2H or LA	-	Up to 0.500 incl.	58	27	22
					Over 0.500-1.000 incl.	56	27	25
					Over 1.000-2.000 incl.	54	26	25
					Over 2.000-3.000 incl.	52	25	27
					Over 3.000-4.000 incl.	50	22	30
					Over 4.000	50	20	30
			H	-	Up to 0.500 incl.	64	40	13
					Over 0.500-1.000 incl.	62	38	13
					Over 1.000-2.000 incl.	58	34	18
QQ-B-639	Bar		S	All	All	45	16	30
			1/2H	All	All	54	25	20

464, 465,466,467

CHEMICAL COMPOSITION						
Spec. No.	Cu	Pb	Fe	Sn	Zn	Total other elements
QQ-B-637A	59.0 - 62.0	0.20	0.10	0.5 - 1.0	Rem.	0.10
QQ-B-639A	59.0 - 62.0	0.20	0.10	0.5 - 1.0	Rem.	0.10

MECHANICAL PROPERTIES								
Specification No.	Form	Alloy No. or Comp.	Temper	Size (in.) Width	Size (in.) Thickness	UTS ksi	TYS ksi	EL %
QQ-B-637	Bar, rod, shapes		AE	-	All	52	20	30
	Bar, rod, wire		S	-	Up to 1.000 incl.	54	20	30
					Over 1.000-2.000 incl.	52	20	30
					Over 2.000	50	20	30
			1/2H or LA	-	Up to 0.500 incl.	60	27	22
					Over 0.500-1.000 incl.	60	27	25
					Over 1.000-2.000 incl.	58	26	25
					Over 2.000-3.000 incl.	54	25	25
					Over 3.000-4.000 incl.	54	22	27
					Over 4.000	54	22	30
			H	-	Up to 1.000 incl.	67	45	13
					Over 1.000-2.000 incl.	62	37	18
					Over 2.000-3.000 incl.	54	25	27
					Over 3.000	54	22	30

TABLE XXI (Contd.)

464,465,466,467 (Contd.)

MECHANICAL PROPERTIES (Cont.)								
Specification No.	Form	Alloy No. or Comp.	Temper	Size (in.) Width	Size (in.) Thickness	UTS ksi	TYS ksi	EL %
QQ-B-637 (Cont.)	Strip, (flat) wire		S	-	All	52	20	30
			1/2H	-	All	60	35	20
			H	-	All	65	50	10
	Forgings		-	- (up to 4 lbs)		52	22	30
				(over 4 lbs)		50	20	30
	Shapes		S	-	All	52	20	30
			E and D	-	All	58	25	20
QQ-B-639	Bar, plate		S	Up to 30 incl.	Up to 0.375 incl.	52	20	30
				Over 30	Up to 0.375 incl.	50	20	35
				All	Over 0.375	50	20	35
			1/2H	Up to 30 incl.	Up to 0.375 incl.	60	35	20
				Over 30	Up to 0.375 incl.	57	28	30
				All	Over 0.375	54	25	30
	Sheet, strip		S	All	All	52	20	30
			1/2H	All	All	60	35	20
			H	All	All	65	50	10

Notes:
a. Tensile Yield Strength 0.2% offset.

482

CHEMICAL COMPOSITION						
Spec. No.	Cu	Pb	Fe	Sn	Zn	Total other elements
QQ-B-637A	59.0 - 62.0	0.4 - 1.0	0.10	0.5 - 1.0	Rem.	0.10
QQ-B-639A	59.0 - 62.0	0.4 - 1.0	0.10	0.50 - 1.0	Rem.	0.10

MECHANICAL PROPERTIES								
Specification No.	Form	Alloy No. or Comp.	Temper	Size (in.) Width	Size (in.) Thickness	UTS ksi	TYS ksi	EL %
QQ-B-637	Bar, Rod shapes		AE	-	All	52	20	25
	Bar, rod wire		S	-	Up to 1.000 incl.	54	20	25
					Over 1.000-2.000 incl.	52	20	25
					Over 2.000	50	20	25
			1/2H or LA	-	Up to 1.000 incl.	60	27	18
					Over 1.000-2.000 incl.	58	26	20
					Over 2.000-3.000 incl.	54	25	20
					Over 3.000-4.000 incl.	54	22	20
					Over 4.000	54	22	25
			H	-	Up to 1.000 incl.	67	45	11
					Over 1.000-2.000 incl.	62	37	15
	Shapes		S	-	All	52	20	25
			E and D	-	All	58	25	15

TABLE XXI (Contd.)

482 (Contd.)

MECHANICAL PROPERTIES (Cont.)								
Specification No.	Form	Alloy No. or Comp.	Temper	Size (in.) Width	Thickness	UTS ksi	TYS ksi	EL %
QQ-B-637 (Cont.)	Forgings		-	(Up to 4 lbs. incl.)		52	22	25
QQ-B-639	Bar, plate		S	Up to 30 incl.	Up to 0.375 incl.	52	20	30
				Over 30	Up to 0.375 incl.	50	20	35
				All	Over 0.375 incl.	50	20	35
			1/2H -	Up to 30 incl.	Up to 0.375 incl.	60	35	20
				Over 30	Up to 0.375 incl.	57	28	30
				All	Over 0.375	54	25	30

485

CHEMICAL COMPOSITION						
Spec. No.	Cu	Pb	Fe	Sn	Zn	Total other elements
QQ-B-637A	59.0 - 62.0	1.3 - 2.2	0.10	0.5 - 1.0	Rem.	0.10
QQ-B-639A	59.0 - 62.0	1.3 - 2.2	0.10	0.5 - 1.0	Rem.	0.10

MECHANICAL PROPERTIES								
Specification No.	Form.	Alloy No. or Comp.	Temper	Size (in.) Width	Thickness	UTS ksi	TYS ksi	EL %
QQ-B-637	Bar, rod, shapes	3	AE	-	All	52	20	20
	Bar, rod, wire	3	S	-	Up to 1.000 incl.	54	20	20
					Over 1.000-2.000 incl.	52	20	20
					Over 2.000	50	20	20
			1/2H or LA	-	Up to 1.000 incl.	60	27	12
					Over 1.000-2.000 incl.	58	26	20
					Over 2.000-3.000 incl.	54	25	20
					Over 3.000-4.000 incl.	54	22	20
					Over 4.000	54	22	20
			H	-	Up to 1.000 incl.	67	45	10
					Over 1.000-2.000 incl.	62	37	13
	Shapes	3	S	-	All	52	20	20
			E and D	-	All	58	25	15
	Forgings	3	-	(Up to 4 lbs. incl.)		52	22	20
QQ-B-639	Plate, bar	3	S	Up to 30 incl.	Up to 0.375 incl.	52	20	30
				Over 30	Up to 0.375 incl.	50	20	35
				All	Over 0.375	50	20	35
			1/2H	Up to 30 incl.	Up to 0.375 incl.	60	35	20
				Over 30	Up to 0.375 incl.	57	28	30
				All	Over 0.375	54	25	30
	Sheet,	3	S	All	All	52	20	30
			1/2H	All	All	60	35	20
			H	All	All	65	50	10

TABLE XXI (Contd.)

510

CHEMICAL COMPOSITION						
Spec. No.	Cu	Pb	Fe	Sn	Zn	P
QQ-B-750(2)	99.5[a]	0.05	0.10	3.5 - 5.8	0.30	0.03 - 0.35
QQ-W-321D	99.5[a]	0.05	0.10	4.2 - 5.8	0.30	0.03 - 0.35
MIL-T-3595	99.5[a]	0.05	0.10	3.5 - 5.8	0.30	0.03 - 0.35

MECHANICAL PROPERTIES								
Specification No.	Form	Alloy No. or Comp.	Temper	Size (in.) Width	Size (in.) Thickness	UTS ksi	TYS ksi	EL %
QQ-B-750	Rod (round)	A	S	All	Less than 1/4	40-58	-	-
	Rod (round)	A	H	All	Less than 1/4	80-128	-	-
	Rod (round, hexagon)	A	H	All	1/4-1/2 incl.	70	-	13
					Over 1/2-1 incl.	60	-	15
					Over 1-3 incl.	55	-	18
					Over 3	50	-	18
	Bar (squares, rect.)	A	H	All	Up to 3/8 incl.	60	-	10
					Over 3/8	55	-	15
	Rod (round)	A	Spr.	All	Under 0.026	125	-	-
					0.026-1/16 incl.	115	-	-
					Over 1/16-1/8 incl.	110	-	-
					Over 1/8-1/4 incl.	105	-	3.5
					Over 1/4-3/8 incl.	100	-	5.0
					Over 3/8-1/2 incl.	90	-	9.0
	Plate, sheet, strip, wire (flat)	A	S	All	-	40-55	-	-
			1/2H	All	-	55-70	-	-
			H	All	-	72-87	-	-
			XH	All	-	84-99	-	-
			Spr	All	-	91-105	-	-
			XSpr	All	-	96-109	-	-
QQ-W-321	Wire Round	-	-	All	Up to 0.025 incl.	145	-	-
					Over 0.025-0.0625 incl.	135	-	-
					Over 0.0625-0.125 incl.	130	-	-
					Over 0.125-0.250 incl.	125	-	-
					Over 0.250-0.375 incl.	120	-	5.0
					Over 0.375-0.500 incl.	105	-	9.0
MIL-T-3595	Tube	-	1/4H	All	-	55-70	-	-

Notes:
a. Cu + Sn + P min.

TABLE XXI (Contd.)

524

CHEMICAL COMPOSITION						
Spec. No.	Cu	Pb	Fe	Sn	Zn	P
QQ-B-750(2)	99.5[a]	0.05	0.10	9.0 - 11.0	0.20	0.03 - 0.35

MECHANICAL PROPERTIES								
Specification No.	Form	Alloy No. or Comp.	Temper	Size (in.) Width	Size (in.) Thickness	UTS ksi	TYS ksi	EL %
QQ-B-750	Rod (round)	D	S	All	Under 1/4	60-75	-	-
			H	All	Under 1/4	105-160	-	-
	Rod (round, hexagon)	D	H	All	1/4-1/2 incl.	95	-	10
					Over 1/2-1 incl.	85	-	12
					Over 1	70	-	15
	Bar (square, rect.)	D	H	All	Up to 3/8 incl.	76	-	10
					Over 3/8	70	-	15
	Plate, sheet, strip wire (flat)	D	S	All	-	58-73	-	-
			1/2H	All	-	76-91	-	-
			H	All	-	94-109	-	-
			XH	All	-	107-122	-	-
			Spr.	All	-	115-129	-	-
			XSpr	All	-	120-133	-	-

Notes:
a. Cu + Sn + P min.

544

CHEMICAL COMPOSITION								
Spec. No.	Cu	Sn	P	Zn	Pb	Fe	Cu + Sn + P + Pb + Zn	Total other elements
QQ-B-750(2)	Rem.	3.5 - 4.5	0.01 - 0.5	1.5 - 4.5	3.5 - 4.5	0.10	99.5	-
MIL-B-13501	Rem.	3.5 - 4.5	-	1.5 - 4.0	3.5 - 4.5	0.10	-	0.2

MECHANICAL PROPERTIES									
Specification No.	Form	Alloy No. or Comp.	Temper	Size (in.) Width	Size (in.) Thickness	UTS ksi	TYS ksi	EL %	Hardness
QQ-B-750	Rod (round, hexagonal)	B	H	All	1/4-1/2 incl.	60	-	10	-
					Over 1/2-1 incl.	55	-	12	-
					Over 1	50	-	15	-
	Bar (square, rect.)	B	H	All	1/4-3/8 incl.	55	-	10	-
					Over 3/8	50	-	15	-
MIL-B-13501	Bearings Bushings	B	-	All	All	-	-	-	As specified

TABLE XXI (Contd.)

606

CHEMICAL COMPOSITION				
Spec. No.	Cu	Fe	Al	Sum of named elements
QQ-C-450	92.0 - 96.0	0.50	4.0 - 7.0	99.5 min.
QQ-C-465	92.0 - 96.0	0.50	4.0 - 7.0	99.5 min.

MECHANICAL PROPERTIES								
Specification No.	Form	Alloy No. or Comp.	Temper	Size (in.) Width	Size (in.) Thickness	UTS ksi	TYS ksi	EL %
QQ-C-450	Plate, bar, sheet, strip		H	Up to 30 incl.	Up to 0.0625 incl.	60	24	8
				Up to 30 incl.	0.0625-0.50 incl.	60	24	25
				Over 30	Up to 0.0625 incl.	55	22	8
				Over 30	Up to 0.50 incl.	55	22	25
				All	Over 0.050	50	20	30
			S	All	All	45	17	40
QQ-C-465	Rod		StR	-	Up to 0.5 incl.	80	40	30
					Over 0.5-1.0 incl.	75	35	30
					Over 1.0-2.0 incl.	70	32	30
					Over 2.0-3.0 incl.	70	30	30
	Wire (flat), strip		H	-	-	60	24	25 [a]
			A	-	-	45	17	40

Note:

a. For thicknesses less than 1/16 in., a minimum elongation of 8 percent in 2 inches will be permitted.

612

CHEMICAL COMPOSITION				
Spec. No.	Cu	Fe	Al	Sum of named elements
QQ-C-450	90.0 - 93.0	0.50	7.0 - 9.0	99.5 min.

MECHANICAL PROPERTIES								
Specification No.	Form	Alloy No. or Comp.	Temper	Size (in.) Width	Size (in.) Thickness	UTS ksi	TYS ksi	EL %
QQ-C-450	Plate, bar, sheet, strip		H	Up to 30 incl.	Up to 0.0625 incl.	65	27	8
				Up to 30 incl.	0.0625-0.50 incl.	65	27	20
				Over 30	Up to 0.0625 incl.	60	25	8
				Over 30	Up to 0.50 incl.	60	25	20
				All	Over 0.50	55	22	25
			S	All	All	50	20	30

TABLE XXI (Contd.)

613

CHEMICAL COMPOSITION					
Spec. No.	Cu	Al	Fe	Sn	Cu plus sum of named elements
QQ-C-450	88.0 - 92.5	6.0 - 8.0	3.5	0.20 - 0.50	99.5

MECHANICAL PROPERTIES								
Specification No.	Form	Alloy No. or Comp.	Temper	Size (in.) Width	Size (in.) Thickness	UTS ksi	TYS ksi	EL %
QQ-C-450	Plate, bar, sheet, strip		Hard	All	Up to 0.125 incl.	85	55	30
					Over 0.125-0.3125 incl.	80	50	30
					Over 0.3125-0.50 incl.	75	45	35
					Over 0.50-1.0 incl.	70	40	35
					Over 1.0	70	40	30
			Soft	All	Up to 0.50 incl.	72	32	30
					Over 0.50-2.0 incl.	70	30	35
					Over 2.0-5.0 incl.	65	28	35

614

CHEMICAL COMPOSITION					
Spec. No.	Cu	Fe	Al	Mn	Sum of named elements
QQ-C-450	88.0 - 92.5	1.5 - 3.5	6.0 - 8.0	1.0	99.5 min.
QQ-C-465	88.0 - 92.5	1.5 - 3.5	6.0 - 8.0	-	99.5 min.

MECHANICAL PROPERTIES								
Specification No.	Form	Alloy No. or Comp.	Temper	Size (in.) Width	Size (in.) Thickness	UTS ksi	TYS ksi	EL %
QQ-C-450	Plate, bar, sheet, strip		H	All	Up to 0.125 incl.	85	55	30
					Over 0.125-0.3125 incl.	80	50	30
					Over 0.3125-0.50 incl.	75	45	35
					Over 0.50-1.0 incl.	70	40	35
					Over 1.0	70	40	30
			S	All	Up to 0.50 incl.	72	32	30
					Over 0.50-2.0 incl.	70	30	35
					Over 2.0-5.0 incl.	65	28	35
QQ-C-465	Rod	5	St. R.	All	Up to 0.5 incl.	80	40	30
					Over 0.5-1.0 incl.	75	35	30
					Over 1.0-2.0 incl.	70	32	30
					Over 2.0-3.0 incl.	70	30	30
	Wire (flat) strip	5	H	All	Up to 0.125 incl.	85	55	30 [a]
					Over 0.125-0.188 incl.	80	50	30
			A	All	Up to 0.125 incl.	75	42	30
					Over 0.125-0.188 incl.	72	38	32

Note:

a. For thicknesses less than 1/16 inch, a minimum elongation of 8 percent in 2 inches will be permitted.

TABLE XXI (Contd.)

620

CHEMICAL COMPOSITION				
Spec. No.	Cu	Fe	Al	Total other elements
MIL-B-16166A(1)	Rem.	3.2 - 3.7	9.8 - 10.5	0.50

MECHANICAL PROPERTIES							
Specification No.	Form	Alloy No. or Comp.	UTS ksi	TYS ksi	EL %	RA %	Hardness RC
MIL-B-16166	Forgings	1	95	45	8	8	15

628

CHEMICAL COMPOSITION						
Spec. No.	Cu	Al	Fe	Mn	Ni	Cu plus sum of named element
QQ-C-450	78.0 - 85.0	8.0 - 11.0	1.5 - 3.5	0.5 - 2.0	4.0 - 710	99.5

MECHANICAL PROPERTIES								
Specification No.	Form	Alloy No. or Comp.	Temper	Size (in.) Width	Thickness	UTS ksi	TYS ksi	EL %
QQ-C-450	Plate, bar, sheet, strip		Soft	All	Up to 2.0 incl. Over 2.0-3.5 incl. Over 3.5-5.0 incl.	90 85 80	36 33 30	10 10 10

TABLE XXI (Contd.)

630

CHEMICAL COMPOSITION

Spec. No.	Cu	Fe	Sn	Ni	Al	Mn	Si	Sum of named elements	Total other elements
QQ-C-465	78.0-85.0	2.0-4.0	0.20	4.0-5.5	9.0-11.0	1.5 max.	0.25 max.	99.5 min.	-
MIL-B-16166A(1)	Rem.	2.0-4.0	max.	4.0-5.5	9.0-11.0	1.5	-	-	0.35

MECHANICAL PROPERTIES

Specification No.	Form	Alloy No. or Comp.	Temper	Size (in.) Width	Size (in.) Thickness	UTS ksi	TYS ksi	EL %	RA %	Hardness BHN
QQ-C-465	Rod, bar		A	All	0.50-1.0 incl.	100	50	5	-	-
					Over 1.0-2.0 incl.	90	45	6	-	-
					Over 2.0-4.0 incl.	85	42.5	10	-	-
					Over 4.0	80	40.0	12	-	-
	Shapes		AE, A	All	-	85	42.5	10	-	-
	Forgings		A	All	-	85	42.5	10	-	-
MIL-B-16166	Forgings	2	-	-	-	105	55	10	10	202[a]

Notes:
a. 3000kg. load, 10mm ball, 30 sec.

642

CHEMICAL COMPOSITION

Spec. No.	Cu	Fe	Sn	Zn	Ni	Al	Mn	Si	Te	Sum of named elements
QQ-C-465	80.0-93.0	4.0 max.	0.60	1.0[a] max.	5.5[a]	6.5-11.0	1.5	2.2[a]	0.60	99.5 min.

MECHANICAL PROPERTIES

Specification No.	Form	Alloy No. or Comp.	Temper	Size (in.) Width	Size (in.) Thickness	UTS ksi	TYS ksi	EL %
QQ-C-465	Bar, rod	1	StR, A	All	Up to 0.50 incl.	80	40	15
					Over 0.50-1.0 incl.	75	37.5	15
					Over 1.0-3.0 incl.	72	35	20
			HR, FT, ET	All	Over 3	70	30	15
	Shapes	1	AE, A	All	-	70	30	15
	Forgings	1	A	All	-	70	-	15
			Properties "when specified"					
	Bar, rod	1	CR StR	All	Up to 0.50 incl.	85	45	15
					Over 0.50-1.0 incl.	85	44	15
					Over 1.0-2.0 incl.	78	42	20
					Over 2.0-3.0 incl.	75	37	30
					Over 3.0-4.0 incl.	70	30	15
					Over 4.0	70	25	15

Notes:
a. When Si and Ni are present, only one shall exceed 0.25%

TABLE XXI (Contd.)

647

CHEMICAL COMPOSITION							
Spec. No.	Cu	Si	Zn	Fe	Ni	Pb	Cu plus sum of named elements
QQ-C-591D(1)	Rem.	0.40 - 0.8	0.50	0.10	1.6 - 2.2	0.10	99.5

MECHANICAL PROPERTIES								
Specification No.	Form	Alloy No. or Comp.	Temper	Size (in.) Width	Size (in.) Thickness	UTS ksi	TYS ksi	EL %
QQ-C-591	Rod		CF	-	3/32-1/4 incl.	60	50	10
					Over 1/4-3/4 incl.	55	45	10
					Over 3/4-1-1/2 incl.	50	40	10
			H	-	Up to 1-1/2 incl.	90	80	8
					Over 1-1/2-2 incl.	80	70	8
	Bar (square)		H	-	1/8-1 incl.	90	80	8
					Over 1-1-1/2 incl.	80	70	8
	Bar (rect.)		H	Up to 2-1/2	Up to 1-1/2	80	70	8
	Sheet,		CF, lt. rolled	1/2-18	0.010-0.250	40	30	7
			CF, hvy. rolled	1/2-18	0.010-0.250	55	50	2
			H	1/2-18	0.010-0.250	80	65	3
	Wire (round, hexagonal, octagonal, square)		CF	-	Up to 0.125 incl.	70	60	4
					Over 0.125-0.375 incl.	60	50	10
					Over 0.375-0.750 incl.	50	40	14
			H	-	Up to 0.750 incl.	90	80	5
	Wire (rectangular)		CF	0.100-1.000 incl	0.020-0.100 incl.	50	40	4
			H	0.100-1.000 incl.	0.020-0.100 incl.	90	70	5

651

CHEMICAL COMPOSITION								
Spec. No.	Cu	Pb	Fe	Zn	Ni	Mn	Si	Sum of named elements
QQ-C-591D(1)	96.0 min.	0.05	0.8	1.5	0.6	0.7	0.8 - 2.0	99.5 min.

MECHANICAL PROPERTIES								
Specification No.	Form	Alloy No. or Comp.	Temper	Size (in.) Width	Size (in.) Thickness	UTS ksi	TYS ksi	EL %
QQ-C-591	Rod		S	All	-	40	12	30
			1/2H	All	Up to 2 incl.	55	20	12
			H	All	Up to 2 incl.	60	40	10
			XH	All	Up to 1/2 incl.	85	55	6
					Over 1/2-1 incl.	75	45	8
					Over 1-1-1/2 incl.	75	40	8

TABLE XXI (Contd.)

651 (Contd.)

MECHANICAL PROPERTIES (Cont.)								
Specification No.	Form	Alloy No. or Comp.	Temper	Size (in.) Width	Thickness	UTS ksi	TYS ksi	EL %
QQ-C-591 (Cont.)	Plate		S	All	All	40	12	30
	Sheet, strip, wire (flat), bar		S	All	All	40	12	30
			1/2H	All	All	47	20	12
			H	All	All	60	35	8
	Wire		S	All	All	40	12	30
			1/8H	All	Up to 7/8 incl.	50-65	20	20
			1/4H	All	Up to 7/8 incl.	60-75	42	12
			1/2H	All	Up to 5/8 incl.	70-85	50	10
			3/4H	All	Up to 1/2 incl.	80-95	55	7
			H	All	Up to 7/16 incl.	90-110	60	5
			Spr.	All	Up to 1/4 incl.	100	62	-

653

CHEMICAL COMPOSITION						
Spec. No.	Cu	Si	Fe	Ni	Pb	Cu plus sum of named elements
QQ-C-591D(1)	91.0 min.	2.0 - 3.0	0.8	0.6	0.05	99.5

MECHANICAL PROPERTIES								
Specification No.	Form	Alloy No. or Comp.	Temper	Size (in.) Width	Thickness	UTS ksi	TYS ksi	EL %
QQ-C-591	Plate		S	All	All	50	15	35
	Sheet, strip, wire (flat), bar		S	All	All	50	15	35
			1/2H	All	All	70	40	10
			H	All	All	80	60	5
	Forgings		-	-	-	50	15	30
	Shapes		S	All	All	45[a]	11[a]	35[a]

Notes:

a. When specified; otherwise negotiated.

TABLE XXI (Contd.)

655

CHEMICAL COMPOSITION								
Spec. No.	Cu	Pb	Fe	Zn	Ni	Mn	Si	Sum of named elements
QQ-C-591D(11)	94.8 min.	0.05	0.8	1.5	0.6	1.5	2.8 - 3.8	99.5 min.

MECHANICAL PROPERTIES								
Specification No.	Form	Alloy No. or Comp.	Temper	Size (in.) Width	Size (in.) Thickness	UTS ksi	TYS ksi	EL %
QQ-C-591	Rod		S	-	-	52	15	35
			1/2H	-	Up to 2 incl.	70	38	17
			H	-	Up to 1/4 incl.	90	55	8
					Over 1/4-1 incl.	90	52	15
					Over 1-1-1/2 incl.	80	45	20
					Over 1-1/2-3 incl.	70	38	20
	Plate		S	All	All	50	15	35
	Sheet, strip, wire, (flat) bar		S	All	All	50	15	35
			1/2H	All	All	70	40	10
			H	All	All	80	60	5
	Forgings		S	All	All	50	15	30
	Shapes		S	All	All	45[a]	11[a]	35[a]

Note:

a: When specified; otherwise negotiated.

661

CHEMICAL COMPOSITION						
Spec. No.	Cu	Pn	Fe	Mn	Si	Sum of named elements
QQ-C-591D(1)	94.0 min.	0.2 - 0.8	0.25	1.5	2.8 - 3.5	99.5

MECHANICAL PROPERTIES								
Specification No.	Form	Alloy No. or Comp.	Temper	Size (in.) Width	Size (in.) Thickness	UTS ksi	TYS ksi	EL %
QQ-C-591	Rod	661	S	All	All	52	15	35
			1/2H	All	Up to 2 incl.	70	38	17
			H	All	Up to 1/4 incl.	90	55	8
					Over 1/4-1 incl.	90	52	15
					Over 1-1-1/2 incl.	80	45	20
					Over 1-1/2-3 incl.	70	38	20

TABLE XXI (Contd.)

670

CHEMICAL COMPOSITION

Spec. No.	Cu	Pb	Fe	Sn	Zn	Al	Mn	Total other elements
QQ-B-728	63.0 - 68.0	0.20	2.0 - 4.0	0.50	Rem.	3.0 - 6.0	2.5 - 5.0	0.10

MECHANICAL PROPERTIES

Specification No.	Form	Alloy No. or Comp.	Temper	Size (in.) Width	Size (in.) Thickness	UTS ksi	TYS ksi	EL(%) Finished Cold	EL(%) Finished Hot
QQ-B-728	Bar, rod	B	S	All	All	85	45	10	20
			1/2H	All	All	105	60	7	12
	Rod	B	H	All	All	115	68	5	10
	Forgings	B	S	All	-	85	45	10	20
			1/2H	All	-	93	50	7	15
			H	All	-	100	55	5	15

675

CHEMICAL COMPOSITION

Spec. No.	Cu	Pb	Fe	Sn	Zn	Al	Mn	Total other elements
QQ-B-728	57.0 - 60.0	0.20	0.8 - 2.0	0.5 - 1.5	Rem.	0.25	0.05 - 0.5	0.10

MECHANICAL PROPERTIES

Specification No.	Form	Alloy No. or Comp.	Temper	Size (in.) Width	Size (in.) Thickness	UTS ksi	TYS ksi	EL %
QQ-B-728	Bar, rod	A	S	-	All	55	22	20
			1/2H	-	Up to 1.000 incl.	72	36	13
					Over 1.000-2.500 incl.	70	35	15
					Over 2.500	65	32	17
	Rod	A	H	-	Up to 1.000 incl.	80	56	8
					Over 1.000-1.500 incl.	76	52	10
					Over 1.500-2.500 incl.	73	48	12
					Over 2.500	68	45	16
	Shapes	A	S	-	All	55	22	20
	Forgings	A	S	-	-	60	25	15
	Plate, sheet, strip, wire (flat)	A	S	Up to 30 incl.	Up to 0.5 incl.	57	22	20
				Over 30	Up to 0.5 incl.	56	22	25
			1/2H	Up to 30 incl.	Up to 0.5 incl.	60	24	18
				Over 30	Up to 0.5 incl.	58	23	22
				All	Over 0.5	58	23	22

TABLE XXI (Contd.)

692

CHEMICAL COMPOSITION						
Spec. No.	Cu	Pb	Fe	Zn	Si	Total of named elements
QQ-C-591D(1)	89.0 - 91.0	0.05	0.05	Rem.	0.8 - 1.5	99.5 min.

MECHANICAL PROPERTIES								
Specification No.	Form	Alloy No. or Comp.	Temper	Size (in.) Width	Size (in.) Thickness	UTS ksi	TYS ksi	EL %
QQ-C-591	Rod		S	-	-	40	12	30
			1/2H	-	Up to 2 incl.	55	20	12
			H	-	Up to 2 incl.	60	40	10
			XH	-	Up to 1/2 incl.	85	55	6
					Over 1/2-1 incl.	75	45	8
					Over 1-1-1/2 incl.	75	40	8
	Plate		S	All	All	40	12	30
	Sheet, strip, bar, wire (flat)		S	All	All	40	12	30
			1/2H	All	All	47	20	12
			H	All	All	60	35	8
	Wire		S	-	All	40	12	30
			1/8H	-	Up to 7/8 incl.	50-65	20	20
			1/4H	-	Up to 7/8 incl.	60-75	42	12
			1/2H	-	Up to 5/8 incl.	70-85	50	10
			3/4H	-	Up to 1/2 incl.	80-95	55	7
			H	-	Up to 7/16 incl.	90-110	60	5
			Spr	-	Up to 1/4 incl.	100	62	-

735

CHEMICAL COMPOSITION							
Spec. No.	Cu	Pb	Fe	Zn	Ni	Mn	Total other elements
QQ-C-585A	70.5 - 73.5	0.10	0.25	Rem.	16.5 - 19.5	0.50	0.50

MECHANICAL PROPERTIES								
Specification No.	Form	Alloy No. or Comp.	Temper	Size (in.) Width	Size (in.) Thickness	UTS ksi	TYS ksi	EL %
QQ-C-585	Plate, sheet, strip, bar		1/4H	All	All	56-69	-	-
			1/2H	All	All	63-75	-	-
			H	All	All	73-84	-	-
			XH	All	All	79-90	-	-

TABLE XXI (Contd.)

745

CHEMICAL COMPOSITION							
Spec. No.	Cu	Pb	Fe	Zn	Ni	Mn	Total other elements
QQ-C-585A	63.5 - 68.5	0.10	0.25	Rem.	9.0 - 11.0	0.50	0.50
QQ-C-586B	63.5 - 66.5	0.05	0.25	Rem.	9.0 - 11.0	0.50	0.50
QQ-W-321D	63.5 - 66.5	0.05	0.05	Rem.	9.0 - 11.0	0.50	0.50

MECHANICAL PROPERTIES								
Specification No.	Form	Alloy No. or Comp.	Temper	Size (in.) Width	Thickness	UTS ksi	TYS ksi	EL %
QQ-C-585	Plate, sheet, strip, bar		1/4H	All	-	56-73	-	-
			1/2H	All	-	67-82	-	-
			H	All	-	80-94	-	-
			XH	All	-	89-102	-	-
			Spr	All	-	95-108	-	-
QQ-C-586	Rod (round)		1/4H	All	Over 0.02-0.050 incl.	75-95	-	-
	Rod, (round, hexagonal, octagonal)		H	All	Over 0.02-0.25 incl.	90-110	-	-
					Over 0.25-0.50 incl.	80-100	-	-
					Over 0.50-1.00 incl.	75-95	-	-
					Over 1.00	70-90	-	-
	Rod, (square, rect.)		H	All	All	75-95	-	-
QQ-W-321	Wire		1/4H	All	0.02-0.250 incl.	73-88	-	-
			1/2H	All	0.02-0.250 incl.	88-103	-	-
			H	All	0.02-0.250 incl.	108-123	-	-
			Spr [a]	All	0.02-0.0253 incl.	130 min.	-	-
					Over 0.0253-0.0625 incl.	125 min.	-	-
					Over 0.0625-0.125 incl.	120 min.	-	-
					Over 0.125-0.250 incl.	112 min.	-	-

Note:

a. Bend properties. Spring temper wire up to 0.250 inch shall withstand without cracking, being bent at room temperature through an angle of 120° around a radius equal to the diameter or distance between parallel faces of the wire.

752

CHEMICAL COMPOSITION							
Spec. No.	Cu	Pb	Fe	Zn	Ni	Mn	Total other elements
QQ-C-585A	63.0 - 66.5	0.10	0.25	Rem.	16.5 - 19.5	0.50	0.50
QQ-C-586B	63.0 - 66.5	0.05	0.25	Rem.	16.5 - 19.5	0.50	0.50
QQ-W-321D	63.0 - 66.5	0.10	0.25	Rem.	16.5 - 19.5	0.50	0.50

TABLE XXI (Contd.)

752 (Contd.)

MECHANICAL PROPERTIES								
Specification No.	Form	Alloy No. or Comp.	Temper	Size (in.) Width	Thickness	UTS ksi	TYS ksi	EL %
QQ-C-585	Plate, sheet, strip, bar		1/4H	All	-	58-72	-	-
			1/2H	All	-	66-80	-	-
			H	All	-	78-91	-	-
			XH	All	-	86-98	-	-
			Spr	All	-	90-101	-	-
QQ-C-586	Rod (round)		1/4H	All	Over 0.02-0.050 incl.	60-80	-	-
	Rod (round, hexagonal, octagonal)		H	All	Over 0.02-0.25 incl.	80-100	-	-
					Over 0.25-0.50 incl.	70-90	-	-
					Over 0.50-1.00 incl.	65-85		
					Over 1.00	60-80	-	-
	Bar (square, rect.)		H	All	All	68-88	-	-
	Strip, wire, (flat)		1/4H	All	All	58-72	-	-
			1/2H	All	All	66-80	-	-
			H	All	All	78-91	-	-
			Spr[a]	All	All	90-101	-	-
QQ-W-321	Wire		1/4H	All	0.02-0.250 incl.	68-84	-	-
			1/2H	All	0.02-0.250 incl.	83-97	-	-
			H	All	0.02-0.250 incl.	99-111	-	-

757

CHEMICAL COMPOSITION							
Spec. No.	Cu	Ni	Pb	Fe	Mn	Zn	Total other elements
QQ-W-321D	63.5 - 66.5	11.0 - 13.0	0.05	0.25	0.50	Rem.	0.50

MECHANICAL PROPERTIES								
Specification No.	Form	Alloy No. or Comp.	Temper	Size (in.) Width	Thickness	UTS ksi	TYS ksi	EL %
QQ-W-321	Wire		1/4H	All	0.02-0.250 incl.	73-88	-	-
			1/2H	All	0.02-0.250 incl.	88-103	-	-
			H	All	0.02-0.250 incl.	108-123	-	-
			Spr[a]	All	0.02-0.0253 incl.	130 min.	-	-
					Over 0.0253-0.0625 incl.	125 min.	-	-
					Over 0.0625-0.125 incl.	120 min.	-	-
					Over 0.125-0.250 incl.	112 min.	-	-

Note:

a. Bend properties. Spring temper wire up to 0.250 inch shall withstand without cracking, being bent at room temperature through an angle of 120° around a radius equal to the diameter or distance between parallel faces of the wire.

TABLE XXI (Contd.)

762

CHEMICAL COMPOSITION							
Spec. No.	Cu	Ni	Pb	Fe	Mn	Zn	Total other elements
QQ-C-585A	57.0 - 61.0	11.0 - 13.5	0.10	0.25	0.50	Rem.	0.10

MECHANICAL PROPERTIES								
Specification No.	Form	Alloy No. or Comp.	Temper	Size (in.) Width	Size (in.) Thickness	UTS ksi	TYS ksi	EL %
QQ-C-585	Plate, sheet, strip, bar		1/4H	All	All	65-81	-	-
			1/2H	All	All	75-91	-	-
			H	All	All	90-105	-	-
			XH	All	All	101-114	-	-
			Spr	All	All	109-122	-	-

764

CHEMICAL COMPOSITION							
Spec. No.	Cu	Pb	Fe	Zn	Ni	Mn	Total other elements
QQ-C-586B	58.5 - 61.5	0.05	0.25	Rem.	16.5 - 19.5	0.50	0.50
QQ-W-321D	58.5 - 61.5	0.05	0.25	Rem.	16.5 - 19.5	0.50	0.50

MECHANICAL PROPERTIES								
Specification No.	Form	Alloy No. or Comp.	Temper	Size (in.) Width	Size (in.) Thickness	UTS ksi	TYS ksi	EL %
QQ-C-586	Rod (round)	3	1/4H	All	Over 0.02-0.05 incl.	75-95	-	-
	Rod (round, hexagonal, octagonal)	3	H	All	Over 0.02-0.25 incl.	90-110	-	-
					Over 0.25-0.50 incl.	80-100	-	-
					Over 0.50-1.00 incl.	75-95	-	-
					Over 1.00	70-90	-	-
	Bar (square, rect.)	3	H	All	All sizes	75-95	-	-
QQ-W-321	Wire		1/4H	All	0.02-0.250 incl.	74-93	-	-
			1/2H	All	0.02-0.250 incl.	92-110	-	-
			H	All	0.02-0.250 incl.	112-128	-	-
			Spr[a]	All	0.02-0.0253 incl.	130	-	-
					Over 0.0253-0.0625 incl.	125	-	-
					Over 0.0625-0.1250 incl.	120	-	-

Note:

a. Bend properties. Spring temper wire up to 0.250 inch shall withstand without cracking, being bent at room temperature through an angle of 120° around a radius equal to the diameter or distance between parallel faces of the wire.

TABLE XXI (Contd.)

766

CHEMICAL COMPOSITION							
Spec. No.	Cu	Pb	Fe	Zn	Ni	Mn	Total other elements
QQ-C-585A	55.0 - 58.0	0.10	0.25	Rem.	11.0 - 13.5	0.50	0.50

MECHANICAL PROPERTIES								
Specification No.	Form	Alloy No. or Comp.	Temper	Size (in.) Width	Size (in.) Thickness	UTS ksi	TYS ksi	EL %
QQ-C-585	Plate, sheet, strip, bar		1/4H	All	All	65-81	-	-
			1/2H	All	All	75-91	-	-
			H	All	All	90-105	-	-
			XH	All	All	101-114	-	-
			Sp	All	All	109-122	-	-

770

CHEMICAL COMPOSITION							
Spec. No.	Cu	Pb	Fe	Zn	Ni	Mn	Total other elements
QQ-C-585A	53.5 - 56.5	0.10	0.25	Rem.	16.5 - 19.5	0.50	0.50
QQ-C-586B	53.5 - 56.5	0.05	0.25	Rem.	16.5 - 19.5	0.50	0.50
QQ-W-321D	53.5 - 56.5	0.10	0.25	Rem.	16.5 - 19.5	0.50	0.50

MECHANICAL PROPERTIES								
Specification No.	Form	Alloy No. or Comp.	Temper	Size (in.) Width	Size (in.) Thickness	UTS ksi	TYS ksi	EL %
QQ-C-585	Plate, sheet, strip, bar	770	1/4H	-	-	69-87	-	-
			1/2H	-	-	78-95	-	-
			H	-	-	92-107	-	-
			XH	-	-	102-115	-	-
			Spr	-	-	108-120	-	-
QQ-C-586	Rod (round)	2	1/4H	-	Over 0.02-0.05 incl.	75-95	-	-
	Rod (round, hexagonal, octagonal)	2	H	-	Over 0.02-0.25 incl.	90-110	-	-
					Over 0.25-0.50 incl.	80-100	-	-
					Over 0.50-1.00 incl.	75-95	-	-
					Over 1.00	70-90	-	-
	Bar (square, rect.)	2	H	All	All	75-95	-	-
	Flat wire, strip	2	1/4	All	All	69-87	-	-
			1/2	All	All	78-95	-	-
			H	All	All	92-107	-	-
			Spr	All	All	108-120	-	-
QQ-W-321	Wire		1/4H	-	0.02-0.250 incl.	74-93	-	-
			1/2H	-	0.02-0.250 incl.	92-110	-	-
			H	-	0.02-0.250 incl.	112-128	-	-
			Spr [a]	-	0.02-0.0253 incl.	130	-	-
			Spr	-	0.0253-0.0625 incl.	125	-	-
			Spr	-	0.0625-0.250 incl.	120	-	-

Note: a. Bend properties. Spring temper wire up to 0.250 inch shall withstand without cracking, being bent at room temperature through an angle of 120° around a radius equal to the diameter or distance between parallel faces of the wire.

TABLE XXI (Contd.)

792

CHEMICAL COMPOSITION							
Spec. No.	Cu	Ni	Pb	Fe	Mn	Zn	Total other elements
QQ-C-586B	59.0 - 66.5	11.0 - 13.0	0.8 - 1.4	0.25	0.50	Rem.	0.50

MECHANICAL PROPERTIES								
Specification No.	Form	Alloy No. or Comp.	Temper	Size (in.) Width	Thickness	UTS ksi	TYS ksi	EL %
QQ-C-586	Rod (round)		1/4H	-	Over 0.02-0.050 incl.	60-80	-	-
	Rod (round, hexagonal, octagonal)		H	-	Over 0.02-0.25 incl.	80-100	-	-
					Over 0.25-0.50 incl.	70-90	-	-
					Over 0.50-1.00 incl.	65-85	-	-
					Over 1.00	60-80	-	-
	Bar (square, rect.)		H	-	All	68-88	-	-

794

CHEMICAL COMPOSITION							
Spec. No.	Cu	Ni	Pb	Fe	Mn	Zn	Total other elements
QQ-C-586B	59.0 - 66.5	16.5 - 19.5	0.8 - 1.2	0.25	0.50	Rem.	0.50
QQ-W-321D	59.0 - 66.5	16.5 - 19.5	0.8 - 1.2	0.25	0.50	Rem.	0.50

MECHANICAL PROPERTIES								
Specification No.	Form	Alloy No. or Comp.	Temper	Size (in.) Width	Thickness	UTS ksi	TYS ksi	EL %
QQ-C-586	Rod (round)	4	1/4H	-	Over 0.02-0.050 incl.	60-80	-	-
	Rod (round, hexagonal, octagonal)	4	H	-	Over 0.02-0.25 incl.	80-100	-	-
					Over 0.25-0.50 incl.	70-90	-	-
					Over 0.50-1.00 incl.	65-85	-	-
					Over 1.00	60-80	-	-
	Bar (square, rect.)	4	H	-	All	68-88	-	-
QQ-W-321	Wire	794	1/2H	All	0.02-0.250 incl.	75-95	-	-

TABLE XXI (Contd.)

COMPOSITION 11 (No CDA Number)

CHEMICAL COMPOSITION

Spec. No.	Cu	Pb	Ni	Zn	Sn	Fe	Total other elements
QQ-B-613C	58.5 - 71.5	3.7	1.0	Rem.	-	0.50	0.50
QQ-B-626C	58.5 - 71.5	3.7	1.0	Rem.	1.50	0.50	0.50

MECHANICAL PROPERTIES

Specification No.	Form	Alloy No. or Comp.	Temper	Size (in.) Width	Size (in.) Thickness	UTS ksi	TYS ksi	EL %	Hardness RF	Hardness RB
QQ-B-613[a]	Plate, bar, sheet, strip	11	SA	-	Over 0.020	-	-	-	54-75	-
			LA	-	Over 0.020	-	-	-	67-87	-
			1/4H	-	Over 0.020	-	-	-	-	40-65
			1/2H	-	Over 0.020	-	-	-	-	57-77
			H	-	Over 0.020	-	-	-	-	76-86
			XH	-	Over 0.020	-	-	-	-	83-91
			Spr	-	Over 0.020	-	-	-	-	87-93
QQ-B-626	Rod (round)	11	1/2H	-	All	-	-	-	-	60-90

TABLE XXII. APPLICATIONS - WROUGHT ALLOYS (CDA)

Number	Nominal Composition %	Fabricating Characteristics and Typical Applications
101	99.99 Cu	Excellent hot and cold workability; good forgeability. Fabricated by *coining, coppersmithing, drawing and upsetting,* hot forging and pressing, spinning, swaging, stamping. Uses: busbars, bus conductors, waveguides, hollow conductors, lead-in wires and anodes for vacuum tubes, vacuum seals, transistor components, glass to metal seals, coaxial cables and coxial tubes, klystrons, microwave tubes, automotive rectifiers.
102	99.95 Cu	Fabricating characteristics same as Copper No. 101. Uses: busbars, waveguides.
104, 105, 107	99.95 Cu(a)	Fabricating characteristics same as Copper No. 101. Uses: auto gaskets, radiators, busbars, conductivity wire, contacts, radio parts, windings, switches, terminals, commutator segments; chemical process equipment, printing rolls, clad metals, printed circuit foil.
109	99.99 Cu, 0.010 B	Fabricating characteristics same as Copper No. 101. Uses: busbars, bus conductors, communications cable shielding, electronic devices, waveguides, vacuum and conventional switchgear, microwave components, heat sinks, copper to glass sealing, pinch off tubes, clad metal.
110	99.90 Cu, 0.04 O	Fabricating characteristics same as Copper No. 101. Uses: down-spouts, gutters, roofing, gaskets, auto radiators, busbars, nails, printing rolls, rivets, radio parts.
111	99.90 Cu, 0.04 O, 0.01 Cd	Fabricating characteristics same as Copper No. 101. Uses: electrical *power transmission where resistance* to softening under overloads is desired.
113, 114, 115, 116	99.90 Cu, 0.04 O, Ag(b)	Fabricating characteristics same as Copper No. 101. Uses: gaskets, radiators, busbars, windings, switches, chemical process equipment, clad metals, printed circuit foil.
119, 120, 121	99.9 Cu(g)	*Fabricating characteristics same as Copper No.* 101. Uses: busbars, electrical conductors, tubular bus, and applications requiring welding or brazing.
122	99.90 Cu, 0.02 P	Fabricating characteristics same as Copper No. 101. Uses: gas and heater lines; oil burner tubing; plumbing pipe and tubing; condenser, evaporator and heat exchanger, dairy and distiller tubing, steam and water lines, air, gasoline and hydraulic lines.
125, 127, 128, 129, 130	99.88 Cu(d)	Fabricating characteristics same as Copper No. 101. Uses: same as Copper No. 101.
142	99.4 Cu, 0.3 As, 0.02 P	Fabricating characteristics same as Copper No. 101. Uses: Plates for locomotive fireboxes, staybolts, heat exchanger and condenser tubes.
145	99.5 Cu, 0.50 Te, 0.008 P	Fabricating characteristics same as Copper No. 101. Uses: forgings and screw machine products and parts requiring high conductivity, extensive *machining, corrosion resistance,* copper color, or a combination of these; electrical connectors, motor and switch parts, plumbing fittings, soldering coppers, welding torch tips, transistor bases and furnace brazed articles.

TABLE XXII (Contd.)

Number	Nominal Composition %	Fabricating Characteristics and Typical Applications
147	99.6 Cu, 0.40 S	Fabricating characteristics same as Copper No. 101. Uses: screw machine products and parts requiring high conductivity, extensive machining, corrosion resistance, copper color, or a combination of these; electrical connectors, motor and switch components, plumbing fittings, cold headed and machined parts, cold forgings, furnace brazed articles, screws, soldering coppers, rivets and welding torch tips.
150	99.8 Cu, 0.15 Zr	Fabricating characteristics same as Copper No. 101. Uses: switches, high temperature circuit breakers; commutators, stud bases for power transmitters, rectifiers, soldering-welding tips.
162	99.0 Cu, 1.0 Cd	Excellent cold workability; good hot formability. Uses: trolley wire, heating pad, electric-blanket elements, spring contacts, railbands, high-strength transmission lines, connectors, cable wrap, switch gear components and waveguide cavities.
165	98.6 Cu, 0.8 Cd, 0.6 Sn	Fabricating characteristics same as Copper Alloy No. 162. Uses: electrical springs and contacts, trolley wire, clips, flat cable, resistance welding electrodes.
172	99.5 Cu, 1.9 Be, 0.20 Co	Excellent hot workability. Commonly fabricated by blanking, drawing, forming and bending, turning, drilling, tapping. Uses: bellows, bourdon tubing, diaphragms, fuse clips, fasteners, lock washers, springs, switch parts, roll pins, valves, welding equipment.
182	99.5 Cu, 0.9 Cr	Good hot and cold workability. Uses: resistance-welding electrode tips and wheels, circuit breaker parts, cable connectors, parts for electronic devices.
187	99.0 Cu, 1.0 Pb	Good cold workability; poor hot formability. Uses: connectors, motor and switch parts, screw machine parts requiring high conductivity.
190	98.7 Cu, 1.1 Ni, 0.25 P	Fabricating characteristics same as Copper No. 101. Uses: springs, clips, electrical connectors, power tube and electron tube components, high-strength electrical conductors, bolts, nails, screws, cotter pins, and parts requiring some combination of high strength, high electrical or thermal conductivity, high resistance to fatigue and creep, and good workability.
194	97.5 Cu, 2.4 Fe, 0.13 Zn, 0.03 P	Fabricating characteristics same as Copper No. 101. Uses: circuit breaker components, contact springs, electrical clamps, electrical springs, electrical terminals, flexible hose, fuse clips, gaskets, gift hollow ware, plug contacts, rivets, and welded condenser tubes.
210	95.0 Cu, 5.0 Zn	Excellent cold workability, good hot workability for blanking, coining, drawing, piercing and punching, shearing, spinning, squeezing and swaging, stamping. Uses: coins, medals, bullet jackets, fuse caps, primers, plaques, jewelry base for gold plate.
220	90.0 Cu, 10.0 Zn	Fabricating characteristics same as Copper Alloy No. 210, plus heading and upsetting, roll threading and knurling, hot forging and pressing. Uses: etching bronze, grillwork, screen cloth, weatherstripping, lipstick cases, compacts, marine hardware, screws, rivets.
226	87.5 Cu, 12.5 Zn	Fabricating characteristics same as Copper Alloy No. 210, plus heading and upsetting, roll threading and knurling. Uses: angles, channels, chain, fasteners, costume jewelry, lipstick cases, compacts, base for gold plate.

TABLE XXII (Contd.)

Number	Nominal Composition %	Fabricating Characteristics and Typical Applications
230	85.0 Cu, 15.0 Zn	Fabricating characteristics same as Copper Alloy No. 226. Uses: weatherstripping, conduit, sockets, fasteners, fire extinguishers, condenser and heat exchanger tubing, plumbing pipe, radiator cores.
240	80.0 Cu, 20.0 Zn	Excellent cold workability. Fabricating characteristics same as Copper Alloy No. 226. Uses: battery caps, bellows, musical instruments, clock dials, pump lines, flexible hose.
260	70.0 Cu, 30.0 Zn	Excellent cold workability. Fabricating characteristics same as Copper Alloy No. 226, except for coining, roll threading, and knurling. Uses: radiator cores and tanks, flashlight shells, lamp fixtures, fasteners, locks, hinges, ammunition components, plumbing accessories, pins, rivets.
268, 270	65.0 Cu, 35.0 Zn	Excellent cold workability. Fabricating characteristics same as Copper Alloy No. 226. Uses: Same as Copper Alloy No. 260 except not used for ammunition.
280	60.0 Cu, 40.0 Zn	Excellent hot formability and forgeability for blanking, forming and bending, hot forging and pressing, hot heading and upsetting, shearing. Uses: architectural, large nuts and bolts, brazing rod, condenser plates, condenser, evaporator and heat exchanger tubing, hot forgings.
314	89.0 Cu, 1.75 Pb, 9.25 Zn	Excellent machinability. Uses: screws, machine parts, pickling crates.
316	89.0 Cu, 1.9 Pb, 1.0 Ni, 8.1 Zn	Good cold workability; poor hot formability. Uses: electrical connectors, fasteners, hardware, nuts, screws, screw machine parts.
330	66.0 Cu, 0.5 Pb, 33.5 Zn	Combines good machinability and excellent cold workability. Fabricated by forming and bending, machining, piercing and punching. Uses: pump and power cylinders and liners, ammunition primers, plumbing accessories.
332	66.0 Cu, 1.6 Pb, 32.4 Zn	Excellent machinability. Fabricated by piercing, punching and machining. Uses: general purpose screw machine parts.
335	65.0 Cu, 0.5 Pb, 34.5 Zn	Similar to Copper Alloy No. 332. Commonly fabricated by blanking, drawing, machining, piercing and punching, stamping. Uses: butts, hinges, watch backs.
340	65.0 Cu, 1.0 Pb, 34.0 Zn	Similar to Copper Alloy No. 335. Fabricated by blanking, heading and upsetting, machining, piercing and punching, roll threading and knurling, stamping. Uses: butts, gears, nuts, rivets, screws, dials, engravings, instrument plates.
342, 353	65.0 Cu, 2.0 Pb, 33.0 Zn	Fabricating characteristics same as Copper Alloy No. 340. Uses: clock plates and nuts, clock and watch backs, gears, wheels and channel plate.
350	62.5 Cu, 1.1 Pb, 36.4 Zn	Fair cold workability; poor hot formability. Uses: bearing cages, book dies, clock plates, engraving plates, gears, hinges, hose couplings, keys, lock parts, lock tumblers, meter parts, nuts, sink strainers, strike plates, templates, type characters, washers, wear plates.

TABLE XXII (Contd.)

Number	Nominal Composition %	Fabricating Characteristics and Typical Applications
356	63.0 Cu, 2.5 Pb, 34.5 Zn	Excellent machinability. Fabricated by blanking, machining, piercing and punching, stamping. Uses: same as Copper Alloy No. 342 and 353.
360	61.5 Cu, 3.0 Pb, 35.5 Zn	Excellent machinability. Fabricated by machining, roll threading and knurling. Uses: gears, pinions, automatic high speed screw machine parts.
365 to 368	60.0 Cu, 0.6 Pb, 39.4 Zn	Combines good machinability with excellent hot formability. Uses: condenser tube plates.
370	60.0 Cu, 1.0 Pb, 39.0 Zn	Fabricating characteristics similar to Copper Alloy No. 365 to 368. Uses: automatic screw machine parts.
377	59.0 Cu, 2.0 Pb, 39.0 Zn	Excellent hot workability. Fabricated by heading and upsetting, hot forging and pressing, hot heading and upsetting, machining. Uses: forgings and pressings of all kinds.
385	57.0 Cu, 3.0 Pb, 40.0 Zn	Excellent machinability and hot workability. Fabricated by hot forging and pressing, forming, bending and machining. Uses: architectural extrusions, store fronts, thresholds, trim, butts, hinges, lock bodies and forgings.
411	90.0 Cu, 0.5 Sn, 9.5 Zn	Excellent cold workability; good hot formability.
413	90.0 Cu, 1.0 Sn, 9.0 Zn	Excellent cold workability; good hot formability. Uses: plater bar for jewelry products, flat springs for electrical switchgear.
422	87.0 Cu, 1.0 Sn, 12.0 Zn	Excellent cold workability, fair hot formability.
425	88.5 Cu, 2.0 Sn, 0.20 P, 9.3 Zn	Excellent cold workability; good hot formability. Uses: electrical switches and springs, fuse and pen clips, weather stripping.
443, 444, 445	71.0 Cu, 28.0 Zn, 1.0 Sn	Excellent cold workability for forming and bending. Uses: condenser, evaporator and heat exchanger tubing, condenser tubing plates, distiller tubing, ferrules.
464 to 467	60.0 Cu, 39.25 Zn, 0.75 Sn	Excellent hot workability and hot forgeability. Fabricated by blanking, drawing, bending, heading and upsetting, hot forging, pressing. Uses: aircraft turnbuckle barrels, balls, bolts, marine hardware, nuts, propeller shafts, rivets, valve stems, condenser plates, welding rod.
485	60.0 Cu, 1.75 Pb, 37.5 Zn, 0.75 Sn	Combines excellent hot forgeability and machinability. Fabricated by hot forging and pressing, machining. Uses: marine hardware, screw machine parts, valve stems.
505	98.75 Cu, 1.25 Sn trace P	Excellent cold workability; good hot formability. Fabricated by blanking, bending, heading and upsetting, shearing and swaging. Uses: electrical contacts, flexible hose, pole-line hardware.

TABLE XXII (Contd.)

Number	Nominal Composition %	Fabricating Characteristics and Typical Applications
510	95.0 Cu, 5.0 Sn, trace P	Excellent cold workability. Fabricated by blanking, drawing, bending, heading and upsetting, roll threading and knurling, shearing, stamping. Uses: bellows, bourdon tubing, clutch discs, cotter pins, diaphragms, fasteners, lock washers, wire brushes, chemical hardware, textile machinery, welding rod.
521	92.0 Cu, 8.0 Sn, trace P	Good cold workability for blanking, drawing, forming and bending, shearing, stamping. Uses: generally for more severe service conditions than Copper Alloy No. 510.
524	90.0 Cu, 10.0 Sn, trace P	Good cold workability for blanking, forming and bending, shearing. Uses: heavy bars and plates for severe compression, bridge and expansion plates and fittings, articles requiring good spring qualities, resiliency, fatigue resistance, good wear and corrosion resistance.
544	88.0 Cu, 4.0 Pb, 4.0 Zn, 4.0 Sn	Excellent machinability; good cold workability. Fabricated by blanking, drawing, bending, machining, shearing, stamping. Uses: bearings, bushings, gears, pinions, shafts, thrust washers, valve parts.
608	95.0 Cu, 5.0 Al	Good cold workability; fair hot formability. Uses: condenser, evaporator and heat exchanger tubes, distiller tubes, ferrules.
614	91.0 Cu, 7.0 Al, 2.0 Fe	Fabricated by blanking, drawing, forming and bending, heading and roll threading. Uses: nuts, bolts, stringers and threaded members, corrosion resistant vessels and tanks, structural components, machine parts and members, condenser tubing and pipe, protective sheathing and fastening, mixing troughs and blending chambers.
638	99.5 Cu, 2.8 Al, 1.8 Si, 0.40 Co	Excellent cold workability and hot formability. Uses: springs, switch parts, contacts, relay springs, glass sealing and porcelain enameling.
651	98.5 Cu, 1.5 Si	Excellent hot and cold workability. Fabricated by forming and bending, heading and upsetting, hot forging and pressing, roll threading and knurling, squeezing and swaging. Uses: hydraulic pressure lines, anchor screws, bolts, cable clamps, cap screws, machine screws, machine hardware, nuts, pole-line hardware, rivets, U-bolts, electrical conduits, heat exchanger tubing, welding rod.
655	97.0 Cu, 3.0 Si	Excellent hot and cold workability. Fabricated by blanking, drawing, forming and bending, heading and upsetting, hot forging and pressing, roll threading and knurling, shearing, squeezing and swaging. Uses: similar to Copper Alloy No. 651 including propeller shafts.
675	58.5 Cu, 1.4 Fe, 39.0 Zn, 1.0 Sn, 0.1 Mn	Excellent hot workability. Fabricated by hot forging and pressing, hot heading and upsetting. Uses: clutch discs, pump rods, shafting, balls, valve stems and bodies.
687	77.5 Cu, 20.5 Zn, 2.0 Al, 0.1 As	Excellent cold workability for forming and bending. Uses: condenser, evaporator and heat exchanger tubing, condenser tubing plates, distiller tubing, ferrules.
706	88.7 Cu, 1.3 Fe, 10.0 Ni	Good hot and cold workability. Fabricated by forming and bending, welding. Uses: condensers, condenser plates, distiller tubing, evaporator and heat exchanger tubing, ferrules, salt water piping.

TABLE XXII (Contd.)

Number	Nominal Composition %	Fabricating Characteristics and Typical Applications
715	70.0 Cu, 30.0 Ni	Similar to Copper Alloy No. 706.
725	88.2 Cu, 9.5 Ni, 2.3 Si,	Excellent cold and hot formability; fabricated by blanking, bending, heading and upsetting, shearing, and swaging. Uses: relays, switches, and connectors.
745	65.0 Cu, 25.0 Zn, 10.0 Ni	Excellent cold workability. Fabricated by blanking, drawing, etching, forming and bending, heading and upsetting, roll threading and knurling, shearing, spinning, squeezing and swaging. Uses: rivets, screws, slide fasteners, optical parts, etching stock, hollow ware, nameplates, platers' bars.
752	65.0 Cu, 17.0 Zn, 18.0 Ni	Fabricating characteristics similar to Copper Alloy No. 745. Uses: rivets, screws, table flatware, truss wire, zippers, bows, camera parts, core bars, temples, base for silver plate, costume jewelry, etching stock, hollow ware, nameplates, radio dials.
754	65.0 Cu, 20.0 Zn, 15.0 Ni	Fabricating characteristics similar to Copper Alloy No. 745. Uses: camera parts, optical equipment, etching stock, jewelry.
757	65.0 Cu, 23.0 Zn, 12.0 Ni	Fabricating characteristics similar to Copper Alloy No. 745. Uses: slide fasteners, camera parts, optical parts, etching stock, nameplates.
770	55.0 Cu, 27.0 Zn, 18.0 Ni	Good cold workability. Fabricated by blanking, forming and bending, and shearing. Uses: optical goods, springs and resistance wire.

Notes:

a. Copper No. 104: 8 oz/ton Ag; No. 105, 10 oz /ton; No. 107, 25 oz/ton.

b. Copper No. 113: 8 oz/ton Ag; No. 114, 10 oz/ton; No. 115, 16 oz/ton, No. 116, 25 oz/ton.

c. Copper No. 119: 0.006 P; No. 120, 0.008 P; Copper No. 121, 0.008 P and 4 oz/ton Ag.

d. Copper No. 127: 8 oz/ton Ag; No. 128, 10 oz/ton; No. 129, 16 oz/ton; No. 130, 25 oz/ton.

Custodians:
Army-MR
Navy-AS
Air Force-84

Review Activities:
DSA-IS

Preparing Activity:
Army-MR

Project No. 9500-0026

☆U.S. GOVERNMENT PRINTING OFFICE:1972-714-910/419