NOTE: MIL-STD-438E has been redesignated as a Design Criteria Standard. The cover page has been changed for Administrative reasons. There are no other changes to this Document.

MIL-STD-438E(SH)
15 May 1973
SUPERSEDING
MIL-STD-438D(SHIPS)
30 OCTOBER 1969

DEPARTMENT OF DEFENSE
DESIGN CRITERIA STANDARD

SCHEDULE OF PIPING, VALVES, FITTINGS, & ASSOCIATED PIPING COMPONENTS FOR SUBMARINES SERVICE

AMSC N/A

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DEPARTMENT OF THE NAVY

NAVAL SHIP ENGINEERING CENTER

CENTER BUILDING

HYATTSVILLE, MARYLAND 20782

Schedule of Piping, Valves,
Fittings and Associated
Piping Components for
Submarine Service
MIL-STD-438E(SHIPS)

1. This Military standard is approved for use by all activities under the cognizance of the Naval Ship Systems Command and is published to establish the requirements for submarine piping system components, in order to preclude the necessity for including a piping schedule in each ship specification. This standard represents and includes the latest material requirements previously covered in the ship specifications. It is the intent to refer to this standard in Section 9480-0 in the ship specifications for all new submarines.

2. Recommended corrections, additions, or deletions should be addressed to the Commander, Naval Ship Engineering Center, Department of the Navy, Center Building, Prince George's Center, Hyattsville, Maryland 20782.

FOREWORD

1. This standard covers requirements for basic submarine piping system components. It is not the intension herein to include every conceivable component, valve or fitting that might be used in a submarine piping system. Special items or components not covered in this standard, should be a matter of approval by the cognizant Supervisor of Shipbuilding, Naval Shipyard, Naval Ship Systems Command or the Naval Ship Engineering Center.

2. This issue of MIL-STD-438(SHIPS) is bound so that any category and groups can be removed and replaced with revised issues of that category. It is the intention of the Naval Ship Engineering Center to make changes to individual categories and groups as required, rather than issue a complete revision of the standard. These changes will be issued as notices and will be numbered consecutively.

3. This standard includes a "List of categories" with the latest date of issue for each category. When a category is modified, the "List of categories" will also be modified and will be forwarded for insertion in the users copy of the standard.

4. All superseded categories and "List of categories" should be kept. In this manner, when users are applying the standard to applications which may predate any of the latest category issues, all of the applicable issues will be available.

INDEX

Since operating conditions may vary among different designs of ships, this index often refers to a category of materials only for each system. Within each category, selection shall be made of that group which can accommodate the specific operating conditions of pressure and temperature for the system under condideration. (Example: Where the category only is specified, such as "A", the proper group, that is A-1, A-2, etc. shall be selected according to the operating conditions.)

D (cont'd)	Applicable category and group
Distilling unit high pressure brine	C-1
Distilling unit for low pressure brine	C-2
Distilling unit, sea water supply	C-1
Distilling unit, steam drains	A or B-1
Distilling unit, steam supply	A
Drain collecting, fresh water	B-1
Drain collecting fresh water and gland seal	B-1
Drains, from distilling unit steam supply	A or B-1
Drains, steam	A or B
Drain and trim	C
E	
Electrolyte agitation for battery water	B-2
Electronic equipment and missile tube cooling, fresh water for	N
Engine room fresh water cooling	B-1
Exhaust diesel engine, inboard	G-1
Exhaust diesel engine, outboard	G-2
Exhaust ventilation and low pressure blow, inboard	H-1
Exhaust ventilation and low pressure blow, outboard	H-2
F	
Feed to distilling unit, sea water	C-1
Feed water	A
Filling transfer and purification, lubricating oil	D-2
Fresh (battery) water cooling	B-2
Fresh water cooling of electronic equipment and missile tubes	N
Fresh water drain collecting	B-1
Fresh water drain collecting (gland seal drains)	A or B-1
Fuel oil and compensating	C-1
Fuel oil service, diesel generator sets	D-2
Fuel oil service, filling and transfer	C-1 or C-2
G	
	Drawing
Gage piping	810-1385850
Gear, reduction vent piping	0
Gland seal supply and exhaust from main turbines	A
Gland seal supply and exhaust from turbo-generators	A
Gravity drains	B-1
H	
Heating and cooling system for missile tube	N
High pressure brine, distilling unit	C-1
Hydraulic control of clutch	D-1
Hydraulic service, inside pressure hull, 3000 psig	E-1
Hydraulic service, inside pressure hull, 700 psi (including return lines)	E-3
Hydraulic service, outside pressure hull, 3000 psig	E-2
Hydrogen	K-1
L	
Low pressure ballast unloading, inboard	H-1
Low pressure ballast unloading, outboard	H-2
Low pressure distilling unit brine	C-2
Lube oil heating storage tank steam	A
Lubricating oil filling, transfer and purification	D-2
Lubricating oil service to diesel engines	D-2
Lubricating oil service to electric propulsion motors	D-2
Lubricating oil service to propulsion shafts	D-2
Lubricating oil service to turbines	D-2

	Applicable category and group
M	
Main sea water cooling	C-1
Main steam	A
Main turbine gland seal and exhaust	A
Mechanical cooling, chilled water	B-1
Missile tube heating and cooling	N
N	
Nitrogen	F
O	
Oxygen	K
P	
Plumbing	C-1 and C-2
Potable water	B-1
Propulsion shaft lubricating oil service	D-2
R	
Reduction gear vent piping	O
Refrigerating plants (R-12)	J-1
Refrigerating plants (R-11 and R-114)	J-2
S	
Sea water	C
Sea water auxiliary cooling	C-1
Sea water cooling to batteries	C-1
Sea water cooling to diesel generator sets	C-1
Sea water, distilling unit feed	C-1
Sea water, main cooling	C-1
Sea water supply to distilling unit	C-2
Sea water systems not subjected to submergence depth	C-2
Sea water systems subjected to submergence depth	C-1
Shafts, propulsion, lubricating oil service	D-2
Steam drains	A
Steam, main	A
Steam for heating lube oil storage tank	A
Steam to auxiliaries	A
Steam to turbo-generators	A
Steam to distiller air ejectors	A
Steam to distilling unit	A
Suction, air ejector	B-1
T	
Trim and drain	C
Turbine lubricating oil service	D-2
Turbo-generator set gland seal supply and exhaust	A
Turbo-generator set steam	A
V	
Ventilation exhaust and low pressure blow, inboard	H-1
Ventilation exhaust and low pressure blow, outboard	H-2
Ventilation, reduction gear	O
W	
Water, battery, filling	B-2
Water, chilled, air conditioning and mechanical cooling	B-1
Water, feed	A
Water, fresh, diesel generator cooling	D-1
Water, fresh, for cooling electronic equipment and missile tubes	N
Water, potable	B-1
Water, sea	C

GENERAL NOTES

1. Gage piping requirements are specified on Drawing 810-1385850. If discrepancies exist with other specification requirements, clarification should be obtained from the command or agency concerned. Materials other than those specified are acceptable provided that they are entirely satisfactory in all respects and are approved by the command or agency concerned. The order of listing herein does not represent any order of preference.

2. Where American Society for Testing and Materials (ASTM) or other commercial specifications are used, the contractor shall furnish, upon specific request, affidavits certifying the chemical and physical properties of the materials purchased. The certification shall include the actual test, examination or other verifiable data.

3. Where valves, fittings, and flanges, are specified to commercial standards, the design and dimensions shall conform to the American National Standards Institute (ANSI) or other applicable industry standards. Unless otherwise specified herein, the pressure temperature rating tables of ANSI B16.5 shall be used to select ferrous valves, flanges and flanged fittings for the applicable service conditions. Butt welding or socket welding fittings shall be of a schedule or thickness compatible with the service conditions.

4. All valves for sea water service (except ball valves) shall have nickel-copper or nickel-copper aluminum alloy stems, seats, discs, disc nuts, hinge pins and side plugs, as applicable. Ball valves for sea water service shall have seats of plastic materials, balls of titanium alloy (6AL4V) and stems of copper or nickel alloy as approved, except that stems shall be nickel-copper-aluminum alloy with non-metallic bushings in those designs where the stem hole penetrates the ball waterway or where the waterway is angled (angle or three-way type). Materials for ball valves shown on NavShips mechanical standard drawings shall be as specified on the drawings. Nickel-copper-aluminum or nickel-copper-silicon may be used as an alternate for nickel-copper for seat and disc material to eliminate galling. Bronze valves for other than sea water service may have bronze stems, seats, discs, disc nuts, hinge pins and side plugs, as applicable.

5. For valves (except for valves on Navy mechanical standard drawings), fittings and flanges, contractor's designs previously approved for comparable installations may be substituted for those specified, subject to justification to and approval of the command or agency concerned. Extension of the applicability of previously granted waivers or approvals for reasons of shipbuilding or other expediency are not valid.

6. Butt welding end valves, fittings and flanges shall not be used for sizes smaller than 1/2 inch except upon specific approval by the command or agency concerned and are preferred in sizes 1 inch and larger. Socket welding end valves, fittings and flanges for P-1 piping may be used in sizes up to and including 2 inches. For welding end steel valves, fittings and flanges, the carbon content of the steel shall not exceed 0.35 percent. The use of short radius elbows is acceptable.

7. Steel valves (not covered by Military specifications) except instrument root valves in steam and feed systems normally operating at pressures of 150 pounds per square inch gage (psig) and above shall have seat and disc seating surfaces hard faced using material in accordance with type MIL-RCoCr-A of MIL-R-17131. Steel valves in steam and feed systems below 150 psig shall have either hard faced seat and disc seating surfaces as specified above or seats or discs hardened by heat treatment. Special normally open valves not used for throttling, such as solenoid trips, shall have seating surfaces suitable for the service application.

8. Pipe threaded connections between piping, machinery and valves and in piping system joints are not permitted except by specific approval in the following areas only:

(a) Connections to commercial equipment such as washing machines and drinking water coolers which are unessential to the ship under combat conditions and where failure would not create a hazard to the surrounding area or affect the operation of other vital equipment.
(b) Pipe plugs of a material compatible with the parent equipment in sizes 3/4 inch and below used for applications where pressures do not exceed 50 pounds per square inch (psi).
(c) Instrumentation, controls, vent, filling and drain connections for applications where pressures are 50 psi and below and where fluids handled are neither toxic nor dangerous nor could cause atmospheric contamination and which would not cause, in the event of failure, a major breakdown of the equipment nor create a hazard to the surrounding area nor affect the operation of other vital equipment.

9. Backing rings for butt welding connections shall comply with MIL-STD-22.

10. For steel components having flanged ends and for flanges which are specified to be in accordance with ANSI B16.5 the facing shall be of the raised face type, unless specifically indicated otherwise.

11. Bolting. Except as otherwise specified, bolting shall be as follows:

(a) Flanged joint bolt-stud threads shall be UNC2A fit and nut threads shall be UNC2B fit.
(b) Bolts and studs shall be in accordance with MIL-B-857. Bolts shall be type II or type III and studs shall be style a or b.
(c) Except as otherwise specified, nuts shall be in accordance with type III of MIL-B-857 and shall be style a or b.
(d) Nuts on flanged joint bolts or studs in all tanks and external to the pressure hull, where temperatures do not exceed 450°F, shall be of the plastic insert prevailing torque type in accordance with MS17828. (Polyamide 250°F maximum polyamide 450°F maximum.)
(e) Nuts on flanged joint bolts or studs in all tanks and external to the pressure hull where temperatures exceed 450°F shall be of the all metal prevailing torque type in accordance with MIL-N-25027.
(f) Hull integrity piping connections are defined as all flanged joints from the hull up to and including the inboard flange of the back-up valve. Included in this category are the bonnet joints of the hull and back-up valves and both line flanges and the bonnet joint of the first valve (such as blowput valves) in branch lines connected to piping between the hull and the back-up valve. Connections shall be as follows:
  (1) All bolted hull integrity piping connections as defined above, shall be fitted with nickel-copper-aluminum alloy bolting in accordance with MS18116 (see (g) and (h)). Where plastic insert type nuts are used the nuts may be of nickel-copper.
  (2) For services involving integrity of the hull against the sea as defined in 11(f) energy absorption shall be provided by making the mounting studs, and bolt-studs of essentially uniform strength throughout their length. This may be achieved by threading over the entire length, by reducing the unthreaded shank diameter to the pitch diameter when rolled threads are used, or reducing the unthreaded shank diameter when cut threads are used.
(g) Nickel-copper-aluminum alloy bolting shall be in accordance with MS18116 for bolts and studs. Nuts may be class B hot forged or cold drawn in accordance with QQ-N-281 or class A or B of QQ-N-286.
(h) Nickel-copper-alloy and nickel-copper-aluminum alloy bolting may only be used for service temperatures up to 800°F.
(i) Bolted connections located in the bilge or inaccessible for examination or routine replacement in service (except for hull integrity connections, and except for those services subjected to temperatures over 800°F) shall conform to the following:
  (1) Nickel-copper alloy shall be used with "soft" gaskets only. "Soft" gasket include sheet asbestos gaskets 1/8 inch thick or more, non-metallic "O" rings gaskets and sheet rubber gaskets. Nickel-copper alloy bolting shall be as follows:
    a. Bolts. Class A, hot rolled, in accordance with QQ-N-281.
    b. Nuts. Class B, hot rolled or cold drawn, nickel-copper in accordance with QQ-N-281.
  (2) Nickel-copper-aluminum alloy is required with "hard" gaskets, which include sheet asbestos gaskets less than 1/8 inch thick, metallic-asbestos spiral wound gaskets and other gaskets requiring comparable or higher compression for sealing (see (g)).

12. Where not specified in the tables herein, hose, hose couplings and other flexible devices used in piping configuration for noise attenuation or piping connections to resiliently mounted equipment shall be compatible in all respects with the other components in the system concerned. Hose and flexible devices shall also be compatible with the fluid used. Hose, hose couplings and flexible devices shall be in accordance with the latest issue of the following instructions:

(a) BuShips Instruction 9480.65.
(b) BuShips Instruction 9480.67.
(c) BuShips Instruction 9480.70.

Hose assemblies shall be installed in accordance with BuShips Instruction 9480.65. Flexible devices of the E.B. type joint shall be installed in accordance with BuShips Instruction 9480.67. Alternate designs may be submitted to the command or agency concerned for approval. However, such submission shall contain complete substantiating data.

13. All butt welding elbows and return bends shall have 1/2 inch-minimum tangents. For commercial fittings, the 1/2 inch minimum tangents shall be outside the ANSI radius dimension. Tangents on fittings may be omitted where consumable inserts are used or where welding without backing rings is permitted. Where consumable insert welding has been previously approved for the shipbuilder by the command or agency concerned, butt welding will be permitted down to and including 1/2 inch. Where consumable inserts are used they shall be in accordance with class I of MIL-I-23413. Material shall be compatible with the system requirements.

14. Thermometer wells installed for temperature measuring equipment shall conform to the requirements of Drawing 810-1385917 and MIL-W-24270 using materials selected and shall be compatible with the materials specified for the intended service.

15. Branch outlets other than those effected through the use of fittings covered in this standard will be permitted as follows:

(a) Branches extruded from tubing in accordance with a procedure approved by the command or agency concerned.
(b) Integrally reinforced branch outlet fitting or integrally reinforced insert butt welding outlet fitting.

16. Where commercial valves are furnished, handwheels may be of commercial design and materials, except that the use of cast iron will not be permitted.

17. Unreinforced branch connections (a connection where the branch pipe is attached directly to the run pipe by welding or brazing and joint fabrication does not include the techniques specified (in note 15) will not be permitted in any system where the design pressure is over 150 psi or design temperature is over 449°F. Obtaining the required reinforcement by weld buildup is not permitted and any branch connection fabricated by the use of welding only will be considered as unreinforced except for branch fittings in accordance with Drawing 810-1385950, and root connections in accordance with Drawing 810-1385850.

18. Hydrostatic tests of forged welding outlets and fittings and brazing outlets prior to installation are not required.

19. Flat face flanges may be used, where applicable, to mate with component flanges.

20. For the radiographic inspection requirements of cast piping system components see applicable ships specification.

21. Flange finishes. The machine surface finish of gasket mating surfaces on flanges in piping system and connected components shall be as follows:

(a) Non-ferrous and ferrous flanges for use with sheet gaskets:
  (1) For flanges of a nominal size of 12 inches of less, a finish with a circular lay (concentric of 500) to 1000 roughness height rating (RHR) or phonographic 125 to 250 RHR produced by machining 30 to 80 cuts of uniform depth per inch of face width.
  (2) For flanges over a nominal size of 12 inches, the requirements shall be the same except that 21 to 80 serrations per inch of face width may be used.
  (3) For flanges where the flange face cannot be turned and tool marks run across the flange face, the surface finish shall have a maximum RHR of 500.
(b) All flanges for "O" ring seals:
  (1) A finish of 63 RHR maximum in "O" ring grooves.
  (2) A finish of 125 RHR maximum on the flange face opposite the groove.
(c) Ferrous flanges for spiral wound (metallic-asbestos) gaskets:
  (1) A finish with a circular lay (concentric or phonographic) having a roughness not exceeding 500 RHR produced by machining not less than 40 cuts of uniform depth per inch of face width.
  (2) For special installations involving radioactive service or hazardous fluids (toxic or explosive) where a finer finish is required, the requirements shall be same as above except that the finish shall be 125 RHR maximum.

(3) For flanges where the flange face cannot be turned and tool marks run across the flange face, the surface finish shall have a maximum RHR of 125.

22. Oil free packing and gaskets shall be used in valves and components in secondary plant systems. These include but should not necessarily be limited to the following systems:

(a) Condensate
(b) Feed
(c) Steam drains
(d) Main steam
(e) Auxiliary steam
(f) Air ejector piping
(g) Distilling
(h) Reserve feed

23. All carbon steel tubing installed shall be of one thickness only for each size. The selected thickness shall be that required for the maximum service pressure for which that size is used.

24. Hull penetrating grease line valves shall be in accordance with type I of MIL-V-22687 with outboard end welded or in accordance with Drawing 845-2050555. Manifold type of multiple grease should be similar or equal to Drawing 211-1437414.

25. Naval brass shall not be used as a pressure housing material for components in the main ballast tank (MBT) blow piping or other applications subject to sea water.

26. Ground joint unions and valves having ground joint union bonnets or ground joint union ends shall not be used for vacuum service unless the union bonnet design uses an "O" ring or gasket which is totally captured and the union ends use an "O" ring and retainer ring in the joint design similar to the figure for unions with retainer ring and O-ring shown in MIL-F-1183. Valves that employ this "O" ring and retainer ring have been tested in vacuum service and are acceptable.

27. Gaskets noted herein are for line joints only. Valve bonnet gaskets and any other gaskets used in piping components shall be in accordance with the applicable component specification requirements. The use of line gaskets other than those covered in this standard shall be as approved by the command or agency concerned.

28. Flange bolting requirements listed in the individual categories of this standard are for line joints only except as otherwise noted herein.

29. Where carbon steel galvanized bolting is specified the tests for salt spray and hexavalent chromium of supplementary film specified in QQ-Z-325 are not required to be performed.

30. Where socket welded fittings in accordance with grade WPB of ASTM A234 are specified, fittings in accordance with ASTM A-181 may be used.

Category and groups	Services	Design pressure psig	Maximum temperature degree F	Remarks
A-2	Steam and high pressure steam drains	400 to 1100	775	---
	Feed water	600 to 1300	275	---

Item	Types	Material	Applicable documents	Remarks
Pipe and tubing (see note A-2-2).	Seamless	Carbon steel	MIL-T-20157, type E	----
		Nickel-copper alloy	MIL-T-1368, class A	
Valves (see notes A-2-1, and A-2-3)	Globe, throttle, stop check and lift check, 2 inches and smaller	Carbon steel Nickel copper alloy	Drawing 810-2177525	Socket weld ends, or butt weld ends or flanged
	3-way by-pass 1/2 through 1 inch	---	Drawing 810-1385965	
	Globe, throttle, stop check and lift check 2-1/2 inches 3 and 4 inches 5 and 6 inches		Drawing 810-2177140 Drawing 810-2177141 Drawing 810-2177142	Butt weld ends
	Globe 8 inches and larger	Carbon steel ASTM A-105, grade II ASTM A-216, grade WCB	MIL-V-22052	Butt weld and flanged
	Gate 1/4 through 4 inches 5 through 16 inches		MIL-V-18110 Drawing 810-2177518	Socket weld ends or butt weld ends
	Swing check	---	Commercial, ANSI B16.10	---
	Pressure regulating and control		MIL-V-17848 (see note A-2-4) MIL-V-18030	Flanged, ANSI B16.5
	Astern	Carbon steel ASTM A-216, grade WCB	MIL-V-22682	
Fittings	Socket weld	Forged carbon steel ASTM A-234, grade WPB	Commercial, ANSI B16.11	---
		Nickel-copper alloy, 400, QQ-N-281	ANSI B16.11	1/2 inch to 2 inches
	Butt weld	Carbon steel, ASTM A-234, grade WPB	Commercial, ANSI B16.9	---

Category and group	Services	Design pressure psig	Maximum temperature degree F	Remarks
A-2 (cont'd)	Steam and high pressure steam drains	400 to 1100	775	----
	Feed water	600 to 1300	275	----

Item	Types	Material	Applicable documents	Remarks
Fittings (cont'd)	Socket welding end branch outlet	Forged carbon steel, ASTM A-234, grade WPB	Commercial	---
	Butt welding end branch outlets	Carbon steel, ASTM A-234, grade WPB	Commercial	---
	Flanged	Cast carbon steel, ASTM A-216, grade WCB	Commercial, ANSI B16.5, series 600	---
	Socket welding end root nipple	Carbon steel, ASTM A-105, grade II	Drawing B-214, figure 7(b) modified to socket weld outlet	---
Flanges	Socket weld	Forged carbon steel, ASTM A-105, grade II	Commercial, ANSI B16.5, series 600	1/2 inch to 2 inches
	Butt weld (welding neck)			2-1/2 inches and larger
	Socket weld, 1/4 to 3/8 inch		Commercial, series 600	1/4 inch raised face
	Blind		ANSI B16.5, series 600	---
	Socket weld	Nickel-copper alloy 400, QQ-N-281	ANSI B16.5	1/2 inch to 2 inches
Gaskets	Spiral wound	Metallic-asbestos	MIL-G-21032, type II, class B	---
Flange bolting	Bolt-stud	Alloy steel	MIL-S-1222, type I, any grade	---
	Nuts	Carbon steel	MIL-S-1222, type II, symbol H or 4	See note A-2-5
			ASTM A-194, grade 2H; cold drawn, hot forged	
	Bolts	Nickel-copper-aluminum, MS18116	MIL-B-857, type III	---
	Studs		MIL-B-857, type I	
	Bolt-studs		MIL-S-1222	
	Nuts	Nickel-copper, QQ-N-281, class B	---	

NOTES TO CATEGORY AND GROUP A-2:

A-2-1 Valves for these services, except as waived in general note 7, shall have integral hard surface seats and discs. Hard surfacing material shall be in accordance with type MIL-RCoCr-A of MIL-R-17131.

A-2-2 Drain nipples shall be schedule 80 pipe thickness.

A-2-3 Flexible wedge gate valves shall be provided with 3-way by-pass valves.

A-2-4 For applications involving regulator set pressures 50 psig and below, direct spring or gas referenced regulators may be used as approved.

A-2-5 Nuts shall be magnetic particle inspected. Inspection and inspection marking shall be in accordance with MIL-S-1222.

Category and group	Services	Design pressure psig	Maximum temperature degrees F	Remarks
A-4	Steam and low pressure steam drains	165	400	See group B-1 for these systems at lower temperatures

Item	Types	Material	Applicable documents	Remarks
Pipe (see note A-4-1)	Seamless	Carbon steel	MIL-T-20157, type E	---
Valves	Globe, throttle, stop check, and lift check 2 inches and smaller	Carbon steel	Drawing 810-2177525	Socket weld ends butt weld ends
	Globe, 2-1/2 inches and larger	Carbon steel, ASTM A-105, grade II Carbon steel, ASTM A-216, grade WCB	MIL-V-22052	Butt weld ends Flanged, ANSI B16.5
	Gate		MIL-V-18110 2 inches and above, only	
	Check		Commercial, ANSI B16.10	
	Relief		MIL-V-20065, type II	Flanged, ANSI B16.5
	Pressure regulating and control		MIL-V-17848 MIL-V-18030 (See note A-4-2)	

Category and group	Services	Design pressure psig	Maximum temperature degrees F	Remarks
A-4 (cont'd)	Steam and low pressure steam drains	165	400	See group B-1 for these systems at lower temperatures

Item	Types	Material	Applicable documents	Remarks
Valves (cont'd)	Combined exhaust and relief	Carbon steel, ASTM A-216, grade WCB Carbon steel, ASTM A-105, grade II	Drawing 5000-S4824-1385797 and Drawing 5000-S4824-1385798	Flanged, ANSI B16.5
Fittings	Socket weld	Forged carbon steel, ASTM A-234, grade WPB	Commercial, ANSI B16.11	----
	Butt weld seamless	Carbon steel, ASTM A-234, grade WPB	Commercial, ANSI B16.9	----
	Socket welding end branch outlets	Forged carbon steel, ASTM A-234, grade WPB	Commercial	----
	Butt welding end branch	Carbon steel, ASTM A-234, grade WPB	----	
	Flanged	Cast carbon steel, ASTM A-216, grade WCB	Commercial, ANSI B16.5, series 150	
	Socket weld end root nipple	Carbon steel, ASTM A-105, grade II	Drawing B-214, figure 7(b) modified to socket welding outlet	
Flanges	Socket weld	Forged carbon steel, ASTM A-105, grade II	Commercial, ANSI B16.5, series 150	----
	Socket weld, 1/4 to 3/8 inch		Commercial, series 150	1/16 inch raised face

Category and group	Services	Design pressure psig	Maximum temperature degrees F	Remarks
A-4 (cont'd)	Steam and low pressure steam drains	165	400	See group B-1 for these systems at lower temperatures

Item	Types	Material	Applicable documents	Remarks
Flanges (cont'd)	Welding neck	Forged carbon steel ASTM A-105, grade II	Commercial, ANSI B16.5 series 150	----
Gaskets	Sheet asbestos	Sheet asbestos or asbestos-metallic cloth	MIL-A-17472 or HH-P-31	----
	Spiral wound	Metallic-asbestos	MIL-G-21032, type II class B	
Flange bolting	Bolts	Steel, zinc or cadmium coated	MIL-B-857, type II or III, grade 2	----
	Nuts		MIL-B-857, type III, grade 2	

NOTES:

A-4-1 Drain nipples shall be schedule 80 pipe thickness.

A-4-2 For applications involving regulator set pressures 50 psig and below direct spring or gas referenced regulators may be used as approved.

Category and group	Services	Design pressure psig	Maximum temperature degree F	Remarks
B-1	Low pressure steam drains, condensate, and other fresh water services	165	300	---

Item	Types	Material	Applicable documents	Remarks
Pipe	Seamless	Copper	MIL-T-24107	0.065 inch minimum wall thickness (see note B-1-1)
		Copper-nickel (70-30)	MIL-T-16420, type I	----
		Brass	MIL-T-20168	0.065 inch minimum wall thickness, (see note B-1-1)
		Corrosion-resisting steel, type 304	MIL-P-1144, type I	For oxygen analyzer
Valves	Globe, stop check, gate and swing check, 1/4 to 2 inches	Bronze	Drawings 810-1385714, 810-1385721 and 810-4384536	Silver brazing or socket welding union ends
	Globe, 2-1/2 through 15 inches		Drawing 5000-S4824-1385623	Flanged ends
	Gate, 2-1/2 through 12 inches		Drawing 810-2177917	
	Gate, above 12 inches		MIL-V-1189, type I	----
	Swing check, above 12 inches		MIL-V-17547	
	Swing check, 2-1/2 through 12 inches		Drawing 810-1385637	
	Relief		MIL-V-24332	
	Diaphragm control		MIL-V-18030	
	Globe stop check and lift check, 1/4 through 2 inches	Copper-nickel	Drawing 810-2177934	Silver brazed, butt weld or socket ends
	Butterfly	Bronze	MIL-V-22133	----
	Hose globe		Drawing 810-1385711 and 810-1385712	Flanged

Category and group	Services	Design pressure psig	Maximum temperature degree F	Remarks
B-1 (cont'd)	Low pressure steam drains, condensate, and other fresh water services	165	300	---

Item	Types	Material	Applicable documents	Remarks
Valves (cont'd)	Globe and angle	Corrosion-resisting steel	Commercial	150 psi union bonnet or bolted bonnet for oxygen analyzer
	Ball	As approved	As approved	----
Fittings	Silver brazing	Bronze	MIL-F-1183	180°F, maximum
	Silver brazing union		MIL-F-1183	
	Sound isolator		MIL-H-24135, or as approved	
	Flexible connection	As approved	Corrosion-resisting steel, flexible metal hose	
	Socket or butt welding end outlets	Corrosion-resisting steel	As approved	Welded to pipe run
	Socket weld	Copper-nickel alloy (70-30), MIL-C-15726	As approved	----
	Butt weld, seamless	Copper-nickel alloy (70-30)	MIL-F-24202, type I or as approved	
Flanges	Silver brazing	Bronze	MIL-F-20042	----
	Socket weld	Copper-nickel alloy (70-30), MIL-C-15726	----	
	Butt weld		As approved	
			Drawing 810-1385992, 810-1385861 or as approved	
Gaskets	Cloth or sheet	Asbestos-metallic cloth or compressed asbestos sheet	HH-P-31 or MIL-A-17472	----
		Cloth inserted rubber	HH-P-151	212°F maximum
Flange bolting (not in bilge)	Bolts and studs	Carbon steel, zinc or cadmium coated	MIL-B-857, type II or III, grade 2	----
	Nuts		MIL-B-857, type III, grade 2	
Flange bolting (located in bilge)	Bolts, studs and nuts	Nickel-copper alloy or nickel-copper-aluminum alloy	MIL-B-857, type II or III	----

NOTE:

B-1-1 The thickness of copper tubing in condensate piping shall be calculated using allowable stresses for the fully annealed condition.

Category and group	Services	Design pressure psig	Maximum temperature degrees F	Remarks
B-2	Battery fresh water	100	120	See note B-2-2

Item	Types	Material	Applicable documents	Remarks
Pipe	Seamless	Copper	MIL-T-24107	See note B-2-1, regarding tinning
		Brass	MIL-T-20168	
		Corrosion-resisting steel	MIL-P-1144	See note B-2-3
Valves	Globe, angle, stop check, lift check, 2-1/2 through 15 inches	Bronze	Drawing 5000-S4824-1385541	Flanged ends
	Globe and stop check, 1/4 to 2 inches		Drawing 810-1385722	Union ends
	Globe, stop check and lift check, 1/4 through 2 inches	Copper-nickel	Drawing 810-2177934	Silver brazed, butt weld or socket ends
	Gate, 1/4 to 2 inches	Bronze	Drawing 810-4384536	Union ends
	Gate, 2-1/2 through 12 inches		Drawing 810-2177917	Flanged ends
	Gate, above 12 inches		MIL-V-1189, type I	
	Swing check, 2-1/2 through 12 inches		Drawing 810-1385637	----
	Swing check, above 12 inches		MIL-V-17547	

Category and group	Services	Design pressure psig	Maximum temperature degrees F	Remarks
B-2 (cont'd)	Battery fresh water	100	120	See note B-2-2

Item	Types	Material	Applicable documents	Remarks
Valves (cont'd)	Swing check (cont'd) 2 inches and smaller	Bronze	Drawing 810-1385721	Union ends
	Gage cock		MIL-D-1203, type E	----
	Globe, angle, gate, check	Corrosion-resisting steel (18-8)	Commercial, as approved	See note B-2-3
	Ball	As approved	As approved	----
Fittings	Silver brazing, including unions and union end fittings	Bronze	MIL-F-1183	1/4 to 2 inches
	Socket or butt welded end outlet	Corrosion-resisting steel	As approved	Welded to pipe run
	Welding	Corrosion-resisting steel (18-8)	Commercial, as approved	See note B-2-3

Category and group	Services	Design pressure psig	Maximum temperature degrees F	Remarks
B-2 (cont'd)	Battery fresh water	100	120	See note B-2-2

Item	Types	Material	Applicable documents	Remarks
Flanges	Silver brazing end	Bronze	MIL-F-20042, class 150 psi, plain	----
Gaskets	Sheet	Synthetic rubber	MIL-R-1149 or HH-P-151	----
Flange bolting (not in bilge)	Bolts	Carbon steel, zinc or cadmium coated	MIL-B-857, type II or III, grade 2	----
	Nuts		MIL-B-857, type III, grade 2	
Flange bolting (in bilge)	Bolts	Nickel-copper alloy or nickel-copper aluminum alloy	MIL-B-857, type II or III	----
	Nuts		MIL-B-857, type III	----
Hose	Flexible, polyvinylchloride	Polyvinylchloride	Commercial, as approved	----

NOTES TO CATEGORY AND GROUP B-2:

B-2-1 All copper or brass battery water piping valves and fittings on discharge side of ion exchanger and in battery operating and cooling piping shall be tin coated on the inside with a 75 percent tin and 25 percent lead dip except as follows:

(a) Fresh water circulating pump is excepted.
(b) For valves, only the bodies shall be coated.

B-2-2 Piping joints for copper and brass tubing made in shop shall be made up with grade III silver brazing alloy in accordance with QQ-B-654 and flux as specified in O-F-499. Field joints shall be made up with a soft solder consisting of 95 percent tin and 5 percent antimony.

B-2-3 Where corrosion-resisting pipe or tube is used, the other components in the system shall be of corrosion-resisting steel materials.

Category and group	Services	Design pressure psig	Maximum temperature degrees F	Remarks
C-1	Sea water	---	---	See note C-1-1

Item	Types	Material	Applicable documents	Remarks
Valves	Globe, stop check and lift check, 1/4 through 2 inches	Copper-nickel	Drawing 810-2177934	Silver brazed Socket welded Butt welded (see note C-1-2)
	Ball: 3 inch		Drawing 810-2178493	Butt welded
	4 inch		Drawing 810-2178494	
	5 inch		Drawing 810-4384431	
	6 inch		Drawing 810-4384681	
	8 inch		Drawing 810-4385058	
	Ball swing check, 8 inches		Drawing 810-4385059	
	10 inch		Drawing 810-4385051	Flanged
	Backup ball, 1/2 inch		Drawing 810-2178492	Butt welds
Valves, hull and backup	Hull and backup ball, 1-1/2 inch	Copper-nickel	Drawing 810-4385050	Flanged
	Poppet ball hull and backup: 8 inches	HY-80 MIL-S-23008 or MIL-S-23009	810-4385049	Butt welded
	12 inches		Drawing 810-4384539	
	14 inches		Drawing 810-4385030	

NOTES:

C-1-1 For components other than those listed, see the applicable ship specification.

C-1-2 Socket or butt weld end valves in sizes 1/4, 3/8 and 1/2 inch are acceptable for hull and back-up applications.

Category and group	Services	Design pressure psig	Maximum temperature degrees F	Remarks
C-2	Sea water	100	150	See note C-2-4

Items	Types	Material	Applicable documents	Remarks
Tubing	Seamless	70-30 copper-nickel	MIL-T-16420, type I	See note C-2-2
Valves	Globe, 2-1/2 through 15 inches	Bronze	Drawing 5000-S4824-1385623	Flanged ends, see note C-2-3
	Globe and stop check, 1/4 to 2 inches		Drawing 810-4384536	Union ends
	Globe, stop check and lift check, 1/4 to 2 inches	Copper-nickel	Drawing 810-2177934	Silver brazed socket or butt weld
	Globe, stop check and lift check 2-1/2 and larger		As approved	Welded flanged
	Swing check			
	Gate, 2-1/2 through 12 inches	Bronze	Drawing 810-2177917	---
	Gate, above 12 inches		MIL-V-1189, type I	Flanged ends
	Gate, 1/4 to 2 inches		Drawing 810-1385714	Union ends
	Swing check, above 12 inches		MIL-V-17547, or as approved	Flanged ends
	Swing check, 2-1/2 through 12 inches		Drawing 810-1385637	
	Swing check, 1/4 to 2 inches		Drawing 810-1385721	Union end
	Relief		MIL-V-24332	Flanged or union ends
	Pressure reducing		MIL-V-2042	----
	Ball	Bronze	Commercial	
	Butterfly	Bronze	MIL-V-22133	

Category and group	Services	Design pressure psig	Maximum temperature degrees F	Remarks
C-2 (cont'd)	Sea water	100	150	See note C-2-4

Item	Types	Material	Applicable documents	Remarks
Fittings seamless	---	Bronze	----	----
	Silver brazing (including unions and union end fittings)		MIL-F-1183	
	Butt welding	Copper-nickel alloy 70-30	Drawing 810-1385880	----
	Socket weld	Copper-nickel alloy 70-30	ANSI B16.11	
	Socket or butt welding branch outlet	Copper-nickel alloy 70-30	As approved	
	Silver brazing end outlet bosses	Copper-nickel alloy 70-30	Drawing 810-1385950	----
Flanges	Silver brazing	Bronze	MIL-F-20042, class 150 psi, plain	----
	Socket or butt weld	Copper-nickel alloy 70-30	ANSI B16.15, drilling and O.D. in accordance with MIL-F-20042	Flat face
Gaskets	Sheet	Synthetic rubber	MIL-R-1149	----
		Synthetic rubber, cloth inserted	HH-P-151	
		Compressed sheet asbestos	MIL-A-17472	
Flange bolting (not in bilge) (see note C-2-1)	Bolts	Carbon steel, zinc or cadmium coated	MIL-B-857, type II or III, grade 2	----
	Nuts		MIL-B-857, type III, grade 2	
Flange bolting (in bilge)	Bolts	Nickel-copper alloy or nickel-copper-aluminum alloy	MIL-B-857, type II or III	----
	Nuts		MIL-B-857, type III	

NOTES TO CATEGORY AND GROUP C-2:

C-2-1 May be the same material as bolts and nuts located in bilge, if desired.
C-2-2 Galvanized steel pipe in accordance with type E of MIL-T-20157 shall be used for bilge suction to minimize electrolytic action. Suitable transition pieces shall be provided.
C-2-3 Modified with monel trim.
C-2-4 For new designs seawater systems shall not be brazed.

Category and group	Services	Design pressure psig	Maximum temperature degrees F	Remarks
D-1	Oil systems (other than hydraulic)	151 to 1000	180	---

Item	Types	Material	Applicable documents	Remarks
Tubing	Seamless	Carbon steel	MIL-T-20157	----
		70-30 copper-nickel	MIL-T-16420	
Valves	Globe, throttle stop check and lift check, 2 inches and smaller	Carbon steel, ASTM A-216, grade WCB, Carbon steel, ASTM A-105, grade II	Drawing 810-2177525	Socket weld ends Butt weld ends
	Globe, 2-1/2 inches and larger		MIL-V-22052	Flanged, ANSI B16.10
	Gate		MIL-V-18110	
	Check		ANSI B16.5	
	Relief		MIL-V-24332	Flanged, ANSI B16.5
	Diaphragm control		MIL-V-18030	
	Pressure reducing		As approved	

Category and group	Services	Design pressure psig	Maximum temperatures degrees F	Remarks
D-1 (cont'd)	Oil systems (other than hydraulic)	151 to 1000	180	---

Item	Types	Material	Applicable documents	Remarks
Valves (cont'd)	Globe and angle, direct brazing or silver brazing union end	Bronze	Soft seating design, commercial	Silver brazing union ends in accordance with Drawing 810-1385946 or 810-1385943
	Ball		MIL-V-22687	
Fittings	Socket welding	Carbon steel, ASTM A-234, grade WPB	Commercial, ANSI B16.11	----
	Socket welding end root nipple	Carbon steel, ASTM A-105, grade II	Drawing B-214, figure 7(b) modified to socket weld outlet	
	Butt welding seamless	Carbon steel, ASTM A-234, grade WPB	Commercial, ANSI B16.9	
	Socket welding end branch	Forged carbon steel, ASTM A-234, grade WPB	Commercial	
	Butt welding end branch outlet	Carbon steel, ASTM A-234, grade WPB		
	Flanged	Cast carbon steel, ASTM A-234, grade WCB	Commercial, ANSI B16.5	
	Silver brazing (ips)	Bronze	Drawing 810-1385942 (2 inches maximum)	

Category and group	Services	Design pressure psig	Maximum temperature degrees F	Remarks
D-1 (cont'd)	Oil systems (other than hydraulic)	151 to 1000	180	---

Item	Types	Material	Applicable documents	Remarks
Fittings (cont'd)	Unions, silver brazing (ips)	Bronze Nickel-aluminum-bronze	Drawing 810-1385946 (2 inches maximum)	----
Flanges	Socket weld	Forged carbon steel, ASTM A-105, grade II	Commercial, ANSI B16.5	----
	Socket weld, 1/4 inch and 3/8 inch		Commercial	
	Welding neck		Commercial, ANSI B16.5	
Gaskets	Spiral wound	Metallic-asbestos	MIL-G-21032, type II	----
	"O" rings, as approved	As approved	As approved	
Flange bolting (not in bilge)	Bolts	Carbon steel, zinc or cadmium coated	MIL-B-857, type II or III, grade 2	----
	Nuts		MIL-B-857, type III, grade 2	
Flange bolting (in bilge)	Bolts	Nickel-copper alloy or nickel-copper-aluminum alloy	MIL-B-857, type II or III	----
	Nuts		MIL-B-857, type III	

Category and group	Services	Design pressure psig	Maximum temperature degrees F	Remarks
D-2	Oil systems (other than hydraulic)	150	180	See note D-2-1

Item	Types	Material	Applicable documents	Remarks
Pipe and tubing	Seamless	Copper-nickel	MIL-T-16420, type I	----
		Carbon steel (70-30)	MIL-T-20157, type E	
Valves	Globe, throttle, stop check and lift check, 1/4 through 2 inches	Carbon steel, ASTM A-216, grade WCB Carbon steel, ASTM A-105, grade II	Drawing 810-2177525	Socket weld ends Butt weld ends Flanged, ANSI B16.5
	Globe, 2-1/2 inches and larger		MIL-V-22052	
	Gate		MIL-V-18110	
	Swing check		Commercial, ANSI B16.5	
	Relief		MIL-V-24332	Flanged, ANSI B16.5
	Diaphragm control		MIL-V-18030	
	Pressure reducing		As approved	
	Butterfly		MIL-V-22133	
	Globe and stop check, 1/4 to 2 inches	Bronze	Drawing 810-4384536	Union end
	Globe, 2-1/2 through 15 inches		Drawing 5000-S4824-1385623	Flanged ends
	Gate valves, 1/4 to 2 inches		Drawing 810-1385714	Union end
	Gate valves, above 12 inches		MIL-V-1189, type I	Flanged
	Gate valves, 2-1/2 through 12 inches		Drawing 810-2177917	

Category and group	Services	Design pressure psig	Maximum temperature degrees F	Remarks
D-2 (cont'd)	Oil systems (other than hydraulic)	150	180	See note D-2-1

Item	Types	Material	Applicable documents	Remarks
Valves (cont'd)	Swing check, 1/4 to 2 inches	Bronze	Drawing 810-1385721	Union end
	Swing check, 2-1/2 through 12 inches		Drawing 810-1385637	Flanged end
	Swing check, above 12 inches		MIL-V-17547	
Fittings	Socket weld	Forged carbon steel, ASTM A-234, grade WPB	Commercial, ANSI B16.11	----
	Butt weld, seamless	Carbon steel, ASTM A-234, grade WPB	Commercial, ANSI B16.9	
		Copper-nickel (70-30)	MIL-F-2402, type I	
	Socket welding end branch outlets	Forged carbon steel, ASTM A-234, grade WPB	Commercial	
	Socket welding end root nipple	Carbon steel, ASTM A-105, grade II	Drawing B-214, figure 7(b), modified to socket weld outlet	
	Butt welding end branch	Carbon steel, ASTM A-234, grade WPB	ANSI B16.9	
	Flanged, 1/2 inch and larger	Cast carbon steel, ASTM A-216, grade WCB	Commercial, ANSI B16.5 series 150	
	Silver brazing	Bronze	MIL-F-1183	
	Socket welding	Copper-nickel (70-30) MIL-C-15726	As approved	

Category and group	Services	Design pressure psig	Maximum temperature degrees F	Remarks
D-2, (cont'd)	Oil systems (other than hydraulic)	150	180	See note D-2-1

Item	Types	Material	Applicable documents	Remarks
Fittings (cont'd)	Silver brazing union	Bronze	MIL-F-1183	----
	Silver brazing end outlet bosses	Copper-nickel	Drawing 810-1385950	----
Flanges	Socket weld, 1/4 inch and 3/8 inch	Forged carbon steel, ASTM A-105, grade II Cast carbon steel, ASTM A-216	Commercial, series 150	1/16 inch raised face
	Socket weld		Commercial, ANSI B16.5, series 150	----
	Slip-on			
	Welding neck			
	Silver brazing	Bronze	MIL-F-20042	
	Butt welding	Copper-nickel (70-30) MIL-C-15726	Drawing 810-1385992	----
	Socket welding		As approved	
Gaskets	Spiral wound	Metallic-asbestos	MIL-G-21032, type II, class B	----
	Sheet	Asbestos	MIL-A-17472	See note D-2-2
		Fiber	HH-P-96	
Flange bolting (not in bilge)	Bolts	Carbon steel, zinc or cadmium coated	MIL-B-857, type II or III, grade 2	----
	Nuts		MIL-B-857, type III, grade 2	
Flange bolting (in bilge)	Bolts	Nickel-copper alloy, QQ-N-281 or nickel-copper-aluminum alloy	MIL-B-857, type II or III	Used with spiral wound gaskets
	Nuts		MIL-B-857, type III	
	Nuts	Nickel-copper alloy, QQ-N-281	MIL-N-25027 or MS17828	Used with all gaskets

NOTES TO CATEGORY AND GROUP D-2:

D-2-1 For reduction gear vent piping see category O.
D-2-2 Sheet gaskets may only be used with flat faced flanges to mate up with components having flat faced flanges.

Cateogry and group	Services	Design pressure psig	Maximum temperature degrees F	Remarks
E-1	Hydraulic service, inside pressure hull	3000	180	See note E-1-1

Item	Types	Material	Applicable documents	Remarks
Pipe and tubing	Seamless	Corrosion-resisting steel	MIL-P-1144, type I, composition 304, 304L or 316, ASTM A-269, A-271 or A-312, grades TP 304, 316 or 316L	----
		70-30 copper-nickel alloy	MIL-T-16420	See note E-1-2
Valves	Ball	Bronze, aluminum-bronze, Naval brass, corrosion-resisting steel	MIL-V-22687, sizes 1/8 - 2-1/2 inches	----
	Globe, angle and needle	Corrosion-resisting steel, bronze, nickel-aluminum-bronze, Naval brass	As approved	Union end or direct silver brazing or welding ends in accordance with Drawings 810-1385884, 810-1385888, 810-1385943 810-1385948 See note E-1-3 and E-1-4
	Check	----	Soft or metal coating design, as approved	
	Flow restrictor, fixed or variable		As approved	
	Globe and angle	Aluminum bronze	MIL-V-24109, sizes 1/4 - 1-1/4 inches	Union end connections
	Relief	Aluminum alloy 6061-T6 (mechanically stress relieved), corrosion-resisting steel, bronze, nickel-aluminum-bronze, Naval brass	MIL-V-8813, MS28893	MS33649, end connections
	Control-special (includes directional, flow control, pressure regulating)	Aluminum alloy 6061-T6 (mechanically stress relieved)	Subplated or manifold mounted, as approved	----
		Titanium, MIL-T-9047, 6Al-4V-ELI		
		Corrosion-resisting steel		

Category and group	Services	Design pressure psig	Maximum temperature degrees F	Remarks
E-1 (cont'd)	Hydraulic service inside pressure hull	3000	180	See note E-1-1

Item	Types	Material	Applicable documents	Remarks
Fittings	Socket welding	Corrosion-resisting steel QQ-S-763, classes 304, 304L, 316 or 316L or ASTM A-403, grade WP316, WP316L, WP304 or WP304L Copper-nickel, MIL-C-15726	ANSI B16.11	----
	Butt welding	Corrosion-resisting steel QQ-S-763, classes 304, 304L, 316 or 316L or ASTM A-403, grade WP316, WP316L, WP304 or WP304L	----	----
	Silver brazing (Od type)	Valve bronze	Drawing 810-1385944	See note E-1-4
	Silver brazing (ips type) See note E-1-4	Valve bronze	Drawing 810-1385941	----
		Bronze	Drawing 810-1385942	1500 psi maximum
		Nickel-aluminum-bronze	Drawing 810-1385963	----
	Silver brazing, outlet bosses	Copper-nickel alloy	Drawing 810-1385950	1/8 inch - 2 inches See note E-1-4
	Unions, silver brazing (od type)	Valve bronze	Drawing 810-1385948	See note E-1-4
	Unions, silver brazing (ips type)	Bronze, valve bronze, copper-nickel, nickel-aluminum-bronze	Drawing 810-1385943	See note E-1-4
		Valve bronze, nickel-aluminum-bronze	Drawing 810-1385946	1/8 inch - 2 inches See note E-1-4 1500 psi maximum
	Unions, butt or socket weld	Corrosion-resisting steel, QQ-S-763, classes 304, 304L, 316 or 316L or ASTM A-403, grade WP316, 316L, WP304 or WP304L	Drawing 810-1385884	----
	Unions, adapter-tail-pieces for O-ring sealed unions	Corrosion-resisting steel, class 304 or 316, condition A, or ASTM A-403, grades WP304 or WP416	As approved	

Category and group	Services	Design pressure psig	Maximum temperature degrees F	Remarks
E-1 (cont'd)	Hydraulic service inside pressure hull	3000	180	See note E-1-1

Item	Types	Materials	Applicable documents	Remarks
Flanges	Butt weld or socket weld	70-30 copper-nickel, MIL-C-15726	As approved	----
		Corrosion-resisting steel, ASTM A-403, grade WP316, WP316L, WP304 or WP304L		
	Silver brazing end	Valve-bronze, MIL-B-16541, gun metal, QQ-C-390, alloy D5; copper-nickel, MIL-C-15726; manganese-bronze, QQ-B-728, class A		See note E-1-4
	Flanges, weld and blank	Corrosion-resisting steel, QQ-S-763, class 304, condition A or ASTM A-182, grade F304		----
Gasket	O-ring	Nitrile, MIL-P-5516	AN6227 or AN6230	----
		Fluorocarbon, elastomer, MIL-G-23652, type I	As approved	
Flange bolting (in bilge)	Bolts	Nickel-copper alloy or nickel-copper-aluminum alloy	MIL-B-857 type II or III	----
	Nuts		MIL-B-857, type III	
Flange bolting (not in bilge)	Bolts	Carbon steel, zinc or cadmium coated	MIL-B-857, type II or III, grade 2	----
	Nuts		MIL-B-857, type III, grade 2	
	Cap screws	Alloy steel, FF-S-86	MS24677, MS24678, or as approved	----
		Corrosion-resisting steel, FF-S-86	MS24673, or as approved	

NOTES TO CATEGORY AND GROUP E-1:

E-1-1 The table of components for this group includes items for use with corrosion-resisting steel tubing and copper-nickel tubing and also includes components for pipe size outside diameters (ips type) as well as tube size outside diameters (od type). Where corrosion-resisting steel components are used, they shall be joined either by welding or by mechanical couplings, as specified. Corrosion-resisting steel components shall not be brazed except where unavoidable and then with specific approval of the command or agency concerned or its field representative. Care shall be taken in selecting components to insure that all are compatible as to sizing (for example, whether they are in ips sizes or od sizes) and that where interconnection between these different sizing systems are required, suitable adapters are provided for.

E-1-2 Copper-nickel tubing in od sizes is equally acceptable, providing it otherwise conforms with the applicable requirements of MIL-T-16420.

E-1-3 Ball valve balls may be electrolized or equivalently hard chrome finished.

E-1-4 For new designs, hydraulic systems shall not be brazed.

Category and group	Services	Design pressure psig	Maximum temperature degrees F	Remarks
E-2	Hydraulic service outside the pressure hull	3000	160	See notes E-2-1 and E-2-2

Item	Types	Material	Applicable documents	Remarks
Piping and tubing	Seamless	Corrosion-resisting steel	MIL-P-1144, type I composition 316L or ASTM A-269, A-271 or A-312, grade TP 316L	----
		70-30 copper-nickel	MIL-T-16420	
		Nickel-copper alloy	MIL-T-1368	
Valves	Ball	Corrosion-resisting steel	MIL-V-22687	Welding ends (See note E-2-3)
	Globe, angle and check			
	Control-special (includes directional, flow control, pressure regulating	As approved	As approved	----
Fittings	Socket welding	Corrosion-resisting steel, QQ-S-763, class 316L or ASTM A-403, grade WP316L	ANSI B16.11	----
		70-30 copper-nickel alloy, MIL-C-15726		
	Butt welding	Corrosion-resisting steel, QQ-S-763, class 316L or ASTM A-403, grade WP316L	ANSI B16.9	
		70-30 copper-nickel alloy, MIL-C-15726		
Flanges	Weld neck or socket weld	70-30 copper-nickel alloy, MIL-C-15726	As approved	"O" ring face
		Corrosion-resisting steel, QQ-S-763, class 316L or ASTM A-403, grade WP316L		

Category and group	Services	Design pressure psig	Maximum temperature degrees F	Remarks
E-2 (cont'd)	Hydraulic service outside the pressure hull	3000	160	See notes E-2-1 and E-2-2

Item	Types	Material	Applicable documents	Remarks
Gaskets	O-ring	Nitrile, MIL-P-5516	AN6227 or AN6230	----
		Fluorocarbon, elastomer, MIL-G-23652, type I	As approved	
Bolting	Bolts	Nickel-copper-alloy, or nickel-copper-aluminum alloy	MIL-B-857, type II or III	----
	Cap screws	Corrosion-resisting steel, FF-S-86	MS24677, MS24678, or as approved	
		QQ-N-281, class A	As approved	
		QQ-N-286, class A	MS18116	
	Nuts	Nickel-copper alloy, or nickel-copper-aluminum alloy	MIL-B-857, type III	----

NOTES TO CATEGORY AND GROUP E-2:

E-2-1 The table of components for this group includes items for use with corrosion-resisting steel tubing and copper-nickel tubing and also includes components for pipe size outside diameters (ips type) as well as tube size outside diameters (od type). Where corrosion-resisting steel components are used, they shall be joined either by welding or by mechanical couplings, as specified. Corrosion-resisting steel components shall not be silver brazed except where unavoidable and then with specific approval of the command or agency concerned or its field representative. Care shall be taken in selecting components to insure that all are compatible as to sizing (for example, whether they are in ips sizes or od sizes) and that where interconnection between these different sizing systems are required, adapters are provided for.

E-2-2 Copper-nickel tubing in od sizes is equally acceptable, providing it otherwise conforms with the applicable requirements of MIL-T-16420.

E-2-3 Ball valve balls may be electrolized or equivalently hard chrome finished.

Category and group	Services	Design pressure psig	Maximum temperature degrees F	Remarks
E-3	Low pressure hydraulic systems inside pressure hull (including return lines)	700	180	---

Item	Types	Material	Applicable documents	Remarks
Piping and tubing	Seamless	Corrosion-resisting steel	MIL-P-1144, type I composition 304 or 316 or ASTM A-269, A-271, or A-312, grades TP 316, 316L, 304 or 304L	See note E-3-1
		70-30 copper-nickel	MIL-T-16420	----
		Copper	MIL-T-24107	Use limited to non-pressured vent and drain piping
Valves	Ball	Bronze, aluminum-bronze, corrosion-resisting steel	MIL-V-22687 Sizes 1/8 inch - 2-1/2 inches	Union end or direct silver brazing or welding ends
	Globe and angle	Aluminum-bronze	MIL-V-24109 sizes 1/4 - 1-1/4 inches	Union end connection
	Stop; globe, angle, or needle	Bronze	Drawing 810-4384536 or commercial, as approved	400 psi maximum
	Swing check, union or direct brazing ends		Drawing 810-1385721	
	Check	Corrosion-resisting steel, bronze, nickel-aluminum-bronze, Naval brass	As approved	Union end or direct silver brazing or welding ends in accordance with Drawings 810-1385884, 810-1385888, 810-1385943, 810-1385948
	Flow restrictor, fixed or variable			
	Relief	Aluminum alloy 6061-T6 (mechanically stress relieved), corrosion-resisting steel, bronze, nickel-aluminum bronze, Naval brass	MIL-V-8813, MS28893	MS33649, end connections
			As approved	
	Control-special (includes directional, flow control, pressure regulating)	Aluminum alloy, 6061-T6 (mechanically stress relieved), as approved	Subplate or manifold mounted, as approved	----

Category and group	Services	Design pressure psig	Maximum temperature degrees F	Remarks
E-3 (cont'd)	Low pressure hydraulic systems inside pressure hull (including return lines)	700	180	---

Item	Types	Material	Applicable documents	Remarks
Fittings	Silver brazing, ips type	Bronze	MIL-F-1183 MIL-F-24227	400 psi maximum See note E-3-2
	Silver brazing, od type	Bronze	Drawing 810-1385944	See note E-3-2
	Butt welding, seamless	Corrosion-resisting steel, QQ-S-763, classes 304, 304L, 316 316L or ASTM A-403, grade WP316, WP316L, WP304 or WP304L	ANSI B16.9	----
		70-30 copper-nickel alloy	MIL-F-24202	
	Socket welding	Copper-nickel, MIL-C-15726	ANSI B16.11	----
	Unions	Bronze	MIL-F-1183 MIL-F-24227	400 psi, maximum
		Bronze, nickel-aluminum-bronze	Drawing 810-1385946 Drawing 810-1385948	----
	Silver-bronze outlet bosses	70-30 copper-nickel alloy	Drawing 810-1385950	See note E-3-2
Flanges	Welding neck or socket weld	70-30 copper-nickel alloy, MIL-C-15726	As approved	----
		Corrosion-resisting steel, QQ-S-763, class 316L or ASTM A-403, grade WP316L		
Gaskets	O-ring	Nitrile, MIL-P-5516	AN6227, AN6230, MS28775 or MS28778	----
Flange bolting	Bolts	Carbon steel, zinc or cadmium coated	MIL-B-857, type II or III, grade 2	----
	Nuts		MIL-B-857, type III, grade 2	
	Cap screws	Alloy steel, FF-S-86	MS24677, MS24678, or as approved	----
		Corrosion-resistant steel, FF-S-86	MS24673, or as approved	

NOTES TO CATEGORY AND GROUP E-3:

E-3-1 Copper-nickel alloy in od sizes is acceptable providing it otherwise conforms with the applicable requirements of MIL-T-16420.

E-3-2 For new designs, hydraulic systems shall not be brazed.

Cagegory and group	Services	Design pressure psig	Maximum temperature degrees F	Remarks
F-1	Air and nitrogen	6000	150	See notes F-1-2, F-1-3 and F-1-6

Item	Types	Material	Applicable documents	Remarks
Pipe	Seamless	70-30 copper-nickel alloy	MIL-T-16420, type I	See notes F-1-2 and F-1-5
		Corrosion-resisting steel	MIL-P-1144, type I or ASTM A-312, grade TP-316 or 304	
Valves	Globe and angle, 1/4 through 1-1/4 inches	Aluminum-bronze	MIL-V-24109	End connections: Welding union ends in accordance with Drawing 810-1385884 or direct welding ends
	Ball (see note F-1-1)	Bronze, aluminum-bronze, copper-nickel, corrosion-resisting steel, nickel-copper	MIL-V-22687	
	MBT blow	70-30 copper-nickel alloy	As approved	
	Automatic shut-off	Bronze, aluminum-bronze, copper-nickel, corrosion-resisting steel, nickel-copper, Naval brass	MIL-V-24394	
	Check lift and in-line		Soft seating design, as approved	
	Vent check		MIL-V-23953	
	Relief		MIL-V-22549	
	Control-special		As approved	
	Pressure reducing		MIL-V-2961	See note F-1-4
	Manifolds, pressure reducing		MIL-V-24272	See note F-1-7
Fittings	Socket welding	Forged copper-nickel alloy, MIL-C-15726 corrosion-resisting steel QQ-S-763, class 316 or 304, condition A ASTM A-403, grade WP316 or 304	ANSI B16.11	----

Category and group	Services	Design pressure psig	Maximum temperature degrees F	Remarks
F-1 (cont'd)	Air and nitrogen	6000	150	See notes F-1-2, F-1-3 and F-1-6

Item	Types	Material	Applicable documents	Remarks
Fittings (cont'd)	Butt welding, seamless	ASTM A-403, grade WP316 or 304 copper-nickel alloy, MIL-C-15726	ANSI B16.9	----
	Unions	Forged copper-nickel, MIL-C-15726 or corrosion-resisting steel, QQ-S-763, 316 or 304	Drawing 810-1385884	See note F-1-6
	Socket or butt welding outlets	Corrosion-resisting steel, 316 or 304 or 70-30 copper-nickel	As approved	Welded to pipe run
Gaskets	"O" ring	----	MIL-G-23652, type II	----

NOTES TO CATEGORY AND GROUP F-1:

F-1-1 Ball valve may be polytetrachlorofluoroethylene coated where required to meet torque limitations of MIL-V-22687.

F-1-2 MBT blow piping/fittings outboard of the blow valve, all air bank and external charging connections piping/fittings and valves outboard of the pressure hull and all pressurized air bank drain lines and components shall be copper-nickel alloy. Valves in the foregoing shall be copper-nickel or nickel-copper.

F-1-3 All lubricants shall be of an approved type as listed in the NAVSHIPS technical manual.

F-1-4 Naval brass shall not be used as a pressure housing material for valves in the MBT blow piping or other applications where valves may be subjected to sea water.

F-1-5 Thickness of corrosion-resisting pipe in sizes 1-1/2 inches and above shall be calculated. Schedule thicknesses in these sizes shall not be used.

F-1-6 The following connections shall be in accordance with Drawing 845-2444527. All union connections from inlet of the emergency blow valve to the hull valves including cross connect piping, pressure side of all drain valves and normally closed valve or check valve, if installed.

F-1-7 Quiet design pressure reducing manifolds shall, in addition to meeting the requirements of MIL-V-24272, be in accordance with the following:

(a) Structureborne noise levels shall not exceed those levels required by the specifications applicable to the ship in which the valve is to be installed. Each size of a basic design pressure reducing manifold shall be procured and structureborne noise tested by NSRDC, Annapolis.

(b) Each basic design shall be tested for not less than 2 hours actual flow operation with no signs of instability or any other unsatisfactory or out of specification operation NSRDL, Annapolis shall conduct flow operation testing on basic design.

(c) The quiet air reducing manifold purchase specification and vendor valve assembly drawings shall be submitted for NAVSHIPS approval.

Category or group	Service	Design pressure psig	Maximum temperature degrees F	Remarks
F-2	Air, nitrogen and helium	3000	150	See notes F-2-2, F-2-3, F-2-4 and F-2-5

Item	Types	Material	Applicable documents	Remarks
Pipe	Seamless	Copper	MIL-T-24107	----
		Corrosion-resisting steel	ASTM A-312, grade 304 or 316 or MIL-P-1144	----
		70-30 copper-nickel alloy	MIL-T-16420	See notes F-2-1 and F-2-2
Valves	Globe and angle, 1/4 through 1-1/4 inches	Aluminum-bronze	MIL-V-24109	End connections: Silver brazing or welding union ends in accordance with Drawings 810-1385948, 810-1385884 810-1385943, 810-1385888 (See note F-2-6 and F-2-8)
	Ball (see note F-2-6)	Bronze-aluminum, bronze, copper-nickel, corrosion-resisting steel, nickel-copper	MIL-V-22687	
	Check-lift and in-line	Bronze, aluminum-bronze, copper nickel, corrosion-resisting steel, 304 or 316, nickel-copper, Naval brass	Soft seat design as approved	
	Relief		MIL-V-22549	
	Automatic shut-off		MIL-V-24394	
	Control-special		As approved	
	Pressure reducing		MIL-V-2961	
	MBT blow	70-30 copper-nickel alloy	As approved	
	Manifolds, pressure reducing	----	MIL-V-24272	See note F-2-7

Category and group	Services	Design pressure psig	Maximum temperature degrees F	Remarks
F-2 (cont'd)	Air, nitrogen and helium	3000	150	See notes F-2-2, F-2-3, F-2-4 and F-2-5

Item	Types	Material	Applicable documents	Remarks
Fittings	Silver-brazed (ips)	Bronze	Drawing 810-1385941	See note F-2-8
		Nickel-aluminum-bronze	Drawing 810-1385963	
	Socket or butt welded (ips)	Corrosion-resisting steel, ASTM A-403, grade WP 304 or 316	ANSI B16.11 or B16.9	
	Silver brazed (od)	Bronze	Drawing 810-1385944	
	Socket or butt welding branch outlet	Copper-nickel, 70-30	As approved	Weld to copper-nickel pipe run
		Corrosion-resisting steel, 304 or 316		Weld to corrosion-resisting steel pipe run
	Silver brazed end outlet bosses	70-30 copper-nickel alloy	Drawing 810-1385950	See note F-2-8
Unions	Silver brazed (ips)	Bronze, nickel-aluminum-bronze	Drawing 810-1385943	
	Silver brazed (od)	Bronze	Drawing 810-1385948	
Gaskets	"O" ring	----	MIL-G-23652, type II	----

Category and group	Services	Design pressure psig	Maximum temperature degrees F	Remarks
F-3	Air and nitrogen	1500	150	----

Item	Types	Material	Applicable documents	Remarks
Pipe	Seamless	Copper	MIL-T-24107	----
		70-30 copper-nickel alloy	MIL-T-16420	See note F-3-1
Valves	Globe and angle 1/4 through 1-1/4 inches	Aluminum bronze	MIL-V-24109	End connections silver brazed, union end in accordance with Drawing 810-1385943
	Globe and angle, stop and stop check, left check, 1/4 through 2 inches	Copper-nickel	----	700 psi
	Check	Naval brass, bronze, aluminum bronze	Soft seating design, as approved	End connections: Silver brazing direct or union ends in accordance with Drawing 810-1385946
	Ball	----	MIL-V-22687	See note F-3-3
	Relief		MIL-V-22549	
	Control-special		As approved	
	Pressure reducing		MIL-V-2961	
	Manifolds, pressure reducing		MIL-V-24272	See note F-3-2
	Automatic shut-off		MIL-V-24394	----
Fittings	Silver brazed (ips)	Bronze	Drawing 810-1385941	See note F-3-3
		Nickel-aluminum-bronze	Drawing 810-1385963	
	Silver brazed end outlet bosses	70-30 copper-nickel alloy	Drawing 810-1385950	See note F-3-3
	Socket or butt welding brand outlet	Copper-nickel 70-30	As approved	Weld to copper-nickel pipe run
		Corrosion-resisting steel, 304 or 316		Weld to corrosion-resisting steel pipe run
Unions	Silver brazed (ips)	Bronze	Drawing 810-1385943	See note F-3-3
		Nickel-aluminum bronze	Drawing 810-1385946	
Gaskets	O-ring	----	MIL-G-23652, type II	----

NOTES TO CATEGORY AND GROUP F-3:

F-3-1 Copper-nickel tubing in od sizes is acceptable, providing it otherwise conforms with the applicable requirements of MIL-T-16420.

F-3-2 Quiet design pressure reducing manifolds shall, in addition to meeting the requirements of MIL-V-24272, be in accordance with the following:

(a) Structureborne noise levels shall not exceed those levels required by the specifications applicable to the ship in which the valve is to be installed. Each size of a basic design pressure reducing manifold shall be procured and structureborne noise tested by NSRDC, Annapolis.

(b) Each basic design shall be tested for not less than 2 hours actual flow operation with no signs of instability or any other unsatisfactory or out of specification operation. NSRDL, Annapolis shall conduct flow operation testing on basic design.

(c) The quiet air reducing manifold purchase specification and vendor valve assembly drawings shall be submitted for NAVSHIPS approval.

F-3-3 For new designs, nitrogen systems subject to pressures greater than 400 psi shall not be brazed.

Category and group	Services	Design pressure psig	Maximum temperature degrees F	Remarks
F-4	Air and nitrogen	400	150	---

Item	Types	Material	Applicable documents	Remarks
Pipe and tubing	Seamless	Copper	MIL-T-24107	----
Valves	Globe, angle, stop check, swing check and gate, 1/4 through 2 inches	Bronze	Drawings 810-1385714, 810-4384536 and 810-1385721	----
	Globe, angle, stop check and lift check, 1/4 through 2 inches	Copper-nickel	Drawing 810-2177934	Direct silver brazing
	Ball	Bronze, aluminum-bronze, corrosion-resisting steel, copper-nickel	MIL-V-22687	----
	Pressure reducing	Bronze	MIL-V-2961	Silver brazing union end
	Relief	Bronze, aluminum-bronze, corrosion-resisting steel, copper-nickel	MIL-V-22549	----
	Manifolds, pressure reducing	----	MIL-V-24272	See note F-4-1
	Automatic shut-off		MIL-V-24394	----
Fittings	Silver brazed	Bronze	MIL-F-1183 and MIL-F-24227	250 psi, maximum for sizes above 6 inches
	Unions, silver brazed		MIL-F-1183	----
Flanges	Silver-brazed	Bronze	MIL-F-20042	----

NOTE TO CATEGORY AND GROUP F-4:

F-4-1 Quiet design pressure reducing manifolds shall, in addition to meeting the requirements of MIL-V-24272, be in accordance with the following:

(a) Structureborne noise levels shall not exceed those levels required by the specifications applicable to the ship in which the valve is to be installed. Each size of a basic design pressure reducing manifold shall be procured and structureborne noise tested by NSRDC, Annapolis.

(b) Each basic design shall be tested for not less than 2 hours actual flow operation with no signs of instability or any other unsatisfactory or out of specification operation. NSRDL, Annapolis shall conduct flow operation testing on basic design.

(c) The quiet air reducing manifold purchase specification and vendor valve assembly drawings shall be submitted for NAVSHIPS approval.

Category and group	Services	Design pressure psig	Maximum temperature degrees F	Remarks
F-5	Control air, air and nitrogen	100	150	---

Item	Types	Material	Applicable documents	Remarks
Pipe and tubing	Seamless	Copper	MIL-T-24107	----
Valves	Globe, stop check, swing check and gate, 1/4 through 2 inches	Bronze	Drawings 810-1385714, 810-4384536, and 810-1385721	----
	Globe, stop check and lift check 1/4 through 2 inches	Copper-nickel	Drawing 810-2177934	----
	Ball	Bronze, aluminum-bronze, copper-nickel corrosion-resisting steel	MIL-V-22687	----
	Pressure regulating	----	MIL-V-24384	Silver brazing union end
	Relief	Bronze, aluminum bronze, copper-nickel, corrosion-resisting steel	MIL-V-22549	
Fittings	Silver brazed	Bronze	MIL-F-1183	----
	Union, silver brazed			
	Silver brazed	Wrought-copper	ANSI B16.22	1/4 inch od only
	Flared, 37 degree	Forged brass	SAE J514b	See note F-5-1
Flanges	Silver brazed	Bronze	MIL-F-20042	----

NOTE:
F-5-1 Flare type fittings may be used in 20 psi or below ventilation and air conditioning control air systems only.

Category and group	Services	Design pressure psig	Maximum temperature degrees F	Remarks
F-6	Salvage air inboard of hull valve	50	100	----

Item	Types	Material	Applicable documents	Remarks
Pipe	Seamless	Copper-nickel	MIL-T-16420	----
Fittings	Silver-brazed	Bronze ASTM B61	MIL-F-1183	----

Category and group	Services	Design pressure psig	Maximum temperature degrees F	Remarks
F-7	Battery electrolyte agitation	50	100	See note F-7-1

Item	Types	Material	Applicable documents	Remarks
Pipe	Seamless	Polyvinylchloride	ASTM D-1785, type 2, grade I	Schedule 80
Fittings	Elbows	Polyvinylchloride	MIL-P-22011, type C, class 2, style A	----
	Unions			
	Boss	Polyvinylchloride, ASTM A-1784, type II, grade I	As approved	
Flanges	Socket	Polyvinylchloride, ASTM D-1784 type II, grade I	Commercial	----

NOTE:
F-7-1 This section applies to battery compartment piping only.

Category and group	Services	Design pressure psig	Maximum temperature degrees F	Remarks
G-1	Diesel engine exhaust, (inboard)	30	1000	See notes G-1-1 and G-1-3

Item	Types	Material	Applicable documents	Remarks
Pipe	Welded	Nickel-chromium-molybdenum-cobalt alloy ASTM B443	As approved	----
	Seamless	Nickel-chromium-molybdenum-cobalt-alloy ASTM B443	ASTM B444	
Fittings	Welded expansion joints and welded fittings	Nickel-chromium-molyb-denum-cobalt alloy, ASTM B443	Design, as approved	----
Valves	Isolation	As approved	As approved	----
	Drain	Nickel-chromium-molyb-denum-cobalt alloy ASTM B446-72	As approved	
Flanges	Slip-on	Nickel-chromium-molyb-denum-cobalt alloy, ASTM B443	ANSI B16.5, series 150	See note G-1-2
Flange bolting	Bolts	Nickel-copper alloy, or nickel-copper-aluminum alloy	----	800°F, maximum See 11(i)(1) or (2), as applicable under general notes
		Alloy steel	MIL-S-1222, type I, symbol B16	1000°F, maximum
	Nuts	Nickel-copper alloy, or nickel-copper-aluminum alloy	----	800°F, maximum See 11(i)(1) or (2), as applicable under general notes
		Alloy steel	MIL-S-1222, type II, symbol 4	1000°F, maximum
Gaskets	Sheet asbestos	Sheet asbestos	MIL-A-17472	800°F, maximum
	Spiral wound	Metallic-asbestos	MIL-G-21032	1000°F, maximum
	As approved	As approved	----	----

NOTES:

G-1-1 For hull integrity valves, see category G-2.

G-1-2 Fabrication of flange shall be in accordance with joint design P-16 of MIL-STD-22, except maximum temperature does not apply.

Category and group	Services	Design pressure psig	Maximum temperature degrees F	Remarks
G-2	Diesel engine exhaust, (outboard)	Free flood	400	----

Item	Types	Material	Applicable documents	Remarks
Pipe	Welded	Nickel-chromium-molybdenum-cobalt alloy, ASTM B443	----	----
	Seamless	Nickel-chromium-molybdenum-cobalt alloy, ASTM B446	ASTM B444	
Valves	Lift-check	Nickel-chromium-molybdenum-cobalt alloy, ASTM B443	Design, as approved	----
	Hull and back up; flapper, poppit, or as approved	HY-80, MIL-S-23008		See note G-2-1
Fittings	Welded expansion joints and weldments	Nickel-chromium-molybdenum-cobalt alloy, ASTM B443 or ASTM B446	Design, as approved	----
	Butt welding		ANSI B16.9, or as approved	
Flanges	Slip-on	Nickel-chromium-molybdenum-cobalt alloy, ASTM B443	ANSI B16.5	See note G-2-2 and G-2-3
Flange bolting	Bolts	Nickel-copper alloy or nickel-copper-aluminum alloy	MIL-B-857, type II or III, grade 2	800°F, maximum (see note G-2-4)
	Nuts	Nickel-copper alloy or nickel-copper-aluminum alloy	----	See note G-2-4
Gaskets	As approved	As approved	----	----

NOTES:

G-2-1 Mechanically joined pressure boundary items may be fabricated from either HY-80 or nickel-chromium-molybdenum-cobalt alloy. HY-80 exposed to diesel exhaust gasses and cooling seawater shall have nickel-chromium-molybdenum-cobalt alloy protection in the form of cladding with plate or weld. Hull integrity drain valves to be fabricated from nickel-chromium-molybdenum-cobalt alloy (ASTM B446). (See applicable Ships specification for design pressures.)

G-2-2 The diesel exhaust system shall be of welded construction to the maximum extent. Flanged joints should be used only where removal of equipment for servicing is necessary or as approved.

G-2-3 Fabrication of flange shall be in accordance with joint design P-16 of MIL-STD-22.

G-2-4 For bolting of hull integrity connections - see general note 11(f). Bolting for all other connections - see general note 11(d) or (e) as applicable.

Category and group	Services	Design pressure psig	Maximum temperature degrees F	Remarks
H-1	Ventilation exhaust and low pressure blow (inboard)	20	Ambient	----

Item	Types	Material	Applicable documents	Remarks
Pipe	Seamless or welded	MIL-P-1144 or QQ-S-766, class 347 or 70-30 copper-nickel, MIL-T-16420. Welded carbon steel MIL-S-22698, grade M (galvanized after fabrication) copper, MIL-T-24107	Special, as approved	----
Valves	Relief	Carbon steel, MIL-S-22698, nickel-copper, QQ-N-288 or aluminum bronze, QQ-C-390, alloy G3, G5, G6 and G7	----	----
	Isolation	As approved	As approved	See note H-1-1
Flanges	Slip-on	Carbon steel, MIL-S-22698	ANSI B16.5, 150 series	----
Flange bolting	Bolts	Carbon steel, zinc or cadmium coated	MIL-B-857, type II or III, grade 2	----
	Nuts		MIL-B-857, type III, grade 2	
Gaskets	Sheet	Rubber	HH-P-151	----
		Asbestos	MIL-A-17472	

NOTE:

H-1-1 Maximum temperature, Diesel exhaust side 1000°F for inboard Diesel exhaust, see category G-1.

Category and group	Services	Design pressure psig	Maximum temperature degrees F	Remarks
H-2	Low pressure blow (outboard)	Internal: 20 External: See applicable ship specifications	Ambient	----

Item	Types	Material	Applicable documents	Remarks
Pipe (see note H-2-1)	Seamless	70-30 copper-nickel	MIL-T-16420	----
		Carbon steel	MIL-T-20157, type E	For ventilation blower exhaust mast only.
Valves (see note H-2-2)	Flapper swing check, lift check globe, angle gate	Bronze gun metal, QQ-C-390, alloy D5	Special, as approved	See applicable Ship specifications for design pressures
	Ball	As approved	As approved	
Fittings	Silver brazing	Bronze	Drawing 810-1385942, or as approved	----
	Welding	70-30 copper-nickel	MIL-F-24202	
Flanges	Silver brazing	Bronze	Drawing 810-1385947	----
	Butt welding	Nickel-copper	Drawing 810-1385861	
Flange bolting	Bolts	Nickel-copper-aluminum alloy, QQ-N-286, class A	MIL-B-857, type II or III	----
	Nuts	Nickel-copper-aluminum or nickel-copper alloy	MIL-B-857, type III	See general note 11(d)
Gaskets	O ring	Synthetic rubber	MIL-P-5516 and AN6227 and AN6230	----

NOTES:
H-2-1 External piping shall be painted, as required, for topside painting.
H-2-2 For hull integrity valves, see category C-1.

Category and group	Services	Design pressure psig	Maximum temperature degrees F	Remarks
J-1	Refrigerating plants, R-12 refrigerant	2 inches vacuum to 125 psig	30 to 250	See note J-1

Item	Types	Material	Applicable documents	Remarks
Pipe and tubing	Seamless	Copper	WW-T-799, type L	----
		Copper-nickel	MIL-T-16420	
Valves	Manual	Bronze Forged brass	MIL-V-20064	----
	Relief Control	Brass	MIL-R-16743	
Fittings	Silver brazed	Wrought copper or forged brass	ANSI B16.22	----
	Socket and butt weld	Copper-nickel	ANSI B16.11 or B16.9	
Flanges	Silver brazed 4-bolt tongue and groove	Steel	ASTM A-105	Flange
		Brass	ASTM B-16	Adapter
Flange bolting	Bolts Nuts	ASTM B98, copper-silicon, QQ-C-591, aluminum bronze, QQ-C-450, aluminum bronze, QQ-C-750, phosphor bronze	MIL-B-857, type II MIL-B-857, type III	----
Gaskets	Sheet	Sheet asbestos	ASTM F-104	----

NOTE:

J-1 Copper-nickel piping with welded joints shall be used where practical for locations where joints would not otherwise be accessible for leak detection and repair.

Category and group	Services	Design pressure psig	Maximum temperature degrees F	Remarks
J-2	Refrigerant piping, refrigerants R-11 and R-114	30 inches vacuum to 50 psig	30 to 250	See note J-2-1

Item	Types	Material	Applicable documents	Remarks
Pipe and tubing	Seamless	Copper	WW-T-799, type L	----
		Copper-nickel	MIL-T-16420	
Valves	Manual	Bronze Forged brass	MIL-V-20064	----
	Angle relief (line)	----	MIL-R-16743	
	Control	----	MIL-R-16743 or MIL-R-24085	
Fittings	Silver brazed	Wrought copper or forged brass	ANSI B16.22	----
	Socket and butt weld	Copper-nickel	ANSI B16.11 or B16.9	
Flanges	Silver brazed, 4-bolt tongue and groove	Steel	ASTM A-105	Flange
		Brass	ASTM B-16	Adapter
Flange bolting	Bolts	ASTM B-98, copper-silicon, QQ-C-591, copper silicon, QQ-C-450, aluminum-bronze, QQ-B-750, phosphor-bronze	MIL-B-857, type II	----
	Nuts		MIL-B-857, type III	
Gaskets	Sheet	Sheet asbestos	ASTM F-104	----

NOTE:

J-2-1 Copper-nickel piping with welded joints shall be used where practical for locations where joints would not otherwise be accessible for leak detection and repair.

Category and group	Services	Design pressure psig	Maximum temperature degrees F	Remarks
K-1	Oxygen and hydrogen	3000	Ambient	See notes K-1-1, K-1-2, and K-1-3

Item	Types	Material	Applicable documents	Remarks
Pipe	Seamless	Nickel-copper alloy	MIL-T-1368	----
Valves	Globe, angle, needle and check	Nickel-copper alloy, QQ-N-281	MIL-V-24439	With nickel-copper nipples welded to body
	Relief	Nickel-copper alloy	MIL-V-22549 (see note K-1-3)	
	Pressure reducing		MIL-V-24336 (see note K-1-3)	
Fittings	Socket welding	Nickel-copper alloy, class A, hot rolled or forged hot finished, QQ-N-281, class A	ANSI B16.11	----

NOTES:
K-1-1 For details of oxygen system components, see Drawing 810-1385846.
K-1-2 All lubricants shall be of an approved type as listed in the NAVSHIPS technical manual.
K-1-3 Relief and pressure reducing valves for hydrogen service shall be as approved.

Category and group	Services	Design pressure psig	Maximum temperature degrees F	Remarks
K-2	Oxygen	100	Ambient	See notes K-2-1 and K-2-2

Item	Types	Material	Applicable documents	Remarks
Pipe	Seamless	Copper-nickel	MIL-T-16420	----
		Copper	MIL-T-24107	
Valves	Globe and angle needle	Bronze, MIL-B-16541	Commercial, as approved	Socket ends for silver brazing polytetrachloro-fluoroethylene stem packing, polytetrachloro-fluoroethylene or KEL-F disc washer
	Pressure reducing	Bronze	MIL-V-24336	Union ends
	Diaphragm, packless	MIL-B-16541	Commercial, as approved	Socket ends for silver brazing polytetrachloro-fluoroethylene or KEL-F disc washer
		QQ-B-637		
	Relief	Bronze	MIL-V-22549	----
Fittings	Silver brazing	Bronze	MIL-F-1183, except for unions	----
	Unions	Bronze	Drawing 810-1385946	Silver brazing ends, with suitable gasket material approved for oxygen
		Nickel-aluminum-bronze		
	Silver brazed end outlet bosses	Copper-nickel	Drawing 810-1385950	----

NOTES:

K-2-1 All lubricants shall be of an approved type as listed in the NAVSHIPS technical manual.

K-2-2 For oxygen systems subject to 100 psi in new designs, see category and group K-1 since these systems shall not be brazed.

Category and group	Services	Design pressure psig	Maximum temperature degrees F	Remarks
N	Electronic and auxiliary fresh water cooling system, heating and cooling system for missile tube	100	150	See note N-1

Item	Types	Material	Applicable documents	Remarks
Pipe	Seamless	Copper	MIL-T-24107	0.065 inch minimum wall thickness
Valves	Globe angle, globe stop check, check, angle stop check, swing check, lift check and gate, 1/4 to 2 inches	Bronze	Direct silver brazed or silver brazing unions, Drawings 810-1385714, 810-1385721 and 810-4384536	Direct brazing up to and including 2 inches
	Globe angle, globe stop check and angle stop check		Drawing 5000-S4824-1385541	Flanged ends
	Gate		Drawing 810-2177917	
	Swing check		MIL-V-17547	
	Relief		MIL-V-24332	
	Control		MIL-V-18030	
	Ball		Commerical	----
Fittings	Silver brazing	Bronze	MIL-F-1183	----
	Silver brazing union			
	Sound isolator	----	MIL-H-24135, or as approved	

Category and group	Services	Design pressure psig	Maximum temperature degrees F	Remarks
N (cont'd)	Electronic and auxiliary fresh water cooling system, heating and cooling system for missile tube	100	150	See note N-1

Item	Types	Material	Applicable documents	Remarks
Flanges	Silver brazing	Bronze	MIL-F-20042	----
Gaskets	Sheet	Synthetic rubber	MIL-R-1149	----
Flange bolting (not in bilge)	Bolts	Carbon steel, zinc or cadmium coated	MIL-B-857, type II or III, grade 2	----
	Nuts		MIL-B-857, type III, grade 2	
Flange bolting (located in bilge)	Bolts	Nickel-copper alloy or nickel-copper-aluminum alloy	MIL-B-857, type II or III	----
	Nuts		MIL-B-857, type III	
Hose	Flexible, polyvinylchloride	Polyvinylchloride	Commercial, as approved	----

NOTE:

N-1 From the solenoid operated stop valves up to the connections to the guardian capsule and pipe runs inside the tube piping valves and fittings shall be designed for submergence pressure. Category C-1 of this schedule should be used as a guide for such valves and fittings.

Category and group	Services	Design pressure psig	Maximum temperature degrees F	Remarks
O	Vents-reduction gear	50	180	---

Item	Types	Material	Applicable documents	Remarks
Pipe	Seamless	Copper-nickel (70-30)	MIL-T-16420, type I	----
Fittings	Silver-brazing	Bronze	MIL-F-1183	----
	Butt welding, seamless	Copper-nickel (70-30)	MIL-F-24202, type I	----
	Socket welding	Copper-nickel (70-30) MIL-C-15726	As approved	----
Flanges	Silver-brazing	Bronze	MIL-F-20042	Plain, 150 psi
	Butt welding	Copper-nickel (70-30) MIL-C-15726	Drawing 810-1385992	----
	Socket welding		As approved	
Gaskets	Cloth or sheet	Asbestos-metallic cloth or compressed asbestos sheet	HH-P-31	----
			MIL-A-17472	
Flange bolting	Bolts	Carbon steel, zinc or cadmium coated	MIL-B-857, type II or III, grade 2	----
	Nuts	----	MIL-B-857, type III, grade 2	

CATEGORIES WITH LATEST DATE OF ISSUE

(When any category or general note is modified this record will be corrected and reissued to indicate the latest date of issue of that category.)[1/]

Category and group	Service	Date
General notes		15 May 1973
A-2	Steam and high pressure steam drains; feed water (400 to 1100 psig, 775°F) 600 to 1300 psig, 275°F)	15 May 1973
A-4	Steam, low pressure steam drains (165 psig, 400°F)	15 May 1973
B-1	Low pressure steam drains, condensate, and other freah water services (165 psig, 300°F)	15 May 1973
B-2	Battery fresh water (100 psig, 120°F)	15 May 1973
C-1	Sea water	15 May 1973
C-2	Sea water (100 psig, 150°F)	15 May 1973
D-1	Oil systems (other than hydraulic) (151 to 1000 psig, 180°F)	15 May 1973
D-2	Oil systems (other than hydraulic) (150 psig, 180°F)	15 May 1973
E-1	Hydraulic service, inside pressure hull (3000 psig, 180°F)	15 May 1973
E-2	Hydraulic service, outside pressure hull (3000 psig, 160°F)	15 May 1973
E-3	Low pressure hydraulic systems inside pressure hull (including return lines) (700 psig, 180°F)	15 May 1973
F-1	Air and nitrogen (6000 psig, 150°F)	15 May 1973
F-2	Air, nitrogen and helium (3000 psig, 150°F)	15 May 1973
F-3	Air, and nitrogen (1500 psig, 150°F)	15 May 1973
F-4	Air and nitrogen (400 psig, 150°F)	15 May 1973
F-5	Control air, air and nitrogen (100 psig, 150°F)	15 May 1973
F-6	Salvage air inboard of hull valves (50 psig, 100°F)	15 May 1973
F-7	Battery electrolyte agitation (50 psig, 100°F)	15 May 1973
G-1	Diesel engine exhaust (inboard), (30 psig, 1000°F)	15 May 1973
G-2	Diesel engine exhaust (outboard) (free flood, 400°F)	15 May 1973
H-1	Ventilation exhaust and low pressure blow (inboard) (20 psig, ambient)	15 May 1973
H-2	Low pressure blow (outboard)(internal: 20 psig, external: see applicable ship specifications; ambient)	15 May 1973
J-1	Refrigeration plants (R-12), refrigerant, (2 inches vacuum to 125 psig, 30° to 250°F)	15 May 1973
J-2	Refrigerant piping, refrigerants R-11 and R-114 (30 inches vacuum to 50 psig, 30° to 250°F)	15 May 1973
K-1	Oxygen and hydrogen (3000 psig, ambient)	15 May 1973
K-2	Oxygen (100 psig, ambient)	15 May 1973
N	Electronic and auxiliary fresh water cooling systems; heating and cooling system for missile tube (100 psig, 150°F)	15 May 1973
O	Vents-reduction gear (50 psig, 180°F)	15 May 1973

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

Preparing activity:
Navy - SH
(Project 4730-N269)

1/ Complete cross referenced index of categories and groups on pages v through xiv should be used to locate the desired information.

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

OMB Approval
No. 22-R255

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