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INCH-POUND

MIL-D-18641F(SH)
5 April 1993
SUPERSEDING
MIL-D-18641E(SHIPS)
30 August 1%0

MILITARY SPECIFICATION

DISTILLATION UNITS, WATER STEAM, OR FLASHED VAPOR OPERATED, OR HOT FRESH WATER HEATED, LOW PRESSURE NAVAL SHIPBOARD

This specification is approved for use by the Naval Sea Systems Command Department of the *Navy, and is available for use by all Departments and Agencies of the Department of Defense*.

1. SCOPE

1.1 Scope This specification covers low pressure steam or hot fresh water (heat recovery) heated vacuum operated distillation units for making fresh water from sea water in, Naval shipboard installations.

1.2 Classification.

1.2.1 Types Distillation units should be of the following types as specified (see 6.2):

Type I	Submerged tube type, low pressure steam operated
Type II	Flash type, low pressure steam operated
Type III	Vertical basket type, low pressure steam operated
Type IV	Flash type, hot fresh water heated (heat recovery)
Type V	Submerged tube, hot fresh water heated (heat recovery)

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Naval Sea Systems Command SEA 05Q42, 2431 Jefferson Davis Hwy, Arlington, VA 22242-5160 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A FSC 4620

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1.2.2 Classes Distillation units should be of the following classes, as specified (see 6.2):

class 1	Composition 70-30 copper-nickel alloy for submarine application
class 2	Composition 90-10 copper-nickel alloy for surface ship application.

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents shall be those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATIONS

FEDERAL

PPP-B-601	Boxes, Wood, Cleated-Plywood
PPP-B-621	Boxes, Wood, Nailed and Lock-Corner
QQ-N-281	Nickel-Copper Alloy Bar, Rod, Plate, Sheet, Strip, Wire, Forgings, and Structural and Special Shaped Sections
QQ-N-286	Nickel-Copper-Aluminum Alloy, Wrought (UNS N05500)
QQ-N-288	Nickel-Copper Alloy and Nickel-Copper-Silicon Alloy Castings
TT-P-28	Paint, Aluminum, Heat Resisting (1200 °F)

MILITARY

MIL-C-104	Crates, Wood: Lumber and Plywood Sheathed, Nailed and Bolted
MIL-P-116	Preservation, Methods of
MIL-B-121	Barrier Material, Greaseproof Waterproofed, Flexible
MIL-C-132	Crate, Wood Open; Maximum Capacity 2,500 Pounds
MIL-S-901	Shock Tests, HI (High Impact); Shipboard Machinery, Equipment and Systems, Requirements for

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MIL-E-917	Electric Power Equipment Basic Requirements (Naval Shipboard Use)
MIL-S-1222	Studs, Bolts, Hex Cap Screws, Socket Head Cap Screws, and Nuts
MIL-M-2082	Meters, Flow, Mechanical, Volumetric Positive Displacement, Liquid, Cold Water and Hot Water Type, Naval Shipboard Use
MIL-G-2860	Glasses, Sight-Flow, Clear, Borosilicate
MIL-C-3774	Crates, Wood; Open 12,000- and 16,000-Pound Capacity
MIL-P-5425	Plastic Sheet, Acrylic, Heat Resistant
MIL-G-5514	Gland Design, Packings, Hydraulic, General Requirement for
MIL-T-15005	Tubes, 70-30 and 90-10 Copper Nickel Alloy Condenser and Heat Exchanger
MIL-P-15024	Plates, Tags and Bands for Identification of Equipment
MIL-P-l5024/5	Plates, Identification
MIL-S-15103	Salinity Indicating Equipment
MIL-E-15465	Ejector Assemblies, Air
MIL-C-15726	Copper-Nickel Alloy, Sheet, Plate, Strip, Bar, Rod and Wire
MIL-P-15742	Plugs, Plastic (Heat-Exchanger-Tube)
MIL-E-15809	Expander, Tube, Condenser and Heat Exchangers
MIL-V-16556	Valve, solenoid, Three-Way Bypass (Naval Shipboard Use)
MIL-I-17244	Indicators, Temperature, Direct-Reading, Bimetallic, (3 and 5 Inch Dial)
MIL-P-17639	Pump, Centfigal, Miscellaneous Service, (Naval Shipboard use)
MS 17828	Nut, Self-Locking, Hexagon, Regular-Height, (Non-Metallic Insert) 250 “F, Nickel-Copper Alloy
MIL-P-17840	Pumps, Centrifugal, Close-Coupled, Navy Standard (For Surface Ship Application)
MIL-V-l8030	Valves, Control, Air-Diaphragm-Operated (Complete with instrumentation)
MS 18116	Bolt, Stud, and Socket Head Cap Screw, Nickel-Copper-Aluminum Alloy

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MS 18288	Lockplate
MIL-P-18472	Pumps, Centrifugal, Condensate, Feed Booster Waste Heat Boiler and Distilling Plant
MIL-V-18683	Vacuum Pumps, Power Driven, Centrifugal Pump Priming Service, Naval Shipboard
MIL-G-18997	Gauge, Pressure, Dial Indicating
MIL-A-19521	Anodes, Corrosion Preventive, Zinc and Plugs, Zinc Anode Retaining; Design of and Installation in Shipboard Condensers and Heat Exchangers
MIL-T-19646	Thermometers, Remote Reading, Self-Indicating Dial, Gas Actuated
MIL-I-20037	Indicators, Sight, Liquid Level, Direct/Indirect Reading, Tubular Glass/Plastic
MIL-V-20065	Valves, Angle, Pressure Relief, Naval Shipboard, for Steam Service
MIL-C-20159	Copper-Nickel Alloy Castings (UNS No. C76200 and C76400)
MIL-R-21252	Rubber Sheet, Solid, Synthetic, Shipboard Water Evaporator Gasketing
MIL-P-21397	Proportioning Unit, Chemical (For Distilling Plants Naval Shipboard Use)
MIL-E-21562	Electrodes and Rods – Welding, Bare, Nickel Alloy
MIL-G-21610	Gaskets, Heat Exchanger, Various Cross Section Rings, Synthetic Rubber
MIL-E-22200	Electrodes, Welding, Covered: General Specification for
MIL-E-22200/3	Electrodes, Welding, Covered: Nickel Base Alloy and Cobalt Base Alloy
MIL-E-22200/4	Electrodes, Welding, Covered, Copper-Nickel Alloy
MIL-N-24106	Nickel-Copper Alloy Bars, Rods, and Forgings
MIL-T-24107	Tube, Copper (Seamless) (Copper Alloy Numbers C10100, C10200, C10300, C10800, C12000, C12200, and C14200)
MIL-T-24270	Thermowells for Thermometers and Electrical Temperature Sensors, General Specification for
MIL-L-24479	Lubricant, Red Lead and Graphite in Mineral Oil
MIL-B-24480	Bronze, Nickel-Aluminum (UNS No. C95800) Castings, for Seawater Service

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MIL-C-24643	Cables and Cords Electrical, Low Smoke, for Shipboard Use, General Specification for
DOD-D-24577	Distiller Scale Preventative Treatment Formulations (Metric)
MIL-A-24696	Gasket, Sheet, Non-Asbestos
MIL-P-24691	Pipe and Tube, Carbon, Alloy and Stainless Steel, Seamless and Welded, General Specification for
MIL-P-24691/l	Pipe and Tube, Carbon Steel, Seamless
MIL-R-83248	Rubber, Fluorocarbon Elastoner, High Temperature, Fluid, and Compression Set Resistant

STANDARDS

MILITARY

MIL-STD-129	Marking for Shipment and Storage
MIL-STD-167-1	Mechanical Vibrations of Shipboard Equipment (Type I - Environmental and Type II - Internally Excited)
MIL-STD-271	Requirements for Nondestructive Testing Methods
MIL-STD-278	Welding and Casting Standard
MIL-STD-438	Schedule of Piping, Valves, Fittings, and' Associated Piping Components for Submarines Service
MIL-STD-740-1	Airborne Sound Measurements and Acceptance Criteria of Shipboard Equipment
MIL-STD-740-2	Structureborne Vibratory Acceleration Measurements and Acceptance Criteria of Shipboard Equipment
MIL-STD-777	Schedule of Piping, Valves, Fittings, and Associated Piping Components for Naval Surface Ships
DOD-STD-1399, Section 301	Interface Standard for Shipboard Systems Ship Motion and Attitude (Metric)

(Unless otherwise indicated, copies of federal and military specification, standards, and handbooks are available from the Naval Publications and Forms Center, (ATTN: NPODS), 5801 Tabor Avenue, Philadelphia, PA 19120-5099.)

2.1.2 other Government documents drawing and publications. The following other Government documents drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues are those cited in the solicitation.

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DRAWINGS

NAVAL SEA SYSTEMS COMMAND (NAVSEA)

B 214	Root Connections for Attaching Pipe
803-5959186	Submarine Heat Exchanger Anode Plug
803-1385541	Valves, Bronze Flanged, B-135, Globe

(Application for copies should be addressed to: Commander, Portsmouth Naval Shipyard, Code 202.2, Portsmouth, NH 03801.)

PUBLICATIONS

NAVSEA

0900-LP-001-7000	Fabrication and Inspection of Brazed Piping System
0908-LP-000-3010	Surface Ship Shock Design Criteria
T9070-M-DDT-010/(C) SUBS	Design Data for Submarine Combatants, Nuclear Powered Ship Motion Design Criteria

(Application for copies should be addressed to the Naval Publications and Forms Center, (ATTN: NPODS), 5801 Tabor Avenue, Philadelphia, PA 19120-5099.)

2.2 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DOD adopted are those listed in the issue of the DODISS cited in the solicitation. Unless otherwise specified the issues of documents not listed in the DODISS are the issues of the documents cited in the solicitation (see 6.2).

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

B1.1	Unified Inch Screw Threads (UN and UNR Thread Form); (DOD adopted)
B1.12	Class 5 Interference-Fit Thread

(Application for copies should be addressed to the American National Standards Institute, 1430 Broadway, New York, NY 10018.)

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AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

Boiler and Pressure Vessel Code, Section 111, Nuclear Power Plant Components

(Application for spies should be addressed to the American Society of Mechanical Engineers, 345 East 47th Street, New York, NY 10007.)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

A 285	Standard Specification for Pressure Vessel Plates, Carbon Steel, Low- and Intermediate-Tensile Strength; (DOD adopted)
A 515	Standard Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service; (DOD adopted)
B 61	Standard Specification for Steam or Valve Bronze Castings; (DOD adopted)
B 111	Standard Specification for Copper and Copper-Alloy Seamless Condenser Tubes and Ferrule Stock; (DOD adopted)
B 127	Standard Specification for Nickel-Copper Alloy (UNS N04400) Plate, Sheet, and Strip; (DOD adopted)
B 151	Standard Specification for Copper-Nickel-Zinc Alloy (Nickel Silver) and Copper-Nickel Rod and Bar; (DOD adopted)
B 152	Standard Specification for Copper Sheet, Strip, Plate, and Rolled Bar: (DOD adopted)
B 164	Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire; (DOD adopted)
B 171	Standard Specification for Copper-Alloy Plate and Sheet for Pressure Vessels, Condensers, and Heat Exchangers
B 584	Standard Specification for Copper Alloy Sand Castings for General Applications; (DOD adopted)
D 512	Standard Test Methods for Chloride Ion in Water
D 3951	Standard Practice for Commercial Packaging; (DOD adopted)
F 1166	Standard Practice for Human Engineering Design for Marine Systems, Equipment, and Facilities

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.)

(Non-Government standards and other publications are normally available from the organizations that prepare or disribute the documents. These documents also may be available in or through libraries or other informational services.)

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2.3 Order of precedence In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption 'has been obtained.

3. REQUIREMENTS

3.1 Qualification. Water distillation units furnished under this specification shall be products which are authorized by the qualifying activity for listing on the applicable qualified products list at the time of award of contract (see 4.2 and 6.5).

3.2 Shock resistance. Shock tests of complete distillation units or separately mounted components thereof weighing approximately 400,000 pounds (this weight includes the weight of the unit or component, test fixture, ancillary equipment and fluids) or less are required (see 4.4 and 6.2).

33 Dynamic analysis. Distilling units which cannot be shock tested shall be dynamically analyzed in accordance with NAVSEA 0908-LP-000-3010. The distilling units, sub-bases, feet, structural members and hold down bolts shall be included in the analysis.

3.4 vibration Distilling units shall be subject to the requirements of MIL-STD-167-1 (see 4.5).

3.5 Airborne and structureborne noise. Distilling units shall meet the requirements of - MIL-STD-740-1 for airborne noise of grade B equipment and in accordance with MIL-STD-740-2 for structureborne noise (see 4.6).

3.6 Reliability. The mean-time-between-failures (MTBF) and mean-time-to-repair (MTTR) shall be as specified (see 6.2 and 6.3).

3.7 Maintainability. The distilling unit shall be such that al! maintenance, both corrective and preventive, can be accomplished at the organizational level with no outside assistance. Preventive and corrective maintenance shall be demonstrated by successful completion of the maintainability demonstration (see 6.3). Demonstration within the maintenance envelope dimensions is required.

3.8 Safety. Safety design features, including fail safe features, shall be incorporated into the design to prevent damage to equipment and to ensure optimal personnel protection during operation, repair or interchanging of any component or assembly.

3.8.1 One-button shutdow. Distilling units for submarines shall accommodate a one-button shutdown of the unit which will safely secure all steam supply, seawater feed, and brine dilution, trip all solenoid-operated dump valves, and secure all distilling plant pumps. The one-button shutdown system will be provided by the shipbuilder.

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3.9 Human engineering. Human engineering in accordance with ASTM F 1166 as applicable shall be applied to the distiller to preclude or minimize the possibility of failure through improper operation or excessive and complicated maintenance procedures.

3.10 Size and weight. Distilling unit size and weight limitations shall be as specified (see 6.2).

3.11 Materials. The materials shall be as specified hereinafter. Any parts for which materials are not specified shall be of material best suited for the purpose intended and shall be approved by the drawing review activity.

3.11.1 Threaded parts. Threaded parts shall be in accordance with MIL-S-1222 except that materials shall be as specified herein. The construction shall be such that standard wrenches can be used throughout. Tapered pipe threads shall not be used. A class 5 interference fit in accordance with ANSI B1.12 shall be used for assembly of tap-end of studs. Studs shall not be bottomed or shouldered. For the set end of studs, a class 3 fit used with sealing compound, grade AV or AW of MIL-S-22473, may be substituted for a class 5 interference fit where temperatures do not exceed 220 degrees Fahrenheit (“F).

3.11.1.1 Thread lubricants. Threaded fasteners that have torque requirements shall be lubricated before assembly. The lubricant shall be in accordance with the following:

a. For submarine distilling plants the thread lubricant for bolting in joints involving seawater submergence pressure tightness shall be red lead and graphite in mineral oil per MIL-L-24479.

b. For fasteners exposed to steam or condensate, the thread lubricant shall be graphite in isopropanol in accordance with MIL-L-24131 (Military Symbol CGI).

c. For all other applications, the thread lubricant shall conform to one of the following:

(1) Graphite in isopropanol in accordance with MIL-L-24131 (Military Symbol CGI)
(2) Molybdenum disulfide in isopropanol in accordance with MIL-L24478

3.11.1.2 Fastener types. Fastener types shall be in the following order of preference:

a. Through bolt or through (two-nut) stud
b. Tap-end stud (one-nut)
c. cap screw.

3.11.13 cap screws. Cap screws shall not be used for waterbox-to-shell or waterbox-to-tube sheet bolting, for inspection cover bolting, or for corrosion-preventive anode support cover bolting.

3.11.1.4 Collar or stud bolts. Where collar bolts or stud bolts are used to make up a multiple flange joint, they shall have a square extension beyond the threads on one end for use of a wrench to prevent turning of the bolt when the nuts are tightened or removed.

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3.11.15 Thread engagement. Stud engagement shall hold the maximum design load. Engagement shall be not less than the diameter of the fastener. Nuts shall be fully engaged. For a threaded fastener, not less than one thread nor more than four threads shall protude beyond the crown of the nut. For threaded fasteners that have torque requirements, the bolting shall be tightened to a stipulated torque value by means of a torque wrench.

3.11.1.6 Screw thread selection.

3.11.1.6.1 Unified thread series. Unless otherwise specified herein, screw threads shall be of the unified thread series in accordance with ANSI B1.1.

3.11.162 Coarse and fine thread series. The coarse thread series shall be used unless the component design indicates a necessity for the fine thread series.

3.11.1.63 Eight-thread series. For fasteners of diameter 1 inch and larger, the eight-thread series shall be used.

3.11.2 Welding and allied processes. Welding and allied processes shall be in accordance with MIL-STD-278. Welded joints, except vent and drain nipple root connections, on the salt water side of heat exchangers subject to submarine submergence pressure shall be radiographable. Brazed connections may be used for vent and drain attachments to the salt water side of heat exchanger subject to submarine submergence pressure only for the case of gun metal and cast bronze water boxes; when used, they shall permit ultrasonic testing for bond and shall be fabricated and inspected in accordance with NAVSEA 0900-LP-001-7000, except that requirements for use of pre-inserted rings do not apply to the root connection. Brazing alloy shall contain not less than 43 percent silver. All pressure boundary welds regardless of size, fresh and sea water, shall be welded inside and out. Joints accessible only from one side shall be purged and welded with 100 percent penetration

3.113 Materials for type I evaporators and type V heat recovery units. The materials used in the construction of the evaporators of class 1 distillation units shall be as shown in table I. Materials for class 2 distilling units shall be as specified in table I, except that copper-nickel alloy shall be 90-10 composition.

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TABLE I. Materials for class 1 distillation units, on type I evaporation and type V heat recovery units.

Part	Material	Applicable document
Shell	Copper-nickel alloy, composition 70-30 minimum thickness 0.120 inch	MIL-C-15726
Tube sheets	Copper-nickel alloy, composition 70-30	MIL-C-15726
Tube support plates	Copper-nickel alloy, composition 70-30	MIL-C-15726
Steam chest (type I) or water boxes for hot fresh water (type V)	Copper-nickel alloy, composition 70-30;	MIL-C-15726 or MIL-C-20159
	or gun metal;	Alloy C90300 of ASTM B 584
	or valve bronze;	Alloy C92200 of ASTM B 584
	or nickel-aluminum bronze	MIL-B-24480
Baffles	Copper-nickel alloy, composition 70-30	MIL-C-15726
Mesh type separators with support grids	Nickel-copper alloy	ASTM B 164
Bolts, studs, nuts exposed to water or vapor or in joints involving water tightness	Nickel alloy grade 400, 405 or 500	MIL-S-1222
Stay rods, spacers, and stay rod nuts	Nickel-copper alloy or copper-nickel alloy, composition 70-30	ASTM B 164 ASTM B 111 and ASTM B 151
Other bolts and nuts	Nonferrous	MIL-S-1222
Piping, water	(see 3.14.30)	
Piping, steam inlet	(see 3.14.30)	
Piping, vapor	(see 3.14.30)	
Distillate condensor	(see 3.11.7)	
Distillate cooler	(see 3.11.8)	
Vapor feed heaters	(see 3.11.9)	
Drain regulators	(see 3.11.10)	

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3.11.4 Materials for evaporators and stage condensers for types II and XV. The materials used in instruction of the evaporator and stage condensers of class 1 distilling units shall be in accordance with table II. Materials for class 2 distilling units shall be as specified in table II, except that copper-nickel alloy shall be 90– 10 composition.

TABLE II. Material for class 1 distilling units, types II and IV evaporators and stage condensers.

Part	Material	Applicable document
Shell	Copper-nickel alloy, composition 70-30 minimum thickness 0.120 inch	MIL-C-15726
Tube sheets	Copper-nickel alloy, composition 70-30	MIL-C-15726
Tube support plates	Copper-nickel alloy, composition 70-30	MIL-C-15726
Baffles, flash devices, stage flow controllers, and so forth	Copper-nickel alloy, composition 70-30	MIL-C-15726
Mesh type separators with support grid	Nickel-copper alloy	ASTM B 164
Bolts, studs, and nuts exposed to water, or vapor or joints involving water tightness[1]	Nickel alloy grade 400, 405, or 500	MIL-S-1222
Stay rods, spacers and stay rod nuts	Nickel-copper or 70-30 copper-nickel	ASTM B 164 ASTM B 111 and ASTM B 151
Tie rods for spray caps exposed to salt water or brine feed flow	Nickel-copper alloy	ASTM B 164
Other bolts and nuts	Nonferrous	MIL-S-1222
Piping, water	(see 3.14.30)	
Piping, vapor	(see 3.14.30)	
Water boxes	Gun metal; or valve bronze; or copper-nickel alloy, composition 70-30; or nickel-aluminum bronze	Alloy C90300 of ASTM B 584 Alloy C92200 of ASTM B 584 MIL-C-15726 MIL-B-24480
Salt water feed heaters	(see 3.11.6)	
Distillate cooler	(see 3.11.8)	

[1]Materials for bolts, studs and nuts in joints subjected to submergence pressure (submarine service) shall be in accordance with 3.14.28.1.13.

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TABLE IV. Materials for class 1 distillation units, types II and IV salt waler feed heaters.

Part	Material	Applicable document
Shell	Steel plate (type II), or steel tubing (type II); or copper tubing (type IV)	ASTM A 285 or A 515 MIL-P-24691 and MIL-P-24691/1 MIL-T-24107
Tube support plates and baffle plates	Steel plate (type II), or naval brass (type IV)	ASTM A 285 or A 515 ASTM B 171
Water boxes	Copper-nickel alloy, composition 70-30; or valve bronze; or gun metal; or nickel-aluminum bronze	MIL-C-15726 or MIL-C-20159 Alloy C92200 of ASTM B 584 Alloy C90300 of ASTM B 584 MIL-B-24480
Steam piping	(see 3.14.30)	
Bolts, studs, and nuts in contact with water or vapor or for joints involving water tightness	Nickel alloy grade 400, 405 or 500	MIL-S-1222
Tie rods, tie rod nuts and spacers, (type IV)	70-30 copper-nickel alloy or nickel-copper alloy	ASTM B 111 and ASTM B 164
Tube sheets	Copper-nickel alloy, composition 70-30	MIL-C-15726
Other bolts and nuts	Nonferrous	MIL-S-1222
Drain regulator	(see 3.11.10)	

3.11.7 Materials for distiller condensers for types I, III, and V. The materials used in the construction of the distiller condenser shall be as shown in table V or class 1. Class 2 materials shall be the same as for class 1 except that copper-nickel alloy shall be of composition 90-10.

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3.11.5 Materials for type III evaporators. The materials used in the construction of the evaporators of class 1 distilling units shall be as specified in table III.

TABLE III. Materials for class 1 distillation units, type III evaporator.

Part	Material	Applicable document
Shell	Nickel-copper alloy, minimum thickness 0.120 inch	ASTM B 127
Corrugated baskets	Nickel-copper alloy	ASTM B 127
Mesh type separators with support grids	Nickel-copper alloy	ASTM B 164
Stay rods, spacers and nuts	Nickel-copper alloy	ASTM B 164
Bolts, studs, and nuts exposed to water, or vapor or for joints involving water tightness	Nickel alloy grade 400, 405 or 500	MIL-S-1222
Other bolts and nuts	Nonferrous	MIL-S-1222
Piping, water	(see 3.14.30)	
Piping, steam inlet	(see 3.14.30)	
Piping, vapor	(see 3.14.30)	
Distiller condenser	(see 3.11.7)	
Distillate cooler	(see 3.11.8)	
Vapor feed heater	(see 3.11.9)	
Drain regulator	(see 3.11.10)	

3.11.6 Materials for types II and IV salt water feed heaters. The materials for construction of the salt water feed heater shall be as shown in table IV for class 1 distillation units. Materials for salt water feed heaters of class 2 distilling units shall be as shown in table IV, except that all copper-nickel alloy used shall be 90-10 composition.

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TABLE V. Material for class 1 distillation units, types I, III, and V

Part	Material	Applicable document
Shell, if separate	Copper-nickel alloy, composition 70-30, minimum thickness 0.120 inch	MIL-C-15726
Tube sheets	Copper-nickel alloy, composition 70-30	MIL-C-15726
Tube support plates and baffle plates	Copper-nickel alloy, composition 70-30	MIL-C-15726
Water boxes	Copper-nickel alloy, composition 70-30, or nickel-aluminum bronze	MIL-C-15726 or MIL-C-20159 MIL-B-24480
Flash chamber	Copper tubing, or copper-nickel alloy, composition 70-30	MIL-T-24107 MIL-C-15726
Bolts, studs, and nuts in contact with water or vapor or in joints involving water tightness[1]	Nickel alloy grade 400, 405 or 500	MIL-S-1222
Tie rods, tie rod nuts, and spacers	Nickel-copper alloy, or 70-30 copper-nickel	ASTM B 164 ASTM B 111 and ASTM B 151
Other bolts and nuts	Nonferrous	MIL-S-1222

[1]Materials for bolts, studs, and nuts in joints subjected to submergence pressure (submarine service) shall be in accordance with 3.14.28.1.1.5.

3.11.8 Materials for distillate coolers, all types. The materials used in the construction of the distillate coder for class 1 distillation units shall be as show in table VI. Class 2 materials shall be the same as for class 1 except that copper-nickel alloy shall be composition 90-10.

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TABLE VI. Materials for class 1, distillate coolers.

Part	Material	Applicable document
Shell	Copper-nickel alloy, composition 70-30; or seamless copper tubing; or gun metal; or valve bronze minimum thickness 0-120 inch	MIL-C-15726 MIL-T-24107 Alloy C90300 of ASTM B 584 Alloy C92200 of ASTM B 584
Baffles	Copper-nickel alloy, composition 70-30, or naval brass	MIL-C-15726 ASTM B 171
Tube sheets	Copper-nickel alloy, composition 70-30	MIL-C-15726 or MIL-C-20159
Water boxes	Copper-nickel alloy, composition 70-30, or nickel-aluminum bronze	MIL-C-15726 or MIL-C-20159 MIL-B-24480
Bolts, studs, and nuts in contact with water or for joints involving water tightness[1]	Nickel alloy grade 400, 405 or 500	MIL-S-1222
Tie rods, tie rod nuts, and spacers	Nickel-copper alloy or 70-30 copper-nickel	ASTM B 164 ASTM B 111 and ASTM B 151
Other bolts and nuts	Nonferrous	MIL-S-1222

[1]Materials for bolts, studs, and nuts in joints subjected to submergence pressure (submarine service) sh ccordance with 3.14.28.1.1.5.

3.11.9 Materials for vapor feed heaters, types I and III. The materials used in the construction of the vapor feed heaters of class 1 distillation units shall be as shown in table VII. Class 2 materials shall be the same as for class 1 except that copper-nickel alloy shall be composition 90-10.

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TABLE VII. Materials for class 1 of types I and III vapor feed heaters.

Part	Material	Applicable document
Water boxes	Copper-nickel alloy, composition 70-30;	MIL-C-15726 or MIL-C-20159
	or gun metal;	Alloy C90300 of ASTM B-584
	or valve bronze;	Alloy C92200 of ASTM B 584
	or nickel-aluminum bronze	MIL-B-24480
Tube sheets	Copper-nickel alloy, composition 70-30	MIL-C-15726
Tube support plates	Copper-nickel alloy, composition 70-30	MIL-C-15726
Shell	Copper-nickel alloy, composition 70-30	MIL-C-15726
Bolts, studs, and nuts exposed to water or in joints involving water tightness[1]	Nickel alloy grade 400, 405 or 500	MIL-S-1222
Tie rods, tie rod nuts, and spacers	Nickel-copper alloy, or 70-30 copper-nickel	ASTM B 164 ASTM B 111 and ASTM B 151
Other bolts and nuts	Nonferrous	MIL-S-1222

[1]Materials for bolts, studs, and nuts in joints subjected to submergence pressure (submarine service) shall be in accordance with 3.14.28.1.1.5.

3.11.10 Materials for types I and III tube nest drain regulator and type II salt water feed heater drain regulator. The materials used in the construction of the regulator shall be as shown in table VIII.

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TABLE VIII. Materials for regulator.

Part	Material	Applicable document
Bodies and covers	Gun metal, or valve bronze	Alloy C90300 of ASTM B 584 Alloy C92200 of ASTM B 584
Valve	Nickel-copper alloy, wrought, or nickel-copper alloy, cast composition E	ASTM B 164 QQ-N-288
Float (for condensate)	Copper	ASTM B 152
Float (for salt water)	Nickel-copper alloy	ASTM B 127

3.11.11 Gasket application. For design pressures of 200 pounds per square inch (lb/in^2) and above, O-ring gaskets shall be used instead of flat gaskets. Blind gaskets (those incapable of being replaced without destructive disassembly) shall not be used.

3.11.11.1 Flat gaskets. Flat gaskets shall be 1/16 or 1/8-inch thick. Components shall be so constructed that a minimum gasket width of 5/16 inch is provided under waterbox partitions. Gasket material shall be acid resistant synthetic rubber in accordance with MIL-R-21252 exempt that non-asbestos gasket sheet in accordance with MIL-G-24696 shall be used where the temperature of metal surfaces contacting the gasket will exceed 250 degrees Fahrenheit (“F’) during any condition of operation.

3.11.11.2 O-ring gaskets. O-ring gaskets shall conform to class 1 of MIL-R-83248 or to type I of MIL-G-21610, except for the special applications for adaptors and plugs; in these cases; O-ring gaskets in accordance with class 2 of MIL-R-83248 shall be used. O-ring segments for sealing under waterbox partitions shall be integral with the peripheral O-ring. Design of retaining grooves for O-ring gaskets shall conform to MIL-G-5514.

3.11.12 Recovered materials. Unless otherwise specified herein, all equipment material, and articles incorporated in the products covered by this specification shall be new and may be fabricated using materials produced from recovered materials to the maximum extent practicable without jeopardizing the intended use. The term “recovered materials” means materials which have been collected or recovered from solid waste and reprocessed to become a source of new materials, as opposed to virgin raw materials. None of the above shall be interpreted to mean that the use of used or rebuilt products is allowed under this specification unless otherwise specifically specified.

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3.11.13 Prohibited material. The following material shall not be used for service, manufacture, test or inspection of distilling units:

a. Mercury (except fluorescent or mercury vapor lighting)
b. Carcinogenic materials
c. Cadmium, magnesium, lead (except for thread lubricant for bolting in joints involving seawater submarine submergence pressure tightness), or asbestos.

3.12 Operation.

3.12.1 Types I, II, and III. The distillation unit shall use steam at a pressure of 15 (lb/in^2) gage or less, to distill to a final vacuum at the air ejector suction of 7-1/2 inches of mercury (Hg) absolute pressure, or less (see 6.2), and shall deliver the distillate at a temperature not exceeding 95 'F with an initial temperature of seawater of 85 'F. For single effect units, the evaporator shell shall operate at a pressure of 11 to 14 inches of mercury absolute to distill seawater.

3.12.2 Type IV. The heat from hot fresh water at specified temperature (see 6.2) shall be transferred to seawater in a feedwater heater. The heated seawater shall then be injected into a flash chamber (or chambers in series) in which part of the seawater is flashed to vapor under a vacuum. The vapor shall then be condensed in a condenser.

3.123 Type V. Hot fresh water at specified temperature (see 6.2) shall be circulated through a tube bundle. The tube bundle shall be enclosed in a shell and surrounded by the seawater which is to be evaporated by transfer of heat from the fresh water. The vapor formal shall be condensed in a distiller condenser.

3.12.4 Types lV and V. Types IV and V shall distill to a final vacuum as required and shall deliver the distillate at a temperature not exceeding 95 'F with an initial seawater temperature of 85 'F.

3.12.5 Temperature In some cases, a higher distillate temperature than 95 'F may be accepted (see 6.2).

3.13 Rating. The average production rate shall be not less than the rated capacity of the unit (see 6.2) for 24 hours of continuous operation when supplied with seawater between 28 and 85 "F and with designed brine density as indicated on the heat balance drawing and related technical data after 90 days of normal operation. The 90 days of operation shall be as nearly continuous as practicable. Scale preventive treatment in accordance with DOD-D-24577 may be used during capacity tests.

3.13.1 Condition of operation. Unless otherwise specified (see 6.2), the distillation unit shall produce distillate having a salinity content not exceeding 0.0325 equivalents per million of chlorides (0.125 grain of sea salts per gallon) under all conditions of operation, when evaporating seawater

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of not less than 1/32 density (that is: 32 pounds of seawater containing 1 pound of dissolved solids) under the ship motion conditions given in section 301 of DOD-STD-1399 (see 6.2).

3.13.1.1 Orientation. The contractor shall advise the contracting activity if limitations of his design require orientation different from that specified for the distilling unit to meet the requirements specified herein (see 6.2).

3.13.2 Brine concentration. The distillation unit shall operate with a brine concentration of one and one-half thirty seconds density or less in the shell of the last evaporator effect or stage. This equates to a minimum seawater feed to distillate produced ratio of 3 to 1.

3.13.3 First stage. In type H distillation units the temperature of the feedwater entering the first stage feed inlet compartment shall be limited to between 165 and 175 “F.

3.13.4 Bacteriologically potable distillate. In type I, HI, IV, and V distillation units, provision shall be made for raising the temperature of the feedwater or distillate to at least 165 “F at some point in the cycle to ensure that the distillate is bacteriologically potable when the unit is operated with seawater feed considered contaminated, or with brackish feed which may be contaminated, and carry over of which would not register on the salinity indicators. Water shall not enter the unit at a lower temperature than 165 ‘F subsequent to the point at which the feed has been raised and held for not less than 7 seconds at that temperature.

3.14 Design. General design shall be as follows (see 6.3 and appendix A):

a. Distillation units shall be of the lightest and most compact construction consistent with reliability.

b. Distillation units shall be constructed and furnished as complete package type units to the extent that the shipbuilder need only to make external water supply and discharge connections, and external steam, air and electrical connections. Pumps, motors and controllers, steam pressure reducing valve (if required for proper operation of the unit), water meter, three way dump valve, and salinity indicating equipment shall be conveniently mounted on the unit and piped and wired by the distilling unit manufacturer. Motor controllers and salinity indicating equipment shall be mounted on a steel panel or panels l/4-inch minimum thickness. The distiller feed, brine, condensate drain, and distillate pumps may be located separately from the unit in order to permit ready accessibility for maintenance and to provide a better net positive suction head (NPSH) on the pumps pumping from a vacuum.

c. On units with mounted electrical equipment, the appropriate components shall be completely wired in accordance with MIL-E-917 and MIL-C-24643. When required by suction water level conditions, circulating and feed pumps shall be furnished by the distilling unit manufacturer for separate mounting by the shipbuilder (see 6.2).

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d. The distilling unit manufacturer shall furnish pumps of adequate capacity for the various services, with discharge pumping heads as determined by the shipbuilder (see 6.2), and with adequate motor horsepower as determined by these conditions.

e. Feed for types I and III distilling units shall be furnished normally under sufficient pressure from the distiller condenser circulating system by means of a back pressure valve in the overboard discharge line, the valve to be furnished by the shipbuilder. In the case of multi-effect units, in which this would require excessive circulating pump power, a separate feed pump shall be furnished (see 6.2).

f. Feed and circulating pumps shall be in accordance with MIL-P-17840 or MIL-P-17639 where these pumps are not covered in the rating charts of MIL-P-17840. Distillate, brine, and condensate pumps shall be in accordance with MIL-P-18472, except that the brine pump shall have mechanical seals in accordance with MIL-P-17639. The distillate and condensate pumps shall be furnished with stuffing box packing. Sealing water shall be supplied from the discharge piping except for the brine overboard pump which shall be supplied from the feed or circulating pump discharge. Individual motor driven pump units are required (double ended motor pump units are not permitted). Salinity indicating equipment shall be in accordance with MIL-S-5103. Steam pressure reducing valve shall be in accordance with MIL-V-18030. Each steam pressure regulating valve shall be supplied with isolation valves and by-pass the throttling valve, Y-strainer and supply and discharge pressure gauges. When specified (see 6.2), a water operated eductor shall be provided in lieu of a brine overboard pump.

g. A drain regulator (see 3.22) or other type of automatic level controller shall be furnished for any component of the distillation unit fresh water system wherein a specific water level must be maintained to permit operation of the unit.

h. When necessary (such as in submarine installation in which the seawater temperature varies rapidly when the depth of submergence changes), a thermostatically controlled valve shall be provided either in the outlet circulating water line from the distiller condenser or to bleed air into the condenser, so as to prevent sudden changes in vacuum and consequent unbalanced operation which will result in carry-over of salt water from the evaporator to the distiller condenser.

i. Cleanout openings or flanges shall be provided as required to enable manual cleaning out of accumulated scale, mud or sand from any location in which such accumulation, after any length of time, will interfere with the proper operation of the unit. Examples are:

(1) Seal pipes between effects or stages which may become clogged with flakes of scale or with mud or sand which may accumulate.

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(2) Chambers in which orifices are installed for injection of feed into the evaporating section. (Dislodged scale or debris may accumulate and clog the orifices.)

3.14.1 Type I. A type I distillation unit shall consist of one or more evaporating effects composed of a shell or shells in which horizontal, straight or U-bent tube bundles are submerged in the salt water to be evaporated and supplied with heating steam or vapor inside the tubes, a distiller condenser, distillate cooler if necessary, air ejectors and after-condenser, vapor feed heaters if necessary, integral piping, valves and fittings, thermometers, gauges, flash tank drain regulators, meters, pumps, motors, controllers, and salinity indicating equipment.

3.14.2 Type II. A type II distillation unit shall consist of one or more evaporating stages in a single or multiple shell, a salt water feed heater, distillate cooler if necessary,air ejectors, after condenser, integral piping, valves and fittings, thermometers, gauges, drain regulators, meters, pumps, motors, controllers, and salinity indicating equipment. Each stage shall be equipped with a feed inlet with means for introducing the feed into the evaporator shell in proper form for most effective flashing of part of the water into vapor, necessary baffles and a vapor separator to prevent carry over of salt water, and a stage condenser to condense the vapor so flashed.

3.143 Type III. A type III distillation unit shall consist of one or more evaporating effects, each composed of a vertical, corrugated basket or multiple baskets surrounded by a shell, in which the salt water to be evaporated is contained between the shell and basket corrugations and the heating steam or vapor is contained inside the corrugated basket, a distiller condenser, distillate cooler if necessary, air ejector and after condenser, vapor feed heaters if necessary, integral piping, valves and fittings, thermometers, gauges, flash tank drain regulators, meters,, pumps, motors, controllers, and salinity indicating equipment.

3.14.4 Type IV. A type IV distillation unit shall consist of one or more evaporating stages in a single or in multiple shells, a salt water feed heater for transferring heat from the hot fresh water to the sea water, distillate cooler if necessary, air ejector, after condenser or vacuum pump (see 6.2), integral piping, valves and fittings, thermometers, gauges, drain regulators, meters, pumps, motors, controllers, and salinity indicating equipment. Each stage shall be equipped with a feed inlet with means for introducing the feed into the evaporator shell in proper form for most effective flashing of part of the water into vapor, necessary baffles and a vapor separator to prevent carry-over of salt water, and a stage condenser to condense the vapor so flashed.

3.14.5 Type V. A type V distillation unit shall consist of one or more evaporating effects comprised of an evaporator shell or shells in which a tube bundle is submerged in the salt water to be evaporated and the hot fresh water is circulated through the tubes. The remaining components shall consist of a mesh vapor separator, a distiller condenser, air, sea water, brine and distillate pumps or eductors, distillate coder if necessary; valves, fittings, thermometers, gauges, drain regulators, meters, pump motors and controllers, and salinity indicating equipment.

3.14.6 Supports. Supporting feet or brackets shall secure the unit, its components or accessories adequately against high impact shock or when the ship is listed, pitching, or rolling (see 3.13.1). Components shall not be supported by plates or brackets in such manner that the

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primary means of support is the clamping action of the bolts securing the shell end flange-tube sheet-water box flange joints of the components, nor shall nozzle flanges or piping constitute the primary means of support of components or accessories.

3.14.6.1 Shock resistance

3.14.62 Bolts. Bolts to be stressed in shear shall be installed in holes not greater than the following sizes:

Nominal bolt diameter inch	Maximum diameter of hole inch
3/4 and smaller	Nominal bolt diameter plus 1/32
Larger than 3/4	Nominal bolt diameter plus 1/16

3.14.63 Rigid supports. Units that arc rigidly supported shall not be attached to two structures which can deflect relative to each other under shock loadings.

3.14.6.4 Shock mountings. Shock mountings shall not be used without prior approval from NAVSEA

3.14.63 Braces. Where braces must be employed to afford stability under vibration, the braces shall be constructed to fail under a load caused by a force equal to five times the weight of the unit. This bad shall be acting at the center of gravity of the unit.

3.14.6.6 Snubbers. Where snubbers must be employed to limit deflection under shock loading, the snubber shall be constructed in accordance with NAVSEA 0908-LP-000-3010.

3.14.697 Locking devices. The use of spring lock washers is not permitted. Acceptable locking devices are self locking nuts in accordance with MS 17828, lock tab washers in accordance with MS 18288 or lockwire.

3.14.7 Piping connections. Connection flanges (see 6.2) shall be in accordance with the applicable schedule of MIL-STD-777 for surface ships or MIL-STD-438 for submarines as appropriate. Root connections shall be in accordance with Drawing B 214. In lieu of instruction shown on Drawing B 214, nozzles may be fabricated from short lengths to pipe provided with a slip-on flange welded to one end, and pads shall be bar stock or plate of requisite thickness for studs. Nozzles shall be of the minimum length possible for installation or removal of through bolts,

3.14.7.1 Alternate flange construction. For surface ships, the main flanges of nonferrous fabricated water boxes or shells, the flanges of waterbox and shell nozzles, and the flanges of access openings when provided with a neck may be of steel in accordance with ASTM A 285, grade C. When the use of steel flanges is elected, they shall be constructed to ensure that the steel cannot come in contact with seawater. This shall be accomplished by lining the steel flange to a depth of

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not less than 3/16 inch thick with nickel-copper alloy or 70-30 copper-nickel alloy in accordance with MIL-E-22200 and MIL-E-22200/4 or type MIL-EN67 of MIL-E-21562, or nickel-copper alloy in accordance with MIL-9N10 of MIL-E-22200 and MIL-E-2200/3 or types MIL-RN60 or MIL-EN60 of MIL-E-21562. On the face of the flange this protection shall extend from the bore to at least the inner edge of the bolt holes. The 3/16 inch thickness of the protecting alloy is the minimum required after final machining of the flange. Inlay thickness shall be verified after depositing (allowance for machining shall be provided) and, after final machining of the flange.

3.14.8 Waterboxes. Components of the distillation unit which require salt water circulation through the tubes shall be provided with waterboxes so proportioned as to provide sufficient area at all points for flow of the circulating water with a minimum of turbulence, and for uniform distribution of the water to all tubes in each pass. Single pass components shall have an inlet waterbox depth measured normal to the tube sheet at the center of not less than one-half the diameter of the tube sheet exposed to circulating water flow. Multi-pass components shall have waterboxes so constructed that the depth at each inlet pass, at the center thereof, shall be not less than one-half of the diameter of a circle of area equivalent to that portion of the tube sheet exposed to inlet circulating water flow. Waterboxes shall be provided with adequate vents, including vent holes in the partitions between passage and with drains as necessary.

3.14.9 Flow velocity limits. The velocity of flow of circulating water or feed entering the inlet nozzles of the distillate coder, distiller or stage condensers, air ejector pre-cooler and after-condenser, and vapor or salt water feed heaters shall not exceed 7.5 feet per second average under the rated conditions. Salt water feed heaters of type II units using recirculated brine may be designed for an average velocity through the tubes of 8 feet per second. If divergent nozzles are provided, this velocity shall not be exceeded at the actual entrance of the water into the waterbox.

3.14.10 Salt water feed beating. In types I and III, provision for heating the salt water feed shall be made by segregation of a section of the distiller condenser tubes, circulation of the feedwater through the ejector after condenser, and provision of a vapor feed heater for each evaporator effect except the last, the feedwater being circuited through these components in series. The foregoing series may be varied as best suits the design of the unit for operation with varying water temperatures. In types 11 and IV, provision for heating the sea water feed shall be made by circulation of the feedwater through the distillate cooler, the stage condensers, the ejector after condenser, and the salt water feed heater in series.

3.14.11 Installation of salinity cells. Provision shall be made as applicable in the integral piping or drain regulators for installation of salinity cells in the fresh water drains from each component of the distillation unit in which salt water leakage may contaminate the condensate or distillate. The salinity cells shall be so oriented as to be submerged in water under any condition of operation. Cells associated with dump valve operations shall be located a sufficient distance upstream of the valve to prevent passage through the valve of any contamination sensed by the salinity cell.

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3.14.12 Dump valve. A three-way solenoid operated distillate dump valve, the solenoid being actuated by the salinity cell located in the line provided for final delivery of distillate (after all heat exchangers), shall be provided with the distillation unit. The valve shall be in accordance with MIL-V-16556.

3.14.12.1 Type III. An additional solenoid operated dump valve, in accordance with MIL-V-16556, actuated by the salinity cell located in the air ejector after condenser drain line shall be provided with type 111 distillation units using vertical distiller condensers unless the air offtake thereof and the air ejector are so located that there is no possibility of carry-over of salt contaminated distillate into the after condenser.

3.14.12.2 Type II. On type II distillation units, a three-way solenoid-operated dump valve in accordance with MIL-V-16556, actuated by a salinity cell located in the drain line from the salt water feed heater, shall be installed in the salt water feed heater drain line. The drain line from the air ejector after condenser shall connect to the salt water feed heater hotwell through a loop seal.

3.14.13 Tubes. Tubes in the evaporators, vapor feed heaters, distiller condenser, stage condensers, salt water feed heaters, and distillate coder shall be composition 90-10 in class 2 distillation units, or composition 70-30 in class 1 distillation units, in accordance with MIL-T-15005. Tubes shall normally be 5/8 inch outside diameter (od), number 18 Birmingham wire gauge (BWG) (0.049 inch wall thickness). In small capacity units of up to 5,000 gallons per day of distillate, when the use of smaller diameter tubes will result in fewer passes in the above heat exhangers, the tubes may be 3/8 inch od, number 18 BWG. In some submarine usage, the tubes may be required thicker than number 18 BWG (see 6.2).

3.14.13.1 U-bent tubes. When U-bent tubes are allowed (see 3.15.2, 3.16.1, 3.19.1, 3.20.1, 3.21.1), the minimum radius of the U-bend shall be 5/8 inch for 3/8 inch od tubes, 15/16 inch for 5/8 inch od tubes, and 1-1/8 inch for 3/4 inch od tubes.

3.14.13.1.1 Expansion of tubes. Tubes shall be expanded at each end into the tube sheets by means of an automatic tube expander control and with tube expanders in accordance with MIL-E-15809. The tube expander shall be adjusted so that expansion of the tube is stopped within 1/8 inch of the inner face of the tube sheet. In double tube sheet heat exchangers, the expansion of the tubes in the inner tube sheet shall not start closer than 1/8 inch from the outer face of that tube sheet and shall stop within 1/8 inch of the inner face. Care shall be taken that there is no abrupt change in contour of the inner tube surface caused by the expanding operation. The expander shall be set such that a wall reduction of approximately 10 percent is attained. .

3.14.14 Tube sheet drilling. The holes for 3/8 inch od tubes shall be reamed to 0.376 inch diameter with a plus tolerance of 0.005 inch. The holes for 5/8 inch od tubes shall be reamed to 0.626 inch diameter with a plus tolerance of 0.005 inch- The holes for 3/4 inch od tubes shall be reamed to 0.751 inch diameter with a plus tolerance of 0.005 inch. The holes for the inlet ends of the tubes shall be flared on a radius of 5/16 inch for 3/8 inch od tubes, 1/2 inch for 5/8 inch od

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tubes and 3/4 inch od tubes, to a diameter at the outer face of the tube sheet of 1/2 inch for 3/8 inch od tubes, 3/4 inch for 5/8 inch od tubes, and 7/8 inch for 3/4 inch od tubes.

3.14.15 Tube sheet thickness. The minimum acceptable tube sheet thickness shall be 3/4 inch for 5/8 inch od tubes and 5/8 inch for 3/8 inch od tubes. (For 3/4 inch od tubes see 3.18.1.3.)

3.14.16 Tube spacing. The minimum acceptable tube spacing shall be 13/16 inch, center-to-center for 5/8 inch od tubes and 17/32 inch for 3/8 inch od tubes (For 3/4 inch od tubes see 3.18.1.4.)

3.14.17 Support plates. Tubes of 3/8 inch and 5/8 inch od shall be supported by tube support plates so that the maximum span between tube sheet and support plates or between support plates will not exceed 2 feet and 3 feet respectively. If the construction is such that the cross-flow baffles drilled for the tubes are installed between the tube sheet and support plates and between support plates, the thickness of the support plates and baffles shall be not less than 1/4 inch. If such cross-flow baffles are not installed, the support plates shall be not less than 9/16 inch thick. Holes for tubes in support plates shall be drilled not more than 1/64 inch diameter larger than the nominal outside tube diameter. Holes for tubes shall be rounded on each face of the support plate to a 1/16 inch radius. Holes in cross-flow baffles shall have sharp edges removed (For 3/4 inch od tubes see 3.18.1.5.)

3.14.18 Shell expansion. Provision shall be made for expansion and contraction of the shell of shell and tube type heat exchanger components of distillation units. Acceptable provisions for shell expansion and contraction are:

a. One support shall be constructed to flex and the other support shall be rigid, both drilled as specified in 3.14.6.2

b. Both supports shall be rigid. One support shall be provided with slotted holes for the foundation bolts. A bushing shall be provided around the foundation bolt, so dimensioned that the bolt head is prevented from binding the support when the nut is tightened. Clearance between a shoulder on the bushing and a machined or spot-faced surface surrounding the bolt hole shall not exceed 0.005 inch, in order to minimize impact on the foundation bolt under high impact shock load. Total clearances of the inside diameter of the bushing over the nominal bolt diameter and the width of the slotted hole in the support over the od of the bushing shall not exceed those specified in 3.14.6.2 The other support shall be drilled as specified in 3.14.6.2

c. When U-bent tubes are used, an expansion joint shall be provided in the shell between two rigid supports.

d. When one support constructed to flex is used, the rigid support shall be constructed to withstand the entire high impact shock load in the direction longitudinal of the heat exchanger. When a shell expansion joint is heated between two rigid supports, each support shall be constructed to withstand the high impact shock load equivalent to the

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weight of the tube bundle plus that of the adjacent water box and that portion of the shell between the expansion joint and the shell end flange adjacent to the support, in the direction longitudinal of the heat exchanger.

3.14.l8.l Unrestrained expansion and contraction. Provision for unrestrained expansion and contraction of the tubes of all shell and straight tube type heat exchanger components of the distillation unit shall be made by use of an expansion joint in the shell, located between one supporting foot and the shell end flange, or by use of floating head instruction- In the case of heat exchangers with an odd number of passes, restraint of tube expansion and contraction shall be avoided by providing an expansion joint in the piping connected to the water box adjacent to the shell expansion joint or the floating head. If the piping is integral with the distillation unit, the expansion joint shall be provided with the piping.

3.14.19 Component removal provisions. Adequate guides, slides, lifting lugs, and access openings shall be provided to facilitate removal of the evaporator tube nests or baskets, mesh vapor separators, stage condenser tube bundle and vapor feed heater tube nests from the shells and for handling the water boxes of the distiller condenser, stage condensers, salt water feed heater and the distillate cooler.

3.14.20 Jack screws. Jack screws shall be provided in all flanges of flanged joints that must be disassembled for maintenance. Jack screws are not required for flanged joints which incorporate O-ring face seals.

3.14-21 Bolts or stud bolts. The water box flange, tube sheet and shell flange joints of all components shall be secured by through bolts or stud bolts. Studs shall not be used unless it is impracticable to use through or stud bolts. If through bobs are used, alternate bolts shall be collar bolts; if stud bolts are used they shall be driven into tapped holes in the tube sheets, so that the joint between the tube sheet and shell flange will not be broken when the water boxes are removed. Collar bobs shall be replaceable without removing the water boxes. Collar and stud bolts shall be provided with one square end for use of a wrench to prevent turning when the nut at the water box flange end is removed.

3.14022 Sight glass. Sight glass assemblies, if glass is used, shall be composed of a metal flanged frame to be bolted to a boss or flange on the evaporator shell. The flame shall contain the sight glass. The glass shall be secured with gaskets by means of a ring screwed into the flame so as to obtain even pressure on the glass, and so that the pressure on the glass is not changed when the sight glass frame assembly is removed from the evaporator shell. Jack screws shall be provided in the flange of the frame. Glasses shall be in accordance with MIL-G-2860.

3.14.22.1 Plastics acrylic sight glass assemblies. The use of plastic acrylic heat resistant sheet shall be limited to applications having service temperatures below 150 “F. Sight glass assemblies, if plastic acrylic heat resistant sheet is used in lieu of glass, shall be a single flange, bolted to the face of a pad or flange on the evaporator shell, securing the plastic sheet thereto between resilient gaskets. The flange shall be provided with jack screws. The plastic sheet shall be finish A in accordance with MIL-P-5425 and shall be of suitable thickness for the intended service.

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3.14.23 Vents and drains. Vents and drains shall be provided in each component as required. Low points in integral piping which will not drain when the distillation unit is shut down shall be provided with a plugged drain so that they may be drained when the ship is secured and unheated.

3.14.24 Cathodic protection Readily replaceable zinc anodes in accordance with MIL-A-19521 shall be installed in the salt water circuits of all heat exchangers of the distillation units except the evaporating shells in accordance with the following:

a. For submarine submergence pressure applications, threaded support plugs shall not be used. Cover plates secured by four or more threaded fasteners shall be used for support of anodes.

b. For submarine non-submergence pressure applications, bolted rover plates or threaded plugs shall be used for support of anodes. If used, threaded plugs shall conform to Drawing 803-5959186.

c. For surface ship applications, support plugs shall be of the straight thread O-ring seal type in accordance with MIL-A-19521. In exception to the material requirements of MIL-A-19521, plug materials shall conform to the following:

Nickel-copper alloy	QQ-N-281 or ASTM B 164
70-30 Copper-nickel alloy	MIL-C-15726 or alloy 715 of ASTM B 151

3.14.25 Air ejector assemblies. The air ejector assembly furnished with the distillation unit shall conform to type II of MIL-E-15465. The class shall be the same as specified for the distillation unit, except for saturated steam propelled ships the air ejector assemblies shall be class 3. Only one air ejector is required. Furnishing of a single or two stage air ejector unit shall be determined by the distillation unit manufacturer as best fitting the vacuum requirements of the distillation unit. A two stage air ejector shall be of the type which does not require an inter-condenser. The air ejector steam pressure and temperature shall be as specified (see 6.2).

3.14.25.1 Oversized air ejectors. Oversized air ejectors and their after condenser shall not be provided for the purpose of obtaining extra feed heating by using the high pressure air ejector motive steam and thus decreasing the number of stages or effects or the size of the evaporators or the salt water heater which uses low pressure auxiliary exhaust steam.

3.14.25.2 Check valve A check valve shall be provided in the air off-take line between the distiller or stage condenser and the air inlet of the air ejector, or at the discharge of the air ejector, to prevent loss of vacuum in the condenser due to sudden fluctuations in the steam supply to the air ejector.

3.14253 Nozzles. Nozzles for units constructed with multi-stage air ejectors shall not be interchangeable.

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3.14.25.4 Steam chests. Air ejector steam chests for all units shall be manufactured of a 400 series stainless steel.

3.1425.5 Test orifice A test orifice connection with orifice plate and cut-out valve shall be installed in the air ejector suction piping. The test orifice connection shall be installed downstream of the cut-out valve to allow a metered amount of air to the air ejector suction to check air ejector performance.

3.14.26 Vacuum pump. When specified (see 6.2), the vacuum pump for types IV and V distilling units shall be in accordance with MIL-V-18683. Pumps shall be single or multiple stage as required by vacuum conditions.

3.14.26.1 Eductor. In lieu of the vacuum pump specified in 3.14.26, a water operated eductor may be furnished. Materials shall be nickel-copper alloy for the eductor nozzle and bronze in accordance with ASTM B 61 for the eductor body.

3.14.27 Flow meters. Flow meters shall be provided for each type I, III, or V distillation unit. Meters for flow of feed or brine shall be of a construction which is not readily affected by scale formation. In particular, meters equipped with a guide rod on which the float rides, or with an indicating rod mounted on the float and extending through a guide or packing gland are not acceptable. If method of feed is such that the ratio of feed and distillate must be controlled feed and distillate meters shall be provided; otherwise, only a feed meter will be required.

3.14.27.1 Water meter. A distillate water meter shall be provided with each unit. Meter shall conform to class B in accordance with MIL-M-2082, except that a magnetic drive shall be provided.

3.14.28 Distilling units for saturated steam propelled surface ships and submarines.

3.14.28.1 Submergence pressure. In submarines, the feed for the distilling unit will be reduced from submergence pressure to that required by the feed circuit of the unit by means of a pressure reducing valve furnished by the shipbuilder who will also furnish a relief valve to safeguard against malfunction of the reducing valve. Any parts of the distilling unit located ahead of the reducing valve and thus subjected to submergence pressure shall be constructed to withstand this pressure.

3.14.28.1.1 Heat exchangers. Heat exchangers of the shell and tube type provided as components of the distillation unit for saturated steam propelled surface ships or submarines shall be provided with two tube sheets at each end, except when U-bent tubes are used, two tube sheets shall be used at the inlet-outlet end. For straight tube bundle exchangers, the inner tube sheets shall be welded to the shell. A space not less than 1/2 inch wide shall be provided between the tube sheets by use of a spacer ring or by machining one face of one or both tube sheets. The space shall be provided with a vent and drain to atmosphere. The joint between tube sheets or between tube sheet and spacer shall be welded. The contractor shall be responsible for providing the proper span of tubes between double tube sheets, so that the tubes will not be overstressed due to radial expansion differentials of the double tube sheets (see 6.3 and appendix C).

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3.14.28.1.1.1 Tube sheet tube holes. For submarines, in heat exchangers subjected to submergence pressure, the tube sheet shall be drilled as specified in 3.14.14 or 3.18.12, except that the holes for 3/8 inch, 5/8 inch or 3/4 inch od tubes in the outer tube sheets shall have three grooves 1/8 inch wide and 0.012 inch deep, located 1/8 inch apart, and the holes for 3/8 inch, 5/8 inch or 3/4 inch od tubes in the inner tube sheets shall have two grooves 1/8 inch wide and 0.012 inch deep, located 1/8 inch apart. In heat exchangers not subjected to submergence pressure in submarines and in those for saturated steam propelled surface ships, the tube sheets shall be drilled as specified in 3.14.14 or 3.18.1.2 except that the inner tube sheet holes shall have one groove 1/8 inch wide and 0.012 inch deep.

3.14.28.1.1.2 Tube expansion. Tubes shall be expanded into both inner and outer tube sheets at each end specified in 3.14.13.1.1. Minimum depth of expansion in the inner tube sheet shall be 1/2 inch for 3/8 inch od tubes, 5/8 inch for 5/8 inch cd tubes and 3/4 inch for 3/4 inch od tubes, The expander shall be set such that a wall reduction of approximately 10 percent is attained. After expansion of the tube ends, the specified water side hydrostatic test pressure shall be applied to the spaces between the double tube sheets (see 4.3.1.1).

3.14.28.1.1.3 Water box flanges. The water boxes shall have either internal or external flanges. Internal water box flanges shall be studded, with nuts on the shell side of the inner tube sheet, and guide pins longer than the studs and inserted in holes having smaller diametrical clearance than the holes for the studs shall be provided to prevent damage to the threads on the studs when the water boxes are installed. Through bolts shall be used with external water box flanges.

3.14.28 .1.1.4 Parts subjected to submergence pressure Parts subjected ‘to submergence pressure including structure composed of outer and inner tube sheets together with short sections of tubes between paired inner and outer tube sheets, shall be constructed in accordance with the requirements of the ASME Boiler and Pressure Vessel Code, Section III, Nuclear Power Plant Components, class 1 components, as a minimum, except welding shall be in accordance with MIL-STD-278. Reinforcement of openings shall be integral with the water box shell or nozzle (or both). Separate pads or saddle type reinforcements shall not be used. Welds shall be ground smooth and the comers and fillets shall be well rounded as necessary to minimize notch effect. In the design of heat exchangers, the forces exerted by the circulating water inlet and discharge piping on the respective water box nozzles shall be as follows:

$$\text{Piping axial load} = \pi\, r_m\, t \left(Sy - \frac{P\, r_i}{2\, t}\right)$$

$$\text{Piping bending moment} = 1.3\, \pi\, r_m^2\, t \left(Sy - \frac{P\, r_i}{2\, t}\right)$$

$$\text{Piping torsional moment} = \pi\, r_m^2\, t \sqrt{Sy^2 - \frac{P\, r_i}{(2\, t)^2}}$$

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where:

P = design pressure for component, lb/in^2
r_i = pipe inside radius, inches
r_m = pipe mean radius, inches
S_y = tabulated value of yield strength of the piping material at componen design temperature, lb/in^2
t = pipe thickness, inches (see 6.2)

3.14.28 .1.1.4.1 Force loading. In the design of heat exchanger salt water sides, full consideration shall be given to the cyclic nature of the pressure and external force loading. The design shall be based on the number of total depth changing cycles specified in NAVSEA T9070-AA-DDT-010/(C) SUBS, with associated temperature variation in conjunction with that piping reaction load (see 3. 14.28.l.l.4) that produces the highest stress, 8,000 cycles of start up and shut down, 200 cycles each of the specified hydrostatic test pressure when applied in the water box or between the double tube sheets and 300 cycles of loss of seawater (see 6.3 and appendix C). The analysis shall be in accordance with the methods and criteria of ASME Boiler and Pressure Vessel Code, section III, division 1, class 1 components. Design fatigue curves for materials commonly used in distillation units and design stress intensity values for materials not covered in section III (class 1 components) of ASME code shall be obtained from NAVSEA or the purchaser. Method of analysis of flat perforated plates shall be in accordance with Article A-8000, of Section III of ASME Code, division 1, appendices. Cumulative usage factor for all cyclic transients shall not exceed 0.8.

3.14.28.1.1.4.2 Submergence pressure Heat exchangers subjected to submergence pressure shall have an even number of salt water passes, so that the inlet and outlet salt water nozzles will be on the same water box. Thus the stiffness of the piping will not affect expansion or contraction of the heat exchanger tubes.

3.14.28.l.l.5 Bolts and studs composition Bolts and studs subjected to submergence pressure shall be nickel-copper alloy in accordance with QQ-N-281, class A, hot finished; or nickel-copper alloy in accordance with MIL-N-24106, cold drawn, and stress relieved or hot finished; or nickel-copper-aluminum alloy in accordance with QQ-N-286, class A, hot finished, annealed and age hardened or cold drawn, annealed and age hardened. Nuts for these bolts and studs shall be nickel-copper alloy in accordance with QQ-N-281, class A or B, hot finished condition; or nickel copper alloy in accordance with MIL-N-24106, cold drawn and stress relieved or hot finished; or nickel-copper alloy in accordance with ASTM B 164, hot finished. Nickel-copper-aluminim alloy bolts and studs shall also conform to MS 18116.

a. Calculated bolt stress due to design pressure shall be limited to one-third of the yield strength of the material at the design temperature.

b. Maximum value of service stress average across bolt cross-section and neglecting stress concentration factor shall be limited to two-thirds of the yield strength of the material at the design temperature.

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c. Maximum value of service stress at periphery of the bolt cross-section resulting from tension plus bending neglecting stress concentration factor shall be limited to the yield strength of the material at the design temperature.

d. Threaded fasteners with torque requirements shall be lubricated with red-lead-graphite mineral oil per MIL-L-24479.

e. The range of inefficient of friction for the lubricant shall be accounted for in determining torque value as follows:

(1) Using the hydrostatic test load or the load bawl on design pressure plus maximum piping load on nozzles, whichever is greater, and high coefficient of friction (μ = 0.13), determine torque using the following equation:

$$T = \frac{Pr_t}{12}\left(\frac{\cos\theta\tan\alpha + \mu}{\cos\theta - \mu\tan\alpha} + \frac{r_c\,\mu}{r_t}\right)$$

where:

r_t = minimum pitch radius of external threads (inches)
= 1/2 of thread angle (degrees)
= helix angle (degrees)
= arc tan $[1/(2\pi r_t N)]$, where N = number of threads per inch
r_c = collar radius, average of $D_h/2$ and bolt major radius (inches), where
D_h = diameter across flats of nuts (average of maximum and minimum inches)
D = average of mean pitch and minor diameters of external thread (inches)
μ = 0.13, coefficient of friction (high value), dimensionless
T = torque (foot-pounds)
P = load as defined above (pounds)

(2) Using the installation torque above and low coefficient of friction (μ = 0.065), determine stress from the following equation:

$$S_{av} = \frac{P}{6\pi\mu^2 D_h^2 D^3}\left[(D^2 + 16\mu^2 D_h^2)^{3/2} - D^3\right] \text{ lb/in}^2$$

P in this equation is the preload force in pounds, using the low coefficient of friction (0.065) and the installation torque calculated above. This calculated stress when combined with other stresses specified in ASME shall not exceed the limits of ASME Boiler and Pressure Vessel Code, section III.

f. Fatigue analysis of bolts shall be in accordance with section III, division 1, subsection NB, class 1 of ASME Boiler and Pressure Vessel Code, except that cumulative usage factor shall not exceed 0.8.

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g. Submergence pressure boundary studs and bolts shall be of a reduced shank design to reduce bending stresses.

3.14.281.1.5.1 Inspection openings. Threaded fasteners securing water box inspection openings in submarine distilling plant heat exchangers subjected to submergence pressure shall be designed such that 200 inspection cover removal and reinstallation cycles and the cycles specified in 3.14.28.1.1.4.1, will not cause the maximum cumulative usage factor to exceed 0.8. The effect on threaded fastener stress levels caused by any movement between the inspection rover and inspection cover flange when the seawater side of the water box is pressurized shall be specifically analyzed. The amount of movement or relative slip used in above analysis shall be confirmed during factory hydrostatic testing of first unit (see 4.3.1.1). The measured amount of relative slip shall be compared to the assumed value. The fastener shall meet the requirements of ASME Boiler and Pressure Vessel Code, section III, division 1, subsection NB, class 1 components when the measured slip (rather than the assumed slip) is factored into the analysis.

3.14.28.1.1.6 Operation. Distillation units for submarines shall operate at an ambient pressure of 30 inches of Hg absolute with a variable of plus or minus 6 inches Hg and shall not be damaged when subjected to an ambient absolute pressure between 10 and 30 lb/in^2 with the minimum internal pressure which will prevail under any condition of operation.

3.14928,2 Shutdown. Distilling units on saturated steam propelled surface ships and submarines shall accommodate a one-button shutdown of the unit which will safely secure all steam, sea water feed and brine dilution, trip all solenoid operated dump valves and secure all distilling plant pumps. The one-button shutdown system will be provided by the shipbuilder.

3.14.283 Heating steam circuit For distilling units on saturated steam propelled surface ships, the heating steam circuit of the salt water feed heater shall be vented to atmosphere only. The vent piping shall contain an orifice sized for normal operation. A bypass with globe valve shall be provided around the orifice for use during start up.

3.14.29 Acid cleaning connections. Connections, with hose-gate valves, complete with chain and cap shall be provided in the integral piping of the unit, if feasible, or in shipbuilder furnished external piping, for introduction, circulation and discharge of acid solution for chemically cleaning the distilling unit. Type II units shall have the feedwater piping so arranged that reducing flanges with 1 inch nominal pipe size nipples (to be furnished with the unit) may be installed to permit the salt water heater, the air ejector after condenser and the stage condensers to be individually chemically cleaned

3.1430 Piping. Integral piping, valves, fittings and similar items shall be in accordance with MIL-STD-777 or MIL-STD-438 as applicable Seawater feed control valves for Types II and IV distilling plants shall be in accordance with MIL-V-18030 or Drawing 803-1385S41 except that valve body, seat and disc material shall be nickel copper alloy.

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3.1431 Scale preventive compound Connections shall be provided for introduction of scale prevention compound into the salt water feed stream.

3.14.32 Proportioning pump. A proportioning pump and supply tank, in accordance with MIL-P-21397, shall be furnished for introduction of the scale preventive compound.

3.14.32.1 _Flow meter. A flow meter of design, materials, and measurement range for usc with either feed treatment addition or on-line citric acid cleaning, shall be furnished.

3.15 Evaporators for type I, submerged tube type low pressure steam operated or type V heat reovery units.

3.15.1 Cleaning and descaling. The tubes and tube nests shall be arranged as to be readily removable and easily accessible for cleaning, descaling and repairs; and so that cleaning and descaling can be accomplished with the removal of the least possible number of fittings and connections.

3.15.2 Tubes. Two steam passes (type 1) or water passes (type V) shall be provided, The tubes shall be so arranged that none of the heating surfaces will be exposed above the normal working water level. The evaporator tubes may be straight and expanded into tube sheets at each end or may be U-bent tubes expanded into an inlet/outlet tube sheet.

3.15.3 Scale preventive compound. The piping system of the distilling unit shall be provided with a connection for injection of a scale preventing compound, so located that the compound will pass through the tubes of all salt water feed heaters and all of the compound will pass into the first effect evaporator shell with the feed.

3.15.4 Sump space An adequate sump space underneath the tubes shall be provided for scale to lodge. A flat removable rover shall be provided so that the sump may be cleaned without removing the tube nest.

3.15.5 Baffles. Baffles for suppression of wash and for moisture separation shall be fitted over the tube nest as necessary to meet the requirements of 3.13.1.

3.15.6 Heating surface The ratio of heating surface of tubes to the disengaging surface (water surface) shall not exceed 14.5 (type I).

3.15.7 Shell. The shell of each evaporator effect shall be fitted with two sight glasses located just above the working water level.

3.15.8 Air vents and valves Each tube nest shall be provided with adequate air vents, and valves shall be provided for regulation thereof.

3.15.9 Strainers. Strainers shall be provided in the evaporator shells or in the integral piping of the distillation unit for the brine overboard pump suction and for the evaporator feed between effects. Access shall be provided for cleaning any strainer installed inside the shell.

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3.5.10 Level controls. Adjustable or fixed weir type level controls shall be provided for maintaining a constant level of brine in each effect.

3.15.11 Evaporator. The following connections and fittings shall be provided for each evaporator:

a. Evaporator shells: (minimum thickness 0.120 inch)

(1) Feed inlet connection
(2) Brine outlet connection
(3) Compound pressure and vacuum gauge, 4-1/2 inch diameter
(4) Water gauge glass, with mark showing top of the tubes. When weir level controls are provided, gauge glasses shall be located thereon.
(5) Relief valve (first effect only)
(6) Vapor discharge connection
(7) Sump with removal plate for cleaning
(8) Foundation fittings and necessary attachments for anti-rolling braces, where fitted
(9) Drain from vapor separator if external separator is provided
(l0) Sight glasses
(11) Air vent from brine pump in last effect shell only.

b. Evaporator steam heads

(1) Steam supply connections
(2) Drain connection
(3) Air vent connections
(4) Relief valve (first effect only)
(5) Gauge glass; except when drain regulators are provided, the gauge glass shall be located thereon
(6) Compound pressure and vacuum gauge, 4-1/2 inch diameter
(7) Thermometer
(8) Lifting and handling eyebolts or lugs.

3.15.12 Orifice plate One orifice plate with proper size orifice shall be provided with the type I distillation unit for the steam supply to the fret-effect steam chest to limit the steam flow to that specified for rated capacity. Orifice plate shall be provided with a tab for pulling and shall be stamped with the orifice size and manufacturer's part number.

3.15.13 Desuperheater. A desuperheater shall be provided in the steam supply piping furnished with the distillation unit, if required for proper performance of the unit (type I). Desuperheater shall be supplied with a strainer and isolation valve.

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3.15.14 Vapor separator. Each evaporator effect shall be provided with a mesh type vapor separator, so constructed as to remove all entrained salt water from the vapor generated before the vapor passes into the vapor feed heater or the distiller condenser. The vapor separators shall be removable from the evaporator shells without other component disassembly.

3.16 Evaporator and stage condensers for types II and IV.

3.l6.l Tubes. Tubes of the stage condensers may be straight and expended into tube sheets at each end or may be U-bent and expanded into an inlet-outlet tube sheet.

3.162 Baffles. Baffles for suppression of swash and for moisture separation shall be fitted as necessary to meet the requirements of 3.13.1.

3.163 Shell. The shell of each evaporator stage shall be fitted with a sight glass. Minimum thickness for evaporator and stage condenser shell material shall be 0.120 inch.

3.16.4 Connection and fittings. The following connections and fittings shall be provided as required for the evaporators and the condensers:

a. Feed inlet connection
b. Feed outlet connection
c. Brine outlet connection
d. Distillate inlet from interstate drain regulator of preceding stage
e. Distillate outlet
f. Vent
g. Foundation fittings and necessary attachments for anti-rolling braces, if required
h. Sight glasses
i. Vent connections from distillate and brine overbroad pumps
j. Thermometers and gauges
k. Lifting and handling eyebolts or lugs
l. Drain connections and loop seals
m. Access openings for cleaning evaporator feed compartments (see 3.14i.)
n. Access openings for cleaning seal pipes between stages (see 3.14i.).

3.16.5 Vapor separator. Each evaporator stage shall be provided with a mesh type vapor separator, so constructed as to remove all entrained salt water from the vapor flashed before the vapor passes into the condenser of that stage. The vapor separators shall be removable from the evaporator shells\without other component disassembly.

3.17 Evaporators for type III.

3.17.1 Inspection. The evaporator shall be so arranged that the corrugated baskets will be readily removable and easily accessible for inspection.

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3.17.1.1 Baskets. The dimensions of the corrugated baskets of distilling units to be installed in submarines shall be such that the baskets can be removed through a standard hatch, or in case there is no hatch in the compartment in which the distilling unit is to be installed, such that the basket can be moved through bulkhead opening into a compartment provided with a hatch (see 6.2).

3.17.12 Welds. Radiographic examination of the welds joining the basket flanges to the corrugated heating surface, the crimped ends of the fingers and the longitudinal welds of the fingers is required (see 4.3.4).

3.17.2 Evaporator effect. The shell or door of each evaporator effect shall be provided with sight glasses as necessary to observe operation and the extent of scaling of the basket.

3.17.3 Connections and fittings. The following connections and fittings shall be provided for each evaporator:

a. Feed inlet connection
b. Brine outlet connection
c. Compound pressure and vacuum gauge, 4-1/2 inch diameter
d. Water gauge glass
e. Relief valve and rupture discs
f. Vapor discharge connection
g. Foundation fittings and necessary attachments for anti-rolling braces, where fitted
h. Drain from vapor separator
i. Air vent from brine pump in last effect shell only
j. Steam supply connections
k. Drain connections
l. Air vent connections
m. Sight glasses
n. Thermometers
o. Lifting and handling eyebolts or lugs
p. Gauge connections.

3.17.4 Vapor separators. Each evaporator effect shall be provided with mesh type vapor separators, so constructed as to remove all entrained salt water from vapor generated before the vapor passes into the vapor feed heater or the distiller condenser. The vapor separators shall be removable without other component disassembly.

3.175 Desuperheater. A desuperheater shall be provided for the inlet steam to the first effect baskets if required by the inlet steam conditions. Desuperheater shall be supplied with a strainer and isolation valve.

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3.17.6 Orifice plate. One orifice plate with proper size orifice shall be furnished with the distillation unit to limit the steam flow to the first-effect steam chest to that required for rated capacity. Orifice plate shall be provided with a tab for pulling and shall be stamped with the orifice size and manufacturer's part number.

3.17.7 Scale preventive compound. The piping system of the distilling unit shall be provided with a connection for the injection of scale preventing compound, so located that the compound will pass through the tubes of the feed heaters and all of the compound will pass into the first effect evaporator shell with the feed.

3.17.8 Access openings. Access openings shall be provided for replacement, observation, and cleaning (manually and chemically) of vapor separators. Any drain piping connected to the vapor separator shall be cleanable through such access openings.

3.18 Salt water heater for types II and IV.

3.18.1 Salt water feed heater. The salt water feed heater shall be constructed for circulation of the salt feedwater through the tubes. Baffling shall be provided to prevent direct impingement of the entering steam on adjacent tubes (type II). Surface shall be provided to insure conformance to the requirements of 3.13.

3.18.1.1 Tubes. The tubes of the salt water feed heater shall be 3/4 inch od number 18 BWG (0.049 inch wall thickness) in accordance with MIL-T-15005. Tubes for feed heaters of class 2 distilling units shall be 90-10 imposition and for class 1 they shall be 70-30 composition. Tubes shall be straight and shall be expanded into sheets at each end as specified in 3.14.13.1.1.

3.1$.1.2 Tube sheet tube holes. The holes for tubes in the tube sheets shall be reamed to 0.751 inch diameter with a plus tolerance of 0.005 inch. The holes for the inlet tube ends shall be belled to approximately 7/8 inch diameter on a 1/2 inch radius at the outer face of the tube sheet- Holes shall be provided with one centrally located groove 1/8 inch wide and 0.012 inch deep. Edges of all holes which are not belled shall be rounded on a 1/16 inch radius at the faces of the tube sheet.

3.18.1.3 Sheet thickness. The minimum thickness of tube sheets shall be 7/8 inch.

3.18.1.4 Tube spacing. The minimum center-to-center spacing of tubes shall be 15/16 inch.

3.18.1.5 Tube support plate. Tubes of 3/4 inch od shall be supported by tube support plates so that the maximum span between tube sheets and support plates or between support plates will not exceed 4 feet. The support plates shall be 9/16 inch minimum thickness. Holes for tubes shall be drilled not more than 49/64 inch diameter and shall be rounded at each face of the tube support to a 1/16 inch radius.

[see B.2] and with adequate [illegible]

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3.18.1.6 Transverse baffles. When transverse baffles are used in the feedwatcr heater for type IV units to direct the flow of the hot fresh water across the tubes, the baffles shall be not less than 1/8 inch thick A sufficient number of these baffles shall be increased in thickness to 1/4 inch to act as tube support plates. Holes for tubes in transverse baffles shall be drilled as specified in 3.18.1.5 and shall have all roughness removed from the faces of the baffles at the edges of the drilled holes,

3.l8.1.7 Desuperheater. If required by inlet steam conditions, an adequate desuperheater shall be provided for the feedwater heater steam (type II). Desuperheater shall be supplied with a strainer and isolation valve.

3.l8.l.8 Orifice plate An orifice plate with proper size orifice to limit the steam flow to the salt water heater to that required for rated capacity shall be furnished (type II). Orifice plate shall be provided with a tab for pulling and shall be stamped with the orifice size and manufacturer's part number.

3.19 Distiller condenser for types I, III, and V.

3.19.1 Tubes. The distiller condenser shall be of the straight or U-bent tube, surface type with cooling water in the tubes. It shall be a component of the distillation unit and may be built integral with the last evaporator effect or as a separate unit. Sufficient surface shall be provided for precooking the air ejector suction and may be provided for subcooling the distillate to specified delivery temperature.

3.19.1.1 Tube surface. For types I, 111, and V distillation unit, the distiller condenser shall have sufficient surface to condense the vapor from the last effect together with that flashed in the flash chamber from the tube nest drains of the last effect (types I and III) at the requisite vacuum when the distillation unit is operating in clean condition with initial sea water temperature of 85 'F.

3.19.2 Flash chamber. A flash chamber shall be provided for the distiller condenser of multiple effects units. It shall receive the drains from the last evaporator effect tube nest through the drain regulator, and shall be provided with an adequate vent to the distiller condenser shell. The distillate from the distiller condenser shall combine with that portion of the last effect tube nest drains which is not flashed and this final product of the distillation unit shall drain to the distillate pump suction.

3.20 Distillate cooler for all types.

3.20.1 Cooler tube type. The distillate cooler shall be of the shell and straight or U-bent tube type, arranged for circulation of the whole amount or part of circulating water required by the distiller condenser (types I, III, and V) or the unit (types II and IV) through the tubes and for circulation of the distillate drained from the distiller condenser flash chamber or the last stage condenser across the tubes in the shell. If only part of the circulating water is used in the distillate coder, the necessary bypass valves and piping shall be furnished with the cooler. The distillate cooler shall not be completely bypassed.

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3.20.2 Cooling surface The distillate cooler shall have sufficient surface to cool the distillate drained from the distiller condenser flash chamber or the last stage condenser to the specified temperature when supplied with seawater at 85 “F when the distillation unit is operating at rated capacity.

3.21 Vapor feed heaters for types I and III.

3.21.1 Vapor line A straight or U-bent tube type feed heater shall be provided in the vapor line from each effect evaporator except the last; the heating agent shall be the vapor from the evaporator shell which shall pass over the tubes with the feed passing through the tubes.

3.21.2 Feed heater. Each vapor feed heater shall be provided with the following connections and fittings.

a. Water boxes:

(1) Feed inlet connection
(2) Feed outlet connection
(3) Air vent
(4) Drain connection.

b. Shells:

(1) Vapor inlet connection
(2) Vapor outlet connection
(3) Drain connection
(4) Attachments for foundation, if separate shell is furnished.

3.21.3 Heater construction. The vapor feed heaters may be built into the shell of the evaporator effect from which the vapor for heating is obtained, or may be furnished in a separate shell, as best fits the overall arrangement of the distillation unit. The tube nest shall, in either case, be removable from the shell.

3.22 Tube nest drain regulator for types I and III and salt water feed beater drain regulator for type II.

3.22.1 Drain regulator. A drain regulator shall consist of a cage and rover enclosing a balanced cage valve operated by a ball float or by a diaphragm and air pilot operated control. A drain regulator may also be built into the hotwell or sump of a salt water feed heater, thereby eliminating the east cage and equalizing connections.

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3.22.2 Regulator equipment. Each regulator shall be provided with the following fittings and connections:

a. Drain inlet connection
b. Discharge connection
c. External bypass suitably valved (May be omitted if valve can be jacked open manually)
d. Air vent
e. Equalizing pipe to the part being drained
f. Water gauge glass, protected
g. External gear for hand operation (see item c).

3223 Regulator control. A drain regulator shall be provided for the control of the discharge of the tube nest drain pump or salt water feed heater drain pump so as to maintain adequate submergence. The regulator shall be so located as to drain adequately the first effect steam chest or the salt water feed heater shell. The regulator shall be provided with equalizer connections to the steam chest of the evaporator or the shell of the salt water feed heater.

3.22.3.1 Pressure differences. In cases where pressure differences between stages are too large for use of loop seals, the regulator specified in 3.22.1 may be used as an interstate drain regulator.

3.22.3.2 Heat exchanger component. A drain regulator shall be provided for any heat exchanger component of a distillation unit, the design of which requires that a definite liquid level be maintained. The drain regulator shall be in accordance with 3.22.1.

3.22.4 Compensation of pressure difference In case the first effect steam chest or the salt water feed heater shell is to be drained into a main or auxiliary condenser instead of a steam chest drain pump or a salt water feed heater drain pump being used, means shall be provided by the shipbuilder for compensation of the difference in pressure between the steam chest or salt water feed heater and the condenser into which they are drained.

3.23 Fittings.

3.23.1 Gauge glasses. Gauge glasses shall be provided for the different components as required. They shall be protected and mounted in fittings in accordance with MIL-I-20037 and of the indirect type.

3.232 Relief valve Type I distillation units shall be provided with a relief valve on each evaporator steam chest and shell. Types II and IV distillation units shall be provided with a relief valve of sufficient size to protect the evaporator shell should the brine overboard valve be closed when the feed pump is in operation or a suitable rupture disc shall be provided. Type II salt water feed heater shell shall also be provided with a relief valve. Type III distillation units shall be provided with relief valves of sufficient size to protect the baskets from internal over-pressuring. Relief valves shall conform to type A-1, class C of MIL-V-20065.

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3233 Furnished gauges Gauges conforming to MIL-G-18997 shall be furnished as shown in table IX Unless otherwise specified (see 6.2), gauges will be furnished by the shipbuilder. Connections, as required, shall be provided on the distilling unit. Table IX covers the minimum gauges necessary for proper operation of the unit. Gauges shall mount on a gauge board supplied by the shipbuilder (gauge board may, be furnished with the distillation unit) .

TABLE IX. Gauges.

Number and connection	Diameter (inches)	Pressure or compound	Graduated to pounds or inches of Hg	Marking
Types I, III, and *V*				
One for steam supply above orifice	4-1/2	Pressure	30 pounds	Evaporator swam
One for steam supply below orifice	4-1/2	Compound	30 inches to 30 pounds	First effect steam chest
One for last effect	4-1/2	Compound	30 inches to 30 pounds	Last (number) shell
One for circulating and feed pump discharge	4-1/2	Pressure	100 pounds	(Name) pump discharge
One each for all other pump discharges	4-1/2	Compound	30 inches to 100 pounds	(Name) pump discharge
Type II				
One for salt water heater steam supply above orifice	4-1/2	Compound	30 inches to 30 pounds	Salt water heater steam
One for last stage shell	4-1/2	Compound	30 inches to 30 pounds	Last (number) stage shell
One for feedwater heater shell	4-1/2	Compound	30 inches to 30 pounds	Feedwater heater shell
One for feed pump discharge	4-1/2	Pressure	100 pounds	Feed pump discharge
One for salt water heater drain pump discharge	4-1/2	Compound	30 inches to 100 pounds	Salt water heater drain pump discharge
One each for all other pump discharges	4-1/2	Compound	30 inches to 30 pounds	Name) pump discharge

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TABLE IX. *Gauges – Continued.*

Type IV				
Number and connection	Diameter (inches)	Pressure or compound	Graduated to pounds or inches of Hg	Marking
One for salt water heater supply pump from jacket water system (when required)	4-1/2	Compound	30 inches to 30 pounds	Salt water heater supply pump discharge
One for feed or circulating pump	4-1/2	Pressure	30 pounds	(Name) pump discharge
One each for all other pump discharges	4-1/2	Compound	30 inches to 30 pounds	(Name) pump discharge
One for last effect shell	4-1/2	Compound	30 inches to 30 pounds	Last (number) stage shell
One for flash chamber	4-1/2	Compound	30 inches to 30 pounds	Flash chamber

3.23.4 Thermometers. Unless otherwise specified (see 6.2), thermometer will be furnished by the shipbuilder. Thermometers shall be in accordance with MIL-I-17244. Distant reading dial type thermometers in accordance with class C of MIL-T-19646 may be used when access to location for reading is difficult. Thermometers shall be furnished as specified in table X. Thermometers considered necessary for proper operation of the distilling unit shall include those required for heat balance performance verification.

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TABLE X. *Thermometers*.

Quantity	Location	Graduated to °F
1	Seawater supply temperature (all types)	20 to 240
1	Salt water inlet to first stage (types II and IV)	20 to 240
1	Steam supply after orifice (types I, II, and III)	50 to 400
1	Feed heater shell (types II and IV)	50 to 400
1	Distillate discharge from distillate cooler (all types)	20 to 240
2	Jacket water supply and return to salt water heater (type IV) or evaporator fresh water tube bundle (type V)	20 to 240
As required	Each stage shell and condenser	20 to 240

3.23.4.1 Thermometer wells. Thermometer wells shall be in accordance with MIL-T-24270.

3.23.5 Instrumentation. Instrumentation shall be installed to provide information for operation and troubleshooting and to permit verification of the distilling plant heat balance.

3.24 Painting. The distillation units shall be painted as follows:

a. External ferrous surfaces shall be thoroughly cleaned and coated with two coats of heat resisting paint in accordance with TT-P-28.

b. Nonferrous surfaces are not required to be painted.

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3.25 identification plates. Identification plates of sheet or cast brass or bronze shall be provided in accordance with MIL-P-15024 and MILP-15024/5. Identification plate data shall include the following:

a. Manufacturer's name
b. Government contract number
c. National stock number (allow 17 spaces)
d. Date of manufacture
e. Blank space for Government inspector's stamp
f. Blank space for unit number (two spaces, stamped by shipyard).

3.26 Special tools. Special tools for maintenance of the distillation units shall be furnished on a per ship basis. Such tools shall include a special device for removal of the vertical basket of type III units, one tube expander of each size and type necessary for expanding the tubes of double tube sheet heat exchangers, and a permanent tube plugging tool set (See 3.26.1) for saturated steam propelled ship seawater feed heaters.

3.26.1 Permanent tube plugging tool set For saturated steam propelled ship distilling plants, permanent tube plugging tool sets shall be furnished as specified (see 3.26) for surface ships, and (see 6.2) for submarines. Tool sets shall be based on the following

a. Tools shall be provided for removing the tube end from the hole in the outer tube sheet, across the space between the double tube sheets and for finishing the tube end flush with the outer face of the inner tube sheet free from burrs. Tools shall also be provided for expanding the permanent tube plugs (see b) into the tube hole in the outer tube sheet and into the tube end in the inner tube sheet. Such tools shall be arranged for power operation.

b. Permanent tube plugs shall be fabricated from the stock of same material as the heat exchanger tubes and of proper gauge so that, when turned down to fit inside the tube end in the inner tube sheet, the wall thickness will be not less than that of the heat exchanger tubes. An end plug in accordance with MIL-C-15726, composition 70-30 or 90-10 as applicable, shall be welded into the small diameter end of the tube plug. Alternatively, the permanent tube plugs may be machined from bar stock in accordance with MIL-C-15726, composition 70-30 or 90-10 as applicable, with above limitation as to wall thickness. Each permanent plug shall pass the inspections specified in 4.7.

c. Tapered phenolic tube plugs in accordance with MIL-P-15742 shall be provided for plugging the open end of the permanent tube plug after the permanent plug has been installed and the installation proved satisfactory.

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3.26.1.1 Tools. Each tool set shall contain the following:

a. Permanent tube plugs, 10 percent of the number of tubes but not to exceed 100

b. Tapered phenolic plugs equal to the number of permanent plugs

c. One each of all tools required to install the permanent plug (including bevel gear, extension, universal joint, or flexible shaft if required, however a drive motor shall not be furnished)

d. One spare set of tube cutter bits (if tube cutter is used)

e. One spare set of rollers for each expander

f. one copy of procedure and drawings specified in 6.6.

3.26.1.2 Tool box. Each tool set shall be contained in a sturdy metal tool box suitable for the intended purpose. The outside of each tool box shall be marked as follows:

a. Nomenclature – "Tool Set for Permanent Plugging of Tubes in Double Tube Sheet Seawater Feed Heater"

b. Tool Set NSN - (add if available)"

c. Seawater feed heater manufacturer

d. Name of component and its CID (APL) number

e. Contract number

f. Applicable ships

g. Tube plug NSN - (add if available)."

3.27 Interchangeability. In no case shall parts be physically interchangeable or reversible unless such parts are also interchangeable or reversible with regard to function, performance and strength.

3.28 Workmanship. Distiller units shall be constructed, assembled and finished to ensure quality equipment is supplied to the Government. The product shall be free of imperfections that will affect durability, operability, serviceability and safety.

4. QUALITY ASSURANCE PROVISIONS.

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements (examinations and tests) as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facilities suitable for the performance of the inspection

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requirements specified herein, unless disapproved by the Government. The Government reserves the tight to perform any of the inspections set forth in this specification where such inspections are deemed necessary to ensure supplies and services conform to prescribed requirements.

4.1.1 Responsibility for compliance. All items shall meet all requirements of sections 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program (see 6.2). The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of ensuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspection, as part of the manufacturing operations, is an acceptable practice to ascertain conformance to requirements, however, this does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to accept defective material.

4.1.2 Critical materials. For parts of distilling units subjected to submergence pressure, the following items are designated as critical materials. Each of these items shall have material traceability including heat lots, chemical and physical test reports. Critical materials shall consist of the following:

a. Tube sheets

b. Seawater vent and drain connections including double tube sheet void space vents and drains

c. Heat transfer tubing

d. Water boxes, including all parts (except gaskets), subparts and access covers

e. Nuts, studs, and bolts joining seawater containing parts

f. Permanent tube plugs including blind nipples.

Traceability records shall be retained by the contractor for 7 years from delivery. At the expiration of the retention period, all records shall be made available to NAVSEA or its authorized representative by written notification If no disposition is authorized within 6 months, the records may be destroyed

4.2 Qualification tests. Qualification tests shall be conducted at a facility satisfactory to NAVSEA These tests shall consist of the tests specified in 4.21 and 433. The tests shall be based only on the use of natural seawater. These tests shall be run continuously shutdowns for weekends during the duration of the test will be permitted.

4.2.1 Operation. The unit shall be mounted on a stable foundation and operated under the conditions specified in 3.121 or 3.124 for a sufficient time, to be determined by NAVSEA to allow evaluation of the suitability of design and materials, and to determine conformance to 3.13, and the distillate purity requirements of 3.13.1. Normal scale preventive treatment (see 3.13) may be used during this test.

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422 Extension of qualification Qualification of type I, II or III units will be considered as qualifying type IV or V units. Qualification of type V units will be considered as qualifying type I units.

43 Tests.

43.1 Pressure tests. Parts of the plant shall be subject to hydrostatic pressure test as specified in table XI.

TABLE XI. *Hydrostatic pressure test.*

Name of part	Test pressure lb/in^2
Evaporator, distilling condenser and vapor feed heater shells and vapor piping	30
Evaporator steam chests and tubes (type 1)	50
Distilling condenser: water boxes and tubes	50 (see 4.3.1.1)[1]
Feed heaters: water boxes and tubes	50[1]
Distillate cooler: shell, water boxes and tubes	50 (see 4.3.1.1)[1]
Steam inlet piping	50
Feed piping	50[1]
Fresh water piping	30
Evaporator baskets and steam chests (for type II)	30
Other parts not specified	1-1/2 times working pressure

[1]Or 1-1/2 times working pressure, whichever is higher.

43.1.1 Hyrostatic pressure. Parts of distilling units for submarine installations which are exposed to submergence pressure shall be subjected to hydrostatic pressure equal to the specified submergence test pressure (see 6.2). After installation of tubes, a hydrostatic test pressure equal to the specified submergence test pressure shall be applied to the spare between the double tube sheets. Any leak appearing at the tube end where tubes are expanded into the outer tube sheet shall be corrrected by re-rolling the individual leaking tube end. After this test, a hydrostatic pressure in the shell as specified in 4.3.1 shall be applied with the drain connection to the space

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between the double tube sheets open. Any indication of leakage of tube end expansion in the holes in the inner tube sheets shall be corrected by minimum possible re-rolling. Hydrostatic test to the pressure in 4.3.1 shall be applied to heat exchangers for saturated steam propelled surface ships.

4.3.1.2 Test pressures. The hydrostatic test pressures specified in 43.1 shall be increased as necessary to demonstrate that damage will not result under the conditions specified in 3.1428.1.1.6.

4.3.2 Performance tests after installation. After installation, at least three capacity tests shall be made on each distillation unit. The test duration shall be 24 hours minimum for the first unit of a design For units which are exact duplicates of a design which has passed the 24 hour tests, the duration of the test may be reduced to 8 hours. Tests shall be as follows:

4.3.2.1 First test. The first test shall be made prior to the official trials of the ship, using circulating water as available at the ship's berth. The capacity shall be as specified in 3.13. If the water available is such as to foul the tubes of the unit, this test may be waived by the Government.

43.2.2 Second test. The second capacity test shall be made during the official preliminary trials of the ship, the seawater used for feed being not less than 1/32 density. The capacity shall be as specified in 3.13.

4.3.2.3 Final test. After 90 days of operation on the ship with seawater feed of not less than 1/32 density, which operation shall be as nearly continuous as practicable, a final capacity test shall be made to determine the ability of the unit to produce rated capacity (see 3.13).

433 Determination of salinity content. In case of any question as to the accuracy of the determination of the salinity content of the distillate by the methods available aboard the ship, a sample of the distillate shall be submitted to a qualified laboratory for determination of the salinity content as specified in ASTM D 512.

43.4 Basket weld inspections. During or after fabrication of the corrugated baskets for type III units, the welds joining the basket flanges to the corrugated heating surface, the crimped over ends of the fingers, and the longitudinal welds of the fingers shall be 100 percent radiographed in accordance with MIL-STD-271 to prove them free from the following unacceptable defects:

a. Cracks of any length
b. Incomplete penetration of any degree
c. Lack of fusion
d Any porosity
e. Any inclusion which may lead to a high stress area under alternating cycles
f. Any undercutting of the welds.

4.3.5 Experimental proof tests. For each heat exchanger salt water side which will be subjected to submarine Submergence pressure and which is not amenable to a fatigue loading

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analysis, the experimental proof test (see 3.14.28.1.1 .5.1) shall utilize stress coat (or its equivalent) or photostress (molded birefringent coatings) techniques as deemed suitable, in order to determine the location of maximum strain. Quantitative measurement of the magnitude of maximum principal strain in the water box shall be obtained from strain gauges of 1/8 inch gauge length or smaller. Water box loading (that load which produces the highest stress) shall be comprised of a combination of design submergence pressure in conjunction with piping reaction loading applied to the nozzles. The nozzle loads shall be calculated as specified in 3.14.28.1.1.4. A loading jig incorporating mechanical or hydraulic jacks shall be provided to apply external loads on the nozzle flanges. The following combinations of loads shall be applied.

a. Internal pressure equipment to 100 percent depth and external piping load (that piping reaction load which produces the highest stress) applied to one flange

b. Internal pressure equivalent to 100 percent depth and equal external piping load (that piping reaction load which produces the highest stress) applied to both flanges.

43.5.1 Angular orientations. Experimental proof test shall be as follows. Since the angular orientations of the applied moments to give the maximum stress for each load combination are unknown, and the location of maximum stress is also unkonown the angular orientations of the applied moments for load combinations (a) and (b) shall correspond to increments of 45 degrees around the nozzles from O to 360 degrees in the first run, and a minimum of 9-degree increments shall be used in the 45 degrees maximum stress sector in the second run. The location, magnitude and direction of the maximum principal strain (stress) can be determined by brittle coating or photostress, but must be checked with electric resistance strain gauges. Determine the maximum value of principal strain (stress) in the water box (by either load combination (a) or (b)). Determine the number of allowable cycles (corresponding to above stress) from the fatigue curve for the particular material involved. Call these cycles as N_1. Form a ratio of design cycles (n_1) to allowable cycles (N_1). Take half of the maximum value of principal strain (stress) in the water box. Determine the number of allowable cycles (corresponding to this stress) from the fatigue curve for the material involved. Call these cycles as N_2. Form a ratio of design cycles (n_2) to allowable cycles (N_2). If the sum of

$$\frac{n^1}{N_1} + \frac{n^2}{N_2}$$ is less than or equal to 0.8, the water box design is acceptable.

where:

n_1 = 100 percent test depth changes from NAVSEA T9070-AA-DDT-010/(C) SUBS

n_2 = 50 percent test depth changes from NAVSEA T9070-AA-D DT-010/(C) SUBS

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4.4 Shock resistance. Shock tests shall be conducted as specified in MIL-S-901 with the following modifications:

a. Under the test procedure for medium weight equipment, the first blow in each group shall be applied using the standard horizontal mounting adaptor; the second blow in each group shall be applied with the unit mounted on adaptors holding it at a 30-degree angle from the horizontal in the direction of its least transverse strength.

b. Shock test extension will be considered for units if they are of a similar design, construction, weight, and materials to units which have successfully passed the test in accordance with MIL-S-901. Shock test extension requests shall be prepared in accordance with the instructions specified in MIL-S-901.

4.4.1 Shock resistance levels. As specified (see 6.2), shock resistance of distillation units shall be in accordance with the following levels.

a. Level A - The distillation unit, after sustaining mechanical shock, shall operate normally (see 3.12) and no parts thereof shall create a missile hazard to personnel or contiguous apparatus or otherwise constitute a personnel hazard (such as a rupture of parts containing steam or hot water, with consequent danger of scalding personnel) at the time of the shock.

b. Level B - The requirements of level B shall be the same as level A except that the distillation unit need not operate normally after sustaining mechanical shock.

4.5 Vibration The distilling unit shall perform its function after the tests specified for type I environmental vibrations of MIL-STD-167-1 (see 63).

4.6 Airborne and structureborne noise Airborne noise shall be measured in accordance with MIL-STD-740-1 for grade D equipment. Structureborne noise shall be measured at the mounting point in accordance with MIL-STD-740-2 (see 6.3).

4.6.1 Resilient mounts Equipment shall be mounted on resilient mounts even though they may not be used in service.

4.6.2 Equipment shall be operating in the modes as specified (see 3.121 and 3.124).

4.7 Permanent tube plus Each permanent tube plug for saturated steam propelled surface ship and submarine distilling plants shall be subjected to an internal hydrostatic test of not less than 1000 lbs/in^2. Each plug shall be tight under this pressure and shall show no bulges, cracks, flaws, porous places, or other harmful defects. In addition, each permanent tube plug for submarine distilling plants shall also be given a 100 percent liquid penetrant inspection in accordance with MIL-STD-271 on its outer surface after the hydrostatic test. The liquid penetrant inspection standards shall be as follows:

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a. Plugs which show the following liquid penetrant indications shall be subject to rejection:

(1) Any liquid penetrant indications of cracks, seams, or laps, except scratches whose depth is less than 5 percent of the wall thickness

(2) Round indications 1/16 inch diameter or greater

(3) Round indications which are linearly disposed whose center-to+enter distance is less than 3/16 inch.

b. Superficial polishing with 120 grit emery cloth may be used as an aid in determination of the extent of the indications defined in a.(1), (2) and (3). Not more than 5 percent of the wall thickness shall be removed in the effort to remove the indications, always provided that design wall thickness is maintained.

c. If the vendor chooses to remove the defects, the area containing the indication shall be reinspected by liquid penetrant inspection after polishing, to ensure that all indications have been removed.

4.8 Inspection of packaging. Sample packages and packs, and the inspection of the preservation, packing and marking for shipment and storage shall be in accordance with the requirements of section 5 and the documents specified therein.

5. PACKAGING

(The packaging requirements specified herein apply only for direct Government acquisition. For the extent of applicability of the packaging, requirements of referenced documents listed in section 2, see 6.9.)

5.1 Preservation. Preservation shall be level A or commercial as specified (see 6.2).

5.1.1 Level A. The distillation unit shall be preserved in accordance with method III of MIL-P-116. Interior surfaces shall be thoroughly dried after which openings shall be sealed with caps, plugs, or plywood blanks to prevent entry of foreign matter. Barrier material conforming to grade A of MIL-B-121 shall be placed between the plywood blank and the mating flange.

5.1.1.1 Accessories. Gauges and thermometer shall be removed from the unit and individually preserved by methods IA and III respectively in accordance with MIL-P-116.

5.12 Commercial. The distillation unit shall be preserved in accordance with ASTM D 39-51.

5.2 Packing. Packing shall be level A, B, C, or commercial as specified (see 6.2).

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5.2.1 Levels A, B, and C with type, class, and style selection at the option of the contractor. The distillation unit shall be packed in a sheathed crate conforming to MIL-C-104. When specified (see 6.2), for levels B and C only, packing shall be in unsheathed crates conforming to MTLC-132 or MIL-C-3774. The closure and strapping of containers and the anchoring, blocking, bracing, cushioning and waterproofing of container contents shall be in accordance with the applicable container specification or appendix thereto.

5.2.1.1 Detached accessories. Detached accessories, preserved as specified in 5.1.1.1 shall be packed in boxes conforming to class 1 of PPP-B-621 or PPP-B-601 (domestic) and secured within the shipping containers with the complete unit.

5.2.2 Commercial. Distillation units, preserved as specified in 5.1, shall be individually packed in accordance with ASTM D 3951.

53 Marking. In addition to any special marking required (see 6.2), for levels A, B, and C, interior and exterior shipping containers shall be marked in accordance with MIL-STD-129, commercial containers in accordance with ASTM D 3951.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Mended use. The distillation units specified herein are for making fresh water from sea-water in Naval shipboard installations with heated distillation units using low pressure steam or hot fresh water.

6.2 Acquisition requirements. Acquisition documents must specify the following:

a Title, number and date of this specification

b. Issue of DODISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1.1 and 2.2)

c. Type of distillation unit to be supplied (see 1.2.1)

d. Class required (see 1.2.2)

e. Level of resistance to mechanical shock (level A should be specified if operation of the distillation unit is necessary to allow the ship to complete its immediate operation and to allow it to return to port) (see 3.2)

f. MTBF and MTTR (see 3.6)

g. Size and weight limitations, if applicable (see 3.10)

h. Limiting steam consumption for types 1, II, or III (low pressure steam for evaporators or salt water heater and high pressure steam for air ejectors) (see 3.121)

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i. Amount and temperature of hot fresh water available for types IV or V (see 3.122 and 3.12.3)

j. Temperature of distillate if higher than 95 'F is acceptable (see 3.12.5)

k. Rated capacity required (see 3.13 and 3.13.1)

l. Ship motion and attitude requirements, if other than specified (see 3.13.1)

m. orientation of unit in the ship (see 3.13.1.1)

n. Whether circulating or feed pump must be mounted separately because of suction water level conditions (see 3.14 c)

o. Discharge pumping heads required for pumps (see 3.14 d)

p. Whether feed pump is required (type I or III distilling units) (see 3.14 e)

q. Whether brine overboard pump or brine eductor shall be furnished (see 3.14 f)

r. Whether air ejector and after condenser or vacuum pump is required (see 3.14.4 and 3.14.26)

s. Flange requirements, if different from those specified (see 3.14.7)

t. Whether thicker tubes than number 18 BWG are required for submarine service (see 3.14.13)

u. Steam pressure and temperature to air ejectors required (see 3.14.25) and to first effect steam chest or salt water heater

v. Vacuum pumps for types IV and V distilling units, when specified (see 3.14.26)

w. For submarine submergence pressure heat exchangers, requirements for attached sea-water piping (see 3.14.28.1.1.4)

x. Dimensions of hatch, bulkhead opening, or other access openings available for removal of corrugated basket of type III distilling units from the compartment in which the unit will be installed (see 3.17.1.1)

y. Whether gauges and thermometers, including replacements, shall be furnished with the distilling unit (see 3.23.3 and 3.23.4)

z. Number of submarine distilling plant seawater feed heater permanent tube plugging test sets required (see 3.26.1) (It is intended that the tool set for submarines be carried by the appropriate sub tenders and repair yards.)

aa. For distilling plants exposed to submarine submergence pressure, MIL-Q-9858 should be invoked for the quality assurance program. For all other distilling plants, either MIL-Q-9858 or MIL-I-45208 should be invoked for the quality assurance program (see 4.1 and 4.1.1).

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bb. Hydrostatic pressure required (see 4.3.1)

u. If for submarine service, submergence test pressure (observe security requirements (see 4.3.1.1)

dd. Shock resistance level (see 4.4.1)

ee. Selection of applicable levels of preservation and packing (see 5.1 and 5.2)

ff. When packing shall be in unsheathed crates (see 5.21)

gg. Special marking required (see 5.3).

63 Consideration of data requirements. The following data requirements should be considered when this specification is applied on a contract. The applicable Data Item Descriptions (DIDs) should be reviewed in conjunction with the specific acquisition to ensure that only essential data are required/provided and that the DIDs are tailored to reflect the requirements of the specific acquisition. To ensure correct contractual application of the data requirements, a Contract Data Requirements List (DD Form 1423) must be prepared to obtain the data, except where DOD FAR Supplement 27.475-1 exempts the requirement for a DD Form 1423.

Reference Paragraph	DID Number	DID Title	Suggested Tailoring
3.6	DI-R-7085	Failure mode, effects, and criticality analysis report	
3.7	DI-MNTY-80144	Maintainability demonstration report	
3.14 and appendix A	DI-DRPR-80651	Engineering drawings	Level 3
3.14.28.1.1, 3.14.28.1.1.4.1, and appendix C	DI-MISC-80652	Technical information reports	
4.5	UDI-T-23762	Report, vibration testing	
4.6	DI-HFAC-80272	Equipment airborne sound measurement test report	

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Reference Paragraph	DID Number	DID Title	Suggested Tailoring
4.6	DI-HFAC-80274	Equipment structureborne vibratory acceleration measurement test report	
4.4	DI-ENVR-80707	Shock test report	
4.2 and 4.3.2	DI-MISC-80653	Test report	

The above DIDs were those cleared as of the date of this specification. The current issue of DOD 5010.12-L Acquisition Management Systems and Data Requirements Control List (AMSDL), must be researched to ensure that only current, cleared DIDs are cited on the DD Form 1423.

63.1 Special guidance when ordering equipment for the Naval Sea Systems Command (NAVSEA). The table below lists, as a separate line item, every candidate data deliverable arising from this specification and lists the reference paragraph for the deliverable. When this specification is invoked in a contract to purchase equipment for NAVSEA, items marked with a "Yes" should be prepared and delivered:

Reference Paragraph	Name of Deliverable	Desired on orders for equipment for NAVSEA
3.14 and appendix A	Drawings	Yes
3.14.28.1.1 and appendix C	Design report	Yes
4.2	Report of qualification tests	Yes
4.3.2	Report of performance tests after installation	Yes
4.4	Shock test report	Yes
4.5	Report of environmental vibration text	Yes
4.6	Report of airborne and structureborne noise tests	Yes
6.4 and appendix B	Technical manual	Yes

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6.4 Technical Manuals. The requirement for technical manuals should be considered when this specification is applied on a contract. If technical manuals are required, military specifications and standards that have been cleared and listed in DOD 5010.12-L Acquisition Management Systems and Data Requirements Control List (AMSDL) must be listed on a separate Contract Data Requirements List (DD Form 1423), which is included as an exhibit to the contract- The technical manuals must be squired under separate contract line item in the contract. Technical content should include the requirements of appendix B, titled 'Technical Manual Technical Content Requirements.[w]

6.5 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in Qualified Products List No. 18641 whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may k eligible to be awarded contracts or purchase orders for the products covered by this specification. The activity responsible for the Qualified Products List is the Naval Sea Systems Command, SEA 05Q22, 2531 Jefferson Davis Hwy, Arlington, VA 22242-5160 and information pertaining to qualification of products may be obtained from that activity. Application for qualification tests must be made in accordance with "Provisions Governing Qualification SD-6" (see 6.5.1).

6.5.1 Copies of "Provisions Governing Qualification SD-6" may be obtained upon application to Standardization Documents Order Desk 700 Robbins Ave., Building 4D, Philadeiphia, PA 19111-5094.

6.6 For saturated steam propelled ship distilling plants, distilling plant manufacturer should forward the following to NAVSEA:

a. Permanent tube plugging procedure

b. Drawings of the permanent tube plug and tools (including tapered tube plug)

c. Drawings showing the permanent plug and each tool in its proper position in the tube end or permanent plug.

6.6.1 The drawings and procedures specified in 6.6 should be included in the distilling plant technical manual.

6.7 Provisioning. Provisioning Technical Documentation (PTD), spare parts, and repair parts. should be furnished as specified in the contract.

6.7.1 When ordering spare parts or repair parts for the equipment covered by this specification, the contract should state that such spare parts and repair parts should meet the same requirements and quality assurance provisions as the parts used in the manufacture of the equipment. Packaging for such parts should also be specified.

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6.8 Sub-contracted material and parts. The packaging requirements of referenced documents listed in section 2 do not apply when material and parts are acquired by the contractor for incorporation into the equipment and lose their separate identity when the equipment is shipped.

6.9 Subject term (key word) listing.

Baffles
Brine
Flange
Flash chamber
Shell
Waterbox

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

Preparing activity
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(Project 4620-N034)

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ENGINEERING DRAWINGS TECHNICAL CONTENT REQUIREMENTS

10. SCOPE

10.1 Scope. This appendix covers the technical content that shall be included on drawings when required by the contract or order. This appendix is mandatory only when data item description DI-DRPR-80651 is cited on the DD Form 1423.

20. APPLICABLE DOCUMENTS

This section is not applicable to this appendix.

30. DRAWING CONTENTS

30.1 Drawing types. The following types of drawings are required:

a. Outline drawings. Outline drawings are external arrangement drawings that shall show all necessary external views of the unit and shall include all external dimensions required for reproduction on ship's machinery arrangement drawings, for guidance of the shipyard in designing the foundation structure for the unit, for installation thereof, and for connection of the unit to the external piping. The drawing shall show the space required for removal and replacement of tubes in the heat exchanger components, removal of water boxes, covers of access openings, zinc anodes, vapor separators, location of lifting lugs or eyebolts provided for handling of the unit or its components and size of openings therein provided for lifting.

b. Assembly drawings. Assembly drawings shall show complete longitudinal and transverse cross sectional views of the unit, relationship of all parts, arrangement of tubes in heat exchanger components, method of tube end expansion, baffles, vapor separators, and welding of adjacent parts. Liberal use of enlarged views or sections shall be made. If necessary, subassembly drawings conforming to the above may be furnished for individual components of the unit. The drawing shall be such that a thorough understanding of the design and construction of the apparatus may be obtained without reference to the related detailed drawings.

c. List of materials. The assembly drawing shall contain a list of materials showing names of parts with identifying numbers and materials of all parts. The identifying numbers shall also be shown adjacent to the part depicted in the various views, with arrows pointing to the parts.

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d. Zinc anodes. The drawing shall indicate that the zinc anodes provided in the heat exchanger comply with the requirements of MIL-A-19521, as modified herein (see 3.14.24).

. e. Major parts. _ Detail drawings_of all major parts such as shells, water boxes, tube sheets, tube supports, baffles, vapor separators, demister, flash cones and air ejectors shall be provided. The drawings shall be completety dimensioned with finishes and welding symbols indicated, as required for manufacture.

f. Diagrammatic piping arrangement A diagrammatic piping arrangement drawing shall be provided showing complete piping required for the operation of the apparatus, with piping furnished with the apparatus and that to be furnished by the shipbuilder clearly indicated. Location of gauges, thermometers, valves, orifice plates, acid cleaning connections, and salinity indicators shall be indicated.

g. Electrical components. A wiring and connection drawing or drawings shall be provided for such electrical components as are furnished as part of the unit.

30.2 Tabulation. Tabulated drawings are encouraged as a means to reduce drafting time, number and size of detail drawings.

30.3 Certification data sheets. Certification data sheets shall be provided and shall include a tabulation of the following data:

a. Velocity of circulating water under rated conditions in the tube of each component

b. Complete heat balance diagrams for showing capability of the unit to produce rated capacity over the required operating range. Diagrams for seawater temperatures of 28, 60, and 85 “F are required. In addition for submarine service a diagram for 45 “F is required.

c. Hydrostatic test pressure for all components, list of on board repair parts furnished and all similar pertinent design data

d. A drawing list tabulation with columns for drawing title, manufacturer’s drawing number and revision symbol. This list shall include all equipment drawings which comprise the design. The revision symbol column shall be kept up to date to the time of manufacture so that it will finally indicate for each drawing the revision applicable to the equipment as buiit-

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30.4 Sufficient drawings shall be provided to:

a. Provide design information sufficient to ensure conformance to the requirements of this specification including compatibility with ship and ship systems

b. Evaluate the suitability of design for intended Naval use

c. Evaluate performance and maintenance capability

d. Enable shipyard installation without contractor's assistance

e. Enable Naval ship and shore activities to repair and maintain the item without assistance from the original contractor.

30.5 Bolting torque. The bolting preload torque shall be specified in the applicable component drawings.

30.6 Critical materials. Critical materials shall be designated on drawings.

steam in the water box shall be obtained from steam g[illegible]

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TECHNICAL MANUALS TECHNICAL CONTENT REQUIREMENTS

10. SCOPE

10.1 Scope This appendix covers the technical content that shall be included in technical manuals when required by the contract or order. This appendix is mandatory only when delivery of a technical manual is required by contract.

20. APPLICABLE DOCUMENTS

This section is not applicable to this appendix.

30. TECHNICAL MANUAL CONTENTS

30.1 Content requirements. Technical manuals shall be in accordance with MIL-M-15071. Technical manuals shall include sufficient drawings to permit ship and shore activities to repair and maintain the unit without contractor's assistance. The manual shall contain instructions for proper installation of locking devices and criteria for their renewal. The manual shall include torque values for seawater containing element fasteners. The technical manual shall specify the experimentally determined values of bolting preload torque. The technical manual shall include complete operating instructions including initial inspections, step-by-step startup procedure, operation checks and adjustments, operation maintenance and step-by-step shutdown procedure.

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TECHNICAL REPORT TECHNICAL CONTENT REQUIREMENTS

10. SCOPE

10.1 Scope. This appendix covers the technical content requirements that shall be included in technical reports when required by the contract or order. This appendix is mandatory only when data item description DI-MISC-80652 is cited on the DD Form 1423.

20. APPLICABLE DOCUMENTS

This section is not applicable to this appendix.

30. DESIGN REPORT

30.1 Design report content. When required by the contract or order, design report content for applications for which cyclic life requirements are established, shall contain an analysis demonstrating the adequacy of the design. For heat exchangers designed for submergence pressure, a design report shall be included. The report shall be in a format to facilitate an independent review of its content. lt is, therefore, imperative that it be simple to follow, free from ambiguity, and should contain the following as a minimum:

a. Description of design requirements such as steady state transient pressures, temperatures, and external loading

b. Regions of the component analyzed

c. Materials used and their mechanical properties

d. General description of the methods of analysis and assumptions

e. All reference sources shall be listed.

f. All computer programs shall be properly identified and described.

g. Report contains copies of the computer printouts (input and output).

h. Stresses shall be tabulated for each area of investigation and compared to the allowable stresses for all stress categories.

i. Satisfaction of cyclic requirements including stress concentration factors used in the cyclic analysis.

j. Manufacturer shall submit calculations demonstrating that the free length of tubes provided between the double tube sheets is sufficient to comply with 3.14.28.1.1.

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STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.

2. The submitter of this form must complete blocks 4, 5, 6, and 7.

3. The preparing activity must provide a reply within 30 days from receipt of the form.

NOTE: This form may not be used to request copies of documents, nor to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

I RECOMMEND A CHANGE:	1. DOCUMENT NUMBER	2. DOCUMENT DATE (YYMMDD)
	MIL-D-18641F(SH)	1993 MAY 5

3. DOCUMENT TITLE DISTILLATION UNITS, WATER: STEAM, OR FLASHED VAPOR OPERATED, OR HOT FRESH WATER HEATED, LOW PRESSURE, NAVAL SHIPBOARD

4. NATURE OF CHANGE *(Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)*

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME (Last, First, Middle Initial)	b. ORGANIZATION	
c. ADDRESS (Include Zip Code)	d. TELEPHONE (Include Area Code) (1) Commercial (2) AUTOVON (If applicable)	7. DATE SUBMITTED (YYMMDD)

8. PREPARING ACTIVITY

a. NAME	b. TELEPHONE (Include Area Code)	
TECHNICAL ENGINEER: . Walter Aerni, NAVSEA 05X23	(1) Commercial (703) 602-6065	(2) AUTOVON 332-6065
c. ADDRESS (Include Zip Code) Commander, Naval Sea Systems Command ATTN: 05Q42, 2531 Jefferson Davis Hwy Arlington, VA 22242-5160	IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT: Defense Quality and Standardization Office 5203 Leesburg Pike, Suite 1403, Falls Church, VA 22041-3466 Telephone (703) 756-2340 AUTOVON 289-2340	