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SUPERSEDING
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MILITARY SPECIFICATION

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

1. SCOPE

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

1.2 Classification.-

1.2.1 Types.- Distillation units shall be of the following types except as otherwise specified (see 6.1). Any type may be supplied as applicable:

- 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 VI - Combination vertical basket and flash type, steam operated.
- Type VII- Submerged tube, hot fresh water heated (heat recovery).

1.2.2 Classes.- Distillation units shall be of the following classes, as specified (see 6.1):

- Class A - Basically composition 70-30 copper-nickel alloy.
- Class B - Basically composition 90-10 copper-nickel alloy.
- Class C - Basically aluminum bronze.

2. APPLICABLE DOCUMENTS

2.1 The following specifications, standards and drawings, of the issue in effect on date of invitation for bids, form a part of this specification to the extent specified herein.

SPECIFICATIONS

FEDERAL

- QQ-N-286 - Nickel-Copper-Aluminum Alloy, Wrought (K-Monel).
- QQ-N-288 - Nickel-Copper Alloy and Nickel-Copper-Silicon Alloy Castings.
- WW-T-797 - Tubes, Copper, Seamless, 6,000 P.S.I. Maximum Pressure.
- PPP-B-601 - Boxes, Wood, Cleated-Plywood.
- PPP-B-621 - Boxes, Wood, Nailed and Lock-Corner.

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- MIL-C-104 - Crates, Wood; Lumber and Plywood Sheathed, Nailed and Bolted.
- MIL-P-116 - Preservation, Methods of
- MIL-B-121 - Barrier Material, Greaseproofed, Waterproofed, Flexible.
- MIL-C-132 - Crate, Wood, Open; Maximum Capacity 2,500 Pounds.
- MIL-R-196 - Repair Parts for Internal Combustion Engines, Packaging of
- MIL-T-656 - Thermometers, Self-Indicating, Liquid-In-Glass (Navy Type).
- MIL-B-857 - Bolts, Nuts and Studs.
- MIL-S-901 - Shockproof Equipment, Class HI (High-Impact), Shipboard Application, Tests for
- MIL-T-940 - Thermometers, Indicating, Capillary Tube and Bulb, Mercury Actuated.
- MIL-D-963 - Drawings, Production, Procedure for Procurement of
- MIL-M-2082 - Meters, Volumetric Positive Displacement, Liquid, Cold Water and Hot Water Type, Naval Shipboard.
- MIL-G-2860 - Glasses, Port-Light, Evaporator.
- MIL-C-3774 - Crates, Open, Wood (2,500 to 10,000 lb.).
- MIL-P-5425 - Plastic, Sheet, Acrylic, Heat Resistant.
- MIL-T-15005 - Tubes, 70-30 and 90-10 Copper Nickel Alloy, Condenser and Heat Exchanger.
- MIL-M-15071 - Manual, Technical, for Mechanical and Electrical Equipment (Less Electronics).
- MIL-S-15103 - Salinity Indication Equipment.

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MIL-P-15137 - Provisioning and Technical Documentation for Repair Parts for Electrical and Mechanical Equipment (Naval Shipboard Use).
MIL-P-15424 - Packaging of Hand Tools for Domestic and Overseas Shipment and Storage.
MIL-E-15465 - Ejector Assemblies, Air.
MIL-C-15726 - Copper-Nickel Alloy Rods, and Flat Products (Flat Wire, Strip, Sheet, Bar, and Plate).
MIL-P-15742 - Plugs, Plastic (Heat-Exchanger-Tube).
MIL-E-15809 - Expander, Tube, Condenser and Heat Exchangers.
MIL-A-15939 - Aluminum Bronze Bars, Plates, Rods, Sheets, Strips, Forgings, and Structural and Special Shaped Sections.
MIL-P-16298 - Preservation, Packaging, Packing, and Marking of Electric Machines Having Rotating Parts and Associated Repair Parts.
MIL-T-16420 - Tube, 70-30 and 90-10 Copper-Nickel Alloy, Seamless and Welded.
MIL-V-16556 - Valve, Solenoid, Three-Way Bypass (Naval Shipboard Use).
MIL-P-16789 - Preservation, Packaging, Packing and Marking of Pumps General, and Associated Repair Parts.
MIL-T-17244 - Thermometer, Self-Indicating Bimetallic, Shock-Resistant.
MIL-A-17472 - Asbestos Sheet Compressed (Packing Material).
MIL-P-17639 - Pumps, Centrifugal, Miscellaneous Service, for Use on Naval Ships.
MIL-C-17728 - Control and Drive Assembly, Tube Expander, Automatic.
MIL-P-17840 - Pumps, Centrifugal, Close-Coupled, Navy Standard.
MIL-V-18030 - Valves, Pressure Control, Diaphragm Operated, External Air Pilot Actuated.
MIL-P-18472 - Pumps, Centrifugal, Condensate, Feed Booster and Distilling Plant.
MIL-V-18683 - Vacuum Pumps, Power Driven, Centrifugal Pump Priming Service, Naval Shipboard.
MIL-G-18997 - Gages, Pressure, Dial Indicating, Bourdon Tube.
MIL-A-19521 - Anodes, Corrosion Preventive, Zinc; 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 Reading, Reflex Tubular Gage Glass.
MIL-F-20042 - Flanges, Pipe, Bronze (Silver Brazing).
MIL-V-20065 - Valve, Relief, Naval Shipboard.
MIL-P-20087 - Paint, Heat-Resisting.
MIL-T-20157 - Tube and Pipe, Carbon Steel, Seamless.
MIL-F-20670 - Flanges, Pipe, Carbon Steel, 150 P.S.I., W.S.P.
MIL-R-21252 - Rubber Sheet, Solid, Synthetic, Shipboard Water Evaporator Gasketing.
MIL-P-21397 - Proportioning Unit, Chemical (for Distilling Plants Naval Shipboard Use).
MIL-G-21610 - Gaskets, Heat Exchanger, Various Cross Section Ring, Synthetic Rubber.

STANDARDS

MILITARY

MIL-STD-129 - Marking for Shipment and Storage.
MIL-STD-278 - Welding and Allied Processes for Machinery for Ships of the United States Navy.

DRAWINGS

BUREAU OF SHIPS

B214 - Root Connections for Attaching Piping.
5000-S-4800-3000 - Schedule for Piping, Pipe Fittings, Valves and Types of Joints Used in Piping Systems.

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

2.2 Other publications. - The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids shall apply.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Boiler and Pressure Vessel Code, Section VIII, Rules for Construction of Unfired Pressure Vessels.

(Application for copies should be addressed to the American Society of Mechanical Engineers, 29 West 39th Street, New York 18 N.Y.)

AMERICAN SOCIETY FOR TESTING MATERIALS

A7 - Steel for Bridges and Buildings.
A53 - Welded and Seamless Steel Pipe.
A285 - Low and Intermediate Tensile Strength Carbon-Steel Plates of Flange and Firebox Qualities (Plates 2 inches and under in thickness).
A350 - Forged or Rolled Carbon and Alloy Steel Flanges, Forged Fittings, and Valves and Parts for Low Temperature Service.
B36 - Brass Plate, Sheet, Strip and Rolled Bar.
B98 - Copper-Silicon Alloy Rod, Bar and Shapes.
B111 - Copper and Copper-Alloy Seamless Condenser Tubes and Ferrule Stock.
B127 - Nickel-Copper Alloy Plate, Sheet and Strip.
B139 - Phosphor Bronze Rod, Bar and Shapes.
B143 - Tin-Bronze and Leaded Tin-Bronze Sand Castings.
B152 - Copper Sheet, Strip, Plate and Rolled Bar.
B164 - Nickel-Copper Alloy Rod and Bar.
B171 - Copper-Alloy Condenser Tube Plates.
D512 - Method of Test for Chloride Ion in Industrial Water and Industrial Waste Water.

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

NATIONAL BUREAU OF STANDARDS

Handbook H28 - Screw-Thread Standards for Federal Services.

(Application for copies should be addressed to the Superintendent of Documents, Government Printing Office, Washington 25, D.C.)

OFFICIAL CLASSIFICATION COMMITTEE

Uniform Freight Classification Rules.

(Application for copies should be addressed to the Official Classification Committee, 1 Park Avenue at 33rd Street, New York 16, N.Y.)

3. REQUIREMENTS

3.1 Qualification.- The distillation unit furnished under this specification shall be a product which has been tested, and passed the qualification tests specified herein, and has been listed on or approved for listing on the applicable qualified products list.

3.2 Material.- The materials as specified hereinafter shall be used as the basis for design. Any parts for which materials are not specified shall be of material best suited for the purpose intended.

3.2.1 Threaded parts.- Threaded parts shall conform to Handbook H28. The design shall be such that standard wrenches can be used throughout.

3.2.2 Welding and allied processes.- Welding and allied processes shall be in accordance with Standard MIL-STD-278.

3.2.3 Gaskets.- Gaskets shall be of the following materials:

(a) Gaskets between waterbox flanges and tube sheets:

(1) Not subjected to submarine submergence pressure shall be acid resisting synthetic rubber in accordance with Specification MIL-R-21252.
(2) Subjected to submarine submergence pressure shall be O-ring, type I in accordance with Specification MIL-G-21610.

(b) Gaskets between tube sheets and shell flanges:

(1) Edges of which will not be subjected to the action of acid solution in chemical cleaning, shall be compressed asbestos, in accordance with Specification MIL-A-17472.
(2) Edges of which will be subjected to the action of acid solution in chemical cleaning, shall be acid resisting synthetic rubber, in accordance with Specification MIL-R-21252.

(c) Gaskets between double tube sheets or between tube sheets and spacer ring between tube sheets, shall be O-ring, type II in accordance with Specification MIL-G-21610.

(d) Gaskets for flanges of access openings, sight glass flanges, integral piping flanges:

(1) Edges not subjected to acid solution shall be compressed asbestos in accordance with Specification MIL-A-17472.
(2) Edges of which will be subjected to acid solution shall be in accordance with Specification MIL-R-21252.
(3) Subjected to submergence pressure shall be O-ring, type I of Specification MIL-G-21610.

3.3 Operation.-

3.3.1 Types I, II, III and VI.- The distillation unit shall be designed to use steam at a pressure of 5 pounds per square inch gage (p.s.i.g.) or less, to

distill to a final vacuum at the air ejector suction of 7-1/2 inches of mercury absolute pressure, or less, and to deliver the distillate at a temperature not exceeding 95° Fahrenheit (F.), with an initial temperature of sea water of 85°F.

3.3.2 Type IV.- The heat from hot fresh water at specified temperature (see 6.1) shall be transferred to sea water in a heat exchanger. The heated sea water shall then be injected into a flash chamber (or chambers in series) in which part of the sea water is flashed to vapor under a vacuum. The vapor shall then be condensed in a condenser(s).

3.3.3 Type VII.- Hot fresh water at specified temperature (see 6.1) shall be circulated through a tube bundle. The tube bundle shall be enclosed in a shell and surrounded by the sea water which is to be evaporated by transfer of heat from the fresh water. The vapor formed shall be condensed in a distiller condenser.

3.3.4 Types IV and VII shall distill to a final vacuum as required, and shall deliver the distillate at a temperature not exceeding 95°F. with an initial temperature of sea water of 85°F.

3.3.5 In some cases a higher distillate temperature than 95°F. may be accepted (see 6.1 for limiting temperature).

3.4 Rating.-

3.4.1 The rated capacity of the unit (see 6.1) for 24 hours continuous operation when supplied with sea water between 28°F. and 85°F., and with designed brine density as indicated on the heat balance drawing and related technical data shall be obtained after 90 days of normal operation. The standard Navy scale prevention compound shall be used as feed treatment in types I, III, VI and VII or with recirculated brine in a type II unit. Above number of days operation shall be as nearly continuous as practicable.

3.4.2 A distillation unit furnished for a nuclear powered ship shall produce distillate having a salinity content not exceeding 0.0325 equivalents per million (e.p.m.) of chlorides (0.125 grain of sea salts per gallon) and a distillation unit furnished for an oil fuel burning ship shall produce distillate having a salinity content not exceeding 0.065 e.p.m. (0.25 grain of sea salts per gallon), both under all conditions of operation, when evaporating sea water of not less than 1/32 density (that is: 32 pounds of sea water containing 1 pound of dissolved solids) when the ship is under the following conditions of inclination:

Surface ships:

(a) Up to 5 degrees from the normal horizontal position in the fore and aft plane (permanently inclined).

(b) Up to 15 degrees to either side (permanently inclined).

(c) With the ship rolling up to 30 degrees from the vertical to either side or pitching 10 degrees up or down from the normal horizontal plane.[1]

Submarines:	Surfaced	Submerged
(a) Trim, fore and aft (permanent)	30 degrees	7 degrees
(b) List, port and starboard (permanent)	15 degrees	15 degrees
(c) Pitching	10 degrees	10 degrees
(d) Period of complete pitch cycle	60 seconds	6 seconds
(e) Rolling	30 degrees	30 degrees[2]
(f) Period of complete roll cycle	12 seconds	8 seconds

[1]The unit shall be so designed that no damage will occur if it is subjected to rolling of 45 degrees.

[2]The unit shall be so designed that no damage will occur if it is subjected to rolling of 60 degrees.

Note.- Degrees are measured from the horizontal fore-and-aft plane, up or down for trim and pitch, and from the vertical to either side for list and roll. The conditions for permanent list and roll or for trim and pitch shall not be considered additive. The period is the time for one complete cycle; that is, the time for the ship to pitch or roll from one extreme to the other and return to the first extreme.

3.4.2.1 The manufacturer shall consider the proposed orientation of the unit in the ship (see 6.1); it is his responsibility to advise if limitations of his design require different orientation in order that the distilling unit may meet the requirements specified herein.

3.4.3 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.

3.5 In type II distillation units the temperature of the feed water entering the first stage feed inlet compartment shall be limited to between 165° and 175°F.

3.6 In type I, III, IV, VI and VII distillation units, provision shall be made for raising the temperature of the feed water or distillate to at least 165°F. at some point in the cycle to insure that the distillate is bacteriologically potable when the unit is operated with salt feed water considered contaminated, or with brackish feed water which may be contaminated, and carry over of which would not register on the salinity indicators. Provision shall be made to insure that no water enters the unit at a lower temperature than 165°F. subsequent to the point at which the feed water has been raised to that temperature.

3.7 General design.- General design shall be as follows:

(a) *Distillation units* shall be of the lightest and most compact design consistent with reliability.

(b) Distillation units shall be designed and furnished as complete package type units to which the shipbuilder can make the necessary external water supply and discharge connections, and external steam and electrical connections. All pumps, motors, and controllers, steam pressure reducing valve (if required for proper operation of the unit), 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 panel or panels.

(c) 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 6.1).

(d) It shall be the distilling unit manufacturer's responsibility to furnish pumps of adequate capacity for the various services, with discharge pumping heads as determined by the shipbuilder (see 6.1), and with adequate motor horsepower as determined by these conditions.

(e) Feed water for types I, III, and VI 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 6.1).

(f) Feed and circulating pumps shall be in accordance with Specification MIL-P-17840 or MIL-P-17639 where these pumps are not covered in the rating charts of Specification MIL-P-17840. Distillate, brine overboard, and evaporator steam chest (coil) drain pumps shall be in accordance with Specification MIL-P-18472. Salinity indicating equipment shall be in accordance with Specification MIL-S-15103. Steam pressure reducing valve shall be in accordance with Specification MIL-V-18030. When specified (see 6.1) a water operated eductor shall be provided in lieu of a brine overboard pump. Materials of the eductor shall be suitable for the service.

(g) A drain regulator (see 3.15) 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 installations in which the sea water temperature varies rapidly when the depth of submergence changes), a thermostatically controlled valve shall be provided either in the inlet circulating water line to 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) Adequate 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:

(1) Seal pipes between effects or stages which may become clogged with scale which flakes off of the shell, baffles or other surfaces, or into which mud or sand settled out of the feedwater may be washed and accumulate.

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

3.7.1 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 water heater(s) if necessary, integral piping, valves and fittings, thermometers, gages, flash tank, drain regulators, meters, pumps, motors, controllers, and salinity indicating equipment.

3.7.2 A type II distillation unit shall consist of one or more evaporating stages in a single or multiple shell. Each stage shall be equipped with a feed water inlet with means for introducing the feed water 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; a salt feed water heater, distillate cooler if necessary, air ejector(s), air precooler (if necessary) and after condenser, integral piping, valves and fittings, thermometers, gages,

drain regulators, meters, pumps, motors, controllers, and salinity indicating equipment.

3.7.3 A type I 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 system or vapor is contained inside the corrugated basket, a distiller condenser, distillate cooler if necessary, air ejector and after condenser, vapor feed water heater(s) if necessary, integral piping, valves and fittings, thermometers, gages, flash tank, drain regulators, meters, pumps, motors, controllers, and salinity indicating equipment.

3.7.4 A type IV distillation unit shall consist of one or more evaporating stages in a single or in multiple shells. Each stage shall be equipped with a feed water inlet with means for introducing the feed water 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; a salt feed water heater for transferring heat from the hot fresh water to the sea water, distillate cooler if necessary, air ejector, air precooler (if necessary) and after condenser or vacuum pump (see 6.1) integral piping, valves and fittings, thermometers, gages, drain regulators, meters, pumps, motors, controllers, and salinity indicating equipment.

3.7.5 A type VI distillation unit shall consist of a combination of one or more evaporating effects of the vertical corrugated basket type as described in 3.7.3 and one or more flash type evaporating stages as described in 3.7.2 with the necessary stage condensers, distillate cooler if necessary, air ejector and after condenser, integral piping, valves and fittings, thermometers, gages, drain regulators, meters, pumps, motors, controllers, and salinity indicating equipment.

3.7.6 A type VII distillation unit shall consist of one evaporating effect comprised of an evaporator shell in which a horizontal tube bundle is submerged in the salt water to be evaporated and through which hot fresh water is circulated; a vapor separator of suitable design; a distiller condenser; air, sea water, brine and distillate pumps; distillate cooler if necessary; valves; fittings; thermometers; gages; drain regulators; meters; pump motors and controllers; and salinity indicating equipment.

3.7.7 Supporting feet or brackets shall be designed to secure the unit, its components or accessories adequately against high impact shock or when the ship is listed, pitching or rolling (see 3.4.2). Components shall not be supported by plates or brackets in such manner that the 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.

3.7.7.1 Shock resistance.-

3.7.7.1.1 Shock tests of complete distillation units or of separately mounted components thereof weighing 4500 pounds or less are required. Shock tests shall be performed as specified in Specification 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 45 degree angle from the horizontal in the direction of its least transverse strength.

(b) Waiver of shock testing will be considered for units if they are of similar design, construction, weight, and materials to units which have successfully passed test in accordance with Specification MIL-S-901.

3.7.7.1.2 For distilling units weighing over 4500 pounds, the subbases, feet, structural members and holding down bolts shall be designed for the shock design numbers of figure 1. Calculations shall be submitted upon request.

3.7.7.1.3 Shock resistant design.-

3.7.7.1.3.1 Bolts designed to be stressed in shear shall be installed in holes no greater than the following sizes:

Nominal bolt diameter Inches	Maximum diameter of hole Inches
3/4 and smaller	Nominal bolt diameter + 1/32
Larger than 3/4	Nominal bolt diameter + 1/16.

3.7.7.1.3.2 Units that are rigidly supported shall not be attached to two structures which can deflect relative to each other under shock loadings.

3.7.7.1.3.3 Shock mountings shall not be used without prior approval from the bureau or agency concerned.

3.7.7.1.3.4 Where braces must be employed to afford stability under vibration, the braces shall be designed to fail under a load caused by a force equal

to five times the weight of the unit. This load shall be assumed to be acting at the center of gravity of the unit.

3.7.7.1.3.5 Where buffers must be employed to limit deflection under shock loading, the buffer shall be designed in accordance with figure 1.

3.7.8 Flanges shall be in accordance with Specifications MIL-F-20042 and MIL-F-20670, except for submarines. Unless otherwise specified (see 6.1), flanges subjected to submergence pressure shall be plain flanges, 100-pound, standard sizes conforming to Specification MIL-F-20042, except that the thickness shall be in accordance with dimension A for plain flanges, 400-pound, standard sizes. Root connections shall be in accordance with drawing B-214. In lieu of construction shown on drawing B-214, nozzles may be fabricated from short lengths of pipe provided with a slip-on flange welded to one end, and pads may be bar stock or plate of requisite thickness for studs. Nozzles shall be of the minimum length possible for through bolts.

3.7.8.1 The main flanges of non-ferrous fabricated waterboxes 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 Publications A285(firebox) or A7(open hearth, carbon content 0.35 percent maximum) except for flanges subjected to submergence pressure, if steel is used, it shall be grade LF1 in accordance with ASTM Publication A350, including impact requirements. Steel Flanges shall be adequately protected from contact with salt water by inlay or overlay of copper-nickel material.

3.7.9 All components of the distillation unit which require salt water circulation through the tubes shall be provided with water boxes so proportioned as to provide sufficient area at all points for flow of the circulating water with the minimum of turbulence, and for uniform distribution of the water to all tubes in each pass. Single pass components shall have an inlet water-box 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 water boxes so designed 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 passes, and with drains as necessary.

3.7.10 The velocity of flow of circulating water or feed entering the inlet nozzles of the distillate cooler, distiller or stage condensers, air ejector precooler and after-condenser, and vapor or salt water feed heater(s)[1], and the average velocity through the tubes of these components shall not exceed 6 feet per second (f.p.s.) under the rated conditions. If divergent nozzles are provided, this velocity shall not be exceeded at the actual entrance of the water into the waterbox.

3.7.11 In types I and III, provision for heating the sea water feed shall be made by segregation of a section of the distiller condenser tubes, circulation of the feed water through the ejector after condenser, and provision of a vapor feed heater for each evaporator effect except the last, the feed water circulating 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 II and IV, provision for heating the sea water feed shall be made by circulation of the feed water through the distillate cooler, the ejector after condenser, the stage condensers and the salt feed water heater in series. In type VI, provision for heating the sea water feed shall be made by circulation of the feed water through the distillate cooler, distiller condenser, air ejector after condenser, and first effect vapor feed heater in series. Part of the feed water discharge from the first effect vapor feed heater shall be used as feed for the first effect, the remainder, together with brine from the first effect, as feed for the second effect.

3.7.12 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.

3.7.13 A solenoid operated distillate by-pass 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 Specification MIL-V-16556.

3.7.13.1 An additional solenoid operated by-pass valve, actuated by the salinity cell located in the air ejector after condenser drain line shall be provided with type III distillation units using vertical distiller condensers unless the air offtake thereof and the air ejector are so located that there is no possibility of carryover of salt contaminated distillate into the after condenser.

3.7.14 All tubes in the evaporators, vapor feed heaters, distiller condenser, stage condensers, air ejector precooler, after condenser and distillate cooler shall be composition 90-10 in class B and class C distillation units, or composition 70-30 in class A distillation units, in accordance with Specification MIL-T-15005. Tubes shall normally be 5/8 inch outside diameter (o.d.), number 18 Birmingham wire gage (BWG) (0.049 inch wall thickness). In small capacity units, up to 5000 gallons per day (GPD) of distillate, when the use of smaller diameter

[1] Salt water feed heaters of type II units using recirculated brine may be designed for an average velocity through the tubes of 8 f.p.s.

tubes will result in a lesser number of passes in the above heat exchangers the tubes may be 3/8 inch o.d., number 18 BWG. The tubes of the after condenser of types II or IV units shall be not less than 5/8 inch o.d. and may be 3/4 inch o.d. number 18 BWG. In some submarine usage, the tubes may be required thicker than number 18 BWG (see 6.1).

3.7.14.1 When U-bent tubes are allowed (see 3.8.3, 3.9.2, 3.12.2, 3.13.2, 3.14.2), the minimum radius of the U-bend shall be 5/8 inch for 3/8 inch o.d. tubes, 15/16 inch for 5/8 inch o.d. tubes and 1-1/8 inch for 3/4 inch o.d. tubes.

3.7.14.1.1 All tubes shall be expanded at each end into the tube sheets by means of an automatic type of tube expander control in accordance with Specification MIL-C-17728 and with tube expanders in accordance with Specification MIL-E-15809. The tube expander shall be so adjusted 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. Care shall be taken that there is no abrupt change in contour of the inner tube surface caused by the expanding operation.

3.7.15 The holes for 3/8 inch o.d. tubes shall be reamed to 0.376 inch diameter with a plus tolerance of 0.002 inch. The holes for 5/8 inch o.d. tubes shall be reamed to 0.626 inch diameter with a plus tolerance of 0.002 inch. The holes for 3/4 inch o.d. tubes shall be reamed to 0.751 inch diameter with a plus tolerance of 0.002 inch. The holes for the inlet ends of the tubes shall be flared on a radius of 5/16 inch for 3/8 inch o.d. tubes, 1/2 inch for 5/8 o.d. tubes and 3/4 inch o.d. tubes, to a diameter at the outer face of the tube sheet of 1/2 inch for 3/8 inch o.d. tubes, 3/4 inch for 5/8 inch o.d. tubes and 7/8 inch for 3/4 inch o.d. tubes.

3.7.16 The minimum acceptable tube sheet thickness shall be 3/4 inch for 5/8 inch o.d. tubes and 5/8 inch for 3/8 inch o.d. tubes. (For 3/4 inch outside diameter tubes see 3.11.2.3.)

3.7.17 The minimum acceptable tube spacing shall be 13/16 inch, center to center for 5/8 inch o.d. tubes and 17/32 inch for 3/8 inch o.d. tubes. (For 3/4 inch outside diameter tubes see 3.11.2.4.)

3.7.18 All 3/8 inch and 5/8 inch outside diameter tubes 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 3 feet. If the design is such that cross-flow baffles drilled for the tubes are installed between the tube sheets and support plates and between support plates, the thickness of the support plates 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 41/64 inch diameter. All 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 outside diameter tubes (see 3.11.2.5)).

3.7.19 Provision shall be made for expansion and contraction of the shell of shell-and-tube type heat exchanger components of distillation units. Suggested acceptable provisions for shell expansion and contraction are:

(a) One support shall be designed to flex and the other support shall be rigid, both drilled as specified in 3.7.7.1.3.1.

(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 clearance of the inside diameter of the bushing over the nominal bolt diameter and the width of the slotted hole in the support over the outside diameter of the bushing shall not exceed those specified in 3.7.7.1.3.1. The other support shall be drilled as specified in 3.7.7.1.3.1.

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

(d) When one support designed to flex is used, the rigid support shall be designed to withstand the entire high impact shock load in the direction longitudinal of the heat exchanger. When a shell expansion joint is located between two rigid supports, each support shall be designed to withstand the high impact shock load equivalent to the weight of the tube bundle plus that of the adjacent waterbox 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.

3.7.19.1 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 construction. In the case of heat exchangers with an odd number of passes, restraint of tube expansion and contraction shall be avoided by the provision of an expansion joint in the piping connected to the waterbox 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. If the piping is furnished by the shipbuilder, the applicable drawing shall indicate the necessity for provision of an expansion joint in the shipbuilder's piping.

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

3.7.21 Jack screws shall be provided in all flanges of flanged joints which will be necessary to break for maintenance purposes.

3.7.22 The waterbox 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 bolts are used, alternate bolts shall be collar bolts; if stud bolts are used they shall be driven into tapped holes in the tube sheets, in order that the joint between the tube sheet and shell flange will not be broken when the waterboxes are removed. Collar bolts shall be replaceable without removing the waterboxes. Collar and stud bolts shall be provided with one square end for use of a wrench to prevent turning when the nut at the waterbox flange end is removed.

3.7.23 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 frame shall contain the sight glass. The glass shall be secured with its gaskets by means of a ring screwed into the frame 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 Specification MIL-G-2860.

3.7.23.1 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 resiliant gaskets. The flange shall be provided with jack screws. The plastic sheet shall be finish A in accordance with Specification MIL-P-5425 and shall be of suitable thickness for the intended service.

3.7.24 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 unwatered when the ship is secured unheated.

3.7.25 Zinc anode protection.- Provision for the future installation of zinc anodes shall be made by the manufacturer in the salt water circuits of all components of the distillation unit except the evaporators, but the zinc anodes and their supporting plugs shall not be furnished with the distillation unit. The zinc anodes, if later installed, shall be in accordance with Specification MIL-A-19521. Pipe-tapped bosses provided for the zinc anode supporting plugs shall be plugged with pipe plugs of the material specified for the zinc anode supporting plugs in Specification MIL-A-19521.

3.7.26 Air ejector assemblies.- The air ejector assembly furnished with the distillation unit shall conform to type B of Specification MIL-E-15465. The class shall be the same as specified for the distillation unit, for example, class 1 corresponds to class A. Only one air ejector is required. Furnishing of a single or multiple 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. An inter-condenser shall be provided for condensing the steam from the first stage of a three stage ejector used for a type II distillation unit. The condensate from the inter-condenser shall drain into the brine in one of the distillation unit stages. The air ejector steam pressure and temperature shall be as specified (see 6.1). Should an air precooler or inter-condenser be required for the air ejector, the design and materials thereof shall be as specified in Specification MIL-E-15465 for a type B after condenser.

3.7.26.1 In no case shall oversized air ejectors and their after condenser be provided for the purpose of thereby obtaining extra feed heating by utilization of 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 utilize low pressure auxiliary exhaust steam.

3.7.26.2 If all or most of the operating steam for the distillation unit must be taken from a high pressure source, a steam ejector designed for high pressure motive steam may be used in lieu of a reducing valve to supply operating steam at the requisite pressure to the first effect steam chest or the salt water heater. Such an ejector may handle a percentage of the vapor produced by the first effect. The steam ejector shall conform to the requirements for a type B air ejector.

3.7.26.3 A suitable 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.

3.7.27 Vacuum pump.- The vacuum pump for types IV and VII distilling units, when specified (see 6.1), shall be in accordance with Specification MIL-V-18683. Pumps shall be single or multiple stage as required by vacuum conditions.

3.7.27.1 In lieu of the vacuum pump specified in 3.7.27, a water operated eductor may be furnished. The eductor shall be of commercial quality. Materials used shall be suitable for salt water service.

3.7.28 Meters of the "rotometer" type shall be provided for each type I, III, VI or VII distillation unit. Meters of the "rotometer" type for flow of feed or brine shall be of a design 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.

3.7.28.1 A distillate meter, conforming to class A or B (depending on distillate temperature) of Specification MIL-M-2082, shall be provided with each unit of any type.

3.7.29 Distilling units for nuclear propelled surface ships and submarines.-

3.7.29.1 In submarines, the feed water 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 designed to withstand this pressure. When distilling units for submarines are specified to be class A, it is the intent that all parts subjected to submergence pressure be of materials required for class A units; all other parts shall be of materials required for class B units.

3.7.29.1.1 All heat exchangers of the shell and tube type provided as components of the distillation unit for nuclear 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. 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 may be welded or gasketed. The vendor shall be responsible for providing the proper span of tubes between double tube sheets, so that the tubes will not be over stressed due to radial expansion differentials of the double tube sheets. The manufacturer shall submit calculations to the bureau or agency concerned demonstrating that the free length of tubes provided between the double tube sheets is sufficient to comply with this requirement.

3.7.29.1.1.1 Tube sheet drilling.- For submarines, in heat exchangers subjected to submergence pressure the tube sheets shall be drilled as specified in 3.7.15 or 3.11.2.2, except that the holes for 3/8 inch, 5/8 inch or 3/4 inch outside diameter tubes in the outer tube sheets shall have three grooves 1/16 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 outside diameter tubes in the inner tube sheets shall have one groove 1/16 inch wide and 0.012 inch deep, centrally located. In heat exchangers not subjected to submergence pressure in submarines and in those for nuclear powered surface ships, the tube sheets shall be drilled as specified in 3.7.15 or 3.11.2.2, except that the inner tube sheet holes shall have no groove.

3.7.29.1.1.2 Tubes shall be expanded into both inner and outer tube sheets at each end, those in the outer tube sheet shall be as specified in 3.7.15, those in the inner tube sheet with expansion started 1/8 inch inside the outer face of the tube sheet and stopped 1/8 inch inside the inner face of the tube sheet. Minimum depth of expansion in the inner tube sheet shall be 1/2 inch for 3/8 o.d. tubes, 5/8 inch for 5/8 inch o.d. tubes and 3/4 inch for 3/4 inch o.d. tubes. Care shall be taken that there is no abrupt change in contour of the inner tube walls caused by the tube end expansion. After expansion of the tube ends, the specified water side hydrostatic test pressure shall be applied to the spaces between the double tube sheets as specified in 4.4.1.1.

3.7.29.1.1.3 The inner tube sheets shall be welded to the shell. If the joint between inner and outer tube sheets and spacer (if used) is not welded, the inner tube sheet shall be sufficiently larger in diameter than the shell to form an external bolting flange for securing the outer tube sheet and spacer (if used). If used, the bolting for the joint between the inner and outer tube sheets and spacer (if used) shall be adequate with no reliance on the bolting for the water-box-outer tube sheet joint. Studs in the outer tube sheet, with nuts on the shell side of the inner tube sheet; cap screws or tap bolts may be used.

3.7.29.1.1.4 The waterboxes may have either internal or external flanges. Internal waterbox 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 diametral clearance than the holes for the studs shall be provided to prevent damage to the threads on the studs when the waterboxes are installed. Through bolts shall be used with external waterbox flanges.

3.7.29.1.1.5 All parts subjected to submergence pressure shall be designed in accordance with the requirements of the ASME Boiler and Pressure Vessel Code, Section VIII, Rules for Construction of Unfired Pressure Vessels as a minimum, except welding shall be in accordance with Standard MIL-STD-278. Reinforcement of openings shall be integral with the waterbox shell or nozzle (or both), separate pads or saddle type reinforcements shall not be used. Welds shall be ground smooth and the corners and fillets shall be well rounded as necessary to minimize notch effect. In the design of the waterboxes, the forces exerted by the piping connected to the nozzles shall be considered as resulting from a maximum bending stress in the piping of 11,000 per square inch p.s.i. and a direct axial force of (1000 pounds X the nominal pipe size). These two loadings may be treated as a single overturning moment equal to:

$M = 10,000\ dm^2t$, where
M = overturning moment, inch pounds
dm = mean diameter of attached piping, inches (not counting transitions immediately adjacent to the nozzles)
t = thickness of piping (see 6.1)

(NOTE: This formula includes a factor of about 1.05 to cover slight increases in pipe wall above nominal values, a factor of 1.10 in moment to cover the above specified axial load and a simple approximation for section modulus which is always slightly conservative.)

3.7.29.1.1.5.1 In the design of waterboxes, full consideration shall be given to the cyclic nature of the pressure loading. The design shall be based on 15,000 cycles to full design submergence plus 50,000 cycles to 50 percent of design submergence. An analysis of fatigue loading on this basis shall be submitted to the bureau or agency concerned.

3.7.29.1.1.5.2 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 waterbox. Thus the stiffness of the piping will not affect expansion or contraction of the heat exchanger tubes.

3.7.29.1.1.6 Bolts subjected to submergence pressure shall be nickel-copper-alloy, class A of ASTM Publication B164 or nickel-copper-aluminum alloy, class A of Specification QQ-N-286, age-hardened. Nuts for these bolts shall be nickel-copper-alloy, class A or B of ASTM Publication B164 or nickel-copper-aluminum alloy, class A of Specification QQ-N-286, age-hardened, respectively. This bolting shall be so designed that the prestress necessary to maintain joint tightness when subjected to the specified hydrostatic test pressure (see 6.1) shall not exceed 37.5 percent of the yield strength at 0.2 percent offset indicated in the applicable material specification. When installing the bolting, a torque wrench, set so as not to exceed the above stress, shall be used.

3.7.29.1.1.7 Distillation units for submarines shall be designed to operate at an ambient pressure of 30 inches of mercury (Hg) absolute with a variation of plus or minus 6 inches Hg and shall not be damaged when subjected to an ambient pressure between 10 and 30 p.s.i. absolute with the minimum internal pressure which will prevail under any condition of operation.

3.7.30 Connections, with hose-gate valves, 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. These connections shall be indicated on the diagrammatic piping arrangement drawing (see 3.22.2.5). Type II units shall have the feedwater piping so arranged that reducing flanges with 1 inch iron 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.

3.7.31 Integral piping, valves, fittings, and similar items shall be in accordance with Drawing 5000-S4800-3000.

3.7.32 When parts made of bronze, aluminum, wrought, in accordance with Specification MIL-A-15939, are fabricated by welding, they shall be adequately heat treated to prevent stress corrosion cracking.

3.7.33 Connections shall be provided as required on types I, III, VI and VII distillation units for introduction of the standard Navy scale prevention compound as feed treatment. Introduction shall be in location such as to protect the heat exchanger tubes, as well as the evaporator surface, from scale formation.

3.7.34 A proportioning pump and supply tank, in accordance with Specification MIL-P-21397, shall be furnished with types I, III, VI and VII distillation units, or with type II when recirculation of brine is used, for supply of standard Navy scale prevention compound to the feedwater (see 3.4.1).

3.8 Evaporators for type I, submerged tube type low pressure steam operated or type VII heat recovery units.-

Table I — Material for class A distillation units.

Part	Material	Applicable document
Shells	Copper-nickel alloy, composition 70-30	MIL-C-15726
Tube sheets	Copper-nickel alloy, composition 70-30	ASTM B171[3]
Tube support plates	Copper-nickel alloy, composition 70-30	MIL-C-15726
Steam chests (type I) or waterboxes for hot fresh water (type VII)	Copper-nickel alloy, composition 70-30	MIL-C-15726
	or gun metal, alloy 1B	ASTM B143
	or valve bronze, alloy 2A	ASTM B143
	or steel	ASTM A285 (firebox)
	or steel	ASTM A7 (open hearth)[4]
Baffles	Copper-nickel alloy, composition 70-30	MIL-C-15726
Vapor separators[1]	Copper-nickel alloy, composition 70-30	MIL-C-15726
	or Naval brass	ASTM B171
Bolts, nuts and stay-rods exposed to salt-water vapor or in joints involving salt-water tightness[2]	Nickel-copper alloy	ASTM B164
	or bronze aluminum, wrought, composition 5, stress relieved	MIL-A-15939
	or phosphor bronze, alloy A or D	ASTM B139
	or copper-silicon alloy	ASTM B98
Other bolts and nuts	----------	MIL-B-857
Piping, water	Copper-nickel tubing, composition 70-30	MIL-T-16420
Piping, steam inlet	Steel	ASTM A53[4]
Piping, vapor	Copper tubing	WW-T-797

[1] If manufacturer elects to furnish mesh type vapor separators the mesh shall be galvanically compatible with adjacent materials.

[2] Form in accordance with Specification MIL-B-857.

[3] Iron content 0.4-0.7 percent, nominal 0.5 percent.

[4] Carbon content 0.35 percent maximum.

3.8.1 The materials used in the construction of the evaporators of class A distillation units shall be as shown in table I.

3.8.1.1 Materials for class B distilling units shall be as specified in table I, except that copper-nickel-alloy shall be 90-10 composition. Iron content of tube sheets shall be 1.0 to 1.75 percent, nominal 1.5 percent.

3.8.1.2 Materials for class C distilling units shall be as specified in table I, except that bronze, aluminum, wrought, composition 5, of Specification MIL-A-15939 shall be substituted for the copper-nickel-alloy.

3.8.2 The tubes and tube nests shall be so 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.

3.8.3 Minimum tube spacing shall be 1-5/8 inch center-to-center when 5/8 inch o.d. tubes are used or 7/8 inch center-to-center when 3/8 inch o.d. tubes are used. Two steam passes (type I) or water passes (type VII) shall be provided; and the tubes in the lower steam pass shall be inclined to provide good drainage. The tubes shall be so arranged that none of the heating surface 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.

3.8.4 The head or door provided for the tube nest withdrawal opening shall have a flat surface for making the joint with the shell.

3.8.5 An adequate sump space underneath the tubes shall be provided for lodgement of scale, and a flat removable cover shall be provided so that the sump may be cleaned without removing the tube nest.

3.8.6 Adequate baffles for suppression of swash and for moisture separation shall be fitted over the tube nest as necessary to conform to 3.4.2.

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

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

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

3.8.10 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.

3.8.11 When specified (see 6.1), adjustable weir type level controls shall be provided for maintaining a constant level of brine in each effect.

3.8.12 The following connections and fittings shall be provided for each evaporator:

(a) Evaporator shells:
- (1) Feed inlet connection.
- (2) Brine outlet connection.
- (3) Compound pressure and vacuum gage, 4-1/2 inch diameter.
- (4) Water gage glass, with mark showing top of the tubes. When weir level controls are provided, gage glasses shall be located thereon.
- (5) Relief valve (first effect only).
- (6) Vapor discharge connection.
- (7) Sump with removable 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.
- (10) Sight glasses.
- (11) Air vent from brine pump in last effect shell only.
- (12) Cold-shock and quick flooding connection.

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

3.8.13 One orifice plate with proper size orifice shall be provided with the type I distillation unit for the steam supply to the first-effect steam chest to limit the steam flow to that specified for rated capacity.

3.8.14 An adequate desuperheater shall be provided in the steam supply piping furnished with the distillation unit, if required for proper performance of the unit (type I).

3.8.15 Each evaporator effect shall be provided with an adequately sized quick flooding connection for use in cold-shocking the evaporator. These connections shall be connected to the circulating water pump of the distillation unit.

3.8.16 The piping system of the distilling unit shall be provided with a connection for injection of Navy Standard Scale Preventing Compound, so located that the compound will pass through the tubes of all feedwater heaters and all of the compound will pass into the first effect evaporator shell with the feedwater.

3.8.17 Each evaporator effect shall be provided with an adequate vapor separator, so designed 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 separated moisture shall be drained from the separator to a location below the normal working water level. The vapor separators shall be removable from the evaporator shells.

3.9 Evaporators and stage condensers for types II, IV, and for type VI, flash stage(s).

3.9.1 The material used in construction of the evaporators and stage condensers of class A distilling units shall be in accordance with table II.

3.9.1.1 Materials for class B distilling units shall be as specified in table II, except that copper-nickel-alloy, shall be 90-10 composition. Iron content of tube sheets shall be 1.0-1.75 percent, nominal 1.5 percent.

3.9.1.2 Materials for class C distilling units shall be as specified in table II, except that bronze, aluminum, wrought, composition 5 of Specification MIL-A-15939 shall be substituted for copper-nickel-alloy.

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

3.9.3 Adequate baffles for suppression of swash and for moisture separation shall be fitted as necessary to meet the requirements of 3.4.2.

3.9.4 The shell of each evaporator stage shall be fitted with a sight glass.

3.9.5 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.

TABLE II – Materials for class A distilling units.

Part	Material	Applicable document
Shells	Copper-nickel-alloy, 70-30 composition	MIL-C-15726
Tube sheets	Copper-nickel-alloy, 70-30 composition	ASTM B171[3]
Tube support plates	Copper-nickel-alloy, 70-30 composition	MIL-C-15726
Baffles	Copper-nickel-alloy, 70-30 composition	MIL-C-15726
Vapor separators[1]	Copper-nickel-alloy, 70-30 composition or Naval brass	MIL-C-15726 ASTM B171
Bolts exposed to salt water, vapor, or condensate or for joints involving salt water tightness[2]	Nickel-copper-alloy, class A, or bronze, aluminum, wrought, composition 5, stress relieved	ASTM B164 MIL-A-15939
	or phosphor bronze, alloy A or D	ASTM B139
	or copper-silicon alloy	ASTM B98
Stay rods exposed to salt water	Nickel-copper-alloy, class A,	ASTM B164
	or bronze, aluminum, wrought, composition 5, stress relieved	MIL-A-15939
	or phosphor bronze, alloy A or D	ASTM B139
	or copper-silicon alloy	ASTM B98
Nuts for bolts and stay-rods specified above[2]	Nickel-copper-alloy, class B	ASTM B164
	or bronze, aluminum, wrought, composition 5, stress relieved	MIL-A-15939
	or phosphor bronze, alloy A or D	ASTM B139
	or copper-silicon alloy	ASTM B98
Other bolts and nuts	----------	MIL-B-857
Piping, water	Copper-nickel-alloy 70-30 composition	MIL-T-16420
Piping, vapor	Copper tubing	WW-T-797
Water boxes	Gun metal, alloy 1B	ASTM B143
	or valve bronze, alloy 2A	ASTM B143
	or copper-nickel-alloy 70-30 composition	MIL-C-15726

[1] If manufacturer elects to furnish mesh type vapor separators, the mesh shall be galvanically compatible with adjacent materials.

[2] Form in accordance with Specification MIL-B-857.

[3] Iron content 0.4-0.7 percent, nominal 0.5 percent.

(d) Distillate inlet from interstage 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 overboard pumps.
(j) Thermometers and gages.
(k) Lifting and handling eye-bolts or lugs.
(l) Drain connections and loop seals.
(m) Access openings for cleaning evaporator feed compartments (see 3.7 (i)).
(n) Access openings for cleaning seal pipes between stages (see 3.7(i)).

3.9.6 Each evaporator stage shall be provided with an adequate vapor separator, so designed as to remove all entrained salt water from the vapor flashed before the vapor passes into the condenser of that stage. The separated moisture shall be drained back to the evaporator. The vapor separators shall be removable from the evaporator shells.

Table III – Materials for class A distilling units.

Part	Material	Applicable document
Shells	Nickel-copper-alloy	ASTM B127
Corrugated baskets	Nickel-copper-alloy	ASTM B127
Vapor separators	Copper-nickel-alloy, composition 90-10	MIL-C-15726
	or Naval brass	ASTM B171
	or nickel-copper-alloy	ASTM B127
Bolts exposed to salt water, vapor, or condensate or for joints involving salt water tightness[1]	Nickel-copper-alloy, class A	ASTM B164
	or bronze, aluminum, wrought, composition 5, stress relieved	MIL-A-15939
	or phosphor bronze, alloy A or D	ASTM B139
	or copper-silicon alloy	ASTM B98
Stay rods exposed to salt water	Nickel-copper-alloy, class A	ASTM B164
Nuts for bolts and stay-rods specified above[1]	Copper-silicon alloy	ASTM B98
	or phosphor bronze, alloy A or D	ASTM B139
	or aluminum bronze	MIL-A-15939
Other bolts and nuts	----------	MIL-B-857
Piping, water	Copper-nickel-alloy; composition 70-30	MIL-T-16420
Piping, steam inlet	Steel	ASTM A53[2]
Piping, vapor	Copper tubing	WW-T-797

[1] Form in accordance with Specification MIL-B-857.

[2] Carbon content 0.35 percent maximum.

3.10 Evaporators for type III and for type VI vertical basket effect(s).-

3.10.1 The material used in the construction of the evaporators of class A distilling units shall be as specified in table III.

3.10.1.1 Materials for class B evaporators shall be as specified in table III except that all copper-nickel-alloy shall be composition 90-10.

3.10.1.2 Materials for class C shall be as specified in table III except that aluminum bronze, composition 5 of Specification MIL-A-15939 shall be substituted for nickel-copper-alloy and copper-nickel-alloy, where specified.

3.10.2 The evaporator shall be so arranged that the corrugated basket(s) will be readily removable and easily accessible for inspection.

3.10.3 Adequate provision shall be provided for cold-shocking each effect.

3.10.4 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.

3.10.5 Adequate provision shall be made for protection of the corrugated baskets against external overpressuring by the cold-shocking water. A rupture disc on each effect may be used for this purpose.

3.10.6 The following connections and fittings shall be provided for each evaporator

(a) Feed inlet connection.
(b) Brine outlet connection.
(c) Compound pressure and vacuum gage, 4-1/2 inch diameter.
(d) Water gage glass.
(e) Relief valves 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) Cold-shock connection.
(k) Steam supply connections.
(l) Drain connections.
(m) Air vent connections.
(n) Sight glasses.
(o) Thermometers.
(p) Lifting and handling eyebolts or lugs.
(q) Gage connections.

3.10.7 Each evaporator effect shall be provided with adequate vapor separators, so designed as to remove all entrained salt water from the vapor generated before the vapor passes into the vapor feed

Table IV — Materials for class A distillation units.

Part	Material	Applicable document
Shell	Steel plate	ASTM A285 (firebox)
	or steel plate	ASTM A7 (open hearth)[2]
	or steel pipe	ASTM A53[2]
	or steel tubing	MIL-T-20157
	or copper tubing	WW-T-797
Tube support plates and baffle plates	Steel plate	ASTM A285 (firebox)
	or steel plate	ASTM A7 (open hearth)[2]
Water boxes	Copper-nickel-alloy, 70-30 composition	MIL-C-15726
	or valve bronze, alloy 2A	ASTM B143
	or gun metal, alloy 1B	ASTM B143
Steam piping	Steel	ASTM B53[2]
Bolts in contact with salt water or for joints involving salt water tightness[1]	Nickel-copper alloy, class A	ASTM B164
	or bronze, aluminum, wrought, composition 5, stress relieved	MIL-A-15939
	or phosphor bronze, alloy A or D	ASTM B139
	or copper-silicon alloy	ASTM B98
Tie-rods and spacers in contact with fresh water	Brass	ASTM B36
Nuts for bolts and tie-rods specified above[1]	Nickel-copper alloy	ASTM B164
	or phosphor bronze, alloy A or D	ASTM B139
	or aluminum bronze	MIL-A-15939
	or copper-silicon alloy	ASTM B98
Tube sheets	Copper-nickel-alloy, 70-30	ASTM B171[3]
Other bolts and nuts	----------	MIL-B-857

[1] Form in accordance with Specification MIL-B-857.

[2] Carbon 0.35 percent maximum.

[3] Iron content 0.4-0.7 percent, nominal 0.5 percent.

heater or the distiller condenser. The separated moisture shall be drained from the separator.

3.10.8 An adequate desuperheater shall be provided for the inlet steam to the first effect baskets and for cold-shocking steam if required by the inlet steam conditions for type III or VI evaporators.

3.10.9 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 (type III or VI), except when a steam ejector is provided (see 3.7.26.2).

3.10.10 The piping system of the distilling unit shall be provided with a connection for the injection of Navy Standard Scale Preventing Compound, so located that the compound will pass through the tubes of the feedwater heaters and all of the compound will pass into the first effect evaporator shell with the feedwater.

3.10.11 Access openings shall be provided for the observation of and cleaning out (manually and chemically) of scale which forms in the vapor separator. Any drain piping connected to the vapor separator shall be cleanable through such access openings. Mesh type vapor separators, if used, shall be removable from the evaporator shells.

3.11 Feedwater heater for types II and IV.-

3.11.1 The material for construction of the salt feedwater heater shall be as shown in table IV for class A distillation units.

3.11.1.1 Materials for feedwater heaters of class B distilling units shall be as shown in table IV, except that all copper-nickel-alloy used shall be 90-10 composition. Tube sheets shall have iron content of 1.0-1.75 percent, nominal 1.5 percent.

3.11.1.2 Materials for feedwater heaters for class C distilling units shall be as shown in table IV, except that bronze, aluminum wrought, composition

5 of Specification MIL-A-15939, shall be substituted for copper-nickel-alloy.

3.11.2 The feedwater heater shall be designed for circulation of the salt feedwater through the tubes. Adequate baffling shall be provided to prevent direct impingement of the entering steam on adjacent tubes (type II). Sufficient surface shall be provided to insure compliance with the requirements of 3.4.1.

3.11.2.1 The tubes of the feedwater heater shall be 3/4 inch outside diameter number 18 BWG (0.049 inch wall thickness) in accordance with Specification MIL-T-15005. Tubes for feedwater heaters of class B and C distilling units shall be 90-10 composition and for class A they shall be 70-30 composition. All tubes shall be straight and shall be expanded into sheets at each end as specified in 3.7.14.

3.11.2.2 The holes for tubes in the tube sheets shall be reamed to 0.751 inch diameter with a plus tolerance of 0.002 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. All holes shall be provided with one groove 0.025 inch wide and 0.007 inch deep, with the outer edge of the groove three-eights inch from the outer face of the tube sheet. Edges of all holes which are not belled shall be rounded on a 1/16 inch radius at the faces of the tube sheet.

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

3.11.2.4 The minimum center to center spacing of tubes shall be 15/16 inch.

3.11.2.5 All 3/4 inch tubes 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.

3.11.2.6 When transverse baffles are used in the feedwater 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 3.11.2.5 and shall have all roughness removed from the faces of the baffles at the edges of the drilled holes.

3.11.2.7 If required by inlet steam conditions, an adequate desuperheater shall be provided for the feedwater heater steam (type II).

3.11.2.8 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).

3.12 Distiller condenser for types I, III, VI and VII.-

3.12.1 Material.- The materials used in the construction of the distiller condenser shall be as shown in table V for class A.

Table V — Materials for class A distillation units.

Part	Material	Applicable document
Shell, if separate	Copper-nickel-alloy, composition 70-30	MIL-C-15726
Tube sheets	Copper-nickel-alloy, composition 70-30	ASTM B171[4]
Tube support plates and baffle plates	Copper-nickel-alloy, composition 70-30	MIL-C-15726
	or Naval brass	ASTM B171
	or Commercial brass	
Water boxes	Copper-nickel-alloy, composition 70-30	MIL-C-15726
	or valve bronze, alloy 2A	ASTM B143
	or gun metal, alloy 1B	ASTM B143
Flash chamber	Copper tubing	WW-T-797
	or copper-nickel-alloy, composition 70-30	MIL-C-15726
Bolts, nuts, tie rods and spacers in contact with water or vapor or in joints involving salt-water tightness[1]	Nickel-copper-alloy	ASTM B164
	or bronze, aluminum wrought, composition 5, stress relieved	MIL-A-15939
	or phosphor bronze, alloy A or D	ASTM B139
	or copper silicon alloy	ASTM B98
	or admiralty metal[2]	ASTM B111
	or commercial brass[3]	
Other bolts and nuts	----------	MIL-B-857

(See p. 18 for footnotes to Table V).

[1]Form in accordance with Specification MIL-B-857.

[2]Spacers only.

[3]Tie rods and tie rod nuts only.

[4]Iron content 0.4-0.7 percent, nominal 0.5 percent.

Note.- Water boxes, bolts, tie rods, and nuts subjected to submergence pressure in units for submarines shall be of the following materials: Water boxes-composition - 70-30 copper-nickel, Specification MIL-C-15726; Bolts and tie rods: Nickel-copper-alloy, class A, ASTM Publication B164; Nuts: Nickel-copper-alloy, class A or B, ASTM Publication B164 or bronze, aluminum, wrought, composition 5, stress relieved, Specification MIL-A-15939.

3.12.1.1 Class B materials shall be the same as for class A except that copper-nickel-alloy shall be of composition 90-10. Tube sheets shall have iron content of 1.0-1.75 percent, nominal 1.5 percent.

3.12.1.2 Materials for class C shall be as shown in table VI.

3.12.2 The distiller condenser shall be of the straight or U-bent tube, surface type with cooling water in the tubes. It shall be designed as 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 precooling the air ejector suction and may be provided for subcooling the distillate to specified delivery temperature.

Table VI — Materials for class C.

Part	Material	Applicable document
Shell, if separate	Bronze, aluminum, wrought, composition 5	MIL-A-15939
Tube support plates and baffle plates	Bronze, aluminum, wrought, composition 5	MIL-A-15939
Water boxes	Bronze, aluminum, wrought composition 5	MIL-A-15939
	or valve bronze, alloy 2A	ASTM B143
	or gun metal, alloy 1B	ASTM B143
Flash chamber	Copper tubing	WW-T-797
	or bronze, aluminum, wrought, composition 5	MIL-A-15939
Bolts, nuts, tie rods and spacers in contact with water or vapor or in joints involving salt-water tightness[1]	Bronze, aluminum, wrought, composition 5, stress relieved,	MIL-A-15939
	or phosphor bronze, alloy A or D	ASTM B139
	or copper-silicon alloy	ASTM B98
	or Admiralty metal[2]	ASTM B111
	or commercial brass[3]	
Other bolts and nuts	----------	MIL-B-857
Tube sheets	Bronze, aluminum, wrought, composition 5	MIL-A-15939

[1]Form in accordance with Specification MIL-B-857.

[2]Spacers only.

[3]Tie rods and tie rod nuts only.

3.12.2.1 For types I, III, VI and VII distillation units, 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, III and VI) at the requisite vacuum when the distillation unit is operating in clean condition with initial sea water temperature of 85°F.

3.12.3 A flash chamber shall be provided for the distiller condenser of multiple effect units. It shall receive the drains from the last evaporator effect tube nest via 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.

3.13 Distillate cooler for all types.-

3.13.1 The materials used in the construction of the distillate cooler for Class A distillation units shall be as shown in table VII.

Table VII — Materials for class A.

Part	Material	Applicable document
Shell	Copper-nickel-alloy, composition 70-30	MIL-C-15726
	or seamless copper tubing	WW-T-797
	or gun metal, alloy 1B	ASTM B143
	or valve bronze, alloy 2A	ASTM B143
Baffles	Copper-nickel-alloy, composition 70-30	MIL-C-15726
	or Naval brass	ASTM B171
Tube sheets	Copper-nickel-alloy, composition 70-30	ASTM B171[2]
Water boxes	Copper-nickel-alloy, composition 70-30	MIL-C-15726
	or gun metal, alloy 1B	ASTM B143
	or valve bronze, alloy 2A	ASTM B143
Bolts, nuts, tie rods and spacer in contact with water or in joints involving salt-water tightness[1]	Nickel-copper-alloy	ASTM B164
	or bronze, aluminum wrought, composition 5 stress relieved	MIL-A-15939
	or phosphor bronze, alloy A or D	ASTM B139
	or copper-silicon alloy	ASTM B98
Other bolts and nuts	----------	MIL-B-857

[1] Form in accordance with specification MIL-B-857

[2] Iron content 0.4-0.7 percent, nominal 0.5 percent

Note.- Water boxes, bolts, tie rods, and nuts subjected to submergence pressure in units for submarines shall be of the following materials:
Water boxes, composition 70-30 copper-nickel, Specification MIL-C-15726;
Bolts and tie rods: Nickel-copper-alloy, class A, ASTM Publication B164.
Nuts: Nickel-copper-alloy, class A or B, ASTM Publication B164, or bronze, aluminum, wrought, composition 5, stress relieved, Specification MIL-A-15939.

3.13.1.1 Class B materials shall be the same as for class A except that copper-nickel-alloy shall be composition 90-10. Tube sheets shall have iron content of 1.0-1.75 percent, nominal 1.5 percent.

3.13.1.2 The materials for class C shall be as shown in table VIII.

3.13.2 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 VII) or the unit (types II, IV and VI) through the tubes in one pass and for circulation of the distillate drained from the distiller condenser flash chamber or the last stage condenser across the tubes in the shell in multi-pass. If only part of the circulating water is used in the distillate cooler, the necessary bypass valves, and piping shall be furnished with the cooler. It is not the intent that the distillate cooler be completely bypassed.

3.13.3 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 sea water at 85°F. when the distillation unit is operating at rated capacity.

3.14 Vapor feed heaters for types I, III, and VI.-

3.14.1 The materials used in the construction of the vapor feed heaters of class A distillation units shall be as shown in table IX.

Table VIII — Materials for class C.

Part	Material	Applicable document
Shell	Bronze, aluminum, wrought, composition 5	MIL-A-15939
	or seamless copper tubing	WW-T-797
	or gun metal, alloy 1B	ASTM B143
	or valve bronze, alloy 2A	ASTM B143
Baffles	Bronze, aluminum, wrought, composition 5	MIL-A-15939
	or Naval brass	ASTM B171
Tube sheets	Bronze, aluminum, wrought, composition 5	MIL-A-15939
Water boxes	Bronze, aluminum, wrought, composition 5	MIL-A-15939
	or gun metal, alloy 1B	ASTM B143
	or valve bronze, alloy 2A	ASTM B143
Bolts, nuts, tie rods, and spacers in contact with water or in joints involving salt-water tightness[1]	Bronze, aluminum, wrought, composition 5 stress relieved	MIL-A-15939
	or phosphor bronze, alloy A or D	ASTM B139
	or copper-silicon alloy	ASTM B98
Other bolts and nuts	----------	MIL-B-857

[1]Form in accordance with Specification MIL-B-857.

Table IX — Materials for class A.

Part	Material	Applicable document
Water boxes	Copper-nickel-alloy, composition 70-30	MIL-C-15726
	or gun metal, alloy 1B	ASTM B143
	or valve bronze, alloy 2A	ASTM B143
Tube sheets	Copper-nickel-alloy, composition 70-30	ASTM B171[2]
Tube support plates	Copper-nickel-alloy, composition 70-30	MIL-C-15726
Shell	Copper-nickel-alloy, composition 70-30	MIL-C-15726
Bolts, nuts, or tie rods exposed to water or vapor[1] or in joints involving salt water tightness	Nickel-copper-alloy, class A	ASTM B164
	or bronze, aluminum wrought, composition 5, stress relieved	MIL-A-15939
	or phosphor bronze, alloy A or D	ASTM B139
	or copper-silicon alloy	ASTM B98
Other bolts and nuts	----------	MIL-B-857

[1]Form in accordance with Specification MIL-B-857.

[2]Iron content 0.4-0.7 percent, nominal 0.5 percent.

3.14.1.1 Class B materials shall be the same as for class A except that copper-nickel-alloy shall be composition 90-10. Tube sheets shall have iron content of 1.0-1.75 percent, nominal 1.5 percent.

3.14.1.2 Materials for class C shall be as shown in table X.

3.14.2 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 water passing through the tubes. In type VI units this applies to the first effect only.

3.14.3 Each vapor-feed heater shall be provided with the following connections and fittings:

(a) Water boxes:
  (1) Feed water inlet connection.
  (2) Feed water outlet connection.

Table X — Materials for class C.

Part	Material	Applicable document
Water boxes	Bronze, aluminum, wrought, composition 5	MIL-A-15939
	or gun metal, alloy 1B	ASTM B143
	or valve bronze, alloy 2A	ASTM B143
Tube sheets	Bronze, aluminum, wrought, composition 5	MIL-A-15939
Tube support plates	Bronze, aluminum, wrought, composition 5	MIL-A-15939
	or Naval brass	ASTM B171
Shell	Bronze, aluminum, wrought, composition 5	MIL-A-15939
Bolts, nuts or tie rods exposed to water or vapor or in joints involving salt-water tightness[1]	Bronze, aluminum, wrought, composition 5 stress relieved	MIL-A-15939
	or phosphor bronze, alloy A or D	ASTM B139
	or copper-silicon alloy	ASTM B98
Other bolts and nuts	----------	MIL-B-857

[1] Form in accordance with Specification MIL-B-857.

Table XI — Material for regulator.

Part	Material	Applicable document
Bodies and covers	Gun metal, alloy 1B	ASTM B143
	or valve bronze, alloy 2A	ASTM B143
Valve	Nickel-copper-alloy, wrought	ASTM B164
	or nickel-copper-alloy, cast	QQ-N-288
Float (for condensate)	Copper	ASTM B152
Float (for saltwater)	Nickel-copper-alloy	ASTM B127

(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.

3.14.4 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.

3.15 Tube nest drain regulator for types I, III, and VI - Salt feed water heater drain regulator for type II.-

3.15.1 Materials.- The materials used in the construction of the regulator shall be as shown in table XI.

3.15.2 A drain regulator shall consist of a cage and cover enclosing a balanced cage valve operated by a ball float or by a diaphragm and air pilot operated control.

3.15.3 Each regulator shall be provided with the following fittings and connections:

(a) Drain inlet connection.
(b) Discharge connection.
(c) External by-pass 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 gage glass, protected.
(g) External gear for hand operation (see item (c)).

3.15.4 A drain regulator shall be provided for the control of the discharge of the tube nest drain pump or feedwater 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 feedwater heater shell. The regulator shall be provided with equalizer connections to the steam chest of the evaporator or the shell of the feedwater heater. A drain regulator will not be required if the drain pump is to discharge into only one system (see 6.1).

3.15.4.1 In cases where pressure differences between stages are too large for use of loop seals, the regulator specified in 3.15.2 may be used as an interstage drain regulator.

3.15.4.2 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 3.15.2.

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

3.16 All class C distillation units shall be adequately heat treated after welding of the aluminum bronze to prevent stress corrosion-cracking of the material.

3.17 Fittings.-

3.17.1 Gage glasses shall be provided for the different components as required. They shall be suitably protected and mounted in fittings in accordance with Specification MIL-I-20037.

3.17.2 Type I distillation units shall be provided with a relief valve on each evaporator steam chest and shell. Type 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 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 basket(s) from internal overpressuring. Relief valves shall conform to type A-1, class C of Specification MIL-V-20065.

3.17.3 Gages conforming to Specification MIL-G-18997 shall be furnished as shown in table XII. Unless otherwise specified (see 6.1) gages shall be furnished by the shipbuilder. Connections, as required, shall be provided on the distilling unit. Table XII covers the minimum gages considered necessary for proper operation of the unit. Gages shall be suitable for mounting on a gage board supplied by the shipbuilder (gage board may be furnished with the distillation unit).

3.17.4 Unless otherwise specified (see 6.1), thermometers shall be furnished by the shipbuilder. Thermometers for distillation units installed on nonnuclear propelled ships shall be in accordance with Specification MIL-T-656; Distant reading dial type thermometers in accordance with Specification MIL-T-940 may be substituted when location is difficult for access for reading. Thermometers for nuclear propelled ships shall be in accordance with Specification MIL-T-17244. Distant reading dial type thermometers in accordance with class C of Specification MIL-T-19646 may be used when location is difficult for access for reading. Thermometers shall be furnished as follows:

Number and location	Graduated to °F.
1 - Sea water supply temperature (all types)	30 to 240
1 - Salt water inlet to first stage (types II and IV)	30 to 240
1 - Steam supply after orifice (types I and III)	50 to 400
1 - Distillate discharge from distillate cooler (all types)	30 to 240
1 - Jacket water supply to salt water heater (type IV) or evaporator fresh water tube bundle (type VII)	30 to 240

Note.- Above are minimum thermometers considered necessary for proper operation of the distilling unit.

3.18 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 Specification MIL-P-20087 or commercial equivalent.
(b) Nonferrous surfaces are not required to be painted.

3.19 Identification plates.- Identification plates of sheet or cast brass or bronze shall be provided. Identification plate data shall include the following:

(a) Manufacturer's name.
(b) Government contract number.
(c) Federal stock number. (Allow 17 spaces.)
(d) Date of manufacture.
(e) Blank space for Government inspector's stamp.
(f) Blank space for unit number (2 spaces, stamped by shipyard).

3.20 Repair parts and tools.-

3.20.1 Repair parts.- Stock repair parts shall conform to Specification MIL-P-15137. Onboard repair parts shall be furnished as follows:

(a) Springs for relief valves as required by Specification MIL-V-20065.
(b) Gage glasses and sight glasses, rotameter glass tubes---------- 100 percent.
(c) Gages[1]---------- 1 per ship of each type and graduation furnished.
(d) Thermometers[2]---------- 1 per ship of each type, size, and temperature range furnished.

(See page 24 for footnotes)

Table XII – Gages.

Types I, III, and VI				
Number and connection	Diameter	Pressure or compound	Graduated to pounds or inches of mercury	Marking
	Inches			
One for steam supply above orifice	4-1/2	Pressure	30 pounds	Evaporator steam
One for steam supply below orifice	4-1/2	Compound	30 inches to 30 pounds	First effect steam chest
One for last effect shell	4-1/2	Compound	30 inches to 30 pounds	Last (number) effect shell
One for circulating and feed pump discharges	4-1/2	Pressure	100 pounds	(-) discharge
One each for all other pump discharges	4-1/2	Compound	30 inches to 100 pounds	(-) pump discharge
		Type II		
	Inches			
One for salt water heater steam supply	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 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	(-) pump discharge
Type IV				
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	(-) pump discharge
One each for all other pump discharges	4-1/2	Compound	30 inches to 30 pounds	(-) 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

(e) Rupture discs (if furnished)----------100 percent.
(f) O-ring gaskets, except those between double tube sheets-----100 percent.
(g) Valves, as required by applicable specifications.
(h) Pumps, motors, controllers, as required by applicable specifications.
(i) Salinity indicating equipment, as required by applicable specification.

[1]Unless otherwise specified (see 6.1) replacement gages shall be provided by the shipbuilder.
[2]Unless otherwise specified (see 6.1) replacement thermometers shall be furnished by the shipbuilder.

6 3.20.2 Special tools.- Special tools for maintenance of the distillation units shall be furnished on a per ship basis. Such tools shall include any special device for removal of the vertical basket of type III or VI units, one fluted drill type cleaning tool for the feedwater heater tubes of type II units, one tube expander of each size and type necessary for expanding the tubes of double tube sheet heat exchangers and special tube plugs for double tube sheet heat exchangers.

3.20.2.1 The special tube plugs for double tube sheet heat exchangers shall be furnished on the basis of 10 per cent of the total number of tubes on the ship to a maximum of 100 plugs and shall be as follows:

(a) A hand or power operated tool shall be provided, which shall be suitable for cutting the tube end out of the tube 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 or sharp edges.

(b) Tube plugs, of material specified in Specification MIL-P-15742, shall be provided for insertion into both the tube end in the inner tube sheet and the tube hole in the outer tube sheet. The dimensions of the tube plugs shall be in general accordance with those for 5/8 inch outside diameter (o.d.) tubes (for plugging the tube end) and for 3/4 inch o.d. tubes (for plugging the hole in the outer tube sheet) as shown on the applicable figures in Specification MIL-P-15742, except the length shall be reduced as required. When the two plugs are driven, there shall be a gap between their ends.

3.20.2.2 Special tools are defined as those tools not listed in the Navy Stock List of General Stores. (Copies of this stock list may be consulted in the office of the Government inspector.)

3.21 Technical manuals.- Technical manuals shall conform to type II of Specification MIL-M-15071. Technical manuals for distillation units for submarines shall include instructions as to maximum torque which shall be placed on the bolting subjected to submergence pressure and the pattern of tightening the bolting.

3.22 Drawings.-

3.22.1 Drawings shall be submitted for approval to the bureau or agency concerned within the time specified (see 6.1) and before procurement of material and fabrication are begun, and the distillation units shall be manufactured in accordance with the drawings as approved.

3.22.2 Drawings shall be furnished in accordance with the requirements of Specification MIL-D-963.

3.22.2.1 Types of drawings.- In lieu of the drawing types listed in Standard MIL-STD-7, the following types of drawings are required:

3.22.2.2 An external arrangement drawing, called "Outline Drawing". This drawing shall show all necessary external views of the unit, 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 waterboxes, 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.

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

3.22.2.3.1 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.

3.22.2.3.2 The drawing shall indicate that the zinc anodes provided in the heat exchanger components comply with the requirements of Specification MIL-A-19521.

3.22.2.4 Detail drawings of all major parts such as shells, waterboxes, tube sheets, tube supports, baffles, and vapor separators. The drawings shall be completely dimensioned, with finishes and welding symbols indicated, as required for manufacture.

3.22.2.4.1 Detail drawings need not be submitted for approval provided the assembly drawing required in 3.22.2.3 embodies sufficient detail information for adequate appraisal of the design. Detail drawings shall be furnished as part of the final drawings in order that the intent of 3.22.2.9(e) may be met.

3.22.2.5 A diagrammatic piping arrangement drawing 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 gages, thermometers, valves, orifice plates, acid cleaning connections, and salinity indicators shall be indicated.

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

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

3.22.2.8 Certification data sheets as specified in Specification MIL-D-963 will not be required. In lieu thereof, a separate drawing, which shall be a ship's drawing, shall contain 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 rated capacity.
(c) Hydrostatic test pressure for all components, list of onboard repair parts furnished, list of reference drawings, and all similar pertinent design data.

3.22.2.9 Sufficient drawings shall be provided to:

(a) Provide design information sufficient to assure conformance to requirements of this Specification including compatability 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 supplier's assistance.
(e) Enable naval ship and shore activities to repair and maintain the item without assistance from the original supplier.

3.23 Workmanship.- The workmanship shall be first class in every respect.

4. QUALITY ASSURANCE PROVISIONS

4.1 The supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the supplier may utilize his own or any other inspection facilities and services acceptable to the Government. Inspection records of the examination and tests shall be kept complete and available to the Government as specified in the contract or order. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Qualification tests.-[1] Qualification tests shall be conducted at a laboratory satisfactory to the Bureau of Ships. These tests shall consist of the tests specified in 4.2.1 and 4.2.1.1.

4.2.1 The unit shall be operated under the conditions specified in 3.3.1 or 3.3.4 as applicable for a sufficient time, to be determined by the Bureau of Ships, to allow evaluation of the suitability of design and materials, and to determine compliance with 3.4.1 and the distillate purity requirements of 3.4.2 with the unit mounted on a stable foundation. Normal feed treatment (see 3.4.1) shall be followed during this test.

4.2.1.1 Salinity content of the distillate shall be determined as specified in 4.4.3 during the qualification test.

4.2.2 Because of similarity of design, qualification of type II or III units will be considered as qualifying type IV units.

4.3 Examination and test at place of manufacture.-

4.3.1 Examination.- The various materials and parts of the components of the distillation unit and the complete unit shall be subjected to examination for adjustment, fit, material, finish and any other requirements specified herein not involving tests.

4.4 Tests.-

4.4.1 Pressure tests.- All parts of the plant shall be subject to a hydrostatic pressure test as follows:

[1] Application for Qualification conditions tests shall be made in accordance with "Provisions Governing Qualification" (see 6.2 and 6.3).

Name of part:	Test Pressure, p.s.i.g.
Evaporator, distilling condenser and vapor feed heater shells and vapor piping	30
Evaporator steam chests and tubes (type I)	50
Distilling condenser: water boxes, and tubes	[1]50 (see 4.4.1.1)
Feedwater heaters: water boxes, and tubes	[1]50
Distillate cooler: shell, water boxes and tubes	[1]50 (see 4.4.1.1)
Steam inlet piping	50
Feedwater piping	[1]50
Fresh-water piping	30
Evaporator baskets and steam chests (for type II, or VI)	30
Other parts not specified	1-1/2 times working pressure

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

4.4.1.1 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. After installation of tubes a hydrostatic test pressure equal to the specified submergence test pressure shall be applied to the space between the double tube sheets. Any leaks appearing at the tube end where tubes are expanded into the outer tube sheet shall be corrected by re-rolling the individual leaking tube end. After this test, a hydrostatic pressure in the shell as specified in 4.4.1 shall be applied with the drain connection to the space 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. Similar hydrostatic test to the pressure in 4.4.1 shall be applied to heat exchangers for nuclear propelled surface ships.

4.4.1.1.1 The hydrostatic test pressures specified in 4.4.1 shall be increased as necessary to demonstrate that damage will not result under the conditions specified in 3.7.29.1.1.7.

4.4.2 Performance tests after installation.- After installation, at least three capacity tests shall be made on each distillation unit as follows:

4.4.2.1 The first capacity test specified in 4.4.2 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 3.4.1. Should it be considered that the water available is such as to foul the tubes of the unit, this test may be waived by the Government.

4.4.2.2 The second capacity test specified in 4.4.2 shall be made during the official preliminary trials of the ship, the sea water used for feed being not less than 1/32 density. The capacity shall be as specified in 3.4.1.

4.4.2.3 After 90 days of operation on the ship with feedwater 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 3.4.1).

4.4.3 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 by the ASTM Publication D512.

4.5 Additional inspection.- Where other specifications form a part of this specification, sampling, inspection and tests shall be conducted as required in the referenced specifications.

5. PREPARATION FOR DELIVERY

5.1 Preservation and packaging.- Preservation and packaging shall be level A or C as specified in the contract or order (see 6.1).

5.1.1 Level A.- The distillation unit shall be packaged in accordance with method III of Specification 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 Specification MIL-B-121 shall be placed between the plywood blank and the mating flange.

5.1.1.1 Accessories.- Gages and thermometers shall be removed from the unit and packaged by methods IA and III respectively in accordance with Specification MIL-P-116.

5.1.2 Level C.- The distillation unit shall be preserved and packaged in accordance with the supplier's commercial practice.

5.2 Packing.- Packing shall be level A, B or C as specified in the contract or order (see 6.1).

5.2.1 Levels A and B.- The distillation unit shall be packed in a sheathed crate conforming to Specification MIL-C-104. When specified (see 6.1) packing shall be in unsheathed crates conforming to Specification MIL-C-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 packaged as specified in 5.1.1.1 shall be packed in boxes conforming to class 1 of Specification PPP-B-621 or PPP-B-601 (domestic) and secured within the shipping containers with the complete unit.

5.2.2 Level C.- Distillation units, packaged in accordance with level A or C as specified (see 6.1) shall be packed in containers in a manner to insure safe delivery and acceptance at destination. Containers or method of packing shall comply with the Uniform Freight Classification Rules or other carrier regulations as applicable to the mode of transportation.

5.3 Repair parts and tools.-

5.3.1 Preservation, packaging and packing.- Onboard and stock repair parts and tools shall be preserved, packaged, and packed for the level specified (see 6.1) in accordance with Specification MIL-R-196, MIL-P-16789, MIL-P-16298, or MIL-P-15424 as applicable. Repair parts and tools not specifically covered therein shall be unit protected in accordance with the guide lines of Specification MIL-P-116. Repair parts and tools shall be packaged individually except when used in sets or quantities greater than one.

5.4 Technical manuals.- Technical manuals (see 3.21) shall be prepared for shipment in accordance with Specification MIL-M-15071. Unless otherwise specified (see 6.1) one or two copies of the manual shall be packed within the shipping container holding the main unit of equipment. Bulk packing shall be for the level specified (see 6.1) in accordance with Specification MIL-M-15071.

5.5 Drawings.- Drawings, (see 3.22), shall be packaged and packed in accordance with Specification MIL-D-963.

5.6 Marking.- In addition to any special marking required by the contract or order, interior and exterior shipping containers shall be marked in accordance with Standard MIL-STD-129.

6. NOTES

6.1 Ordering data.- Procurement documents should specify the following:

(a) Title, number, and date of this specification.
(b) Whether a particular type is required (see 1.2.1).
(c) Class required (see 1.2.2).
(d) Limiting steam consumption for types I, II, III or VI (low pressure steam for evaporators or salt water heater and high pressure steam for air ejectors) (see 3.3.1).
(e) Amount and temperature of hot fresh water available for types IV or VII (see 3.3.2 and 3.3.3).
(f) Temperature of distillate if higher than 95°F. is acceptable (see 3.3.5).
(g) Rated capacity required (see 3.4.1).
(h) Proposed orientation of unit in the ship (see 3.4.2.1).
(i) Whether circulating or feed pump must be mounted separately because of suction water level conditions (see 3.7(c)).
(j) Discharge pumping heads required for pumps (see 3.7(d)).
(k) Whether feed pump is required (type I, III or VI distilling units) (see 3.7(e)).
(l) Whether brine overboard pump or brine eductor shall be furnished (see 3.7(f)).
(m) Whether air ejector and after condenser or vacuum pump is required (see 3.7.4 and 3.7.27).
(n) Flange dimensions, if different from those specified (see 3.7.8).
(o) Whether thicker tubes than number 18 BWG are required for submarine service (see 3.7.14).
(p) Steam pressure and temperature to air ejectors required (see 3.7.26) and to first effect steam chest or salt water heater.
(q) Pipe thickness which will be used for connecting piping (see 3.7.29.1.1.5).
(r) Hydrostatic pressure required (see 3.7.29.1.1.6).
(s) Whether weir type level controls are to be furnished (for type I) (see 3.8.11).
(t) Whether gages and thermometers, including replacements, shall be furnished with the distilling unit (see 3.17.3, 3.17.4 and 3.20.1).
(u) Whether drain pump is to discharge alternatively to more than one system (see 3.15.4).
(v) Time limit for submission of drawings (see 3.22.1).
(w) If for submarine service, submergence test pressure (observe security requirements) (see 4.4.1.1).

(x) Selection of applicable levels of preservation, packaging and packing (see 5.1, 5.2 and 5.3).
(y) When packing shall be in unsheathed crates (see 5.2.1).
(z) Whether one or two manuals shall be packed in the shipping container and level for bulk packing (see 5.4).

6.2 With respect to products requiring qualification, awards will be made only for such products as have, prior to the time set for opening of bids, been tested and approved for inclusion in Qualified Products List QPL 18641, whether or not such products have actually been so listed by that date. The attention of the suppliers is called to this requirement, 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 be eligible to be awarded contracts or orders for the products covered by this specification. The activity responsible for the qualified products list is the Chief of the Bureau of Ships, Department of the Navy, Washington 25, D.C., and information pertaining to qualification of products may be obtained from that activity. Application for Qualification tests shall be made in accordance with "Provisions Governing Qualification" (see 6.3).

6.3 Copies of "Provisions Governing Qualification" may be obtained upon application to Commanding Officer, Naval Supply Depot, 5801 Tabor Avenue, Philadelphia 20, Pa.

Notice.- When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

Preparing activity:
Navy - Bureau of Ships
(Project 4620-N012Sh)

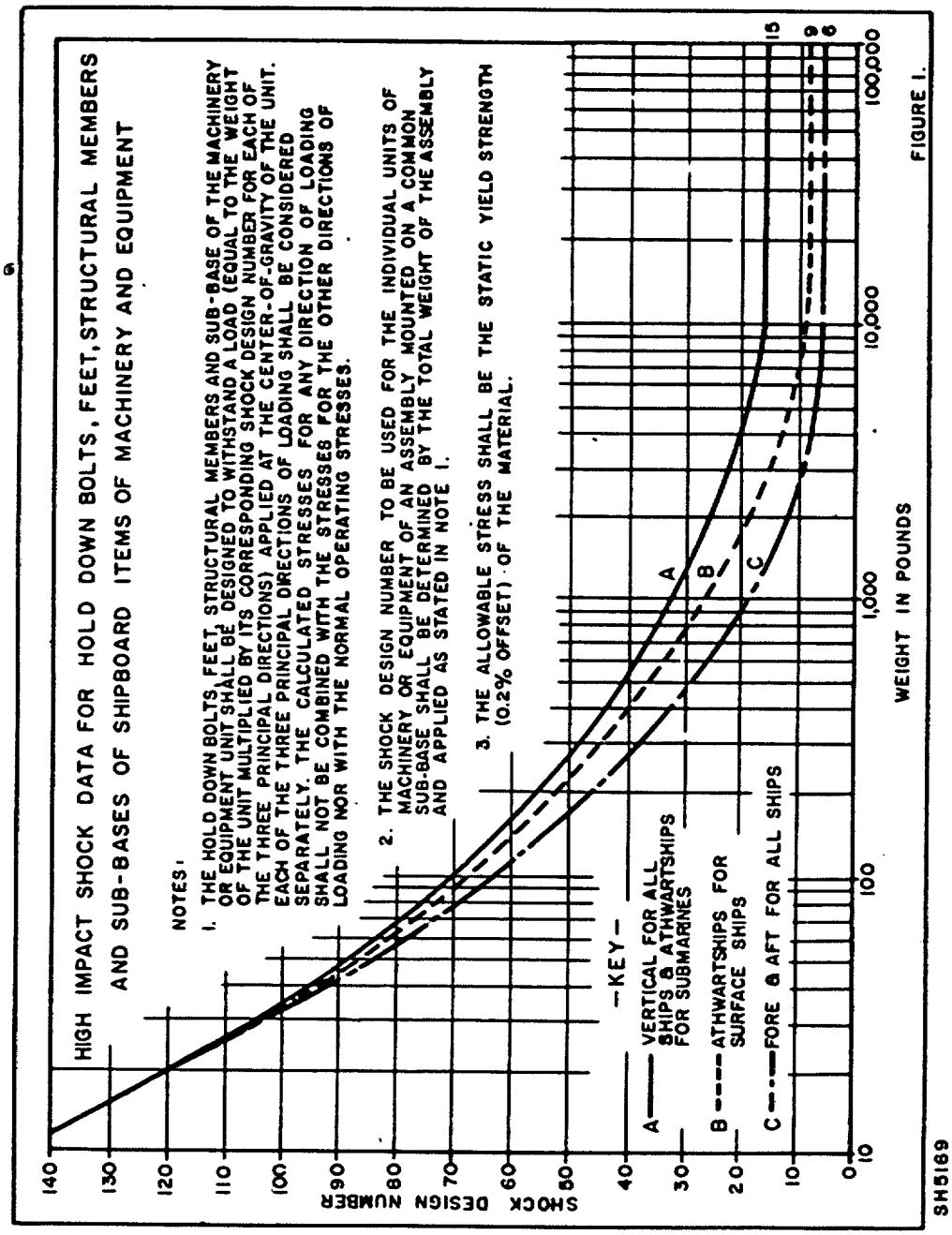

Figure 1 – H.I. Shock Design Data