INCH-POUND
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1 March 1991
SUPERSEDING
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(See 6.11)

MILITARY SPECIFICATION

REFRIGERATING PLANTS AND SYSTEMS, MECHANICAL; AND REFRIGERATING SYSTEM COMPONENTS - DICHLORODIFLUOROMETHANE (R-12) - NAVAL SHIPBOARD

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

1. SCOPE

1.1 Scope. This specification covers mechanical naval shipboard refrigerating plants, systems and components using a reciprocating compressor and dichlorodifluoromethane (R-12) refrigerant. Components include the various assemblies or parts that comprise a system or plant. Design, construction and test requirements herein establish minimum requirements for satisfactory shipboard use.

1.2 Classification. Refrigerating equipment should be of the following groups, types, and classes as specified (see 6.2):

Group I - Components for shipboard refrigerating plants and systems acquired separately.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Naval Sea Systems Command, SEA 55Z3, Department of the Navy, Washington, DC 20362-5101 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A FSC 4130

Group II - Refrigerating plants and assemblies.

Type I - Plants and assemblies for refrigerated storage applications (see 3.7.1, for service A or B see table II):

Class 1 - Compressor unit assembly (see 3.7.1.1)
Class 2 - Condensing unit assembly (see 3.7.1.2)

Service A
Service B

Class 3 - Complete refrigeration plant (see 3.7.1.3)

Service A
Service B

Type II - Plants and assemblies for air conditioning applications (see 3.7.2, for service A or B see table III):

Class 1 - Compressor unit assembly (see 3.7.2.1)
Class 2 - Condensing unit assembly (see 3.7.2.2)

Service A
Service B

Class 3 - Built-up air conditioning plant (see 3.7.2.3)

Service A
Service B

Class 4 - Prefabricated air conditioning plant (see 3.7.2.4)

Service A
Service B

2. APPLICABLE DOCUMENTS

2.1 Government documents.

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

SPECIFICATIONS

FEDERAL

BB-F-1421	- Fluorocarbon Refrigerants.
PPP-C-96	- Cans, Metal, 28 Gage and Lighter.
QQ-N-286	- Nickel-Copper-Aluminum Alloy, Wrought (UNS N05500).

FEDERAL (Continued)

QQ-N-288	- Nickel-Copper Alloy and Nickel-Copper-Silicon Alloy Castings.
TT-P-645	- Primer, Paint, Zinc Chromate, Alkyd Type.
TT-P-1757	- Primer Coating, Zinc Chromate, Low-moisture Sensitivity.
VV-L-825	- Lubricating Oil, Refrigerant Compressor, Uninhibited.

MILITARY

MIL-C-104	- Crates, Wood; Lumber and Plywood Sheathed, Nailed and Bolted.
MIL-P-116	- Preservation, Methods of.
MIL-S-901	- Shock Tests, H.I. (High-Impact); Shipboard Machinery, Equipment and Systems, Requirements for.
MIL-E-917	- Electric Power Equipment, Basic Requirements (Naval Shipboard Use).
DOD-D-1000	- Drawings, Engineering and Associated Lists.
MIL-F-1183	- Fittings, Pipe, Cast Bronze, Silver-Brazing, General Specification for.
MIL-F-1183/10	- Fittings, Pipe, Cast Bronze, Silver-Brazing, Union, Pipe.
MIL-E-2036	- Enclosures for Electric and Electronic Equipment.
MIL-C-2212	- Controllers, Electric Motor A.C. or D.C., and Associated Switching Devices.
MIL-M-3971	- Meters, Time Totalizing, Non-Hermetically Sealed, Electrical: General Specification for.
MIL-M-7793	- Meter, Time Totalizing.
MIL-M-7793/7	- Meter, Time Totalizing, Miniature, Digital, 115 V, 60 Hz.
MIL-P-15024	- Plates, Tags and Bands for Identification of Equipment.
MIL-P-15024/5	- Plates, Identification.
MIL-E-15090	- Enamel, Equipment, Light-Gray (Formula No. 111).
DOD-P-15328	- Primer (Wash), Pretreatment (Formula No. 117 for Metals) (Metric).
MIL-T-15377	- Temperature Monitor Equipment Naval Shipboard.
MIL-C-15730	- Coolers, Fluid, Naval Shipboard: Lubricating Oil, Hydraulic Oil, and Fresh Water.
MS16142	- Boss, Gasket Seal Straight Thread Tube Fitting, Standard Dimensions for.
MIL-T-16420	- Tube, Copper-Nickel Alloy, Seamless and Welded (Copper Alloy Numbers 715 and 706).
MIL-M-17060	- Motors, 60-Hertz, Alternating Current, Integral-Horsepower, Shipboard Use.
MIL-I-17244	- Indicators, Temperature, Direct-Reading, Bimetallic, (3 and 5 Inch Dial).
MIL-M-17508	- Mounts, Resilient: Types 6E2000, 6E900, 6E900BB, 7E450, 7E450BB, 6E150, and 6E100.

MILITARY (Continued)

MIL-A-18001 - Anodes, Corrosion Preventive, Zinc; Slab Disc and Rod Shaped.
MS18229 - Plug for "O" Ring Gasket.
MIL-G-18997 - Gauge, Pressure, Dial Indicating.
MIL-S-19500 - Semiconductor Devices, General Specification for.
MIL-T-19646 - Thermometers, Remote Reading, Self-Indicating Dial, Gas Actuated.
MIL-M-19863 - Mount, Resilient: Type 5B5000H.
MIL-F-20042 - Flanges, Pipe and Bulkhead, Bronze (Silver Brazing).
MIL-V-20064 - Valve, Nonferrous for Use with Halogenated Refrigerants.
MIL-G-21610 - Gaskets, Heat Exchanger, Various Cross Section Ring, Synthetic Rubber.
MIL-T-22214 - Tube, Condenser and Heat Exchanger with Integral Fins (UNS Alloy Nos. C71500, C70600, C12200).
MIL-S-22473 - Sealing, Locking, and Retaining Compounds: (Single-Component).
MIL-T-24270 - Thermowells for Thermometers and Electrical Temperature Sensors General Specification for.
MIL-L-24479 - Lubricant, Red Lead and Graphite in Mineral Oil.
MIL-B-24480 - Bronze, Nickel-Aluminum (UNS No. C95800) Castings for Seawater Service.
MIL-V-24578 - Valves, Globe, Pressure Instrument, Stem Test Connection, Union End.
MIL-C-24707 - Castings, Ferrous, General Specification for.
MIL-C-24707/5 - Castings Ductile Iron and Austenitic Ductile Iron.
MIL-C-24746 - Coolers, Unit Forced Air for Ship's Refrigerated Stores.
MIL-R-83248 - Rubber, Fluorocarbon Elastomer, High Temperature Fluid, and Compression Set Resistant.
MIL-R-83248/2 - Rubber, Fluorocarbon Elastomer, High Temperature, Fluid, and Compression Set Resistant, O-Rings, Class 2, 90 Hardness.

STANDARDS

MILITARY

MIL-STD-22 - Welded Joint Design.
DOD-STD-100 - Engineering Drawing Practices.
MIL-STD-101 - Color Code for Pipelines and for Compressed Gas Cylinders.
MIL-STD-109 - Quality Assurance Terms and Definitions.
MIL-STD-129 - Marking for Shipment and Storage.
MIL-STD-167-1 - Mechanical Vibrations of Shipboard Equipment (Type I - Environmental and Type II - Internally Excited).
MIL-STD-195 - Marking of Connections for Electric Assemblies.

MILITARY (Continued)

MIL-STD-248 - Welding and Brazing Procedure and Performance Qualification.
MIL-STD-271 - Requirements for Nondestructive Testing Methods.
MIL-STD-278 - Welding and Casting Standard.
MIL-STD-438 - Schedule of Piping, Valves, Fittings, and Associated Piping Components for Submarines Service.
MIL-STD-461 - Electromagnetic Emission and Susceptibility Requirements for the Control of Electromagnetic Interference.
MIL-STD-701 - Lists of Standard Semiconductor Devices.
MIL-STD-721 - Definitions of Terms for Reliability and Maintainability.
MIL-STD-740-1 - Airborne Sound Measurements and Acceptance Criteria of Shipboard Equipment.
MIL-STD-740-2 - Structureborne Vibratory Acceleration Measurements and Acceptance Criteria of Shipboard Equipment.
MIL-STD-777 - Schedule of Piping, Valves, Fittings, and Associated Piping Components for Naval Surface Ships.
MIL-STD-785 - Reliability Program for Systems and Equipment Development and Production.
MIL-STD-882 - System Safety Program Requirements.
MIL-STD-1186 - Cushioning, Anchoring, Bracing, Blocking and Waterproofing; with Appropriate Test Methods.
MIL-STD-1399, Section 300 - Interface Standard for Shipboard Systems Electric Power, Alternating Current.
MIL-STD-1472 - Human Engineering, Design Criteria for Military Systems, Equipment and Facilities.
MIL-STD-2073-1 - DOD Materiel Procedures for Development and Application of Packaging Requirements.
MIL-STD-45662 - Calibration Systems Requirements.

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Standardization Documents Order Desk, BLDG. 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

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

DRAWINGS

NAVAL SEA SYSTEMS COMMAND (NAVSEA)

NAVSHIPS 810-1385839 - Condenser, Refrigerant Finned Tube for Refrigeration Application.
NAVSHIPS 810-1385850 - Piping, Instrument Pressure for All Services.
NAVSHIPS 810-1385861 - Flanges Sea Water 700 PSI Max.
NAVSHIPS 803-5959186 - Anode Plug, Submarine Heat Exchanger.

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

PUBLICATIONS

NAVAL SEA SYSTEMS COMMAND (NAVSEA)
0900-LP-001-7000 - Fabrication and Inspection of Brazed Piping Systems.
0948-LP-045-7010 - Material Identification Control.
NSTM Chapter 078 - Gaskets, Packing and Seals.

(Application for copies should be addressed to the Standardization Documents Order Desk, BLDG. 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

DAVID TAYLOR RESEARCH CENTER (DTRC)
DTMB Report No. 880 - A Guide for the Selection and Application of Resilient Mounting to Shipboard Equipment.
DTMB Report No. 1480 - Mathematical Analysis and Digital Computer Solution of Natural Frequencies and Normal Modes of Vibration for a Compound Solution Mounting System.

(Application for copies should be addressed to David Taylor Research Center, Bethesda, MD 20084.)

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

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)
B1.12 - Class 5 Interference-Fit Thread.
B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings. (DoD adopted)
B18.2.1 - Square and Hex Bolts and Screws Inch Series. (DoD adopted)
B18.2.2 - Square and Hex Nuts.
B46.1 - Surface Texture (Surface Roughness, Waviness, and Lay). (DoD adopted)

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

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)
A 240 - Standard Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels. (DoD adopted)
A 519 - Standard Specification for Seamless Carbon and Alloy Steel Mechanical Tubing. (DoD adopted)

ASTM (Continued)

A 536 - Standard Specification for Ductile Iron Castings. (DoD adopted)
B 61 - Standard Specification for Steam or Valve Bronze Castings. (DoD adopted)
B 62 - Standard Specification for Composition Bronze or Ounce Metal Castings. (DoD adopted)
B 88 - Standard Specification for Seamless Copper Water Tube. (DoD adopted)
B 98 - Standard Specification for Copper Silicon Alloy Rod, Bar, and Shapes. (DoD adopted)
B 117 - Standard Method of Salt Spray (Fog) Testing. (DoD adopted)
B 122 - Standard Specification for Copper-Nickel-Tin Alloy, Copper-Nickel-Zinc Alloy (Nickel Silver), and Copper-Nickel Alloy Plate, Sheet, Strip, and Rolled Bar. (DoD adopted)
B 127 - Standard Specification for Nickel-Copper Alloy (UNS N04400) Plate, Sheet, and Strip. (DoD adopted)
B 135 - Standard Specification for Seamless Brass Tube. (DoD adopted)
B 139 - Standard Specification for Phosphor Bronze Rod, Bar, and Shapes. (DoD adopted)
B 148 - Standard Specification for Aluminum-Bronze Sand Castings.
B 164 - Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire. (DoD adopted)
B 165 - Standard Specification for Nickel-Copper Alloy (UNS N04400) Seamless Pipe and Tube. (DoD adopted)
B 169 - Standard Specification for Aluminum Bronze Plate, Sheet, Strip, and Rolled Bar. (DoD adopted)
B 369 - Standard Specification for Copper-Nickel Alloy Castings.
B 466 - Seamless Copper-Nickel Pipe and Tube.
B 467 - Standard Specification for Welded Copper-Nickel Pipe.
B 507 - Standard Practice for Design of Articles to be Electroplated on Racks.
B 587 - Standard Specification for Welded Brass Tube.
D 3951 - Standard Practice for Commercial Packaging.
E 243 - Standard Practice for Electromagnetic (Eddy-Current) Testing of Seamless Copper and Copper-Alloy Tubes.
F 104 - Standard Classification System for Nonmetallic Gasket Materials. (DoD adopted)
F 467 - Standard Specification for Nonferrous Nuts for General Use.

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

ELECTRONIC INDUSTRIES ASSOCIATION (EIA)

Safety Engineering Bulletin No. 3 - System Safety Analytical Techniques.

(Application for copies should be addressed to the Electronic Industries Association, 2001 Eye Street, N.W., Washington, DC 20006.)

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR CONDITIONING ENGINEERS (ASHRAE)
23 - Methods of Testing for Rating Positive Displacement Refrigerant Compressors.

(Application for copies should be addressed to American Society of Heating, Refrigerating, and Air Conditioning Engineers, 1791 Tullie Circle, N.E. Atlanta, GA 30329.)

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)
Boiler and Pressure Vessel Code, Section VIII - Rules for Construction of Pressure Vessels.

(Application for copies should be addressed to the American Society of Mechanical Engineers, 345 East 47th Street, New York, NY 10017.)

UNDERWRITERS LABORATORIES, INC.
207 - Refrigerant-Containing Components and Accessories - Nonelectrical.

(Application for copies should be addressed to Underwriters Laboratories, Inc., 333 Pfingsten Road, Northbrook, IL 60062.)

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

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

3. REQUIREMENTS

3.1 Qualification of compressors. The compressors furnished under this specification shall be products which are authorized by the qualifying activity for listing on the applicable qualified products list at the time of award of contract (see 4.3 and 6.5). All repair and replacement parts for the compressors qualified for listing in the applicable QPL shall be products manufactured and inspected in accordance with the design accepted during the qualification of the compressor.

3.2 First article. When specified (see 6.2), a sample shall be subjected to first article inspection (see 6.6) in accordance with 4.4.

3.3 Performance.

3.3.1 Capacity rating. Capacity rating is the rate of heat removal from a medium or space to be cooled at specified conditions. Capacity rating shall be stated in tons of refrigeration. A ton of refrigeration shall be defined on the basis of heat removal at the rate of 12,000 British thermal units (Btu) per hour. The capacity rating of a compressor unit assembly or a condensing unit assembly shall be based on the capacity of the compressor unit assembly when operating at a suction pressure at the compressor equivalent to the saturated vapor temperature as required or as indicated in tables II or III unless otherwise specified (see 6.2). Refrigerating plants shall be supplied in standard capacities as specified (see 6.2). Standard capacities (in tons of refrigeration) are specified in table I.

TABLE I. Refrigerating plants - tons.

Ships stores and cargo			Air conditioning		
1/2	2	4-1/2	10	25	75
3/4	2-1/4	5	12	30	80
1	2-1/2	6	14	35	
1-1/4	3	7	16	45	
1-1/2	3-1/2	8	18	55	
1-3/4	4	9		65	

3.3.1.1 Associated motor and condenser. The associated motor and condenser shall have adequate capacity and performance characteristics for continuous operation at the maximum developed output of the compressor at conditions equivalent to a saturated suction temperature of 25 degrees Fahrenheit (°F) where capacity of the compressor is based on saturated suction temperature of 25°F and below, or at 45°F where based on saturated suction temperatures above 25°F. The water regulating valve shall be sized to provide cooling water based on compressor capacity at 0°F saturated suction temperature for ship's stores and refrigerated cargo and 35°F for air conditioning (see 6.2).

3.3.1.2 Refrigerating plants. Refrigerating plants shall deliver not less than rated capacity when operating at the rating conditions in tables II or III as applicable and at any of the applicable operating conditions specified in 3.3.4. With 95°F seawater entering the condenser, type I plant service A and type II plant services A and B shall operate stably under automatic control. Type II plant shall deliver 44°F chilled water with a capacity loss not greater than 15 percent of rated capacity. No adjustment of controls shall be required when operating from 88 to 95°F entering seawater. In addition to table II, refrigerating plants for submarine ship's stores application shall operate in an emergency condition while being supplied with 100°F water. Under this condition, assume the compressor will be operating at minus 10°F saturated suction and 115°F condensing temperatures.

3.3.2 Power. Compressor motor kilowatt (kw) power required shall be determined for full load and partial load with variations in sea water temperatures for ship's stores and cargo refrigerating plants, and with variations of sea water temperatures and chilled water temperatures for air conditioning plants.

TABLE II. Ships stores or cargo plant rating conditions - type I.

(a)	Refrigerant evaporating temperature 1/	minus 20°F
(b)	Sea water temperature entering condenser:	
	Surface ships	
	Service A	88°F
	Submarine (fresh water)	
	Service B 2/	60°F
(c)	Condensing temperature:	
	Surface ships	
	Service A	105°F
	Submarine	
	Service B	80°F
(d)	Sea water velocity through tubes	6 ft/sec max.
(e)	Sea water velocity through nozzles	7.5 ft/sec max.
(f)	Condenser waterside fouling coefficient	0.0005 scale factor
(g)	Sea water pressure drop through condenser	10 lb/in^2 max.
(h)	Factory pressure test - all refrigerant containing components 3/	350 lb/in^2
(i)	Operating discharge gauge pressure	125 lb/in^2
(j)	Design pressure for refrigerant-containing component	240 lb/in^2
(k)	Refrigerant leak test pressure	225 lb/in^2
(l)	Refrigerant hold pressure	240 lb/in^2
(m)	Refrigerant relief valve setting	235 lb/in^2
(n)	Sea water design pressure (surface ships)	250 lb/in^2
(o)	Sea water test pressure (surface ships)	335 lb/in^2
(p)	Fresh (chilled) water design pressure	100 lb/in^2
(q)	Fresh (chilled) water test pressure	135 lb/in^2

1/ Superheat of 75°F up to maximum of 65°F suction temperature.
2/ For submarine service the condenser cooling water is fresh water from the mechanical cooling (air conditioning) chilled water system via a two way or three way water regulating valve with condenser water discharge returned to the chilled water system.
3/ Use dry gas for refrigerant components.

TABLE III. Air conditioning plant rating conditions - type II.

(a)	Refrigerant evaporating temperature 1/	33°F min.
(b)	Sea water temperature entering condenser:	
	Surface ships	
	Service A	88°F
	Submarine	
	Service B	85°F
(c)	Condensing temperature:	
	Surface ships	
	Service A	105°F
(d)	Outlet chilled water temperature	44°F
(e)	Chilled water flow, approximately 2/	3.6 gal/min/ton
(f)	Chilled water pressure drop through chiller, at condition (e), above 2/	10 lb/in^2 max.
(g)	Sea water velocity through tubes	6 ft/sec max.
(h)	Sea water velocity through nozzles	7.5 ft/sec max.
(i)	Condenser waterside fouling coefficient	0.0005 scale factor
(j)	Sea water pressure drop through condenser	10 lb/in^2 max.
(k)	Factory pressure test - all refrigerant containing components 3/	350 lb/in^2
(l)	Operating discharge gauge pressure	125 lb/in^2
(m)	Design pressure for refrigerant-containing component	240 lb/in^2
(n)	Refrigerant leak test pressure	225 lb/in^2
(o)	Refrigerant hold pressure	240 lb/in^2
(p)	Refrigerant relief valve setting	235 lb/in^2
(q)	Sea water design pressure for	
	Surface ships	250 lb/in^2
	Submarines	as specified
(r)	Sea water test pressure for	
	Surface ships	335 lb/in^2
	Submarines	as specified

See footnotes at end of table.

TABLE III. Air conditioning plant rating conditions - type II - Continued.

(s)	Fresh (chilled) water design pressure	100 lb/in^2
(t)	Fresh (chilled) water test pressure	135 lb/in^2

1/ Superheat of 75°F up to a maximum of 65°F suction temperature.
2/ In addition, each plant shall produce the capacity specified plus or minus 5 percent when the chilled water flow is approximately 4.5 gal/min/ton, and the chilled water pressure drop through the chiller is 15 lb/in^2 maximum, and all other conditions are the same as specified in this table.
3/ Use dry gas for refrigerant components.

3.3.3 Energy savings. Even though reliability must be of paramount consideration in the design of refrigerating plants, assemblies and components, consideration shall be given to designing for high efficiency and energy saving. The manufacturer or contractor shall consider and may offer to NAVSEA or the contracting activity for review and approval energy-saving materials and designs not included in this specification.

3.3.4 Range of operating conditions. Each plant shall operate continuously and satisfactorily while delivering not less than rated capacity under any combination of the following range of operating conditions:

(a)	Ambient air temperature in space	40 to 125°F
(b)	Seawater temperature (service A)	28 to 88°F
(c)	Seawater temperature (service B air cond.)	28 to 85°F
(d)	Seawater gauge pressure (service A and B)	35 to 180 lb/in^2
(e)	Seawater gauge pressure (service B air cond.)	As specified (see 6.2)
(f)	Atmospheric pressure (service B)	11.8 to 18.6 lb/in^2 absolute (see note)
(g)	Chilled water gauge pressure	Up to 125 lb/in^2

NOTE: Submarine (service B) plants shall not be damaged when subjected to any ambient absolute pressure between 10 and 30 pounds per square inch (lb/in^2) whether operating or secured. However, the plant may shut down when the pressure range specified in the table is exceeded.

3.3.5 Noise limitations. Plants and compressors shall not exceed airborne and structureborne noise levels specified herein (see 6.3). Unless otherwise specified (see 6.2), for nonrotating, nonreciprocating equipment, if the first three units of a design are found to be below the criteria by 10 decibels (dB) or more at all frequencies, the following units of identical equipments on a contract or order need not be tested for airborne noise.

3.3.5.1 Airborne sound measurements. Each plant and compressor shall be tested for airborne sound (see 6.3). The airborne sound measurements shall comply with MIL-STD-740-1. Unless otherwise specified (see 6.2), compressors and plants shall comply with the sound pressure levels criteria required for category D equipment.

3.3.5.2 Structureborne vibratory acceleration measurements. Plants and compressors for submarines shall be tested for structureborne noise (see 6.3). When specified (see 6.2), structureborne vibratory acceleration measurements shall be made for surface ships. The structureborne vibratory acceleration measurements shall comply with MIL-STD-740-2. Unless otherwise specified (see 6.2), the compressor shall comply with the structureborne vibratory acceleration criteria required for type I equipment. (See 3.6.1.7 regarding use of resilient mounts.)

3.3.6 Reliability. The assurance of maximum reliability shall be of paramount controlling principle in the design, fabrication, assembly and testing of these plants. Parts subjected to wear or possible corrosion shall be fabricated from materials and so designed to satisfy this principle and to assure compliance with the reliability requirements herein. The basis for design of replaceable parts shall be an equivalent of 3 years of ship operation before replacement is necessary.

3.3.6.1 Reliability requirement. The minimum acceptable mean-time-between-failure (MTBF) for each refrigerating plant shall be 15,000 operating hours (see 6.3 and appendix B).

3.3.6.2 Reliability definitions. Reliability terms shall be defined in accordance with MIL-STD-721 except as otherwise defined in this specification.

(a) Refrigerating or air conditioning plant failure. A failure of a plant shall be defined as any event which requires securing the plant for corrective maintenance which requires more than 2 hours to perform. All corrective maintenance which can be performed by ship's force in less than 2 hours and is supported by on board repair parts and tools will not be considered a failure.

3.3.7 Service life. Each plant and its components shall have an operating life of at least 60,000 hours when subjected to any or all of the shipboard conditions specified herein. Such performance shall be obtained with a minimum and reasonable degree of preventive maintenance. The plant shall have a useful life of 180,000 hours. Such life expectancy shall be obtained with up to three overhauls consisting of compressor/motor rebuild, condenser/chiller re-tubing, and control/instrumentation replacement as needed.

3.3.8 Environmental performance. The plant shall operate and perform its function without deleterious effects on reliability and wear rate when installed and operated on board Navy ships under the following shipboard arrangements and environmental conditions, which shall be understood to prevail simultaneously or occur in any combination. Under these conditions, the plant shall operate satisfactorily, maintain adequate lubrication, avoid loss of oil or other fluids and drain without spillage.

(a) Orientation on ship. The plant will be installed by the shipbuilder with the compressor main shaft either fore and aft or athwart ship. The operation of the refrigerating plant shall not be adversely affected by orientation.

(b) Marine environment. The plant will be constantly exposed to marine environment which shall be understood to mean extremes of and constantly changing ambient temperatures, high humidity in a salt laden atmosphere, and high incidence of conditions for electrolytic action of dissimilar metals. Plants shall be designed and constructed to be highly resistant to the effects of this environment and to the shipboard conditions of vibration, roll, pitch and shock.

(c) Vibration. The plant will be constantly exposed to ship's vibration which shall be understood to mean high incidence to low order vibrations (4 to 33 hertz (Hz)) of a pulsating nature. It shall perform reliably under the vibrational conditions resulting from self-generating vibration, ship environmental vibrations and combinations thereof. The plant and components shall meet the type I vibration requirements in accordance with MIL-STD-167-1.

(d) Ship inclination. The plant shall permit operation at the permanent and cyclic ship inclinations in table IV.

3.3.9 Shock resistance. The plant and components shall withstand high impact shock. Each plant and components shall be of a shock resistant design that shall pass the high impact shock tests specified in MIL-S-901. Unless otherwise specified (see 6.2), plants for surface ships shall be grade A, class III equipment and plants for submarines shall be grade A, class II equipment of MIL-S-901. Guidance regarding shock tests and design of shock resistant naval equipment can be found in MIL-S-901 and publications referenced therein. This data is a factor in the review of the equipment design by the drawing review activity.

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TABLE IV. Ship's motion (in degrees displacement from horizontal).

Application	Permanent trim by bow or stern	Permanent list	Symmetrical rolling	Symmetrical pitching
Surface ship (service A)	5	15	45	10
Submarine (service B plants)	30	15	2/60	3/10

1/ Trim and list conditions or roll and pitch conditions shall be considered to occur simultaneously.
2/ Time of a complete roll cycle - (Submarines - 15 seconds).
3/ Time of a complete pitch cycle - (Submarines - 9 seconds).

3.4 Design and construction. Refrigerating plants, systems and components shall be commercial grade, modified as necessary to ensure satisfactory performance in a shipboard environment, and for standardization as specified herein. Components may be acquired separately (see 1.2) or assembled for refrigerating applications. Components acquired separately shall meet the requirements for each component as specified herein and shall be suitable for the intended use.

3.4.1 Safety. The plant shall be designed so that all procedures for installing, operating, inspecting, maintaining, repairing, and adjusting the plant can be accomplished in a safe manner (see 6.3). To insure maximum protection for operating and maintenance personnel against hazards and accidents, the plant shall, as a minimum, incorporate the following safeguards and protective features:

(a) Exposed moving and rotating parts shall be covered by removable guards of expanded metal or similar sturdy serviceable material.
(b) Exposed edges shall be generously rounded and made smooth to prevent cutting edges and sharp corners.
(c) Insulated connectors and plugs of all electric current carrying conductors shall be of such design that they will not constitute an electrical shock or residual discharge hazard when they are disconnected for maintenance and repair.
(d) Components or parts of a heavy or unwieldy nature shall be mounted so that they are not free to fall, topple, or slide and drop when their mounting fasteners are removed. Lifting the component for mounting/dismounting or assembly/disassembly shall constitute a separate action apart from removing the mounting fasteners. Special lifting and rigging provisions shall be made for the disassembly and movement of any component or part which weighs over 80 pounds.
(e) Pressurized components and systems shall be safeguarded against sudden and catastrophic rupture by:

(1) Hydrostatic proof testing, or gas testing for refrigerant components, of assemblies and components during construction including the refrigerant circuit.
(2) Nondestructive testing of welds and joints.
(3) Selection of material to prevent interchangeability between low and high strength components.
(4) Avoidance of stress concentrations.
(5) Installation of pressure relief devices.

3.4.2 Human engineering. Refrigeration plants, assemblies, and components shall be designed for efficient man-machine interface in accordance with MIL-STD-1472. Controls and indicators shall be visible and accessible without removing guards or covers. Access to components requiring maintenance or replacement shall not require removal of piping or other components. The design and location of controls and indicators shall minimize the possibility of equipment failure resulting from misunderstanding of indicators.

3.4.3 Hazard analysis. Hazard analysis shall include examination of the equipment, subsystems, components, and their interrelationship to training, maintenance, and operational environment (see 6.3). The contractor shall call attention to the danger of undetected refrigerant leaks in a confined space with minimum quantity of makeup air. MIL-STD-882 and EIA Bulletin No. 3 may be used as guidance for selection and use of safety analysis techniques.

3.4.4 Ease of maintenance. Plants shall be designed and constructed so they can be easily maintained, disassembled, repaired and reassembled. Maintenance operations shall be made straightforward and simple with proper regard to the fact that maintenance often will be performed under adverse conditions with the ship at sea far from normal sources of supply and performed by maintenance personnel who are not seasoned mechanics. Design criteria for ease of maintenance shall include parts standardization, parts interchangeability, configuration control, accessibility for maintenance and repair, and portability. Those parts requiring lifting aids shall be provided with lifting lugs or drilled and tapped holes for the safe use of eye bolts. If eye bolt holes are adopted, holes shall also be provided to permit lifting at one end of an oblong component to facilitate safe vertical removal through a hatch.

3.4.5 Parts standardization. Plant design shall standardize, as far as practicable, on those components, fasteners, and items used in manufacture to reduce the number of sizes and kinds of items which are generally similar. To the maximum extent possible, the manufacturer shall design for the use of standard, commercially available parts. For example: A design incorporating grade 8, 1/4-20 UNC-2 inch bolts in one location and grade 5, 1/4-20 UNC 2-1/2 inch bolts in another location should standardize on grade 8 1/4-20 UNC 2-1/2 inch bolts. O-ring material shall be standardized to the maximum extent possible. O-ring diameters and sizes should be those commonly available from industrial supply houses. Parts shall not be standardized where it will permit improper use, such as installing a low pressure part in a high pressure application.

3.4.6 Interchangeability. All identical components, including repair parts or corresponding apparatus furnished on the same contract or order or built to the same drawings, shall be interchangeable without hand fitting and additional machining. Components which are functionally interchangeable shall, as far as practicable, be physically, electrically, and mechanically interchangeable, and this provision shall apply not only to wearing parts but also to components not normally considered wearing parts such as the refrigerant condenser. However, when two similar items are not functionally interchangeable, they shall not be physically interchangeable and shall differ significantly so that their non-interchangeability is obvious. In no case shall parts be physically interchangeable or reversible unless such parts are also interchangeable or reversible with regard to function, performance and strength.

3.4.7 Configuration control. Components and parts of plants shall be designed and constructed such that replacement parts subsequently manufactured in accordance with the manufacturer's drawings can be replaced without additional machining, handfitting, scraping, welding, or otherwise customizing. "Inseparable assemblies" as defined in DOD-STD-100 shall not, so far as practicable, be used.

3.4.8 Materials. Materials of construction shall be equal or better than those specified in the sections for the specific components. Where materials are not specified, they shall be selected on the basis of successful state-of-the-art commercial applications for similar service conditions to those specified herein, except that cast iron, where used, shall be ductile (nodular) type in accordance with MIL-C-24707 and MIL-C-24707/5 or grade 65-45-12 in accordance with ASTM A 536. Gray cast iron components which have successfully passed the high impact shock requirements of MIL-S-901 may be used if the component is small enough to pass through existing access openings. Materials shall be protected against corrosion. Corrosion-resisting steel, copper, brass, bronze, chromium, copper-nickel and nickel-copper alloys are considered corrosion resistant materials. Cadmium plating shall not be used as protection against corrosion. The selection of materials other than those specified herein is subject to NAVSEA review. All materials shall be identified in the drawings in a manner so that the physical and chemical properties and chemical composition are defined without ambiguity. All components, castings, weldments, machined parts and piping shall be thoroughly cleaned and inspected for soundness, cleanliness and performance acceptability prior to assembly.

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

3.4.10 Mercury restriction. Mercury and mercury containing instruments (except fluorescent or necessary vapor lighting) shall not be used in the manufacture or testing of any item used in these refrigerating plants (see 6.3 and appendix D).

3.4.11 Galvanic corrosion. To prevent galvanic corrosion, direct contact of electrolytically dissimilar materials shall be avoided as far as practicable.

3.4.12 Dangerous materials. Materials which are capable of producing dangerous gases or causing other harmful effects under conditions (including fire) encountered in Naval shipboard service shall not be used. Magnesium and its alloys shall not be used.

3.4.13 Material identification. Materials which act as pressure boundaries in level I essential piping systems shall be permanently identifiable and traceable back to records for the material heat and lot/load number within a heat, and its chemical and mechanical properties shall be in accordance with NAVSEA 0948-LP-045-7010.

(a) Seawater pressure boundary items for submarine plants are classified as level I.
(b) For this equipment, the refrigerant circuit is considered as level N/A.

3.4.14 Castings. Castings from materials other than nodular or gray iron shall comply with the requirements of MIL-STD-278. Castings shall not have excessive porosity, sponginess, or cracks. Castings shall not be peened to repair defects. Iron castings shall not be welded or patched. Radiography shall be performed in compliance with MIL-STD-278. Radiography and marking of castings shall be as follows:

(a) Casting radiography - Castings for which radiography is required shall be radiographed in accordance with MIL-STD-271.

(b) Marking of castings - Acceptable castings shall be legibly and permanently marked "RT" for radiographic testing and a serial number or code for identification of casting to radiographs. Marking of castings shall be accomplished by one of the following methods:

(1) Vibro tool etched.
(2) Stamping with round low stress stamps.

(c) Location of markings - Wherever possible markings shall be so located that they shall:

(1) Not be removed in subsequent manufacturing operations. If removed, they shall be reestablished.
(2) Be visible after assembly or installation of the finished casting into its end use.

Location of these markings and the method of marking shall be shown on the radiographic shooting sketches (see 6.3 and appendix A).

(d) Radiographic acceptance standards shall be as specified in MIL-STD-278.

3.4.15 Assembly processes.

3.4.15.1 Equipment alignment. Components and assemblies that are alignment critical shall be positively held in place by fitted bolts, keys, rabbeted or tongue and groove joints, or other indexing means. The alignment shall not be disturbed nor shall any undue stresses be set in on any part as a result of performance under the environmental conditions specified in 3.3.8 and 3.3.9.

3.4.15.2 Welding. Welding and allied processes, including inspection, repairs and materials, shall be in accordance with MIL-STD-278. Welding of tube sheets for submarine units may be accomplished by means of the electron beam technique, provided the procedure and operator have been qualified in accordance with MIL-STD-248. Welds shall be ultrasonically inspected. Welded joints on the seawater side of the condenser for submarine units shall be radiographable except for vent and drain nipples and tube sheets. Radiographic inspection shall conform to MIL-STD-271. Vent and drain nipple welded connections shall meet the 100 percent weld efficiency requirement for pressure vessels and liquid penetrant inspections shall be utilized to inspect these welds.

3.4.15.3 Brazing. Brazing shall be in accordance with NAVSEA 0900-LP-001-7000. Brazing shall be restricted to non-seawater piping systems.

3.4.15.4 Threaded fasteners. Threaded fasteners shall be such that standard wrenches can be used throughout. Tapered pipe threads shall not be used except as specified in 3.5.1.1. Unless otherwise specified herein, the form of bolts, nuts and studs shall conform to ANSI B18.2.1 and B18.2.2. A class 5 interference fit conforming to ANSI B1.12 may be substituted for assembly of tap-end of studs. The practice of "bottoming" or "shouldering" studs shall be avoided. For set end of studs, a class 3A fit used with locking compound, grade AV of MIL-S-22473 may be substituted for a class 5 interference fit. The following additional requirements apply:

(a) Screw threads.

(1) Unified thread series. Screw threads, except as specified in (b)(3), shall conform to ANSI B18.2.1 and B18.2.2.
(2) Coarse versus fine thread series. Coarse thread series shall be used unless the component design indicates a necessity for the use of the fine thread series.
(3) Eight-thread series. For fasteners 1-inch diameter and larger, the eight thread series shall be used wherever practicable.

(b) Class of fit.

(1) Class 2A-2B. Class 2A-2B fit shall be used for the major portion of interchangeable screw thread fasteners.
(2) Class 3A-3B. Class 3A-3B shall be limited to applications where the necessity for accuracy of lead and angle of thread can be justified.
(3) Class 5. Class 5 interference fits shall be used only for tap end of studs.

(c) General rules for applications.

(1) Thread engagement - nuts. Threads of nuts shall be fully engaged. Maximum protrusion of the fasteners from the top of the nut shall protrude at least one full thread length or one diameter of threads beyond the top of the nut or locking element. Thread protrusion shall not exceed 10 threads.
(2) Thread engagement - tapped holes. Tapped holes for stud bolts and cap screws shall have full threads for a depth of not less than the nominal diameter of the fasteners.

(d) Torque and lubrication. For waterside applications, threaded fasteners shall be tightened to design torque requirements. The contractor shall establish these requirements. Threaded fasteners used to attach water heads shall be lubricated with lubricant in accordance with MIL-L-24479 or the lubricant may be made up as follows: Red lead graphite and mineral oil. This lubricant shall be made as follows: 4-1/2 pounds of high grade, dry red lead shall be weighed in a clean container. 1-1/4 pounds of finely divided, high grade, air-floated graphite shall be weighed in a clean container. One quart of straight mineral oil (viscosity shall be 275-325 Saybolt Second universal (SSu) at 37.8 degrees Celsius (°C)) shall be measured in clean, gallon container. The graphite shall be added slowly to the red lead, stirring constantly until the mixture is uniform in consistency and color. Mixture of red lead and graphite shall be added slowly to the oil, stirring constantly until a smooth, uniform blend, free of lumps, is obtained. Partial batches in the same proportion are acceptable. This lubricant shall not be used on alloys containing more than 15 percent nickel if the temperature of operating exceeds 400°F.

3.4.15.5 Machine finishes. The following are typical parts of the plant which shall be machine finished:

(a) Bearing, mounting, or faying surfaces or machinery bases and foundations which require accurate alignment.
(b) Bearing surfaces for nuts and bolt heads on uneven surfaces.
(c) Faying surfaces of all projections from the bodies of pedestals, blocks, or other supports meeting finished parts.
(d) Sealing surfaces.
(e) Working parts.

Surface finish identification shall be in accordance with ANSI B46.1. All sealing surfaces for gaskets and O-rings which form a part of the refrigerant envelope shall have a finish of 32 root mean square (rms) or better. O-rings shall be in accordance with NSTM Chapter 78, MIL-R-83248 and MIL-R-83248/2.

3.4.16 Cleaning and sealing. All refrigerant containing components exclusive of valves and fittings shall be cleaned, dehydrated, provided with a holding charge of nitrogen and sealed prior to delivery.

3.5 General design.

3.5.1 Piping. Valves, flanges and fittings for pipe connections shall conform to the requirements of MIL-STD-777 for surface ships and MIL-STD-438 for submarine application.

3.5.1.1 Threaded pipe connections. Flareless bite type fittings shall not be used. Tapered pipe threaded connections or plugs and flared connections between piping, machinery, and valves and in piping system joints shall not be used where external leakage from the connection will result in water, or refrigerant entering the ship. Tapered pipe threaded connections and plugs, and flared connections between piping, machinery and valves and in piping system joints may be used in the following areas:

(a) Internal compressor and motor lube oil piping and plugs on the interior of the air conditioning plants.
(b) Flared connections on the exterior of the unit may be used to service the plant (refrigerant charge, oil, drain, gauge calibration, etc.). These connections shall be capped when not being used to prevent leakage and protect the threads and sealing surfaces. In addition, each service connection shall have a shut-off valve to isolate it from the plant during normal operation.

3.5.1.2 Refrigerant piping. The capacity and size of the refrigerant piping shall be as specified herein or in the contract or order (see 6.2). All pipe or tube shall conform to ASTM B 88, and with a wall thickness not less than that required for type L. Liquid and suction lines shall be not less than 3/8 inch in outside diameter. Refrigerant lines to controls, instruments and gauges may be 1/4 inch outside diameter (od). Instrument piping shall be in accordance with Drawing 810-1385850.

3.5.1.3 Vibration isolator. The refrigerant piping shall include vibration isolators in a 90 degree configuration at the compressor suction and discharge refrigerant piping. A suction line filter shall be installed in the suction line before each compressor. The filter shall be a right angle type (see 3.6.7) installed close to the compressor at the end of the horizontal run.

3.5.1.4 Small piping, tubing and wiring. Small piping, tubing and wiring shall be fabricated, supported, fastened and protected to minimize mechanical damage due to shock and vibration, or from personnel working on the refrigerant plant or adjacent equipment. Support hangers, straps and vibration eliminators shall be installed as necessary.

3.5.1.5 Shut-off valves. Shut-off, purge, drain and throttle valves for refrigerant control shall be of the diaphragm or packed type. Valves through 1-1/8 inch od shall conform to type III and valves larger than 1-1/8 inch od shall conform to type II of MIL-V-20064 except valves shall have non-galling stainless steel stems and nylon ASTM D 4066 valve disc. All valved service connections for trouble shooting shall be self sealing capped 1/4 inch SAE male flare. Refrigerant valves for submarine application shall have non-galling stainless steel stems, nylon ASTM D 4066 valve disc and shall be the packless type.

3.5.1.6 Fittings. All fittings shall be forged brass or wrought copper.

3.5.1.7 Joints. All fittings and joints for piping and components connected to the piping shall be brazed with silver brazing alloy or phosphorous copper. Connections shall be kept at a minimum, and where tubing joints are necessary, couplings shall be used. Swage connections shall not be used.

3.5.2 Mode of operation. Components and systems shall be fitted with controls and piping accessories to provide for functional operation and protection of equipment. The plant shall be capable of continuous uninterrupted service when operating under the conditions specified herein with a minimum of attention. Automatic safety controls shall be provided so that the compressor motor cannot be started without adequate condenser water supply and will stop when condenser water supply is insufficient. Operation shall automatically maintain the refrigerating capacity for which the plant is set within the specified tolerance (see 3.5.5).

3.5.3 Liquid refrigerant control and piping assembly. The liquid refrigerant control and piping assembly shall include a shut-off valve between the condenser and receiver with a pressure relief valve arranged as a bypass around the shutoff valve to prevent excessive pressure in the receiver. For a surge type receiver the equalizing line from the top of the receiver shall contain a shutoff valve and the relief valve piped in parallel. The relief valve shall be set at 225 lb/in^2. Following the receiver, the control assembly shall include a shut-off valve, sight flow indicator, moisture indicator, main liquid line solenoid valve, unless otherwise specified (see 6.2), combination charging and drain valve, a filter-dehydrator assembly and heat exchanger. For ships stores and cargo refrigeration plants, if all solenoid valves can be activated to shut off refrigerant flow by the compressor motor controller, then it will not be necesary to provide a main liquid line solenoid valve.

3.5.3.1 Moisture indicator. The moisture indicator may be provided integral with the filter-dehydrator. Where a separate moisture indicator is used it may be installed directly in the liquid line.

3.5.3.2 Heat interchanger. Where the heat interchanger is installed in a refrigerated storage application, the liquid control assembly shall include a valve at the liquid inlet, and a by-pass line and valve arranged to bypass the liquid around the heat interchanger. A valve shall not be installed in the liquid line outlet.

3.5.3.3 The refrigerant charging and evacuation valve shall be the same size as the refrigerant charging hose and not smaller than 3/8 inch.

3.5.4 Evaporator control and piping assembly. Evaporator control shall consist of a shutoff valve, liquid line strainer, thermostatically operated solenoid valve with temperature control switch, thermal expansion valve, a hand expansion valve arranged as a bypass around the thermal expansion valve, and a shutoff valve at the evaporator outlet for each cooling coil. The hand expansion valve shall not be installed on forced circulation cooling coils or chilled water air conditioning plants. The evaporator outlet shutoff valve, and liquid line strainer shall not be installed on chilled water air conditioning plants.

3.5.5 Condensing unit control. Condensing unit controls shall include a low pressure switch to start and stop the compressor as the refrigerating load requires, a separate high pressure switch, an oil pressure failure switch and a high oil temperature switch as safety devices, an anti-recycle timer, a water regulating valve to maintain constant condensing pressure and a water pressure failure switch as a safety device to stop the compressor in the event of water failure. The water failure switch is not required, where the condensing unit with a sea water condenser is for submarine application. A shutoff valve shall be provided in the pressure sensing line to the water regulating valve.

3.5.6 Condensing unit for water chiller. A condensing unit serving a water chiller for air cooling shall include an electronic temperature controller to regulate the chilled water to the desired temperature, an operating temperature switch to cycle the compressor on and off automatically at low loads, and a low temperature switch as a safety device to stop the compressor to prevent the chilled water from freezing.

3.5.7 Electrical.

3.5.7.1 Electrical power. Electric power supply will be 440-volts, 3-phase, 60 Hz alternating current (ac). All controls and oil heaters shall be operated from 115 volts.

3.5.7.2 Electrical equipment. Electrical equipment components, controls and devices shall conform to the requirements of MIL-E-917. Enclosures for electrical and electronic equipment shall conform to the requirements of MIL-E-2036. Equipment shall perform as specified when supplied with type I power, as defined in MIL-STD-1399, section 300. Vacuum tubes shall not be used. Permanent markers for wire and cable shall be provided as required by MIL-STD-195. An ammeter to determine motor current shall be supplied for installation on the gaugeboard. The controller shall be suitable for remote mounting.

3.5.7.2.1 Electromagnetic interference. The equipment shall meet the following requirements of MIL-STD-461:

(a) The control system including associated transducers, sensors, actuators, and interconnecting cables shall meet the following requirements of Part 5 of MIL-STD-461:

CE01	RE02	CS06	RS03
CE03	CS01	RS01	
RE01	CS02	RS02	

(b) Previously tested and certified equipment that has met the EMI test limits of previous revisions of MIL-STD-461 (see 6.7) are acceptable, without retest, upon delivery of an EMI certification. EMI testing of the control system shall be performed to verify compliance with the requirements of MIL-STD-461 (see 6.3). Government witness of testing is required.

(c) To satisfy the requirements of MIL-STD-461, the contractor shall demonstrate that the overall approach, design procedures, and techniques employed are appropriate for meeting the EMI requirements. The overall approach, design procedures and techniques shall be reviewed at a series of informal technical meetings with a Government EMI specialist.

3.5.7.3 Motors. Motors shall be in accordance with MIL-M-17060 as applicable, or as specified (see 6.2). Motors shall be of sufficient horsepower rating to start, accelerate, and operate the driven auxiliaries under all maximum load conditions without exceeding specified limitations. They shall have the following characteristics:

Service	A (unless otherwise specified (see 6.2))
Type	Squirrel cage induction
Duty	Continuous
Design	B
Enclosure	Dripproof
Ambient temperature	50°C
Insulation	Class B
Efficiency	Minimum 97 percent at 4/4 load, 96 percent at 3/4 and 95 percent at 2/4 load

The motor shall have a sealed insulation system approved by NAVSEA.

3.5.7.4 Motor controllers. Unless otherwise specified (see 6.2), motor controllers shall be in accordance with MIL-C-2212. The controller shall be arranged to stop the compressor motor when any of the switches open. Each compressor motor controller shall be provided with a manual push-button master switch of the momentary contact type to permit bypassing of the low pressure control switch. The control operation shall be such that opening of the compressor high pressure, water failure, high oil temperature, or oil failure switch, manual re-starting of the compressor will be required. Provision shall be included for the connection of a refrigerant solenoid valve circuit. The circuit shall be such that the solenoid valve shall receive power only upon closing of all of the following switches: high pressure switch, oil pressure switch, low temperature switch, water failure switch, high oil temperature switch and chilled water operating thermostat, low voltage relay, and overload relay. The operation of the low pressure switch shall not affect the solenoid valve circuit. Closing the low pressure switch shall not restart the motor without the solenoid valve being energized. The circuit also shall be arranged to permit the option of connecting the water failure switch so that its operation does not affect the solenoid valve circuit. The low voltage relay shall have a consistently higher drop-out voltage than the compressor motor contactor. The low voltage relay circuit shall function to de-energize the compressor motor before a low voltage condition can cause any other component to interrupt the compressor motor circuit. Once the low voltage relay drops out, manual restarting of the compressor motor shall be required.

3.5.7.4.1 Control circuit. The control circuit shall also function to actuate the oil cooler solenoid, oil heaters, anti-recycle timer and operating time meter. The oil cooler solenoid valve shall be energized when the compressor is operating and de-energized when the compressor stops for any reason. The crankcase electric oil heaters shall be energized when the compressor stops and de-energized when the compressor starts. The circuit for the oil heaters shall include an indicating light mounted on the condensing unit gaugeboard. The indicating light shall be energized when the crankcase heater is energized. The anti-recycle timing device and control relay shall prevent immediate restarting the compressor after it has stopped for any reason. The anti-recycle timer shall be adjustable in the 5 to 10 minute range. A bypass push-button shall be provided for emergency restart. The operating time meter shall be a nonadjustable elapsed (running) digital time meter to indicate total hours of compressor operation. The meter shall be in accordance with MIL-M-3971 or MIL-M-7793 and MIL-M-7793/7 except the operating time indicator shall be capable of indicating 99,999 hours.

3.5.7.4.2 Water pump motor controller. Each condenser water pump motor controller shall include a maintaining contact switch. Provision for the required semi-automatic performance, automatic performance and low voltage protection may be made through interconnection with the controller for the compressor motor. The controller for the pump motor shall be suitable for interconnection to the controller for the compressor motor so that the controller for the pump motor is dependent on the operation of the control switches and relays, but not the water-failure switch of the controller for the compressor.

3.5.7.4.3 Compressor motor controller. The compressor motor controller shall be in accordance with the following requirements:

Dripproof enclosure.
Ambient temperature of 50°C.
Continuous duty.
Magnetic operation.
Across-line start.
Low voltage and overload protection.
Time delay on restart.
Over current relays.
An interlock shall be provided to activate oil heaters and controls when the unit is not in operation and oil cooler solenoid valve when unit is operating.

3.5.7.5 Master switches. Master switches shall include pressure controls, temperature controls and push button switches and shall be in accordance with MIL-C-2212 or as otherwise specified herein or in the contract or order (see 6.2).

3.5.7.5.1 Pressure and temperature controls. Pressure and temperature controls shall conform to the following classification requirements:

Ambient temperature.....50°C
Duty.....Continuous
Voltage.....As required by control circuit
Enclosure.....Spraytight

3.5.7.5.2 Push button master switches. Push button master switches shall conform to the following classification requirements:

Enclosure.....Local: As required by the controller
Remote: Spraytight

3.5.8 Pressure indicators. Pressure indicators and switches shall be piped in accordance with Drawing 810-1385850. Whenever possible, pressure indicators and switches which monitor the same pressure shall use a common sensing line and be piped in accordance with Drawing 810-1385850. Pressure indicators or gauges shall conform to MIL-G-18997, except the dial diameter shall be 3-1/2 inches and modified to include shock resistance. Condenser water gauges shall be composition 2; other gauges shall be composition 1. Condenser water gauges for submarine application shall have a range as specified (see 6.2). Gauges, when specified herein, shall include the following ranges and units as applicable for the equipment furnished:

	Range
One gauge for suction of compressor	30 inches vacuum to 150 pounds lb/in^2
One gauge for discharge of compressor	30 inches vacuum to 300 lb/in^2
One gauge for refrigerant evaporator outlet (air conditioning)	0 to 150 lb/in^2

One gauge for circulating water from condenser	0 to 100 lb/in^2
One gauge for chilled water inlet to chiller	0 to 100 lb/in^2
One gauge for chilled water outlet from chiller	0 to 100 lb/in^2
One gauge for oil pressure	30 inches vacuum to 150 lb/in^2

3.5.9 Gaugeboards. Gaugeboards shall be fitted to mount control switches as well as gauges. The gaugeboard shall be constructed of aluminum with a nominal thickness not less than 0.18 inch. All instruments mounted on the gaugeboard shall have a rubber washer at least 0.0625 inch thick on each securing bolt between the instrument case and the gaugeboard. Shutoff valves shall be provided on the gaugeboard designating connected machine and service of each instrument. The shutoff valve for each pressure gauge and switch shall have a stem test connection to check for accuracy and setting using an external pressure source without removing the pressure indicator or switch from the control panel. The shutoff valve shall be in accordance with MIL-V-24578. The controls shall be arranged and located on the gaugeboard so that they are accessible for setting and adjusting and located such that personnel are safeguarded against electrical shock hazard. Gaugeboards that include controls that are inaccessible to adjust or may create a shock hazard during inspection and test shall be rejected (see 4.4.2.11.1 (b), (c)).

3.5.10 Temperature indicators. Temperature indicators shall be bimetallic, distant reading, thermoelectric or electrical-resistance as specified herein or in the contract or order (see 6.2). Temperature indicators for submarine application shall be of the thermoelectric or electrical resistance type. Temperature indicators shall include the following units and ranges as applicable for the equipment furnished:

	Range (°F)
One temperature indicator for suction line to each compressor	Minus 40 to 180
One temperature indicator for discharge line from each compressor	50 to 550
One temperature indicator for refrigerant liquid line from each receiver	Minus 40 to 180
One temperature indicator for crankcase lube oil	20 to 240
One temperature indicator for circulating water supply and one from the outlet of each condenser. One inlet temperature indicator may be supplied in the common inlet shared by two condensers.	Minus 40 to 180
One temperature indicator for chilled water supply and one for chilled water outlet of each chiller	Minus 40 to 180

3.5.10.1 Bimetallic temperature indicators. Bimetallic temperature indicators shall conform to MIL-I-17244; distant reading temperature indicators shall conform to MIL-T-19646. These temperature indicators shall be installed in thermowells in accordance with MIL-T-24270. The wells shall be 70-30

copper-nickel alloy for sea water application or with bronze for chilled water or refrigerant. Thermometer wells for sea water application shall have straight threads and O-ring seals in accordance with MS16142.

3.5.10.2 Thermoelectric or electrical-resistance temperature indicators. Thermoelectric or electrical-resistance temperature indicators shall have construction features as required in MIL-T-15377 and shall be a type satisfactory to the Command or agency concerned (see 6.2).

3.6 Group I components. The provisions of this section specify the requirements for design and construction of components of the refrigerating plants. Components shall comply with the design requirements in tables II and III as applicable.

3.6.1 Compressors. Compressors shall be of the open, multi-cylinder reciprocating type, designed to operate at a maximum speed of 1800 revolutions per minute (r/min). The compressor shall be statically and dynamically balanced at operating speed. When belt drive is used, compressor balancing shall be with respect to the flywheel. Compressor cooling shall be accomplished by means other than water. Compressors shall include suction and discharge stop valves; an internal removable suction strainer; full positive forced feed lubricating system; variable capacity control; oil heaters; high oil temperature switch; oil thermometer; oil cooler; oil filter; necessary gauge and control connections. Where the compressor stop valves are part of or flanged directly on the compressor, approval of the stop valves will be considered during compressor qualification tests and examinations. Compressor service or stop valves included in the piping shall be as specified in 3.5.1.5. Refrigerant piping or valve connections to the compressor shall be four-bolt flanged type or as approved by NAVSEA. Other service connections such as gauges and pressure switches shall be O-ring straight thread in accordance with MS16142. Where the compressor design incorporates an internal relief valve, the internal relief valve shall be furnished. The setting of the relief valve shall be in accordance with the manufacturer's standard practice. The crankcase seal, main and connecting rod bearings shall be replaceable types.

3.6.1.1 Compressor valves. Compressor valves shall operate quietly, and shall be of the steel disc or diaphragm type to assure positive contact with the ground or finished valve seat. The suction valve arrangement shall be such that suction vapors will enter the cylinder without free access to the crankcase.

3.6.1.2 Lubrication system. The compressor forced-feed lubricating oil system shall be the type that supplies oil under pressure to all main crankshaft and connecting rod bearings via a drilled crankshaft and internal piping, by an oil pump directly connected to, or gear-driven from the crankshaft of the compressor. The oil pump shall take its suction from the compressor sump through an oil filter screen, and discharge through a replaceable filter element. The compressor pistons shall provide relief for oil to be returned to the crankcase in the vicinity of the oil ring. The lubrication system shall be fitted with a pressure-regulating valve, oil heaters or heater, high oil temperature switch, oil cooler, oil pressure gauge, oil temperature indicator, replaceable element oil filter, an oil-level indicator and the unit fitted with a refrigerant service valve with flare capped connections for oil charging and draining. A connection shall be provided for an oil pressure failure switch to be installed to stop the

compressor in case of oil failure. The lubrication system shall operate properly in inclined positions (see 3.3.8). The lubricating oil shall comply with type II of VV-L-825.

3.6.1.2.1 Oil heaters. Electric oil heaters shall be installed in the oil sump to maintain lubricating oil temperatures above ambient during shut down. Oil heaters shall be replaceable without draining the compressor oil or disassembly of the compressor. Heaters shall be thermostatically controlled to limit oil temperature at 130 to 140°F. Capacity of electric heaters shall maintain oil at 40 to 50°F above ambient during shut down when the machinery space temperature is 40°F. An oil temperature thermometer shall be provided to monitor the oil temperature. An indicating light shall be provided to show that the heaters are energized. A high oil temperature safety switch shall be provided to de-energize the oil heaters to prevent high oil temperatures.

3.6.1.2.2 Oil cooler. A separate lubricating system oil cooler shall be provided to maintain oil sump temperature between 120 and 130°F during compressor operation. The oil cooler shall use chilled water for cooling when installed in a chilled water air conditioning plant compressor unit. The chilled water supply to the oil cooler shall have a thermostatically operated modulating chilled water regulating valve to maintain a uniform outlet oil temperature from the oil cooler. The water regulating valve actuating bulb shall be installed in a well in the cooler oil outlet line. A solenoid valve shall be installed in the chilled water supply to the heat exchanger to secure the chilled water supply when the compressor stops, and to open to permit oil cooling when the compressor starts. Shut off valves shall be provided in the chilled water supply and outlet for oil cooler maintenance. Materials of construction for the oil cooler shall comply with MIL-C-15730, type A, class 5.

3.6.1.2.2.1 Thermostatic switch and solenoid valve. In a ship's stores refrigerating plant, cargo refrigerating plant or air conditioning refrigerating plant with direct expansion cooling coils, refrigerant shall be used as the cooling medium in an oil-to-refrigerant heat exchanger. The refrigerant inlet to the oil-to-refrigerant heat exchanger shall be thermostatically controlled by a thermostatic expansion valve. A thermostatic switch and solenoid valve to control refrigerant flow to the expansion valve shall be provided to maintain a uniform leaving oil temperature. The refrigerant gas from the heat exchanger shall return to the suction line. A solenoid valve shall be installed in the refrigerant supply to the heat exchanger to secure the refrigerant supply when the compressor stops and to open to permit oil cooling when the compressor starts. Shut off valves shall be provided in the refrigerant supply and outlet for oil cooler maintenance. The heat exchanger shall be made of nonferrous material and suitable for the application intended.

3.6.1.2.2.2 Heat exchanger and controls. The heat exchanger and controls to maintain uniform oil temperatures shall be approved by NAVSEA.

3.6.1.2.3 Oil filter. The oil filter shall be a type external to the compressor with a replaceable filter element. The unit element shall be the compressor manufacturer's standard commercial filter. The filter shall be equipped with isolation valves for filter element replacement without requiring the draining of the compressor oil.

3.6.1.2.4 Oil charging and draining. The plant shall contain valved hose connections for charging and draining lubricating oil. Detachable hoses shall be provided for draining the oil. An oil charging hose and hand operated oil charging pump shall be equipped with end fittings for proper hookup or adapters shall be provided if required for hook-up. Portable containers with valved connections shall be provided for draining the oil from the plant and recharging the plant with lubricating oil. Volume of the containers shall be sufficient to hold the complete charge of one plant.

3.6.1.3 Capacity control. Variable capacity control of the compressor shall be provided. A controller shall sequence compressor cylinder loading to prevent more than one stage of loading to take place at a time on startup and when the load increases. The time interval between stages of loading should be at least 60 seconds. The capacity variation shall be in increments of partial capacity with the lowest capacity step not more than 50 percent of total capacity for two cylinder compressors and not more than 33-1/3 percent of total capacity for all other compressors. Compressors with six or less cylinders shall not unload more than one cylinder at each step. The maximum unloading for all other compressors shall be not more than two cylinders at each step. The capacity control system shall start the compressor fully unloaded and load the capacity control stages as required by load conditions. Ship's stores and cargo refrigerating plants capacity control shall be activated automatically by suction pressure to permit capacity variations.

3.6.1.3.1 Sequence controller. Chilled water air conditioning plants shall have an electro-mechanical capacity sequence controller system actuated by changes in the chilled water temperature. The controller system shall be fully assembled and capable of passing high shock requirements in accordance with MIL-S-901, grade A equipment. The system shall maintain a chilled water outlet temperature of plus or minus 1°F of the set point while modulating compressor capacity under varying load conditions from minimum load to fully loaded. The loading and unloading of the compressor shall be by a gradual timed step function to minimize the incidence of refrigerant floodback and cycling of the compressor unloaders. The temperature sensor of the capacity control system shall be installed in a well in the chiller outlet water piping.

3.6.1.3.1.1 Semi-conductor devices. Semi-conductor devices shall conform to MIL-S-19500 and shall be listed in MIL-STD-701 or be justified for application.

3.6.1.4 Compressor drive. The compressor drive shall be V-belt or direct drive as required or as specified (see 6.2). The V-belt drive shall include compressor flywheel (or driven pulley) multiple V-belts and motor pulley. The flywheel and motor pulley shall be grooved to match the type, size and quantity of V-belts required. The flywheel shall be dynamically balanced with respect to the compressor. The motor pulley shall be machined to a finished surface and accurately balanced. The V-belts shall be selected for at least 125 percent of motor horsepower at design load conditions. A positive-acting belt adjustment device shall be provided to permit adjustment of belt tension. The direct drive shall be by means of flexible coupling.

3.6.1.5 Compressor drive guard. A guard shall be provided over each drive unit for protection. The guard for the V-belt drive shall consist of an expanded

steel mesh with an enclosing steel band. The guard for the flexible coupling shall consist of a substantial sheet metal enclosure over the coupling.

3.6.1.6 Compressor base. The base shall be fabricated of steel or aluminum with welded joints. Both the top and bottom bearing surfaces of the bedplate shall be machine finished. The bedplate shall support the weight of the complete assembly. The base, foundation feet and brackets shall have sufficient rigidity to maintain equipment alignment when subjected to the imposed motions resulting from the vibration, inclination and shock specified in 3.3.8 and 3.3.9. Where required for low noise application, the compressor unit assembly shall be arranged structurally for resilient mounts.

3.6.1.7 Resilient mounts. Where required for noise attenuation and when specified, resilient mounts shall be used in the installation of plants. Resilient mounts shall comply with either MIL-M-17508 or MIL-M-19863. Mount snubbers shall be in accordance with MIL-M-19863. DTMB 880 and DTMB 1480 may be used as guides for procedures and techniques for mounting a plant or an assembly of plant equipment and the selection of resilient mounts. Resilient elements shall not be painted. Welding or cutting in way of mounts shall be finished before installation of the mounts. The temperature at the mounts shall not exceed 125°F.

3.6.1.7.1 Mount service life. Mounts which have been in storage for more than 7 years since their manufacture shall not be installed. The date that mounts are installed shall be stamped on metal parts adjacent to the mounts' identification data, and shall be visible without removing the mount from its installed position. Service life of the mount shall commence with this date.

3.6.1.7.2 Plants or assemblies. Plants or assemblies, when resiliently mounted, shall have sufficient stability to prevent excessive motion under shock and all ship motions (see 3.3.8). Maximum deflections of the resilient mounts which can be expected under shock conditions are as follows:

MIL-M-17508 (6E2000 and 6E900) with snubber:
0.375 inch axially plus 0.5 inch laterally
MIL-M-19863 (5B5000) with snubber:
0.75 inch axially plus 0.75 inch

The selection, design and arrangement of mounts shall be such that in the event any of the resonant frequencies of the installed equipment falls within the frequency range of propeller blade excitation, such resonant frequencies shall not also coincide with hull criticals or the natural frequency of its foundation (see 6.2).

3.6.1.7.3 Accelerometers. Accelerometer mounting surfaces shall be provided for installation of accelerometers. Mounting surfaces shall be located to allow accessibility of accelerometers after ship installation and provide noise/vibration characteristics of the machine. Mounting surface quantity, location, finish and method of attachment, shall be in accordance with MIL-STD-740-2 unless otherwise provided by the procuring activity (see 6.2).

3.6.1.8 Vibration isolators. Vibration isolators shall be provided for each R-12 compressor. Flexible metal connectors shall be installed in a 90 degree configuration close to the compressor in the suction and discharge refrigerant piping. The connectors are intended to prevent stress fatigue and vibration transmission to refrigerant piping. Other refrigerant piping subject to vibration shall be provided with flexible connections.

3.6.1.8.1 Flexible metal connectors. The flexible metal connectors shall consist of a corrugated metal core with two wire braids. The core shall terminate with outside diameter solder male copper tube ends. The corrugated core and wire braids shall be made of stainless steel, ASTM A 240 type 304L or bronze. The connectors shall be of brazed or welded construction, designed for 450 lb/in^2 and suitable for a working pressure of 300 lb/in^2. Two samples of each type of connector shall be given a strength test at 1500 lb/in^2 as required by UL-207. After fabrication, each connector shall be pressure tested at 450 lb/in^2. Upon completion of fabrication and test, the connectors shall be cleaned and dehydrated for refrigerant service and sealed in a plastic film to prevent entrance of moisture and foreign matter.

3.6.2 Condensers (surface ships and submarine air conditioning). Condensers shall be 2-pass shell and tube design with water in the tubes and refrigerant in the shell. The unit shall be designed for use with sea water entering at the temperature specified for the intended service. Sea water velocities through the condenser tubes shall not exceed 6 feet per second (ft/sec). The condenser shell shall include connection for purging non-condensable gases from the refrigerant circuit and a refrigerant relief valve take down connection in accordance with MIL-STD-777. Condensers shall be designed with removable heads to permit tubes to be examined, cleaned or replaced as necessary. Condenser heads shall have provision to install plugs for zinc anode and be provided with means for venting entrained air from inlet passes and for draining. Vent and drain connections shall be provided with plugs or caps suitable for the application.

3.6.2.1 Condenser shell. Condenser shell and head ring shall be fabricated from 90-10 copper-nickel tubing in accordance with ASTM B 467, red brass seamless tubing, ASTM B 135 alloy C23000 or red brass welded tubing ASTM B 587 alloy C23000.

3.6.2.2 Tube sheets. Tube sheets shall be machined and tube holes grooved to accommodate tubes expanded at the inlet and outlet ends. Holes for expanded tubes shall be drilled and reamed to a diameter of 0.751 inch with a tolerance of plus 0.009 inch, minus 0.000 inch. Holes at each face of the tube sheet shall be deburred and rounded off to a radius of approximately 1/16-inch, or chamfered using chamfer of 1/16-inch - 45 degrees to remove the corner, except that on the water inlet end of tubes, on the outer (water) side of the tube sheet, the tube holes shall be belled with 1/2-inch radius to a diameter of 7/8-inch for tubes to be belled and finished flush with the tube sheets. Tube sheets shall be constructed of 70-30 copper-nickel alloy conforming to ASTM B 122. Tube sheets shall be not less than 1 inch thick and shall be welded to the condenser shell.

3.6.2.3 Tube support plates. Tube support plates shall be provided and installed so that the maximum unsupported tube length between supports or between a tube sheet and a support plate will not exceed 3 feet 0 inch. Tube support plates shall be of the same material as the shell.

3.6.2.4 Baffles. Baffles shall be installed as necessary to prevent direct impingement of high velocity vapor against the tubes and to insure good distribution of the refrigerant to all parts of the condenser.

3.6.2.5 Tubes. Condenser tubes shall be of the integral fin type in accordance with MIL-T-22214. Tubes shall be expanded into the tube sheet by means of an automatic controller. Condensers shall accommodate initial tube lengths of 24, 36, 48, 60, 72 and 84 inches with a tolerance of plus 1/8 inch and minus 0.000 inch. Initial lengths include the plain end section used to roll the tube in the tube sheet. The manufacturer shall install nylon tube inserts with adhesive in the inlet end of each condenser tube. The nylon inserts shall be at least 6 inches long and be Crane drawing R-21375 or equal.

3.6.2.6 Condenser heads. Condenser heads shall be so proportioned to provide sufficient areas at all points for easy flow of the circulating water and for uniform distribution of water to all tubes in each pass. The joint between the partition edge and the face of the tube sheet shall be provided with a gasket in accordance with type I of MIL-G-21610. For condenser head fasteners the following shall apply:

(a) Fasteners shall be tightened to a contractor stipulated prestress value by means of a torque wrench (see 6.3 and appendix A).

3.6.2.6.1 Zinc protection. Zinc anode protection shall be provided in the condenser heads. The zinc anodes shall be capable of replacement without removing the heads. The bosses for the zinc anodes on the condenser head shall be drilled and tapped for internal thread for O-ring in accordance with MS16142. The mating zinc anode plug shall be a bore type plug made of 70-30 copper-nickel, ASTM B 122 material and in accordance with Drawing 803-5959186 except level 1 requirements are not applicable for surface ships. The anode for the plug shall be zinc type ZRN in accordance with MIL-A-18001. The O-ring for the plug shall be in accordance with MIL-R-83248 and MIL-R-83248/2.

3.6.2.7 Condensers for surface ships. Sea water containing parts and components and refrigerant containing parts and components shall be designed and tested for the pressures specified in table II or III. The condenser shall include a relief valve followed by a bursting disc to relieve refrigerant overboard in the event of excessive pressure (see 3.6.10). A capped self-sealing refrigerant test valve and a commercial type gauge shall be installed between the relief valve and bursting disc to detect the presence of refrigerant and determine if the relief valve is leaking. The relief valve, test valve, gauge and bursting disc will be piped by the installing activity. Surface ship condensers shall be in accordance with Drawing 810-1385839 except as noted herein.

3.6.2.7.1 Condenser tubes. Condenser tubes shall be constructed of copper-nickel alloy UNS No. C71500 for class A application in accordance with MIL-T-22214. Tubes shall be 3/4 inch od, shall be integral fin type with 26 fins per inch and a minimum wall thickness of 0.049 inch at the root of the fin portion.

3.6.2.7.2 Condenser heads. Condenser heads shall be constructed of nickel-aluminum-bronze in accordance with ASTM B 148; gun metal or valve bronze in accordance with ASTM B 61, alloy C92200 or 70-30 copper-nickel alloy in accordance with ASTM B 122. Water connections shall be of the nonferrous flanged type in accordance with MIL-F-20042. Condenser head and inlet nozzle shall reduce inlet velocities and resultant tube sheet erosion to a minimum. Circulating water inlet and outlet nozzles shall be integral with the head, and the inlet nozzles shall be as nearly normal to the tube sheet as practicable for each installation. Sharp corners or edges in the flow of circulating water through the heads shall be eliminated to provide a smooth streamlined flow. Entrance nozzles may be of a diverging type (7-1/2 degree maximum taper). In order to absorb high entrance velocities which may produce erosion of tube ends by impingement effect, the head depth, measured normal to the tube sheet, shall be not less than one-half the condenser head inside diameter of the tube sheet.

3.6.2.7.2.1 Water head vent. Water head vent and drain connections shall be drilled and tapped for internal thread for O-ring in accordance with MS16142. The plug for vent and drain shall be in accordance with MS18229.

3.6.2.7.2.2 Bolting. Bolting material including bolts, studs and nuts used to fasten water heads shall be either nickel-copper in accordance with ASTM B 164; aluminum-bronze, stress relieved, in accordance with ASTM B 169; copper-silicon in accordance with ASTM B 98; or phosphor-bronze in accordance with ASTM B 139.

3.6.2.8 Condensers for submarine refrigerated ship's store. The condenser for ship's store refrigeration plants shall be designed as combination condenser-receiver and designed and tested for the pressures specified in table II. The condenser will use the fresh water from the mechanically cooled chilled water air conditioning plant. The condenser shall have water in the tubes and refrigerant in the shell, be two-pass with U-tubes, and have a water velocity which does not exceed 6 ft/sec. The condenser shall include connection for purging non-condensible gases from the refrigerant circuit, connection for water regulating valve, and vent and drain valves on the water head. The condenser-receiver shall have ample capacity to hold 100 percent of the refrigerant charge and be provided with an approved liquid level indicator. The level indicator shall have all joints welded against refrigerant leakage.

3.6.2.8.1 Condenser receiver. The condenser-receiver shall be welded 90-10 copper-nickel construction with nonferrous water passages. The shell shall be fabricated of seamless 90-10 copper-nickel pipe, ASTM B 466; tube sheet 90-10 copper-nickel, ASTM B 122; finned U-bend copper tubes 3/4 inch od with 0.049 inch minimum wall thickness at root of fin, MIL-T-22214, class B; front water head 90-10 copper-nickel ASTM B 467; nickel-aluminum-bronze in accordance with ASTM B 148; gun metal or valve bronze in accordance with ASTM B 61, alloy C92200. The condenser shall include a relief valve set at 235 lb/in^2 to discharge to an adjoining condenser-receiver.

3.6.2.9 Condensers for submarine air conditioning plants. Condensers for submarine air conditioning plants shall be designed with an even number of sea water passes. Sea water containing parts and components shall withstand without damage a hydrostatic test of 1-1/2 times the sum of submergence pressure plus pump shut-off pressure as specified (see 6.2). Refrigerant containing parts shall be designed and tested for the pressures specified in table III. The condenser shall include a relief valve to relieve refrigerant in the event of excessive pressure. The relief valve shall be set to relieve refrigerant system pressure at a setting not higher than 235 lb/in^2. The relief valve will be piped up by the installing activity to relieve to a receiver tank.

3.6.2.9.1 Tube sheets. The condenser shall be a double tube sheet construction. A supplementary tube sheet shall be installed adjacent to each main tube sheet. This double tube sheet complex shall provide at least 1/2 inch wide void space at each end of the condenser for detection of any seepage of sea water through expanded tube ends. This space shall be provided with vents and drains with suitable plugs or caps. Primary (outer) tube sheet and supplementary or inner tube sheet shall be constructed of 70-30 copper-nickel alloy conforming to ASTM B 122. The supplementary tube sheet shall withstand the submergence test pressure required for the primary tube sheet. Thickness of each tube sheet shall be based on the sea water pressure specified. In any case, thickness shall be not less than 1 inch.

3.6.2.9.2 Condenser tubes. Condenser tubes shall be constructed of copper-nickel UNS alloy No. 71500, class A in accordance with MIL-T-22214. Tubes shall be 3/4-inch od and shall be integral fin type with 26 fins per inch and a minimum wall thickness of 0.065 inch at the root of the fin portion. Tubes shall be installed in the tube sheet with a minimum ligament of 0.183 inch unless fatigue calculations for a submarine condenser establish the need for a thicker ligament, in which case such design value shall become the minimum ligament thickness.

3.6.2.9.2.1 Integral finned condenser tubes. Integral finned condenser tubes for submarine plants shall be UT inspected prior to finning and inspected after finning by the eddy current method. The eddy current inspection procedure and acceptance criteria shall be in accordance with ASTM E 243.

3.6.2.9.3 Condenser water heads. Condenser water heads shall be constructed of cast nickel-aluminum-bronze, in accordance with MIL-B-24480; cast copper-nickel alloy C96400 in accordance with ASTM B 369; nickel-copper alloy in accordance with ASTM B 127; or 70-30 copper-nickel alloy in accordance with ASTM B 122. Condenser head flanges shall be as specified (see 6.2).

3.6.2.9.3.1 Solder coating. Condenser water heads fabricated from nickel-copper alloy shall have the inside surface coated with solder of two parts lead to one part tin to a thickness of not less than 1/64 inch and not more than 1/16 inch. Threaded surfaces for zinc fingers, vent and drain connection bores, flange surfaces and O-ring groove surfaces shall not be solder coated. After solder coating, no heat (e.g., welding or burning) which can cause local or overall heating of the condenser head above 275°F shall be applied.

3.6.2.9.3.2 Water head form. Water heads shall be hemispherical or semi-ellipsoidal form. If semi-ellipsoidal form is used the water nozzles and their reinforcements may be located within the central 80 percent of the water head diameter provided the maximum stress intensities, in the vicinity of the nozzle and the nozzle itself and to the limits of reinforcement, and in the crown and knuckle region of the head, meet the design stress intensity limits defined in the ASME Boiler and Pressure Vessel code. Strengthening ribs shall not be used on water heads. Openings in the shell of the water heads for nozzles and the nozzles attached thereto shall be radial. Reinforcement of openings shall be integral with the water head shell or nozzle (or both). Separate pads or saddle type reinforcements shall not be used. Welds shall be ground smooth and all corners and fillets shall be rounded to minimize notch effect. Cooling water inlet and outlet connections shall be in accordance with Drawing 810-1385861.

3.6.2.9.3.3 Vent and drain connections. Water head vent and drain connections shall conform to joints P-70 or P-72 of MIL-STD-22 using copper-nickel bar stock in accordance with ASTM B 122. Nipples shall be 1/2-inch nominal pipe size square ended in accordance with the dimensional and non-destructive test (NDT) requiremsnts of MIL-T-16420, class 3300. Tube sheet void space vent and drain connections shall conform to joint P-14 of MIL-STD-22 using 1/2-inch nominal pipe size MIL-T-16420 70-30 CuNi type I class 3300 square ended nipples. Vent and drain nipples shall be a minimum of 6 inches long.

3.6.2.9.4 Bolting material. Bolting material including bolts, studs and nuts used to fasten water head to the unit shall be in accordance with the following:

(a) Bolts, nuts, and studs shall be nickel-copper-aluminum in accordance with QQ-N-286 and ANSI B18.2.1 and B18.2.2.
(b) Nuts may be nickel-copper in accordance with ASTM F 467 class B if necessary to prevent galling and supported by the stress calculations.

3.6.3 Water regulating valves. Water regulating valves for surface ship application shall be a modulating pressure actuated type which opens on refrigerant pressure increase. These valves shall be suitable for sea water and shall be used to modulate the flow of water required for the condenser. Valves shall maintain a relatively constant condenser discharge pressure automatically during conditions of varying operating load, sea water temperature or pressure without any adjustments (see 3.3.4) by modulating the flow of water to the condenser. They shall be of the direct-acting or pilot-controlled type actuated by condenser refrigerant gas pressure. Valves shall be selected to regulate the water flow from shut-off to required capacity within a maximum operating refrigerant gas pressure rise of 40 lb/in^2. Valves shall be adjustable within an operating range of 90 to 140 lb/in^2 refrigerant gas pressure. The capacity of the water regulating valves shall be at least equal to the water requirement of the condenser, based on an inlet water pressure of 35 lb/in^2 unless otherwise specified (see 6.2), and not more than 15 lb/in^2 pressure loss through the valve at the required flow (see 3.3.1.1). Valve seat leakage rate shall be not greater than 0.5 percent of rated valve capacity. The sea water containing parts and refrigerant containing parts shall be designed as required in table II or III or as specified for the condenser. First production valve shall be tested for flow and leakage rate (see 4.4.4.2).

3.6.3.1 Water regulating valves material. The valve shall be constructed of non-ferrous or corrosion-resisting material. The valve body and end connections shall be made of nickel-aluminum bronze ASTM B 148 (UNS C95800) nickel-copper alloy QQ-N-288 composition A or B or valve bronze ASTM B 61. The ASTM B 148 material shall be given a temper anneal heat treatment at 1250 + 50°F for 6 hours minimum. Alternate materials will be considered in lieu of those specified, but their use will only be permitted after the command or agency concerned has been satisfied by testing or by other means such that the proposed substitutes fully meet the service requirements of this specification. Cooling shall be by the fastest means possible that will not cause excess distortion or cracking. The valve shall have a proportioning type of plug to smooth the flow modulation at low flows in cold sea water. Body passages shall produce gradual changes in flow direction to reduce any effects of concentrated impingement and 90 degree turns. In portions of the valve subject to velocity increases and flow direction changes, such as immediately downstream of the seat, the design shall eliminate 90 degree impingement against the walls at close range. The design of the body cavity downstream of the seat shall present a high angle of incidence to the issuing jet. At points where direct impingement at close range does occur and cannot be eliminated, section thickness must be substantially increased to provide adequate material to withstand the additional erosive effect. In addition, the internal metal parts including stems and seats subject to corrosion or erosion shall be replaceable and made of nickel-copper alloy QQ-N-286 (UNS N05500). The valve shall be provided with flanged connectors in accordance with MIL-F-20042 or with union ends. The valve shall be constructed in such a manner as to prevent the possibility of entry of sea water into the refrigerant system in the event of derangement. A root valve shall be installed in the refrigerant sensing line so the line can be isolated if damage occurs or repairs must be made to the plant or water regulating valve. The valves shall contain internal strainers for pilot valves that shall be accessible for cleaning.

3.6.3.2 Shock and vibration. The valve and actuator shall pass high shock requirements in accordance with MIL-S-901 (see 3.3.9) and vibration requirements in accordance with MIL-STD-167-1 (see 3.3.8(c)). The refrigerant and sea water circuits shall be designed and tested for the pressures indicated in table II or III as applicable (see 6.3 and appendix A).

3.6.3.3 Water regulating valve for submarine air conditioning. The water regulating valve for submarine air conditioning plant application shall be suitable for sea water, made of nonferrous materials and similar in operation to water regulating valve for surface ships (3.6.3 through 3.6.3.2). The valve shall be designed for varying submergence conditions and analyzed (see 6.2).

3.6.3.4 Water regulating valve for submarine refrigerated ship's stores. The water regulating valve for submarine refrigerated ship's stores plant shall use fresh water and supply the required quantity of water under the design conditions in table II with a pressure differential of approximately 5 lb/in^2. The valve shall be similar in materials and operation to that specified for surface ships (see 3.6.3). The refrigerant and chilled water circuits shall be designed and tested for pressures specified in table II.

3.6.4 Receiver. The refrigerant liquid receiver shall be of the horizontal type. The receiver shall have the capacity to hold at least 100 percent of the complete refrigerant charge required for normal connected load. The normal connected load shall include at least the operating charge of the compressor, condenser, heat interchanger, evaporators, and piping (or 100 feet of piping where the arrangement is not specified) plus 10 percent for a liquid seal in the receiver. The capacity shall be expressed in pounds of refrigerant. The receiver shall be so arranged to insure a liquid seal in the receiver outlet under conditions of rolling and pitching of the ship. Horizontal receivers shall have two outlets.

3.6.4.1 Magnetic liquid level. Each receiver shall be provided with a magnetic liquid level indicator to determine the refrigerant level. The indicator shall consist of a gauge having a magnetically driven pointer. The dial shall be replaceable. All joints shall be welded against leakage of refrigerant. The float and other internal parts shall be designed for the test pressure of the receiver.

3.6.4.2 Receiver construction. The liquid receiver shall be constructed of 90-10 copper-nickel tubing in accordance with ASTM B 467 or red brass in accordance with ASTM B 135 or ASTM B 507 alloy C23000 and with welded elliptical dished heads. The design of the receiver shall comply with the rules of section VIII of the ASME Boiler and Pressure Vessel Code covering requirements for design, fabrication, inspection and testing of unfired pressure vessels.

3.6.5 Heat interchangers. The heat interchanger shall be shell and tube and arranged for counter flow of the liquid and suction refrigerant. The design shall be such that the pressure drop through the suction circuit shall not exceed 0.25 lb/in^2 when used with equivalent design refrigerant temperatures of 20°F or less and not greater than 0.75 lb/in^2 for higher temperature applications. The pressure drop in the liquid circuit shall be not greater than 0.75 lb/in^2. Self sealing access connections with seal caps shall be provided to measure the pressure drop through the suction circuit (see 3.7). The heat interchanger shall be capable of sub-cooling the liquid at least 10°F with a vapor temperature entering the heat exchanger equal to the evaporating temperature, plus approximately 10°F of superheat. The unit shall be arranged so that oil will not be trapped in the assembly.

3.6.5.1 Heat interchanger shell. The shell shall be constructed of brass, copper or 90-10 copper-nickel. Tubing where used shall conform to ASTM B 88 with a wall thickness not less than that required for type L.

3.6.6 Strainers. Strainers for installation in refrigerant lines shall be angle type arranged for screen removal without disconnecting piping. Strainers shall be constructed of copper or brass shell. The flange ring and flange cover plate shall be bronze castings designed to withstand distortion caused by uneven drawing up of bolts. The gasket shall be fully retained in the cover plate in a tongue and groove arrangement. A minimum of eight bolts and nuts constructed of silicon bronze shall be provided for the flange. The strainer housing shall be

designed for a minimum working pressure of 300 lb/in^2. Screen cartridges shall retain foreign matter on inside of screen basket, and be arranged for adequate clearance between outside of screen and inside of shell. The screen cartridge shall be replaceable and securely located by means of spring tension to prevent by-passing refrigerant. Screen cartridge shall be monel 100-mesh for liquid line application, supported and reinforced by a brass screen of coarser mesh. The entire cartridge assembly shall withstand without rupture or distortion a pressure drop of 150 pounds in the event of complete stoppage.

3.6.7 Suction line filter. Suction line filter shall be installed in the suction line close to the compressor upstream of the compressor suction shutoff valve. The filter shall be of the angle type arranged for filter core removal without disconnecting the filter housing from the piping system. The flow through the filter shall be non-directional, however the filter shall be installed so that the inlet is to the outside of the filter core. The suction line filter shall have a fluted filter, one capable of trapping contaminants 5 micrometers or larger. The filter shall be sized such that during system operation the pressure drop across the filter does not exceed 2 lb/in^2. The filter shall be designed for a minimum working pressure of 300 lb/in^2.

3.6.7.1 Filter construction. The filter shall be constructed of steel material. The body shall be made from seamless steel tubing in accordance with ASTM A 519 with steel end and cover plates and have outside diameter solder inlet and outlet wrought copper fittings in accordance with ASTM B 88. The filter core shall be composed of a fluted felt filter with steel retention screening on the outside, flattened steel retention cylinder on the inside, and wool gaskets at both ends. The cover plate for the filter body shall have a fully retained gasket in a tongue and groove arrangement with the filter body. The gasket shall be made of Durlon 8500 in accordance with ASTM F 104, UNS F712400-M9. The cover plate shall have a 1/4-inch SAE flare self sealing access port with seal cap nut. The cover plate shall be attached with stainless steel cap screws, UNS 30200. Joints shall be sil-brazed or heli-arc pressure tight welded.

3.6.7.2 Cleaning and painting. After fabrication the unit shall be cleaned and painted using a low temperature epoxy powder paint. The paint thickness shall be 1.5 to 2.0 mil and oven baked with an 80 gloss finish. The coating shall withstand the 500-hour salt spray test in accordance with ASTM B 117.

3.6.8 Filter-dehydrators. Dehydrators for installation in refrigerant lines shall be filter-dehydrator type. The filter-dehydrator shall be of the replaceable cartridge type with an angle configuration to permit changing the desiccant cartridge without disconnecting the refrigerant piping. The size of the dehydrator shall be based on a quantity of desiccant to have at least 1 cubic inch of desiccant per 4 pounds of refrigerant-12 charge or fraction thereof for the intended system. Where the refrigerant charge is not known, the capacity of the receiver plus 10 percent shall be assumed to be the refrigerant charge. A moisture indicator in accordance with 3.6.9 may be provided integral with the dehydrator cover plate.

3.6.8.1 Dehydrator design. The dehydrator shall be constructed of brass shell and brass end cap and designed for a minimum working pressure of 300 lb/in^2. The inlet and outlet refrigerant connections shall be copper with female solder connections in accordance with ANSI B16.22. The flange ring and flange cover plate shall be bronze casting, ASTM B 62, designed to withstand distortion caused by uneven drawing up of bolts. A minimum of eight bolts shall be used to fasten the cover plate to the flange ring. The bolts and nuts shall be made of silicon bronze ASTM B 98 alloy C65100. The cover plate gasket shall be retained in the cover plate in a tongue and groove arrangement. The dehydrator shall have a side inlet connection and an outlet connection centered in the opposite end of the shell. An arrow indicating the direction of refrigerant flow shall be affixed to the dehydrator shell. Each dehydrator shall be equipped with a gasket between the shell and cartridge to prevent the refrigerant from by-passing the desiccant. A safety cap, separately attached to the outlet of the dehydrator cartridge to prevent desiccant from entering the refrigerant in the event the outlet screen ruptures, as well as a cartridge retaining spring and any necessary spacers, shall be provided. All internal metal parts shall be corrosion resistant material. The design of the dehydrator shall be such as to permit replacement of cartridges with one or more cartridges having a common diameter and with limiting dimensions specified in table V. The overall diameter is the greatest diametrical dimension, usually at the end caps and does not include the protrusion for aligning the cartridge in the shell.

TABLE V. Dehydrator cartridge sizes.

Dehydrator shell (id) (inches)	Overall diameter (inches)	Overall length (inches)	Maximum number of cartridges per dehydrator	Desiccant volume In^3/cartridge
2.0	1.890 + 0 -0.0312	5.0 ± 0.0312	3	10
3.0	2.805 + 0 -0.0312	9.0 ± .0312	3	45
4.0	3.900 + 0 -0.0312	10.5 ± .0312	4	109
5.0	4.724 + 0 -0.0312	5.0 + .0312	5	50

One change of dehydrant cartridge consisting of one or more cartridges as required shall be furnished with each dehydrator.

3.6.8.2 Desiccant cartridge. Cartridges shall be manufactured of perforated brass material with 0.024 inch diameter holes. The cartridge shall have protrusions at each end or some other positive means to position itself in the dehydrator shell and allow refrigerant flow through the cartridge wall to the desiccant. An arrow indicating the direction of refrigerant flow as well as the manufacturer's name, logo or trademark shall be indelibly imprinted on each cartridge shell. The cartridge shall be provided with pull tabs or an acceptable alternative for easy removal from the dehydrator shell.

3.6.8.2.1 Desiccant. The cartridge shall contain a combination of loose desiccant and solid core within the shell. The loose desiccant shall be in bead form and shall be a blend of activated aluminum, Alcoa Aluminum H-151 or equal, and molecular sieve, Union Carbide, Lindy Div. 4A-XH-6 or equal. The loose desiccant shall surround the desiccant solid core which both filters and dries the refrigerant. The solid core of the dehydrator cartridge shall be a combination of activated aluminum in granular form, Alcoa Aluminum grade F-1 or equal and 4A-XH-6 molecular sieve. The block shall filter over 10 micrometer particles. Fiberglass pads, fabricated from Owens-Corning Fiberglass PF-335-1/2, 3/4 pound density or equal, shall be installed in the cartridge assembly at both the inlet and outlet ends of the cartridge. A perforated cup shall be soldered at the inlet to hold the desiccant in place and a 24 by 110 Dutch Weave brass cup shall be soldered at the outlet end. The assembled unit shall filter particles 10 micrometers and larger. Cartridges shall be so filled that the desiccant is kept tightly compacted to prevent abrading and powdering of the desiccant. The filter-dehydrator pressure drop shall be not greater than 2 lb/in^2 at rated refrigerant flow through the unit.

3.6.8.2.2 Cartridge packaging. Each cartridge shall be furnished individually packaged in a hermetically sealed moisture proof, key operated metal container. A filter-dehydrator flange gasket for replacement shall be packaged with each cartridge. The cartridge shall be dry such that the maximum weight loss of the desiccant shall be not greater than 0.5 percent when maintained at 350°F for 4 hours. The cartridge container shall be indelibly marked identifying the type of cartridge, manufacturer, manufacturer's model number, and date of manufacture.

3.6.9 Moisture indicator. The moisture indicator shall visually indicate whether there is acceptable or unacceptable level of moisture in the refrigerant. This shall be accomplished by means of a reversible color change in a replaceable indicating element. With the refrigerant at 100°F, the change shall be such that for R-12 refrigerant the deepest color in the dry range shall show a moisture content below 10 parts per million (p/m) and color change in the wet condition shall be completed at or below 30 p/m of moisture.

3.6.9.1 Moisture indicator assembly. Where the moisture indicator is provided as a separate assembly it shall be constructed of forged brass body or copper plated steel with solder type connections and a heavy glass viewing assembly on which the indicating element is retained.

3.6.10 Relief valve. Relief valves for installation in refrigerant piping shall be spring-loaded type, and constructed of nonferrous metal with corrosion-resisting seat. Relief valves shall be a type that is not affected by back pressure except relief valves designated for overboard discharge. The relief valves shall be set as specified (see 3.5.3, 3.6.2.7 and 3.6.2.9).

3.6.10.1 Relief valve for overboard discharge. The relief valve shall be a diaphragm type and shall be set to relieve at the pressure indicated in tables II or III. The disc where used shall burst at 10 lb/in^2. The disc shall have a capacity at least that of the relief valve and shall not limit the relief valve to achieve its full capacity flow. The minimum required discharge capacity of the relief valve and disc for each refrigerating plant shall be determined by the following:

$$C = fDL$$

Where:

C = minimum required discharge capacity of the relief valve or disc in pounds of air per minute.
f = factor dependent upon kind of refrigerant, for R-12, f = 1.6.
D = outside diameter of the plant's receiver, in feet.
L = length of the plant's receiver in feet.

The capacity of the pressure-relief devices for the refrigerating plants shall be determined by the size of the receiver. All piping and fittings between the pressure relief valve and the parts of the system it protects shall have at least the area of pressure relief valve inlet. The size of the discharge piping from the pressure relief through the rupture disc shall be not less than the size of the pressure relief valve outlet. The rupture disc shall be supported by the refrigerating plant so that no stress is transmitted to the pressure relief valve.

3.6.11 Sight-flow indicator. The sight-flow indicator shall be double port type. The unit shall be constructed of forged or cast brass body with heavy plate glass view assemblies. The view assemblies shall be provided with gasketed caps.

3.6.12 Pressure control switches. Pressure control switches shall comply with the electrical requirements of master switches (see 3.5.7.5) and shall be operated by a seamless metallic bellows power element directly actuated by pressure. The bellows operates a switch mechanism to open and close the electric circuit. Pressure differential switches shall be the type that open on failure of the pressure differential. Control switches shall be adjustable and shall be provided with range and differential adjustments indicated in table VI.

TABLE VI. Pressure control switches.

Description	Range lb/in^2	Differential lb/in^2
Low pressure control switch	20 inch vacuum to 80	9 to 30
High pressure control switch	60 to 350	15 to 50
Water failure control switch	3 to 50	9 to 30
Pressure differential control switch (oil failure switch)	4 to 35 (maximum operating pressure - 80 lb/in^2) or 7 to 70 (maximum operating pressure - 160 lb/in^2)	

3.6.13 Temperature control switches. Temperature control switches shall comply with electrical requirements for master switches (see 3.5.7.5) and shall be operated by a seamless metallic bellows power element operated by a fluid in capillary tube and sensing bulb or element. The bellows operates a switch mechanism to open and close the electric circuit. Capillary tubes shall be 5 or 10 feet long or in increments of 10 feet where greater lengths are required as specified (see 6.2). The control switches shall be adjustable and shall be provided with range and differential adjustments indicated in table VII. All temperature sensing bulbs shall be installed in wells in accordance with MIL-T-24270.

TABLE VII. Temperature control switches.

Description	Range °F	Differential
Low chilled water temperature switch	-10 to +50	5°F or less at lowest (min) setting
Chilled water operating thermostat switch	25 to 90	5°F or less at lowest (min) setting
High oil temperature switch	90 to 165	5°F or less at lowest (min) setting

3.6.14 Heating-cooling dual temperature control switch. The heating-cooling switch shall comply with electrical requirements of master switches (see 3.5.7.5). The switch shall be class HI shockproof in accordance with MIL-S-901 and shall be housed in spraytight (or better) enclosure. The dual temperature control shall incorporate switches to open and close two electric circuits for actuating solenoids of magnetic valves on a cooling coil and a heating coil. The switches shall be interlocked in a manner to insure that both switches cannot be closed simultaneously. Both switches shall be actuated by a common sensing element responsive to changes in temperature of the ambient air in which the element is located.

3.6.14.1 Control switch set points. The control shall have two operating set points, one for cooling and one for heating. The temperature at which the heating switch opens shall be approximately 1 degree below the temperature at which the cooling switch opens. The two operating set points shall be approximately 3°F apart. Set point is defined as the temperature midway between opening and closing points of the switch. The cooling or heating differential shall not exceed 2°F at settings determined in air within the range of the control. The differential is defined as the change in temperature necessary to move the switch from open to closed position, or the reverse operation. The range shall comprise a spread of at least 50 to 90°F. The temperature control shall be adjustable to operate at any set point within this range. Changing the set point of the control shall not alter the 1-degree dead spot between opening temperatures of the cooling and heating switches and shall not alter the fixed spread of 3°F between the set points of the two switches. The switch shall not show drift or permanent change of plus or minus 2°F when subjected to 125°F for 24 hours. The differential shall not show permanent change in excess of 1/2°F.

3.6.14.2 Control switch dial. A dial, calibrated in degrees Fahrenheit, shall be provided for ease in the setting. The dial shall be calibrated to show a set point corresponding to the temperature at which the cooling coil switch opens. Means shall be provided to lock the control set point to prevent its being moved by unauthorized personnel. A special key shall be provided for locking.

3.6.14.3 Control switch wiring. The control shall be supplied for 110 volt ac and shall be a type that has been approved by NAVSEA.

3.6.15 Expansion valves. The expansion valve shall be the modulating type actuated by a thermal element. The valve shall be of the direct operating, thermal type. The thermal-expansion valve shall maintain substantially a constant superheat in the cooling coil at the point of the application of the remote thermal element. Thermal element capillary tubes shall be 5 or 10 feet long or in increments of 10 feet where greater lengths are required as specified (see 6.2). The expansion valve shall be provided with an external device for adjusting superheat setting. In addition, an external equalizer connection shall be provided where required for proper operation or as specified (see 6.2).

3.6.15.1 Valve replacement. Expansion valves shall be of a type that may be disassembled for repair or replacement of parts without disconnecting piping connections other than external equalizer line, if furnished. The valve body shall be of the brass solder type.

3.6.16 Solenoid valves. Solenoid valves used for control in refrigeration application shall be electrically operated, tight-seated, and quiet in operation. The valve shall be arranged to open when energized and close when de-energized. All solenoid valves shall be provided with a means of manually opening the valve in case of coil failure. Valves for cooling shall be supplied in the same voltage and current as required for the compressor motor or cooling coil fan motor as applicable or as specified (see 6.2). Valves shall be class HI shockproof in accordance with MIL-S-901. The electrical portions of the valve shall conform fully to the requirements of MIL-C-2212 and be suitable for continuous duty operation. The maximum permissible temperature rise, for valves used for cooling based on a 50°C (122°F) ambient, shall not exceed the values specified in MIL-C-2212 for the class of insulation used. Coils shall be of the encapsulated type with integral terminals. The electrical portions shall be housed in a spraytight (or better) enclosure. A terminal block shall be provided for the connection of the external power leads and mounted within the coil enclosure. Valves shall be designed for operating in any position.

3.6.16.1 Refrigerant solenoid valves. The capacity of each refrigerant solenoid shall be at least equal to the requirements of the refrigerant circuit or circuits in tons of refrigeration for the specific valve application based on 100 percent liquid at saturation temperature at valve inlet with not more than 2 lb/in^2 pressure loss across the valve. In addition, the valve shall operate under a pressure differential of at least 150 lb/in^2. Refrigerant solenoid valves shall be provided with four-bolt tongue and groove solder type flanges for sizes 1-3/8 inches od and above, and with solder type for sizes under 1-3/8 inches.

3.6.16.1.1 Three-way refrigerant solenoid valves. The three-way solenoid valve shall have a single solenoid arrangement and divert the fluid from the valve inlet to either of the outlets. The valve shall take oil supplied by the refrigerant compressor oil pump at a common inlet and direct oil pressure to the cylinder unloader power element when de-energized, and when energized, release the unloader power element oil pressure to the compressor crankcase. The valve shall be marked to indicate the function of each opening.

3.6.16.2 Chilled water solenoid valve. Chilled water solenoid valves shall pass high shock requirements in accordance with MIL-S-901 (see 3.3.9) and vibration requirements in accordance with MIL-STD-167-1 (see 3.3.8(c)). The valves shall have a means for manually opening the valve to direct the water flow to the cooling coil when the valve is electrically inoperative. The valves shall be two-way or three-way as required (see 6.2). The valves shall be suitable for installation in a closed circulating water system at a maximum pressure of 100 lb/in^2. The internal parts in contact with water shall be nonferrous or corrosion resistant steel except where required for the magnetic circuit. Where corrosion resistant steel is used it shall be nickel plated. Core tubes shall be seamless nickel-copper alloy tubing in accordance with ASTM B 165. Valves shall operate in any position without special adjustments or parts. All internal parts shall be replaceable without removing valves from pipe lines. Valves shall be provided with flanges in accordance with MIL-F-20042 or brazed union ends in accordance with MIL-F-1183 and MIL-F-1183/10 with pre-inserted rings of silver brazing alloy.

3.6.16.2.1 Two-way chilled water solenoid valve. The valve shall open under full 100 lb/in^2 pressure. The pressure drop required to open the valve shall be not greater than 5 lb/in^2.

3.6.16.2.2 Three-way chilled water solenoid valve. The three-way solenoid valve shall take water at a common inlet and direct chilled water through the cooling coil or by-pass the coil. The valve shall have a single solenoid arrangement such that when the solenoid is energized water will flow through the coil; when the solenoid is de-energized, water will be directed through the by-pass. The applicable flanges shall be marked "inlet", "cooling" and "bypass". The valve shall be provided with two separate flow adjustment devices to control the flow through the cooling coil and the bypass. The manual override adjusting devices shall regulate the flow of water in any amount from full closed to full open. The valve shall be designed for a minimum operating pressure differential of 2 lb/in^2 and a maximum operating pressure differential of 15 lb/in^2.

3.6.16.3 Steam solenoid valves. Steam solenoid valves shall be two-way with brass body. Seating shall be metal to metal using corrosion-resisting steel or resilient. If resilient seating is used, the valve shall be subjected to the test described in 4.4.4.6 to demonstrate the durability of the material. The solenoid coil shall be provided with class H insulation of MIL-E-917. The valve shall not be damaged when subjected to steam pressure of 150 lb/in^2 gauge and 375°F. The valve shall pass 100 pounds of steam per hour with an inlet pressure of 35 lb/in^2 gauge at a temperature of 375°F and a pressure drop not greater than 10 lb/in^2. The valve shall have union ends conforming to MIL-F-1183 and MIL-F-1183/10 with preinserted rings or flanges in accordance with MIL-F-20042.

3.6.17 Suction-pressure regulating valve. A suction-pressure regulating valve shall be used to maintain a minimum evaporating pressure within a cooling coil at a relatively higher temperature than is required in other coils on the same plant. The valve shall be of the direct or pilot-operated packless type, externally adjustable with a range of at least 40 pounds, and shall operate satisfactorily with a minimum differential of 2 lb/in^2 between evaporator and suction pressures. The suction-pressure regulating valve shall have a capacity based on a minimum differential of 3 lb/in^2 refrigerant suction pressure between the cooling coil and the suction line. A refrigerant self-sealing gauge connection shall be provided on the valve to facilitate setting the regulator. The construction of the valve shall be such as to permit disassembly for repair or replacement of actuating mechanism without the necessity of disconnecting the refrigerant connections.

3.6.18 Cooling coils.

3.6.18.1 Gravity-air finned pipe coil. The gravity-air finned pipe coil shall be of the direct expansion type and rated in square feet of total primary and secondary external surface. The finned coil shall be constructed of 1-3/8 inch od copper tubing on 5-1/4 inch tube centers and provided with copper fins 0.02 inch thick on 1-1/4 inch centers. Fins shall be bonded to the tubes. The coil shall be in flat coil arrangement and externally tinned after fabrication. The coil assembly shall mount on the inside surface of a compartment wall and shall be single-tube deep where practical but not to exceed double row. Coil supports shall be steel, hot dipped galvanized after fabrication. Numbered metallic tags shall be secured to each coil for identification.

3.6.18.2 Forced air cooler for refrigerated cargo. The forced air cooler for cooling refrigerated cargo shall be a direct expansion unit of the plenum type. The unit shall house and support the coil in a casing. The coil casing shall include tube sheets to support the coil, side panels, hinged doors, access plates, drain pans and provide for attaching a plenum above the coil for connection to an axial flow fan. Ports or windows shall also be provided to permit ready inspection of coil surface condition. The coil intake shall be provided with hinged doors which can be closed during defrosting. The drain pans shall be adequate to prevent spilling of water under conditions of inclination, pitch and roll. Complete draining as required shall be accomplished under these conditions. All parts of the coil casing shall be fabricated of steel at least 0.10 inch thick and hot dipped galvanized after fabrication. Cooling coils intended for spaces maintained at a temperature below 32°F shall be furnished with electric defrosting or with defrosting spray pipes for hot sea water as specified (see 6.2).

3.6.18.2.1 Construction. Cooling coils shall be of the finned-tube construction using copper tubes, copper fins and headers. The tubes shall be 3/4-inch od or 7/8-inch od with a wall thickness not less than type L of ASTM B 88. Liquid and suction connections shall be on the same side. The suction header shall be made of seamless tubing and have a minimum 0.065-inch wall thickness. The fins shall be not less than 0.10 inch thick and shall have drawn collars for the tubes. The fins shall be spaced not more than five fins per inch. The cooling coil shall be designed for a temperature of 10°F between the refrigerant

and entering air when evaporator suction temperature is minus 20 to minus 10°F. Coils shall be equipped with distributors for efficient refrigerant distribution and shall be furnished with external equalized thermal expansion valves. The support plates shall include copper ferrules for the tube penetration. Tube support shall be corrosion resistant steel type 304 of ASTM A 240 and spaced not greater than 24 inches. After fabrication the coil shall be sealed and hot tin dipped. The unit shall be blown out after tinning to ensure free refrigerant flow.

3.6.18.2.2 Defrosting coils. Coils shall include automatic electric defrost or defrosting by means of hot sea water spray as specified. Electric defrost shall be suitable for 440 volt, 3 phase, 60 Hz power.

3.6.18.2.2.1 Defrost controls. The controls for the electric defrost shall be designed for 60 Hz, 115 volt single phase power. Heater elements for the coil shall be stainless steel sheathed and wired in a parallel arrangement. The defrosting cycle shall be time initiated and temperature terminated with a time termination backup to prevent heaters from overheating. Each cooler shall have its own separate defrost timer and control box. The timer which controls the defrost cycle shall initiate at least 12 defrost cycles each 24 hour period. The timer shall be adjustable as to the number of defrost cycles per 24 hours and the time of day that each defrost cycle is initiated. When the defrost is initiated, the fan shall automatically shut down and restart at the conclusion of the defrost cycle. A high temperature safety switch shall be provided which will terminate the defrost cycle, energize the solenoid, and prevent the fan from starting until the coil has returned to its operating temperature. All electrical controls and indicating lights for each cooler shall be contained in a single control box located outside the refrigerated space. The controls, relays and indicator lights shall be designed for 115 volts to match single phase power. Lights shall be provided indicating defrost (green), defrost trouble (amber), heater failure (red), and power on (white).

3.6.18.2.2.2 Spray headers. Where defrosting with hot brine is specified, defrosting spray headers and nozzles shall be arranged over the cooling coils such that the coil may be defrosted by spraying hot brine over the coil. A sufficient number of spray headers and nozzles shall be located over the coils to completely spray the coil. Defrosting spray pipes, headers and nozzles shall be constructed of 90-10 copper nickel in accordance with ASTM B 122.

3.6.18.3 Forced air cooler for refrigerated ship's stores. The forced air cooler for refrigerated ship's store spaces shall be in accordance with MIL-C-24746.

3.6.19 Air conditioning water chillers. Refrigerant water chillers shall be the shell and tube dry-expansion type with refrigerant within the tubes and fresh water within the shell. The chiller shall have two unequal refrigerant circuits, the sum of which shall equal the required capacity. Solenoid valve controlled, direct operating expansion valves shall be used to control capacity in the refrigerant circuits. The expansion valves shall be of different capacity commensurate with the design capacity of each circuit. Activation and

deactivation of the chiller circuit shall be controlled by the compressor capacity control system. At full plant capacity both refrigerant plant circuits shall be in operation. The chiller capacity shall be reduced in the following order:

(a) Smaller circuit inactive with larger circuit active.
(b) Smaller circuit active with larger circuit inactive.

The capacity of the chiller shall be based on the following requirements (see 6.2):

(a) Water flow, gallons per minute (gal/min).
(b) Temperature, entering water, °F.
(c) Temperature, leaving water, °F.
(d) Refrigerant evaporating temperature, °F.

The design refrigerating temperature shall be not lower than 33°F. The chiller shall be provided with a minimum of 4 square feet of cooling surface per ton of refrigeration. The water pressure drop through the chiller shall not exceed 10 lb/in^2. At design conditions (refrigerant temperature, water flow and temperature, and tonnage), the refrigerant gas leaving the chiller shall be superheated 10°F above the design evaporator temperature. The chiller and its expansion valves shall be stable in operation at the lowest intended operating condition of the compressor.

3.6.19.1 Water chiller shell. The chiller shell shall be made of one of the following materials:

(a) Red brass seamless tubing, ASTM B 135 alloy C23000.
(b) Red brass welded tubing, ASTM B 587 alloy C23000.
(c) Corrosion resistant steel ASTM A 240 type 304L or 316L.
(d) 90-10 copper-nickel ASTM B 467.

Tube sheets shall be at least 7/8 inch thick and shall be made of admiralty metal, copper silicon alloy, rolled naval brass or corrosion resistant steel ASTM A 240 type 304L. Nonferrous shells shall be silver brazed or welded to nonferrous type tube sheets. Corrosion resistant steel shells shall be welded to corrosion resistant steel tube sheets and 90-10 copper-nickel shells shall be welded to 90-10 tube sheets. Water baffles shall be nonferrous. The tubes shall be straight, seamless copper in accordance with type K of ASTM B 88, annealed where necessary. The use of internal heat transfer enhancement is permitted where the technology for enhancement has been approved by NAVSEA. The ligament between tubes shall be not less than 0.1875 inch. The tubes shall be expanded into tube sheets by means of an approved automatic tube expander. The well for the low chilled water temperature switch bulb shall be installed in the chiller shell. The well for the chilled water operating thermostat switch and the capacity control temperature sensor shall be installed in the chilled water outlet nozzle. All joints on the chiller shall be welded or silver brazed (see 3.4.15). The chiller shall be designed and built to the requirements of section VIII, division 1 of the ASME Boiler and Pressure Vessel Code.

3.6.19.2 Refrigerant heads. The refrigerant heads shall be provided with an adequate number of passes to permit proper flow of refrigerant and positive entrainment of oil. The heads shall be removable and provided with die-cut gaskets suitable for the refrigerant. Steel heads shall be cleaned by sand-blasting and the outside coated with two coats of baked phenolic resinoid. Bolts and nuts for fastening the heads shall be aluminum bronze, phosphor bronze, copper-silicon alloy or austenitic stainless steel.

3.6.19.3 Shell draining and purging. Provision shall be made for draining and purging the shell. Water connections shall be flanged type. The flanges shall be in accordance with MIL-F-20042. The inlet and outlet water nozzles shall be located at the top quadrant of the unit, otherwise vents shall be provided to purge the chiller shell. Refrigerant connections shall be four-bolt, tongue and groove type refrigerant flanges and provided with the mating flanges. The four-bolt refrigerant flanges for the chiller shall be located in the piping so that chiller heads may be removed without interference from refrigerant piping. Water and refrigerant connections shall extend a minimum of 2 inches from the chiller to permit the application of insulation after installation. The refrigerant and chilled water circuit shall be designed and tested for the pressures specified in table III.

3.7 Group II, refrigerating plants and assemblies. Refrigerating plants and assemblies shall comply with the design requirements in tables II and III. Heat exchangers in plants shall have installed self sealing access connections with seal caps on both sides of the heat exchanger suction return line to determine pressure drop through the heat exchanger and aid in servicing. Refrigerant piping, valves and fittings for interconnections shall be provided as specified (see 6.2). Plant assemblies shall be furnished in the quantity, capacity, voltage and arrangement as specified (see 6.2). The valved connection to be used for evacuating the plant shall be large enough so that the plant can be evacuated in 2 hours or less. Plants or assemblies for submarine application shall be installed on resilient mounts. Resilient mounts shall be used for other low noise applications where specified (see 6.2).

3.7.1 Type I, refrigerated storage application.

3.7.1.1 Class 1, compressor unit assembly. The compressor unit assembly shall include a single compressor, compressor motor, drive and guard all mounted on a common base, a motor controller, pressure and temperature indicators, switches and controls, and gaugeboard for remote mounting (see 3.5.9). Where the compressor in a compressor unit assembly does not have an internal relief valve between the suction and discharge, then an external relief valve shall be furnished. When the relief valve is external, the necessary pipe and fittings for connection between the compressor suction and discharge shall be provided. The motor controller shall be remote mounted.

3.7.1.1.1 Submarine application. Where the compressor unit assembly is intended for submarine application a muffler or pulsation dampening device shall be installed in the discharge from each compressor.

3.7.1.2 Class 2, condensing unit assembly. The condensing unit assembly shall include the following components for the indicated applications:

(a) Surface ships, ship's stores - The condensing unit assembly shall include a compressor unit assembly, condenser including a condenser relief valve, bursting disc and test valve, heat interchanger, suction line strainer, vibration isolators, receiver, pressure and temperature indicators, controls, and gaugeboards for remote mounting, and tools as required for the application or as specified (see 6.2).

(b) Submarines, ship's stores - The condensing unit assembly shall include compressor unit assembly, a combination condenser-receiver including a condenser relief valve, heat interchanger, suction line strainer, vibration isolators, pressure and temperature indicators, controls and gaugeboards for remote mounting, and tools as required for the application or as specified (see 6.2).

3.7.1.3 Class 3, complete plant. Each complete plant for surface ship refrigerated storage shall consist of one or more condensing unit assemblies, main liquid line solenoid valves, liquid refrigerant control and piping assembly, cooling coils, evaporator control and piping assemblies, sets of tools and all refrigerant pipe, valves and fittings needed for interconnection as required for the application or as specified (see 6.2).

3.7.1.3.1 High and low temperature cooling coils. Where a plant includes both high and low temperature cooling coils, the vapor pressure of the high temperature cooling coils shall be controlled by a suction pressure regulating valve, and a self-sealing refrigerant gauge connection for setting the regulating valve shall be provided. The self-sealing gauge connection may be provided on the valve or on the piping immediately upstream of the valve. Shut off and bypass valves shall be provided around the regulating valve for maintenance or conversion to low temperature application.

3.7.1.3.2 Submarine plants. The condensing unit assembly provided with the plant for submarine refrigerated storage application shall be mounted on a common bedplate in a single or duplex arrangement as specified. Unless otherwise specified (see 6.2), the unit shall be arranged so that the bedplate can be center-of-gravity mounted on resilient mounts on a foundation. Temperature indicators shall be thermo-electric or electric-resistance (see 3.5.10) with the temperature detectors attached to the outside of refrigerant pipe at representative locations where piping is supplied by refrigerant equipment manufacturer (see 6.2). An approved pyrometer shall be provided.

3.7.2 Type II, air conditioning application.

3.7.2.1 Class 1, compressor unit assembly. The compressor unit assembly shall consist of the components specified in 3.7.1.1.

3.7.2.2 Class 2, condensing unit assembly. The condensing unit assembly shall be as follows:

(a) Surface ships - The condensing unit assembly shall consist of the components specified in 3.7.1.2(a).
(b) Submarine - The condensing unit assembly shall consist of the components specified in 3.7.1.2(b), except the condenser shall include a relief valve and no bursting disc or test valve. A muffler or pulsation dampening device shall be installed in the discharge from each compressor. The unit or units shall be resilient mounted.

3.7.2.3 Class 3, built up air conditioning plant. The built up air conditioning plant shall consist of one or more condensing unit assemblies, heat interchanger, low temperature control switch, liquid refrigerant control and piping assembly, water chiller assembly, evaporator control and piping assemblies, evacuation connection to evacuate the plant in 2 hours or less, sets of tools and all necessary refrigerant pipe, fittings and valves needed to connect all components, controls, pressure and temperature indicators as required for the application or as specified (see 6.2).

3.7.2.4 Class 4, prefabricated air conditioning plant. A prefabricated air conditioning plant shall consist of two structural assemblies identified as a prefabricated compressor unit assembly and a condenser-chiller assembly. All electrical and refrigerant circuits for each assembly shall be complete so that the plant is ready for operation when located in place aboard ship, connected to power, water services, interconnection of refrigerant piping between assemblies and interconnection of electrical control circuits where necessary. Unless otherwise specified (see 6.2), the interconnecting suction and discharge piping between assemblies shall not be furnished with the plant.

3.7.2.4.1 Prefabricated compressor unit assembly. Prefabricated compressor unit assembly shall consist of the components specified in 3.7.1.1. and a suction line strainer and vibration isolators. The motor controller, controls and pressure and temperature indicators shall be arranged for remote mounting adjacent to the compressor unit assembly. Where the motor controller and instruments are in one enclosure, the controller and instruments shall be compartmented to separate fluid and electrical devices. The location and arrangement of controls shall be such that there is no danger of electrical shock hazard to personnel during maintenance and adjustment. Provision shall be included to drain off any fluid leakage.

3.7.2.4.2 Condenser-chiller assembly. The condenser-chiller assembly shall consist of the condenser including a condenser relief valve, bursting disc gauge and test valve; water chiller, receiver, liquid refrigerant control and piping assembly, liquid-suction heat interchanger, evaporator control and piping assembly, pressure and temperature indicators, controls and gaugeboard. The gaugeboards shall include a water failure switch, operating thermostat switch, and low chilled temperature switch. Wells shall be provided in the piping for installing the thermal expansion valve bulbs. The assembly shall be mounted on a welded steel framework designed for shock resistance and shall be provided with a

means for securing to a deck. The components shall be mounted completely to conserve space without sacrificing accessibility for serviceable items. The major components shall be stacked with the condenser over the receiver and chiller. The condenser water connections and chiller refrigerant connection shall be at the same end of the assembly. The water regulating valve will be installed in the condenser water outlet piping by the shipbuilder or installing activity. The chiller shall be insulated with insulation having a thermal conductivity equivalent of 1 inch of polyurethane foam with a density of 2 lb/in^3. The water chiller shall have service connections at the inlet and outlet refrigerating lines for evacuation and troubleshooting. The troubleshooting connections shall be capped self-sealing refrigerant service type valves with 1/4 inch SAE male flare. The evacuation connection and mating hoses shall be large enough so that the vacuum pump can evacuate the plant in 2 hours or less. Take down joint shall be provided for the relief valve.

3.7.2.4.2.1 Condenser-chiller controls. The condenser-chiller assembly shall be of a right-hand or a left-hand arrangement with respect to location of instruments and controls as specified (see 6.2). The right-hand arrangement shall have the gaugeboard on the right side of the assembly when facing the condenser water chiller refrigerant connections. The dehydrators, valves and controls not mounted on the gaugeboard or not accessible for servicing from either end of the assembly shall be accessible from the right side. The liquid level indicator and moisture indicator shall be visible from the right side. The left-hand assembly shall be the opposite of the right-hand assembly. The gaugeboard shall be on the left side of the unit and the components as specified above shall be accessible or visible from the left side of the assembly.

3.8 Identification plates. Identification plates shall be made of brass (type A) aluminum or corrosion-resisting steel (type H), in accordance with MIL-P-15024 and MIL-P-15024/5. Information plates shall be made of laminated plastic (type F) aluminum or corrosion-resisting steel (type H) in accordance with MIL-P-15024 and MIL-P-15024/5. Plates shall be secured to equipment with electrolytically compatible fasteners and shall contain at least the following information:

(a) Name of equipment: Refrigerating Plant for Air Conditioning, ship's stores, or cargo as applicable.
(b) Manufacturer's name and address.
(c) Manufacturer's model, type, capacity.
(d) Manufacturer's serial number on each compressor.
(e) Date of manufacture.
(f) Government or shipbuilder's contract or purchase order number.
(g) MIL-R-16743 and appropriate type, service, class and arrangement.
(h) NAVSEA Technical Manual Number.

In addition to an identification plate for the plant, identification plates shall be furnished for each compressor unit, condenser, receiver, chiller, and forced air cooler.

3.9 Painting. All surfaces to be painted shall be thoroughly cleaned to remove oil, grease, dirt, scale, rust, weld beads, and slag and sand core residues. Cleaning by acid pickling and by shot or grit blasting, if considered

necessary, shall be accomplished on the components prior to compressor assembly. Grit or sand blasting shall not be done on an assembled compressor. Following assembly of the compressor and final surface cleaning, a determination of acceptable surface conditions for painting shall be made.

3.9.1 Selected painting. External unmachined surface of metal parts which are subjected to temperatures of 300°F or less, except corrosion-resisting steel, copper or brass shall be coated with paint in accordance with the following specifications or equivalent materials:

(a) One coat of pretreatment coating DOD-P-15328 or TT-P-1757.
(b) One coat of zinc chromate TT-P-645 or red lead primer.
(c) One finish coat of light gray equipment enamel MIL-E-15090.

Surfaces under attachments (such as nonfaying mounting brackets, identification plates, and under thermal insulation and lagging) shall be cleaned, and primed. Paint and primer coats shall not be applied to identification plates, bearings and bearing surfaces, plastics, indicating dials, windows, and faying surfaces such as flange faces, rotating parts, internal spaces of fluid containing areas.

3.10 Special tools. The need for special tools shall be avoided except where considered necessary and to prevent tampering. Special tools shall be those tools and apparatus needed for adjustment and maintenance of the plant but which are items that are not listed in the Federal Supply Catalogue. A copy of this catalogue is available for review in the local office of the Defense Contract Administration Services Management Area (DCASMA). The manufacturer shall review the procedures and tool requirements for all maintenance operations and shall establish a definitive list of the required special tools which comprise a set of Special Tools. Special tools as necessary for safe, reliable and efficient performance of maintenance operation shall be furnished in sets, designated as On Board Special Tools. The requirement for each special tool and its adequacy shall be confirmed during the specified maintainability demonstration (see 4.4.2.11). The special tools for electric motors, and motor controllers shall be in accordance with the specifications for those components.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements (examinations and tests) as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in this specification where such inspections are deemed necessary to ensure supplies and services conform to prescribed requirements.

4.1.1 Responsibility for compliance. All items shall meet all requirements of sections 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program (see 6.3). The absence of any inspection requirements in the specification shall not relieve

the contractor of the responsibility of ensuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspection, as part of the manufacturing operations, is an acceptable practice to ascertain conformance to requirements, however, this does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to accept defective material.

4.1.2 Test equipment and inspection facilities. The contractor shall insure that test and inspection facilities of sufficient accuracy, quality and quantity are established and maintained to permit performance of required inspections. The control of accuracy and maintenance of test equipment shall be as required by MIL-STD-45662. Instruments containing mercury shall not be used at any time in the test and inspection of plants furnished to this specification.

4.1.3 Terms and definitions. Quality assurance terms used herein are defined in MIL-STD-109 and MIL-STD-721. The contractor shall utilize and uniformly adhere to the terms and definitions as specified.

4.2 Classification of inspections. The inspection requirements specified herein are classified as follows:

(a) Qualification inspection (see 4.3).
(b) First article inspection (see 4.4).
(c) Quality conformance inspection (see 4.5).

4.3 Qualification inspection. One compressor of each contractor's type and design proposed to be furnished by a potential supplier shall be made available and undergo the qualification inspections and tests set forth herein. Where a contractor produces a series of compressors of the same size bore and stroke and the same type and design but with varying number of cylinders, one or more compressors representative of the series may be offered for tests. The extension of approval to other compressors will be limited to those having fewer number of cylinders than the compressor subjected to the tests. Successful demonstration of compliance with the test procedures and acceptance criteria shall be the basis for listing the specific compressors in the series on the Qualified Products List. The qualification inspections and test shall be performed in accordance with the procedures set forth herein and shall include the following:

4.3.1 Qualification drawings. Qualification drawings shall consist of the following:

(a) Drawings for compressor qualification. Engineering drawings shall be submitted to NAVSEA for compressor qualification. Technical data disclosed on the engineering drawings submitted for

compressor qualification shall be sufficient to permit NAVSEA to review the design of the compressor to ascertain compliance with specifications. Failure to reveal necessary design information may be cause for rejection of the compressor for qualification. Engineering drawings submitted for compressor qualification are the property of the manufacturer.

(b) Qualification record drawings. After specified qualification tests and examinations are completed, the manufacturer shall finalize drawings to depict the approved compressor design. These drawings, titled Qualification Record Drawings, shall reflect the compressor design as qualified, including configuration, materials used, applicable specification on board repair part requirements; and shall identify the source of all purchased parts and components. The drawings shall be in accordance with DOD-D-1000, level 2 and drawing practices in accordance with DOD-STD-100. A certification data sheet, titled Qualification Record Certification Data Sheet, shall be the top drawing of the set of Qualification Record Drawings. The Certification Data Sheet shall fully identify the compressor, show performance characteristics, rated capacity, rated discharge pressure, rated speed and horsepower including rating and function of accessories such as lube oil cooler, oil heaters, and capacity control. The Certification Data Sheet shall reference all qualification tests and list all drawings whereby the design of the qualified compressor is described and delineated. One set of Qualification Record Drawings shall be furnished with the Composite Qualification Test Report (see 4.3.2).

4.3.2 Composite qualification test reports. When all qualification tests and inspections have been completed, the individual qualification test reports shall be assembled into a Composite Qualification Test Report under one cover, identifying the tested compressor by the Qualification Record Certification Data Sheet and indicating the compressor serial number, type, size or capacity and the place of manufacture. Two copies of the Composite Qualification Test Report, each with a finalized copy of the Qualification Record Certification Data Sheet (see 4.3.1 and 4.5.7), shall be forwarded to the qualifying activity.

4.3.3 Qualification test procedures.

4.3.3.1 General procedures for qualification tests. As a first step in the performance of the qualification tests, the compressor design shall have been reviewed as indicated in 4.3.3.2. Qualification tests of relatively short duration should be conducted first so that necessary design changes can be made with a minimum of repeat testing. Although not mandatory, the performance of the qualification tests in the sequence as listed in 4.3 is considered optimum. Certain tests may be conducted concurrently; for example, the noise test, the vibration test, and the performance capacity test. For all qualification tests, fresh water may be used for cooling in lieu of sea water.

4.3.3.2 Qualification design evaluation procedure. The qualification design evaluation shall consist of a thorough review of the engineering drawings as indicated in 4.3.1 to establish that the compressor design is in accordance with all requirements of this specification. The contractor shall conduct the review and shall certify that the above requirements have been met. If instances of non-compliance are discovered, then such design changes as are necessary to bring the design into compliance shall be made on the drawings and on the compressor prior to proceeding with qualification testing.

4.3.3.2.1 Acceptance criteria. Certification that the compressor drawings have been reviewed and that the compressor design is in accordance with this specification shall constitute the acceptability of the compressor for further testing. This acceptance shall be subject to design review by NAVSEA.

4.3.3.3 Compressor rating test. The compressor shall be operated at maximum intended speed to obtain compressor capacity rating. The test shall be performed at the rating conditions specified in tables II and III, including the various condensing temperatures and may include other operating conditions proposed by the manufacturer to cover future applications. Compressor ratings shall be obtained for all refrigerant suction temperatures at superheat and condensing temperatures specified in tables II and III.

4.3.3.3.1 Test method. The rating test shall be in conformance with ASHRAE 23. In addition, for both refrigeration and chilled water application, the compressor capacity shall be varied to demonstrate operation of applicable capacity controls and lubricating oil cooler. The compressor shall also be cycled to demonstrate the operation of the lubricating oil heaters. A heat absorbing unit shall be utilized and arranged for accurate measurements of the quantities and temperatures involved.

4.3.3.3.2 Recorded data. Test data shall be taken and recorded in accordance with ASHRAE 23. Data should be summarized in graphic form where applicable. In addition, include volumetric efficiency; the control limits for chilled water temperature modulation from minimum to full load capacity for air conditioning application; pressure differential for each control step and total pressure range from minimum to full load capacity control for refrigerating plant application; lubricating oil heater data and oil cooler data (oil temperature inlet and outlet, chilled water temperature inlet and outlet and chilled water flow or refrigerant inlet and outlet temperature for the refrigerant oil cooler).

4.3.3.3.3 Acceptance criteria. The compressor rating test shall be considered to be acceptable when the test results comply with the requirements of 3.6.1 through 3.6.1.3.1.1.

4.3.3.4 Airborne sound measurement procedure. Airborne sound measurements shall be conducted in accordance with MIL-STD-740-1. Measurements shall be taken with the compressor operating at approximately 50, 75 and 100 percent rated capacity.

4.3.3.4.1 Recorded data. Test data shall be measured and recorded in accordance with MIL-STD-740-1.

4.3.3.4.2 Acceptance criteria. The compressor shall be considered to be acceptable with respect to the noise test requirements if all noise levels are within the limits specified in 3.3.5.

4.3.3.5 Vibration test procedure. The vibration tests shall be running tests conducted in accordance with the test requirements for type I vibrations in MIL-STD-167-1 specified in 3.3.8(c).

4.3.3.5.1 Recorded data. Test data shall be recorded in accordance with MIL-STD-167-1.

4.3.3.5.2 Acceptance criteria. The compressor shall be considered to be acceptable with respect to type I vibrations if the requirements of MIL-STD-167-1 have been met.

4.3.3.6 Inclination test procedure. The inclination test shall determine that the compressor operates satisfactorily at the inclinations specified in 3.3.8(d). The inclination test shall be conducted with the compressor solidly mounted and rigidly secured to a solid base. The compressor shall be operated at maximum intended speed and approximately full capacity. The lubricating system and operating characteristic shall be observed for abnormal operation. The test shall be conducted in accordance with the following procedure:

(a) The base shall be tilted 30 degrees from the horizontal in any cardinal position (front, rear, left, right) and the compressor shall continue to operate for a duration of not less than 30 minutes in the inclined position. The base shall be returned to the horizontal and the compressor shall continue to run in the horizontal position until data readings stabilize.
(b) The base shall be tilted 30 degrees from the horizontal in different cardinal position and the procedure described in paragraph (a) above repeated. This procedure shall continue until the compressor has been tested inclined in all four cardinal positions (front, rear, left, right).
(c) Compressors for submarine service shall be inclined 45 degrees in each cardinal direction and operated for 3 minutes in each direction.

4.3.3.6.1 Recorded data. Test data shall be taken and recorded in 5-minute intervals before, during, and after each time the compressor is inclined. Recorded data shall include the data necessary to evaluate the performance of the critical design features. A recorded data check off list tailored to the compressor design shall be prepared by the contractor. For the inclination tests at 45 degrees test data shall be taken at start up and again prior to concluding the test.

4.3.3.6.2 Acceptance criteria. The compressor shall be considered to be acceptable with respect to the inclination test requirements if all of the following have been met:

(a) The compressor has performed without disqualifying stoppage, and is capable of continuing to perform without disqualifying stoppage with compressor at not less than 75 percent of rated capacity.

(b) The compressor has not lost oil from its sump and the lube oil pump has not lost suction and there is no evidence of outside oil leakage.
(c) Test data readings have not deviated significantly any time during the test from normal test data readings with the compressor operation in the normal horizontal position.
(d) The automatic shutdown features of the system have functioned as required and have not energized to shut down the compressor during tests in any inclined position.

4.3.3.7 Shock test procedure. The shock test shall be a running test conducted in accordance with MIL-S-901 to determine that the compressor meets the high impact shock requirements specified in 3.3.9. During this running test an air cycle may be used.

(a) The mounted compressor shall be rigidly secured to a solid base having the capability of being tilted up to 30 degrees from the horizontal and in such manner that the horizontal component of applied shock shall be transmitted across the axis in which the equipment is deemed weakest.
(b) A medium-weight shock machine shall apply six blows in accordance with MIL-S-901, with the mounting platform in the horizontal plane and in a position such that the blows shall be applied directly under the approximate center of gravity of the compressor.
(c) Six blows shall be applied: three odd numbered blows with the compressor at standstill and three even numbered blows with the compressor running.
(d) The base shall be tilted 30 degrees from the horizontal and two additional blows shall be applied directly under the approximate center of gravity of the compressor in accordance with MIL-S-901. The compressor shall be running during these blows.
(e) After each blow, the compressor shall be operated and thoroughly examined for evidence of disqualifying stoppage.
(f) At the conclusion of the test, the compressor shall be disassembled and each component thoroughly examined for breakage and other signs of failure.

4.3.3.7.1 Recorded data. Data shall be taken and recorded after each blow in accordance with MIL-S-901.

4.3.3.7.2 Acceptance criteria. The compressor shall be considered to be acceptable with respect to the shock test requirements if all of the following have been met:

(a) The compressor has performed without disqualifying stoppage, and is capable of continuing to perform without disqualifying stoppage.
(b) The compressor has not experienced breakage of any part, including accessories, main mounting bolts, and detachment of appurtenances and accessories.
(c) Failure of a mechanically coupled motor shall not be considered as failure of an otherwise acceptable compressor.

(d) The compressor does not require any maintenance or adjustment or replacement of any component or parts in order to operate satisfactorily as specified herein.

4.3.3.8 Reliability test. The reliability test shall be a running test of not less than 2,000 operating hours at maximum operating speed to determine if the compressor meets the reliability acceptance criteria specified in 3.3.6. The 2,000 hour operating time may include intermittent operation and shall include periods of on-off cycling operation. Non-operating periods shall not be counted as part of the 2,000 hour test period. Readings shall be taken and recorded from all instrumentation at least every 2 hours during the 2,000 hour test. A heat absorbing unit shall be utilized to determine capacity. As a basic guide the data required by ASHRAE 23 including data on lube oil heater and cooler shall be taken. The reliability test shall be conducted in accordance with a definitive test agenda proposed by the contractor. The test shall be in accordance with the following guidelines:

(a) After the compressor has had a short break-in period and prior to commencing the reliability tests, the test facility shall disassemble the compressor and take and record accurate measurements of all parts subject to normal wear, deterioration, or damage. These measurements shall be taken again after the first 1,000 hour segment of the test. These parts shall include all bearings, journals, wrist pins, bushings, piston rods, pistons, piston rings, seals, unloader mechanisms, valve discs, valve springs, and seats. Measurements of curvilinear wearing surfaces (such as journals, bearings, cylinders, etc.) shall be measured at 4 cardinal points at 90 degrees and the orientation of such points recorded and scribed on the part. Subsequent measurements shall be made at the same points. Annular parts shall be checked for concentricity and eccentric wear, if any, measured and recorded. Measurements shall be accurate to the nearest tenth of a mil. The same micrometer or measuring instrument shall be used for both sets of readings and, when possible, the same technicians shall take both sets of readings. Each measurement shall be taken by not less than two technicians and all variances resolved prior to data recording.

(b) The 2,000 hour test shall consist of two 1,000 hour operating periods. One period at automatic full rated air conditioning capacity of 750 hours and a 250 hour run with varying capacity, and varying condensing water temperatures. During the 250 hour period the compressor capacity shall be varied in steps of 30 percent of rated capacity from 100 down to 10 percent to demonsrate proper compressor unloading capability and its ability to cycle on and off. The cycles shall be repeated at least 10 times during the test. Each step shall be long enough to show stable compressor operating conditions except for the minimum step.

(c) The second 1,000 hour run shall be divided into two 500 hour tests for refrigerated ship's stores application. The first 500 hour test shall be under automatic refrigeration application at minus

20°F suction temperature. The second 500 hour test shall be at varying capacity and simulated on-off cycling. The compressor capacity shall be varied in steps of 30 percent of rated capacity from 100 down to 10 percent to demonstrate proper compressor unloading capability and its ability to cycle on and off. The cycles shall be repeated at least 10 times during the test. Each step shall be long enough to show stable compressor operating conditions except for the minimum step.

(d) At appropriate times during the automatic operation tests proper functioning of each safety shutdown device shall be demonstrated a minimum of eight times.

(e) NAVSEA shall be notified immediately of any unscheduled shutdowns due to failure or malfunctioning of the compressor. The test shall not be resumed without NAVSEA approval.

(f) The need for any corrective maintenance during the 2,000 hour test time requires the contractor to prepare an analysis of the cause of the failure and a determination of the required corrective action. Upon satisfactory resolution of the failure, the testing shall be carried to completion. Any further testing which may be required to verify the effectiveness of the corrective action shall be resolved between the contractor and the qualifying activity.

4.3.3.8.1 Recorded data. Wear rate data shall be taken and recorded in accordance with 4.3.3.8(a) at the start and at the conclusion of each 1,000 hours test run. The specific reliability test agenda mutually agreed upon by NAVSEA and the manufacturer shall establish a definitive recorded data requirement.

4.3.3.8.2 Acceptance criteria. The compressor shall be considered to be acceptable with respect to the reliability test performance requirements if all of the following have been met:

(a) The compressor has demonstrated its ability to achieve the service life specified in 3.3.7. The service life shall be obtained from the extrapolated wear data.

(b) The compressor has performed without disqualifying stoppage and is capable of continuing to perform without disqualifying stoppage. Disqualifying stoppage shall be understood to mean stoppage because of failure or malfunction of any component (prior to obtaining its specified service life) which would cause the compressor not to be able to function to compress and discharge refrigerant at rated pressure and temperature without repair, replacement or rework of any part or parts of the compressor.

(c) The compressor capacity, while operating at rated capacity, has not decreased at the end of the 2,000 hour operating test.

(d) The control system has functioned as required and the compressor has satisfactorily loaded and unloaded and achieved stable operation at each unloading and loading step.

(e) Each automatic shutdown device operated satisfactorily to shut down the compressor.

4.4 First article inspections and tests.

4.4.1 Refrigerating plants inspections and tests. The first refrigerating plant of each type, size and class produced under any contract or order shall be selected for inspection and test unless waived by NAVSEA. The first article inspections and tests conducted shall include the following:

(a) Design evaluation (see 4.4.2.2).
(b) Pressure and leak test (see 4.4.2.3).
(c) Proof test, submarine only (see 4.4.2.4).
(d) Inclination test (see 4.4.2.5).
(e) Lubricating oil system test (see 4.4.2.6).
(f) Shock test (see 4.4.2.7).
(g) Noise test (see 4.4.2.8).

(1) Airborne
(2) Structureborne (when specified)

(h) Vibration test (see 4.4.2.9).
(i) Capacity test (see 4.4.2.10).
(j) Maintainability demonstration (see 4.4.2.11).
(k) Visual inspection - condenser heads - submarine (see 4.4.2.12).
(l) Electromagnetic interference tests (see 4.4.2.13).

4.4.1.1 First article after test. The first article which has been subjected to the tests and examinations specified in 4.4.1 and found to be entirely satisfactory may be offered for delivery subject to the following:

(a) Any repairs or modifications found necessary as a result of the first article tests and examinations have been proven satisfactory by retesting.
(b) The plant is not degraded in any way.
(c) Equipment which has been subjected to the high-impact shock test and has successfully passed this test shall be considered acceptable for such service as the Command or agency concerned may authorize. However, prior to being offered for delivery, such equipment shall be reconditioned by the contractor as follows:

(1) Minor deformation including alignment. (Minor deformations are defined as those which do not cause rejection of the design under high-impact shock test but which are in excess of the design dimensional tolerances specified on the applicable drawings). Minor deformations shall be corrected.
(2) Bearings shall be replaced.
(3) Each part shall be carefully examined by the contractor and any part which the contractor considers substandard shall be replaced.
(4) Equipment shall be cleaned, leak tested and dehydrated in accordance with the requirements specified herein.

(5) Reconditioned equipment shall be retested as applicable in accordance with the quality conformance tests specified in 4.5. Reconditioned shock tested equipment shall be tested for capacity and noise.

(d) Concurrence of the contracting activity.

4.4.2 First article inspection and test procedures - plants.

4.4.2.1 General. Prior to commencement of testing, the refrigerating plant design shall have successfully passed the design evaluation in 4.4.2.2 (see 6.3 and appendix E). For these tests, fresh water may be used in lieu of sea water for cooling. Whereas some tests may be able to be conducted concurrently, the shock test and the inclined operation test shall be performed separately.

4.4.2.1.1 Test failure. Failure of the plant to pass the tests and examinations specified herein shall constitute rejection of the plant design. The resumption of tests and examinations will be considered by the contracting activity after receipt of data substantiating that the deficiencies found have been corrected satisfactorily.

4.4.2.2 Design evaluation procedure. The design evaluation shall consist of a thorough review of the plant's drawings to establish that the design is in accordance with all requirements of this specification and to determine that it complies with all requirements which cannot be verified by subsequent inspections and tests listed in 4.4.1 (see 6.3 and appendix A). The contractor shall conduct the review. If instances of noncompliance are discovered, then such design changes as are necessary to bring the design into compliance shall be made on the plant prior to proceeding with first article testing.

4.4.2.3 Pressure and leak test procedure. The condenser waterside and components and the chilled waterside and components of each plant shall be hydrostatically tested. Condenser shall be tested as follows:

Condenser (surface ship)	test to 335 lb/in^2
Condenser (submarine - air conditioning)	test to 1-1/2 times the sum of submergence pressure plus pump shut-off pressure, as specified
Condenser void space (submarine - air conditioning)	as specified (see 3.6.2.9.1)
Chiller	test to 135 lb/in^2

4.4.2.3.1 Test method. Water pressure shall be applied slowly and maintained for not less than 1 hour. When the void space is being tested, the primary tube sheet shall be examined for leakage. All joints, seals and components shall be inspected for signs of weakness and leakage. Any leakage shall be corrected. After the hydrostatic test of the void space is completed, the void space shall be blown dry with air.

4.4.2.3.2 Refrigerant envelope test. Refrigerant-containing parts shall be leak tested at the refrigerant test pressure of table II or III. Necessary precautions shall be taken to assure thorough distribution of refrigerant vapor throughout the entire gas volume of parts being leak tested. The leak-detector shall have a leak index sensitivity of 1/2-ounce per year. Individual or cumulative leaks detected with the leak-detector set at the 1/2-ounce per year setting shall be repaired and retested to insure repair has been successful. After all joints have been satisfactorily tested, hold the pressure for 6 hours. No loss in pressure is permitted except as corrected for temperature. Prior to charging and operating test, the entire refrigerant envelope shall be dehydrated and evacuated to a vacuum equivalent to 5 millimeters (mm) of mercury on an absolute pressure indicator. Introduction of additives such as anhydrous methyl alcohol to reduce freezing of residual moisture is not permitted. Upon evacuation of the unit to 5 mm mercury, the vacuum pump shall be secured and isolated from the unit. The evacuated unit shall stand for 6 hours. An increase in pressure, corrected for ambient temperature changes, of greater than 3 mm mercury (8 mm mercury or greater, final absolute pressure) shall be cause for rejection. After a successful vacuum test, the refrigerant envelope shall be charged with refrigerant.

4.4.2.3.3 Acceptance criteria. The plants shall be considered to be acceptable with respect to the pressure and leakage requirements if all the following have been met (see 3.7):

(a) The condenser waterside and chilled waterside showed no leakage at any point, nor porosity of castings, nor any distortion or sign of weakness.
(b) There has been no leakage of the primary tube sheet resulting from the void space test.
(c) The refrigerant envelope met both the vacuum and pressure leakage criteria.

4.4.2.4 Proof test procedure, submarine plants. For condensers which will be subjected to full submergence pressure, the structural adequacy of the inlet-outlet condenser heads shall be verified by a proof test (see 6.3).

4.4.2.5 Inclined operation test procedure. The inclined operation test shall be a running test to determine that the plant operates satisfactorily at inclinations as specified in 3.3.8. The inclination test shall be conducted with the plant solidly mounted and rigidly secured to a solid base. The compressor shall be operated at maximum intended speed and the plant at approximately full capacity. The plant shall be observed for abnormal operation. The test shall be conducted in accordance with the following procedure:

(a) The base shall be tilted 30 degrees from the horizontal in any cardinal position (front, back, left, right) and the compressor shall continue to operate for a duration of not less than 30 minutes in the inclined position. The base shall be returned to the horizontal and the compressor shall continue to run in the horizontal position until data readings stabilize.

(b) The base shall be tilted 30 degrees from the horizontal in a different cardinal position and the procedure described in (a) above repeated. The procedure shall continue until the compressor has been tested inclined in all four cardinal positions.
(c) Plants for submarine service shall be inclined 45 degrees in each cardinal direction and operated for 3 minutes in each direction.

4.4.2.5.1 Recorded data. Test data shall be taken and recorded before, during, and after at 5-minute intervals each time the compressor is inclined. For the inclined operation test at 45 degrees, test data shall be taken at start up and again prior to concluding the test.

4.4.2.5.2 Acceptance criteria. The plant shall be considered to be acceptable with respect to the inclination test requirements if all of the following have been met:

(a) The plant has performed without disqualifying stoppage, and is capable of continuing to perform without disqualifying stoppage with plant capacity not less than 75 percent of rated capacity.
(b) There has been no loss of oil, fluids or lubrication.
(c) Test data readings have not significantly deviated from normal any time during the test from normal test data readings of horizontal plant operation.
(d) The automatic shut down features of the system have not shut the compressor down.
(e) No permanent damage has been incurred.

4.4.2.6 Lubricating oil system test procedures. Except for the test conducted with the plant not operating, this test and inspection can be conducted concurrently with an operating test.

(a) Plant shut down - Apply power to the oil heater prior to operation of the plant which has been shut down long enough to reach ambient temperature (preferably at 40°F or as close thereto as possible). Conduct the following:

(1) Observe that there is oil level in the sight glass.
(2) Observe and record the steady state temperature of the lubricating oil and ambient.

(b) Plant operating.

(1) Observe the oil level in the sight glass to see if it is at the operating level.
(2) Observe and record the oil temperature leaving the oil cooler.

4.4.2.6.1 Acceptance criteria. The plant shall be considered to be acceptable with regard to the lubricating oil system features checked if all the following have been met (see 3.6.1.2):

(a) The sight glass shows oil at the proper levels when shut down and when operating.
(b) The lubricating oil temperature with the plant not operating was between 40 to 50°F above ambient.
(c) The lubricating oil temperature with the plant operating was between 120 to 130°F.

4.4.2.7 Shock test procedure. One complete refrigerating plant of each type, design and size shall be subject to the high-impact shock test specified in MIL-S-901, grade A equipment in the class category specified (see 6.2). Design of the foundation shall be provided by contractor. Actual foundation and resilient mounts when required shall be supplied by contractor.

4.4.2.7.1 Previously tested equipment. Equipment previously shock tested and accepted need not be retested where evidence can be submitted to the Command or agency concerned that the original item was subjected to shock tests in accordance with these requirements and successfully passed, and that the design of the proposed equipment, its intended service and shipboard installation, is such as to result in an equal or better degree of shock resistance.

4.4.2.7.2 Shock test. The plant shall be tested while operating and while secured. Compressor unit assemblies for ships stores refrigeration plants may be tested using air being pumped rather than refrigerant. Test series shall consist of five shots. The unit shall be operating during shots 1, 2 and 5. During shots 3 and 4, the unit shall be secured. Shot 2 (40-foot standoff) shall be oriented with respect to the platform so as to load the equipment in the same manner as would an explosion occurring off the bow or stern of the ship in which the equipment is to be installed. Other shots shall simulate explosions from an athwartship direction. Except for shot 2, failures experienced during any particular shot shall be corrected and proven on the next shot, e.g., an equipment which experi-enced a failure on shot 4 (25 foot stand-off) may be accepted after corrective action and upon satisfactorily withstanding shot 5 (20 foot stand-off). A failure experienced during shot 5 shall necessitate a sixth shot (repeat of 20-foot stand-off) unless the failure is considered by the contracting activity to be clearly capable of correction by post test design modifications. A failure experienced during shot 2 shall necessitate a repeat of shot 2. Between shots, and after the final shot, the equipment shall be operated prior to making any repair to ascertain that it is capable of satisfactory operation.

4.4.2.7.2.1 Medium weight. Where a plant is tested on the medium weight shock machine the requirement of MIL-S-901 shall be followed.

4.4.2.7.2.2 Acceptance criteria. The plant shall be considered to be acceptable with respect to the shock test requirements if all the following have been met (see 3.3.9):

(a) The plant has performed without disqualifying stoppage and is capable of continuing to perform without disqualifying stoppage. Disqualifying stoppage is any stoppage during the shock test.

(b) The plant has not experienced detachment of appurtenances or accessories including mounting bolts. There was no appreciable distortion or dislocation of any part or other factor presenting a hazard to personnel or other equipment.
(c) There has been no degradation of performance.
(d) No leakage of refrigerant or any other fluid or breakage of any part has occurred.
(e) The compressor motor continued to function in accordance with MIL-M-17060. Failure of a motor shall not be considered as failure of an otherwise acceptable compressor.

4.4.2.8 Noise test procedures.

4.4.2.8.1 Airborne sound measurements. Airborne sound measurements shall be in accordance with requirements, measurements and data reporting procedures of MIL-STD-740-1 to determine compliance with the requirements in 3.3.5 and 3.3.5.1. Plants or compressors shall be noise tested in the normal horizontal position while operating at approximately 50, 75 and 100 percent of rated capacity.

4.4.2.8.1.1 Acceptance criteria. The plant or compressor shall be considered to be acceptable with respect to the airborne sound measurement requirements if the measurements recorded do not exceed the maximum acceptable sound pressure levels for category D equipment in MIL-STD-740-1, or as otherwise specified (see 6.2).

4.4.2.8.2 Structureborne vibratory acceleration measurements. Structureborne vibratory acceleration measurements shall be in accordance with requirements, measurements and data reporting procedures of MIL-STD-740-2 to determine compliance with the requirements in 3.3.5 and 3.3.5.2. Plants or compressors shall be tested in the normal horizontal position while operating at approximately 50, 75 and 100 percent of rated capacity.

4.4.2.8.2.1 Acceptance criteria. The plant or compressor shall be considered to be acceptable with respect to structureborne vibratory acceleration measurement requirements if the measurements recorded under any test condition do not exceed the level specified for type I equipment of MIL-STD-740-2 or as otherwise specified (see 6.2).

4.4.2.9 Vibration test procedure. The vibration tests shall be running tests conducted in accordance with the test requirements for type I vibrations in MIL-STD-167-1.

4.4.2.9.1 Recorded data. Test data and associated calculations and analyses shall be recorded in accordance with MIL-STD-167-1.

4.4.2.9.2 Acceptance criteria. The plant or compressor shall be considered to be acceptable with respect to type I vibrations if the requirements of MIL-STD-167-1 have been met (see 3.3.8(c)).

4.4.2.10 Capacity tests.

4.4.2.10.1 Procedure. Chilled water temperature shall be measured to within 0.1°F, all other temperatures within 0.5°F. Flow reading shall be measured within 1 percent of the measured flow, other instrumentation within 0.5 percent of full scale reading. Test data shall be taken every 15 minutes. Operate the plant until the specified capacity is obtained. When the specified capacity is reached it shall be held at least 2 hours or long enough to determine that the specified capacity can be maintained under stable operation. The test also shall determine the ability of the plant to operate automatically at approximately 30, 40, 50, 60, 70, 80 and 100 percent of capacity. The following shall be performed:

(a) For chilled water air conditioning plants the test shall be accomplished with chilled water outlet temperature and flow rate at design conditions, and condenser water entering temperature and flow rate at design conditions (condensing water flow will vary with capacity but shall not exceed the design flow rate). When testing the unit at 30, 40 and 50 percent of rated capacity, the chilled water flow may be reduced to 50 percent of design criteria.
(b) For refrigerating plants the test shall be accomplished using a suitable heat exchanger.
(c) Obtain enough points and data as required to plot the performance of the plant for the curves required (see appendix A, 30.1.2.2).
(d) During or after the capacity test, the function of the instrumentation and each control shall be checked to insure proper operation and adjustment.
(e) The condenser inlet water temperature shall be varied to demonstrate the ability of the water regulating valve to maintain stable condensing conditions automatically at minimum temperature available to 95°F. Establish the range of inlet water temperature and refrigeration capacities.

4.4.2.10.1.1 Acceptance criteria. The plant tested shall be considered to be acceptable with respect to the capacity test requirements if all of the following have been met (see 3.3.1.1):

(a) Refrigeration of not less than the specified capacity has been reached and maintained, as measured by calibrated instrumentation and corrected readings.
(b) The plant, its controls and instrumentation functioned in a stable manner throughout, including automatic compressor variation at 30 through 100 percent of capacity and chilled water was maintained at plus or minus 1°F of the design setting.
(c) A check of the controls and instrumentation showed them to be in proper adjustment to insure proper operation.
(d) The test demonstrated that the water regulating valve automatically maintained stable condensing conditions, along with the ability of the capacity control to automatically maintain stable operation of the plant under test conditions.

(e) Test demonstrated the ability of the capacity control system to automatically maintain stable operation at reduced capacity or reduced chilled water flow as the case may be.
(f) The automatic safety features have functioned as required to protect the plant from incurring damage.
(g) Performance curves of plant capacity, power and motor current with various condensing and suction temperatures were prepared and were within the design parameters.
(h) Tendency to hunt between adjacent step changes is not considered to be instability.

4.4.2.11 Maintainability demonstration procedures. After completion of operating tests, the following maintenance shall be demonstrated (see 6.3 and appendix E):

(a) Maintenance actions shall be performed by two mechanics.
(b) The plant shall be drained and cleaned in accordance with the requirements in 5.1.2. The ability to clean the plant's equipment effectively shall be noted.
(c) The plant shall be disassembled; bearings, piston rings, oil pump, oil filter, capacity controls, cylinder sleeves, shaft, oil cooler, oil heaters, motor coupling, and other internal parts shall be removed and replaced at the discretion of the contracting activity's representative.
(d) Several related maintenance demonstrations may be performed during one maintenance action. However, times for each individual demonstration shall be recorded.
(e) After assembly, record time to evacuate the unit to 5 mm mercury absolute and size of vacuum pump used.

The demonstration shall be conducted utilizing the instruction manual and the recommended tools and skill levels. The demonstration shall show that access and replacement of replaceable parts is possible without personnel hazard and that the removal and replacement of certain components can be accomplished without cutting, welding or brazing.

4.4.2.11.1 Acceptance criteria. The plant shall be considered to be acceptable with respect to the maintainability tests if the following have been met:

(a) Effective drainage and cleaning of the plant, as specified in 5.1.2 was shown to be capable of accomplishment.
(b) Assembly and reassembly, including replacement of components was shown to be possible and without hazard to personnel.
(c) Adjustment or setting of switches shown to be possible without shock hazard.
(d) Removal and replacement of components was accomplished using the specified personnel and the recommended tools.

4.4.2.12 Visual inspection - condenser heads. Where condenser heads on submarine air conditioning plants are fabricated from nickel-copper material, the heads shall have the inside surfaces carefully examined visually to determine that they have been properly solder coated.

4.4.2.12.1 Acceptance criteria. The condenser heads examined shall be considered to be acceptable with respect to the solder coating requirements if it has been determined that all of the following have been met (see 3.6.2.9.3.1):

(a) The solder coating is not less than 1/64 inch nor appreciably more than 1/16 inch thick.
(b) No local or overall heating of the condenser head above 275°F has occurred after soldering.
(c) Threaded surfaces for zinc fingers, vent and drain connection bores, flange surfaces and O-ring groove surfaces have not been solder coated.

4.4.2.13 Electromagnetic interference tests procedure. The plant shall be tested for electromagnetic emission and susceptibility characteristics of electrical and electromechanical equipment and subsystems as required by MIL-STD-461.

4.4.2.13.1 The electrical and electromechanical equipment and subsystems as defined in MIL-STD-461 shall be tested and recorded as required therein.

4.4.2.13.2 The equipment and subsystems shall be considered acceptable if the conducted and radiated emission and susceptibility limits meet the requirements specified in MIL-STD-461 (see 3.5.7.2.1).

4.4.3 Component inspection and test. The first article of each type and size of the following components produced under any contract or order shall be selected for inspection and tests:

Water regulating valve (see 4.4.4.2)
Suction line strainer (see 4.4.4.3)
Filter-dehydrator (see 4.4.4.4)
Heating-cooling temperature switch (see 4.4.4.5)
Steam solenoid valve (see 4.4.4.6)

The first article inspection and tests shall include a design evaluation to establish that the component is in accordance with the requirements of the specification requirements, shock test, pressure test after shock test and performance test. The shock test for the water regulating valve, suction line strainer, filter-dehydrator and steam solenoid valve shall comply with MIL-S-901. The pressure test after shock shall be in accordance with test pressures specified in table II or III. The heating-cooling temperature switch shall be shock tested in accordance with the requirements of MIL-C-2212.

4.4.4 First article inspection and test - components.

4.4.4.1 Design evaluation. The design evaluation shall consist of a review of the components drawings to establish that the design is in accordance with all requirements of the specification (see 6.3 and appendix E). The component shall be inspected for adjustment, fit and finish. The materials shall be compatible for operation in sea water, refrigerant or other elements of the environment as applicable.

4.4.4.2 Water regulating valve test. The water regulating valve shall be tested for valve opening above closing point, operating range adjustment, leakage rate and flow versus pressure drop characteristics as required in 3.6.3 through 3.6.3.1.

4.4.4.2.1 The seat leakage test shall be with clean air or water at a pressure of test medium of 45 to 60 lb/in^2 or maximum operating differential whichever is less. The test fluid shall be applied to the normal valve inlet, and valve body outlet may be open to atmosphere or connected to a low headloss measuring device. The actuator shall be adjusted to meet the operating conditions specified. The full normal closing thrust as applied by air pressure, spring or other means shall then be applied. No allowance or adjustment shall be made to compensate for any increase in seat load obtained when the test differential is less than the maximum valve opening differential pressure.

4.4.4.2.2 Acceptance criteria. The water regulating valve shall be considered to be acceptable if the following have been met:

(a) The water regulating valve satisfactorily passed the shock and pressure test after shock test and showed no leaks, distortion or defects.
(b) The valve opening point above closing was determined.
(c) The valve operating range was as specified (see 3.6.3).
(d) Leakage rate was not greater than 0.5 percent of rated flow.

4.4.4.3 Suction line strainer. The suction line strainer shall be tested for its capacity to retain all contaminants 5 micrometers or larger. The strainer shall be installed such that refrigerant R-113 can be flushed through the strainer and the effluent retained in a clean container. The strainer shall be tested for 500 hours in a salt spray (fog) testing chamber to determine its capability to withstand corrosion. The test shall be in accordance with ASTM B 117.

4.4.4.3.1 Test procedure.

(a) Prepare a 5,000 milliliter (mL) sample of clean filtered R-113 solution.
(b) Flush 1,000 mL of prefiltered R-113 solution through the strainer. Discard the solution.
(c) To 2,000 mL of prefiltered R-113 solution add 2 grams of standardized air cleaner (A-C) fine test dust. Churn the solution to distribute the dust uniformly.
(d) Pass through the strainer the 2,000 mL R-113 solution with the test dust. Retain the effluent. Note: Ensure that all particles of the test dust have been discharged. If some particles remain in the container add additional clean R-113 and pass through the filter.
(e) Pass through the strainer the last 2,000 mL sample of clean prefilter R-113 solution to flush the strainer. Retain the effluent with the effluent in (d).

(f) All the fluid passed through the strainer shall be filtered through a 0.8 micrometer millipore membrane filter. Examine the filter by millipore computer counter to determine evidence of particle sizes 5 micrometers or larger. Millipore computer counter examination may be conducted at Edgewood Research or at a commercial laboratory acceptable to the Government.

4.4.4.3.2 Acceptance criteria. The suction line strainer shall be considered to be acceptable if the following have been met:

(a) The strainer satisfactorily passed the shock and pressure tests and showed no distortion leaks or defects after the shock test.
(b) The millipore filter revealed no evidence of particle sizes of 5 micrometers or larger.
(c) Inspection of the strainer after salt spray test showed no evidence of corrosion.

4.4.4.4 Filter-dehydrator. The same test procedure shall be used for the filter-dehydrator as the suction line strainer except the filter-dehydrators shall retain particles of 10 micrometers or larger (see 4.4.4.3).

4.4.4.4.1 Acceptance criteria. The filter-dehydrator shall be considered to be acceptable if the following have been met:

(a) The filter-dehydrator satisfactorily passed the shock and pressure tests and showed no distortion, leaks, defects, or molecular sieve powdering or breakage after shock test.
(b) The millipore filter revealed no evidence of particle sizes of 10 micrometers or larger.

4.4.4.5 Heating-cooling temperature switch. The heating-cooling temperature switch shall be tested for limit of differential adjustment, range adjustment, and drift at two setting approximately 70°F and 80°F. The switch shall then be subjected to an ambient air temperature of 125°F for a period of 24 hours and the test repeated. The set points shall not show drift or permanent change of more than plus or minus 2°F. The differential shall not show permanent change in excess of plus 1/2°F (see 3.6.14 through 3.6.14.3).

4.4.4.5.1 Acceptance criteria. The heating-cooling temperature switch shall be considered to be acceptable if the following have been met:

(a) The switch satisfactorily passed the shock test and other requirements of MIL-C-2212.
(b) The switch complies with the following:

(1) Has a cooling or heating differential of 2 ± 1/2°F.
(2) The two operating set points are 3 ± 1/2°F apart.
(3) Has a range spread of 50 to 90°F.
(4) After subjecting the switch to 125°F for 24 hours the set points did not show drift or permanent change of plus or minus 2°F and the differential did not show change in excess of 1/2°F.

4.4.4.6 Steam solenoid valve. The steam solenoid valves shall be tested for shock in accordance with MIL-S-901 and capacity. Valves with resilient seats shall be tested for durability of the seat.

4.4.4.6.1 Valve test. The steam solenoid valve shall deliver at least 100 pounds of steam per hour with inlet steam at 35 + 2 lb/in^2 and temperature of 375 + 10°F. The pressure drop through the valve shall be not more than 10 lb/in^2. Data shall be taken every 15 minutes until three successive readings indicate the steam flow rate is at least 100 lb/hr. At the conclusion of the test the hot valve shall be tested for steam leakage. The leakage shall be not greater than 10 cubic centimeters (cm^3) per hour at 35 lb/in^2 of steam pressure. Valves with resilient seats shall be subjected to a test of 50,000 cycles of operation with steam tempera-ture of 375°F. At the conclusion of the test the valve leakage shall be not greater than 10 cm^3 per hour at 35 lb/in^2 pressure (see 3.6.16.3).

4.4.4.6.2 Acceptance criteria. The steam solenoid valve shall be considered acceptable if the following have been met:

(a) The solenoid valve satisfactorily passed the shock test.
(b) The valve delivered 100 pounds of steam per hour under the conditions stated.
(c) The valve leakage was less than 10 cm^3 per hour.

4.5 Quality conformance inspection and tests.

4.5.1 Material verification procedures. The manufacturer shall verify that all materials used in the production process of each plant or component are in accordance with 3.4.8 and sea water boundary parts in submarine plants are identified and controlled in accordance with NAVSEA 0948-LP-045-7010.

4.5.1.1 Acceptance criteria. Acceptance criteria for materials verification shall be manufacturer's record of affirmative findings and identification and control of submarine sea water boundary as specified in NAVSEA 0948-LP-045-7010.

4.5.2 Silver-brazing inspection procedures. All components with silver-brazing as a method of joining shall be inspected in accordance with NAVSEA 0900-LP-001-7000.

4.5.2.1 Acceptance criteria. Acceptance criteria for silver-brazing inspections shall be in accordance with NAVSEA 0900-LP-001-7000.

4.5.3 Nondestructive inspection procedures. Nondestructive inspections shall be conducted in accordance with MIL-STD-271.

4.5.3.1 Acceptance criteria. Acceptance criteria for nondestructive inspections shall be as specified in MIL-STD-271.

4.5.4 Welding inspection procedures. Welds shall be inspected as specified in MIL-STD-278.

4.5.4.1 Acceptance criteria. Acceptance criteria for welding inspections shall be as specified in MIL-STD-278.

4.5.5 Finished parts inspection procedures. Finished part inspection shall be performed by the manufacturer's trained quality control inspectors to determine that each finished part and assembly is complete and in conformance with the contract or order. As a minimum, finished parts inspection shall include the following:

(a) Cleanliness. Assemblies shall be inspected for cleanliness as specified in 3.4.8 and 3.9.
(b) Missing parts. The completed product shall be inspected for completeness of all parts and appurtenances as shown on the applicable drawings and as specified in the contract or order.
(c) Adjustment. The plant or compressor's safety, control, and monitoring devices shall be adjusted and the readings recorded. Settings which should not be altered, once set, shall be tagged with appropriate warnings and cautions.
(d) Preservation. The plant compressor or component shall be inspected to verify that painting and preservation is as specified in 3.9 and section 5.

4.5.6 Quality conformance inspection and tests, plants. The production process inspection and tests shall be performed on each plant during the production process (see 6.3 and appendix E). The sequence of performance and timing of these inspections shall conform to and be an integral part of the production process. The plants shall undergo the following test procedures:

(a) Pressure and leak tests (see 4.4.2.3).
(b) Manufacturing processes (see 4.5.1 through 4.5.5).
(c) Noise tests (see 4.4.2.8).

    (1) Airborne.
    (2) Structureborne (when specified).

(d) Capacity test (see 4.5.6.1).
(e) Condenser head - submarine (lead coat) (see 4.4.2.12).

4.5.6.1 Capacity test. Operate the plant at the specified rating and parameters. Hold long enough to determine that the specified capacity can be maintained under stable conditions. During the test the function of instrumentation and each operating and safety control and relief valve shall be checked for proper operation and adjustment.

4.5.6.1.1 Acceptance criteria. The plant tested shall be considered to be acceptable with respect to the capacity test if the following have been met (see 3.3.1.1):

(a) The refrigeration capacity has been reached and maintained under stable conditions as measured by the calibrated instrumentation and corrected readings.
(b) The controls both operating and safety and relief valves were properly adjusted and functioned satisfactorily.

4.5.7 Quality conformance inspections and tests, components. Components shall be pressure and leak tested in accordance with 4.4.2.3. Components shall be inspected for fits, leaks, materials and finish to determine conformance with the requirements of the specification or approved drawing.

4.5.7.1 Moisture content test and dehydrator cartridge. Where dehydrator cartridges are purchased for stock, samples from each production lot shall be taken for inspection and test for moisture content. The number of units tested shall be as required in the contract or order but shall be not less than two samples per hundred units furnished. The units tested shall not be furnished as part of the contract or order.

4.5.7.1.1 Test procedure. The sample cartridges shall be inspected for conformance with the specification requirements, weighed and the weight recorded. The cartridges shall then be placed in an oven and maintained at 350°F for 4 hours. At the conclusion of the heating period, each cartridge shall quickly be weighed and the weight recorded.

4.5.7.1.2 Acceptance criteria. The dehydrator cartridge shall be considered acceptable if the following have been met:

(a) The inspection shall assure that the cartridge is hermetically sealed in a metal container.
(b) The weight loss after heating is not greater than 0.5 percent of the weight before heating.
(c) The cartridge shall be visually and dimensionally examined to verify compliance with the requirements. Pull tabs or means to remove the cartridge from the shell shall be provided. Gaskets shall be included. Refrigerant shall by-pass the dessicant.

4.5.8 Purchased components inspection procedures. When components or processes for use on the compressor are not manufactured or preformed at the manufacturer's facility but are contracted by the manufacturer to vendors, the manufacturer's quality program procedures shall include at least the following:

(a) Examination upon receipt, consistent with practicability, to detect damage in transit.
(b) Inspection to determine that components comply with applicable specifications and standards.
(c) Inspection prior to installation on the compressor that the component suffered no deterioration or deleterious effects during storage or damage from handling.
(d) Functional testing, either prior to or after installation on the compressor, to determine satisfactory operation.
(e) Identification and protection from improper installation or use.
(f) Electrical components have been tested in accordance with the applicable electrical specification requirements.

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

5. PACKAGING

(The packaging requirements specified herein apply only for direct Government acquisition. For the extent of applicability of the packaging or preparation for delivery requirements of referenced documents listed in section 2, see 6.8.)

5.1 General requirements.

5.1.1 First article packaging sample. When specified (see 6.2), for equipment which is required to be preserved level A and packed level A, a first article pack of equipment shall be subjected to the rough handling tests of MIL-P-116.

5.1.1.1 Dummy or simulated load. When specified (see 6.2), a dummy or simulated load may be used for the rough handling tests. When a dummy or simulated load is substituted for the actual equipment or item in performing the rough handling tests, instrumentation of the pack is required for assurance that the acceleration of the packaged item during the tests is less than the fragility rating of the part or item.

5.1.2 Cleaning. After completion of equipment testing, the oil, water, and refrigerant sides, except compressor, shall be drained and cleaned. Each equipment shall be cleaned so that all surfaces are free of grease, oil, flux, loose particles, and foreign materials.

5.1.2.1 Lubrication system. The lubrication system shall be flushed with normal operating lubricating oil, drained, new filters (see 3.6.1.2.3) installed, and recharged with new lubricating oil.

5.1.2.2 Water side. The water side shall be blown dry with air that is free from oil, water, and dirt. Drains shall be opened to thoroughly remove trapped water.

5.1.2.3 Refrigerant side. The refrigerant side of the condenser and cooler shall be cleaned before or after testing by the pumping of a cleaning solvent through the unit and a series of filters until no dirt or foreign particles remain in the system. Filters to be used shall be rated 15 micrometers absolute (remove all particles larger than 15 micrometers). Pumping procedure shall be operated for a minimum of 20 minutes through clean filters after it has been indicated that no dirt or foreign particles remain. After equipment testing and cleaning is completed, the refrigerant side of the unit shall be dehydrated by evacuation to a vacuum of approximately 5 mm of Hg absolute pressure. The unit shall then be charged (see 3.4.16) with dry, oil-free nitrogen to a positive gauge pressure approximately 5 lb/in^2. The system shall be provided with a separately mounted commercial pressure gauge or an installed system pressure gauge may be used if suitable, for verification that the system is pressurized. In addition, a fitting/connection, if not currently installed, shall be provided adjacent to the gauge for system recharging, when required, during the time equipment is under storage. A tag shall be provided stating that the system is pressurized to 5 lb/in^2 with dry, oil-free nitrogen. In addition, the tag shall contain instructions for depressurization and repressurization of the system.

5.1.3 Capillary tubes. Capillary tubes with bulbs (see 3.6.13) shall be removed only if required from their respective wells, coiled and tied, cushioned and wrapped and secured to the unit in a protected location. Each bulb package and well shall be tagged with each tag containing corresponding information for proper mating and reinstallation. Where used, a supply of heat conducting compound shall be provided for reinstallation of the thermal bulbs. Compound shall be in the quantity recommended by the equipment manufacturer and packaged in accordance with the manufacturer's retail procedure. Each package of compound shall contain complete identification markings, use instructions, storage recommendations and, if applicable, shelf life data.

5.1.4 Noise tested plants. Plants which have been noise tested shall be mounted and shipped on resilient mounts (see 3.3.5 and 3.6.1.7). Necessary precautions shall be taken to ensure that the low noise characteristics of the air conditioning plants are not degraded as a result of shipping.

5.1.5 Piping. Piping of like size and kind shall be bundled in quantities in accordance with commercial practice. Threaded ends shall be provided with protection to prevent thread damage. Ends of piping shall be sealed. Each bundle shall be securely tied with soft annealed wire. Two strands of No. 14 or No. 15 gauge wire shall be used for each tie, wrapped twice around the bundle. A minimum of four ties shall be applied on lengths up to 22 feet and one additional tie for every 6 feet 6 inches over 22 feet.

5.1.6 Replacement dehydrator cartridges and gaskets (see 3.6.8.2.2). Each replacement dehydrator cartridge and applicable gaskets shall be unit protected in a round can conforming to type I of PPP-C-96. The gaskets shall be placed in a bag of minimum practicable size and closed by any suitable means, prior to placing in the unit pack. Cans shall be provided with a scored key-opening band near the top. A corrosion-resistant key shall be attached to one end of the can. External surfaces of cans shall be coated with a rust-inhibiting enamel.

Side seam stripping shall be required. A humidity (color change) indicator shall be included in each pack. The completed unit pack shall meet the quick leak test of MIL-P-116. The unit packs shall be placed for shipment within one of the detached accessories and components shipping container (see 5.5).

5.2 Preservation. Preservation shall be level A or commercial as specified (see 6.2 and 6.3).

5.2.1 Level A. Each plant processed as specified in 5.1.2, 5.1.3 and 5.1.4 shall be protected to meet the requirements of method IIa of MIL-P-116. Exterior unpainted ferrous metal surfaces shall be coated with a preservative compound conforming to P-19 of MIL-P-116. Openings to the plant and attached components shall be covered to prevent entrance of foreign materials. Thermometers shall be removed and unit protected in accordance with method III of MIL-P-116. Gauges shall be cushioned and protected to prevent damage except the pressure-gauge used for inspection of the pressurized refrigerant side. The flexible barrier bag shall be fabricated from transparent material conforming to class E or G, style 2.

5.2.2 Commercial. Commercial preservation shall be in accordance with 5.1.2, 5.1.3, 5.1.4, 5.1.5, and ASTM D 3951.

5.3 Packing. Packing shall be level A or commercial as specified (see 6.2 and 6.3).

5.3.1 General.

5.3.1.1 Center-of-gravity mounted units (see 3.7.1.3.2). The equipment manufacturer shall provide a contractor owned cradle/support structure for each plant for support of the plant during transit and storage and which will remain with the plant until its shipboard installation. The support structure shall be marked:

REUSABLE - DO NOT DESTROY
RETURN TO EQUIPMENT
CONTRACTOR/MANUFACTURER
(NAME AND ADDRESS)

5.3.1.2 Anchoring, blocking, bracing, and cushioning. Anchoring, blocking, bracing, and cushioning of the container contents shall be in accordance with the appendix to MIL-C-104 and MIL-STD-1186.

5.3.2 Level A. Each plant shall be packed in a sheathed crate conforming to MIL-C-104, type II, class 2, and style at the contractor's option. Crates shall be provided with inspection doors. Doors shall be located to permit visual reading of the refrigerant system pressure-gauge and humidity indicator, and, of a size to permit access for repressurization, if required, of the system. Crate closure shall be in accordance with the appendix to MIL-C-104.

5.3.3 Commercial. Commercial packing shall be in accordance with ASTM D 3951. Plants, when shipped uncrated and by an open type carrier, shall be covered with a tarpaulin or reinforced plastic covering and secured to prevent loss and to protect equipment from shipment damage.

5.4 Marking. In addition to any special marking required (see 6.2 and herein), packs (interior and exterior) and unpacked shipments shall be marked in accordance with MIL-STD-129. Commercial packs and unpacked shipments shall be marked in accordance with ASTM D 3951 and herein.

5.4.1 Special markings.

5.4.1.1 Critical close tolerance equipment. Unit packs, shipping containers and unpacked shipments of noise tested plants (see 4.3.3.4) shall be marked with the following:

CRITICAL, CLOSE TOLERANCE
OPERATIONS EQUIPMENT
HANDLE WITH CARE
DO NOT DROP OR SUBJECT
TO SHOCKS OR JARS

Markings shall be stencilled, red color, and applied on two sides and both ends of the container or shipment, letters shall be of minimum 1-1/2 inches high, except for small containers with insufficient space, in which case letters shall be of such size as to be legible. In addition, arrows and the word "UP", center of balance, sling or lifting point markings as indicated in 5.4.1.3 shall apply.

5.4.1.2 Refrigerant side (see 5.1.2.3). Required tag and instructions shall be protected as specified in 5.4.2.1. A surface adjacent to or the inspection door itself shall be marked:

REFRIGERANT SIDE PRESSURE GAUGE - INSPECTION DOOR

5.4.1.3 Structural markings. Structural markings of each plant's container is required and shall be in accordance with MIL-STD-129 and as specified herein. Containers specified in 5.3.2 shall be marked:

REUSABLE CONTAINER

Container markings shall include arrows and the word "UP", center of balance and the sling or lifting points.

5.4.2 Instructions.

5.4.2.1 Unpacking and handling. Each packed plant shall be provided with unpacking and handling instructions. These instructions shall be placed in a sealed waterproof envelope prominently marked:

UNPACKING AND HANDLING INSTRUCTIONS

and firmly affixed to the plant, if shipped unpacked, or to the outside of the shipping container in a protected location (preferably between the cleats on the end of the container adjacent to the identification marking). If the instructions cover a set of equipment packed in multiple containers, the instructions shall be affixed to the number one container of the set or system.

5.4.2.2 Depreservation instructions. Each plant shall be provided a set of instructions covering the depreservation of the plants. Instructions shall state all information necessary for depreservation, assembly of detached accessories and parts, reinstallation of capillary tubes and other information necessary for assembly prior to installation/operation. Instructions shall be protected as specified in 5.4.2.1.

5.5 Detached components. Detached accessories and parts shall be individually preserved to the level as required for the plant. Preservation shall be in accordance with the applicable product specification. In the absence of such specifications, selection of the method of preservation shall be in accordance with MIL-P-116 and the intended use criteria therein. Preserved (unit protected) detached accessories and parts shall be consolidated within one or more of the exterior shipping containers for the level of packing as required for the plant. Containers selected shall be in accordance with table VII, exterior shipping container requirements, of MIL-STD-2073-1, appendix C, and herein. Container selection and options shall be at the contractor's option. Box closure shall be in accordance with the applicable box specification or appendix thereto; except that fiberboard boxes shall be closed with reinforced, pressure-sensitive tapes.

5.5.1 Index list. Each container shall be provided with an index list itemizing the contents of the container. The list shall be placed in an opaque or transparent bag and closed. Closure shall be by heat sealing or the bag may be provided with a press or zip closure. The list shall be placed inside the container on top of container contents to provide for ease of accessibility.

5.6 Technical manuals. Technical manuals, which accompany shipments, shall be unit packed in a transparent, waterproof plastic bag, minimum 4 mil thick. Closure shall be by heat sealing. Technical manuals shall not be placed within any flexible, sealed barrier enclosing components. The copies of the manual shall be placed in the shipping container housing the main unit. Packing lists shall indicate which container contains the technical manuals and shall also state the approximate location therein. For ease of removability, the location of the manuals shall be such that they are readily accessible when the container is opened. Technical manuals, when shipped in bulk quantities, shall not be individually wrapped, but shall be packed in accordance with the requirements of the applicable technical manual specification. Unless otherwise specified in the contract or order, two copies of the technical manuals applicable to each refrigerating plant or assembly shall be packed and delivered with each plant or assembly on a contract or order. Additional copies shall be furnished as specified in the contract or order (see 6.2). In the event the final manual is not available, a preliminary manual shall be included.

5.7 Refrigerant. Refrigerant (see 6.8.3.2) shall be prepared for shipment in accordance with BB-F-1421. In addition, containers shall be color coded in accordance with MIL-STD-101.

5.8 Lubricating oil. Lubricating oil (see 3.6.1.2 and 6.8.3.2) shall be prepared for shipment in accordance with VV-L-825.

6. NOTES

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

6.1 Intended use. These refrigerating plants and components are intended for use in an environmental control system for Navy surface ships and submarines. When required, the plants are designed with low structureborne noise characteristics and resistance to high impact shock associated with Naval combat. Refrigerating plants covered by this specification are used to refrigerate consumable products for ship's stores and cargo ships and to cool circulating water for air conditioning applications.

6.2 Acquisition requirements. Acquisition documents must specify the following:

(a) Title, number and date of this specification.
(b) Group, type, class, service, quantity and capacity required (see 1.2, 3.3.1, and 3.7).
(c) Issue of DoDISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1. and 2.2).
(d) When first article is required (see 3.2).

(e) Vapor temperature required (see 3.3.1).
(f) Water regulating valve requirements (see 3.3.1.1).
(g) Range of water gauges for submarine application (see 3.3.4 and 3.5.8).
(h) Whether structureborne noise testing of non-rotating, non-reciprocating machinery may be discontinued after successful tests of the first two plants (see 3.3.5).
(i) Airborne noise levels if other than those specified (see 3.3.5.1).
(j) Whether structureborne noise requirements shall apply to surface ship plants (see 3.3.5.2).
(k) Structureborne noise levels if other than those specified (see 3.3.5.2).
(l) The class of equipment shock tests, if other than that specified (see 3.3.9 and 4.4.2.7).
(m) Capacity and size of refrigerant piping if other than as specified (see 3.5.1.2).
(n) Whether main liquid solenoid valve is required (see 3.5.3).
(o) The motor service, if other than A (see 3.5.7.3).
(p) The type of motor controller if other than that specified (see 3.5.7.4).
(q) Pressure controls, temperature controls, and switches to be included on master switches (see 3.5.7.5).
(r) Type of temperature indicator required (see 3.5.10 and 3.5.10.2).
(s) Type of temperature detectors and alarms (see 3.5.10.2 and 3.7.1.3.2).
(t) Whether direct or V-belt drive is required (see 3.6.1.4).
(u) The frequency range of propeller excitation, hull critical frequencies and foundation natural frequency (see 3.6.1.7.2).
(v) Accelerometer mounting surface quantity, location, finish and method of attachment (see 3.6.1.7.3).
(w) The hydrostatic test pressure for seawater containing parts in submarine plants (see 3.6.2.9) (Note: CLASSIFIED.)
(x) Submarine condenser head flange design (see 3.6.2.9.3).
(y) If inlet water pressure is other than as specified (see 3.6.3).
(z) Analysis of water regulating valve for varying submergence conditions (see 3.6.3.3).
(aa) Design requirements for sea water containing components (see 3.6.3.3 and 4.4.2.4).
(bb) Length of capillary tubing of temperature control switches (see 3.6.13).
(cc) The capacity, service and length of capillary tubing of thermal expansion valve. Whether external equalizer connection is to be provided (see 3.6.15).
(dd) Type, capacity and voltage of solenoid valves (see 3.6.16 and 3.6.16.2).
(ee) Is electric or hot seawater spray defrosting required for refrigerated cargo forced air coolers (see 3.6.18.2).
(ff) Capacity of water chiller (see 3.6.19).
(gg) Whether surface ship plants are to be resiliently mounted for low structureborne noise requirements (see 3.7).
(hh) Parts and special tools required for class 2 (see 3.7.1.2(a)(b)).
(ii) Parts and special tools required for class 3 (see 3.7.1.3 and 3.7.2.3).

(jj) If bedplate arrangement is other than as specified (see 3.7.1.3.2).
(kk) If interconnecting suction and discharge piping is to be provided with class 4 plants (see 3.7.2.4).
(ll) Arrangement of prefabricated circulating water plant (see 3.7.2.4).
(mm) If condenser-chiller arrangement is right-hand or left-hand (see 3.7.2.4.2.1).
(nn) Thermal and stress analysis and fatigue evaluation (see 4.4.2.4).
(oo) If acceptable sound pressure levels are other than as specified (see 4.4.2.8.1.1).
(pp) If acceptable structureborne vibratory acceleration measurements are other than as specified (see 4.4.2.8.2.1).
(qq) Whether a first article packaging sample test including dummy or simulated load is required (see 5.1.1 and 5.1.1.1).
(rr) Level of preservation and packing required (see 5.2 and 5.3).
(ss) Special marking required (see 5.4).
(tt) If additional copies of technical manuals are required (see 5.6).

6.2.1 Bid data. Bidders should submit with their bids, as applicable, a statement in duplicate showing:

(a) Itemized list and description of equipment to be furnished, including repair parts and tools.
(b) Total weight per unit of equipment and per unit of repair parts and tools.
(c) Description of compressor, including model number, bore, stroke and number of cylinders, revolutions per minute, displacement and qualification test number.
(d) Tons capacity and brake horsepower requirements at conditions from minus 20°F to plus 50°F (in at least 5 degree increments) evaporating and 105°F condensing temperatures. (Graphic form will be acceptable.)
(e) Description of condenser and chiller, including square feet of surface, tube length, shell diameter and number of tubes.

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

Reference Paragraph	DID Number	DID Title	Suggested Tailoring
3.3.5 and 4.4.1	UDI-T-23731	Notification of tests	---
3.3.5	DI-HFAC-80271	Sound test failure notification and recommendation report	---
3.3.5.1	DI-HFAC-80270	Equipment airborne sound measurement plan	---

Reference Paragraph	DID Number	DID Title	Suggested Tailoring
3.3.5.1	DI-HFAC-80272	Equipment airborne sound measurement test report	---
3.3.5.2	DI-HFAC-80273	Equipment structure-borne vibratory acceleration measurement plan	---
3.3.5.2	DI-HFAC-80274	Equipment structure-borne vibratory acceleration measurement test report	---
3.3.6.1 and appendix B	DI-GDRQ-80650	Design data and calculations	---
3.4.1 and 3.4.3	DI-SAFT-80101	System safety hazard analysis report	---
3.4.14, 3.6.2.6, 3.6.3.2, 4.4.2.2, and appendix A	DI-DRPR-80651	Engineering drawings	---
3.4.10 and appendix D	DI-MISC-80678	Certification/data report	---
3.5.7.2.1	DI-EMCS-80201	Electromagnetic interference test plan	---
3.5.7.2.1	DI-EMCS-80200	Electromagnetic interference test report	---
4.1.1	DI-R-4803	Inspection system program plan	---
4.4.2.1, 4.4.2.4, 4.4.2.11, 4.4.4.1, 4.5.6 and appendix E	DI-MISC-80653	Test reports	---
5.2 and 5.3	DI-PACK-80120	Preservation and packing data	---

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

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

6.5 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in Qualified Products List No. 16743 whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or purchase orders for the products covered by this specification. The activity responsible for the Qualified Products List is the Naval Sea Systems Command, NAVSEA 5122P, Department of the Navy, Washington, DC 20362-5101, and information pertaining to qualification of products may be obtained from that activity. Application for qualification tests must be made in accordance with "Provisions Governing Qualification SD-6" (see 6.5.1).

6.5.1 Copies of "Provisions Governing Qualification SD-6" may be obtained upon application to Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

6.6 First article. When first article inspection is required, the contracting officer should provide specific guidance to offerors whether the item(s) should be a preproduction sample, a first article sample, a first production item, a sample selected from the first production items, a standard production item from the contractor's current inventory (see 3.2), and the number of items to be tested as specified in 4.4. The contracting officer should also include specific instructions in acquisition documents regarding arrangements for examinations, approval of first article test results, and disposition of first articles. Invitations for bids should provide that the Government reserves the right to waive the requirement for samples for first article inspection to those bidders offering a product which has been previously acquired or tested by the Government, and that bidders offering such products, who wish to rely on such production or test, must furnish evidence with the bid that prior Government approval is presently appropriate for the pending contract. Bidders should not submit alternate bids unless specifically requested to do so in the solicitation.

6.7 Previously tested and certified equipment that has met the EMI test limits of superseded specification MIL-I-16910 are acceptable, without retest.

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

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

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

6.8.3 Repair and replacement parts. The requirements of this specification apply to all repair and replacement parts furnished under a contract or order, whether for compressors and replacement parts or solely for parts in support of compressors previously acquired to this specification under other contracts. Each repair and replacement part should be of a design which has been qualified as part of the compressor in the qualification tests and as such is listed in the Qualification Record Drawings (see 4.3.1). The selection, identification, and quantity of repair parts for shorebased and replenishment stocks must be as specified in the contract or order.

6.8.3.1 Repair parts. Repair parts are those specific component parts of the plant that must be available in order to perform the planned maintenance prescribed by the manufacturer in the technical manual and those parts required for repair of the plant. For the purpose of determining repair part requirements it should be assumed that plant repair will be confined to anticipated repairs associated with normal wear and the occurrence of failures based on the reliability limitations of the plant as established by the reliability test specified in 4.3.3.8 provided, however, that the repairs are suitable and practicable for accomplishment at sea by electrician and machinist mates. The quantities of each specific repair part which collectively constitutes one set of repair parts, should be sufficient for an installation indicating one, two, three or four plants per ship, for a calendar period of 2 years, and for an actual operating period of 15,000 operation hours of each compressor. The list of repair parts, indicating the quantity of each part comprising one complete set, should be one of the engineering drawings included in the Ship Equipment Drawings (see appendix A). The list of repair parts should indicate the quantity of each part comprising one complete set of repair parts, the identification of each part by name, part number, model number, and ordering number, as applicable, and the name of the manufacturer (if other than the compressor manufacturer). The number of sets of repair parts must be as specified in the contract or order.

6.8.3.2 Fluids replacements. Unless otherwise specified, on board quantities of lubricating oil and refrigerant should be provided based on the following guidance:

(a) Lubricating oil. One replacement charge for each compressor supplied in 1 quart containers.
(b) Refrigerant. The replacement charge should be supplied in 50-pound cylinders. The refrigerant should be in accordance with the requirements of BB-F-1421. Cylinders should be in accordance with RR-C-910 and RR-C-910/1, classification number C910/1-3 for 50-pound cylinders.

The quantity of replacement refrigerant supplied should be in accordance with the following:

Number of plants installed on board ship	Quantity of replacement refrigerant supplied
1 to 3	125 percent of a complete charge 1/
4	225 percent of a complete charge
5 to 8	325 percent of a complete charge

1/ The following example indicates how to determine the quantity of replacement refrigerant: If a ship has 5 plants installed, each requiring 160 pounds of the same refrigerant, the quantity of replacement refrigerant supplied should be 160 pounds x 3.25 = 520 pounds. In order to determine the number of 50-pound refrigerant cylinders, divide 520 (pounds) by 50 = 10 fully charged cylinders, plus 20 pounds. In this case, provide 11 fully charged 50 pound cylinders (or 550 pounds).

6.9 Issuing agency. The word "NAVSEA" as used herein refers to the Naval Sea Systems Command, Washington, DC 20362-5101. The terms "Command," "agency," and "Command or agency" as used herein refer to the contracting activity.

6.10 Subject term (key word) listing.

Air conditioning
Built-up plant
Prefabricated plant
Reciprocating compressor
Refrigerated storage

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

Preparing activity:
Navy - SH
(Project 4130-N308)

APPENDIX A

ENGINEERING DRAWINGS TECHNICAL CONTENT REQUIREMENTS

10. SCOPE

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

20. APPLICABLE DOCUMENTS

20.1 Government documents.

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

SPECIFICATIONS

MILITARY

MIL-M-9868	- Microfilming of Engineering Documents, 35MM Requirements for.
MIL-C-9877	- Cards, Aperture.
MIL-M-38761	- Microfilming and Photographing of Engineering/ Technical Data and Related Documents: PCAM Card Preparation, Engineering Data Micro-Reproduction System, General Requirements for, Preparation of.
MIL-M-38761/2	- Microfilming and Photographing of Engineering/ Technical Data and Related Documents: PCAM Card Preparation, Engineering Data Micro-Reproduction System: Microfilm Aperture and Tabulating Cards for Naval Ship Systems.

STANDARDS

MILITARY

MIL-STD-804	- Formats and Coding of Aperture, Copy and Tabulating Cards for Engineering Data Micro-Reproduction System.

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Standardization Documents Order Desk, BLDG. 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

30.1 Engineering drawings. Drawings and associated lists shall be identified by the manufacturer's drawing numbers and shall be in accordance with DOD-D-1000, level 2 and DOD-STD-100. If material identification and material specifications are not provided on the level 2 drawings, the applicable level 3 part drawings that show the material identification shall also be provided. Full-sized reproducible drawings shall be inked on cloth or polyester film, or they shall be photographic reproductions on cloth or polyester film. The quality, legibility, clearness, and distinctness shall be suitable for microfilming in accordance with MIL-M-9868. Full-sized prints of drawings may be diazo, blueprints, or electrostatic prints.

30.1.1 The drawings required by the Government are needed to delineate, fully and clearly, the design, construction and performance capability of the plant and to permit naval personnel, in conjunction with technical manuals, to install, operate, maintain and repair the plant, its equipment and accessories. To this end, the drawings provided shall contain appropriate elements of the following types of drawings, as described in DOD-STD-100: Assembly drawings; detailed assembly drawings; installation assembly drawings; exploded assembly drawings; interface control drawings; installation drawings; diagrammatic drawings; connection or wiring diagrams; piping diagrams and drawings for plant maintenance and repair. The complete set of drawings provided shall include the following:

(a) Diagram and certification data.
(b) Machinery arrangement.
(c) Piping arrangement.
(d) Assembly drawings.
(e) Electrical circuits arrangements.
(f) Details of selected parts and assemblies.
(g) Maintenance and repair.

Equipment drawings shall include parts list and list of materials. Certification data drawings shall include diagrams and a list of drawings in the drawing set. The number of drawing sheets shall be kept to a practical minimum and shall be consistent with the requirements specified herein.

30.1.2 Assembly drawings. Assembly drawings shall include a sectional assembly with complete list of material with references to applicable subassembly and detail drawings. The list of material shall include every part required in the assembly, including those parts not required to be detailed. Assembly drawings shall contain a warning where noise specifications are invoked that care should be taken to maintain specified tolerances during overhaul periods. Critical features required for noise quieting shall be pointed out. Location of attachment points for noise measurement pick-ups should be shown and suitable means shown for protection of pick-up points. Torque requirements for threaded fasteners used on waterside applications shall be shown. Instructions for prestressing of fasteners shall be given. Assembly drawings shall be provided for each of the following equipment and components, when they are acquired as a component part of an assembly or complete refrigeration plant:

(a) Condenser - chiller assembly.
(b) Compressor unit assembly.
(c) Condensing unit.
(d) Compressor.
(e) Condenser.
(f) Chiller/cooler.
(g) Cooling coils/unit coolers.
(h) Receiver.
(i) Valves.
(j) Moisture indicator.
(k) Dehydrator.
(l) Fans.
(m) Controls.
(n) Instruments.
(o) Heat interchanger.
(p) Strainer or filters.
(q) Safety devices.
(r) Motors.
(s) Controllers.
(t) Couplings.
(u) Seawater regulating valve.
(v) Oil cooler.
(w) Oil heater.
(x) Complete refrigeration plant.
(y) Defrosting system and controls.

Drawings for motors, controllers and other listed components being supplied in accordance with a component specification shall be furnished as required.

30.1.2.1 The assembly drawing shall illustrate design, construction, operation or function, all running clearances, identity of parts and model number. Drawings shall be sufficiently complete to show compliance with the contract and specification requirements. Where necessary to illustrate compliance, subassembly drawings shall be furnished where assembly drawings do not adequately describe and identify subassembly parts and components. The outline assembly drawing shall include all supplementary data necessary to permit installation guidance without contractor assistance. Connections requiring interface with shipbuilder installed piping shall be delineated as to size, type and three-plane dimensional locations indicated with a tolerance not greater than plus or minus 1/4 inch. The outline drawing shall show the following:

(a) Envelope dimension.
(b) Mounting attachments, connection dimensions including methods and sizes of fastenings and list of shipbuilder connections.
(c) Clearances for installation and servicing.
(d) Table of weights of individual components and weight of complete unit.
(e) Radii of gyration of complete unit about each of the three principal axis (required only if equipment is vibration mounted).
(f) Vertical center of gravity for each assembly above the lowest extremity of the equipment support.

30.1.2.2 Curves shall be provided to show plant capacity, motor Kw (see 3.3.2) and motor current with condensing temperatures of 115°F, 105°F, 95°F, 90°F, 80°F, 70°F and 60°F and suction pressure equivalent to 25°F, 10°F, 0°F, minus 10°F and minus 20°F for refrigerating plants. For air conditioning chilled water plants at each of the above condensing temperatures, the chilled water temperature and flow shall be varied to obtain data at chilled water outlet temperature of 44°F, 40°F and 50°F, and chilled water flow at 3.0, 3.6 and 4.5 gal/min per rated ton at design conditions. The results shall be plotted in graphic form. The graph or graphs may be a family of curves. The charts or curves shall indicate how to make a valve selection for a specific application. Flow versus pressure drop curves shall be provided for:

(a) Condenser.
(b) Water chiller.
(c) Lube oil cooler.

30.1.3 Detail drawings. Detail drawings of parts and subassemblies necessary for evaluation of the equipment, and parts necessary for maintenance and overhaul of the equipment shall be furnished. Drawings shall show all essential fabrication details including surface finishes and welding requirements and symbols. Unique weld identification numbers shall be assigned for welds in seawater containing components. Location of radiographic inspection markings shall be shown for castings which require radiographic inspection or other nondestructive testing. Subassemblies whose parts cannot be acquired or serviced individually should be shown as a single part. Multi-detailed drawings are preferred, but mono-detail drawings may be used. Drawings are not required for those parts which are in common commercial use and can be referenced to a commercial standard.

30.1.4 Certification data. Certification data drawings shall be provided. These drawings shall be certification by the contractor that the refrigerating or air conditioning plant, and its components and accessories, comply fully with this specification, as invoked in the contract or order. Certification data drawings shall include a reference drawing list of all the plant assemblies, components, parts, control system items and ancillary components being furnished on the contract or order. Diagrams shall also be provided. Diagrams shall include a refrigerant and water piping diagram, pneumatic or electrical control diagram, lubricating oil and electrical wiring diagram. Diagrams shall show by symbolic representation all fluid piping, internal passages, pipe sizes, electrical interconnections, components, accessories' control and associated instruments, performance characteristics as applicable, direction of flow, operating sequence and connections required by others for operation. For example, a piping diagram shall include associated units, controls, gauges, thermometers, valves, piping accessories, seawater and chilled water connections, as applicable. An electrical schematic wiring diagram shall include and show circuits between motor controllers, motors, controls, switches and accessories as applicable for an understanding of operating sequence with a narrative description of operation. Symbols used for equipment shall be given a piece number and identified in the list of materials with the following information:

(a) Piece number.
(b) Quantity required.
(c) Descriptive name.
(d) Manufacturer's name.
(e) Manufacturer's model or identifying number.
(f) Manufacturer's drawing number.
(g) Weight.
(h) Characteristics.

30.1.5 The characteristics shall include ordering information necessary to supplement data described in reference drawing or manufacturer's model and part number. A separate table shall be used for the various components where necessary and shall include the following:

(a) Compressor unit - bore, stroke, number of cylinders, revolutions per minute (r/min), capacity in tons, design suction rating condition, design condensing temperature, compressor motor rated horsepower, motor frame size number, and electrical characteristics.
(b) Condenser - square feet of tube surface, number of passes, type of surface (finned or bare), design seawater flow (gal/min), water velocity (ft/min), heat rejection (Btu/hr), design pressure drop (lb/in^2), design inlet and outlet water temperatures, design condensing temperature, outside diameter of shell, number of tubes, tube material, minimum wall thickness at the root of the fin, fins per inch, tube length and outside diameter, and overall length.
(c) Receiver - capacity in pounds of refrigerant.
(d) Evaporator:

(1) Water chiller - design water flow (gal/min), design inlet and outlet water temperatures, design refrigerant temperatures, design water pressure drop (lb/in^2), outside diameter of shell, tube length, overall length, tube material, number of tubes and outside diameter of tubes.
(2) Forced circulation cooling coils - capacity at suction evaporating temperature, temperature difference refrigerant to air, coil dimensions, tube size and wall thickness, fan horsepower, coil face velocity and number of fans, refrigerant inlet and outlet tube size connection, fins per inch and fin thickness, electric defrost-voltage, defrost heating element type, make, current and voltage.
(3) Gravity cooling coils - square feet primary and secondary coil surface, tube size, fins per inch and fin size and thickness.

(e) Thermal expansion valves - type of equalizer, capacity (tons), length of capillary and design pressure differential (lb/in^2). Note: The thermal expansion valve shall be identified with its connected load or coil.
(f) Refrigerant charge - type of refrigerant (R-12), estimated operating charge (pounds) for compressor, condenser, heat interchanger, receiver, evaporators and piping.

(g) Complete data for the assembly of equipment shall be provided including manufacturer's name, model number, capacity and rating condition, design test pressure, specification acceptance tests conducted (identify each test), review activity, date, contract order number, and technical manual NAVSEA number.

30.1.6 Electrical component drawings. In addition to drawing requirements specified herein, the content and format of electrical component drawings shall conform to the requirements of the applicable component specification. The master drawing for the compressor motor shall be prepared in accordance with the appendix to MIL-M-17060.

30.1.7 Drawing for maintenance and repair. The drawing for maintenance and repair shall provide all technical data to ship personnel and repair activities for maintenance and repair of the plant. The technical data shall be complementary to the written text as contained in the applicable technical manual supplied by the manufacturer. The drawing for plant maintenance and repair in conjunction with the use of written text as contained in the technical manual, but without additional assistance from the manufacturer, shall include all technical data to accomplish the following operation, maintenance and repair tasks:

(a) Maintain the plant at optimum performance for the intended service.
(b) Determine the degree of wear and acceptability for further service of parts and components.
(c) Document on board repair part provisioning.
(d) List of supplied equipment and replacement parts with weights.

30.1.8 Model development drawings. Drawings and other design information from which the planning yard can develop a full-scale mock-up of the refrigerating plants being supplied shall be provided when required. The mock-up will be used to develop the space arrangement and piping layouts in the area of the air conditioning plant. Drawings supplied to the planning yard shall contain all the information required to develop the mock-up and containing at minimum the following information:

(a) Dimension, locations, and size of components and connections.
(b) Mounting arrangement and locations.
(c) Access areas and clearance required for servicing and maintenance.
(d) Contours of components.

30.2 Microfilm of engineering drawings, aperature cards and tabulating index cards and listings. When specified in the contract or order, microfilm and aperture cards shall be prepared in accordance with MIL-M-9868, type I, class 1, MIL-STD-804, MIL-M-38761, MIL-M-38761/2 and MIL-C-9877.

30.2.1 Microfilm mounted in aperture cards shall be supplied with coverage of drawings applicable to items of equipment. Microfilm shall be one sheet per frame format. A set of cards shall consist of that number of cards necessary for the required coverage. Microfilm shall be in accordance with MIL-M-9868, type I, class 1.

30.2.2 Tabulating index cards shall be supplied for aperture cards. A set of tabulating index cards shall consist of an index card for each aperture card in a set of microfilm aperture cards, as defined herein.

30.2.3 Selection and preparation of aperture and tabulating index cards shall be in accordance with MIL-STD-804, MIL-M-38761, MIL-M-38761/2 and MIL-C-9877.

30.2.4 Responsibility to update sets of microfilm aperture cards and tabulating index cards supplied to the Government. Microfilm mounted in aperture cards and tabulating index cards shall be supplied for drawings generated or revised during the time period between initial submittal of card sets and expiration of the contractor's responsibility for last ship set of equipment.

APPENDIX B

DESIGN DATA AND CALCULATIONS TECHNICAL CONTENT REQUIREMENTS

10. SCOPE

10.1 Scope. This appendix covers the technical content requirements that shall be included in design data and calculations when required by the contract or order. This appendix is mandatory only when data item description DI-GDRQ-80650 is cited on the DD Form 1423.

20. APPLICABLE DOCUMENTS

20.1 Government documents.

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

STANDARDS

MILITARY

MIL-STD-785 - Reliability Program for Systems and Equipment Development and Production.
MIL-STD-1521 - Technical Reviews and Audits for Systems, Equipments, and Computer Software.

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Standardization Documents Order Desk, BLDG. 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

30. CONTENTS

30.1 Reliability program plan. When specified in the contract or order, a reliability program plan shall be prepared. The program shall include provisions to ensure subcontractor performance consistent with the reliability requirements of this specification. The program plan shall incorporate, as a minimum, the reliability program elements of MIL-STD-785 and 30.1.1.

30.1.1 Reliability program elements. The reliability program shall utilize the applicable procedures of MIL-STD-785 required to achieve the specified MTBF, including the following elements of MIL-STD-785, as a minimum:

(a) Subcontractor and contractor reliability programs.
(b) Design techniques.
(c) Reliability analysis.
(d) Parts reliability.
(e) Failure mode, effects, and criticality analysis.
(f) Reliability critical items.

(g) Design reviews. The contracting activity shall be notified at least 15 days prior to each design review to permit possible participation by the contracting activity. The design review shall comply with the procedures of MIL-STD-1521.
(h) Transition from development.

30.1.2 Reliability analysis report. When specified in the contract or order, a reliability analysis report shall be prepared. The report shall consist of data which the contractor has recorded on refrigerating plants, assemblies, or components he manufactures. Data shall have been collected over a 3-year period during actual field operating experience exclusive of prototype testing. The reliability analysis report shall comply with the procedures of MIL-STD-785, task 202, and shall list the following data:

(a) Plant serial numbers.
(b) Plant model numbers.
(c) Quantity in service.
(d) Service time for each plant.
(e) Number and description of failures.

30.2 Stress analysis. When required by the contract or order, detailed rigorous thermal and stress analyses and a fatigue evaluation shall be prepared for all submarine seawater pressure containing components.

APPENDIX C

TECHNICAL MANUAL TECHNICAL CONTENT REQUIREMENTS

10. SCOPE

10.1 Scope. This appendix covers the technical content requirements that should be included in technical manuals when required by the contract or order. This appendix is not a mandatory part of the specification. The information contained herein is intended for guidance only.

20. APPLICABLE DOCUMENTS

20.1 Government documents.

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

SPECIFICATIONS

MILITARY

MIL-M-8910 - Manuals, Technical, Illustrated Parts Breakdown, Preparation of.

MIL-M-15071 - Manuals, Technical: Equipments and Systems Content Requirements for.

MIL-P-24534 - Planned Maintenance System: Development of Maintenance Requirements Cards, Maintenance Index Pages, and Associated Documentation.

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Standardization Documents Order Desk, BLDG. 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

30. TECHNICAL MANUAL CONTENTS

30.1 Technical manuals. Each type of refrigerating system and electrically operated and automatic control valves and control devices that are not included in the refrigerating system technical manual or other system technical manual or instruction book shall have its own individual technical manual. Technical manuals shall conform to the requirements of MIL-M-15071 for type I manuals, MIL-M-8910 for illustrated parts breakdown and NAVSEA S0300-AX-GYD-010. In addition, the unique features specified in 30.1.1 through 30.1.7 shall be included.

30.1.1 Each manual shall contain line drawings of the refrigerating plant or assembly to clearly show the arrangement of components in addition to the illustrations required by MIL-M-15071. A section shall be provided at the back of the manual containing reduced size copies of drawings including diagrams and assembly drawings of the refrigerating plants, ancillary equipment, motor, electrical controllers, circuit breakers, and controls. Drawings may be referenced in order to amplify the text. In addition, those portions of the text which describe operation, maintenance procedures, assembly, disassembly, alignment and control adjustment shall be supplemented with sketches, sectional views, exploded views or schematics as appropriate, located as near as possible to the related text. Text and amplifying material shall be sufficiently detailed to permit accomplishment of procedures or actions without repeated reference to drawings. Drawings furnished, including reduced size copies, must be completely legible without the use of special aids. The technical manual shall include a section calling attention to the toxic effect of refrigerant and the possibility of asphyxiation due to air being displaced by the refrigerant.

30.1.2 Quantitative maintenance data. Manuals shall provide quantitative maintenance data such as maximum allowable wear, maximum permissible eccentricities and misalignment, required clearances, interference fits, torque values of threaded fasteners, sequence of torque application, and prestressing procedures for fasteners on condenser heads. Planned maintenance instructions for the prevention of failures shall be provided. The manual shall include balancing instructions for rotating parts where applicable.

30.1.3 Troubleshooting. Troubleshooting procedures shall be prepared and documented by level of maintenance: organizational, intermediate, and depot. Troubleshooting shall include a listing of the support and test equipment required to accomplish each set of procedures along with the estimated manhours for accomplishment.

30.1.4 Detailed scheduled maintenance. Detailed scheduled maintenance procedures for ships force, tender repair force and depot level of maintenance shall be delineated in the manual. When specified in the contract or order, maintenance requirement cards shall be prepared in accordance with MIL-P-24534.

30.1.4.1 When specified in the contract or order, maintenance index pages shall be prepared in accordance with MIL-P-24534.

30.1.5 Corrective maintenance. Corrective maintenance procedures shall be prepared and documented by level of repair: ships force, tender repair force, and depot. They shall also include a listing of the support and test equipment required to accomplish each operation, the personnel required, and the estimated manhours needed to accomplish each operation. The definitive list of special tools (see 3.10) comprising one set and a drawing for each tool, to permit the ship's personnel to make the tool in an emergency, shall be included in the technical manual for the plant.

30.1.6 Validation. The contractor shall validate or have validated manuscripts for each type, class, arrangement and capacity of new and revised manuals, including changes, furnished under the terms of the contract. In those cases where validation is performed at a subcontractor's plant, the prime contractor is responsible for the quality of the manual manuscript and shall provide verifiable evidence of the adequacy of the validation performed. Validation shall be completed and corrections made and validated prior to presentation of any part of the manuscript to the Government for verification. Validation shall include, but not be limited to, the following:

(a) Written information, engineering drawings, and art work in the manual shall be compared to the related physical equipment to assure that the information presented accurately delineates the equipment.

(b) A demonstration of assembly, operation and maintenance procedures described in the manual shall be accomplished on the equipment. This may coincide with the maintainability demonstration (see 4.4.2.11). Items of the following nature need not be performed:

(1) Actions which would destroy or damage components such as disassembly of electronic components or removal of condenser tubes.

(2) Boring, grinding and other shaping repair procedures.

30.1.6.1 Waiver of validation. The contractor must validate (or have validated) one of each type manual required under the terms of the contract. If the content assurance page of a manual to be supplied indicates complete prior validation, or partial validation of the manual for a refrigerating plant meeting the same requirements as the plant to be supplied under the contract or order concerned, then validation of the manual or of the previously validated part of the manual may be waived at the discretion of the contracting activity. This waiver must be requested by the manufacturer, who shall furnish evidence of prior validation. When it is evident, through visual examination or by following a logical sequence of steps that the procedures or instructions can be performed as indicated, those procedures or instructions may be waived, at the discretion of the contracting activity. When a previously validated design is offered with modifications, only those portions modified and those affected by the modification shall require validation at the discretion of the contracting activity.

30.1.7 NOFORN clause. The NOFORN marking depicted below shall appear on the front cover and title page of unclassified technical manuals:

In addition to security requirements which must be met, this document is subject to special export controls and each transmittal to foreign governments or foreign nationals may be made only with prior approval of the Commander, Naval Sea Systems Command.

APPENDIX D

CERTIFICATION/DATA REPORT TECHNICAL CONTENT REQUIREMENTS

10. SCOPE

10.1 Scope. This appendix covers the technical content requirements that shall be included in certifiction/data reports when required by the contract or order. This appendix is mandatory only when data item description DI-MISC-80678 is cited on the DD Form 1423.

20. APPLICABLE DOCUMENTS

This section is not applicable to this appendix.

30. CERTIFICATION

30.1 Certification contents. When required by the contract or order, certification/data reports shall state that no mercury or mercury containing instruments have been used in the manufacture or testing of the plant and that the plant, when shipped, is free of mercury contamination. The certification shall be signed by a responsible official for the contractor.

APPENDIX E

TEST REPORTS TECHNICAL CONTENT REQUIREMENTS

10. SCOPE

10.1 Scope. This appendix covers the technical content requirements that shall be included in test reports when required by the contract or order. This appendix is mandatory only when data item description DI-MISC-80653 is cited on the DD Form 1423.

20. APPLICABLE DOCUMENTS

This section is not applicable to this appendix.

30. TEST REPORTS

30.1 Test reports technical content. When required by the contract or order, test procedures shall be prepared. The test procedures shall include instrumentation and data to be collected. The procedure shall also indicate which tests can be performed concurrently to satisfy individual test requirements. Reports of all inspections and tests shall be complete and assembled in an organized, indexed format. Each report shall contain a test summary and resume of conclusions. Reports shall substantiate the fact that all required inspections and tests have been conducted and that all requirements of the specification have been met. Test reports shall present the data to enable NAVSEA and the contracting activity reviewers to determine with certainty whether or not the design and performance of the tested and inspected plant or component conforms to the specified acceptance criteria. Reports shall identify the applicable plants or components by contract or order number, contractor's serial number, identification plate data and contracting activity. The report shall be certified by the contractor that the plant has been tested and inspected and found to be acceptable in all respects with regard to the requirements of this specification and the contract or order.

30.2 First article inspection reports.

30.2.1 Test procedure reports. First article test procedure reports shall include procedures for performing proof pressure tests for submarine plants (see 4.4.2.4) and procedures for performing capacity tests (see 4.4.2.10.1). Capacity test procedures shall include a diagram indicating type and location of all instrumentation and piping arrangement.

30.2.2 Inclined operation test. For the inclined operation test (see 4.4.2.5), recorded data shall include the data necessary to evaluate the performance of the critical design features.

30.2.3 Maintainability demonstration. An elapsed time log shall be included in the maintainability demonstration report (see 4.4.2.11) to show the time required to disassemble and reassemble each component. Where maintenance on any component requires removal of other components, the log shall include the time required for disassembly and reassembly of all such components.

30.2.4 Design review (see 4.4.4.1). Certification shall be prepared that the component drawings have been reviewed and that the design is fully in accordance with the specification. The certificate of compliance shall include a set of component drawings to permit Government review.

30.2.5 Water regulating valve test (see 4.4.4.2). Flow charts or curves showing flow versus pressure drop and method of valve selection for various applications shall be prepared.

30.3 Quality conformance inspection reports. When required by the contract or order, the individual test reports for the quality conformance test reports shall be assembled into a Composite Production Unit and In-Process Test Report under one cover or binder. The cover or front sheet of the test report shall identify the specific compressor manufacturing serial number for the plant to which it applies and the Ship Equipment Certification Data Sheet number for components, the type of unit and serial number where applicable.

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.
2. The submitter of this form must complete blocks 4, 5, 6, and 7.
3. The preparing activity must provide a reply within 30 days from receipt of the form.

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

I RECOMMEND A CHANGE:	1. DOCUMENT NUMBER MIL-R-16743F(SH)	2. DOCUMENT DATE (YYMMDD) 1 March 1991

3. DOCUMENT TITLE Refrigerating Plants and Systems, Mechanical and Refrigerating System Components - Dichlorodifluoromethane (R-12) - Naval Shipboard

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

5. REASON FOR RECOMMENDATION

6. SUBMITTER

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

8. PREPARING ACTIVITY

a. NAME Technical Point of Contact (TPOC): Mr. John Merold (SEA 56Y15) PLEASE ADDRESS ALL CORRESPONDENCE AS FOLLOWS:	b. TELEPHONE (Include Area Code) (1) Commercial TPOC: 703-602-0741	(2) AUTOVON 8-332-0741
c. ADDRESS (Include Zip Code) Commander, Naval Sea Systems Command Department of the Navy (SEA 55Z3) Washington, DC 20362-5101	IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT: Defense Quality and Standardization Office 5203 Leesburg Pike, Suite 1403, Falls Church, VA 22041-3466 Telephone (703) 756-2340 AUTOVON 289-2340	