



Designation: F 1433 – 97

An American National Standard

Standard Specification for Mechanically Refrigerated Shipboard Air Conditioner¹

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1. Scope

1.1 This specification covers self-contained mechanically refrigerated air conditioners for shipboard use in air circulation, air cooling, and dehumidification.

1.2 These air conditioners are intended for use in compartments and areas where central system air conditioning is not provided.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

1.4 The values states in SI metric units are to be regarded as standard.

2. Referenced Documents

2.1 ASTM Standards:

- A 276 Specification for Stainless Steel Bars and Shapes²
 - A 569/A 569M Specification for Steel, Carbon (0.15 Maximum Percent), Hot-Rolled Sheet and Strip Commercial³
 - B 16 Specification for Free-Cutting Brass Rod, Bar, and Shapes for Use in Screw Machines⁴
 - B 61 Specification for Steam or Valve Bronze Castings⁴
 - B 75 Specification for Seamless Copper Tube⁴
 - B 148 Specification for Aluminum-Bronze Sand Castings⁴
 - B 209 Specification for Aluminum and Aluminum-Alloy Sheet and Plate⁵
 - D 3951 Practice for Commercial Packaging⁶
- #### 2.2 Air-Conditioning and Refrigeration Institute (ARI):⁷

210 Standard for Unitary Air-Conditioning Equipment

2.3 *American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):⁸*

15 Safety Code for Mechanical Refrigeration

37 Methods of Testing for Rating Unitary Air-Conditioning and Heat Pump Equipment

2.4 *American Water Works Association (AWWA):⁹*

C504 Standard for Rubber-Seated Butterfly Valves

2.5 *National Electrical Manufacturers Association (NEMA):¹⁰*

MG 1 Motors and Generators

ICS 1 General Standards for Industrial Control and Systems

2.6 *Underwriters Laboratories, Inc. (UL):¹¹*

465 Standard for Safety, Central Cooling, and Air Conditioning

873 Standard for Safety Temperature-Indicating and Regulating Equipment

2.7 *Federal Specification:*

FF-B-171 Bearings, Ball, Annular (General Purpose)¹²

2.8 *Federal Regulations:¹²*

Code of Federal Regulations, Title 46

3. Terminology

3.1 Definitions:

3.1.1 *inspection*—the process of measuring, examining, testing, gaging, or otherwise comparing the unit with the applicable requirements.

3.1.2 *lot*—all units of the same type, service, and size offered for delivery at one time.

3.2 Definitions of Terms Specific to This Standard:

¹ This specification is under the jurisdiction of ASTM Committee F-25 on Ships and Marine Technology and is the direct responsibility of Subcommittee F25.11 on Machinery.

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² *Annual Book of ASTM Standards*, Vol 01.05.

³ *Annual Book of ASTM Standards*, Vol 01.03.

⁴ *Annual Book of ASTM Standards*, Vol 02.01.

⁵ *Annual Book of ASTM Standards*, Vol 02.02.

⁶ *Annual Book of ASTM Standards*, Vol 15.09.

⁷ Application for copies should be addressed to the Air-Conditioning and Refrigeration Institute, 1501 Wilson Blvd., Arlington, VA 22209.

⁸ Application for copies should be addressed to the American Society of Heating, Refrigerating and Air Conditioning Engineers, 1791 Tullie Circle, NE, Atlanta, GA 30329.

⁹ Application for copies should be addressed to the American Water Works Association, 666 W. Quincy Ave., Denver, CO 80235.

¹⁰ Application for copies should be addressed to the National Electrical Manufacturers Association, 1300 N. 17th St., Suite 1847, Rosslyn, VA 22209.

¹¹ Applications for copies should be addressed to the Underwriters Laboratories, Inc., 333 Pfingsten Rd., Northbrook, IL 60062.

¹² Available from Standardization Documents Order Desk, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

3.2.1 *air discharge plenum*—an enclosure (housing) containing guide vanes and a grill or louvers in the outlet opening for directing the airflow.

3.2.2 *air handling/evaporator section*—an enclosed component consisting of an air filter, fan with drive motor, evaporator (cooling coil), refrigerant flow control, and condensate collector and drain.

3.2.3 *condensing unit*—contains refrigerating components, consisting of a compressor with a drive motor, condenser, receiver, operating and safety controls, and interconnecting piping and wiring. The controls include a condenser water regulating valve, high and low refrigerant pressure switches, refrigerant relief device, and motor overload protection.

3.2.4 *cooling effect*—the net room sensible cooling effect of a unit is defined as the difference between the net total cooling effect and the dehumidifying effect, expressed in watts. The net total cooling effect is the total useful capacity of the unit for removing heat from the space to be treated, expressed in watts. The net dehumidifying effect is the difference between the moisture content in kilograms per hour of the entering and leaving air, multiplied by 685, expressed in watts.

4. Classification

4.1 The air conditioners should be of the following types, services, arrangements and size as specified:

- Type I drip-proof protected
- Type II explosion-proof enclosed
- Service 1 440-V 60-Hz alternating current (ac)
- Service 2 230-V direct current (dc)
- Service 3 115-V dc
- Service 4 220-V 60-Hz alternating current (ac)
- Arrangement A with air discharge plenum
- Arrangement B without air discharge plenum
- Size 2 minimum cooling capacity 7000 W
- Size 3 minimum cooling capacity 10 500 W
- Size 5 minimum cooling capacity 17 500 W
- Size 7½ minimum cooling capacity 26 000 W

5. Ordering Information

5.1 Orders for material under this specification shall include the following:

- 5.1.1 Title, number, and year of issue of this specification.
- 5.1.2 Type, service, arrangement, and size of unit (see 4.1).
- 5.1.3 Air discharge plenum required (see 6.1 and 6.5.10).
- 5.1.4 Type of power supply for equipment and motors (see 6.5.14.1 and 6.5.14.2).
- 5.1.5 When drip-proof protected or explosion-proof equipment is required (see 4.1, 6.5.14.1, and 6.5.14.2).
- 5.1.6 When certification and test reports are required (see 14.1).

6. Materials and Manufacture

6.1 *General*—Air conditioners covered by this specification shall consist of a condensing unit section, an air handling/evaporator section and a motor controller. An air discharge plenum may be included, if specified. These air conditioners shall be self-contained and shall perform as specified herein when connected to cooling water, drainage, and electric power

in accordance with UL 465 and ARI 210. The refrigerant system shall be constructed in accordance with the requirement of ASHRAE 15. Every component, including interconnecting wiring and piping, shall be enclosed within the cabinet, except where external mounting is permitted by this specification. The air conditioner shall be factory assembled, complete, self-contained, with the refrigerant system and components dehydrated and charged with the operating quantities of refrigerant and oil. The air conditioner shall be ready for operation after removal of the shipping protection, opening of valves, adjustment of belts, and connection to services. Valves, controls, and equipment subject to service and repair shall be readily accessible for servicing through removable panels. Where panels are provided for access to equipment, machine screws may be used for fastening.

6.2 *Refrigerant System*—Every component, including piping, controls, and accessories by the refrigerant system, shall be constructed for use with Refrigerant-22 (monochlorodifluoromethane) or other specified refrigerant.

6.3 *Materials*—Materials shall be as specified herein.

6.3.1 *Dangerous Materials*—Mercury and materials which may produce dangerous gases or cause other harmful effects under conditions, including fire, shall not be used. Magnesium and its alloys shall not be used in the manufacture of the air conditioners or in any component parts.

6.3.2 *Corrosion Protection*—Corrosion-resisting steel, copper, brass, bronze, chromium, copper-nickel, and copper-nickel alloys as specified herein are considered corrosion-resisting materials. Where corrosion-resisting steel is used, it shall be type 316 or 347 in accordance with Specification A 276. Corrosion-resisting steel, when fabricated by any method that tends to reduce corrosion-resisting properties, shall be normalized to restore those properties before being used in the assembly of any unit.

6.3.2.1 *Noncorrosion-Resisting Materials*—Noncorrosion-resisting materials are to be protected against corrosion by the use of the chemicals, electrolytic processes, plating, or paints and enamels.

6.3.2.2 *Fastenings or Fittings*—Bolts, nuts, studs, pins, screws, and such other fastenings or fittings shall be of corrosion-resisting material. Self-tapping screws with machine screw threads may be used in the cabinet assembly. Sheet metal screws with sheet metal threads shall not be permitted.

6.3.3 *Galvanic Corrosion*—Direct contact of electrolytically dissimilar materials shall be avoided to prevent galvanic corrosion.

6.4 *Piping System*—The construction of the piping system shall include inlet and outlet Schedule 40 copper-nickel condenser water piping of the proper diameter, extending horizontally outside of the air conditioner cabinet. Construction shall also include the proper size and type of drain piping from the drain connection of the air conditioner through the cabinet down to the deck level.

6.5 *Air Conditioner Components*:

6.5.1 *Compressor*—The compressor shall be of the hermetic type for service 1 and service 4 air conditioners and of the open type for service 2 and service 3 air conditioners. Provision shall be made for adequate lubrication of the machine and its parts.

surfaces including operation under ship motion as specified in 7.3. Compressors shall be provided with a crankcase heater. Crankcase heaters shall be replaceable without having to remove oil or refrigerant from the compressor and shall be arranged to provide compressor oil heating before start-up and at any time the compressor is in the off cycle. Compressors shall be provided with suction and discharge compressor service shutoff valves and means for charging.

6.5.1.1 Open Compressor—The open compressor shall be of the positive displacement type. The shaft seal and main bearings shall be replaceable in their entirety without the necessity of replacing or refurbishing the crankshaft or crankcase. Compressor speeds for open compressors shall not exceed 1800 revolutions per minute (r/min).

6.5.1.2 Hermetic Compressor—The hermetic compressor shall be of the positive displacement type.

6.5.2 Condenser—The condenser shall be seawater cooled and constructed in accordance with the criteria shown in Table 1. The condenser shall be sized so that the compressor motor shall not be overloaded when the air conditioner is experiencing overload conditions. The condenser shall be a shell and tube construction with water in the tubes and refrigerant in the shell and shall have an even number of water passes. The condenser shall be mechanically cleanable in place with removable water boxes or heads to permit tubes to be examined, cleaned or replaced as necessary. The condenser shall be cleanable from either side of the cabinet. Means shall be provided to remove entrained air from each inlet pass. Condenser heat drains shall be provided. Zinc anodes shall be installed in the condenser heads (seawater side). The condenser shall have a means for purging air and noncondensable gases and a relief valve to prevent overpressurization of the refrigerant side. The tube sheets shall be of copper-nickel (90-10) UNS C70600. The condenser heads shall be of valve bronze, Specification B 61 or nickel-aluminum-bronze, Specification B 148 alloy 95800, heat treated at 650°C for 1 h, to inhibit de-aluminization as prescribed in AWWA standard C504. The

tubes shall be 19-mm outside diameter, constructed of copper-nickel (90-10) UNS C70600. The tubes shall be extruded fin type. Drain and vent fittings and zinc anode holders shall be nickel-copper (70-30) UNS C71500.

6.5.3 Liquid Receiver—The liquid receiver shall have an internal volume at least 25 % greater than the volume of the complete refrigerant charge. The receiver shall contain an outlet shutoff valve and pressure relief device.

6.5.4 Cooling Coil—The cooling coil (evaporator) shall be of finned-tube construction and shall be composed of copper tubes, in accordance with Specification B 75, or aluminum tubes with copper fins. Fins shall be firmly bonded to the tube. A drip pan and drain for collecting the condensate shall be furnished.

6.5.5 Water-Regulating Valves—A water-regulating valve shall be provided at the outlet to each condenser. The valve shall be direct-acting or pilot-controlled actuated by condenser gas pressure to modulate the flow of water required for the condenser. The valve shall withstand seawater inlet pressures up to 1.37 MPa. The valve shall be constructed of nonferrous or corrosion-resisting material. The valve shall be constructed to prevent the entry of seawater into the refrigerant system in the event of derangement.

6.5.6 Strainer—A strainer shall protect the condenser and water-regulating valve. The strainer shall be not less than 19 mm n.p.s. However, it shall be sized as to not restrict seawater flow during overload conditions. The strainer shall be shipped loose for installation in the seawater piping during air conditioner installation.

6.5.7 Expansion Valve—Refrigerant flow to the cooling coil (evaporator) shall be controlled by a thermostatic valve. The valve shall be an adjustable superheat, externally equalized type. The valve body shall be of cast or forged brass or bronze, and the inlet and outlet connections shall be an integral part of the valve body.

6.5.8 Piping—Any piping necessary for the operation of the equipment shall be provided up to and including fittings at each unit required for interconnection to supplementary service. Exterior connection fittings shall be capped or plugged to safeguard against damage before installation. The water regulating valve shall be installed in the condenser water discharge line and shall be readily accessible for adjustment and maintenance. Condenser water supply piping and drain piping shall be copper-nickel alloy 706. Water pipe fittings and seawater connections shall be 90-10 copper-nickel, valve bronze in accordance with Specification B 61 or monel. No tapered pipe threads shall be used anywhere in the unit. Refrigerant piping shall have readily accessible test fittings for high and low pressure and for charging and draining refrigerant. Refrigerant pipe fittings shall be in accordance with Specification B 16. Refrigerant piping and evaporator condensate drain tube shall be copper in accordance with Specification B 75, alloy 12200.

6.5.8.1 Disposable Dehydrator—A disposable dehydrator shall be provided in the refrigerant circuit. The dehydrator shall be equipped with an auxiliary screen or other protective means at the dehydrator outlet to prevent passage of the dehydrating agent in the event of rupture of the cartridge screen outlet. Dehydrator connections shall be flared.

TABLE 1 Air Conditioner Rating Conditions

Maximum seawater design pressure	1.38 MPa
Seawater entering pressure	241 to 345 kPa
Seawater entering temperature	35°C
Seawater velocity through condenser tubes	1.8 m/s (max)
Refrigerant condensing temperature	46°C (max)
Ambient temperature (entering air)	27°C dry bulb 19°C wet bulb

Air Quantity and Static Pressure	Air Quantity	External Static Pressure With External Duct System, Pa
Size 2 air conditioner	0.28 m ³ /s (minimum)	250
Size 3 air conditioner	0.425 m ³ /s	250
Size 5 air conditioner	0.708 m ³ /s	250
Size 7½ air conditioner	1.06 m ³ /s	250
Cooling effect ratio (sensible cooling effect to net total cooling effect)	65 to 70 %	

Overload Conditions		
Seawater entering temperature		38°C
Ambient temperature (entering air)		38°C dry bulb–29°C wet bulb