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An American National Standard

Standard Specification for Mechanically Refrigerated Shipboard Air Conditioner[1]

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

1.4 *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.*

2. Referenced Documents

2.1 *ASTM Standards:* [2]

A 276 Specification for Stainless Steel Bars and Shapes

A 569/A 569M Specification for Steel, Carbon (0.15 Maximum, Percent), Hot-Rolled Sheet and Strip Commercial[3]

B 16/B 16M Specification for Free-Cutting Brass Rod, Bar, and Shapes for Use in Screw Machines

B 61 Specification for Steam or Valve Bronze Castings

B 75 Specification for Seamless Copper Tube

B 148 Specification for Aluminum-Bronze Sand Castings

B 209 Specification for Aluminum and Aluminum-Alloy Sheet and Plate

D 3951 Practice for Commercial Packaging

2.2 *Air-Conditioning and Refrigeration Institute (ARI):*[4]

210 Standard for Unitary Air-Conditioning Equipment

2.3 *American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):*[5]

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):*[6]

C504 Standard for Rubber-Seated Butterfly Valves

2.5 *National Electrical Manufacturers Association (NEMA):*[7]

MG 1 Motors and Generators

ICS 1 General Standards for Industrial Control and Systems

2.6 *Underwriters Laboratories, Inc. (UL):*[8]

465 Standard for Safety, Central Cooling, and Air Conditioning

873 Standard for Safety Temperature-Indicating and Regulating Equipment

2.7 *Federal Specification:*[9]

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

2.8 *Federal Regulations:*[9]

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:*

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[1] This specification is under the jurisdiction of ASTM Committee F25 on Ships and Marine Technology and is the direct responsibility of Subcommittee F25.11 on Machinery and Piping Systems.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Withdrawn.

[4] Available from Air-Conditioning and Refrigeration Institute, 1501 Wilson Blvd., Arlington, VA 22209.

[5] Available from American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE), 1791 Tullie Circle, NE, Atlanta, GA 30329.

[6] Available from American Water Works Association (AWWA), 1401 New York Ave., NW, Suite 640, Washington, DC 20005.

[7] Available from National Electrical Manufacturers Association (NEMA), 1300 N. 17th St., Suite 1847, Rosslyn, VA 22209.

[8] Available from Underwriters Laboratories, Inc., 333 Pfingsten Rd., Northbrook, IL 60062.

[9] 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 in this specification 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 in this specification.

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 in this specification 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 rubbing and wearing 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 in accordance with 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.

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

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/B 16M. 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.

6.5.8.2 *Strainer*—A fine mesh (80 to 100-mesh) strainer shall be located upstream from the expansion device.

6.5.8.3 *Moisture Indicator*—A combination sight flow moisture indicator shall be installed between the strainer and the expansion valve. The moisture indicator elements shall be replaceable without removing the body from the refrigerant piping.

6.5.9 *Cabinet*—The cabinet enclosure shall be constructed of steel or aluminum protected against corrosion. Aluminum shall be Specification B 209, alloy 5052, temper H-32¼ hard. Steel shall be low carbon steel, Specification A 569/A 569Mor equivalent. The cabinet shall incorporate framing, chassis, and support for any component of the air conditioner. The cabinet, framing, and chassis shall support and maintain proper alignment and arrangement of every component under the ship operational conditions as specified in 7.4. The air handling section of the cabinet shall be constructed for front air intake and top air discharge. The air intake shall be provided with a protective grill. The front of the machinery compartment shall be provided with a removable panel for servicing the equipment. The back of the machinery compartment shall be enclosed with an expanded metal screen for service 2 and service 3 air conditioners. After fabrication, the cabinet shall be galvanized or coated with one coat of metal primer and enamel topcoat to protect from corrosion. Brackets or integral frame members shall be provided for mounting and fastening the air conditioner to a deck foundation.

6.5.9.1 *Drip Pan*—A condensate drip pan shall collect condensate from the cooling coil (evaporator). The pan shall be constructed from corrosion-resistant material. The pan shall have depth and baffles and multiple drain outlets to prevent overflow of the condensate and provide for draining of the condensate under conditions as specified in 7.4. The drip pan outlets shall be interconnected to a common drain tube.

6.5.10 *Plenum*—An air discharge plenum shall be provided when specified. The plenum shall be detachable and constructed to mount on top of the cabinet. The plenum shall contain air guide vanes and louvers as required for directing the air flow. The outlet louvers shall permit adjustable directional air flow in both horizontal and vertical planes. Corrosion protection of the plenum shall be identical to that for the cabinet.

6.5.11 *Insulation*—Thermal insulation shall be applied as necessary to the cabinet, piping, and components to prevent sweating, dripping, running off, or blowing off of moisture. Acoustical insulation shall be applied to minimize the transmission of noise generated by the air conditioner to surrounding areas.

6.5.12 *Fans*—Fans shall be of the centrifugal type and be quiet in operation. They shall be secured to shafts and shall be supported by not less than two self-aligning bearings. Bearings shall be replaceable permanently lubricated ball bearing type in accordance with Federal Specification FF-B-171. Bearings shall be replaceable, without removal of the blower, from the front or sides of the unit after removal of the service panel.

6.5.13 *Air Filter*—Air filters shall be arranged to filter ventilation or recirculated air before it enters the evaporator. Filters shall be of the permanent washable type. Materials used in the construction of the filters shall be corrosion-resisting or aluminum. The air filters shall be arranged so they shall not come in contact with condensate from the cooling coils.

6.5.14 *Electrical Equipment*—The electrical equipment shall be in accordance with NEMA MG 1 and NEMA ICS 1 and shall operate in a 50°C ambient temperature. No portion of the electrical circuit shall be grounded. The frames or enclosures of all electrical components shall be grounded to the frame of the air conditioning unit to eliminate hazard from shorts or grounds within the equipment. The air conditioner shall be provided with a motor controller for remote mounting. Electrical equipment for Type II air conditioners shall meet the requirements of Code of Federal Regulations, Title 46, Subchapter J, Subpart 111.105.

6.5.14.1 *Motors*—Motors shall be constant speed, continuous duty, with a maximum speed of 3600 r/min, and shall be for the power supply specified. The temperature rise of motors in accordance with NEMA MG 1 shall not exceed 21°C and they shall be provided with built-in thermal protectors installed in accordance with NEMA MG 1. The motors shall be drip-proof or explosion-proof enclosed. Motors shall start the compressor with the maximum refrigerant pressure differential.

6.5.14.2 *Motor Controls*—Enclosure of the compressor and fan motor controllers shall be one of the following types, as specified.

(1) Drip-proof (45°), watertight, submersible (4.5 m).

(2) Explosion-proof.

(3) Splash-proof.

For hermetic units, overload relays shall be in addition to, and coordinated with, thermal protectors built into the motor. Fans shall be protected with an overload relay or built-in thermal protector. The compressor shall not start or run unless the fan is operating and the compressor shall stop if the fan motor circuit is interrupted. A time delay circuit shall be provided to prevent restarting of the compressor manually or automatically within 5 min of having been stopped for any reason. Delay shall not preclude initial starting of the air conditioner.

6.5.14.3 *Controls*—A selector switch shall permit operation of the fan only, or of the fan and refrigerating equipment. High pressure and low pressure safety switches and a temperature control shall be provided. The selector switch shall be of a three-position type with an off position to secure both the fan and refrigerating equipment. The temperature control shall provide for automatic compressor control. It shall provide for manual adjustment and operate within a temperature range of 18 to 29°C, with a plus or minus 3°C tolerance. The selector switch shall be readily accessible. The temperature control shall be located within the machinery compartment. The unit shall have separate pressure switches properly set to stop the compressor when the refrigerant discharge pressure rises too high, or suction pressure becomes too low. The pressure controls shall be individual units of the lock open, manual reset type. Pressure and temperature controls shall be in accordance with UL 873. A terminal block or blocks shall be provided with the remote motor controller enclosure for the interconnection

of all electrical circuits. The internal wiring within the air conditioner cabinet shall be completed to an enclosure containing the necessary terminal blocks, within the cabinet, for interconnection to the motor controller enclosure. Control switches or other electrical devices located external to the motor controller enclosure shall not have protruding or unprotected electrical connection lugs or terminals. Control switches requiring mechanical adjustment shall not be located within the motor controller enclosure unless provision is made so that the necessary adjustments can be made without removing the enclosure cover. When these control switches are located within the air conditioner cabinet, they shall be mounted directly or indirectly, by means of mounting brackets or mounting plates, to the cabinet structure to minimize the effect of vibration from the rotating machinery. They shall be located to minimize the possibility of personnel coming in contact with live electrical parts when servicing the controls.

7. Performance Requirements

7.1 *Operation*—Operation shall automatically maintain the environmental conditions for which the equipment is set as specified in Table 1.

7.2 *Air-Circulating Equipment*—The unit shall have the capacity for circulating air through the air conditioning unit at not less than 0.7 m^3/min per 290 W of cooling capacity.

7.3 *Ship Inclination*—The air conditioner shall operate on a surface ship while withstanding 15° permanent, or 45° cyclic, inclination.

7.4 *Capacity*—Air conditioner shall deliver not less than its specified capacity when operating at the rating conditions as shown in Table 1. The net capacity shall be exclusive of all electrical energy (heat energy) required to operate the compressor, fan, and other units. The air flow quantity shall be at least that specified in Table 1.

7.5 *Overload*—The temperature rise for motors shall not exceed 70°C for motors in accordance with NEMA MG 1.

7.6 *Condensation*—The air conditioner shall operate without dripping, running, or blow off of moisture either inside or outside the cabinet.

8. Other Requirements

8.1 *Manuals*—Manuals shall be prepared in accordance with the manufacturer's commercial practice. Photo views of the equipment shall be included as part of the general description. A section shall be included containing reduced copies of all drawings required to amplify or illustrate the text, including diagram and assembly drawings. The manual shall contain a parts list and all data necessary to install, operate, repair, and maintain the equipment.

9. Dimensions

9.1 Maximum dimensions of the air conditioner cabinets, including mounting brackets and plenums, shall be as shown in Table 2.

10. Sampling

10.1 When first article inspection is specified, the first air conditioner of each type, service, and size produced under the contract or order shall be selected for testing.

TABLE 2 Cabinets and Plenum Dimensions

	Height, m	Width, m	Depth, m
	Cabinet without plenum		
Size 2	1.65	0.91	0.56
3	1.65	1.02	0.61
5	1.65	1.14	0.64
7½	1.65	1.22	0.64
	Plenums		
Size 2	0.255	0.91	0.56
3	0.255	1.02	0.61
5	0.255	1.14	0.64
7½	0.255	1.22	0.64

11. Quality Assurance Provisions

11.1 *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 in this specification. 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 in this specification. The purchaser reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

11.2 *Responsibility for Compliance*—All items shall meet all specification requirements. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of assuring that all products or supplies submitted 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.

12. Test Methods

12.1 *Classification of Inspections*—The inspection requirements specified in this specification are classified as follows:

(1) First article inspection (see 12.2)

(2) Quality conformance inspection (see 12.3)

12.2 *First Article Inspection*—When specified in the contract or purchase order, first article inspection shall consist of the tests and examinations as specified in 12.4 and 12.5-12.5.4.3.

12.3 *Quality Conformance Inspection*—Quality conformance inspection of each air conditioner shall consist of the tests and examinations as specified in 12.4 and 12.6-12.6.2.

12.4 *Visual Examination*—Each sample unit shall be examined for adjustments, fits, leaks, material, finish, and general conformance to this specification as follows:

(1) The external fittings shall be properly secured.

(2) Bolts, nuts, and screws shall be tight; equipment and parts shall be properly fastened and secured.

(3) No parts shall be fractured, split, torn, dented, or otherwise damaged such as to affect serviceability.

(4) There shall be no sharp or ragged edges on the sheeting that may be injurious to personnel.

(5) Cold lines shall be properly insulated.

(6) The limiting and mounting dimensions shall be in accordance with drawings and Table 2.

(7) The temperature control shall be properly set and functioning.

(8) The selector switch shall operate satisfactorily.

(9) There shall not be any dripping, running, or blowing off of moisture.

(10) The low pressure and high pressure switch shall be functioning and properly set in accordance with the manufacturer's specification.

(11) There shall be no refrigerant leakage at any brazed, welded, or mechanical joint as measured using an electronic halide leak detector adjusted to detect a leak of 14 g per year.

12.5 *First Article Test Procedures*:

12.5.1 *General*—Before testing, the air conditioner shall have successfully passed the visual examination specified in 12.4. For first article tests, fresh water may be used in lieu of seawater for cooling.

12.5.2 *Inclination*—The unit shall be inclined at an angle of 15° each side of the vertical in each of two vertical planes at right angles to each other and operated at least 1 h or cycled at 45° for 1 h, under applied rating conditions as specified in Table 1. Test information shall be monitored at 10-min intervals throughout the test. The unit shall be acceptable if there is no spillage of fluids inside or outside the cabinet, no abnormal noise, and no loss of capacity.

12.5.3 *Capacity Rating*—Capacity rating tests shall be conducted in accordance with the procedures and requirements indicated in ASHRAE 37 and ARI 210. A standard rating test shall be conducted using standard rating conditions in accordance with ARI 210. An application rating test shall be conducted using the operating conditions as shown in Table 1.

12.5.4 *Performance*—The unit to be tested shall be given the continuous operating tests as specified in 12.5.4.1-12.5.4.3 under the average temperature conditions as indicated with a tolerance of ±0.55°C dry bulb, ± wet bulb, and ± condenser water temperature. Observations and readings shall be taken at intervals not greater than 10 min.

12.5.4.1 *Overload*—The unit shall be operated with 38°C dry bulb temperature, 30°C wet bulb temperature unit-ambient-air and room air entering-air-inlet, and 38°C water to the condenser. The test shall be continued until steady conditions have been observed for not less than 4 h. The unit shall operate normally without any interruption caused by tripping of motor-overload devices, without damage to motors as a result of overheating, and without injury to any other component part from any operational cause. The temperature rise of the compressor motor winding shall be determined at the end of this test. The temperature rise shall be not greater than that as specified in 6.5.14.1. The temperature rise of the windings shall be measured and computed by the resistance method. In addition, the air conditioner shall be tested to determine actual capacity under overload conditions as shown in Table 1.

12.5.4.2 *Condensation*—The unit shall be operated continuously for 4 h with 35°C condenser inlet water, 27°C dry bulb temperature, and 24°C wet bulb temperature unit-ambient-air and room air entering-air-inlet. The air conditioning unit shall perform satisfactorily during the test without dripping, running, or blowing off of moisture either inside or outside the cabinet.

12.5.4.3 *Air Delivery*—The unit shall be provided with a means of restricting the outlet air to produce the minimum outlet resistance as specified in Table 1. The air flow quantity shall be not less than that specified in Table 1.

12.6 *Operating Tests*—Each air conditioner shall be operated for a period of at least 1 h with controls set to allow continuous compressor operation as shown in Table 1. During this test, inlet air temperature to the evaporator shall be not less than 24°C dry bulb. At the conclusion of this operation test, the entire refrigerant circuit connections under refrigerant pressure shall be tested to determine leakage. In the event of leakage, the leaks shall be repaired and the operating test shall be repeated.

12.6.1 *Controls*—During this test it shall be verified that the controls are adjusted and functioning properly.

12.6.2 *Electrical Power*—The electrical power input shall be recorded during operating tests and compared with the input of all other units which have been tested. If any unit requires 7 % more power than the average of all the acceptable units, it shall be rejected.

13. Rejection and Rehearing

13.1 *Test Failure*—Failure of the first article air conditioner to pass any of the tests or examinations specified in this specification shall constitute rejection of the air conditioner design. The resumption of tests and examinations will be considered by the contracting activity after receipt of information substantiating that the deficiencies found have been corrected satisfactorily.

13.2 *Acceptance Criteria*—Production units failing to meet the tests specified in 12.6-12.6.2 shall be repaired, defective parts and components replaced, and retested until specification requirements are met before offering the air conditioner for acceptance.

14. Certification

14.1 When specified in the purchase order or contract, the purchaser shall be furnished certification that samples representing each lot have been either tested or inspected as directed in this specification and the requirements have been met. When specified in the purchase order or contract, a report of the test results shall be furnished.

15. Product Marking

15.1 Identification plates shall be made of brass, aluminum, or corrosion-resisting steel. Information plates shall be made of laminated plastic, aluminum, or corrosion-resisting steel. The identification plate shall be located in the front of the machinery compartment. Identification plates shall be secured to equipment with electrolytically compatible fasteners and shall contain the following information:

(1) Name of equipment: Air conditioner,
(2) Manufacturer's name and address,
(3) Manufacturer's model, type, capacity,
(4) Manufacturer's serial number,
(5) Date of manufacture,

(6) Contract or purchase order number, and

(7) Specification number and appropriate type, service, class, size (cooling capacity), and power supply.

15.2 A warning plate shall be mounted on the motor controller enclosure with the following engraving in red letters:

"WARNING: DANGER HIGH VOLTAGE"

15.3 In addition to the identification plate, equipment for explosion-proof applications shall have a warning plate. The warning plate shall be located on the front of the cabinet. Lettering shall be readily legible, reading as follows: *"Caution: This Equipment is for Explosion-Proof Application. Disconnect Power Supply Before Opening Electrical Box Covers. Do Not Energize Unless the Equipment is Fully Assembled and All Electrical Enclosures are Properly Closed."*

16. Packaging and Package Marking

16.1 Packaging and package marking shall be in accordance with Practice D 3951.

16.2 For government packaging and package marking, see Supplementary Requirements.

17. Keywords

17.1 air conditioner; air discharge plenum; compressor; condensing unit; evaporator; liquid receiver; mechanically refrigerated

SUPPLEMENTARY REQUIREMENTS

The following supplementary requirements are applicable to Department of Defense procurements and shall apply only when specified in the contract or order.

S1. Referenced Documents

S1.1 *ASTM Standards:*[2]

D 3951 Standard Practice for Commercial Packaging

S1.2 *Federal Specifications*:[9]

TT-P-664 Primer Coating, Alkyd, Corrosion-Inhibiting, Lead and Chromate Free, VOC Compliant

PPP-F-320 Fiberboard: Corrugated and Solid Sheet Stock (Container Grade) and Cut Shapes

S1.3 *Military Specifications*:[9]

MIL-P-116 Preservation, Methods of

MIL-L-19140 Lumber and Plywood, Fire-Retardant Treated

S1.4 *Military Standards:*[9]

MIL-STD-1186 Cushioning, Anchoring, Bracing, Blocking and Waterproofing; With Appropriate Test Methods

MIL-STD-2073-1 DoD Material Procedures for Development and Applications of Packaging Requirements

S2. Ordering Information

S2.1 Orders for equipment using this supplement shall include the following information in addition to the ordering information from the basic specification:

S2.1.1 Fire-retardant material requirements (see S3.1.1).

S2.1.2 Preservation requirements (see S3.2).

S2.1.3 Packing requirements (see S3.3).

S2.1.4 Required waterproofing (see S3.3.5).

S2.1.5 Package marking requirements (see S3.4).

S3. Packaging

S3.1 *Fire Retardant Requirements:*

S3.1.1 *Treated Lumber and Plywood*—Unless otherwise specified, all lumber and plywood including laminated veneer material used in shipping containers and pallet construction, members, blocking, bracing, and reinforcing shall be fire-retardant treated material conforming to MIL-L-19140 as follows:

Levels A and B	Type II—weather resistant Category 1—general use
Level C	Type I—nonweather resistant Category 1—general use

S3.1.2 *Fiberboard*—Fiberboard used in the construction of class-domestic, nonweather-resistant fiberboard, cleated fiberboard boxes, including interior packaging forms, shall meet the flame spread index and the specific optic density requirements of PPP-F-320 and amendments thereto.

S3.1.3 *Cushioning and Wrapping Materials*—The use of excelsior, newspaper, shredded paper (all types), and similar hygroscopic or nonneutral materials and all types of loose fill materials for packaging applications, such as cushioning, fill, stuffing, and dunnage is prohibited. Materials selected for cushioning and wrapping shall have properties (characteristics) for resistance to fire. Cushioning or wrapping materials, as applicable, shall be provided to prevent item and package damage and to prevent free movement of the container contents.

S3.2 *Preservation*—Preservation shall be level A or commercial as specified.

S3.2.1 *Level A*—Each complete unit shall be unit protected in accordance with Method I requirements of MIL-P-116 and as follows: exterior unpainted ferrous metal surfaces shall be coated with P-19 preservative in accordance with MIL-P-116. The water cooling system shall be thoroughly drained and blown out by the application of clean, dry compressed air. To prevent the entrance of foreign material, all openings shall be sealed with the use of metal or plastic plugs or waterproof pressure-sensitive tape. Drive belts shall be removed, exposed uncoated ferrous metal surfaces of pulleys and shafts shall be cleaned and coated with primer in accordance with TT-P-664. When the primer is thoroughly dry, drive belts shall be remounted in place with tension on the belts relaxed.

S3.2.2 *Commercial*—Commercial preservation shall be in accordance with Practice D 3951.

S3.3 *Packing*—Packing shall be Level A, B, C, or commercial as specified.

S3.3.1 *General*—Shipping containers shall contain identical quantities of identical material and shall be of minimum weight and cube, similar construction, and of uniform size.

S3.3.2 *Level A, B, and C Containers*—Material preserved as specified shall be packed in shipping containers, cleated plywood, or nailed and locked corner boxes or covered crates, for the level of packing specified, in accordance with MIL-STD-2073-1, Appendix C, Table 7. Unless otherwise specified, container selection shall be at the contractor's option.

S3.3.3 *Closure*—Container closure, reinforcing, or banding shall be in accordance with the applicable container specification or appendix thereto except that class weather resistant fiberboard boxes shall be closed in accordance with MIL-STD-2073-1, Method V, and reinforced with nonmetallic or tape banding, and nonweather resistant fiberboard boxes shall be closed in accordance with Method I using pressure-sensitive tape.

S3.3.4 *Weight*—Wood, plywood, and cleated-type containers exceeding 90-kg gross weight shall be modified by the addition of skids in accordance with MIL-STD-2073-1 and the applicable container specification or appendix thereto.

S3.3.5 *Waterproofing*—Unless otherwise specified, level A and when specified, level B, shipping containers shall be provided with caseliners, linings, wraps, or shrouds in accordance with the waterproofing requirements of MIL-STD-1100.

S3.3.6 *Commercial*—Material preserved as specified shall be packed for shipment in accordance with Practice D 3951. Shipping containers exceeding 90-kg gross weight shall be provided with the minimum of 0.08 by 0.1-m nominal wood skids laid flat, or a skid- or sill-type base that will support the material and facilitate handling by mechanical handling equipment during shipment.

S3.4 Marking

S3.4.1 *Level A, B, and C and Commercial Marking*—In addition to any special marking required, level A, B, and C interior packs and shipping containers shall be marked in accordance with MIL-STD-2073-1, Appendix F, and commercial interior packs and shipping containers shall be marked in accordance with Practice D 3951. In addition, bar coding shall be applied in accordance with the marking requirements of MIL-STD-2073-1 and the shipment marking information shall be provided on interior packages and exterior shipping containers and shall include the following:

(1) Nomenclature,
(2) National stock number,
(3) Manufacturer's part number,
(4) Size,
(5) Contract or order number,
(6) Contractor's name, and
(7) Destination.

S3.5 *Technical Manuals*—Technical manuals that accompany shipment shall be packaged in a transparent waterproof plastic bag, minimum 4 mil thick. Closure shall be by heat sealing. The copy(s) of the manual shall be placed in the shipping container housing the main unit. Packing lists shall indicate which container contains the technical manual(s) and shall state the approximate location therein. The manual shall be 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 specifications.