

MIL-H-22594A(SH)
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 SUPERSEDING
 MIL-H-22594 (SHIPS)
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 (See 6.4)

MILITARY SPECIFICATION

HEATERS, DUCT TYPE, ELECTRIC

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

1. SCOPE

1.1 Scope. This specification covers electric, duct type heaters used in heating, ventilating, and air conditioning systems.

1.2 Classification. Electric, duct type heaters shall be of the following sizes, types, (based on temperature rise in table I) and capacities, as specified (see 6.1.1):

Size	Capacity in kilowatts (kW)		
	Type L	Type M	Type H
19EH	-----	-----	0.5
20EH	-----	0.58	1.0
21EH	0.65	1.26	1.9
22EH	1.0	1.93	2.9
23EH	1.52	3.0	4.5
24EH	1.90	3.74	5.5
25EH	2.90	5.72	8.5
26EH	4.59	9.1	13.5
27EH	6.76	13.4	20.0
28EH	9.26	18.3	27.3
29EH	12.3	24.3	36.2
30EH	15.3	30.2	45.0
31EH	17.2	33.9	50.5
32EH	18.2	36.0	53.8
33EH	23.5	46.4	69.2
34EH	28.5	56.3	84.0
35EH	33.9	67.1	100.0
36EH	39.7	78.4	117.0
37EH	50.9	100.6	150.0
38EH	61.9	122.4	183.0

2. APPLICABLE DOCUMENTS

2.1 Issues of documents. The following documents, of the issue in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

SPECIFICATIONS

FEDERAL

- QQ-E-450 - Electrodes, Welding, Covered: Mild Steel.
- QQ-P-35 - Passivation Treatments for Corrosion-Resisting Steel.
- TT-P-645 - Primer, Paint, Zinc-Chromate, Alkyd Type.
- TT-P-664 - Primer Coating, Synthetic, Rust-Inhibiting, Lacquer-Resisting.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Naval Ship Engineering Center, SEC 6124, Department of the Navy, Washington, D.C. 20362 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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- MIL-S-901 - Shock Tests, H.I. (High-Impact); Shipboard Machinery, Equipment and Systems, Requirements For.
- MIL-E-917 - Electric Power Equipment, Basic Requirements For (Naval Shipboard Use).
- MIL-D-5480 - Data, Engineering and Technical; Reproduction Requirements for.
- MIL-P-15024 - Plates, Tags and Bands for Identification of Equipment.
- MIL-P-15024/5 - Plates, Identification.
- MIL-P-15137 - Provisioning Technical Documentation for Repair Parts for Electrical and Mechanical Equipment (Naval Shipboard Use).
- MIL-P-15328 - Primer (Wash) Pretreatment, Blue (Formula No. 117-B for Metals).
- MIL-W-16878 - Wire, Electrical, Insulated High Temperature.
- MIL-W-16878/4 - Wire, Electrical, Type E, 200 Degrees C. and 260 Degrees C., 600 Volts, (Insulated, High Temperature).
- MIL-W-16878/5 - Wire, Electrical, Type EE, 200 Degrees C., and 260 Degrees C., 1000 Volts (Insulated, High Temperature).
- MIL-W-16878/7 - Wire, Electrical, Type F, 200 Degrees C., 600 Volts (Insulated, High Temperature).
- MIL-W-16878/8 - Wire, Electrical, Type FF, 200 Degrees C., 1000 Volts (Insulated, High Temperature).
- MIL-P-17545 - Primer Coating, Alkyd-Red Lead Type, Formula No. 116 and No. 116D.
- MIL-E-17555 - Electronic and Electrical Equipment, Accessories, and Repair Parts; Packaging and Packing of.
- MIL-T-55164 - Terminal Boards, Molded, Barrier, Screw and Stud Types, and Associated Accessories, General Specification For.

STANDARDS

MILITARY

- MIL-STD-167-1 - Mechanical Vibrations of Shipboard Equipment (Type I - Environmental and Type II - Internally Excited).
- MIL-STD-278 - Fabrication Welding and Inspection; and Casting Inspection and Repair for Machinery, Piping and Pressure Vessels in Ships of the United States Navy.
- MIL-STD-1399, Section 103 - Interface Standard for Shipboard Systems, Electric Power, Alternating Current.
- MIL-STD-1472 - Human Engineering Design Criteria for Military Systems, Equipment and Facilities.

PUBLICATION

MILITARY

- NAVSEA 0900-LP-001-7000 - Fabrication and Inspection of Brazed Piping Systems.

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

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

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- A 164 - Electrodeposited Coatings of Zinc on Steel.
- B 344 - Drawn or Rolled Nickel-Chromium and Nickel-Chromium-Iron Alloys for Electrical Heating Elements.
- D 2092 - Recommended Practices for Preparation of Zinc-Coated Steel Surfaces for Painting.

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

AMERICAN SOCIETY OF HEATING, REFRIGERATING, AND AIR CONDITIONING ENGINEERS (ASHRAE)

- 33 - Methods of Testing and Rating Forced Circulation Air Cooling and Air Heating.

(Application for copies should be addressed to the American Society of Heating, Refrigerating and Air Conditioning Engineers, 345 East 47th Street, New York, New York 10017.)

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(Technical society and technical association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal Agencies.)

3. REQUIREMENTS

3.1 Sample for first article inspection. Prior to beginning production, a sample shall be examined and tested as specified in 4.3 (See 6.2).

3.2 Materials. Materials of construction shall be similar or equal to the applicable specifications specified herein and when not specified, the materials shall be the same as successfully used in commercial application except cast iron shall not be used in the construction of the heater. Prior to construction, a list of materials and corresponding specifications shall be submitted to the Naval Ship Engineering Center (NAVSEC) for review.

3.2.1 Corrosion protection. Brass, copper, 300-series corrosion-resisting steel, nickel-copper alloy, and galvanized steel are considered corrosion-resisting materials for this application. When the corrosion-resistance of the 300-series corrosion-resisting steel is degraded by fabrication processes, it shall be restored by heat treatment.

3.2.1.1 Parts fabricated from other than corrosion-resisting materials shall be protected against corrosion after fabrication with chemicals, electrolytic processes, plating, or specified paints. The following methods, while not restrictive, are considered corrosion protection methods when properly applied:

- (a) Electroplating with zinc in accordance with type LS of ASTM A 164 followed by a phosphate treatment conforming to method A of ASTM D 2092.
- (b) One coat of primer conforming to MIL-P-15328 followed by two coats of primer conforming to TT-P-664.
- (c) Hot phosphoric or chromic acid treatment followed by two coats of primer conforming to TT-P-664.
- (d) Vitreous enamel treatment (heating elements only), minimum thickness 3 mils.

3.2.1.2 Fastenings and fittings. Bolts, nuts, studs, screws, and such fastenings or fittings as may be used shall be of corrosion-resisting material passivated in accordance with QQ-P-35, or of a material treated in a manner to render it adequately resistant to corrosion. Self-tapping sheet metal screws shall not be used.

3.2.2 Dissimilar metals. Where dissimilar metal contacts can not be avoided, the materials shall be selected to minimize galvanic corrosion of the heater.

3.2.3 Nonmagnetic material. When nonmagnetic heaters are specified (see 6.1.1), parts normally fabricated of black or galvanized steel shall be fabricated of corrosion-resisting steel which has a permeability of less than 2.0 after fabrication.

3.3 Design and construction.

3.3.1 Reliability and maintainability. It is the intention of this specification to obtain equipment of such design that it will have an operating life of at least 126,000 hours. The basis for design of replaceable parts shall be an equivalent of 5 years of ship operation (approximately 21,000 hours) before replacement is necessary (see 3.4 and 4.3.2.4).

3.3.1.1 Human engineering. Human engineering design criteria and principles shall be applied in the design of the heater so as to achieve safe, reliable, and effective performance by the operator and maintenance personnel and to optimize personnel skill requirements. MIL-STD-1472 shall be utilized as guidelines in applying human engineering design criteria for the heater.

3.3.1.2 Reliability assurance program. The contractor shall establish and maintain an effective reliability assurance program in accordance with 3.3.1.2.1 through 3.3.1.2.5. The contractor shall provide and maintain a reliability plan in accordance with the data ordering document included in the contract or order (see 6.1.2).

3.3.1.2.1 Design reviews. The reliability assurance program shall include provisions for the reliability review and evaluation of design as an integral part of the contractor's engineering design procedures. Design or engineering changes occurring during development or production shall be subjected to comparable review procedures.

3.3.1.2.2 Production control and monitoring. The reliability assurance program shall provide an economical and effective system of production control and monitoring to assure that reliability achieved in design is maintained during production (see 4.1.1).

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3.3.1.2.3 Subcontractor and contractor reliability. The reliability assurance program shall include provisions to assure subcontractor and contractor selection and performance consistent with the reliability requirements of the contract and applicable portions of this specification.

3.3.1.2.4 Reliability analysis. The contractor shall analyze those factors affecting reliability. The reliability analysis shall include, but shall not be limited to, the following:

- (a) List of those parts which experience and judgment show are subject to wear, material deterioration, and service failures.
- (b) Specific design features employed to attain the required service life of the parts with due consideration of shipboard environment and resultant conditions. Some suggested design features are choice of materials, compatibility of materials, hardness, surface finishes, fits, clearances, fastenings, equipment protection fail-safe features, internal and external operating temperatures and suitability of the materials at these temperatures, repairability and accessibility.
- (c) Preventive maintenance and servicing requirements necessary for the achievement of reliable equipment. Any unusual steps or precautions necessary in carrying out maintenance and servicing requirements shall be pointed out.

3.3.1.2.5 Failure reporting, analysis, and feedback. The reliability assurance program shall incorporate a formalized system for recording, collecting, and analyzing all failures that occur during testing, installation, and operation through the tenure of the contract. Analysis shall be fed back to contractor's engineering, management, and production activities on a timely basis. Failure reports received from the using activity shall be integrated into this program for trouble analysis and for experience considerations for future design review.

3.3.1.3 Maintainability. The construction of the heater shall be such that:

- (a) Wiring, terminals, and electrical connections are accessible for servicing and for test purposes by removing terminal enclosure cover but without requiring the removal of a subassembly or complete heating casing.
- (b) Heating elements are replaceable without removing the heater from the adjoining ductwork.
- (c) Heating elements fins can be cleaned with a nonmetallic stiff bristle brush without being damaged.

3.3.2 General design. Heater shall consist of three or more electrical heating elements (see 3.4) wired for single stage operation with terminals marked for acceptance of shipboard cable, mounted and enclosed in metal housing (casing) provided with a spraytight enclosure on one side of the casing for the electrical connection and a manual reset high limit cutout switch, designed for overhead mounting and incorporating a provision to enable connection to a supply duct and a discharge duct, and shall be ready for installation and connection to a power source.

3.3.2.1 General shipboard design conditions. General shipboard design characteristics shall be as follows:

- (a) Power source - type I of MIL-STD-1399, section 103.
 - (1) 115 volts, 3-phase, 60 hertz (Hz) for sizes 19EH through 21EH, and type L, size 22EH.
 - (2) 440 volts, 3-phase, 60 Hz for size 22EH, types M and H, and sizes 23EH through 38EH.
- (b) Perform in accordance with requirements herein under a design entering dry bulb (DB) temperatures of 0°F minimum to 70°F maximum.
- (c) Capable of operating satisfactorily at air flows between 80 to 125 percent of rated air flow (see figure 1).
- (d) Capable of operating satisfactorily in a weather air intake of a ship when exposed to soaking atmospheric spray (rain or sea) or sea water.

3.3.2.2 Shock. Heater shall be designed such that it is capable of passing the high-impact shock specified in MIL-S-901 for grade A, class 1 equipment.

3.3.2.3 Vibration. Heater shall be designed such that no damage will occur or malfunction be caused by the environmental vibrations specified in MIL-STD-167-1 for frequencies up to and including 33 Hz.

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3.3.2.4 Resistance to air flow. The maximum resistance to air flow through a heater shall be 0.35 inch of water at rated air flow.

3.3.3 Kilowatt rating. The kW rating of a specific size and type heater shall be at least equal to that specified in 1.2 and shown on figure 1, based on 10°F DB temperature air entering the heater air inlet at rated air flow, plus or minus 5 percent.

3.3.3.1 Performance. Performance of the heater for a given kW at specified air flows and delta temperature rise (ΔT equals leaving DB temperature minus entering DB temperature) shall be as specified in table I. Tolerances for air flow shall be within plus or minus 5 percent and for ΔT within plus or minus one degree of that specified in table I.

TABLE I. Heater performance.

Type	L			M			H			
Size EH	$\Delta T^\circ F$			$\Delta T^\circ F$			$\Delta T^\circ F$			
	29	24	20	44	35	29	48	39	32	
	Air flow, cubic feet per minute (ft ³ /min)			Air flow, ft ³ /min			Air flow, ft ³ /min			
21	70	85	100	90	115	140	125	155	185	
22	105	130	155	140	175	210	190	235	280	
23	160	200	240	220	275	330	290	365	440	
24	200	250	300	270	340	410	360	450	540	
25	305	380	455	415	520	625	550	690	830	
26	485	605	725	660	825	990	880	1100	1320	
27	710	890	1070	970	1215	1460	1295	1620	1945	
28	975	1220	1465	1330	1665	2000	1775	2220	2665	
29	1295	1620	1945	1770	2210	2650	2355	2945	3535	
30	1610	2015	2420	2195	2745	3295	2930	3660	4390	
31	1810	2260	2710	2465	3080	3695	3285	4105	4925	
32	1925	2405	2885	2625	3280	3935	3495	4370	5245	
33	2475	3095	3715	3375	4220	5065	4500	5625	6750	
34	3000	3750	4500	4090	5115	6140	5455	6820	8185	
35	3575	4470	5365	4880	6100	7320	6505	8130	9755	
36	4180	5225	6270	5700	7125	8550	7600	9500	11,400	
37	5365	6705	8045	7315	9145	10,975	9750	12,190	14,630	
38	6530	8160	9790	8900	11,125	13,350	11,870	14,835	17,800	
								$\Delta T^\circ F$		
								13	10	8
								Air flow, ft ³ /min		
								125	155	185
19										
								$\Delta T^\circ F$		
								20	16	13
								26	21	17
								Air flow, ft ³ /min		
20								90	115	140
								125	155	185

3.3.4 Sizes. Sizes and types of heaters shall be limited to those shown on figure 1.

3.3.4.1 Physical dimensions and tolerances. Physical dimensions and tolerances of the heater shall be as shown on figure 1.

3.3.4.2 Mounting dimensions. Mounting dimensions and tolerances shall be as shown on figure 1.

3.3.5 Casing. Heater casing shall be constructed of steel and shall be of continuously welded construction, with corners of the air inlet and air outlet flanges made smooth and airtight by welding to receive matching duct flanges. Heater casing (when not corrosion-resisting steel) shall be at least 0.056 inch thick when the heater face area (dimension A

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times B of figure 1) is 0.750 square feet or less, and at least 0.070 inch thick when heater face area exceeds 0.750 square feet. Casing constructed of corrosion-resisting steel shall be at least 0.045 inch thick when heater face area is 0.750 square feet or less, and at least 0.056 inch thick when heater face area exceeds 0.750 square feet.

3.3.5.1 Intermediate supports. Intermediate supports shall be provided when the face dimension (dimension B of figure 1) exceeds 23 inches and the distance between the supports shall not exceed 23 inches.

3.3.5.2 Connections (flanges) for ductwork. Surfaces for the connecting flanges shall be drilled with 13/32-inch diameter holes on 3-inch centers, working from the flange corners towards the air inlet and air outlet center lines. When the space between the center line and the adjacent hole exceeds 2 inches, there shall be a hole on the center line. The center of the corner holes shall be located 1/2 inch from the corner edges of the flange. Tolerance for the drilled holes, the distance between hole centers and location of the corner holes shall be plus or minus 1/64 inch.

3.3.5.3 Enclosure for electrical connections. Enclosure for the electrical connections shall be on the side of the heater casing and shall be of spraytight construction except that the heating elements entrance to the enclosure shall be water-tight. Provisions shall be made for the connection of the power source cable and the drainage of condensed moisture. A removable cover plate shall be provided that upon removal shall permit access to the power source terminals, terminals of the electrical components and the fasteners for the heating elements mounting flanges or threaded fittings. Surfaces which mate the removable cover plate shall be gasketed to produce a spraytight seal.

3.3.5.3.1 Power cable entrance. A blank gasketed plate shall be provided in the bottom of the enclosure to permit the drilling of a cable entrance by the installing activity.

3.4 Heating element. Heating elements shall consist of a helically coiled resistance wire centered in a densely packed insulating material enclosed in a hermetically sealed finned metal-sheath and provided with a threaded stud type terminal at each end of the element. Heating elements shall also be in accordance with the following:

- (a) Operating voltage in accordance with 3.3.2.1(a).
- (b) Resistance wire, nickel-chromium conforming to composition 60 Ni - 16 Cr alloy or 80 Ni - 20 Cr alloy of ASTM B344.
- (c) Insulating material, at least 94 percent granular magnesium oxide with zero percent alumina oxide.
- (d) Sheath and fins, vitreous enamel-coated steel, corrosion-resisting steel or nickel-copper alloy.
- (e) Hermetic seal (terminal ends), ceramic-to-metal type.
- (f) Terminals, at least size number 10-32.
- (g) Fins and hermetic seals continuously brazed to the metal-sheath.
- (h) Fitted with threaded fittings or mounting flanges to facilitate watertight entrance into the enclosure for the electrical connection.
- (i) Maximum surface temperature of sheath, 750°F at rated air flow.
- (j) Capable of meeting the requirements of 3.4.1 and 3.4.2 after the element has been completely immersed in water while under a hydrostatic gage pressure of at least 60 pounds per square inch (lb/in²) for a period of at least 20 minutes.
- (k) Capable of continuous operation at rated kW with rated air flow.
- (l) 21,000 hours life when tested as specified in 4.8.2.4.
- (m) Maximum watt density of 55 watts per square inch of sheath area (watt density is the watts per inch of sheath surface area excluding the fins).

3.4.1 Insulation resistance. Insulation resistance of the element at normal operating temperature (maximum sheath temperature not to exceed 750°F) shall be not less than 25 megohms. Insulation resistance when each heating element (excluding wiring) is at ambient room temperature shall be not less than 200 megohms.

3.4.2 Dielectric strength. Heating element shall withstand a dielectric test of twice the rated line voltage plus 1000 volts for a period of 1 minute. The voltage wave shall approximate a sine wave, and frequency shall be not less than 60 Hz.

3.5 Protection for heater. Each heater shall be provided with a manual reset high limit cutout switch that will limit the surface temperature of the heating elements to 750°F or less with no air flow. Cutout switch shall be suitable for pilot duty at 115 volts alternating current (a.c.).

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3.5.1 High limit cutout switch. High limit cutout switch shall conform to MIL-E-917 for insulating materials, and shall have provision for manual reset from the exterior of the enclosure for the electrical connections.

3.6 Electrical connections. Wiring shall be neat and shall be tied or clamped in a manner that supports and prevents chafing of the wire insulation due to vibration and shock. There shall be no splices in the wire and the connections shall be at the terminals of the devices or terminal blocks.

3.6.1 Wire. Internal hookup wire shall conform to MIL-W-16878, MIL-W-16878/4, MIL-W-16878/5, MIL-W-16878/7, or MIL-W-16878/8.

3.7 Creepage and clearance. Creepage and clearance distances used in construction of the heater shall conform to MIL-E-917.

3.8 Circuit strength and insulation resistance tests. Electrical circuits of the heater shall withstand a dielectric test of twice the rated line voltage plus 1000 volts for a period of 1 minute (see 4.8.1.5). The voltage wave shall approximate a sine wave, and the frequency shall be not less than 60 Hz. The insulation resistance of the assembled heater at operating temperature shall be not less than 5 megohms (see 4.8.1.6).

3.9 Gaskets. Gaskets shall be of heat and moisture resistant silicone rubber, or neoprene.

3.10 Welding and brazing. Welding procedures and materials shall be in accordance with MIL-STD-278, except that only visual examination of welds is required. Brazing procedures and materials shall be in accordance with NAVSEA 0900-LP-001-7000.

3.10.1 Zinc-coated surfaces. Where zinc-coated steel is used for fabricating parts, the metallic zinc shall be removed from joints and surfaces on which welds are to be deposited and for a distance of 1 inch from the expected toes of the welds. In areas where the metallic zinc cannot be removed and it is necessary to weld over the zinc-coated surfaces, electrode type G6010 or G6011 shall be used in accordance with QQ-E-450.

3.11 Painting. Interior and exterior surfaces of the heater, except the heating elements and those surfaces constructed of brass, copper, or corrosion-resisting steel shall be thoroughly cleaned and coated as follows:

- (a) One coat of pretreatment coating in accordance with MIL-P-15328.
- (b) Two coats of zinc chromate primer in accordance with TT-P-645, or two coats of red lead primer in accordance with MIL-P-17545.

3.12 Identification plates and terminal markings. Identification plates shall be color style II and shall conform to types A, B, D, F, or H of MIL-P-15024 and MIL-P-15024/5. The physical dimensions of the identification plates shall be equal to or less than the dimensions of a size number 10 plate of MIL-P-15024.

3.12.1 Identification plates. Each heater shall be provided with an identification plate, and the plate shall contain the following information:

- (a) Nomenclature.
- (b) Size and type.
- (c) Kilowatt rating.
- (d) Electrical characteristics.
- (e) National stock number (NSN).
- (f) Component identification number (CID).
- (g) Contract or order number.
- (h) Manufacturer's part number, name, and address.

3.12.2 Marking of terminal board. Terminal boards shall be marked in accordance with MIL-T-55164.

3.13 Wiring diagram. A reduced copy of the heater wiring diagram, either enclosed in a transparent water repellent envelope or printed on a plastic board or aluminum plate, shall be permanently attached to the inside of the enclosure access cover for the electrical connections.

3.14 Repair parts. Unless otherwise specified (see 6.1.1), repair parts shall be furnished in accordance with MIL-P-15137.

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3.15 Technical data. The contractor shall prepare technical data in accordance with the data ordering documents included in the contract or order (see 6.1.2) and as specified in 3.15.1 through 3.15.3.

3.15.1 System safety check list. The contractor shall prepare a system safety check list in accordance with the data ordering document included in the contract or order (see 6.1.2).

3.15.2 Drawings. In addition to the drawing content required by the data ordering document (see 6.1.2), the following unique technical features shall be included:

- (a) Methods and sizes of fastening and clearances for installation and servicing.
- (b) Supplementary data necessary to permit shipyard installation without contractor's assistance.
- (c) Performance data, curves:
 - (1) Leaving DB temperature for the following conditions:
 - a. Entering DB temperature, 10°F to 70°F at 3 degree intervals.
 - b. Air flow, ft³/min, 80 to 125 percent of rated air flow at 5 ft³/min intervals.
 - (2) Resistance to airflow (pressure drop), inches of water, at 80 to 125 percent of rated air flow.
- (d) Specify weight and center of gravity for each size heater.

3.15.3 Technical manual. In addition to the requirements covered by the data ordering document (see 6.1.2), the following unique features shall be included:

- (a) Photo views of the equipment as part of the general description.
- (b) Reduced size copies of all diagrams, assembly drawings, and detail drawings of repair parts.
- (c) Step by step procedures for removal and reinstalling the heating elements, the high limit cutout switch and, for checking continuity and checking for shorted circuit.

3.16 Workmanship. Sharp edges, burrs and other imperfections shall be removed from parts subject to contact with personnel to prevent cuts during repair and maintenance. Fin edges of the heating elements shall be free of burrs and shall not be bent back against the sheath of the heating element. Heater casing corners shall be smooth and square, and fasteners shall be in place and tight.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract, 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 the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.1.1 Inspection system. The contractor shall provide and maintain an inspection system in accordance with the data ordering document included in the contract or order (see 6.1.2).

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

- (a) First article inspection (see 4.3).
- (b) Quality conformance inspection (see 4.4).
- (c) Periodic tests (see 4.5).
- (d) Routine tests (see 4.6).

4.3 First article inspection. Unless otherwise specified (see 6.1.1), one sample of each type and size heater covered in the contract or order shall be submitted for first article inspection. First article inspection shall consist of the examination specified in 4.7 and the tests specified in 4.6.1, 4.6.2; 4.8.1, 4.8.2 (see 4.3.1) through 4.8.4, and 4.9. In addition to this inspection, the largest size heater covered by the contract or order shall be tested as specified in 4.8.5 and 4.8.6. The choice as to the type of heater tested as specified in 4.8.5 and 4.8.6 shall be determined by the contractor. The shock

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test shall be conducted prior to the vibration test of 4.8.6 and the performance tests of 4.8.1. The vibration test of 4.8.6 shall be conducted prior to the performance tests of 4.8.1.

4.3.1 Sample heating elements. One sample heating element of each watt density that is utilized in the heaters submitted for first article inspection shall be submitted for the tests specified in 4.8.2.

4.3.2 Where an identical type and size heater has successfully passed the first article inspection within a period of not more than 5 years of the date of the contract or order the first article inspection may be extended by the command or agency concerned.

4.3.3 Where a heater of a size larger than that submitted for tests has successfully passed the shock test specified in 4.8.5 and the vibration test specified in 4.8.6, the tests may be extended by the command or agency concerned.

4.4 Quality conformance inspection.

4.4.1 Lot. All heaters of the same size and type offered for delivery at one time shall be considered a lot.

4.4.2 Sampling for examination. A random sample of heaters shall be selected from each lot in accordance with table II for the examination specified in 4.7.

TABLE II. Sampling for examination.

Lot size number of heaters	Sample size number of heaters	Defective heaters	
		Acceptance number	Rejection number
1 to 6	All	-----	-----
7 to 15	7	0	1
16 to 25	10	0	1
26 to 40	13	0	1
41 to 65	17	1	2
66 to 110	22	1	2
111 to 180	28	2	3
181 to 300	35	2	3
301 to 500	45	3	4

4.4.3 Sampling for tests.

4.4.3.1 Heating elements. For each 1000 heating elements of the same power rating utilized in heaters furnished under this specification, a sample element shall be selected for the tests specified in 4.8.2.

4.4.4 Inspection. Quality conformance inspection shall consist of the examination specified in 4.7 and the tests specified in 4.8.2 (elements) and 4.8.4 (heaters).

4.5 Periodic tests. Periodic tests are required to assure continuing satisfactory operation of identical heaters. The tests are required under any contract or order for heaters of existing design when the contract or order is dated 5 years or more subsequent to the date of the last previous first article examination and tests of an identical heater. Periodic tests shall be conducted on one sample of each type and size heater covered in the contract or order, and shall consist of the examination and tests specified in 4.3.

4.6 Routine tests.

4.6.1 Heating elements. Each heating element shall be subjected to the tests specified in 4.8.2.1 through 4.8.2.3.

4.6.2 High limit cutout switch. Each high limit cutout switch shall be subjected to the tests specified in 4.8.3.

4.6.3 Heater. Each heater assembly shall be subjected to the tests specified in 4.8.1.5 and 4.8.1.6.

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4.7 Examination. Heaters shall be examined and measured to verify compliance with the requirements of this specification not involving tests. Examination shall be conducted as specified in table III. Any heater in the sample containing one or more defects shall not be offered for delivery, and if the number of defective units in any sample exceeds the acceptance number for the sample, the lot represented by the sample shall not be offered for delivery.

TABLE III. Classification of defects.

Categories	Defects
Critical: 1	None defined.
Major: 101	Size not as specified.
102	Incomplete, component parts missing (heating elements, high limit cutout switch).
103	Materials defective or not as specified.
104	Limited dimensions exceeded.
105	Flange holes and mounting dimensions not as specified.
106	Welding incomplete, not free of cracks, non-fusion, heavy porosity, heavy undercut, slag inclusions.
107	Corner of flanges not smooth, square or airtight.
108	Access cover plates, missing.
109	Cable entrance plate, missing.
110	Gaskets, missing or defective.
111	Fins not brazed to sheath at least 90 percent.
112	Fins bent back against the sheath or burrs not removed.
113	Splices in wire.
114	Electrical connections, not at terminal of components or terminal blocks.
115	Wiring not neat, tied, or clamped.
116	Cutout switch can not be reset without the removal of cover plate.
117	Bolts, nuts, and screws not tight, missing.
118	Sharp edges and burrs not removed from parts subject to personnel contact.
119	Drawings not followed, or wiring diagram missing.
120	Painting (as applicable) nonconforming.
121	Marking, identification plate not complete, missing, not permanent, illegible, or not as specified.

4.3 Tests.4.3.1 Performance tests (see 4.3).

4.3.1.1 Kilowatt rating tests. The kW rating of each size and type heater shall be determined at the conditions specified in 3.3.3. The mean delivered air temperature, at the specified air flow and entering DB air temperature shall be not less than 49°F for type H heaters, 44°F for type M heaters, and 34°F for type L heaters, except for size 19EH the leaving temperature shall be not less than 20°F and for size 20EH the leaving temperature shall be not less than 30°F for type H heater and 26°F for type M heater. The test shall be conducted in accordance with ASHRAE 33, except as follows:

- (a) The type of heating shall be electric and the power source shall be 115 volts plus or minus 5 percent, 3-phase, 60 Hz for heater sizes 19EH through 22EH, type L, and 440 volts plus or minus 5 percent, 3-phase, 60 Hz for heater sizes 22EH types M and H, through 38EH.
- (b) Readings of line volts and amperes and watts input shall be taken and recorded. Heater shall be operated for at least 30 minutes before any readings are taken.
- (c) Use: 3412 British thermal units per hour (Btu/h) = 1 kilowatt.

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4.8.1.2 Flexibility and range tests. The ΔT rise for the heater shall be determined at the conditions specified in 3.3.3.1. The tests shall be conducted as specified in 4.8.1.1. Tolerances for air flow and ΔT shall be in accordance with 3.3.3.1.

4.8.1.3 Air flow resistance. The resistance to air flow of the heater shall be determined in accordance with ASHRAE 33 at rated air flow plus or minus 5 percent. The resistance to air flow shall not exceed that specified in 3.3.2.4.

4.8.1.4 Over-temperature protection. Heater shall be operated at rated air flow and voltage for at least 30 minutes with the entering air at a temperature of at least 70°F. The fan providing the air supply shall be shut off and the surface temperature of the heating elements measured at 5 points selected at random. The mean measured surface temperature at which the high limit cutout switch contacts open shall not exceed 750°F.

4.8.1.5 Circuit strength test. Electrical circuits of the heater shall be subjected to and shall withstand for a period of 1 minute, a dielectric test voltage of twice the rated line voltage plus 1000 volts applied between each electric circuit and the frame, with all other electric circuits and metal parts grounded. The test shall be conducted with the heater at ambient room temperature, and the frequency shall be not less than 60 Hz.

4.8.1.6 Insulation resistance test. Insulation resistance of the heater assembly shall be measured at the normal operating sheath temperature with the heater energized to determine conformance with 3.8.

4.8.2 Heating elements. Heating elements shall be subjected to the tests specified in 4.8.2.1 through 4.8.2.4 and shall be conducted in order shown.

4.8.2.1 Moisture resistance. Element shall be completely immersed in water and while immersed subjected to a hydrostatic gage pressure of at least 60 lb/in² for a period of at least 20 minutes. Terminals of the element shall be wiped dry and subjected to the dielectric test of 4.8.2.2 and the insulation resistance test of 4.8.2.3.

4.8.2.2 Dielectric strength. Element shall be subjected to and shall withstand for a period of 1 minute, a dielectric test voltage of twice the rated line voltage plus 1000 volts applied between the terminal and the sheath. The voltage wave shall approximate a sine wave, and the frequency shall be not less than 60 Hz.

4.8.2.3 Insulation resistance. Insulation resistance shall be measured to determine conformance with 3.4.1 as follows:

- (a) Insulation resistance (cold) - at ambient room temperature.
- (b) Insulation resistance (hot) - at normal operating temperature with heating element energized.

4.8.2.4 Accelerated life test. Accelerated life test by fusion shall be conducted as follows:

- (a) Support element in still air.
- (b) Apply rated voltage and wattage.
- (c) When operating temperature is stabilized, operate at this condition for at least 30 minutes, cycling on-off at 5 minute intervals.
- (d) Increase voltage to the next higher increment of 5 watts per square inch of sheath heating surface area (WSIA) excluding the fins.
- (e) Read and record voltage and wattage and operate the element at this level for at least 30 minutes, cycling on-off at 5 minute intervals.
- (f) Repeat steps (d) and (e) until element fails by fusion.

4.8.2.4.1 Cause for rejection. A life expectancy of less than 21,000 hours shall be cause for rejection. When failure by fusion occurs prior to 85 WSIA, this constitutes a life expectancy of less than 21,000 hours.

4.8.3 Operational test. Each high limit cutout switch shall be subjected to a temperature of 750°F or less to determine whether the switch contacts will open to limit the surface temperature of the heating elements to 750°F or less. Any switch in which there is evidence that the switch contacts fail to open when tested shall be rejected.

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4.8.4 Creepage and clearance. Heater shall have the creepage and clearance distances measured to determine whether the distances are in accordance with MIL-E-917. Any heater where there is evidence that the creepage or clearance distances are not in accordance with MIL-E-917 when measured shall not be offered for delivery.

4.8.5 High impact shock tests (see 4.3). Size 32EH heater and smaller shall be shock tested on the lightweight machine as prescribed for type A shock of MIL-S-901, and standard mounting adapter 4C shown on figure entitled "Standard mounting for deck or platform mounted equipment (type 'A' test LWSM)" of MIL-S-901 shall be used. Size 33EH heater and larger shall be shock tested on the medium weight machine as prescribed for type A shock of MIL-S-901, and standard mounting adapters shown on either figures entitled "Standard mounting platform for testing equipment on medium weight shock testing machine" and figure entitled "30° mounting fixture for testing base mounted equipment on medium weight shock testing machine" shall be used. Heater shall be operated at rated voltage and current during the shock tests. Correction of damage which may have occurred during the shock test shall not be performed prior to conducting the tests specified in 4.8.1 and 4.8.6. Evidence of fragmentation or missile effect of parts or failure to operate shall be cause for rejection.

4.8.5.1 Upon completion of the shock test, post-shock test inspection, and specified tests, the heaters shall be returned to the contractor for examination and further testing.

4.8.6 Vibration tests (see 4.3). Size 32EH and size 38EH shall be subjected to the type I environmental vibration tests specified in MIL-STD-167-1.

4.9 Maintainability demonstration. Heater shall be examined after testing, and the capability to maintain, disassemble, and repair the unit shall be demonstrated to a Government representative. The demonstration shall be conducted utilizing the recommended tools and with other than expert mechanics. The maintainability demonstration shall include but not be limited to the following:

- (a) Wiring, terminals, and electrical connections are accessible for servicing and testing by removing terminal enclosure cover but without requiring the removal of a subassembly or complete heater casing.
- (b) Heating elements are replaceable without removing the heater from the adjoining ductwork.
- (c) Fins of the heating elements may be cleaned with a nonmetallic stiff bristle brush without being damaged.

4.10 Reports. The contractor shall prepare reports in accordance with the data ordering documents included in the contract or order (see 6.1.2) for the following:

- (a) First article tests (see 4.3).
- (b) Periodic tests (see 4.5).
- (c) Shock tests (see 4.8.5).
- (d) Vibration tests (see 4.8.6).
- (e) Maintainability demonstration (see 4.9).

4.11 Inspection of preparation for delivery. The preservation-packaging, packing, and marking shall be inspected for compliance with section 5 of this document.

5. PREPARATION FOR DELIVERY

(The preparation for delivery requirements specified herein apply only for direct Government procurements. For the extent of applicability of the preparation for delivery requirements of referenced documents listed in section 2, see 6.3.)

5.1 Preservation-packaging, packing, and marking. Heaters and repair parts shall be preserved-packaged level A or C, packed level A, B, or C, as specified (see 6.1.1), and marked in accordance with MIL-E-17555.

5.2 Data.

5.2.1 Manuals. Manuals shall be prepared for shipment as specified in MIL-E-17555.

5.2.2 Other data. Other data such as drawings, microfilm, miscellaneous reports, etc., to be forwarded to the contracting activity in compliance with the requirements of this specification, or as specified in the contract data requirements list, shall be packaged and packed level C in accordance with the applicable data specification, or where no preparation for delivery requirements exist, data shall be prepared in accordance with the level C requirements of MIL-D-5480 or MIL-E-17555.

6. NOTES

6.1 Ordering data.6.1.1 Procurement requirements. Procurement documents should specify the following:

- (a) Title, number, and date of this specification.
- (b) Size, type, and capacities required (see 1.2).
- (c) Whether nonmagnetic heaters are required (see 3.2.3).
- (d) Repair parts required (see 3.14).
- (e) First article inspection, if other than as specified (see 4.3).
- (f) Levels of preservation-packaging, packing, and marking required (see 5.1).

6.1.2 Data requirements. When this specification is used in a procurement which invokes the provision of the "Requirements for Data" of the Armed Services Procurement Regulations (ASPR), the data identified below, which are required to be developed by the contractor, as specified on an approved Data Item Description (DD Form 1664), and which are required to be delivered to the Government, should be selected and specified on the approved Contract Data Requirement List (DD Form 1423) and incorporated in the contract. When the provisions of the "Requirements for Data" of the ASPR are not invoked in a procurement, the data required to be developed by the contractor and required to be delivered to the Government should be selected from the list below and specified in the contract.

<u>Paragraph</u>	<u>Data requirements</u>	<u>Applicable DID</u>	<u>Option</u>
3.3.1.2	Reliability program plan	DI-R-2113	-----
3.15.1	System safety check list	UDI-H-26378	-----
3.15.2	Drawings, engineering and associated lists, level 1 (conceptual and developmental design)	DI-E-7013	Design activity designation - contractor Design activity drawing numbers - contractor
	Microfilming of engineering documents, 35 mm and PCAM preparation, microfilm aperture card	UDI-E-23140	Microfilming of drawings on aperture cards - type I, class 1 or type II, class 2 delivered to: NAVSEC Director, Naval Publication and Printing Service Office Washington Navy Yard Building 157, Code 724 Washington, DC 20390
3.15.3	Technical manual, (type I), equipment	UDI-M-23994	Type I of MIL-M-15071
4.1.1	Inspection system program plan	DI-R-4803	-----
4.10	First article inspection report	UDI-T-23450	-----
4.10	Test reports (periodic)	UDI-T-23729	-----
4.10	Equipment shock test reports	UDI-T-23753	-----
4.10	Vibration testing report	UDI-T-23762	-----
4.10	Maintainability demonstration reports	UDI-R-23565	-----

(Copies of data item descriptions required by the contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.)

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6.1.2.1 The data requirements of 6.1.2 and any task in section 3, 4, or 5 of the specification required to be performed to meet a data requirement may be waived by the procuring/purchasing activity upon certification by the offeror that identical data were submitted by the offeror and accepted by the Government under a previous contract for identical item procured to this specification. This does not apply to specific data which may be required for each procurement regardless of whether an identical item has been supplied previously (for example, test reports).

6.2 First article inspection. Invitations for bids should provide that the Government reserves the right to waive the requirement for samples for first article inspection as to those bidders offering a product which has been previously procured 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 procurement.

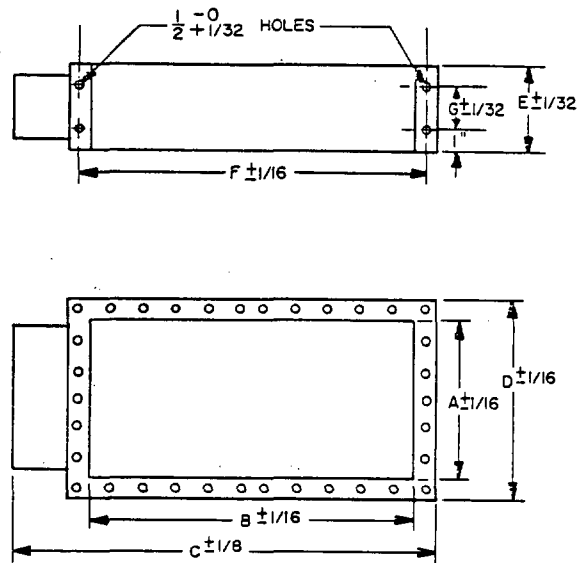
6.3 Sub-contracted material and parts. The preparation for delivery requirements of referenced documents listed in section 2 do not apply when material and parts are procured by the contractor for incorporation into the equipment and lose their separate identity when the equipment is shipped.

6.4 Changes from previous issue. The symbol "#" is 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 4520-N214)

MIL-H-22594A (SHIPS)



SH 10928

Type	L		M		H		Dimensions (Inches)							
	Size EH	Rated kW	Rated air flow ft ³ /min	Rated kW	Rated air flow ft ³ /min	Rated kW	Rated air flow ft ³ /min	A	B	C	D	E	F	G
19	-----	-----	-----	-----	0.5	155	3-1/4	6	13	6-1/4	6	3	4	
20	-----	-----	0.58	115	1.0	155	3-1/4	6	13	6-1/4	6	3	4	
21	0.65	85	1.26	115	1.9	155	3-1/4	6	13	6-1/4	6	3	4	
22	1.0	130	1.93	175	2.9	235	3-1/4	9	16	6-1/4	6	11	4	
23	1.52	200	3.0	275	4.5	365	3-1/4	14	20	6-1/4	6	16	4	
24	1.9	250	3.74	340	5.5	450	6-1/4	9	15	9-1/4	6	11	4	
25	2.9	330	5.72	520	8.5	690	6-1/4	14	20	9-1/4	6	16	4	
26	4.59	605	9.1	825	13.5	1100	6-1/4	22	29	9-1/4	8	24	6	
27	6.76	890	13.4	1215	20.0	1620	9-1/4	22	29	12-1/4	8	24	6	
28	9.26	1220	18.3	1665	27.3	2220	9-1/4	30	38	12-1/4	8	32	6	
29	12.3	1620	24.3	2210	36.2	2945	12-1/4	30	38	15-1/4	8	32	6	
30	15.3	2015	30.2	2745	45.0	3660	15-1/4	30	39	13-1/4	8	32	6	
31	17.2	2260	33.9	3080	50.5	4105	12-1/4	42	51	15-1/4	8	44	6	
32	18.2	2405	36.0	3280	53.8	4370	18-1/4	30	39	21-1/4	8	32	6	
33	23.5	3095	46.4	4220	69.2	5625	16-3/4	42	51	19-1/4	8	44	6	
34	28.5	3750	56.3	5115	84.0	6820	15-1/4	56	66	18-1/4	8	58	6	
35	33.9	4470	67.1	6100	100.0	8130	24-1/4	42	52	27-1/4	8	44	6	
36	39.7	5225	78.4	7125	117.0	9500	21-1/4	56	66	24-1/4	8	58	6	
37	50.9	6705	100.6	9145	150.0	12,190	36-1/4	42	52	39-1/4	8	44	6	
38	61.9	8160	122.4	11,125	183.0	14,835	33-1/4	56	66	36-1/4	8	58	6	

FIGURE 1. Heater dimensions.

