INCH-POUND

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SUPERSEDING
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PERFORMANCE SPECIFICATION

FANS, VANEAXIAL AND TUBEAXIAL, VENTILATION AND AIR CONDITIONING, NAVAL SHIPBOARD

This specification is approved for use by the Department of the Navy and is available for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers fixed vaneaxial and tubeaxial fans for Naval shipboard use in ventilation and air conditioning systems.

1.2 Classification. Fans are of the following types, sizes, current, voltage and phase, enclosures, maximum ambient temperature, structure, thermal protection, and quiet bearings as specified (see 6.2):

1.2.1 Types.

Types	PIN Code
A – Vaneaxial, fixed, Navy Standard (HI Shock)	AA
L – Tubeaxial, fixed, Navy Standard (HI Shock)	LL
X-A – Vaneaxial, fixed, Navy Standard (Non-Shock, commercial marine motor)	XA
X-L – Tubeaxial, fixed, Navy Standard (Non-Shock, commercial marine motor)	XL

Comments, suggestions, or questions on this document should be addressed to: Commander, Naval Sea Systems Command, ATTN: SEA 05Q, 1333 Isaac Hull Avenue, SE, Stop 5160, Washington Navy Yard DC 20376-5160 or emailed to commandstandards@navsea.navy.mil, with the subject line "Document Comment". Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at http://assist.daps.dla.mil.

1.2.2 Sizes.

Types A and X-A vaneaxial fans

Fan Size	Volume (ft^3/min)	Fan Total Pressure (inches, wg)	PIN Code
¼	250	2.5	00Q[1/]
½	660	2.5	00H[2/]
1	1,030	2.65	01W[3/]
1½	1,500	3.0	01H
2	2,000	3.4	02W
2½	2,600	3.4	02H
3	3,200	3.4	03W
3½	3,750	3.5	03H
4½	3,220	7.0	04H
5	4,200	3.75	05W
6	6,300	3.65	06W
7	5,200	7.0	07W
8	7,300	3.3	08W
10	8,500	4.2	10W
11	8,700	5.5	11W
12	10,250	5.0	12W
16	13,200	4.75	16W
17	12,300	6.2	17W
20	18,000	4.85	20W
25	22,000	3.95	25W
28	18,750	6.4	28W
30	25,000	4.2	30W

Types L and X-L tubeaxial fans

Fan Size	Volume (ft^3/min)	Fan Total Pressure (inches, wg)	PIN Code
½	450	0.75	00H
1	1,000	0.50	01W
2	1,900	0.58	02W
3	2,250	0.70	03W

[1/] "Q" denotes the fraction "¼".

[2/] "H" denotes the fraction "½".

[3/] "W" denotes a whole number.

1.2.3 Current.

Type of Current	PIN Code
Alternating current (a.c.)	A
Not applicable	N

1.2.4 Voltage.

Voltage and Phase (frequency of a.c. is 60 Hz)	PIN Code
115-volt, single phase a.c.	1
220-volt, 3-phase a.c.	2
440-volt, 3-phase a.c.	4

1.2.5 Enclosures.

Enclosures	PIN Code
Spraytight	W
Explosion-proof	X

1.2.6 Maximum ambient temperature.

Ambient Temperature	PIN Code
65 °C	6
80 °C	8

1.2.7 Structure.

Structure	PIN Code
Non-magnetic structure of fan and motor	NM
Not applicable	NA

1.2.8 Thermal protection.

Thermal Protection	PIN Code
Thermal protection is applied	TP
Not applicable	NA

1.2.9 Quiet bearing.

Quiet Bearing	PIN Code
Quiet bearing that meets MIL-B-18731	QB
Not applicable	NA

1.3 Part or identifying number (PIN). PINs to be used for fixed vaneaxial and tubeaxial fans acquired to this specification are created as follows (see 1.2.1 through 1.2.9):

M	**18953**	**-**	**XX**	**XXX**	**X**	**X**	**X**	**X**	**XX**	**XX**	**XX**
Prefix for Military Specification	Specification Number		Type	Size	Current	Voltage and Phase	Enclosures	Ambient Temp.	Structure	Thermal Protection	Quiet Bearing

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4, or 5 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3, 4, or 5 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-S-901	Shock Tests, H.I. (High-Impact) Shipboard Machinery, Equipment, and Systems, Requirements for
MIL-M-17059	Motors, 60-Cycle, Alternating-Current, Fractional H.P. (Shipboard Use)
MIL-M-17060	Motors, 60-Hertz, Alternating Current, Integral-Horsepower, Shipboard Use
MIL-B-17931	Bearings, Ball, Annular, for Quiet Operation

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-l67-1	Mechanical Vibrations of Shipboard Equipment (Type I - Environmental and Type II - Internally Excited)
MIL-STD-1399-300	Interface Standard for Shipboard Systems, Electric Power, Alternating Current (Metric)
MIL-STD-2142	Magnetic Silencing Characteristics, Measurement of (Metric)

(Copies of these documents are available online at http://assist.daps.dla.mil/quicksearch/ or http://assist.daps.dla.mil or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

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

NAVSEA TECHNICAL PUBLICATION

S9074-AR-GIB-010/278 – Requirements for Fabrication, Welding and Inspection, Casting Inspection and Repair for Machinery, Piping and Pressure Vessels

(Copies of this document are available from Naval Inventory Control Point, 700 Robbins Avenue, Attn: Code 0862 (Cash Sales), Philadelphia, PA 19111 or online at www.nll.navsup.navy.mil.)

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

AIR MOVEMENT AND CONTROL ASSOCIATION (AMCA) INTERNATIONAL, INC.

AMCA 99-0401	Classification for Spark Resistant Construction
AMCA 111	Laboratory Accreditation Program
AMCA 210	Laboratory Methods for Testing Fans for Aerodynamic Performance Rating (DoD adopted)
AMCA 300	Reverberant Room Method for Sound Testing of Fans (DoD adopted)

(Copies of these documents are available from the Air Movement and Control Association International, Inc., 30 West University Drive, Arlington Heights, IL 60004 or online at www.amca.org.)

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)/AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

ANSI/ABMA STD-4	Tolerance Definitions and Gaging Practices for Ball and Roller Bearings
ANSI/ABMA STD-9	Load Ratings and Fatigue Life For Ball Bearings
ANSI/ABMA STD-13	Rolling Bearing Vibration and Noise (Methods of Measuring)
ANSI/ABMA STD-20	Radial Bearings of Ball, Cylindrical Roller and Spherical Roller Types - Metric Design
ANSI/ABMA/ISO 3290	Rolling Bearings - Balls - Dimensions and Tolerances (DoD adopted)

(Copies of these documents are available from the American Bearing Manufacturers Association, Inc., 2025 M. St., NW, Suite 800, Washington, D.C. 20036 or online at www.abma.org.)

AMERICAN WELDING SOCIETY (AWS)

AWS B2.1	Welding Procedure and Performance Qualification, Standard For (DoD adopted)
AWS B2.2	Brazing Procedure and Performance Qualification, Standard For (DoD adopted)

(Copies of these documents are available from the American Welding Society, 550 NW LeJeune Road, Miami, FL 33216 or online at www.aws.org.)

ASTM INTERNATIONAL

ASTM B26	Standard Specification for Aluminum-Alloy Sand Castings (DoD adopted)
ASTM F1166	Standard Practice for Human Engineering Design for Marine Systems, Equipment and Facilities (DoD adopted)

(Copies of these documents are available from ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959 or online at www.astm.org.)

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE STD 45	Recommended Practice for Electric Installations on Shipboard (DoD adopted)

(Copies of this document are available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331 or online at www.ieee.org.)

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	Motors and Generators (DoD adopted)

(Copies of this document are available from the National Electrical Manufacturers Association, 1300 N. 17th St., Suite 1847, Rosslyn, VA 22209 or online at www.nema.org.)

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

3. REQUIREMENTS

3.1 Qualification. The fans furnished under this specification shall be products that are authorized by the qualifying activity for listing on the applicable qualified products list before contract award (see 4.2 and 6.3).

3.2 Materials. Fan shall be of spark-resistant construction as defined in AMCA 99-0401 Type B construction. Cast iron, excluding nodular iron, shall not be used in the construction of the fans nor shall cast iron be used in fan motors which are components of Types A and L fans. Materials shall be corrosion resisting or material shall be protected against corrosion after fabrication. Material degraded during the fabrication process shall be normalized to restore those properties before assembled in any fan. Selected materials shall be capable of meeting all of the operational and environmental requirements specified herein. Non-metallic materials for the fan casing and impeller shall be avoided due to fire and smoke concerns.

3.2.1 Hazardous material. Materials for use in the construction of fans shall have no effect on the health of personnel when the materials are used for intended purpose. Regardless of other requirements, materials and parts containing asbestos, cadmium, lithium, mercury, or radioactive material shall not be used.

3.2.2 Fasteners. Material for all bolts, nuts, studs, screws and similar fasteners shall be corrosion-resistant passivated or of a material rendered resistant to corrosion. Self-tapping sheet metal screws shall not be used. Galling shall be prevented. Tapped holes shall be reinforced where shearing of thread can occur.

3.2.3 Nonmagnetic construction. When nonmagnetic fan-motor units are specified (see 6.2), all fan parts including the casing, vanes, impeller, impeller bushing, motor mounting, fasteners, washers, conduit box, and fittings shall be of nonmagnetic material. Nonmagnetic material is defined as a material that has a maximum relative permeability of less than 2.0 after fabrication.

3.2.4 Motor material. Motor material shall conform to the requirements of IEEE STD 45 or NEMA MG 1 for nonmagnetic motors.

3.2.5 Dissimilar metals. Fans and components shall not be degraded due to electrolysis.

3.2.6 Faying surfaces. Faying surfaces shall be protected against corrosion.

3.2.6 Recycled, recovered, or environmentally preferable materials. Recycled, recovered, or environmentally preferable materials should be used to the maximum extent possible, provided that the material meets or exceeds the operational and maintenance requirements, and promotes economically advantageous life cycle costs.

3.3 Painting. Equipment and component items shall be painted as specified (see 6.2). If paint requirements are not specified, use standard factory finish.

3.4 Welding and allied processes. Surfaces of parts to be welded or brazed shall be free from rust, scale, paint, grease, and other foreign matter. Welding and allied processes shall be performed by personnel certified to AWS B2.1 and B2.2. NAVSEA Technical Publication S9074-AR-GIB-010/278 shall be used for guidance.

3.5 Identification plates. Each fan shall be provided with a permanently attached corrosion-resistant identification plate. Attachment methods for the identification plate shall be corrosion-resistant. The identification plate shall contain the following information as a minimum:

a. National stock number
b. Manufacturer's name, commercial and government entity (CAGE) number, and part number
c. PIN code
d. Direction of airflow and rotation
e. Bearing lubrication

The identification plate and a duplicate motor identification plate shall be installed on the outside of the fan casing.

3.6 Interchangeability. In no case shall fan parts (excluding motor parts) be physically interchangeable or reversible unless such parts are also interchangeable or reversible with regard to function, performance, and strength.

3.7 Operating life. The equipment shall have an operating life of not less than 223,800 hours (equivalent to approximately 30 years of operation). Any part identified as planned replacement parts shall have an operating life, prior to replacement, of approximately 37,300 hours (equivalent to approximately 5 years of ship operation).

3.8 Human engineering. The fan shall be arranged so as to achieve safe, reliable, and effective performance by the operator and maintenance personnel and to optimize personnel skill requirements. ASTM F1166 shall be utilized as a guideline in applying human engineering design criteria for the fan-motor unit.

3.9 Maintainability. The fan shall be constructed so that:

a. Fan impeller shall be mounted on the motor shaft in such a manner that it is removable using commonly available tools.

b. Bearings shall be removable using commonly available tools.

c. Parts shall be match marked or attached so that reinstallation will be in the same position as originally installed.

d. Motor shall be removable using commonly available tools.

3.10 Design requirements.

3.10.1 Aerodynamic design parameters. The quantities of blades and vanes shall be designed to avoid interacting frequencies within the audible range. The axial distance between blades and vanes shall be designed with minimum noise amplitude in accordance with Table I. The maximum blade tip clearance (radial clearance) shall not exceed ¼ of 1 percent of the casing minimum inside diameter.

TABLE I. Total sound power level in decibels (dB), referenced to 10^{-12} watt.

Fan type	Fan size	Octave band center frequency - Hz							
		63	125	250	500	1000	2000	4000	8000
A and X-A	¼	81	79	80	80	80	76	73	67
	½	81	81	81	82	82	80	77	71
	1	83	82	84	84	84	82	79	73
	1½	82	83	87	87	89	86	82	76
	2	87	89	86	91	95	89	85	79
	2½	85	91	90	91	91	88	85	80
	3	86	88	92	94	92	90	83	77
	3½	87	89	93	94	95	90	87	80
	4½	92	91	96	100	98	96	93	87
	5	87	89	93	93	93	89	83	82
	6	92	91	94	95	94	91	86	82
	7	94	94	100	100	100	98	94	88
	8	93	96	93	95	95	92	87	82
	10	92	97	98	101	96	93	88	82
	11	94	101	102	102	100	97	91	89
	12	94	97	96	99	98	95	90	86
	16	95	97	97	100	101	97	94	87
	17	97	99	103	107	107	101	94	90
	20	96	98	102	102	102	100	97	91
	25	95	97	101	101	99	95	91	87
	28	99	98	99	105	103	101	96	91
	30	96	98	102	102	102	97	93	88
L and X-L	½	86	82	78	83	85	83	75	70
	1	85	81	80	85	87	85	77	72
	2	87	83	82	87	89	87	79	74
	3	90	86	85	90	92	90	82	77

NOTE: Add 4 dB to the octave band in which blade frequency occurs.

3.10.2 Configuration. Fans and motors shall operate in any position on shipboard including vertical (with fan impeller either up or down), horizontal (parallel to ship's centerline or athwartship), or inclined. Each fan-motor unit shall be a complete assembly.

3.10.3 Fan impellers. The fan impeller shall require no assembly or disassembly except to be removable as a unit from the drive shaft. Impellers shall be of airfoil design. The total impeller shall have at least a safety factor of 8, based on the ultimate tensile strength of the material. Impellers shall be designed to prevent retention of water when the fan is installed vertically with the impeller up or down, or horizontally. The hub of the impeller shall not distort or the fit loosen on the drive shaft during the life of the equipment.

3.10.3.1 Nose piece. If a nosepiece is required, it shall be match marked with the impeller or attached to it to ensure reinstallation in the same position relative to the impeller.

3.10.3.2 Balancing. The preferred method of balancing impellers is by removal of material. Provision of sufficient rim thickness or of cast pads on the inside diameter of the impeller rim is recommended for this purpose. If fan balancing is accomplished by adding weight, the weight(s) shall be permanently attached.

3.10.4 Vaneaxial fans.

3.10.4.1 Sizes. Sizes of Types A and X-A vaneaxial fans shall be limited to those listed in 1.2.2.

3.10.4.2 Physical interface dimensions. Physical interface dimensions of the fans shall be as shown on Figure 1.

3.10.4.3 Watertightness. Casings shall be watertight.

3.10.4.4 Flanges. Flanges for duct connections shall be provided at each end of the fan casing. These flanges shall be integral parts of the casing either through manufacture or welding. The flanges shall be drilled as shown on Figure 1. An additional flanged connection may be provided at the contractor's option for stiffening large casings or to permit use of a heavier fan race section. The extra flange shall have the same bolting as the end flanges, as well as three unequally spaced dowels.

3.10.4.5 Direction vanes. Directional vanes shall be provided in the casing.

3.10.4.6 Motor mounting. Motors shall be face mounted. Mounting shall be designed to dampen rotor vibration.

3.10.5 Tubeaxial fans.

3.10.5.1 Sizes. Sizes of Types L and X-L fans shall be limited to those listed in 1.2.2.

3.10.5.2 Physical dimensions. Physical dimensions of the fans shall be as shown on Figure 2.

3.10.5.3 Flanges. Flanges shall be provided at each end of the fan casing. The discharge flange shall be drilled as shown in Figure 2.

3.10.5.4 Safety screen. A removable corrosion resistant 1-inch mesh screen shall be mounted to the inlet flange.

3.10.5.5 Motor mounting. Motors shall be removable.

3.11 Electric equipment.

3.11.1 Motors. Fan motors shall be in accordance with Table II and 3.11.1.1 as applicable. In no case shall motor extend beyond the fan casing. See Figure 1 for Types A and X-A fans. See Figure 2 for Types L and X-L fans. As an alternative, motors of frame sizes 184 or larger conforming to MIL-M-17060 and motors of frame sizes smaller than 184 conforming to MIL-M-17059 and meeting the requirements of 3.11.1.1 through 3.11.3 and Table II are also acceptable. Commercial marine motors shall be in accordance with IEEE STD 45 with energy efficient motors in accordance with NEMA MG 1.

3.11.1.1 General requirements. Motors shall be designed for at least 65 °C or 80 °C ambient temperature, as specified in 6.2 (65 °C if not specified), continuous air over duty, with either face or flange mountings and the following (see 6.2):

Service:	For Types A and L fan - hi-shock qualified motors. For Types X-A and X-L fan - commercial marine motor.
Type:	For single-phase power either split permanent capacitor or split-phase induction with solid-state starting switch accessible and mounted on outside of fan casing. Mechanical centrifugal switches shall not be used. For polyphase power - squirrel cage induction.
Enclosure:	For Types A, X-A, L, and X-L fans - spraytight (see 3.11.1.8) (if not specified) or explosion-proof.
Duty:	Continuous

Insulation: For Types A and L fan, unless otherwise specified (see 6.2), Class F sealed insulation in accordance with MIL-STD-2037. Motor temperature rise not to exceed 55 °C in a 65 °C ambient.
For Types X-A and X-L fan, unless otherwise specified (see 6.2), Class F in accordance with IEEE STD 45 with 55 °C maximum temperature rise in a 65 °C ambient.

Horsepower: See Table II

Mounting: Motors shall operate within the requirements specified herein when mounted in the positions described in 3.10.2.

Protection: Motor, when specified, shall be equipped with thermal protection in each phase to detect over-temperature. Thermal protectors shall be of the automatic reset type with appropriate locked rotor temperature limit. (see 6.2)

Drains: Drain holes with plugs shall be furnished in each spraytight motor to drain condensate from the motor when fan is installed vertically, with the impeller up or down or horizontally. For drainage in the horizontal position, an adequate number of holes shall be provided to allow 360-degree rotation of the fan.

TABLE II. Motor requirements.

Fan type	Fan size	Nominal Hp	Speed	No. wind	Power 60 Hz	Lock rotor current	Torque			Min. Motor Eff. (%)
							Lock rotor	Break down	Pull up	
A and X-A	¼	1/5	Single	1	440V - 3Ø	NEMA MG 1[1/] + 10 percent	70 percent full load torque	NEMA MG 1[1/]	70 percent full load torque	75
	½	⅓	Single	1						80
	1	1	Single	1						86
	1½	1¼	Single	1						86
	2	1½	Single	1						86
	2½	2	Single	1						87
	3	3	Full – ⅔	2		NEMA MG 1[2/]		NEMA MG 1[2/]		85
	3½	3	Single	1						88
	4½	5	Single	1						89
	5	4	Full – ⅔	2						85
	6	5	Full – ⅔	2						86
	7	7½	Full – ½	2						88
	8	6	Full – ⅔	2						86
	10	7½	Full – ⅔	2						88
	11	12½	Full – ⅔	2						89
	12	10	Full – ⅔	2						89
	16	15	Full – ⅔	2						90
	17	17½	Full – ⅔	2						90
	20	20	Full – ⅔	2						90
	25	25	Full – ¾	2						91
	28	25	Full – ⅔	2						91
	30	25	Full – ¾	2						91
L and X-L	½	1/15	Single	1	115V - 1Ø	NEMA MG 1[1/] + 10 percent		NEMA MG 1[1/]		22
	1	⅛	Single	1	115V - 1Ø					50
	2	¼	Single	1	440V - 3Ø					79
	3	¼	Single	1	440V - 3Ø					79

[1/] MIL-M-17059 may be used as an alternative.
[2/] MIL-M-17060 may be used as an alternative.

3.11.1.2 Balancing. Motor rotating assembly shall be balanced in accordance with NEMA MG 1.

3.11.1.3 Speed-torque characteristics. The speed-torque characteristics shall be coordinated with the combined inertia of the rotating assembly, including the fan impeller. It shall be possible to accelerate the fan unit from standstill to high or low speed at 90 percent of the rated voltage when the current rating of the controller overload protective device does not exceed the motor full load current.

3.11.1.4 Bearings. Motors shall be equipped with sealed grease-filled bearings, Type 120 or equivalent, to provide proper bearing lubrication in all fan orientations to insure maximum bearing life. Unless otherwise specified (see 6.2), bearings shall be in accordance with ANSI/ABMA precision classification of ABEC 1 in accordance with ANSI/ABMA STDs 4, 9, 13, 20, and ANSI/ABMA/ISO 3290. Special bearings (ABEC 5) for quiet operations when specified (see 6.2) shall be in accordance with ANSI/ABMA STDs 4, 9, 13, 20, ANSI/ABMA/ISO 3290, and MIL-B-17931.

3.11.1.5 Bearing temperature rise. Bearing temperature rise not to exceed 35 °C in 65 °C ambient as measured on the outer ring. For quiet bearings, temperature rise not to exceed 25 °C in 65 °C ambient as measured on the outer ring.

3.11.1.6 Power leads and grounding conductor (for Types L and X-L fans). Power source leads and a grounding conductor shall be provided and shall extend at least 5 feet beyond fan casing. A separate grounding connection shall be established between the motor frame and the fan casing.

3.11.1.7 Test connection for explosion-proof motors. A single, drilled, tapped, and plugged opening shall be provided in the front bracket of each explosion-proof motor for determining enclosure air leakage rate.

3.11.1.8 Spraytight enclosure. A spraytight enclosure shall be in accordance with IEEE STD 45 for watertight enclosures.

3.11.2 Conduit box. For Types A and X-A fans, a conduit box shall be mounted on the outside of the fan casing in line with motor lead entrance. The box shall permit connection from either side or from one end. Boxes shall have the same degree of enclosure as motors with which they are used.

3.11.3 Conduits. For Types A and X-A fans, the lead wires from the conduit box to the motor shall be enclosed in a watertight conduit or race. An effective electrical ground shall be provided from the motor frame to the fan casing and the conduit box.

3.12 Fan performance.

3.12.1 Types A and X-A vaneaxial fans.

3.12.1.1 Aerodynamic performance. The design point for each size vaneaxial fan shall be the volume-pressure point as specified in 1.2.2. The volume shall be the volume at the fan inlet and the pressure shall be the total pressure (Pt) in water gauge (wg) at the fan discharge. The volumetric flow rate shall not exceed a range of -2% to +5% of the applicable base curve on Figure 4, as measured on a system line. The upper and lower bounds of this stable operation region are as indicated in Figure 3. Throughout this region, the fan shall exhibit stable operation.

3.12.1.2 Aerodynamic stall. The stall and recovery region is established along the TP curve from the highest TP to point “c” in Figure 3. Point “c” shall occur at volume capacities less than or equal to the fan volume-pressure design point as specified in 1.2.2 when tested in accordance with 4.8.4.1.

3.12.2 Types L and X-L tubeaxial fans.

3.12.2.1 Aerodynamic performance. The design point for each size tubeaxial fan shall be the volume-pressure point as specified in 1.2.2. The volume shall be the volume at the fan inlet and the pressure shall be the total pressure (Pt) in water gauge (wg) at the fan discharge. The Pt shall rise continually from free delivery through the design point to a point determined by the intersection of the fan performance curve and the system resistance line passing through a point at 85% of the design volume and the design pressure as specified in 1.2.2. The volumetric flow rate shall not exceed a range of -2% to +5% of the applicable base curve on Figure 5, as measured on a system resistance line. The upper and lower bounds of this stable operation region are as indicated in Figure 3. Throughout this region, the fan shall exhibit stable operation.

3.12.2.2 Aerodynamic stall. Effective stall shall not occur at flow capacities greater than 85 percent of the fan design as specified in 1.2.2.

3.13 Environmental conditions.

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

a. Power source quality - in accordance with MIL-STD-1399-300.
b. Able to operate satisfactorily when exposed to soaking atmospheric spray (rain or sea) or seawater.
c. Perform in accordance with requirements herein in a range of ambient temperatures between -29 °C and 65 °C. Some special applications may require fans designed to operate in a higher (80 °C) ambient temperature.

3.13.2 High impact shock resistance. Unless otherwise specified in 6.2, the fan-motor units shall meet the shock test requirements of MIL-S-901 for Grade A, Class I equipment.

3.13.3 Vibration and balance. Fan-motor units shall be designed such that no damage will occur or malfunction be caused by the environmental vibrations specified in MIL-STD-167-1. Fan-motor units shall be in static and dynamic balance. The vibration amplitude shall not exceed the limits for Type II bearing vibration as specified in MIL-STD-167-1.

3.13.4 Airborne noise. The total sound power levels for the fan-motor unit shall not exceed the levels stated in Table I when tested in accordance with procedures stated in 4.8.5. Exceeding the total sound power levels specified in Table I shall be cause for rejection.

4. VERIFICATION

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

a. Qualification inspection (see 4.2).
b. Conformance inspection (see 4.3).

4.2 Qualification inspection. Qualification inspection shall be performed on Types A and X-A vaneaxial fans and Types L and X-L tubeaxial fans when qualification is required (see 3.1). This inspection shall include the examination and the tests as specified in Table III.

4.3 Conformance inspection. Conformance inspection shall consist of the examinations of tests as specified in Table III. The tests specified shall be performed on each fan-motor unit. Any unit that fails to meet any specified requirements shall be rejected.

TABLE III. Test agenda.

Tests	Reqt.	Verification	Qualification[1/]	Conformance	Type[2/]	Periodic[3/]	Routine[4/]
Shock	3.13.2	4.8.1	A, L[5/]		A, L		
Vibration	3.13.3	4.8.2	A, L[5/]		A, L		
Balance	3.13.3	4.8.3	ALL	ALL	ALL	ALL	ALL
Performance	3.12	4.8.4	ALL		ALL	ALL	
Airborne noise By measurement By ear	3.13.4 3.12.1.2 3.12.2.2	4.8.5 4.8.5 4.8.5.1	 ALL --	 -- ALL	ALL	ALL	
Motor heat	3.11.1.1	4.8.6	ALL		ALL	ALL	
Bearing temperature	3.11.1.5	4.8.6	ALL				
Explosion (explosion-proof motors)	3.11.1.1	4.8.7	All with explosion-proof motors		All with explosion-proof motors		
Air leakage (explosion-proof motors)	3.11.1.7	4.8.7.1		All with explosion-proof motors		All with explosion-proof motors	
Casing tightness	3.10.4.3	4.8.8	A, X-A[4/]	A, X-A[4/]			A, X-A[4/]
Speed	3.11.1	4.8.9	ALL	ALL			ALL
Blade tip clearance measurement	3.10.1	4.9	ALL	ALL			
Non-magnetic	3.2.3	4.11	All non-magnetic units	All non-magnetic units			
Maintainability	3.9	4.12	A representative fan size				

1/ Applies to test specimen of the types indicated.

2/ Applies to test specimen for each design of each size of the types indicated.

3/ Applies to every fan-motor unit produced.

4/ Casing tightness test is required only when specified.

5/ Required (see 3.1), unless a previous test of a similar unit is considered applicable and is extended by the qualifying activity.

4.4 Type tests. Type tests are all required tests of fan-motor units of each type and size by producers whose product of the type being tested is listed in the Qualified Products List. Type tests shall consist of the tests specified in Table III and shall be conducted prior to production on each new fan-motor unit, unless a previous test of a similar unit is considered applicable and is extended by the qualifying activity. In general, such extensions will be granted if the fan-motor unit is of similar construction and the motor is of identical manufacture and of identical frame size, provided that the heating and speed of all motors shall be determined by heat and speed tests with the motor installed in the fan.

4.5 Periodic tests. Periodic tests are required to assure continuing satisfactory operation of identical units. When specified (see 6.2), periodic tests shall consist of the tests specified in Table III.

4.6 Routine tests. Routine tests are required for every fan-motor unit. These tests are specified n Table III. Any unit which fails to meet any specified requirements shall be rejected.

4.7 Material inspection.

4.7.1 Cast impeller and casing. Test samples shall be inspected for chemical content and mechanical properties in accordance with ASTM B26 except radiography of visually sound castings is not required. Repairs of cast impeller are not permitted. Cast casings may be repaired by welding or impregnation if completed in accordance with the procedures specified in NAVSEA Technical Publication S9074-AR-GIB-010/278.

4.7.2 Fabricated steel casing. Visual examination for defects is required. Cracks in the radius of spun flanges or in the welds of welded flanges may be repaired by welding, after proper preparation, provided that radiographic inspection of the repaired area is performed. Wall thickness shall be measured on at least 10 percent of the casing.

4.8 Tests. Tests shall be conducted in accordance with 4.8.1 through 4.12.

4.8.1 High-impact shock. The fan-motor unit shall be shock tested on the medium weight machines as specified for Grade A shock of MIL-S-901 if its weight, fixture and mounting bracket exceeds 550 pounds or if the mounting bracket extends beyond the anvil; otherwise, it shall be shock tested on the light weight machine as specified for Grade A shock of MIL-S-901; the motor shall be shock tested in accordance with the motor specification. The high impact shock test shall be conducted as specified in 4.10. Evidence of fragmentation or missile effect of parts, deformation that will cause active interference between parts, or failure to operate shall be cause for rejection. In this test, bolts shall be used in each of the flange bolt holes. Resilient mountings shall not be used unless specified (6.2). If resilient mountings (vibration or shock) are specified for use, classification of shock testing shall be determined in accordance with MIL-S-901 criteria and the appropriate medium weight or lightweight shock test will be determined and conducted. Fan-motor units that have passed this test may be used as production units after replacement of motor bearings.

4.8.1.1 Shock on lightweight machines. The fan discharge (motor end) flange of Type A fan-motor units shall be bolted to platform number 3, fixture 4 C and that of Type L fan-motor units to fixture 4 A, without bolt spacers or with a single annular spacer as described in MIL-S-901. The test shall consist of nine blows with the unit operating at maximum speed and nine blows with the unit not energized.

4.8.1.2 Shock on medium weight machines. The test of a fan-motor unit shall consist of the nine blows indicated in Table IV. The required fan orientation mountings for tests required in Table IV are as follows:

1. Fan horizontal (motor shaft horizontal), steel mounting brackets attached to both fan flanges for mounting to test platform.

2A. Fan vertical, fan impeller down (motor shaft vertical, impeller on bottom). Fan flange bolted to a steel plate for mounting to test platform.

2B. Fan inclined at 30 degrees fan impeller up (motor shaft inclined 30 degrees from the vertical, impeller on top). Fan flange bolted to a steel plate for mounting to test platform.

Auxiliary channels shall be used as necessary to bolt the mounting brackets or plate to standard fixtures.

TABLE IV. Test on medium weight shock machine.

Blow No.	Group No.	Hammer drop	Anvil travel (inches)	Operating condition	Fan orientation
1	I	(Based on weight, see MIL-S-901)	3	Operating	No.1
2	II		3	Secured	No.1
3	III		1.5	Operating	No. 1
4	I		3	Operating	No 2A
5	II		3	Secured	No. 2A
6	III		1.5	Operating	No. 2A
7	I		3	Operating	No. 2B
8	II		3	Secured	No. 2B
9	III		1.5	Operating	No. 2B

NOTE: If two speed motor, the fan shall be operated at fast speed.

4.8.2 Vibration test. Types A and L fan-motor units shall be subjected to Type I environmental vibration tests as specified in MIL-STD-167-1. The vibration test shall be conducted as specified in 4.10. Any unit that fails to meet any requirements shall be rejected.

4.8.3 Balance test. In this test, the fan-motor unit shall be operated at maximum speed and free delivery, with shaft horizontal. It shall be suspended from a stand by means of two elastic vibration cords, one secured to each end flange. The cords shall have a natural frequency of less than ¼ of the minimum rotational frequency of the unit in Hz. The static deflection shall be within the limits of MIL-STD-167-1 for elastic mounting elements, and this shall be the basis for determining cord size for each unit tested. As an alternative to this suspension test, rigid brackets shall be bolted to the fan end flanges, and these brackets shall be elastically mounted on a rigid, level floor. Another alternative is that the fan-motor unit shall be suspended from an electric hoist by means of two chains, one secured to the end flanges of the fan-motor unit (that is, the ends of the chain secured to opposite flanges); one secured to the electric hoist and to the center of the chain secured to the end flanges. The length of the chains shall be not less than 15 inches nor more than 35 inches, and the link size of the chains shall be not less than ¼ inch nor more than ⅜ inch. With either method, the internally excited vibrational displacement (single amplitude of vibration) shall be measured in mils as follows: four axial measurements 90 degrees apart on the face of one end flange, one horizontal measurement perpendicular to the axis on the edge of each flange, and one vertical measurement on the top edge of each flange. The maximum amplitude of vibration shall be the maximum single reading, and not an average. The operating frequency at which the maximum amplitude occurs shall be measured. Exceeding vibration limit specified in 3.13.3 is cause for rejection.

4.8.4 Performance. Performance tests shall be conducted in accordance with AMCA 210. Any of the alternate test stands and associated instrumentation may be used. The total pressure or the volume or both not being within the specified limits is cause for rejection.

4.8.4.1 Stall and recovery. Test results from AMCA 210 meet the requirements of 3.12.1.2 and 3.12.2.2.

a. Draw a vertical line through the highest point on the continually rising portion of the fan total pressure (TP) curve. The point at the highest pressure shall be established by a test point. If a fan is represented as having constantly rising pressure characteristics from free delivery to cut-off, it shall be the manufacturer's responsibility to provide such characteristics with sufficient test points.

b. Locate a point on the vertical line defined above at a pressure 1-inch wg less than the highest point.

c. Draw a system resistance line through the point defined in b above and intersecting the TP curve.

d. The stall and recovery region is established along the fan TP curve from the highest point in a above to the intersection point in c above. The system resistance curve as defined in c above shall intersect or be left of the design point as listed in 6.2.

4.8.5 Airborne noise. Fan total sound power shall be computed in accordance with AMCA 300. The fan-motor unit shall be operated at the design point during airborne noise testing, see 3.12.1.1 and 3.12.2.1. Dual speed fans shall be operated at high speed during noise tests. There shall be no exposed sound absorbing material on the interior or exterior surfaces of the attached ducts. No sound attenuating devices shall be installed within attached ducts. An orifice plate shall be installed if necessary to obtain design pressure at a known operating point. If an orifice plate is installed, it shall be a quiet type which does not produce excessive flow-induced noise. Exceeding level indicated in Table II in any octave band is cause for rejection.

4.8.5.1 Airborne noise detected by ear. Fan-motor units not undergoing airborne noise testing described in 4.8.5 shall be operated at free delivery. Any unusual airborne noise or any airborne noise thought to be excessive shall be corrected if the cause is apparent. If the cause is not apparent and the condition is not corrected, the fan-motor unit shall be tested herein, and sound power levels shall be computed to determine conformance with sound power level requirements specified in Table I.

4.8.5.2 Airborne noise test facility. The facility wherein measurements of fan-motor unit airborne noise are performed shall be registered in accordance with AMCA 111 as being a qualified facility in which to perform octave band sound measurements in accordance with AMCA 300.

4.8.6 Motor heat. Motor heating shall be measured as specified in the applicable motor specification. In each test, the motor shall be installed in the fan, and a duct shall be attached to the discharge. Maximum load shall be obtained by means of terminal throttle on the test duct. Since neither the fan nor a test stand will normally be available at the motor plant, the heat test may be conducted at the plant of the contractor. Motors with temperature rises of any part in excess of specification limits or bearing temperatures in excess of 3.11.1.1 or 3.11.1.5 shall be rejected.

4.8.7 Explosion. This test is applicable only to electrical equipment requiring an explosion-proof enclosure. Test shall be performed in a petroleum ether atmosphere and certified by a nationally recognized laboratory. Test shall include the conduit and conduit box actually used with the fan. Prior to the explosion containment test, the air leakage rate of the motor enclosure shall be determined by pressurizing the interior of the motor enclosure to 10 pounds per square inch (lb/in^2) and measuring the period of time in seconds for the pressure to drop from 10 to 4 lb/in^2. The air leakage rate shall be recorded on the applicable motor drawing.

4.8.7.1 The motor of explosion-proof fan-motor units shall have the motor enclosure air leakage rate measured to determine whether the rate of leakage exceeds that determined in 4.8.7. Any explosion-proof motor where there is evidence that the predetermined rate of leakage (see 4.8.7) is exceeded when measured shall not be offered for delivery.

4.8.8 Casing tightness. When this test is required in 6.2, the test shall be conducted as follows:

a. Blank flanges (one with air supply and gauge connections) shall be bolted to gasketed fan flanges.

b. Air at a pressure 50 percent higher than the maximum pressure capability of the fan shall be supplied to the casing interior.

c. The pressure drop in 10 minutes shall not exceed 5 percent of the test pressure.

4.8.9 Speed. The fan-motor unit shall be operated at each speed at free delivery to determine whether the speed is at least 97 percent of the design speed at rated voltage. A speed of less than 97 percent of the design speed is cause for rejection.

4.9 Blade tip clearance measurement. The fan blades shall be in a stationary position for the entire measurement. Inspect visually to locate an apparent maximum clearance (radial clearance) from the blade tip to the inside of fan casing. Measure this apparent maximum clearance and move the measurement to three different locations at 90, 180, and 270 degrees relative to the apparent maximum clearance. Compare the four measurements to determine the true maximum blade clearance. This maximum clearance shall not exceed ¼ of 1 percent of the casing inside diameter.

4.10 Test schedule. The schedule for testing the fan shall be performed in the following order:

a. Balance (4.8.3).
b. Casing tightness (4.8.8).
c. Blade tip clearance measurement (4.9).
d. Performance (4.8.4), aerodynamic stall (4.8.4.1), speed (4.8.9), motor heat (4.8.6). These tests shall be conducted concurrently.
e. Airborne noise (4.8.5).
f. Vibration test (4.8.2). The correction of damages, which may have occurred during the vibration tests, shall not be performed prior to the test specified in 4.8.1.
g. High-impact shock (4.8.1). After conducting the high-impact shock test, tests specified in 4.8.4 and 4.8.4.1 shall be again conducted without correction of damages which may have occurred during shock test. Data for tests specified in 4.8.4 and 4.8.4.1, one before and one after high-impact test shall demonstrate that the fan-motor unit satisfies performance and aerodynamic stall as follows:
    (1) Performance (after shock test) to be within 5 percent of the volume indicated in Figure 4 (vaneaxial fan) or Figure 5 (tubeaxial fan.
    (2) The flow rate of the intersection point in 4.8.4.1.c shall not exceed the design point flow rate of 1.2.2 for vaneaxial fans by more than 5 percent.
    (3) The aerodynamic stall shall not occur greater than 90% of the fan design capacity for tubeaxial fans.
h. Explosion (4.8.7).

4.11 Permeability tests for nonmagnetic construction. A permeability test on nonmagnetic material used in construction of fans shall be conducted in accordance with MIL-STD-2142, Test 501 (see 3.2.3).

4.12 Maintainability demonstration. The first production unit shall be examined after testing, and the capability to maintain, disassemble, and repair the unit shall be demonstrated. The demonstration shall be conducted utilizing the recommended tools and with other than expert mechanics. Evidence that maintainability of the fan-motor assembly cannot be accomplished by other than expert mechanics shall be cause for failure of the demonstration. The maintainability demonstration shall include but not be limited to the following:

a. Removal of fan impeller.
b. Removal of motor.
c. Removal of motor bearing.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When packaging of material is to be performed by DoD or in-house contractor personnel, these personnel need to contact the responsible packaging activity to ascertain packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activities within the Military Service or Defense Agency, or within the military service's system commands. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

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

6.1 Intended use. The fan-motor units specified herein are intended for ventilation and air conditioning applications only onboard ships and craft of the United States Navy. The direction of airflow into and out of the fans is axial. The fans are of nonsparking construction. Fans with motors rated for 65 °C ambient temperature are standard; fans rated for 80 °C ambient, for use in unusually high ambient temperatures, are optional.

6.1.1 Vaneaxial fans, Types A and X-A. Types A and X-A fans are high efficiency units intended for air conditioning systems and non-collective protection ventilation systems. Type A is shockproof; Type X-A is identical dimensionally but is equipped with a commercial marine (service C) motor and is not required to be shock resistant.

6.1.2 Tubeaxial fans, Types L and X-L. Types L and X-L fans are moderate-efficiency units intended for short recirculating systems or for ventilating use in exterior bulkheads where resistance does not exceed 0.75-inch water gauge. Type L is shock resistant. Type X-L has identical mounting dimensions but is not required to be shock resistant.

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Title, number, and date of this specification.
b. Type required (see 1.2.1).
c. Requirement for nonmagnetic fan-motor (see 3.2.3).
d. Fan characteristic code in accordance with 1.3 including fan type (see 1.2.1), size (see 1.2.2), motor current (see 1.2.3), motor voltage (see 1.2.4), motor enclosure (see 1.2.5), ambient temperature (see 1.2.6), structure (see 1.2.7), thermal protection (see 1.2.8), and quiet bearing (see 1.2.9).
e. Additional painting requirements (see 3.3).
f. If high impact shock resistance is not required (see 3.13.2).
g. Requirement for motor thermal protection (see 3.11.1.1).
h. Waiver of requirement for sealed insulation motors when ship did not originally have a sealed insulation motor and has a short remaining service life (see 3.11.1.1).
i. Requirement for quiet motor (ABEC 5) bearings (see 3.11.1.4).
j. Requirement for resilient mountings (see 4.8.1).
k. Requirement for casing pressure test (Table III); specify test conditions if other than standard.
l. Requirement for explosion proof motor (see 4.8.7).
m. Packaging requirements (see 5.1).

6.3 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in Qualified Products List QPL No. 18953 whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. Information pertaining to the qualification of products may be obtained by writing Commander, Naval Sea Systems Command, ATTN: SEA O5Q, 1333 Isaac Hull Avenue, SE, Stop 5160, Washington Navy Yard DC 20376-5160 or email to commandstandards@navsea.navy.mil, with the subject line "QPL Comment". Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at http://assist.daps.dla.mil.

6.4 Subject term (key word) listing.

Blade
Hub
Impeller
Nose piece
Vane

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

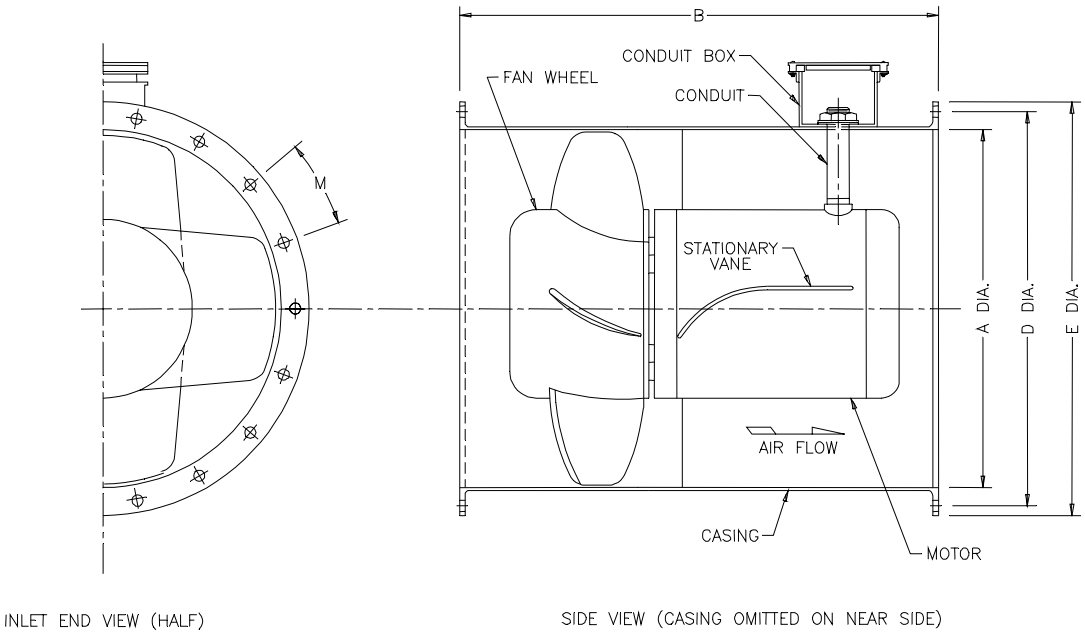
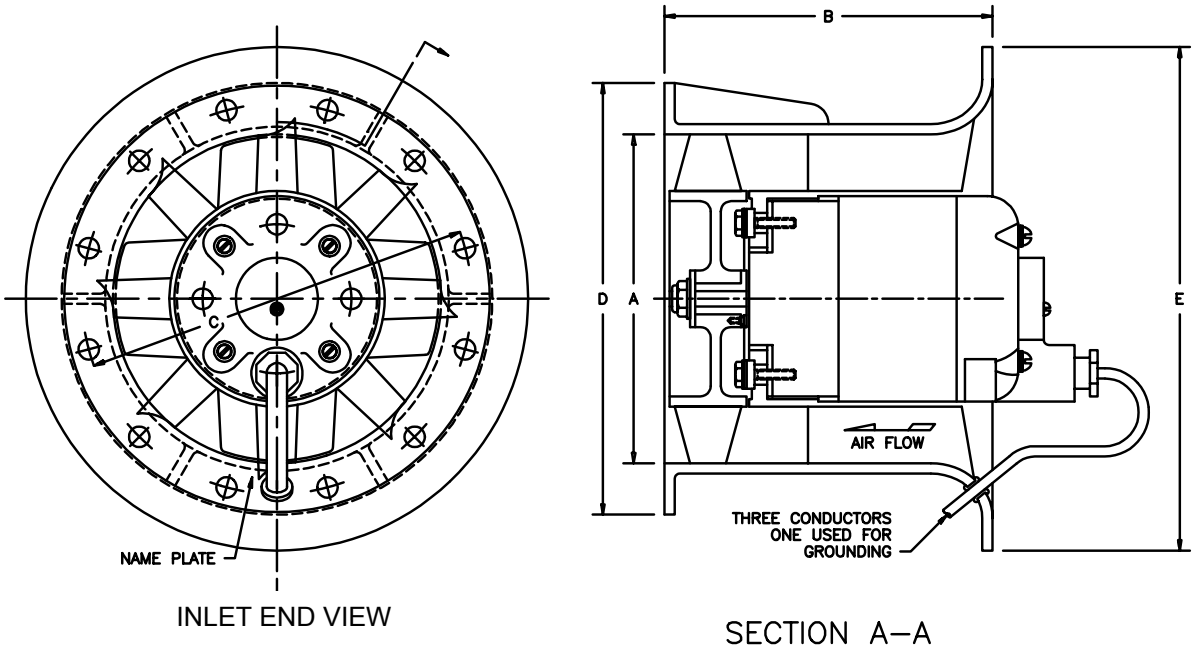


FIGURE 1. Vaneaxial fan – interface data.

PHYSICAL DATA											
FAN SIZE	MOTOR DATA			DIMENSIONS (INCHES)					BOLT HOLES		MAX WEIGHT (POUNDS)
	RPM		MAX HP	A	B	D	E	M (REF)	DIAMETER (INCHES)	NO	
A¼	SINGLE	SINGLE	1/5	9¾	15⅜	11¾	12¾	3.04	13/32	12	70
A½	SINGLE	SINGLE	⅓	10½	15⅜	12⅛	13¼	2.68	17/32	14	105
A1	SINGLE	SINGLE	1	12¾	19⅜	14¾	16	2.88	17/32	16	150
A1½	SINGLE	SINGLE	1¼	14¼	20	16	17½	2.50	17/32	20	170
A2	SINGLE	SINGLE	1½	15½	26	17½	18⅞	3.04	17/32	18	200
A2½	SINGLE	SINGLE	2	15½	24	17½	18 15/16	3.04	17/32	18	245
A3	FULL	⅔ SPEED	3	21⅛	29⅝	23¼	24⅝	3.03	17/32	24	450
A3½	SINGLE	SINGLE	3	22⅛	26	24½	25 13/16	3.20	17/32	24	420
A4½	SINGLE	SINGLE	5	18	27⅛	19¾	21¼	2.58	17/32	24	340
A5	FULL	⅔ SPEED	4	23¼	29⅝	25¼	26 9/16	3.04	17/32	26	465
A6	FULL	⅔ SPEED	5	25⅛	29⅝	27¼	28⅝	2.85	17/32	30	530
A7	FULL	⅔ SPEED	7½	19½	32	21¼	22¾	2.39	17/32	28	465
A8	FULL	⅔ SPEED	6	27¼	32¼	29¼	30 9/16	3.06	17/32	30	600
A10	FULL	⅔ SPEED	7½	29¼	32¼	31¼	32⅝	3.06	17/32	32	780
A11	FULL	⅔ SPEED	12½	31¼	40⅛	33 5/16	35⅝	2.90	17/32	36	940
A12	FULL	⅔ SPEED	10	29¼	37⅞	31¼	32⅝	3.06	17/32	32	880
A16	FULL	⅔ SPEED	15	31¼	37⅞	33 5/16	35 9/16	2.90	17/32	36	1000
A17	FULL	⅔ SPEED	17½	34¼	42	36⅝	38⅝	2.62	17/32	44	1200
A20	FULL	⅔ SPEED	20	36	38⅞	38	39 7/16	2.98	17/32	40	1200
A25	FULL	⅔ SPEED	25	42¼	52	44 5/16	45 9/16	3.03	17/32	46	1750
A28	FULL	⅔ SPEED	25	36	50	38	40⅜	2.98	17/32	40	1500
A30	FULL	⅔ SPEED	25	44¼	52	46 5/16	49⅝	3.03	17/32	48	1890

Bolt hole diameter tolerance shall be ± 1/64 inch, all other tolerances shall be ± 1/16 inch.

FIGURE 1. Vaneaxial fan – interface data - Continued.



Bolt hole diameter (C) tolerance shall be ± 1/64 inch, all other tolerances shall be ± 1/16 inch.

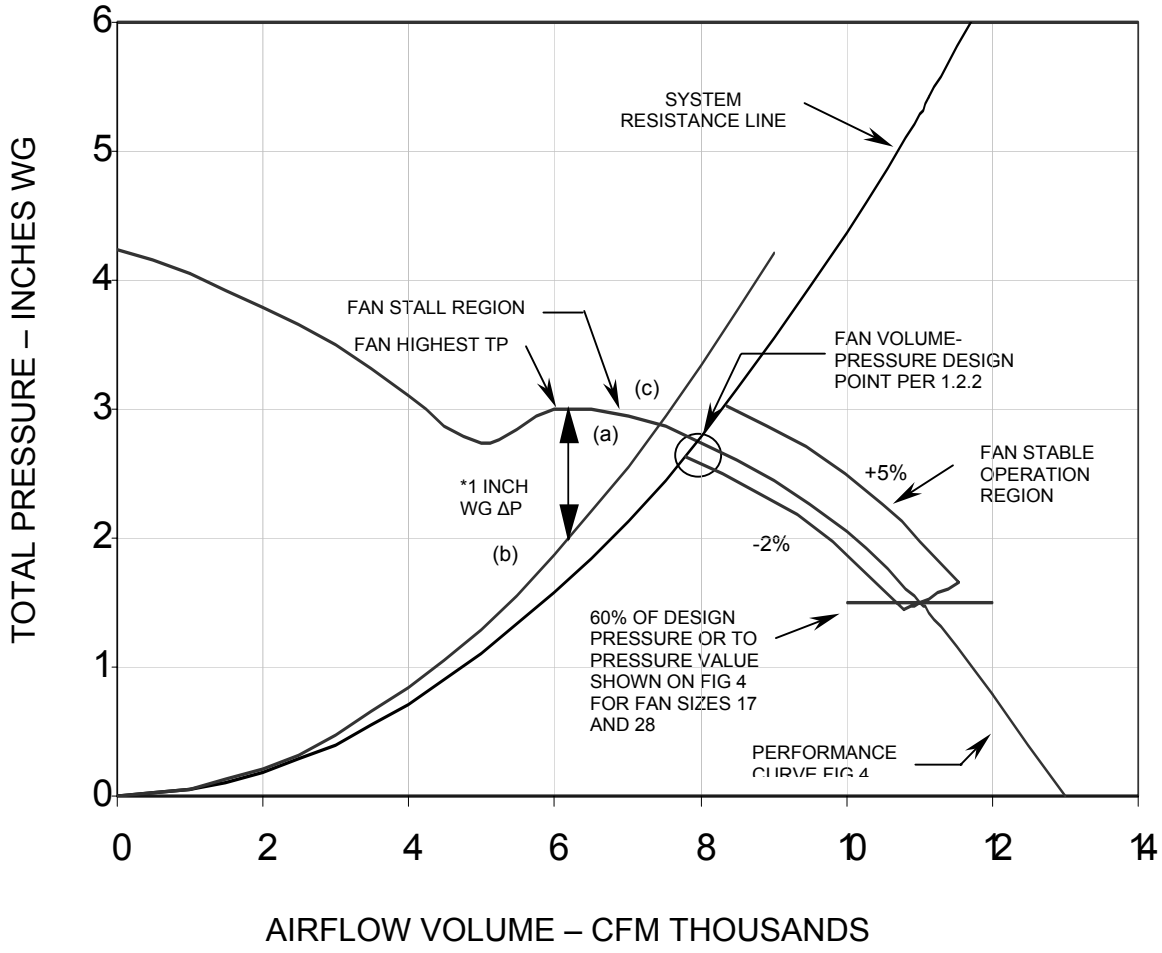
PHYSICAL DATA

FAN SIZE	MOTOR DATA		DIMENSIONS (INCHES)					BOLT HOLES		WEIGHT (POUNDS)
	RPM	HP	A	B	C	D	E	DIAMETER (INCHES)	NO	
L 1/2	3600	1/15	8	13	9 1/2	10 1/2	12 3/8	13/32	12	35
L1	1800	1/8	12 1/8	14	13 3/4	14 3/4	16 1/2	13/32	16	55
L2	1800	1/4	14 3/8	15	16 1/8	17 1/4	18 3/4	13/32	16	60
L3	1800	1/4	15 5/8	18	17 3/8	18 1/2	20	13/32	16	65

NOTES:

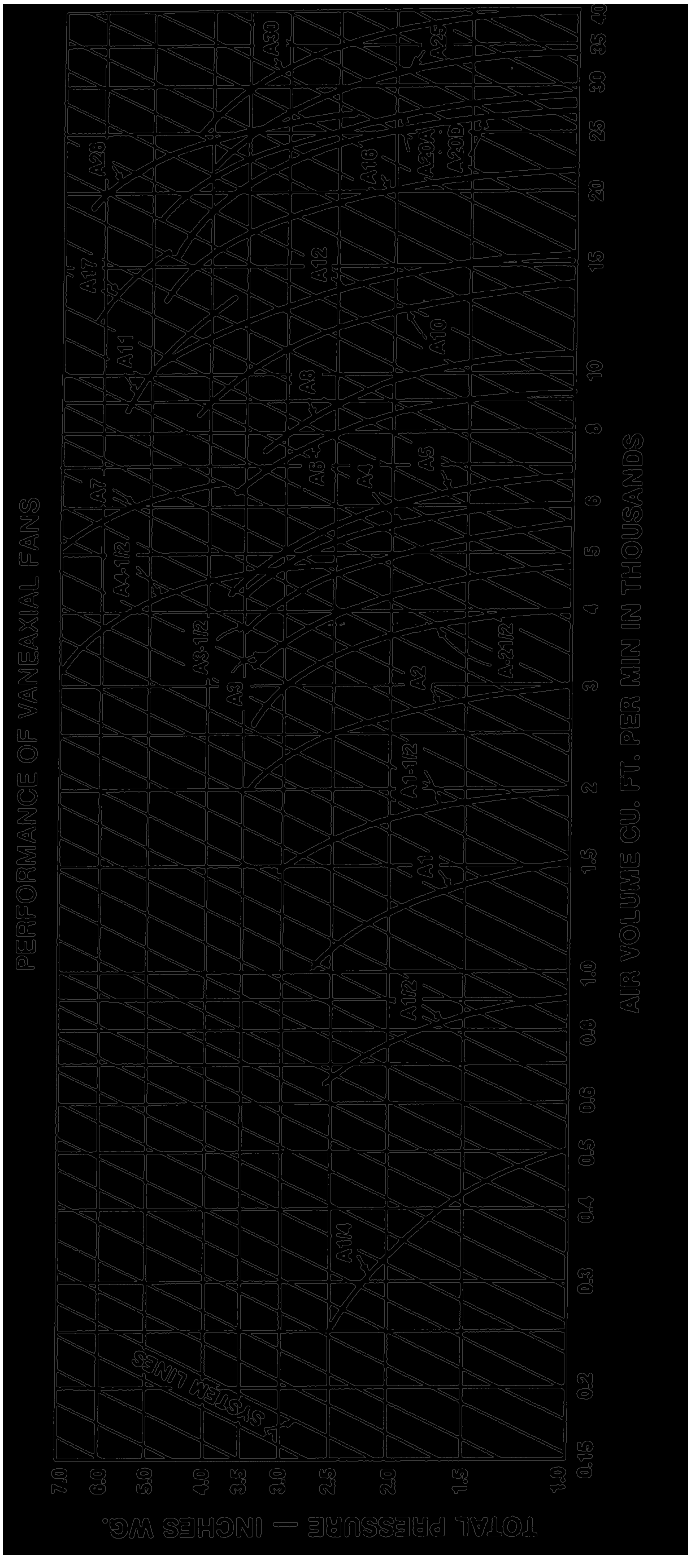
1. All motor data is approximate.
2. Weight for fan with 65 °C (149 °F) ambient motor.
3. All weights are approximate.
4. Dimensions “B” and “D” for information only.

FIGURE 2. Tubeaxial fan – interface data.



* UNDER ALL CONDITIONS ACTUAL FAN PERFORMANCE CURVE MUST MEET THE REQUIREMENT THAT POINT (c) IS RELATED TO POINT (a) AS SHOWN.

FIGURE 3. Region fan stall, recovery, and stable operation.



NOTE: Size A4 shown for informational purposes only.

FIGURE 4. Vaneaxial fan performance curves.

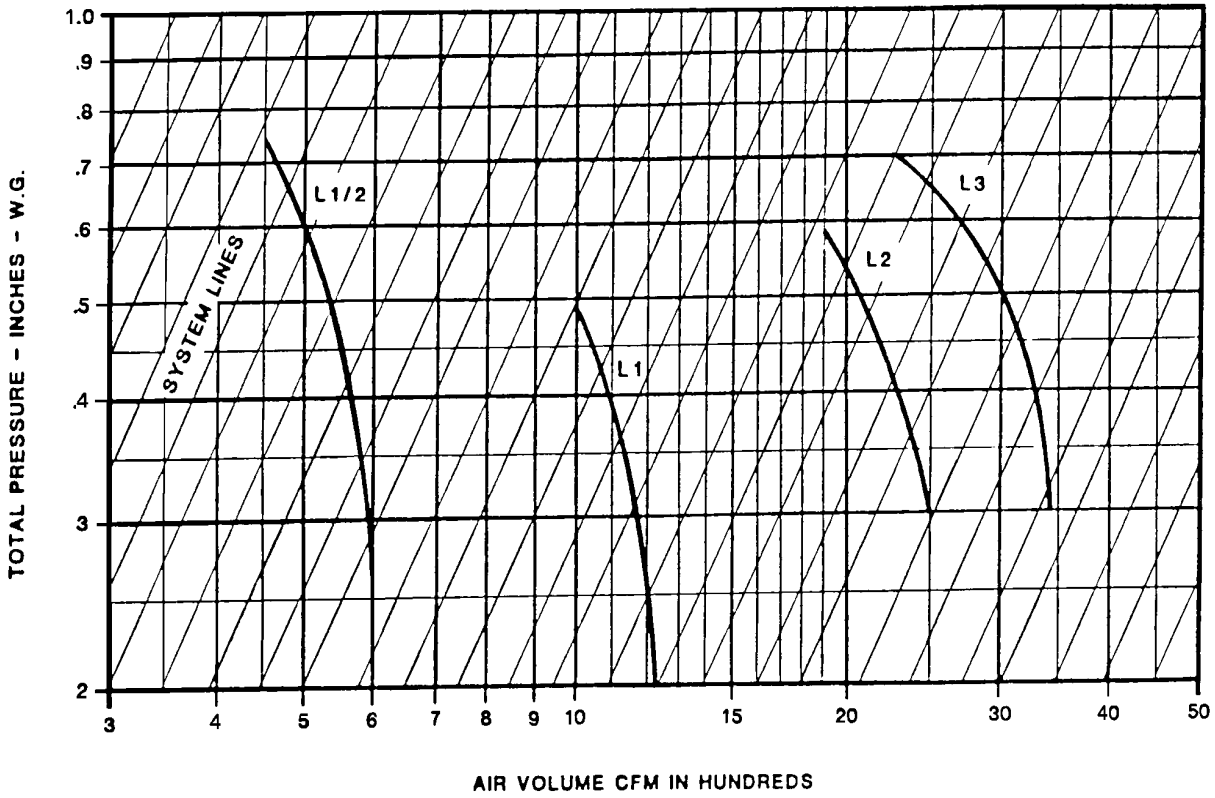


FIGURE 5. Tubeaxial fan performance curves.

Preparing Activity:
Navy - SH
(Project 4140-0153-000)

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at http://assist.daps.dla.mil.