INCH-POUND

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(See 6.16)

MILITARY SPECIFICATION

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

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

1. SCOPE

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

1.2 Classification. Fans shall be of the following types, as specified (see 3.6.1 and 6.2):

Type A	Vaneaxial, fixed, Navy Standard (HI-Shock)
Type L	Tubeaxial, fixed, Navy Standard (HI-Shock)
Type X–A	Vaneaxial, fixed, Navy Standard (Service C motor)
Type X–L	Tubeaxial, fixed, Navy Standard (Service C motor)

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

AMSC N/A FSC 4140

2. APPLICABLE DOCUMENTS

2.1 Government documents.

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

SPECIFICATIONS

FEDERAL

FF-B-171	Bearings, Ball, Annular (General Purpose)
QQ-P 35	Passivation Treatments for Corrosion-Resistant Steel
TT-P-664	Primer Coating, Alkyd, Corrosion-Inhibiting, Lead and Chromate Free, VOC - Compliant
TT-V-119	Varnish, Spar, Phenolic-Resin

MILITARY

MIL-P-116	Preservation, Methods of
MIL-S-901	Shock Test, HI (High-Impact); Shipboard Machinery, Equipment and Systems, Requirements for
MIL-E-917	Electric Power Equipment, Basic Requirements (Naval Shipboard Use)
MIL-E-2036	Enclosures for Electric and Electronic Equipment
MIL-A-8625	Anodic Coatings for Aluminum and Aluminum Alloys
MIL-C-16173	Corrosion Preventive Compound, Solvent Cutback, Cold-Application
MIL-E-16298	Electric Machines Having Rotating Parts and Associated Support Items, Packaging of
MIL-M-17059	Motors, 60-Cycle, Alternating-Current, Fractional HP, Shipboard Use
MIL-M-17060	Motors, 60-Hertz, Alternating-Current, Integral-Horsepower, Shipboard Use
MIL-B-17931	Bearings, Ball, Annular, for Quiet Operation
MIL-A-22262	Abrasive Blasting Media Ship Hull Blast Cleaning
MIL-P-24441	Point, Epoxy-Polyamid, General specification for
MIL-C-81751	Coating, Metallic-Ceramic
DOD-G-24508	Grease, High Performance, Multi-Purpose (Metric)

STANDARDS

FEDERAL

FED-STD-H28	Screw-Thread Standards for Federal Services
FED-STD-595	Colors

MILITARY

MIL-STD-167-1	Mechanical Vibrations of Shipboard Equipment (Type I – Environmental and Type II – Internally Excited)
MIL-STD-278	Welding and Casting Standard
MIL-STD-1399 Section 300	Interface Standard for Shipboard Systems, Electric Power, Alternating-Current (Metric)
MIL-STD-1472	Human Engineering Design Criteria for Military Systems, Equipment and Facilities

(Unless otherwise indicated, copies of federal and military specifications and standards are available from the Naval Publications and Forms Center, (ATTN: NPODS), 5801 Tabor Avenue, Philadelphia, PA 19120-5099.)

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

DRAWINGS

NAVAL SEA SYSTEMS COMMAND (NAVSEA)

810-921784	Fan, Vaneaxial
810-921984	Performance Curves, Vaneaxial Fans
810-925368	Fan, Tubeaxial, Type L

(Application for copies should be addressed to: Commander, Portsmouth Naval Shipyard, Naval Engineering Drawing Support Activity, Code 202.2, Portsmouth, NH 03804-5000).

PUBLICATIONS

NAVSEA

0900-LP-003-8000	Metals, Surface Inspection Acceptance Standards
S9086-CH-STM-010/CH 074 VI	Naval Ships Technical Manual, Welding and Allied Processes

(Application for copies should be addressed to the Naval Publications and Forms Center, (ATTN: NPODS), 5801 Tabor Avenue, Philadelphia, PA 19120-5099.)

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

AIR MOVING AND CONTROL ASSOCIATION (AMCA)

210	Test Code for Air Moving Devices
300	Test Code for Sound Rating

(Application for copies should be addressed to the Air Moving and Control Association, 30 West University Drive, Arlington Heights, IL 60004.)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

A 123	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; (DOD adopted)
B 26	Standard Specification for Aluminum Alloy Sand Castings; (DOD adopted)
B 108	Standard Specification for Aluminum Alloy Permanent Mold Castings; (DOD adopted)
B 633	Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; (DOD adopted)
D 2092	Standard Practice for Preparation of Zinc-Coated (Galvanized) Steel Surfaces for Painting

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

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

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

3. REQUIREMENTS

3.1 Qualification. The fans furnished under this specification shall be products which are authorized by the qualifying activity for listing on the applicable qualified products list at the time of award of contract (see 4.3 and 6.4).

3.2 Materials. Aluminum castings shall conform to the requirements in table I. Other materials of construction shall be equal to the applicable specifications herein and when not specified, the materials shall be the same as successfully used in commercial application. Cast iron shall not be used in the construction of the fans nor shall cast iron be used in motors which are components of types A and L fans.

TABLE I. *Aluminum castings.*

Type	Requirement
Sand castings	ASTM B 26, alloy A356.0 – T61, 712.0 or 713.0
Permanent mold castings	ASTM B 108, alloy 356.0 – T6 or 713.0

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 listed above and aluminum alloys shall be protected against corrosion after fabrication with chemicals, electrolytic processes, plating, or specified paints. The following methods are considered corrosion protection methods when properly applied:

a. Electroplating with zinc in accordance with ASTM B 633, SC4 followed by a phosphate treatment conforming to method A of ASTM D 2092

b. Hot-dipped galvanized in accordance with ASTM A 123

c. One coat of epoxy primer conforming to MIL-P-24441, formula 150 followed by two coats of primer conforming to TT-P-664

d. Hot phosphoric or chromic acid treatment followed by two coats of primer conforming to TT-P-664.

3.2.1.2 **Cleaning and painting.** Parts fabricated from aluminum, aluminum alloys, or corrosion-resistant materials shall be cleaned and painted in accordance with 3.5.1 through 3.5.3.

3.2.2 **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 corrosion-resistant. Self-tapping sheet metal screws shall not be used. Threads of such fastenings or fittings shall conform to FED-STD-H28.

3.2.2.1 **Screws.** Tapped holes in aluminum shall be avoided. When there is no practical alternative, the thread shall be fitted with a 300-series corrosion-resistant steel insert. The thread of the screw shall be coated upon assembly with ceramic metallic coating per MIL-C-8175. Any departures and non-use of corrosion-resistant threaded inserts shall be approved on a case basis.

3.2.3 **Dissimilar metals.**

3.2.3.1 **Fittings.** Copper or brass fittings shall be insulated from aluminum or aluminum alloys by a dielectric barrier. Asbestos paper or similar absorbent material shall not be used in contact with aluminum or aluminum alloys.

3.2.3.2 **Faying surfaces.** Faying surfaces, except for interference fits of aluminum or aluminum alloy with like or dissimilar metals, shall be painted with one coat of epoxy primer in accordance with MIL-P-24441, formula 150, and a top coat of MIL-P-24441, formula 151, before assembly.

3.2.4 **Nonmagnetic material.** 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 which has a maximum permeability of less than 2.0 after fabrication.

3.2.4.1 **Motor material.** Motor material shall conform to the requirements of MIL-M-17060 or MIL-M-17059 as applicable for nonmagnetic motors.

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

3.3 **Design.**

3.3.1 **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).

3.3.1.1 **Human engineering.** Human engineering design criteria and principles shall be applied in the construction of the fan 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 a guideline in applying human engineering design criteria for the fan-motor unit.

3.3.2 **General.** 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 obtained as an assembly from the fan manufacturer or from the authorized sales agent (see 6.3 and appendix A).

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 300, input power shall be 115-volts (V), single-phase, 60-hertz (Hz) or 440 V, 3-phase, 60-Hz as shown in table III

b. Able to operate satisfactorily in a weather air intake of a ship when exposed to soaking atmospheric spray (rain or sea) or seawater

c. Perform in accordance with requirements herein under ambient temperatures between minus 29 and 65 degrees Celsius (°C).

3.3.2.2 **Aerodynamic design parameters.** The quantities of blades and vanes shall be chosen to avoid interacting frequencies within the audible range. The axial distance between blade and vanes shall be chosen with minimum noise amplitude as a prime consideration. The passing angle between a blade trailing edge and a vane leading edge shall be at least 10 degrees. The maximum blade tip clearance (radial clearance) shall not exceed 0.25 of 1 percent of the casing as specified in 4.9.

3.3.2.3 **Noise limitation.** The fan-motor unit shall meet the sound power level indicated in table II (see 4.8.5.1).

TABLE II. *Total sound power level in decibels (dB), re 10^{-12} watts.*

Fan type	Fan size	Octave band center frequency (Hz)							
		63	125	250	500	1000	2000	4000	8000
A and X-A	1/4	87	82	84	89	88	82	75	72
	1/2	86	82	81	80	88	82	77	73
	1	85	84	85	88	87	84	82	74
	1-1/2	86	84	88	95	97	91	84	78
	2	88	89	86	93	96	92	86	80
	2-1/2	89	91	90	94	93	88	85	80
	3	91	88	92	96	92	90	83	77
	3-1/2	92	91	96	97	95	90	87	80
	4	90	89	93	96	93	89	84	80
	4-1/2	92	91	96	100	103	98	93	88
	5	89	91	93	98	97	89	83	80
	6	92	91	94	96	94	91	86	82
	7	94	94	100	100	101	98	94	88
	8	93	96	93	96	96	92	87	82
	10	93	97	100	101	96	93	88	82
	11	96	100	102	102	100	97	91	89
	12	96	97	96	99	98	95	90	86
	16	96	97	97	100	101	97	94	87
	17	97	100	103	107	107	101	94	90
	20	97	98	107	112	112	106	99	93
	25	101	102	101	102	99	95	91	87
	28	100	98	99	107	103	101	96	91
	30	103	100	103	104	102	97	93	88
L and X-L	1/2	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 falls.

3.3.2.4 Vibration and balance. Fan-motor units shall be constructed so that no damage will occur or malfunction be caused by the environmental vibrations specified in MIL-STD-167-1 (see 4.8.2). 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 (see 4.8.3).

3.3.2.5 Shock. Types A and L fan-motor units shall pass the high-impact shock tests specified in MIL-S-901 for grade A, class I equipment. Failure criteria shall be as specified in 4.8.1.

3.3.2.6 Fan impeller.

3.3.2.6.1 Material. The impeller, consisting of hub, web, rim, and blades shall be one-piece sand casting or permanent-mold casting of aluminum alloy conforming to table I. The blades shall be of airfoil design.

3.3.2.6.2 **Strength.** Impellers shall have a safety factor of 8, based on the ultimate tensile strength of the material.

3.3.2.6.3 **Hub inserts.** A 300-series corrosion-resisting steel insert shall be installed in the hub of each impeller. A keyway shall be machined in the bore of the insert. Inserts shall either be cast-in-place or pressed into the impeller, preferably cast-in-place (see 3.3.2.6.3.1 and 3.3.2.6.3.2).

3.3.2.6.3.1 **Cast-in-place inserts.** When casting is complete, inserts shall have an irregularly shaped outer periphery and a circumferential groove or the equivalent to prevent all relative movement (whether axial, circumferential, or radial) between inserts and remainder of hub.

3.3.2.6.3.2 **Pressed-in-place inserts.** Inserts for installation in impeller castings shall be flanged to permit securing to the impellers by means of through-bottings, or non-flanged by means of setting screws positioned half in the wheel casting and half in the insert. There shall be an interference fit of the insert in the impellers requiring substantial insertion pressure, shrinkage, or both.

3.3.2.6.4 **Construction.** To avoid imbalance, impellers shall be constructed to prevent retention of water when the fan is installed vertically with fan impeller up, or horizontally. Where strength requirements permit, a dished web faired into the rim is preferred. However, a web perpendicular to the rim is acceptable. The outside diameter (od) of the impeller rim shall be at least as great as the od of the motor mounting flange. If there is insufficient space between blades for use of an impeller puller, means (such as puller holes) shall be provided in the hub.

3.3.2.6.4.1 **Nose piece.** The nose piece shall be of aluminum, either cast or formed, and shall be match-marked with the impeller or attached to it to assure reinstallation in the same position relative to the impeller.

3.3.2.6.5 **Provision for balancing.** Balancing of the impeller shall be accomplished by removal of metal. Provision of sufficient rim thickness or of cast pads on the inside diameter (id) of the impeller rim is recommended for this purpose.

3.3.2.6.6 **Impeller mounting.** The impeller assembly shall be mounted on the keyed motor shaft and held axially by a heavy steel washer (except non-flanged inserts) and either a tanged lockwasher and locknut or a cotter pin and castellated nut. The od of the flat washer shall be greater than the od of the impeller hub insert. There shall be a slight positive clearance (loose fit) between the impeller assembly and the shaft.

3.3.2.7 **Motors.** Fan-motors shall be in accordance with table III and 3.3.2.7.1 through 3.3.2.7.9, as applicable. Otherwise, motors of frame sizes 184 or larger shall conform to MIL-M-17060 and motors of frame sizes smaller than 184 shall conform to MIL-M-17059.

TABLE III. *Motor requirements.*

Fan type	Fan size	Nominal hp	R/min	Min frame	Min. bearing		No. wind	Power 60 Hz	Lock rotor current	Torque			Motor eff. (percent)
					Drive	Front				Lock rotor	Break down	Pull up	
A and X-A	1/4	1/5	3600	48	204	203	1	440V - 30	MIL-M-17059 + 10 percent (56)[1]	MINIMUM 70 PERCENT FULL LOAD TORQUE	MIL-M-17059 + specified	MINIMUM 70 PERCENT FULL LOAD TORQUE	75
	1/2	1/3	3600	48	204	203	1						80
	1	1	3600	56	304	203	1						86
	1-1/2	1-1/4	3600	56	304	203	1						86
	2	1-1/2	3600	56	304	203	1						86
	2-1/2	2	3600	56/184	304/307	203/305	1						87
	3	3	1800/1200	215	307	305	2		(184)[1] MIL-M-17060		MIL-M-17060 as specified		85
	3-1/2	3	1800	184	307	305	1						88
	4	4	1800/1200	215	308	306	2						85
	4-1/2	5	3600	215	308	306	1						89
	5	4	1800/1200	215	308	306	2						85
	6	5	1800/1200	215	308	306	2						86
	7	7-1/2	3600/1800	215	308	306	1						88
	8	6	1800/1200	215	308	306	2						86
	10	7-1/2	1800/1200	256	308	306	2						88
	11	12-1/2	1800/1200	256	310	308	2						89
	12	10	1800/1200	256	310	308	2						89
	16	15	1800/1200	256	310	308	2						90
	17	17-1/2	1800/1200	256	310	308	2						90
	20	20	1800/1200	286	310	308	2						90
	25	25	1200/900	326	312	311	2						91
	28	25	1800/1200	286	312	310	2						91
	30	25	1200/900	326	312	311	2						91
L X-L	1/2	1/15	3600	Special	203	202	1	115V-10	MIL-M-17059 + 10 percent		MIL-M-17059		53
	1	1/8	1800	48	203	202	1	115V-10					46
	2	1/4	1800	48	204	203	1	440V-30					79
	3	1/4	1800	48	204	203	1	440V-30					79

[1] Min. frame.

3.3.2.7.1 General requirements. Motors shall be constructed for 65 °C ambient temperature, continuous air over duty, with either face or flange mountings and the following (see 6.2):

a.	*Service*	For types A and L fans – service A For types X–A and X–L fans – service C
b.	*Type*	For single phase power – split phase induction with solid-state starting switch accessible and mounted on outside fan casing. Mechanical centrifugal switches shall not be used For polyphase power – squirrel cage induction
c.	*Enclosure*	For types A, X–A and X–L fans – spraytight (if not specified) or watertight or explosion-proof
d.	*Insulation*	Class B, or F – motor temperature rise not to exceed class B insulation (55 °C rise) and class F sealed insulation system with 55 °C maximum temperature rise in 65 °C ambient
e.	*Mounting*	Motors shall operate within the requirements specified herein when mounted in the positions described in paragraph 3.3.2.

3.3.2.7.2 Bearings. Motors shall be equipped with ball bearings conforming to FF-B-171 (ABEC-5) or MIL-B-17931 (quite type). Bearings sizes shall be as specified in table III and shall conform to the following:

a.	*Type*	120
b.	*Internal radial clearance*	Normal
c.	*Grease*	DOD-G-24508
d.	*Mounting*	The inner ring of the drive end shall be held axially against a shaft shoulder by either a locknut and lockwasher or a locknut with nylon insert. The outer ring of the drive end bearings shall be held axially between a housing shoulder and a bearing cap. On the front end, a housing shoulder may be omitted if the bearing is held axially on the shaft. If a housing shoulder is provided, the axial clearance between the bearing and the shoulder shall accommodate thermal linear expansion of the shaft. If a loading spring is used with the front bearing, the deflection due to shaft expansion shall be included in the total spring deflections.
e.		Bearing temperature rise not to exceed 25 °C in 65 °C ambient as measured on bearing outer ring
f.		When MIL-B-17931 bearings are used, the application requirements of the MIL-B-17931 Appendix shall be complied with.

3.3.2.7.3 Motor shafts. Shaft shoulders shall be provided for axially positioning each bearing and the fan impeller. Shoulder positioning is preferred for the rotor. Keys and keyways shall be provided for fan impellers on shaft extensions, for bearing lockwashers (if used) and for rotors, except when the shaft in way of the rotor is straight knurled or when the rotor has a press or shrink interference fit and the rotor is tack welded to the shaft. The diameter of the shaft extension shoulder shall be greater than the od of the insert in fan impellers having pressed-in-place inserts. (This requirement may be averted by using impellers with cast-in-place inserts (see 3.3.2.6.3.1).) The end of the shaft extension shall be threaded for use of a locknut and tanged lockwasher or threaded and drilled for a castellated nut and cotter pin. If the shaft is not of corrosion-resistant material, the shaft extension shall be coated with an antiseize compound in accordance with MIL-C-16173, grade 1 before mounting of the fan impeller.

3.3.2.7.4 Motor end brackets. The material shall be cast steel, modular or malleable iron, or aluminum for service A motors. If aluminum, the brackets shall have 300-series corrosion-resistant steel inserts for bearing housings. For rear brackets of aluminum, a flange bracket and the use of studs, each with two nuts, are preferred for mounting of the motor in the fan casing. A face-type rear bracket may be used if the tapped mounting holes are fitted with 300-series corrosion-resistant steel thread inserts and if a sufficient quantity of mounting series screws is provided. Motors shall be provided with a means to permit easy removal of end shields by any of the following methods: (a) knock off lugs integral with end bracket, (b) holes drilled and tapped in end shield for use of jacking bolts, and (c) recess in frame to permit contact of drift with end shield flange. Match-mark depressions shall be made in the bare metal (before painting) on the outer periphery of brackets and frame to assure duplication of the original assembly.

3.3.2.7.5 Balancing. The preferred method of balancing motor rotating assemblies is by removal of material from the rotor or from discs provided for this purpose.

3.3.2.7.6 Drains. Tapped drain holes with 1/8-inch metal pipe plugs shall be furnished in each spraytight motor to drain condensate from the motor when the fan is installed vertically, with fan impeller up or down, or horizontally. For drainage in the horizontal position, four drains in one end of the frame or on the periphery in one bracket shall be positioned at 90, 135, 225, and 270 degrees from the conduit centerline or stuffing tube connection for integral frame motors. For fractional frame motors, the drains shall be located at 90, 180, 270, and 360 degrees. Channels through the stator core at its outer periphery shall be provided or a separate set of drains shall be furnished in the other end. For drainage in the vertical position, one drain in the face of each bracket is required unless the horizontal drains will adequately serve the purpose. Drains shall not be installed in explosion-proof or watertight motors.

3.3.2.7.7 Magnet wire. Standard whole sizes of round wire as specified in MIL-E-917 shall be used in all motors.

3.3.2.7.8 Power leads and grounding circuits (for types L and X−L fans). Power source leads and a grounding circuit by means of a green wire shall be provided and shall extend at least 5 feet beyond the fan casing. The power leads and the grounding wire shall be encased in a synthetic rubber jacket and shall pass through the motor enclosure by means of a stuffing tube and the fan

casing by means of a rubber grommet. A separate grounding circuit shall be established between the motor frame and the fan casing.

3.3.2.7.9 Test connection for explosion-proof motors. A single boss, drilled, tapped, and plugged with a 1/8-inch metal pipe plug, shall be provided in the front end bracket of each explosion-proof motor for determining enclosure air leakage rate.

3.3.3 Types A and X–A vaneaxial fans.

3.3.3.1 Aerodynamic performance. The design point for each size vaneaxial fan shall be the volume-pressure point as specified in table VI. The volume shall be the volume at the fan inlet and the pressure shall be the total pressure (TP) in water gauge (wg) at the fan discharge. The TP shall rise continually from free delivery through the design point as specified in table IV up to the highest point in the stall and recovery region as specified in 3.3.5. The stable operation region of acceptable fans shall be no more than 2 percent below or 5 percent above the applicable fan curve of Drawing 803-921784, when measured along system resistance lines. The stable operation region shall extend from the design pressure, as specified in table IV, to a value of 60 percent of the design pressure; except for fan sizes A11 and A17 in which the stable performance shall extend from the design pressure to a pressure value as shown on Drawing 803-921784.

TABLE IV. *Performance, type A and X–A vaneaxial fans.*

Fan size	Design	
	Volume (ft^3/min)	Fan total pressure (inches, wg)
1/4	250	2.5
1/2	660	2.5
1	1,030	2.65
1-1/2	1,500	3.0
2	2,000	3.4
2-1/2	2,600	3.4
3	3,200	3.4
3-1/2	3,750	3.5
4	4,300	3.5
4-1/2	3,220	7.0
5	4,200	3.75
6	6,300	3.65
7	5,200	7.0
8	7,300	3.3
10	8,500	4.2
11	8,700	5.5
12	10,250	5.0
16	13,200	4.75
17	12,300	6.2
20	18,000	4.85
25	22,000	3.95
28	18,750	6.4
30	25,000	4.2

3.3.3.2 **Sizes.** Sizes of vaneaxial fans shall be limited to those listed in table IV.

3.3.3.2.1 **Physical dimensions and tolerances.** Physical dimensions and tolerances of the fans shall be as shown on Drawing 803-921784.

3.3.3.3 **Fan casings and associated parts.**

3.3.3.3.1 **Material.** Casings, flanges and vanes shall be made from steel plate or they may be included in a single casting of aluminum alloy.

3.3.3.3.2 **Watertightness.** Casings shall be watertight (see 4.8.8).

3.3.3.3.3 **Material thickness.** Steel casings including the machined fan race area, if applicable, shall be at least 0.140 inch thick for size A1 and smaller, at least 0.172 inch thick for size A1-1/2 through size A16, and at least 0.250 inch thick for size A17 and larger. Aluminum casings including the machined fan race area shall be at least 0.204 inch thick for size A1 and smaller, at least 0.257 inch thick for size A1-1/2 through size A16, and at least 0.364 inch thick for size A17 and larger.

3.3.3.3.4 **Flanges.** Flanges for duct connections shall be provided at each end of the fan casing. These flanges shall be separate steel rings welded to a steel casing, rolled extensions of a steel casing, or integral parts of a cast casing. The flanges shall be drilled as shown on Drawing 810-921784 with equally spaced bolt holes straddling the conduit centerline and aligned in the two flanges. An additional flanged connection may be provided at the contractor's option for stiffening large casings or to permit use of a heavier gauge fan race section. This extra flange shall have the same bolting as the end flanges, as well as three unequally spaced dowels. The radius of rolled flanges shall be between 1/8 and 1/4 inch for casings up to 32 inches in diameter, and 3/8 inch maximum for larger casings.

3.3.3.3.5 **Directional vanes.** Vanes for steel casings shall be of single thickness steel plate or of steel sheet formed into airfoil shape. Each steel vane shall be attached to the inside of the casing wall by means of a continuous weld on one side of the vane or by intermittent welds of equivalent total length, staggered on opposite sides of the vane. On casings of cast construction, vanes shall be cast integral with the casing.

3.3.3.3.6 **Motor mounting.** Motors shall be face mounted by cap screws (see 3.3.2.7.4 for exceptions) and shall be removable for maintenance. The motor mounting flange shall be an integral part of the casing when the casing is an aluminum alloy casting; on steel plate casings, the motor mounting flange shall be of steel and it shall be welded to the vanes by means of an intermittent weld on each side of each vane. A secondary mounting or support may be provided between the motor frame and the vanes or the casing to prevent excessive motor excursion, especially under shock effect. In each of these mountings, damping or rotor vibration shall be achieved by avoiding metal-to-metal contacts.

3.3.3.3.7 Conduit boxes. A conduit box of fabricated steel or of cast aluminum, nodular or malleable iron shall be mounted on the outside of the fan casing in line with the motor lead entrance. The box shall be mounted by means of four screws, permitting box rotation in 90-degree increments, and fitted with a single lead inlet with threaded fitting (see table V for sizes); if the box cannot be rotated, threaded couplings shall be provided on three sides of the box. Boxes shall have the same degree of enclosure as the motors with which they are used. Leads connected within the box to terminals shall be fitted with solderless connectors.

TABLE V. *NPT assignments for conduit boxes.*

Maximum full-load (amps)	NPT	Tube size (conduit size)	Horsepower
18	3/4	2	1, 2, 3, 5, and 7-1/2 (see note 1)
25	1	3	10, 15, 20, 25, and 30 (see note 2)
25	1-1/2	5	1 thru 30 (see note 3)

NOTES:
1. If both two speed horsepower are in the range 1 to 7-1/2 horsepower, the tube size is 2.
2. If both two speed horsepower are in the range 10 to 30 horsepower, the tube size is 3.
3. If the first speed horsepower is in the range between 1 to 7-1/2 horsepower, the second speed horsepower between 10 to 30 horsepower, the tube size is 5.

3.3.3.3.8 Conduits. The lead wires from the conduit box to the motor shall be enclosed in a watertight conduit. Where the casing, vanes and motor frame are included in a single casting, an acceptable conduit may be provided by drilling one or more holes through a vane with the condition that a ground circuit be established between the motor frame and the conduit box. Otherwise, a separate watertight conduit shall be provided, preferably a flexible conduit consisting of braided copper tubing braised to threaded end fittings and covered with a neoprene cover, vulcanized to form a bond with the braid, or galvanized steel with a thermoplastic elastomer outer jacket and threaded, compression, watertight end fittings; if conduit is not flexible a threaded pipe conduit shall be provided, and the damping of the rotor vibration shall be achieved by avoiding metal-to-metal contact. In each case, an effective electrical ground shall be provided from the motor frame to the fan casing and the conduit box.

3.3.4 Types L and X–L tubeaxial fans.

3.3.4.1 Aerodynamic performance. The design point for each size tubeaxial fan shall be the volume-pressure point as specified in table VI. The volume shall be the volume at the fan inlet and the pressure shall be the total pressure (TP) in water gauge (wg) at the fan discharge. The TP shall rise continually from free delivery through the design point as specified in table VI up to the highest point in the stall and recovery region as specified in 3.3.5. The stable operation region of acceptable fans shall be no more than 2 percent below or 5 percent above the applicable fan curve of Drawing 803-921784, when measured along system resistance lines. The stable operation region shall extend from the design pressure, as specified in table VI, to a value of 60 percent of the design pressure.

TABLE VI. *Performance, types L and X–L tubeaxial fans.*

Fan size	Design	
	Volume (ft^3/min)	Fan total pressure (inches, wg)
1/2	450	0.75
1	1000	0.50
2	1900	0.58
3	2250	0.70

3.3.4.2 Sizes. Sizes of types L and X–L fans shall be limited to those listed in table VI.

3.3.4.2.1 Physical dimensions and tolerances. Physical dimensions and tolerances of the fans shall be as shown on Drawing 810-925368.

3.3.4.3 Fan casings and associated parts.

3.3.4.3.1 Material. Casings, flanges, and motor supports shall be made of sheet steel, with the motor supports bolted or welded to the casing, or they may be included in a single casting of aluminum alloy.

3.3.4.3.2 Material thickness. Steel casings including the machined fan race area shall be not less than 0.104 inch thick. Aluminum casings including the machined fan race area shall be not less than 0.157 inch thick.

3.3.4.3.3 Flanges. Flanges shall be provided at each end of the fan casing. These flanges shall be separate steel rings welded to a steel casing, rolled or spun extensions of a steel casing, or integral part of a cast casing. The discharge flange shall be drilled as shown on Drawing 810-925368 with equally spaced bolt holes straddling the motor enclosure stuffing tube. The radius of a rolled flange on the fan discharge shall be not less than 1/8 inch nor more than 1/4 inch and a maximum of 3/8 inch for a spun flange. The radius of the flange on the fan inlet shall be not less than 3/4 inch.

3.3.4.3.4 Safety screen. A 1-inch mesh screen constructed of corrosion-resistant steel or steel plated with zinc shall be bolted to the inlet flange and shall cover the annulus between this flange and the motor.

3.3.4.3.5 Motor mounting. The motor shall be frame mounted by means of support arms extending from the fan casing or face mounted by means of a mounting flange suspended from the casing. With either mounting, damping of rotor vibration shall be achieved by avoiding metal-to metal contacts.

3.3.5 Aerodynamic stall. The stall and recovery region shall be in accordance with figure 1 and 4.8.4.1 as follows:

a. Draw a vertical line through the highest point on the continually rising portion of the fan 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 in 3.3.5.a. at a pressure 1 inch wg less than the highest pressure point.

c. Draw a system resistance line through the point defined in 3.3.5.b. and intersecting the fan TP curve.

d. The stall and recovery region is established along the fan TP curve from the highest point in 3.3.5.a. to the intersection point in 3.3.5.c. The intersection point in 3.3.5.c. shall occur at volume capacities less than or equal to the fan volume-pressure design point as specified in table IV (vaneaxial fan) or table VI (tubeaxial fan).

3.4 Welding and allied processes. Welding and allied processes shall conform to MIL-STD-278, class M. Weld defects that exceed the parameters established by NAVSHIPS 0900-LP-003-8000 shall be corrected through:

a. *Weld rework.* Weld rework is a procedure that will bring the part into total conformance to the drawing and specification requirements and does not diminish the thickness of the parent metal by more than 10 percent and does not affect the parent metal surface by more than 1/32 inch for 15 percent of the weld length or 12 inches, whichever is the least. Rework actions may be completed at the discretion of the contractor.

b. *Weld repair.* Repairs, to a Government approved procedure, are required any time any defect exceeds the rework limits above. If successfully completed, a repair action will create a serviceable yet not fully conforming unit. Cracks shall be repaired in accordance with 4.7.2. Weld repairs shall be inspected and accepted in accordance with MIL-STD-278.

3.5 Surface preparation and painting.

3.5.1 Cleaning of aluminum alloy surfaces. Wherever practicable, cleaning of aluminum alloy shall be done prior to assembly of parts. Cleaning before assembly shall be accomplished by immersing the part in, or swabbing with a solvent or a water soluble detergent. Residual solution shall be removed with clear, cold water followed by hot water until no trace of the cleaning agent is detected.

3.5.1.1 Abrasive blasting. Light abrasive blasting with nonferrous abrasive or roughing with an abrasive pad following the use of the above solvents is permissible for producing a good adhering surface for paint, provided care is exercised to control the surface preparation process so as not to distort or damage the material. Abrasive blasting media shall be in accordance with MIL-A-22262.

3.5.1.2 Flux removal. Welded parts shall have all traces of flux removed before painting. This may be accomplished by brushing the welds while immersed in boiling water with a nonferrous wire brush. For inaccessible welds, the part may be cleaned by immersing in a cold solution of 10 percent sulfuric acid for 30 minutes, or a 5 percent solution of sulfuric acid held at 65.6 °C for 10 minutes. The acid shall contact both the inside and outside surfaces. The acid treatments shall be followed by a thorough rinse in clean, warm water until no trace of acid is detected. Residual flux may be detected by leaching the surface with distilled water and adding a few drops of 5 percent silver nitrate solution to the leach. A white precipitate indicates the presence of flux.

3.5.2 Cleaning of miscellaneous metals. Corrosion-resisting steel, nickel copper alloy, copper and brass surfaces that are to be painted shall be cleaned with a solvent or a water soluble detergent. Residual solution shall be removed with clean, cold water until no trace of the cleaning agent is detected. Welds shall be brushed with corrosion-resisting metal nonferrous wire brushes.

3.5.3 Painting. All exposed surfaces of fan impeller, interior surfaces of fan casing, exposed surfaces of all parts in the air steam, exterior surfaces of motors, and exterior surfaces of fan casing and conduit boxes not previously painted shall be painted in accordance with 3.2.3.2, or in accordance with anodizing process per MIL-A-8625, type II, class 1, nominal thickness 0.0003 inch.

3.6 Identification.

3.6.1 Fan identification code. The size and characteristics of Navy standard fan-motor units shall be designated by a code formed by alternate letters and figures arranged in the following sequence:

Symbol sequence	Characteristic	Code	Meaning
1 (letter)	Type of fan	See 1.2	–
2 (figure)	Fan size	For size code see tables IV and V and 3.3.3.2 and 3.3.4.2	Nominal ft^3/min of standard air in (1/2 = 500 $ft^{3/min}$)
3 (letter)	Type of current	A	Alternating-current (ac)
4 (figure)	Voltage and phase (frequency of ac is 60 Hz)	1	115 volt single phase ac
		2	220 volt, 3-phase ac
		4	440 volt, 3-phase ac
5 (letter)	Motor enclosure	W	Spraytight
		X	Explosion-proof
		S	Submersible – 15 foot
6 (figure)	Maximum ambient temperature	6	65 °C
7 (letter)	Nonmagnetic construction of fan and motor	-NM	(This seventh symbol is omitted unless applicable)

EXAMPLES:

1. A2A4W6-NM represents a type A, nominal 2000 ft^3/min vaneaxial fan driven by a 440 volt, 60 Hz, 3-phase, ac, spraytight, 65 °C ambient temperature, Navy Service A motor. The assembly shall be of nonmagnetic construction.

2. X–L3A4X6 represents a type X–L, nominal 3000 ft^3/min tubeaxial fan driven by a 440 volt, 60 Hz, 3-phase, ac, explosion-proof, 65 °C ambient temperature motor, Navy Service C motor.

3. Navy standard fans with special electrical characteristics not covered above shall have the electrical characteristics (single or 3-phase) identified by text and preceded by the letter "S". Examples: "SA2A2W6 1-phase" represents a special electrical characteristic (S), type A, nominal 2000 ft^3/min vaneaxial fan driven by a 220 volt, 60 Hz, single phase, ac, spraytight, 65 °C ambient temperature motor.

3.6.2 Identification plates. Identification plates for fans having steel casings shall be of corrosion-resistant steel plate and shall be attached with corrosion-resistant steel drive screws. Identification plates for fans having aluminum casings shall be of aluminum alloy and shall be attached with aluminum alloy drive screws. The background of the plate shall be etched and filled with black enamel, and characters shall be raised and unpainted, except that the serial number shall be depressed in the metal by stamping. The manufacturer's drawing number shall include the revision letter. The component identification number may also be stamped if not assigned at the time that plates are ordered. The plates for all fans shall conform to figures 2 and 3. A duplicate motor identification plate shall be installed on the outside of the fan casing; this plate and the fan plate shall be located in line axially with the conduit box or cable entrance. If there is sufficient space on the casing, the motor plate may be located adjacent circumferentially to the fan plate. It is acceptable to combine the fan and motor data in a single plate.

3.7 Interchangeability. In no case shall parts be physically interchangeable or reversible unless such parts are also interchangeable or reversible with regard to function, performance, and strength.

4. QUALITY ASSURANCE PROVISIONS

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

4.1.1 Responsibility for compliance. All items shall meet all requirements of sections 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of ensuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspection, as part of the manufacturing operations, is an acceptable practice to ascertain conformance to requirements, however, this does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to accept defective material.

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

a. Qualification inspection (see 4.3)
b. Type tests (see 4.4)
c. Periodic tests (see 4.5)
d. Routine tests (see 4.6).

4.3 Qualification inspection. Qualification inspection shall be conducted at a laboratory satisfactory to NAVSEA and shall consist of the tests specified in table VII. Prior to test authorization, drawings delineating the test sample or samples shall be submitted for review and approval. Prior to construction, a list of materials and corresponding specifications (industry, Federal, or Military, as applicable) shall be submitted to NAVSEA for review.

TABLE VII. *Test agenda.*

Test	Applicability of test to fan type				Requirement	Test
	Qualification[1]	Type [2]	Periodic[3]	Routine[4]		
Shock	A, L	A, L			3.3.2.5	4.8.1
Vibration	A, L	A, L			3.3.2.4	4.8.2
Balance	All	All	All	All	3.3.2.4	4.8.3
Performance	All	All	All		3.3.3.1, 3.3.4.1, 3.3.5	4.8.4, 4.8.4.1
Noise	All	All	All		3.3.2.3	4.8.5.1
Heat	All	All	All			4.8.6
Explosion, applies to explosion-proof (X) motors		All units with (X) motors			3.3.2.7.1	4.8.7
Air leakage test, (X) motors				All units with (X) motors	3.3.2.7.9	4.8.7.1
Casing lightness				A, X–A[4]	3.3.3.3.2	4.8.8
Speed				All	3.3.2.7	4.8.9

[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 in the contract or order.

4.3.1 Samples for qualification. Qualification tests shall be conducted on one type A fan-motor unit or one fan-motor unit of each type for which qualification is desired. The choice of size shall be determined by the manufacturer. Qualification of a type A fan-motor unit will include qualification of all sizes for types A, L, X–A, and X–L. Qualification of other than type A fan-motor unit submitted will include qualification of all sizes for only that type.

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 VII 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 NAVSEA. 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. The tests are required under any contract or purchase order for fans of existing design when the invitation to bid is dated 4 years or more subsequent to the date of the last previous test of a similar unit. Periodic tests shall consist of the tests specified in table VII.

4.6 Routine tests. Routine tests are required for every fan-motor unit. These tests are specified in table VII. 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 B 26. There is no requirement for radiography of visually sound castings. Repairs of cast impeller are not permitted. Cast casings may be repaired by welding or impregnation, if completed in accordance with the requirements of MIL-STD-278.

4.7.2 Fabricated steel casing. Visual examination for defects is required, especially at the base of flanges. Cracks in the radius of spun flanges or in the welds of welded flanges may be repaired by welding, after proper preparation; cracks shall be repaired in accordance with NAVSEA S9086-CH-STM-010/CH 074 V1. Wall thickness shall be measured on the casings. (See 3.3.3.3.3 and 3.3.4.3.2 for wall thickness and 3.3.3.3.4 and 3.3.4.3.3 for flange construction requirements.)

4.7.3 Electrical components. The quality requirements of the applicable components specification shall be completed by the manufacturer and confirmed by the contractor through routine tests as specified in component specifications.

4.7.4 Assembled fan-motor units. The maximum blade tip clearance shall be measured at four points 90 degrees apart for conformance to 3.3.2.2.

4.8 Tests. Tests shall be conducted in accordance with 4.8.1 through 4.8.9 (see 6.3 and appendix B).

4.8.1 High-impact shock. The fan-motor unit shall be shock tested on the medium weight machines as specified for type A shock of MIL-S-901 if its weight with fixture and mounting bracket exceeds 350 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 after the tests specified in 4.8.2 through 4.8.7. After conducting the high-impact shock test, tests specified in 4.8.2 through 4.8.7 shall be again conducted without correction of damages, which may have occurred during shock tests. Data for tests specified in 4.8.2 through 4.8.7, one before and one after the high-impact shock test, shall be submitted for evaluation. Shock testing in accordance with these requirements shall demonstrate that the fan-motor unit performs its function without change in performance. Shock test acceptance shall not be contingent upon the ability of the equipment to satisfy noise and vibration requirements. 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 (see 6.2) or unless the fan-motor unit will always be resiliently mounted on shipboard. Fan-motor units which have passed this test may be used as production units after replacement of motor bearings.

4.8.1.1 Shock on lightweight machine. The fan discharge 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 4A, without bolt spacers or with a single annular spacer of 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 machine. The test of a fan-motor unit shall consist of the nine blows indicated in table VIII. The required mountings are shown on figure 4. Auxiliary channels shall be used as necessary to bolt the mounting brackets or plate to standard fixtures.

TABLE VIII. *Test on medium weight shock machine.*

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

[1]See figure 3.

4.8.1.3 Upon completion of the shock test, post-shock test inspection, and tests specified in table VII, the fan-motor unit shall be returned to the contractor for examination and further testing.

4.8.2 Vibration test. Fan-motor units shall be subjected to type I environmental vibration tests as specified in MIL-STD-167-1. The exploratory vibration test specified in MIL-STD-167-1 shall include frequencies from 34 Hz up to and including 50 Hz at the table amplitude specified therein. The vibration test shall be conducted prior to the tests specified in 4.8.3 through 4.8.6, and the correction of damages, which may have occurred during vibration tests, shall not be performed prior to these tests. Any unit which fails to meet any specification 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 1/4 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, 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 greater than 35 inches, and the link size of the chains shall be not less than 1/4 inch nor greater than 3/8 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 each 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 limits specified in 3.3.2.4 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. Tests shall be conducted in accordance with AMCA 210.

4.8.5 Noise. The test is a meter test consisting of sound power determination.

4.8.5.1 Sound power. Fan total sound power shall be computed in accordance with AMCA 300. The midpoint measurement required in this standard shall be observed to assure that the test space is sufficiently reverberent. Fan total sound power levels shall be taken in each octave band with fan operating at the design point and shall be referenced to a power of 10^{-12} watts. Exceeding level in any octave band is cause for rejection.

4.8.6 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 in excess of 3.3.2.7.2. e. shall be rejected.

corrosion resistance and low maintenance

4.8.7 Explosion. This test, applicable only to electrical equipment with explosion-proof enclosure, shall be performed in the specified atmosphere (petroleum ether unless otherwise specified) in accordance with MIL-E-2036. Test motors shall include the conduit and conduit box actually used with the fan or complete fan-motor units may be utilized as test specimens. Prior to the explosion 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 measured air leakage rate shall be recorded on the applicable motor drawing.) The tests will normally be conducted at the Mine Safety and Health Administration (MSHA), Approval and Certification Center (ACC) laboratory, or any laboratory certified by the MSHA, in which case arrangements will be made by the Government representative or by NAVSEA.

4.8.7.1 The motor of explosion-proof fan-motor units shall have 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 is exceeded when measured shall not be offered for delivery.

4.8.8 Casing tightness. The casing tightness 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.

A pressure drop in a 10-minute period that exceeds 5 percent of the test pressure is cause for rejection.

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 by eyes 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 tip clearance. This maximum clearance shall not exceed 0.25 of 1 percent of the casing inside diameter.

4.10 Inspection of packaging. Sample packages and packs, and the inspection of the preservation, packing, and marking for shipment and storage shall be in accordance with the requirements of section 5 and the documents specified herein.

5. PACKAGING

(The packaging requirements herein apply only for direct Government acquisition. For the extent or applicability of the packaging requirements of documents listed in section 2, see 6.2.)

5.1 Preservation. Preservation shall be level A or commercial as specified (see 6.2).

5.1.1 Level A. Fan-motor units shall be preserved method II in accordance with MIL-P-116 (sub-method at the contractor's option) dependent on the size and weight of the fan unit.

5.1.1.1 Modified method II. For types A, L, X−A, and X−L fan-motor units, the following will be acceptable in accomplishing the required method II preservation procedure:

a. Preservative application is not required.

b. The threaded connections in the conduit box shall be fitted with pipe plugs.

c. Bagged desiccant shall be attached to the inside of the casing in accordance with MIL-P-116.

d. A rubber disc gasket and a blind gasket of 1/2-inch plywood or minimum 20 gage steel plate shall be bolted to the face of each of the casing flanges.

e. A plug type humidity indicator shall be installed in accordance with MIL-P-116 in one of the blind flanges.

f. The unit as protected shall be marked, "Method II Modified Removed Desiccant Prior to Installation".

5.1.1.2 Commercial. Fan-motor units shall be preserved as specified in 5.1.1.1, except that desiccant, humidity indicator and the marking specified is not required.

5.2 Packing. Packing shall conform to MIL-E-16298 level A, B, C, or commercial as specified (see 6.2).

5.2.1 Shock and vibration mitigation. All levels of packing shall employ a shock and vibration mounting system that will ensure parts of the unit (e.g. bearings) are not damaged due to normal shock and vibration that occur during handling and shipment. Each unit preserved as specified in 5.1 shall be mounted in it's shipping container or commercial pallet box with the fan mounted vertically and the impeller end of the fan pointing up. Shock mounts shall be fastened to the lower fan casing, located equidistant around the casing and shall consist of four metal heli-coil flex type wire mounts. The contractor is responsible to determine the proper mounts for the weight and size of the fan unit to be packed.

thermal expansion; the coefficient of

5.3 Marking. In addition to any special marking required (see 6.2), marking shall be in accordance with MIL-E-16298 except that for the critical close tolerance requirement, such marking shall be placed on the top and on all four sides of the shipping container.

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 on board ships and crafts 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.

6.1.1 Vaneaxial fans, types A and X–A. Types A and X–A fans are high efficiency units intended for systems having a resistance above 1-inch water gauge and up to 2.5-inches water gauge for the smallest fans and 7.0 inches for high pressure units. Their compactness recommends them for general shipboard service, especially when installed horizontally to the overhead. Type A is shockproof; type X–A is identical dimensionally but is equipped with a service C motor and is not required to be shock tested.

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 must specify the following:

a. Title, number, and date of this specification

b. Issue of DODISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1.1 and 2.2)

c. Type required (see 1.2)

d. Whether nonmagnetic fan-motor units are required (see 3.2.4)

e. Fan characteristic code in accordance with 3.6.1, including fan type (see 1.2), size (see 3.3.3.2 and 3.3.4.2), motor current (see 3.3.2.1), motor voltage (see 3.3.2.1), motor enclosure (see 3.3.2.7.1), ambient temperature (see 3.3.2.7.1), and nonmagnetic construction, if applicable

f. Resilient mountings (see 4.8.1)

g. Level of preservation, packing, and marking required (see 5.1, 5.2, and 5.3).

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

Reference Paragraph	DID Number	DID Title	Suggested Tailoring
3.3.2 and appendix A	DI-DRPR-80651	Engineering Drawings	Level 2
4.8 and appendix B	DI-MISC-80653	Test Reports	–

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

6.4 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 purchase orders for the products covered by this specification. The activity responsible for the Qualified Products List is the Naval Sea Systems Command, SEA 55Z3, Department of the Navy, Washington, DC 20362-5101 and information pertaining to qualification of products may be obtained from that activity.

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

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

6.6 Bellmouth intakes. Inlet bells for type A and X–A fans are shown on Drawing 810-451223. These bells are required when ducts are not attached to fan inlets.

6.7 Drainage of motor condensate. It is intended that the lowest condensate drain plug in the motor be removed and discarded when the fan is installed to permit continual drainage of condensate by gravity to the airstream. Where fans exhaust very humid air, as in sculleries, it is also recommended that fans be continued in operation until temperatures have equalized (at least 1 hour after otherwise securing the space).

6.8 Avoiding drainage to conduit box. For horizontal installation on shipboard, a fan should be installed with conduit box above the horizontal centerline. This will prevent drainage of motor condensate to conduit box. Preferred installation is with conduit box 45 degrees above horizontal centerline.

6.9 Technical manuals. Manuals are not normally required for these fan units. Fan, motor, and controller drawings are furnished for ships' files, and they provide all necessary data.

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

6.11 Standardization. In view of the standardization of Navy standard fans, types A, X–A, L, X–L, and O, the acquisition of these fans from any source under Qualified Products List QPL-18953 is considered to indicate compliance with shipboard standardization requirements.

6.12 When non-Navy standard fans are permitted in the contract or order, this specification may be used for construction requirements. Navy standard fan characteristic codes should not be used.

6.13 Performance review. The fan may be acceptable if some part of the fan characteristic curve falls outside of the tolerance band of the stable operation region as specified in 3.3.3.1 (vaneaxial fan) or 3.3.4.1 (tubeaxial fan) provided the measurement uncertainty (maximum 2 percent), as defined in AMCA 210, extends into the acceptable region. For this situation NAVSEA will review and approve/disapprove a waiver based on measurement uncertainty tolerance.

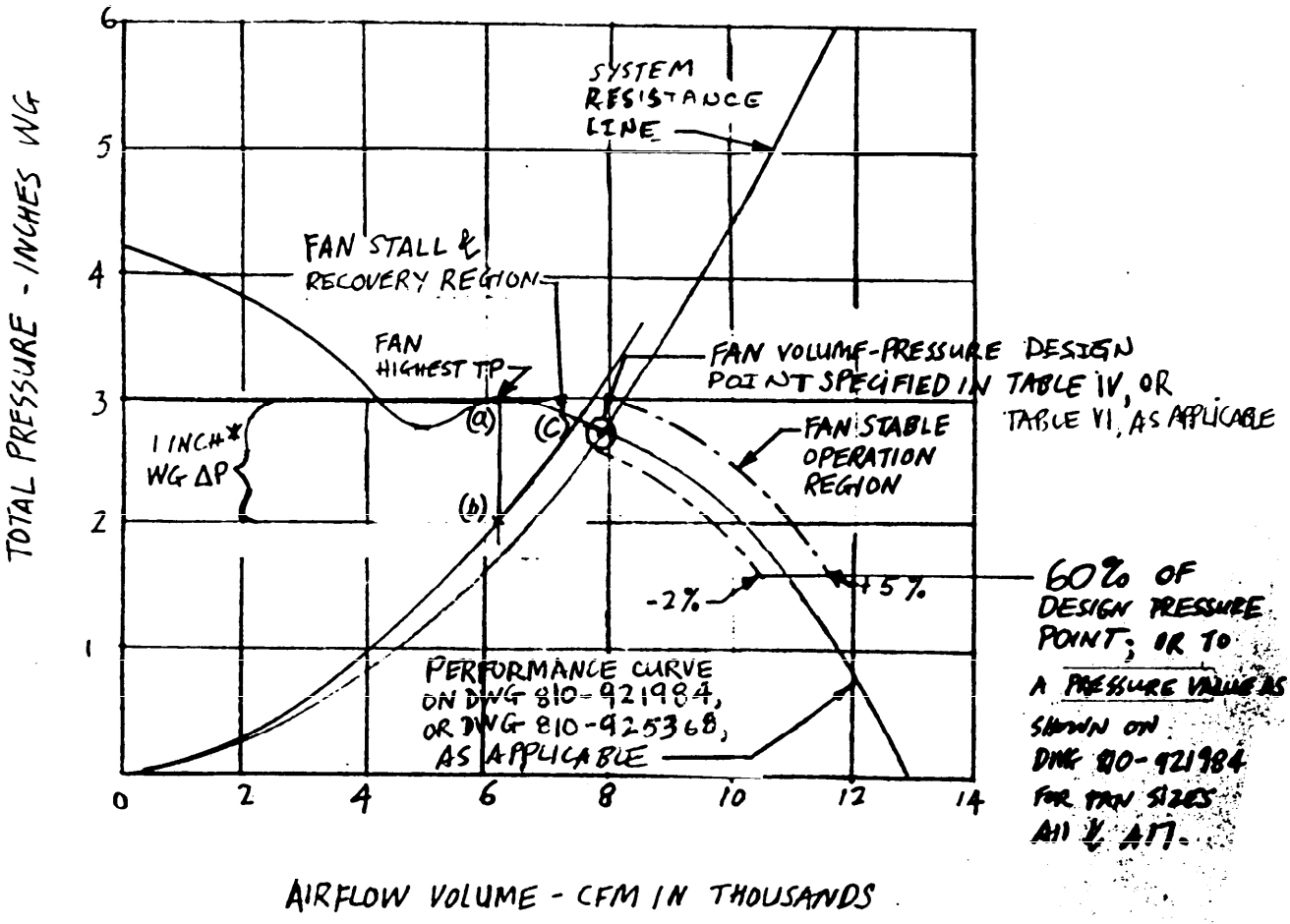
6.14 Design reviews. The reliability assurance program should include provisions for the reliability review and evaluation of design as an integral part of the contractor's engineering design procedures. Design or engineering changes occurring during development or production should be subjected to comparable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

6.15 Subject term (key word) listing.

Blade
Hub
Impeller
Nose piece
Vane

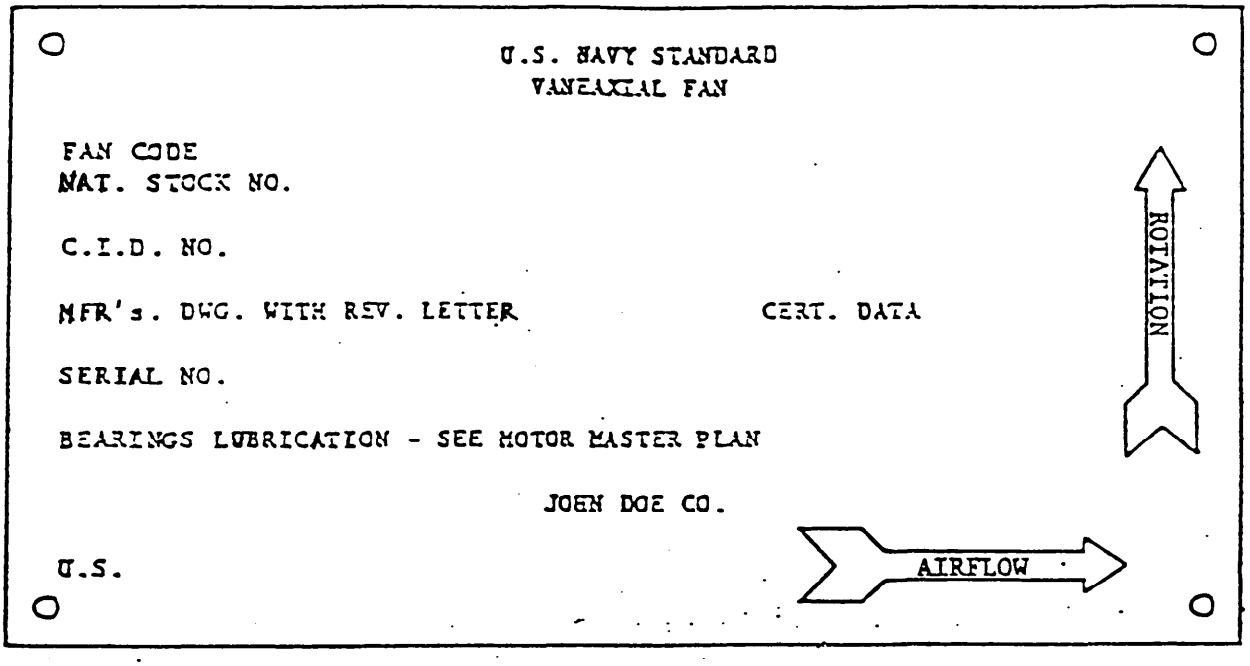
6.16 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

Preparing activity:
Navy – SH
(Project 4140-N044)



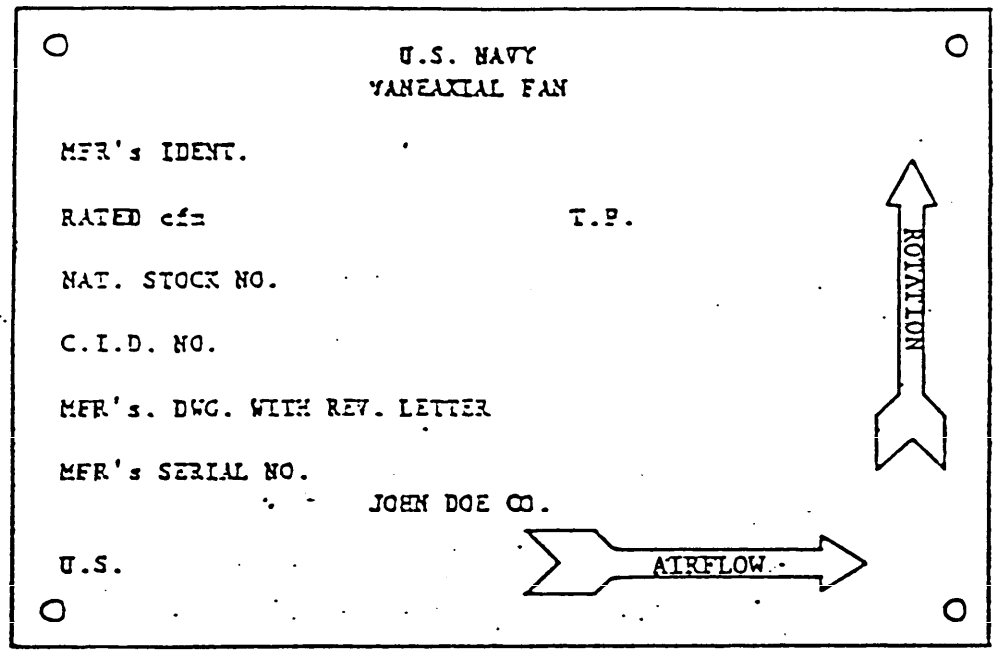
* Under all conditions actual fan performance curve must meet the requirement that point C is related to point A as shown.

FIGURE 1. *Region fan stall and recovery.*



Note that the direction of rotation arrow indicated hereby is for guidance only. However, the direction of airflow arrow shall be shown as specified on figure 1.

FIGURE 2. *Identification plate, Navy standard vaneaxial fan (substitute "TUBEAXIAL" as applicable).*



Note that the direction of rotation arrow indicated hereby is for guidance only. However, the direction of airflow arrow shall be shown as specified on figure 2.

FIGURE 3. *Identification plate, non-Navy standard vaneaxial fan (see 6.11) (substitute "TUBEAXIAL" as applicable).*

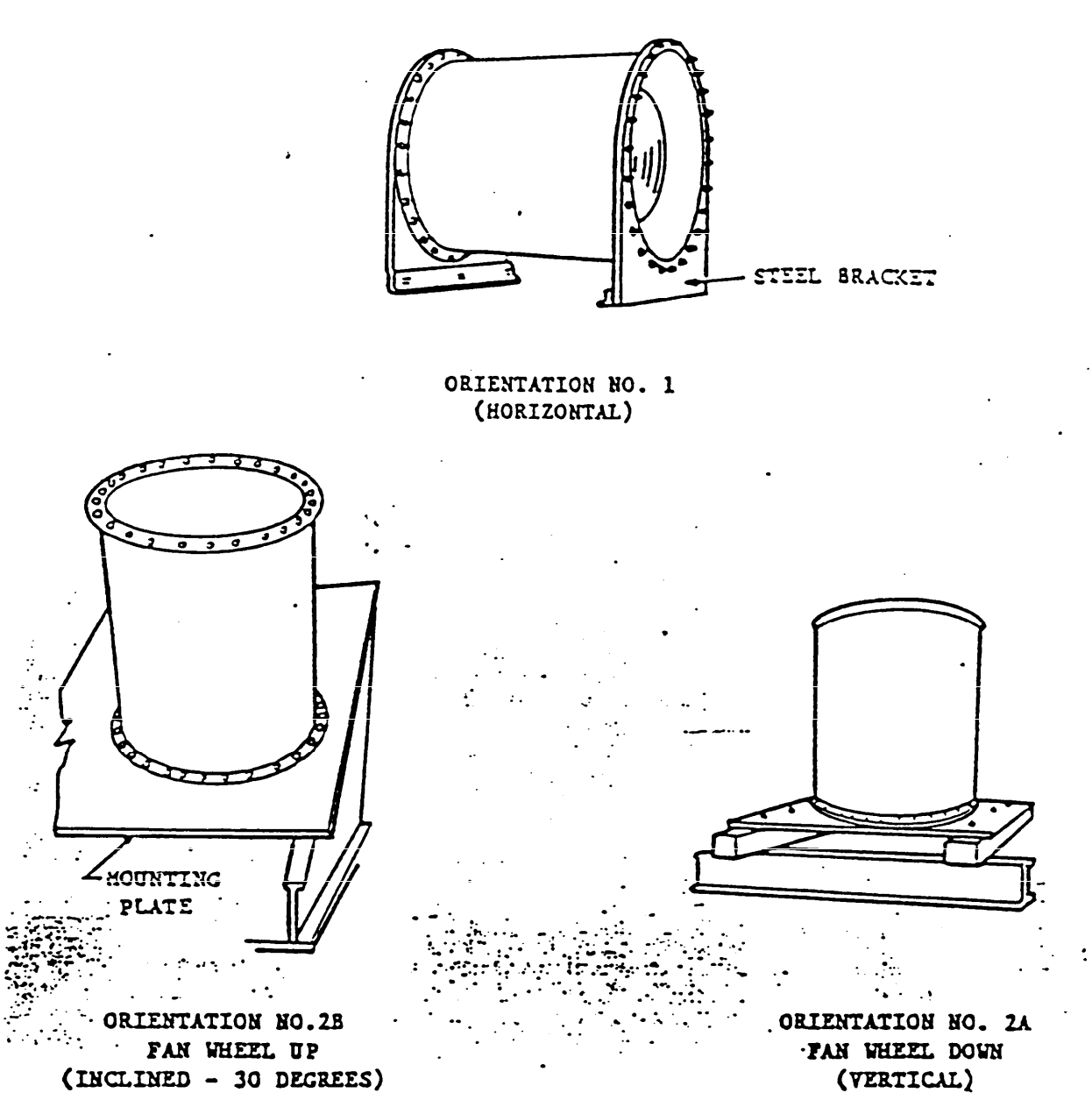


FIGURE 4. *Mountings for medium shock machine.*

FIGURE 4. *Mountings for medium shock machine.*

ENGINEERING DRAWINGS TECHNICAL CONTENT REQUIREMENTS

10. SCOPE

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

20. APPLICABLE DOCUMENTS

20.1 Government documents.

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

SPECIFICATION

MILITARY

DOD-D-1000	Drawings, Engineering and Associated Lists
MIL-F-18953	Fans, Vaneaxial and Tubeaxial, Ventilation and Air Conditioning, Naval Shipboard

STANDARD

MILITARY

MIL-STD-740-2	Structureborne Vibratory Acceleration Measurements and Acceptance Criteria of Shipboard Equipment

(Unless otherwise indicated, copies of military specifications are available from the Naval Publications and Forms Center, (ATTN: NPODS), 5801 Tabor Avenue, Philadelphia, PA 19120-5099.)

APPENDIX A

30. DRAWINGS

30.1 Drawings. When required by the contract or order, drawings shall be identified by the contractor's identification and document number, shall be in accordance with DOD-D-1000 for level 2 drawings is normally requested or level 3 drawings, and shall contain the following information:

30.2 Fan assembly drawing. The fan assembly drawing shall include the following:

a. A longitudinal, sectional view of the fan, showing arrangement of component parts which are identified by piece number flagging. Welds shall be indicated by standard weld symbols. The following additional data shall be shown in this view:

(1) Overall (flange face-to-face) fan length and mounting flange od to the nearest 1/16 inch

(2) Fan casing id and impeller (blade) tip diameter to thousandths of an inch with tolerance

(3) Axial distance from the face of the motor mounting flange to the conduit centerline

(4) Keyway dimensions of the wheel hub, and wheel hub bore diameter to ten thousandths of an inch with tolerance

(5) Axial length of vanes

(6) Indication of the area of impeller from which metal is to be removed in balancing, and the permissible depth of such removal

(7) The nominal axial distance between the trailing edge of a blade at midpoint to the leading edge of a vane

(8) Location on the casing of fan and motor identification plates.

b. An end view of the fan with motor removed, showing the following:

(1) Direction of impeller rotation

(2) Id of the motor-mounting flange or the diameter of the rabbet in the motor mounting flange (whichever surface is used for positioning the motor) in thousandths of an inch with tolerance

(3) The quantity, size, and tolerance of equally spaced mounting holes and the bolt center diameter with tolerance in the fan flanges and motor-mounting flange.

c. If necessary for clarity, separate details of the motor face mounting (and secondary mounting, if provided), conduit, and conduit box

d. Separate details of the motor-mounting gasket; fan identification plate; a section of the impeller showing undimensioned, end profile of a blade with stagger angle at blade root and blade tip indicated; the impeller hub insert; and the fit of the nose to the impeller (if the impeller has a separate nose or cap)

e. A complete list of material. The quantity of blades and vanes shall be indicated, as well as the thickness of casing, vanes, and motor mounting flange, unless the thickness is dimensioned in a view. Thread data of threaded fasteners shall be given.

f. General notes, including the following:

(1) A statement that the fan conforms to MIL-F-18953 and Drawing (indicate 810-921784 or 810-925368)

(2) A statement directing reference to a fan certification data sheet for identification of electrical components and specific fan-motor test data, center of gravity, and moments of inertia

(3) A statement of the permissible tolerance for all untoleranced dimensions

(4) Indication of the method of securing the wheel hub insert in the wheel; if by press fit, the interference fit and the minimum insertion pressure shall be stated

(5) A caution statement directing connections of a ground wire if applicable

(6) Statements identifying the plating, welding, and painting of components or assemblies

(7) Indication of the method of balancing the fan impeller

(8) Indication of the passing angle, viewed axially, of a blade trailing edge and a vane leading edge

(9) A statement of the minimum casing wall thickness (including the fan raceway if it is machined)

(10) Identification of any carbon steel surface which may be machined after plating, and a statement of the treatment of such an area prior to painting

(11) Any other statements necessary for clarity

(12) At the contractor's option, statements for contractor's use only, so designated.

g. A nonlogarithmic graph, with cubic feet of standard air per minute as the abscissa, and total pressure, static pressure, speed revolutions per minute, brake horsepower, power input kilowatts (kW) or input horsepower as ordinates. The graph shall be identified by fan code if it applies to a Navy standard fan, and by the test number and date.

h. A log-log (3 cycle abscissa by 1 cycle ordinate) graph of fan performance curve, with cubic feet of standard air per minute as abscissa, and total pressure in inch of water (in-H_2O) as ordinate.

30.3 Fan detail drawings. Fan detail drawings shall include the following:

a. All parts and subassembly necessary for evaluation of the equipment and all parts necessary for maintenance and overhaul

b. Subassemblies whose parts cannot be acquired or serviced individually shall be shown as a single part

c. Show all essential fabrication details including welding requirements and symbols

d. Drawings are not required for those parts which are in common commercial use and can be referenced to commercial standards.

30.4 Auxiliary drawings. Auxiliary drawings shall include the following:

a. Drawings of motors used with fans shall conform to the requirements of MIL-M-17059 and MIL-M-17060. Structureborne noise levels in accordance with MIL-STD-740-2 shall be shown on each motor drawing for information only and shall not be applied to any specific requirement. Motor efficiency shall be shown on the nameplate.

b. Service C motor drawing shall contain an identification of the bearings used, tabulation of full load heat test data at maximum fan speed, and a tabulation of performance test data, including pull up torque, locked rotor torque, full load torque, locked rotor current, and full load current.

c. Indicate pressure and pressure drop rate (that is, the maximum permitted drop in pressure over a specific length of time) of explosion-proof motor enclosure (see 4.8.7).

d. Drawings shall identify no re-lubrication for type 120 bearing.

3.2.1 Class A structures

APPENDIX B

TEST REPORT TECHNICAL CONTENT REQUIREMENTS

10. SCOPE

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

20. APPLICABLE DOCUMENTS

This section is not applicable to this appendix.

30. REPORTS

30.1 Test reports. When required by the contract or order, test reports shall contain the following information:

a. Results of type tests (see 4.4)

b. Results of periodic tests (see 4.5)

c. Results of shock test (see 4.8.1) with the following unique features:

(1) Drawing number identification of the fan and motor

(2) Photographs of the fan-motor unit in each test mounting.

d. Results of type I vibration test (see 4.8.2)

e. Results of balance test (see 4.8.3)

f. Results of performance test (see 4.8.4) with the following unique technical features:

(1) The figure number of AMCA 210 shall be identified

(2) Dimensions of the duct or chamber and the diameter of nozzle used, shall be identified.

(3) Computations, if not made strictly in accordance with AMCA 210

(4) The following values in tabular form: ambient barometric pressure, dry bulb temperatures, wet bulb temperatures, air density; voltage and current (in each phase if applicable); motor input (kW or horsepower); motor brake horsepower; fan speed; air velocity; total static pressure; total velocity pressure; air quantity (cubic feet of standard air per minute); mechanical efficiency (total); electrical efficiency

(5) A curve sheet showing motor input (kW or horsepower), motor brake horsepower, fan speed, total and static pressure of standard air at fan discharge, as ordinates, and cubic feet of standard air per minute at fan inlet as the abscissa

(6) A log-log curve sheet showing a graph of fan performance curve, with cubic feet of standard air per minute as abscissa, and total pressure in in-H_2O as ordinate.

g. Results of noise test (see 4.8.5) including tables of sound power at design point at each octave band

h. Results of heat test (see 4.8.6) including tables of motor heating at maximum fan load for each speed

i. Results of explosion test (see 4.8.7) with the following unique features:

(1) Identify the test specimen by drawing numbers

(2) Identify the explosive vapor used

(3) Note any dimensional discrepancies

(4) Note motor enclosure test pressure, pressure drop and pressure drop period in seconds.

j. Data for the tests specified in 4.8.2 through 4.8.7, taken before and after the high-impact shock test (see 4.8.1).

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

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

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

I RECOMMEND A CHANGE:	1. DOCUMENT NUMBER	2. DOCUMENT DATE *(YYMMDD)*
3. DOCUMENT TITLE		

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

5. REASON FOR RECOMMENDATION

6. SUBMITTER

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

8. PREPARING ACTIVITY

a. NAME	b. TELEPHONE *(Include Area Code)* (1) Commercial	(2) AUTOVON
Technical Point of Contact (TPOC): Mr. Tien Ngo (SEA 56Y11) Please Address All Correspondence As Follows:	TPOC: (703) 602-7591	8-332-7591
c. ADDRESS *(Include Zip Code)* Commander, Naval Sea Systems Command Department of the Navy (SEA 55Z3) Washington, DC 20362-5101	IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT: Defense Quality and Standardization Office 5203 Leesburg Pike, Suite 1403, Falls Church, VA 22041-3466 Telephone (703) 756-2340 AUTOVON 289-2340	