INCH-POUND

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SUPERSEDING
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1 November 1990

PERFORMANCE SPECIFICATION

FANS, VANEAXIAL GAS TURBINE ENCLOSURE COOLING NAVAL SHIPBOARD

This specification if 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 high pressure and HI shock, type TA vaneaxial fans for use in cooling the gas turbine enclosures of ship propulsion/generator systems.

1.2 Classification. Type TA vaneaxial fans are of the following (see 6.2):

1.2.1 Sizes.

Sizes	PIN Code
TA4½	1
TA5	2
TA17	3
TA22½	4

1.2.2 Current.

Current	PIN Code
60 Hz a.c.	A

1.2.3 Voltage.

Voltage	PIN Code
3-phase, 440 V, 60 Hz	4

1.2.4 Enclosure.

Enclosure	PIN Code
Spraytight totally enclosed air over	W
Not applicable	N

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.

1.2.5 Ambient temperature.

Maximum ambient temperature	PIN Code
65 °C	6

1.2.6 Quiet bearing.

Quiet bearing	PIN Code
Quiet bearing is applied	QB

1.2.7 Nonmagnetic.

Nonmagnetic	PIN Code
Nonmagnetic is applied	NM

1.3 Part or identifying number (PIN). PINs to be used for standard gas turbine enclosure cooling fan-motor units acquired to this specification are created as follows (see 1.2.1 through 1.2.7):

M	**24751**	**-**	**X**	**X**	**X**	**X**	**X**	**XX**	**XX**
Prefix for Military Specification	Specification number		Size	Current	Voltage and phase	Enclosure	Ambient temp.	Quiet bearing	Nonmagnetic

For example M24751-TA3A4W6QBNM represents a nominal 17,000 cubic feet per minute (ft^3/min) vaneaxial fan driven by a 440 volt (V), 60 hertz (Hz), 3-phase, alternating current (ac), spraytight, 65 °C ambient temperature, Navy service A motor, with quiet bearings, and of non-magnetic construction.

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, HI (High Impact); Shipboard Machinery, Equipment, and Systems Requirement For

MIL-B-17931 - Bearings, Ball, Annular, For Quiet Operation

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-167-1	-	Mechanical Vibrations of Shipboard Equipment (Type I - Environmental and Type II - Internally Excited)
MIL-STD-740-2	-	Structureborne Vibratory Acceleration Measurements and Acceptance Criteria of Shipboard Equipment
MIL-STD-889	-	Dissimilar Metals
MIL-STD-1399-300	-	Interface Standard for Shipboard Systems, Electric Power, Alternating Current (Metric)
MIL-STD-2031	-	Fire and Toxicity Test Methods and Qualifications Procedure for Composite Systems
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 or 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 the Naval Inventory Control Point, 700 Robbins Avenue, Attn: Code 0862 (Cash Sale), Philadelphia, PA 19111, or 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, INC. (AMCA)

AMCA 99-0401	-	Classification for Spark Resistant Construction
AMCA 111	-	Laboratory Accreditation Program
AMCA 210	-	Laboratory Methods for Testing Fans for Aerodynamic Performance Rating
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, 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., 1101 Connecticut Avenue, NW, Suite 700, Washington, DC 20036 or online at www.abma-dc.org.)

AMERICAN WELDING SOCIETY (AWS)

AWS B2.1 - Welding Procedure and Performance Qualification, Standard For

AWS B2.2 - Brazing Procedure and Performance Qualification, Standard For

(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 E119 - Standard Test Methods for Fire Tests of Building Construction and Materials (DoD adopted)

ASTM E662 - Standard Test method for Specific Optical Density of Smoke Generated by Solid Materials

ASTM E800 - Standard Guide for Measurement of Gases Present or Generated During Fires

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

IEEE STD 429 - Standard Test Procedure for the Evaluation of Sealed Insulation Systems for AC Electric Machinery Employing Form – Wound Stator Coils

(Copies of these documents 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 is available from the National Electrical Manufacturers Association, 1300 North 17th Street, 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 First article. When specified (see 6.2), a sample shall be subjected to first article inspection in accordance with 4.2.

3.2 Materials. Fan shall be of spark resistant construction as defined in AMCA 99-0401 Type B construction. Cast iron shall not be used in the construction of fans nor shall cast iron be used in motors, which are components of 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 filter. Selected materials shall be capable of meeting all of the operational and environmental requirements specified herein.

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. 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, which 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 as applicable for nonmagnetic motors.

3.2.5 Dissimilar metals. Fans and components shall not be degraded by electrolysis as specified in MIL-STD-889.

3.2.6 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 expressly stipulated.

3.2.7 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 delivered with the manufacturer’s standard finish, except as to comply with the requirements of 3.2.

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. The method of attachment of the identification plate shall be corrosion-resistant. The identification plate shall contain the following information as a minimum:

a. Manufacturer’s name, commercial and government entity, and part number
b. Fan identification code
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 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 General shipboard design conditions. General shipboard design characteristics shall be as follows:

a. Power source quality - In accordance with MIL-STD-1399-300.

3.11 Fan design requirements.

3.11.1 Aerodynamic design parameters. The quantities of blades and vanes shall be chosen to avoid interacting frequencies within the audible range. The axial distance between blades and vanes shall be chosen with minimum noise amplitude as a prime consideration. Blade tip clearance (radial clearance) shall be the minimum clearance to satisfy 4.5.10.

3.11.2 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.

3.11.3 Sizes. Sizes of gas turbine cooling fans shall be limited to those listed in Table I.

TABLE I. Fan characteristics.

Fan Size	Design		Max inside flange dim. (inches)	Max Length (inches)	Max Horsepower	Max Weight
	Volume ft^3	Tp in W.G.[1/] (minimum)				
TA4½	4500	18	19	34	25	645
TA5	5000	10	19	24½	12½	331
TA17	17000	20	32	40	80	1390
TA22½	21200	22	32	40	130	1500

[1/] Total pressure (Tp) in inches watergage.

3.12 Fan casings and associated parts.

3.12.1 Watertightness. Casings shall be watertight.

3.12.2 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 have boltholes drilled approximately 3 inches center to center.

3.12.3 Direction vanes. Airfoil shaped directional vanes shall be provided in the casing.

3.12.4 Motor mounting.

3.12.4.1 Face mounted. Motors shall be face mounted. Mounting shall be designed to dampen rotor vibration.

3.12.4.2 Integrally mounted. Stator mounting may be integrally cast or manufactured with fan casing. Means shall be provided to prevent rotational and axial displacement of stator after insertion. If mechanical fasteners are used, they shall be of corrosion-resistant material.

3.12.5 Conduit box. 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. For horizontal installation on shipboard, a fan should be installed with a 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.

3.12.6 Conduits. 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.

3.12.7 Bellmouths. When specified (see 6.2), a fan bellmouth shall be provided.

3.12.8 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. Impellers shall be designed to prevent retention of water when the fan is installed vertically with the impeller up or down, or horizontally. The total impeller shall have at least a safety factor of 8, based on the ultimate tensile strength of the material. The hub of the impeller shall not distort or the fit loosen on the drive shaft during the life of the equipment.

3.12.8.1 Nosepiece. 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.

3.12.8.2 Balancing. The impeller shall be statically and dynamically balanced in accordance with manufacturer's recommended procedures. 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.

3.13 Electrical equipment.

3.13.1 Motors. In consideration of the cooling effect of the air stream, motors for vaneaxial fans need not conform to referenced motor specifications in regard to horsepower rating of a standard frame size. Motors shall not have excessive horsepower, but shall have sufficient torque to start the fans at 90 percent of rated voltage, and to drive them continuously without overloading when fan delivery is above 50 percent of the minimum delivery as shown in Figure 1. Motors shall be in accordance with IEEE STD 45, IEEE STD 429, and NEMA MG 1.

3.13.1.1 General requirements. Motors shall conform to the following:

a. Motor - 60 Hz, ac, integral-horsepower.
b. Voltage, phase, and frequency - 440V, 3-phase, 60 Hz.
c. Ambient temperature - 65 °C
d. Navy service A - Shock tested to MIL-S-901, type A.
e. Duty - Continuous air over.
f. Enclosure - Spraytight in accordance with IEEE STD 45 and NEMA MG 1.
g. Insulation - Class F or better sealed insulation - with class B temperature rise.
h. Structureborne noise - Motor structureborne noise levels shall not exceed the levels shown for type II in MIL-STD-740-2 or lower when specified by auxiliary manufacturer.
i. Drains - Tapped drain holes with metal pipe plugs shall be provided in each spraytight motor to drain condensate from the motor when the fan is installed vertically with fan impeller up or down, or horizontally.
j. Balancing - Motor rotor shall be statically and dynamically balanced.
k. Revolutions per minute (rpm) - 3600 (synchronous) constant speed.
l. Type - Squirrel cage induction. With not less than 80 percent power factor full load.
m. Efficiency - All motors shall be of the high efficiency type.

3.13.1.2 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.

3.13.1.3 Motor thermostats. A thermostatic protective device shall be installed in each of the motor phases wired such that any of them, when wired in connection with the motor starter control circuit, will cause motor shutdown if damaging heat buildup is encountered.

3.13.1.4 Bearings. Motors shall be equipped with sealed grease-filled bearings. Bearings shall be in accordance with ANSI/ABMA precision classification of ABEC-5 in accordance with ANSI/ABMA STDs 4, 9, 13, 20, and ANSI/ABMA/ISO 3290. Means shall be provided to ensure that grease is always available to the bearing and to prevent the leakage of oil or grease along the shaft. Special bearings for quiet operations when specified (see 6.2) shall be in accordance with ANSI/AFBMA 4, 9, 13, 20, ANSI/ABMA/ISO 3290, and MIL-B-17931.

3.13.1.5 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.

3.14 Fan performance.

3.14.1 Volume and pressure. The design volume-pressure point for each size fan shall be as specified in Table I. The total pressure in inches of water shall rise continually from free delivery to a value at least as high as the total pressure at the stated volume as shown in Table I and throughout this range of stable performance the volume in ft^3/min shall be within 5 percent of the volume on the applicable curve of Figure 1.

3.14.2 Aerodynamic stall. Effective stall shall not occur at capacities greater than 85 percent of the fan design or rated volume (ft^3/min) (see 4.5.2).

3.14.3 Compressor surge. The fan assemblies shall withstand a gas turbine surge condition defined below:

a. Cooling Air Fan for Propulsion Gas Turbines - Single pressure pulse of approximately square wave form with a pulse magnitude of 3 lb/in^2 positive pressure and a duration of 20 milliseconds.
b. Cooling Air Fan for Ship's Service Gas Turbine Generator (SSGTG) Sets - The requirements of 3.14.3a above shall apply.

3.14.4 Surge stress. Surge stress, when combined with normal operating stress, shall not exceed 80 percent of the material static yield stress. Testing is not required.

3.14.5 Differential pressure. The fan assembly, when installed in the ship's ducting system, shall withstand a maximum differential pressure of 20 inches H_2O between the outside and the inside of the fan. The lower pressure shall be inside the fan.

3.14.6 Self-generated vibration. All parts of the fan equipment shall be free of self-induced vibration in accordance with the type II requirements of MIL-STD-167-1 for both steady-state and transient conditions. Dynamic balancing and tolerance control shall be employed over the complete operational range to ensure smooth operation of all rotating parts.

3.15 Environmental conditions.

3.15.1 High impact shock resistance. Unless otherwise specified (see 6.2), the fan-motor units shall meet the shock requirements of MIL-S-901 for Grade A, class 1 equipment.

3.15.2 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.

3.15.3 Airborne noise. The total sound power levels for the fan-motor unit shall not exceed the levels stated in Tables II and III when measured in accordance with procedures stated in 4.5.3. Exceeding the total sound power levels specified in Table III shall be cause for rejection.

3.15.4 Atmospheric spray. Able to operate satisfactorily when exposed to soaking atmospheric spray (rain or sea) or seawater.

3.15.5 Ambient temperature. Perform in accordance with requirements herein in a range of ambient temperatures between minus 29 and 65 °C.

TABLE II. Airborne noise acceptance levels.

Fan Model	Freq. Hz	Sound power level in decibels (dB) with reference to 10^{-12}watt								
		31 1/	63	125	250	500	1K	2K	4k	8K
12½ hp		99	95	94	90	93	104	102	98	91
25 hp		104	100	99	95	98	109	107	103	96
80 hp		110	106	105	101	104	115	113	109	102
130 hp		112	108	107	103	106	117	115	111	104

Note:
1/ Data at 31 Hz reported for information only.

TABLE III. Casing transmission noise acceptance levels.

Fan Model	Freq. Hz	Sound power level in decibels (dB) with reference to 10^{-12}watt								
		31 1/	63	125	250	500	1K	2K	4k	8K
12½ hp		62	65	72	64	63	82	72	71	61
25 hp		67	70	77	69	68	87	77	76	66
80 hp		73	76	83	75	74	93	83	82	72
130 hp		75	78	85	77	76	95	85	74	74

Note:
1/ Data at 31 Hz reported for information only.

4. VERIFICATION

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

a. First article inspection (see 4.2).
b. Conformance inspection (see 4.3).

4.2 First article inspection. First article inspection shall be performed on type TA vaneaxial fans when a first article sample is required (see 3.1). This inspection shall include the examination of Table II.

4.3 Conformance inspection. Conformance inspection shall consist of the examinations of 4.6 and tests as specified in Table IV. The tests specified shall be performed on each size fan-motor unit. Any unit that fails to meet any specified requirements shall be rejected.

TABLE IV. Test agenda.

Applicability of test to fan type					
Tests	**Requirement**	**Verification**	**First article**	**Conformance**	**Periodic**
Performance	3.14	4.6.1	ALL	ALL	ALL
Aerodynamic Stall	3.14.2 & 3.14.3	4.6.2	ALL	ALL	ALL
Airborne noise	3.15.3	4.6.3	ALL	—	ALL
Noise measurement by ear	3.15.3	4.6.3.5	—	ALL	
Balance	3.15.2	4.6.4	ALL	ALL	
Vibration	3.15.2	4.6.5			
Casing tightness	3.12.1	4.6.6	ALL	—	
Speed	3.13.1.2	4.6.7	—	—	
Shock	3.15.1	4.6.8	ALL[1/]	—	
Motor temperature	3.13.1.1	4.6.9	ALL	ALL	ALL
Bearing temperature	3.13.1.5	4.6.10	ALL	—	
Blade tip clearance measurement	3.11.1	4.6.11	ALL	ALL	
Nonmagnetic	3.2.3	4.7	ALL[2/]	-	ALL
Maintainability	3.9	4.8	3/	-	3/

Notes:
1/ Unless otherwise specified in 6.2.
2/ Only if required by 6.2.
3/ First production sample.

4.4 Periodic conformance inspection. 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 an identical unit. Periodic tests shall consist of the tests specified in Table IV.

4.5 Material and dimensional examination.

4.5.1 Cast impeller casing. If a cast impeller is used, repairs are not permitted. Cast casing may be repaired by welding or impregnation if completed in accordance with the requirements of NAVSEA Technical Publication S9074-AR-GIB-010/278.

4.5.2 Fabricated casing. Casing shall be visually examined for defects. Cracks may be repaired by welding.

4.5.3 Dimensional examination. Dimensions, horsepower, and weight shall not exceed limits of Table I.

4.6 Tests. Tests shall be conducted in accordance with 4.6.1 through 4.6.12.

4.6.1 Performance. Performance tests shall be conducted in accordance with AMCA 210. Any of the test stands that utilize nozzles as a flow-measuring device may be used.

4.6.2 Aerodynamic stall. The effective stall capacity shall be determined from the largest capacity measurement of the following three stall measurement methods.

4.6.2.1 Throttled stall capacity. This method is capacity at which the fan goes into stall when slowly throttling the discharge with the fan operating.

4.6.2.2 Stall recovery capacity. This method is capacity at which the fan recovers from a stalled condition when the fan is operating in a stalled condition and the discharge throttle is slowly opened while moving towards free delivery.

4.6.2.3 Stable start-up capacity. This method is capacity at which stable, stall-free operation first occurs, as the fan is started from a no-spin condition with the throttling device fixed as progressively larger openings.

4.6.3 Airborne noise. Octave band sound power levels for a fan-motor unit shall consist of the measurement of sound pressure levels and the computation of sound power levels in accordance with procedures and instrumentation requirements defined in AMCA 300, and amendments to those procedures as identified herein. The fan-motor unit shall be operated at the design point during airborne noise testing, see 3.15.3. All sound measuring instrumentation shall be laboratory calibrated within one year of the date of test, excluding the reference sound source, which shall comply with the laboratory calibration requirements stated in AMCA 300. A random incidence response microphone and a type I (precision) sound level meter conforming to the requirements of AMCA 300 shall be used. The minimum distance between the extreme points of the microphone swing as described in AMCA 300 shall be 27 ft., and the speed of traverse of the microphone shall not exceed 2.4 ft./sec. Sound pressure readings shall be a time-weighted average over an integral number (one or more) of microphone swings. Sound pressure level readings shall be averaged over a minimum period of observation of 30 sec. The fan shall be mounted on resilient mounts, and flexible duct sections shall be installed between the fan flanges and any duct sections required for testing. Resilient mounts shall be loaded within the design load range for the type of mount selected. The frequencies of the natural modes of vibration of the fan mounted in the vertical direction shall not exceed 11 Hz or one quarter of the lowest forcing frequency of the mounted unit, whichever is lower. When a duct section is attached to a fan-motor unit to facilitate measurements, it shall have the same interior, open cross sectional dimensions as that of the fan-motor unit to which it is attached. 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.

4.6.3.1 Total sound power. Test procedures and calculation procedures to determine total sound power levels for a fan-motor unit shall be in accordance with Appendix H of AMCA 300, installation type B: free inlet/ducted outlet, and Figure 4 of AMCA 300. The fan-motor unit and attached discharge duct with orifice plate shall be placed entirely within the reverberant test room.

4.6.3.2 Casing sound power. Test procedures and calculation procedures to determine sound power levels radiated from the casing of a fan-motor unit shall be in accordance with Appendix G of AMCA 300. Duct sections attached to a fan-motor unit to facilitate testing to determine casing radiated sound power shall be rigid, heavy gauge metal ducts and/or solid, double wall ducts to eliminate noise contributions transmitted through duct walls. The noise transmission loss of the walls of the reverberant test room shall be such that noise transmitted into the reverberant test room from adjacent spaces does not contribute to the sound power levels of the fan-motor unit. Penetrations in the walls of the reverberant room in way of ducts shall be acoustically sealed to prevent noise contributions from being transmitted into the reverberant test room from the adjacent room.

4.6.3.3 Inlet sound power. Test procedures and calculation procedures to determine inlet sound power levels for a fan-motor unit shall be in accordance with Figure 2 of AMCA 300, installation type D: ducted inlet/ducted outlet. No orifice plate shall be installed in the inlet duct. The fan-motor unit and attached discharge duct with orifice plate shall be placed entirely within the chamber, and sound pressure level measurements shall be made within the reverberant test room. Acoustical treatments shall be placed within the chamber to provide an acoustic seal at the penetration in the wall separating the chamber from the reverberant room as necessary to ensure that no noise contributions are transmitted from the chamber into the reverberant test room.

4.6.3.4 Outlet sound power. Test procedures and calculation procedures to determine outlet sound power levels for a fan-motor unit shall be in accordance with Figure 3 of AMCA 300, installation type B: free inlet/ducted outlet. An orifice plate shall be installed within the discharge duct if necessary to obtain fan-motor unit operation at the design point. The fan-motor unit with attached discharge duct shall be placed within the chamber. A section of the discharge duct, approximately 2 to 3 duct diameters long and housing an orifice plate, shall extend into the reverberant test room, and sound pressure level measurements shall be made within the reverberant test room. Acoustical treatments shall be placed within the chamber as necessary to provide an acoustic seal at the penetration

in the wall separating the chamber from the reverberant room, and to ensure that no noise contributions are transmitted from the chamber into the reverberant test room.

4.6.3.5 Airborne noise detected by ear. Fan-motor units not undergoing airborne noise testing described in 4.6.3.1 through 4.6.3.4 shall be operated at their design points. 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 in accordance with 4.6.3, and sound power levels shall be computed to determine conformance with sound power level requirements specified in Tables II and III.

4.6.3.6 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.

4.6.4 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 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 limit specified in 3.150.2 cause for rejection.

4.6.5 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 4 Hz up to and including 33 Hz at the table amplitude specified herein. The vibration test shall be conducted as specified in 4.6.12. Any unit, which fails to meet any requirements, shall be rejected.

4.6.6 Casing tightness. When this test is required, the requirements as well as the test conditions shall be specified (see 6.2). If conditions are not specified, the test shall be conducted as follows: Blind flanges (one with air supply and gauge connections) shall be bolted to gasketed fan flanges. Air at a pressure of 50 percent higher than the maximum pressure capability of the fan shall be supplied to the casing interior. The pressure drop in 10 minutes shall not exceed 5 percent of the test pressure.

4.6.7 Speed. The fan-motor unit shall be operated at free delivery to determine whether the speed conforms approximately to design speed at rated voltage.

4.6.8 High-impact shock. The fan-motor unit shall be shock tested on the medium weight machines as specified for type A of MIL-S-901. The high-impact shock test shall be conducted after the tests specified in 4.6.1, 4.6.2, 4.6.3, 4.6.4, 4.6.5, 4.6.6, 4.6.7, 4.6.9, 4.6.10, and 4.6.11. After conducting the high-impact shock test, tests specified in 4.7.1 and 4.7.2 shall be again conducted without correction of damages, which may have occurred during shock test. Shock testing in accordance with these requirements shall demonstrate that the fan-motor unit performs its function with acceptable changes in performance and aerodynamic stall. Shock test acceptance shall be contingent upon the ability of the equipment after shock testing to satisfy performance within 5 percent of the volume indicated in Table I, and aerodynamic stall with capacities not to occur greater than 90 percent of the fan design or rated ft^3/min. Evidence of fragmentation or missile effect of part, 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 boltholes. Resilient mountings shall not be used unless specified (see 6.2). Fan-motor units that have passed this test may be used as production units after replacement of motor bearings.

4.6.8.1 Shock on medium weight machines. The test of a fan-motor unit shall consist of the nine blows indicated in Table V. The required fan orientation mountings for tests required in Table V 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 V. 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	Secured	No. 1
2	II		3	Operating	No. 1
3	III		1.5	Secured	No. 1
4	IV		3	Operating	No. 2A
5	V		3	Secured	No. 2A
6	VI		4.5	Operating	No. 2A
7	VII		3	Secured	No. 2B
8	VIII		3	Operating	No. 2B
9	IX		1.5	Secured	No. 2B

4.6.9 Motor temperature. Motor temperature rise 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. Full 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 fan manufacturer.

4.6.10 Bearing temperature. Bearing temperature shall be measured with a fan mounted in vertical with impeller on bottom. Full load shall be obtained by means of a terminal throttle on attached test duct. Bearing outer ring temperature shall not exceed requirements of 3.13.1.5.

4.6.11 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.

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

a. Balance (4.6.4).
b. Casing tightness (4.6.6).
c. Blade tip clearance measurement (4.6.11).
d. Performance (4.6.1), aerodynamic stall (4.6.2), speed (4.6.7), motor heat (4.6.9), and bearing temperature (4.6.10). These tests shall be conducted concurrently.
e. Airborne noise (4.6.3).
f. Vibration test (4.6.5). The correction of damages, which may have occurred during the vibration tests, shall not be performed prior to the test specified in 4.6.8.

g. High-impact shock (4.6.8). After conducting the high-impact shock test, tests specified in 4.6.1 and 4.6.2 shall again be conducted without correction of damages that may have occurred during shock test. Data for tests specified in 4.6.1 and 4.6.2, one before and one after the high-impact test, shall demonstrate that the fan-motor unit satisfies performance and aerodynamic stall as follows: performance to be within 5 percent of the volume indicated in Figure 1 for the design point shown in Table I.

h. Nonmagnetic (4.8).

4.7 Permeability tests. 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).

4.8 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 materiel 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 use in cooling the gas turbine enclosures of propulsion/generator systems onboard ships of the United States Navy. The direction of airflow into and out of the fans is axial. The fans are of nonsparking construction and are high efficiency units.

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Title, number, and date of this specification.
b. Fan size (see 1.2.1), current (see 1.2.2), voltage (see 1.2.3), enclosure (see 1.2.4), ambient temperature (see 1.2.5), quiet bearing (see 1.2.6), and nonmagnetic material (see 1.2.7).
c. When first article is required (see 3.1).
d. Whether nonmagnetic fan-motor units are required (see 3.2.3).
e. Bellmouth (see 3.12.7).
f. Motor bearings, quiet bearings (see 3.13.1.4).
g. Shock (see 3.15.1).
h. When casing pressure test is required (see Table IV), specify test conditions if other than standard (4.6.6).
i. Resilient mountings (see 4.6.8).
j. Packaging requirements (see 5.1).
k. Shock and vibration mitigation. In addition to packaging requirements specified in the contract, all levels of packing should employ a shock and vibration system that will ensure parts of the unit, such as bearings, are not damaged due to normal shock and vibration that occur during handling and shipment.

6.3 Subject term (key word) listing.

Blade
Casing
Duct
Impeller
Vane

6.4 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.

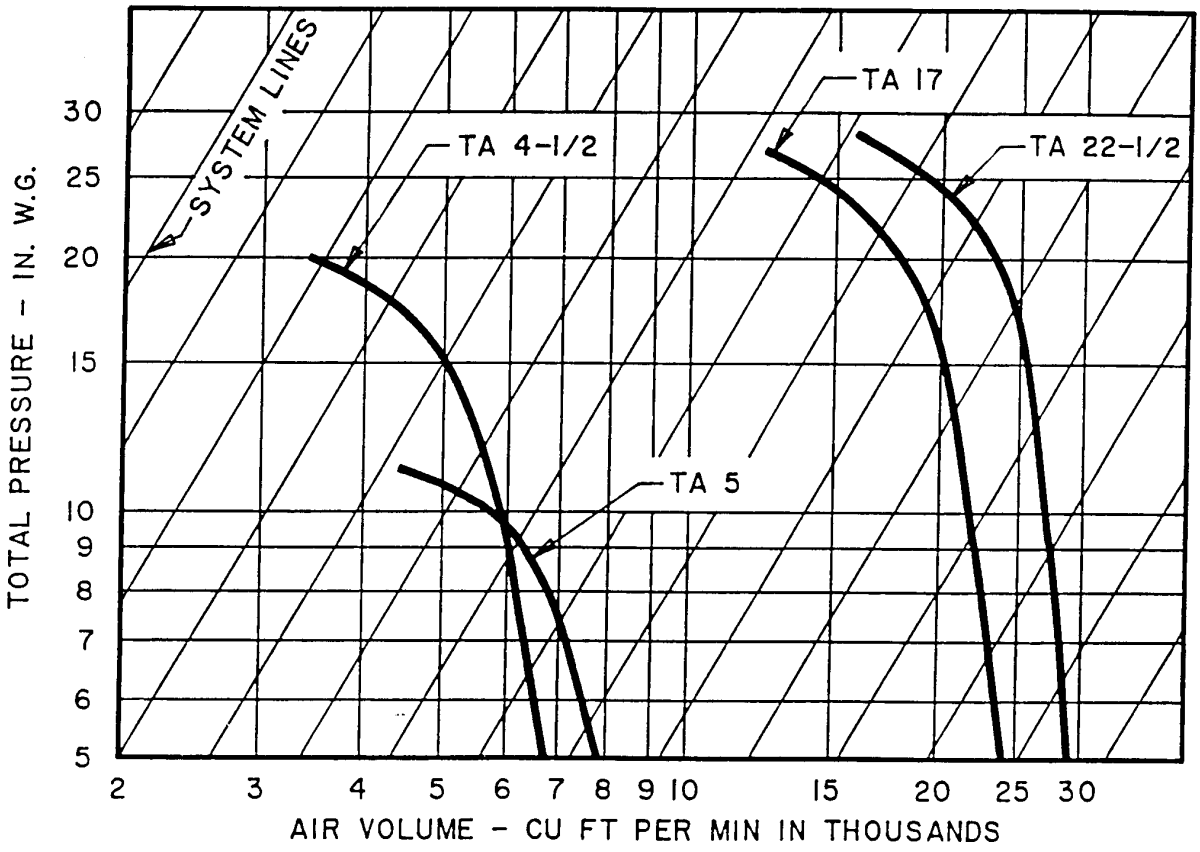

FIGURE 1. GTM enclosure cooling fan performance curves.

Preparing Activity:
Navy – SH
(Project 4140-N003-000)

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.