MIL-STD-740-1(SH)
30 December 1986
SUPERSEDING
MIL-STD-740B(SHIPS)(IN PART)
13 January 1965
(See 6.6)

MILITARY STANDARD

AIRBORNE SOUND MEASUREMENTS AND ACCEPTANCE CRITERIA OF SHIPBOARD EQUIPMENT

AMSC N4008 AREA HFAC

DEPARTMENT OF DEFENSE
NAVAL SEA SYSTEMS COMMAND

Washington, DC 20362-5101

Airborne Sound Measurements and Acceptance Criteria
of Shipboard Equipment

1. This Military Standard is approved for use by Naval Sea Systems Command Department of the Navy, and is available for use by all Departments and Agencies of the Department of Defense.

2. 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.

CONTENTS

CONTENTS - Continued

CONTENTS - Continued

FIGURES

TABLES

1. SCOPE, PURPOSE, APPLICATION, IMPLEMENTATION, AND APPROACH

1.1 Scope. This standard prescribes instrumentation and procedures required for the measurement and analysis of, and maximum acceptable sound level criteria for, airborne sound generated by shipboard equipment.

1.2 Purpose. Airborne sound measurements are conducted to demonstrate that equipment levels are within the limits specified herein.

1.3 Application. This standard supplements specifications and similar documents applicable to all shipboard equipment.

1.4 Implementation. Implementation guidance is provided in section 6.

1.5 Approach.

1.5.1 Measurement. Two basic types of measurement are required by this standard: Weighted sound pressure (average for all measurements and peak for selected measurement) levels; and octave band sound pressure levels.

1.5.2 Acceptance criteria. Airborne sound acceptance criteria are specified in 5.1.

1.5.3 Acceptability of equipment. Equipment is acceptable when none of the airborne levels measured at the designated locations exceed the applicable acceptance criteria.

2. REFERENCED DOCUMENTS

2.1 Government documents.

2.1.1 Specifications and standards. Unless otherwise specified, the following specifications and standards of the issue listed in that issue of the Department of Defense Index of Specifications and Standards (DoDISS) specified in the solicitation form a part of this standard to the extent specified herein.

SPECIFICATIONS

MILITARY

MIL-P-15024	- Plates, Tags and Bands for Identification of Equipment.
MIL-M-17185	- Mounts, Resilient; General Specifications and Tests for (Shipboard Application.)
MIL-M-17508	- Mounts Resilient: Types 6E2000, 6E900, 6E900BB, 7E450, 7E450BB, 6E150, and 6E100.
MIL-M-19379	- Mounts, Resilient, Mare Island Types 11M15, 11M25, and 10M50.
MIL-M-19863	- Mounts, Resilient: Type 5B5000H.
MIL-M-21649	- Mounts, Resilient, Type 5M10,000H.

STANDARD

MILITARY

MIL-STD-1621 - Acoustical and Vibrational Standard Reference Quantities.

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

2.2 Other publications. The following documents form a part of this standard to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted shall be those listed in the issue of the DoDISS specified in the solicitation. The issues of documents which have not been adopted shall be those in effect on the date of the cited DoDISS.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

S1.4 - Sound Level Meters, Specification for.
S1.6 - Preferred Frequencies and Band Numbers for Acoustical Measurements.
S1.10 - Calibration of Microphone, Method for the.
S1.11 - Octave, Half-Octave, and Third-Octave Band Filter Sets.

(Application for copies should be addressed to Publication Sales, Dept. STD, American Institute of Physics, 335 East 45th Street, New York, NY 10017.)

(Nongovernment standards are generally available for reference from libraries. They are also distributed among nongovernment standards bodies and using Federal agencies.)

2.3 Order of precedence. In the event of a conflict between the text of this standard and the references cited herein, the text of this standard shall take precedence.

3. DEFINITIONS

3.1 Symbols. Symbols used herein are as follows:

f_c = Band-center frequency (geometric) (see 3.2.13)
f_1 = Lower band-edge frequency (see 3.2.12)
f_2 = Upper band-edge frequency (see 3.2.12)
L_A = A-weighted sound (pressure) level (see 5.2.2.1)
L_C = C-weighted sound (pressure) level (see 5.2.2.2)
L_p = Sound pressure level
DIM = Distributed isolation material (see 3.2.21)

3.2 Terminology.

3.2.1 Sound. Sound is: (a) An oscillation in pressure, stress, particle displacement, particle velocity, etc., in a medium with internal forces (e.g., elastic, viscous) or the superposition of such propagated oscillations. (b) An

auditory sensation evoked by the oscillation described above. In the case of possible confusion the term "sound wave" or "elastic wave" may be used for concept (a), and the term "sound sensation" for concept (b). The medium in which the sound exists is often indicated by an appropriate adjective, e.g., airborne, waterborne, structureborne.

3.2.2 Frequency. The frequency of a function periodic in time is the reciprocal of the period. The unit of frequency is the hertz (Hz). One Hz is equal to one cycle per second.

3.2.3 Level. The level of a vibratory quantity is the logarithm of the ratio of that quantity to a reference quantity of the same kind. The base of the logarithm, the reference quantity, and the kind of level shall be indicated.

3.2.4 Sound pressure. Sound pressure is the root mean square (rms) value of the vibratory pressure.

3.2.5 Sound pressure level. Sound pressure level, in decibels (dB), is 20 times the logarithm to the base ten of the ratio of the measured sound pressure to the reference sound pressure. The reference sound pressure for airborne sound is 20 micropascals (μPa) = 20 micronewtons per square meter ($\mu N/m^2$) = 0.0002 microbar. $L_p = 20 \log_{10} (p\ \mu Pa/20\ \mu Pa)$.

3.2.6 Sound level. Sound level is the quantity in dB measured by a sound level meter satisfying the requirements of ANSI S1.4. Sound level is the frequency weighted sound pressure level obtained with the standardized dynamic characteristics "fast" or "slow" and weighting A, B, or C. The unit of any of the sound levels is the dB. The weighting employed shall be indicated, otherwise the A-weighting is understood.

3.2.7 A-weighted sound level. A-weighted sound level is the quantity measured using a sound level meter with weighting set on A and is a measure of human response to sound.

3.2.7.1 Equivalent A-weighted sound level. Equivalent A-weighted sound level is the level equivalent to the octave-band levels for the equipment being measured. It is not the weighted sum of the individual octave-band levels but an equivalent level based on experience with spectral shapes of actual shipboard equipment and shipboard spaces.

3.2.8 Peak A-weighted sound pressure level. Peak A-weighted sound pressure level is the A-weighted sound pressure level measured in accordance with 5.2.3.3; i.e., the peak A-weighted sound pressure level measured using a system with total rise time of 200 microseconds or less.

3.2.9 C-weighted sound level. C-weighted sound level is the quantity measured using a sound level meter with the weighting set on C.

3.2.10 Band. A band is a continuous spread of frequencies.

3.2.11 Band level. Band level is the level of the sound contained within a particular band.

3.2.12 Band-edge frequencies. The upper (f_2) and lower (f_1) band - edge frequencies are those frequencies, above and below the frequency of maximum response of a filter, at which the response to a sinusoidal signal is 3 dB below the maximum response.

3.2.13 Band-center frequency (f_c) (geometric). The mid-band frequency is the geometric mean between the band edge frequencies of a band. The geometric mean is the square root of the product of the band edge frequencies, $f_c = (f_1 \times f_2)^{1/2}$.

3.2.14 Bandwidth. The bandwidth of a filter is the difference between f_1 and f_2. This difference may be expressed in Hz, as a percentage of the mid-band frequency, or as the interval between the band-edge frequencies, in terms of octaves or parts thereof, such as one-third, one-fifteenth, etc.

3.2.15 Octave band. An octave band is a band of frequencies in which the ratio of the upper band-edge frequency to the lower band-edge frequency is equal to 2:1. The octave bands designated in this standard are those whose band-center frequencies are the preferred frequencies as specified in ANSI S1.6. The width of an octave band in Hz is approximately 71 percent of its mid-band frequency.

3.2.16 Octave band sound pressure level. The level obtained using the procedure and instruments as specified in 5.2.2.3.

3.2.17 Transient sounds. For this standard, transient sounds are defined as those sounds which occur during turn-on and turn-off of the equipment and infrequent sounds that are less than 15 seconds in duration. If sounds occur at intervals of 1/2 second or less, the sound is considered steady state sound.

3.2.18 Steady state sounds. For this standard, steady state sounds are any sounds which are not defined as transient sounds in 3.2.17.

3.2.19 Equipment. The term "equipment", when used in this standard, refers to any equipment as a system, subsystem, or part thereof which is being measured to determine compliance with the airborne sound acceptance criteria. Equipment is required to meet airborne sound acceptance criteria which have been established based on the spaces in which it is to be placed.

3.2.20 Equipment grades. Equipment grades are as specified in 3.2.20.1 through 3.2.20.6.

3.2.20.1 Grade A3. Grade A3 equipment is that which is to be installed in spaces where direct speech communication must be understood with minimal error and without repetition over a distance of 2 meters (6-1/2 feet) or less.

3.2.20.2 Grade A12. Grade A12 equipment is that which is to be installed in spaces where direct speech communication must be understood with minimal error and without repetition over a distance greater than 2 meters (6-1/2 feet).

3.2.20.3 Grade B. Grade B equipment is that which will be placed in spaces where comfort of personnel in their quarters is the principal consideration.

3.2.20.4 Grade C. Grade C equipment is that which will be placed in the sonar room, sickbay, library, or other spaces requiring low sound levels and which are not covered in other categories.

3.2.20.5 Grade D. Grade D equipment is that which will be placed in spaces where avoidance of hearing loss is the prime consideration and intelligible speech communication is not normally required.

3.2.20.6 Grade E. Grade E equipment is that which will be placed in high sound level areas where voice communication is accomplished with high vocal effort and where amplified speech and telephones are normally available.

3.2.21 Mounting.

3.2.21.1 Resiliently mounted equipment. Resiliently mounted equipment is equipment which is isolated from a support structure by Navy approved resilient mounts. Navy approved resilient mounts are mounts in accordance with MIL-M-17185, MIL-M-17508, MIL-M-19379, MIL-M-19863, or MIL-M-21649. For the purposes of this standard, DIM mounted equipment is considered to be solidly mounted equipment.

3.2.21.2 Solidly mounted equipment. Solidly mounted equipment is equipment which is attached directly to the supporting structure. For the purposes of this standard, DIM mounted equipment is considered to be solidly mounted equipment.

3.2.22 Contracting activity. Contracting activity, when used in this standard, is the Government or its authorized representative.

4. GENERAL REQUIREMENTS

4.1 Equipment sampling. If sampling is called for by the acquisition specifications or the contract or order (see 6.3), selection of equipment for test shall be on the basis of conformance to the drawing requirements for that equipment, and shall not consider advance measurements, observations, or opinions about the acoustical performance of the particular equipment sample.

4.2 Equipment evaluation plan. When specified in the contract or order, an equipment airborne sound measurement plan shall be prepared (see 6.4).

4.3 Testing. The Government shall have the option to witness all tests conducted to meet contractual requirements. When specified in the contract or order, notification of tests letters shall be prepared in accordance with the data ordering document (see 6.4).

4.4 Reporting standards.

4.4.1 Reference quantity identification. The applicable reference quantity shall be indicated on every table, figure, and graph, and at least once in the text. The reference quantity may be introduced by "re" which indicates that the level is "with reference to". For example, the 125 Hz octave band level re 20 μPa is 85 dB.

4.4.2 Measurement bands. The bandwidths of the measurement basis shall be reported together with the measured levels. Normal procedure for reporting measured levels shall include the bandwidth and the band center frequency with the level. For example: the one-third octave 100 Hz band level was 85 dB re 20 µPa, the 10 Hz bandwidth 100 Hz band level was 85 dB re 20 µPa, or the 6 percent bandwidth 100 Hz band level was 85 dB re 20 µPa.

4.4.3 Plotting format. Plotting formats shall be in accordance with MIL-STD-1621. That is, all plots of data in which a level in dB on a linear scale is plotted against frequency on a logarithmic scale shall be made on graphs in which a factor of ten in frequency is equal in length to 25 dB (preferred) or 50 dB. Where the bandwidth of analysis is one-third octave or larger, one factor of ten in frequency shall be 50 mm (preferred) or 2 inches in length. The ordinate and abscissa of all graphs shall be labeled so that levels and frequencies can be readily understood without need to refer elsewhere in the report.

5. DETAILED REQUIREMENTS

5.1 Airborne sound acceptance criteria. The octave band sound pressure levels of the equipment, measured at the locations of 5.3 shall not exceed the limits given in table I for the equipment grade specified (see 6.3). Where no equipment grade has been specified, grade A12 requirements shall apply. Finally, no equipment shall have a peak A-weighted sound pressure level in excess of 140 dB. Equipment which fails to meet the acceptance criteria shall not be installed in the ship until the following have been accomplished:

(a) When specified in the contract or order, a sound test failure notification and recommendations report shall be prepared for each deficient equipment item measured (see 6.4).
(b) The Government or the contracting activity has accepted the deficient equipment or directed the specific course of action.

The final decision, with respect to acceptance, will be made by the Government.

TABLE I. Acceptable octave band sound pressure levels in dB re 20 µPa.

Equipment grade	Octave band center frequency in Hz								
	31.5	63	125	250	500	1000	2000	4000	8000
A3	75	72	69	66	63	60	57	54	51
A12	66	63	60	57	54	51	48	45	42
B	75	72	69	66	63	60	57	54	51
C	72	69	66	63	60	57	54	51	48
D	91	88	85	82	79	76	73	70	67
E	82	79	76	73	70	67	64	61	58

5.2 Measurements. The measurements required by this standard are made using a microphone connected to a sound level meter. No obstruction, including the instrument operator, shall be between the equipment being measured and the microphone.

5.2.1 Microphone mounting and orientation. It is desirable but not required that the microphone for these measurements be mounted on a rigid frame or stand, and that it be connected to the sound level meter by a cable at least 2 meters (6-1/2 feet) in length. If the microphone has the random incidence calibration specified in ANSI S1.4, the microphone shall be clamped so that the principal sound arrives at the diaphragm at near grazing incidence. The instructions for the sound level meter which is being used shall be reviewed to assure that the microphone is properly oriented if other than random incidence calibration has been performed. If it is necessary to have the microphone attached directly to the sound level meter which is held in the hand of an observer, the microphone orientation shall still be the same as that appropriate to the microphone on a cable.

5.2.2 Required measurements. Unless otherwise specified (see 6.3), the following measurements shall be made:

5.2.2.1 A-weighted sound pressure level measurements. A-weighted sound pressure level (L_A) measurements shall be obtained for all equipment in accordance with 5.2.3.1 and shall be made at the locations specified in 5.3. These measurements will be used to determine the locations at which the octave band and peak A-weighted sound pressure measurements will be made.

5.2.2.2 C-weighted sound pressure level measurements. C-weighted sound pressure level (L_C) measurements shall be obtained for all equipment in accordance with 5.2.3.1 and shall be made at the locations specified in 5.3. These measurements will be used to determine the location at which the octave band sound pressure measurements will be made.

5.2.2.3 Octave band sound pressure level measurements. Octave band sound pressure level measurements shall be made for all equipment in accordance with 5.2.3.2 at the location of the highest L_A level and the location of the highest L_C level as measured for 5.2.2.1 and 5.2.2.2. Octave band measurements shall also be made, where applicable, at the location of the operator's head. In addition, octave band measurements shall be made at all other locations where the level exceeds the equivalent A-weighted level of table II. Equivalent A-weighted sound level is not a criterion but rather a screening tool used to identify where additional octave band sound pressure level measurements must be taken.

TABLE II. Equivalent A-weighted sound levels in dB.

Grade	Sound level
A3	63
A12	54
B	63
C	60
D	79
E	70

5.2.2.4 Peak A-weighted sound pressure levels. Peak A-weighted sound pressure levels shall be monitored for equipment generating transient sounds using the procedure specified in 5.2.3.3 at the location selected from 5.2.2.1 and where applicable at the location of the operator's head.

5.2.2.5 Windscreen performance. When a windscreen is used in accordance with 5.3, and when specified in the contract or order, data shall be prepared (see 6.4) which demonstrates that the windscreen does not change the frequency response characteristics of the microphone by more than 1 dB in any octave bands specified for measurement (see 5.2.3.2). A correction factor which accounts for the change in frequency response may be applied to the measured levels.

5.2.3 Measurement procedures. Unless otherwise specified (see 6.3), measurement procedures shall be as specified herein.

5.2.3.1 A- and C-weighted sound pressure level measurement procedures. Using a sound level meter meeting the requirements of ANSI S1.4, type 2 instrument; set it either on A-weighting or C-weighting as appropriate and slow meter response, and then record the maximum of the meter indication at each location as L_A and L_C.

5.2.3.2 Octave band sound pressure level measurement procedure. Unless otherwise specified (see 6.3), unweighted octave band sound pressure level measurements shall be made for at least the bands with band-centers from 31.5 to 8000 Hz, using an instrument set for slow meter response and with filters at least as good as those specified in ANSI S1.11 for class II filters. The input to the octave band instrument will normally be the output of the sound level meter which was used for the L_A and L_C measurements. If any other input is used, the quality and frequency range of the microphone and associated circuitry shall be that required for a type 2 sound level meter in ANSI S1.4. These measurements will be compared to the acceptance criteria.

5.2.3.3 Peak A-weighted sound pressure level measurement procedure. The peak A-weighted sound pressure level measurements shall be made using either a peak reading sound level meter or a combination of instruments with equivalent characteristics, such as a sound level meter and an impact meter, or a sound level meter and a calibrated oscilloscope. The measurements shall be made with a sound level meter, or equivalent, meeting the requirements of ANSI S1.4 for a type 2 meter with addition of a measuring circuit that will make a peak sound pressure level measurement where the total rise time of the instrumentation does not exceed 200 microseconds. The rise time of the peak detector shall be such that a single pulse of 200 microseconds duration produces a meter indication within a 2 dB of the indication produced by a pulse having a duration of 10 microseconds and equal peak amplitude. The amplitude of the 10 microsecond reference pulse shall be such as to produce a meter deflection 1 dB below full-scale.

5.3 Measurement locations. Unless otherwise specified (see 6.3), both A-weighted sound pressure level and C-weighted sound pressure level shall be measured at each of the locations described herein. The number of locations depends upon the size and type of the equipment, as indicated on figures 1 through 4. These figures depict typical equipment configurations; the configuration details are provided for visual reference only. Sound levels are

also to be measured at the typical position of an operators head if the equipment has an operator position associated with it. Microphones shall be placed at locations approximately 1 meter (3-1/4 feet) from the rectangular envelope which just encloses the equipment, except for the typical position of the operator's head (see 6.3). Also, if the equipment has air openings at any of the designated locations, the microphones may be relocated from the designated location to minimize air flow over the microphone. For such cases, the separation between the measurement location and the designated location shall be minimized and shall be not greater than 1/3 meter (1 foot). In addition, a windscreen shall be used on the affected microphone (see 5.2.2.5) to further minimize airflow effects. All distance measurements shall be within plus or minus 10 percent.

5.3.1 Small equipment. For equipment whose maximum dimension is less than 2 meters (6-1/2 feet), the sound levels (L_A and L_C) shall be measured at a minimum of 5 locations as shown on figure 1, in accordance with the following procedure, except for valves where only three locations are required at two opposite sides and at the valve operating mechanism (see figure 4). The microphone shall be placed 1 meter (3-1/4 feet) from the rectangular envelope of the equipment as follows: (a) on each of the four sides on the vertical centerlines at a distance 1 meter above the base of the mounted equipment, or if the one meter location is above the top of the equipment, measure at the height of the horizontal centerline of the equipment, and (b) above the equipment, over the center of the horizontal plane of the envelope.

5.3.2 Medium size equipment. For equipment whose maximum dimensions are between 2 and 4 meters (6-1/2 and 13 feet) the sound levels (L_A and L_C) shall be measured at locations shown on figure 2, in accordance with the following procedure. The microphone shall be placed 1 meter (3-1/4 feet) from the equipment envelope as follows: (a) on each of the four sides on the vertical centerlines at a distance 1 meter above the base of the mounted equipment, and at successive intervals of not more than 1 meter distance along each side of the equipment envelope and (b), above the equipment, over the center of the horizontal plane of the envelope and at successive intervals not greater than 1 meter apart in the horizontal plane. For equipment comprised of any sides whose dimension is less than 2 meters, the measurement positions shall be in accordance with 5.3.1.

5.3.3 Large equipment. For equipment whose maximum dimensions are greater than 4 meters (13 feet) sound levels (L_A and L_C) shall be measured at locations shown on figure 3, in accordance with the following procedure: The microphone shall be placed 1 meter (3-1/4 feet) from the equipment envelope as follows: (a) on each of the four sides on the vertical centerlines at a distance 1 meter above the base of the mounted equipment, and at successive intervals of not more than 2 meters (6-1/2 feet) distance along each side of the equipment envelope, and (b) above the equipment, over the center of the horizontal plane of the envelope and at successive intervals of not more than 2 meters in the horizontal plane. For any side whose dimension is less than 4 meters (13 feet), the measurement position shall be in accordance with 5.3.1 or 5.3.2.

5.4 External influences. Measured levels of equipment sound shall not be adjusted to compensate for the effects of ambient magnetic, electrical, and acoustical fields. Ambient effects shall be at least 10 dB below the levels specified for the equipment. No reflecting surface shall be nearer than 1 meter (3-1/4 feet) to the microphone for any measurement, except measurements where

the operator's normal head position is closer than 1 meter to the equipment. Corrective measures shall be taken to reduce the effects of external sources on the equipment's measured sound level. In cases where pipes are connected to the equipment, within 1 meter of the equipment, a flexible connection shall be inserted in each pipe run between the equipment and any external piping. Acoustical filters, damped piping, or similar devices shall be employed to reduce fluidborne pressure pulsation effects from external sources. The equipment shall be located away from other machinery items. If this is not possible, machinery which is not necessary for the test shall be shut down.

5.5 Mounting of equipment. Unless otherwise specified (see 6.3), mounting methods shall be as specified herein.

5.5.1 Mounting methods. Equipment shall be oriented in its normal shipboard installation position. Equipment shall be resiliently mounted as described below regardless of how the equipment is to be mounted in service. Resilient mounts and subbases or bedplates shall normally be the same ones used for shipboard installation. The subbase used for the equipment evaluation shall not exceed the weight of the shipboard subbase (see 6.3). For the purposes of this standard, the terms subbase and bedplate refer to support structure which is required for shipboard installations and which is necessary for purposes such as to hold one or more components within alignment or to provide a means for attachment to the ship. Resilient mounts used in such a case shall be loaded in accordance with the load range specified in the mount specification. The frequencies of the natural modes of vibration of the mounted equipment in the vertical direction shall not exceed 11 Hz or one-fourth of the lowest forcing frequency, whichever is lower. Resilient mounts conforming to MIL-M-17508, MIL-M-19379, MIL-M-19863, or MIL-M-21649 shall be used where possible. If these mounts cannot be used, commercial mounts for which data can be provided to show they meet the frequency requirements and which are otherwise suitable are acceptable if approved by the contracting activity. When the above mounting methods cannot be met, equipment mounting shall be as approved by the contracting activity. When used in Navy shipboard application, resilient mounts shall be in accordance with MIL-M-17185. The complete assembly shall be supported on a rigid and massive floor, preferably of reinforced concrete or case metal to prevent interaction between the equipment and floor.

5.5.1.1 Foundations. Any foundation pedestals, cradles, etc., required to accommodate resilient mounts shall assure that the installed mounts provide the vibration isolation of the assembly from the foundation for which the resilient mount is designed. Foundations shall have a natural frequency of not less than 25 Hz and shall not have fixed base natural frequencies within plus or minus 0.4 (square root of 2, minus 1) times the fundamental rotational or other primary forcing frequency of the machinery or equipment. In addition, they shall not have natural frequencies within 0.4 times other machinery or equipment exciting frequencies between 0 and 500 Hz. Exciting frequencies shall include but not be limited to rotational, two times rotational, electrical frequencies and harmonics thereof, pump vane frequencies, pressure pulsations, ball bearing frequencies, etc. For the purposes of this standard, the term foundation refers to support structure which is used below the resilient mounts and which may or may not resemble the shipboard structure.

5.5.2 Mounting fixture. Some equipment may be measured while solidly mounted on a resiliently mounted test fixture. This equipment will normally consist of units which have a relatively light framework or structure (for example, controllers, control cubicles, nonrotating or nonreciprocating equipment) and which is to be solidly mounted on shipboard. For the purposes of this standard, the term mounting fixture refers to structure which is used solely for the purpose of resiliently mounting equipment for noise testing, is not used for shipboard installations, and is used above the resilient mounts. The contracting activity will specify whether a mounting fixture is required (see 6.3). Those items requiring attachment to a mounting fixture shall be attached at the normal points of attachment of the equipment. The fixture shall be stiff between points of attachment and shall not have a natural frequency within plus or minus 0.4 times the fundamental rotational frequency or other primary forcing frequency of the machinery or equipment. In addition, they shall not have natural frequencies within 0.4 times other machinery or equipment exciting frequencies between 0 and 500 Hz. If the equipment being measured contains internal sound isolation mounts, the mass of the fixture shall be great enough to permit these internal mounts to function properly. The mass of the fixture shall not exceed 30 percent of the total mass of the equipment. For equipment whose mass exceeds 900 kilograms (kg) (2,000 pounds), the mounting fixture of figure 5 is recommended. It is preferred that equipment items be bolted directly to the fixture, however, the optional mounting pads and clamps shown on figure 5 may be used to attach the items. If in specific cases, the mounting fixture of figure 5 cannot be used, the alternative mounting fixture shall be approved by the contracting activity. The combined assembly of equipment item and mounting fixture shall be resiliently mounted and oriented so that the item is in its normal shipboard installation position.

5.6 Calibration of instrumentation. Instrumentation used shall have been calibrated and have been found to meet the requirements specified herein.

5.6.1 Laboratory calibration. A laboratory calibration shall be made of all sound measuring instrument components within 12 months prior to each use, or after exposure to mechanical shock or other unusual disturbing conditions, or upon request by the Government inspector. Calibration instrumentation, including the sound level calibrator used for field calibration (see 5.6.3), shall have a calibration within 6 months prior to each use traceable to the National Bureau of Standards. The laboratory calibration of components shall be accurate within the instrument manufacturer's specification or plus or minus 1 dB, whichever is more stringent.

5.6.1.1 Microphone calibration. Calibration of microphones shall be performed by one of the methods specified in ANSI S1.10. When secondary microphones are used, they shall be kept under controlled conditions in the equipment manufacturer's laboratory and used only for calibrating the microphones used for equipment measurements.

5.6.2 Electrical calibration for airborne sound measuring system. A calibration of each complete airborne sound measuring system including microphone or simulated microphone, preamplifier, amplifiers, meter, analyzer, level recorder or plotter, magnetic tape recorder, as applicable and so forth, shall be made by introducing known voltage and frequencies in series with the transducers. Cables and connectors shall have the same electrical characteristics (impedance, frequency response, capacitance, etc.) as those used during equipment measurement.

Whenever any component of the measuring system is changed, a laboratory calibration shall be performed for the new component, and an electrical calibration shall be made with the new component in the system. System calibration shall be made accurate within plus or minus 1 dB.

5.6.2.1 Frequency response. Known voltages at known frequencies shall be introduced into the system such as to simulate the microphone output, and the level shall be recorded. The frequencies selected shall be:

(a) For analyzer with fixed filter sets, the band-center frequency of each filter in the specified frequency range.
(b) For analyzers with tunable filter sets used to scan continuously a band of frequencies; at the lower limit, upper limit, and at least two intermediate frequencies (including 500 Hz if within the scanning range) in each frequency range scanned.

5.6.2.2 Linearity calibration. At a low frequency, at 500 Hz, and at a high frequency, calibration shall be made at the following voltages:

(a) Equal to the microphone output that represents the lowest acceptance level for the applicable equipment specifications.
(b) Equal to the microphone output that represents the highest acceptance level for the applicable equipment specifications.

5.6.3 Field calibration. Total system calibrations using a sound level calibrator or equivalent shall be performed for each instrument configuration used in making the required measurements. These calibrations shall consist, as a minimum, of a single frequency at a known sound pressure level being introduced into the microphone from a sound source and adjustment of the system so that the system readout, i.e., the meter or recorder, is indicating the proper sound pressure level. A-weighting will make the proper sound level different from the calibrator sound level. Also, when calibrating the peak measuring circuit, the indicated sound level shall be 3 dB higher than the rms level coming from the sound source. Field calibration of the total system shall be performed for each instrument configuration prior to its use in making a particular type of measurement, i.e., calibrate prior to L_A and L_C measurements, prior to octave band measurements, and prior to peak A-weighted sound pressure level measurements. Also, each instrument configuration shall be field calibrated prior to its use each day. Also, whenever any component of the measuring system is changed, a field calibration shall be made with the new component in the system. If the usual instrument settings and small adjustments do not produce the proper sound level indication during calibration, this normally indicates a problem which must be corrected prior to use of the instrument system. Field calibration shall be accurate within plus or minus 2 dB.

5.7 Equipment operation conditions during measurements. Equipment operating conditions shall be as specified herein and in the contract or order (see 6.3).

5.7.1 Normal conditions. Equipment shall be operated under normal energized operating conditions including sufficient warmup time to reach normal operating temperature. Multiple speed equipment shall be measured at each operating speed. Variable speed equipment shall be operated at maximum, 1/2, and minimum speed (5 percent of maximum if equipment can be operated down to

zero speed). Where equipment has pumps or fans as components, these components shall be operating during measurements. Where equipment operates as a result of a signal, a representative signal shall be used to energize the equipment during measurements. Background measurements shall be made with the equipment not operating for each microphone and location under the normal environmental conditions that will be present when the equipment noise measurements are obtained.

5.7.2 Special operating conditions. If operating conditions other than those specified in 5.7.1 are required (see 6.3), such as during change of operating mode, including starting and stopping of the equipment, these special requirements shall be specified in the equipment specifications.

5.8 Selection of units. Unless otherwise specified (see 6.3), measurements to determine compliance with airborne acceptance criteria shall be made on every unit with the following exception: for nonrotating, nonreciprocating, if the first three units of a design are below the criteria by 10 dB or more at all frequencies, following units shall be selected for test in accordance with the sampling procedures for the applicable selective testing as specified in the equipment specifications.

5.9 Reports. When specified in the contract or order, a test report for each equipment measured shall be prepared (see 6.4).

5.10 Warning plate. The equipment which meets the criteria of this standard shall be prominently identified by affixing a warning plate bearing the legend, "Quiet Design Equipment - Handle with Extreme Care." The plate shall be either type A or B of MIL-P-15024. Unless otherwise specified (see 6.3), the requirement applies only to rotating and reciprocating equipment.

5.11 Drawing and manual information. In addition to the information required on drawings by the applicable equipment specification, the assembly drawings shall contain specific notes as to assembly procedures and tolerances to be maintained during overhaul so that machines may be restored to designed level of quietness. Maintenance information pertinent to quietness, including assembly techniques and procedures, shall be included in technical manuals required by the acquisition documents. The title block of assembly drawings of all electrical power equipment shall include the words, "Special Quiet Design (controller or transformer, etc.) MIL-STD-740-1." Existing drawings are not required to be revised unless the drawings are required to be changed for other reasons.

6. NOTES

6.1 Intended use. This standard is intended for use for equipment acquisition testing.

6.1.1 This standard also prescribes certain warning plate requirements and drawing and manual information requirements for shipboard equipment (see 5.10 and 5.11).

6.2 Technical proposals. When this standard is invoked in acquisitions which require technical proposals for evaluation, the following data should be included in these proposals:

(a) A list of recommended specification changes which will improve the quietness of equipment and assure meeting the acceptance criteria. An estimate of the amount of improvement in quietness and the change, if any, in other characteristics should accompany each proposed change to the equipment specification.
(b) Outline of the facilities proposed for installation to comply with the requirements of the equipment specifications.
(c) A list of features to be incorporated in the equipment design for reduction of airborne sound levels.
(d) A list of actions that will be taken to assure achievement of specified sound levels.

6.3 Implementation guidance. When this standard is invoked, the following should be specified:

(a) Acceptance criteria. The airborne sound acceptance criteria of table I are provided for guidance and use only when other criteria are not specified. Either invoke the criteria of table I or specify a separate criteria. When a large number of sources of small size are to be located within 2 meters (6-1/2 feet) of one another, lower criteria will apply and should be based on the following correction factors. These correction factors are cumulative.

Number of sources	Correction to be subtracted from the values shown in table I
2 to 8	3 dB
9 to 14	5 dB
15 to 22	7 dB
23 and up	9 dB

Compactness of sources. When the sources are within 2 meters of one another, i.e., electronic equipment in racks, subtract 3 dB.

Acceptance criteria will be based on the design of the machinery and consideration of intended service, overall ship operational requirements, and prior experience with similar acceptable machinery.

(b) Sampling procedures for equipment to be specified when sampling is desired (see 4.1).
(c) If an equipment plan is required (see 4.2).
(d) Whether the Government is to be notified of testing, and if so, which organization is to be notified and how long the advance notice time is to be (see 4.3).
(e) The grade assigned to the equipment (see 5.1).
(f) Whether the Government is to be notified of failure, and if so, which organization is to be notified (see 5.1(a)).
(g) Measurement locations to be specified if measurement locations are not to be in accordance with 5.2.2 and 5.3.

(h) Measurement procedures and instrumentation to be specified if they are not to be in accordance with 5.2.3.
(i) The frequency range for octave band measurements to be specified if other than 31.5 through 8000 Hz bands are desired (see 5.2.3.2).
(j) Whether there is an operator position for the equipment and, if so, give the specific location of the operators head (see 5.3).
(k) Mounting methods to be specified if the mounting is not to be in accordance with 5.5.
(l) The weight of the shipboard bedplate (see 5.5.1).
(m) Whether a mounting fixture is required (see 5.5.2).
(n) Special equipment operating conditions during airborne sound measurements (see 5.7 and 5.7.2) to be specified if operating conditions other than the normal full load conditions are desired.
(o) Whether an alternate selection of units plan is to be used and, if so, what the plan is to be (see 5.8).
(p) If a test report is required (see 5.9).
(q) Whether a warning plate is required for equipment which is nonrotating or nonreciprocating (see 5.10).
(r) Technical proposal, if required (see 6.2).

6.4 Data requirements. When this standard is used in an acquisition which incorporates a DD Form 1423, Contract Data Requirements List (CDRL), the data requirements identified below shall be developed as specified by an approved Data Item Description (DD Form 1664) and delivered in accordance with the approved CDRL incorporated into the contract. When the provisions of DoD FAR Supplement, Part 27, Sub-Part 27.410-6 (DD Form 1423) are invoked and the DD Form 1423 is not used, the data specified below shall be delivered by the contractor in accordance with the contract or purchase order requirements. Deliverable data required by this standard is cited in the following paragraphs.

Paragraph no.	Data requirement title	Applicable DID no.	Option
4.2	Equipment airborne sound measurement plan	DI-HFAC-80270	----
4.3	Notification of tests	DI-T-23731	----
5.1	Sound test failure notification and recommendations report	DI-HFAC-80271	----
5.2.2.5, 5.9	Equipment airborne sound measurements test report	DI-HFAC-80272	----

(Data item descriptions related to this standard, and identified in section 6 will be approved and listed as such in DoD 5010.12-L., AMSDL. Copies of data item descriptions required by the contractors in connection with specific acquisition functions should be obtained from the Naval Publications and Forms Center or as directed by the contracting officer.)

6.5 Subject term (key word) listing.

A - weighted sound pressure level
C - weighted sound pressure level
Octave band pressure level
Weighted sound pressure level
Airborne sound measurements
Airborne sound, equipment

6.6 Supersession data. This standard covers airborne sound measurements and acceptance criteria of shipboard equipment formerly covered by MIL-STD-740B(SHIPS).

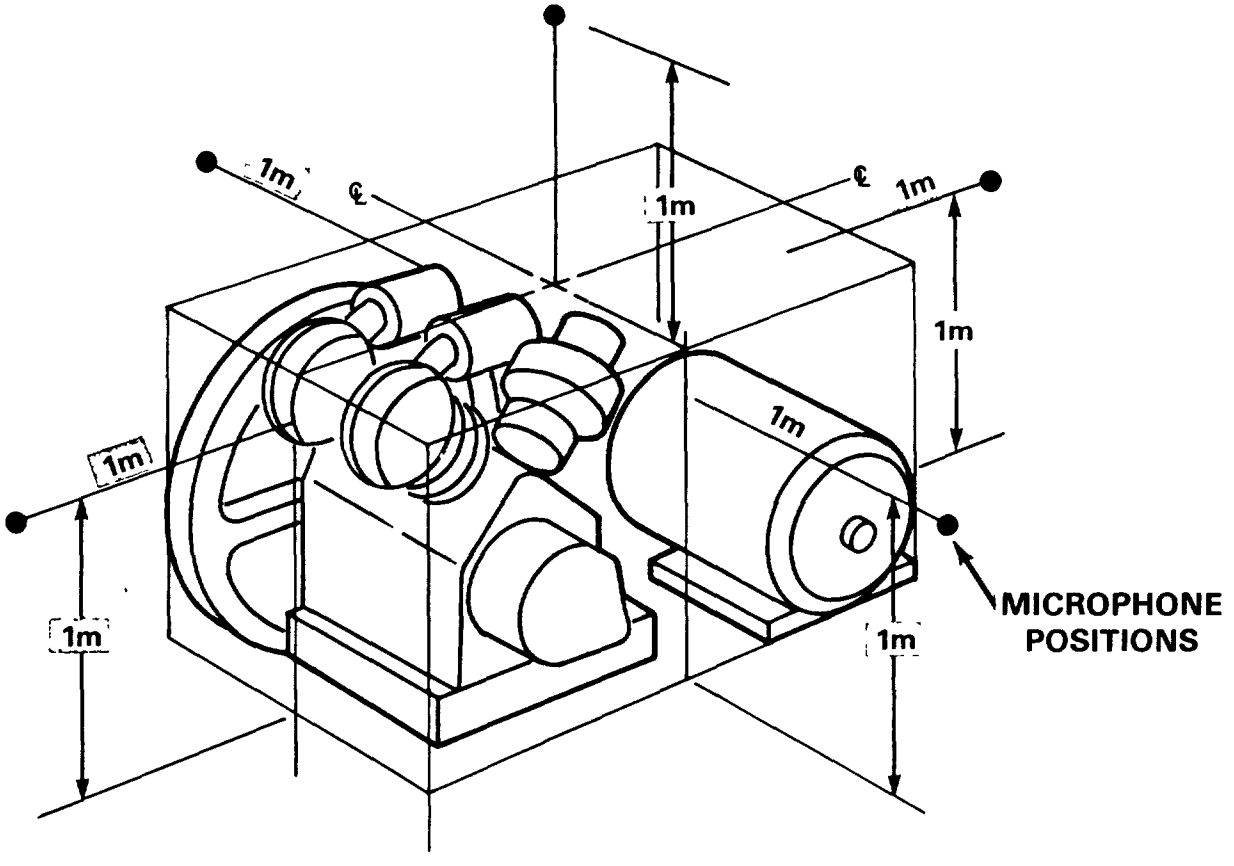
6.7 Grade equivalency. There is no direct comparison between these criteria and those of MIL-STD-740B as these are expressed in terms of sound pressure level (re 20 μPa), while in 740B sound power level (re 10^{-12} watts) was used. Since the time of MIL-STD-740B, noise grade A was divided into A_3 and A_{12} and the criteria for noise grade D was lowered by approximately 6 dB. The changes were made to reflect OPNAVINST 9640.1 regarding permissible ship compartment levels. In addition, spectra shape was changed to more closely follow typical shipboard spectra causing the acceptance levels of low frequencies to be more stringent in the new version compared to 740B. Very approximate relationships are given below based on the following assumptions: (a) omni-directional source, (b) equipment size approximately 1 meter cube, and (c) room constant = $186M^2$ to infinity.

Category A_3, 2 dB greater than 740B for category A
Category A_{12}, 3 dB less than 740B, category A
Category B, 2 dB less than 740B, category B
Category C, 3 dB noisier than 740B, category C
Category D, 4 dB quieter than 740B, category D

6.8 Changes from previous issue. Asterisks 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 HFAC-N003)

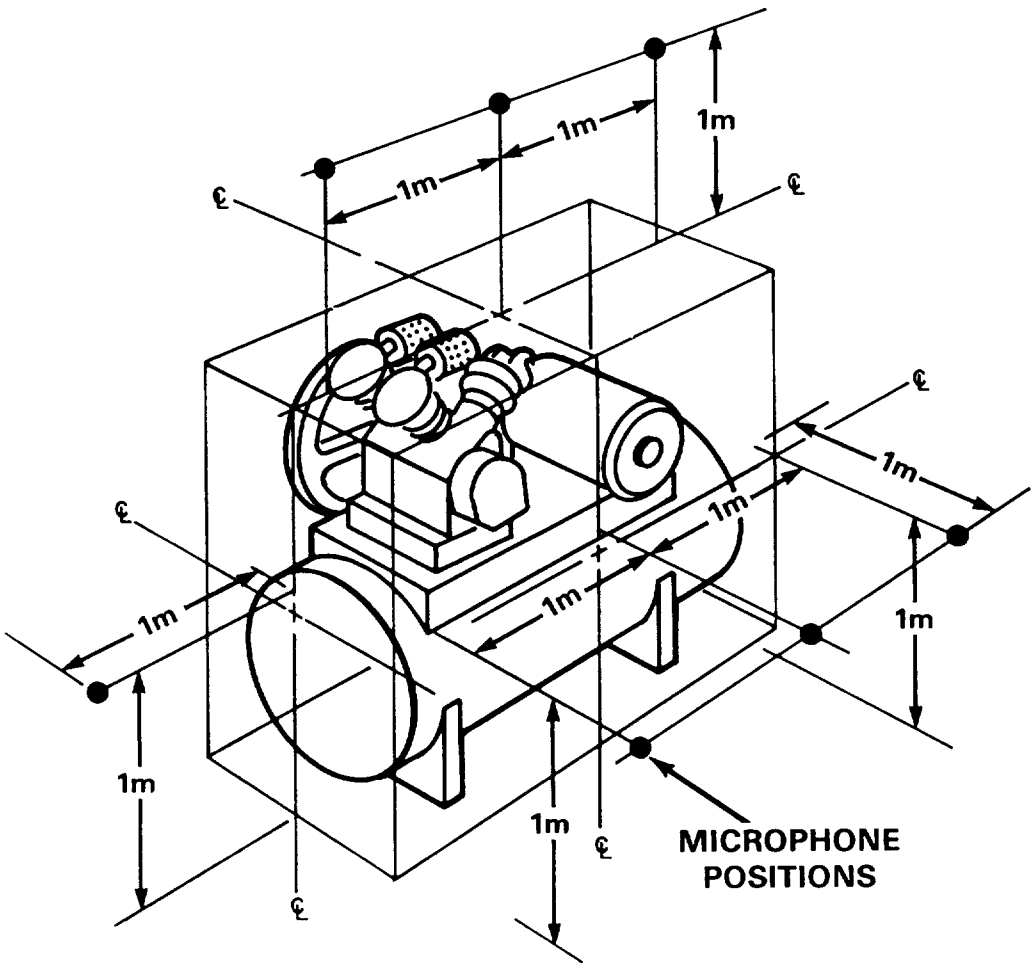
MEASUREMENT LOCATIONS FOR SMALL EQUIPMENT



SH 131824

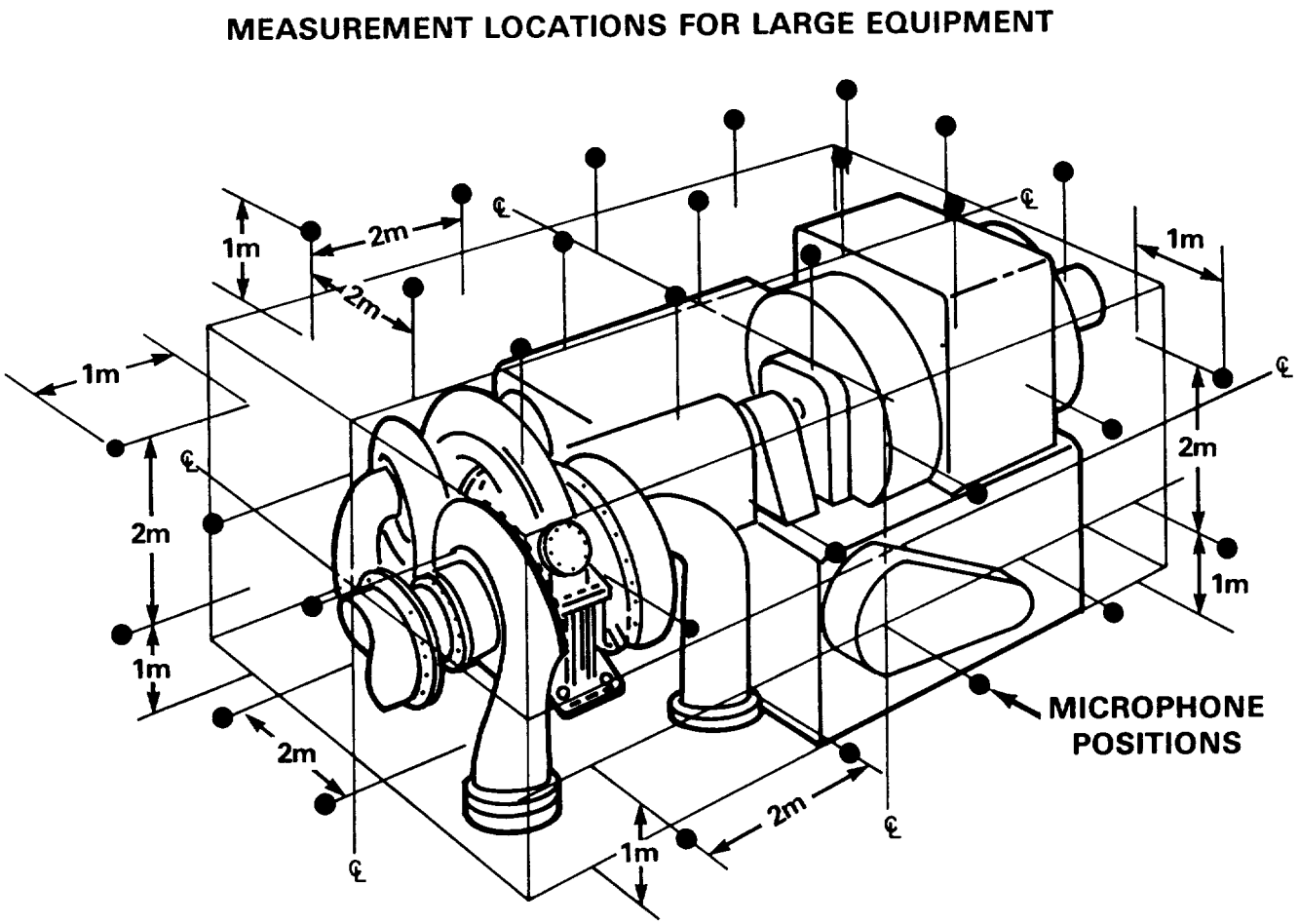
FIGURE 1. Sound measurement locations for small equipment, in addition to location of operator's head.

MEASUREMENT LOCATIONS FOR MEDIUM SIZE EQUIPMENT



SH 131825

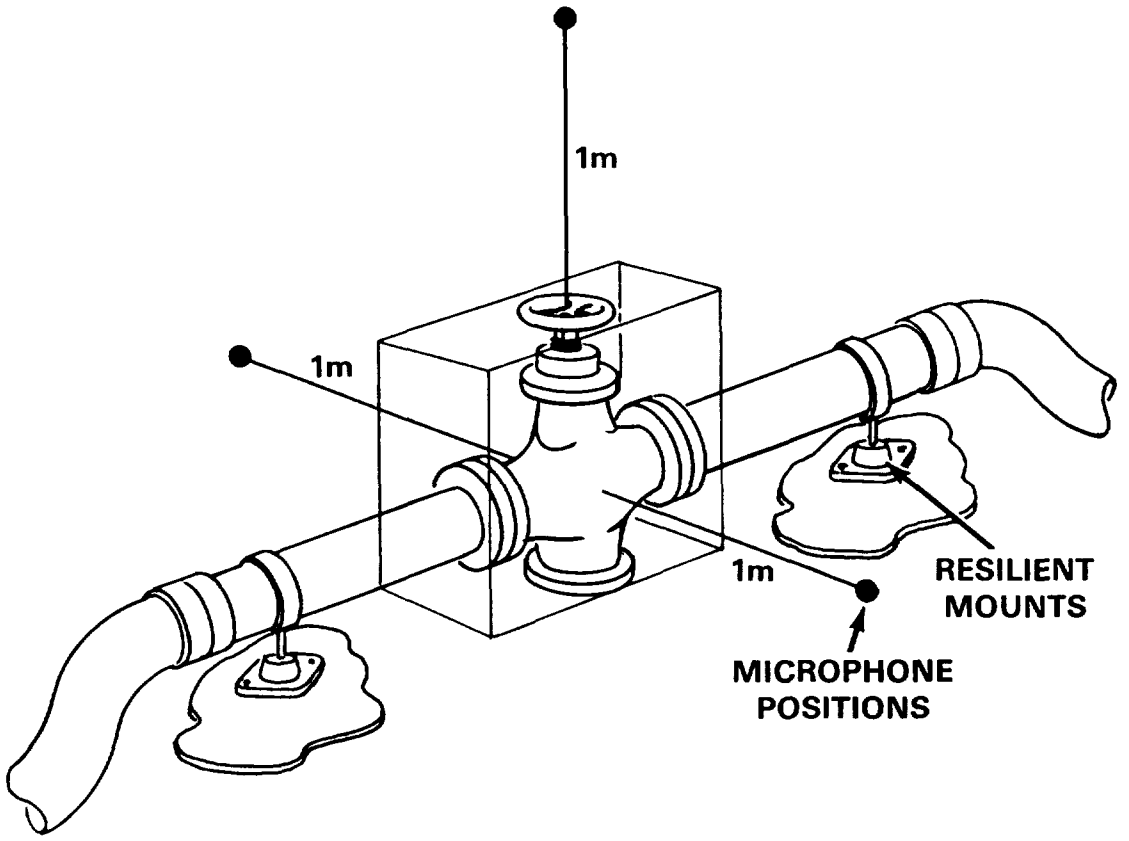
FIGURE 2. Sound measurement locations for medium size equipment, in addition to location of operator's head.



SH 131826

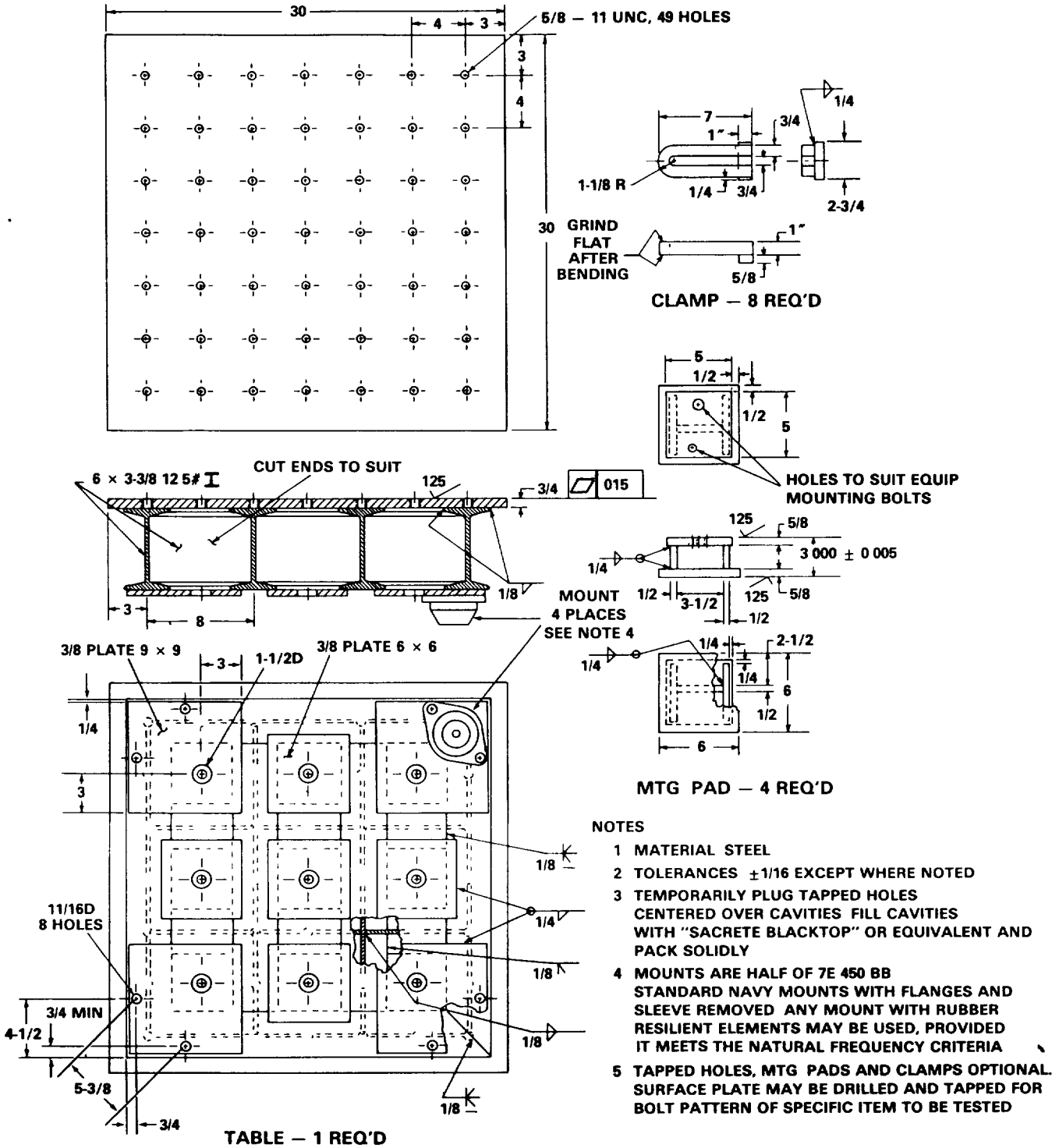
FIGURE 3. Sound measurement locations for large equipment.

MEASUREMENT LOCATIONS FOR VALVES



SH 131827

FIGURE 4. Sound measurement locations for valves.



NOTES

1 MATERIAL STEEL
2 TOLERANCES ±1/16 EXCEPT WHERE NOTED
3 TEMPORARILY PLUG TAPPED HOLES CENTERED OVER CAVITIES FILL CAVITIES WITH "SACRETE BLACKTOP" OR EQUIVALENT AND PACK SOLIDLY
4 MOUNTS ARE HALF OF 7E 450 BB STANDARD NAVY MOUNTS WITH FLANGES AND SLEEVE REMOVED ANY MOUNT WITH RUBBER RESILIENT ELEMENTS MAY BE USED, PROVIDED IT MEETS THE NATURAL FREQUENCY CRITERIA
5 TAPPED HOLES, MTG PADS AND CLAMPS OPTIONAL. SURFACE PLATE MAY BE DRILLED AND TAPPED FOR BOLT PATTERN OF SPECIFIC ITEM TO BE TESTED

All dimensions are in inches

SH 131828

FIGURE 5. Standard test fixture.

INSTRUCTIONS: In a continuing effort to make our standardization documents better, the DoD provides this form for use in submitting comments and suggestions for improvements. All users of military standardization documents are invited to provide suggestions. This form may be detached, folded along the lines indicated, taped along the loose edge *(DO NOT STAPLE)*, and mailed. In block 5, be as specific as possible about particular problem areas such as wording which required interpretation, was too rigid, restrictive, loose, ambiguous, or was incompatible, and give proposed wording changes which would alleviate the problems. Enter in block 6 any remarks not related to a specific paragraph of the document. If block 7 is filled out, an acknowledgement will be mailed to you within 30 days to let you know that your comments were received and are being considered.

NOTE This form may not be used to request copies of documents, nor to request waivers, deviations, or clarification of specification 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.

(Fold along this line)

(Fold along this line)

DEPARTMENT OF THE NAVY

COMMANDER
NAVAL SEA SYSTEMS COMMAND (SEA 55Z3)
DEPARTMENT OF THE NAVY
WASHINGTON, DC 20362-5101

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE $300

BUSINESS REPLY MAIL
FIRST CLASS PERMIT NO 12503 WASHINGTON D C

POSTAGE WILL BE PAID BY THE DEPARTMENT OF THE NAVY

COMMANDER
NAVAL SEA SYSTEMS COMMAND (SEA 55Z3)
DEPARTMENT OF THE NAVY
WASHINGTON, DC 20362-5101

NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions – Reverse Side)

1 DOCUMENT NUMBER	2 DOCUMENT TITLE
MIL-STD-740-1(SH)	AIRBORNE SOUND MEASUREMENTS AND ACCEPTANCE CRITERIA OF SHIPBOARD EQUIPMENT

3a. NAME OF SUBMITTING ORGANIZATION	4. TYPE OF ORGANIZATION *(Mark one)*
	☐ VENDOR
b ADDRESS *(Street, City, State, ZIP Code)*	☐ USER
	☐ MANUFACTURER
	☐ OTHER *(Specify)* _____

5 PROBLEM AREAS

a. Paragraph Number and Wording

b Recommended Wording

c Reason/Rationale for Recommendation

6 REMARKS

7a. NAME OF SUBMITTER *(Last, First, MI)* – Optional	b. WORK TELEPHONE NUMBER *(Include Area Code)* – Optional
c MAILING ADDRESS *(Street, City, State, ZIP Code)* – Optional	8. DATE OF SUBMISSION *(YYMMDD)*

DD FORM 82 MAR 1426 PREVIOUS EDITION IS OBSOLETE.