ANSI/AHRI Standard 575
(Formerly ARI Standard 575)

2008 Standard for

Method of Measuring Machinery Sound Within an Equipment Space

AHRI Air-Conditioning, Heating, and Refrigeration Institute

2111 Wilson Boulevard, Suite 500
Arlington, VA 22201, USA
www.ahrinet.org

PH 703.524.8800
FX 703.562.1942

IMPORTANT

SAFETY DISCLAIMER

AHRI does not set safety standards and does not certify or guarantee the safety of any products, components or systems designed, tested, rated, installed or operated in accordance with this standard/guideline. It is strongly recommended that products be designed, constructed, assembled, installed and operated in accordance with nationally recognized safety standards and code requirements appropriate for products covered by this standard/guideline.

AHRI uses its best efforts to develop standards/guidelines employing state-of-the-art and accepted industry practices. AHRI does not certify or guarantee that any tests conducted under its standards/guidelines will be non-hazardous or free from risk.

FOREWORD

This document establishes a uniform method of measuring the sound levels produced by air-conditioning and refrigerating machinery installed in mechanical equipment spaces. However, it should be emphasized that this standard was developed for use where the test conditions usually cannot be controlled, e.g., ambient temperature; equipment loading; physical attributes of the space; background sound sources, etc. Since the results obtained may vary substantially, a tolerance on these results cannot be specified.

Uniform practices in making sound level measurements are necessary for effective communication between the owner, the architect, the acoustician, the consulting engineer, the contractor and the equipment manufacturer.

Specifications for sound levels produced by machinery may be written, both for the purpose of supplying information in order to evaluate compliance with noise exposure limits and for the purpose of providing information for adequate building design to meet the acoustical design goals of adjacent occupied spaces. In view of the geometrical and acoustical properties of large equipment, both purposes can best be served by sound data expressed in terms of Sound Pressure Level measured close to the equipment. Sound pressure measurements close to the equipment are least affected by the environment in which the machines are installed.

This standard is based upon the procedures established in ANSI Standard S1.13.

Note:

This standard supersedes ARI Standard 575-94 and has no technical changes.

Price $10.00 (M) $20.00 (NM)
Printed in U.S.A.

TABLE OF CONTENTS

FIGURES

APPENDICES

FORMS

METHOD OF MEASURING MACHINERY SOUND WITHIN AN EQUIPMENT SPACE

Section 1. Purpose

1.1 *Purpose.* The purpose of this standard is to establish a uniform method of measuring and recording the Sound Pressure Level of machinery installed in a mechanical equipment space. It is not the intent of this standard to be used for the sound rating of equipment.

1.1.1 *Intent.* This standard is intended for the guidance of the industry, including manufacturers, engineers, installers, contractors and users.

1.1.2 *Review and Amendment.* This standard is subject to review and amendment as technology advances.

Section 2. Scope

2.1 *Scope.* This standard applies to water chilling systems, pumps and similar operating machines and parts thereof, which for reasons of size or operating characteristics are more practically evaluated in situ.

Section 3. Definitions

All terms in this document follow the standard industry definitions in the current edition of *ASHRAE Terminology of Heating, Ventilation, Air-Conditioning, and Refrigeration*, unless otherwise defined in this section.

3.1 *"A"-Weighted Sound Pressure Level.* The measured value obtained with a sound level meter using its "A"-weighting network.

3.2 *Key Measurement Points*. Points located on the measurement parallelepiped at the center of each vertical plane.

3.3 *Octave Band.* A band of sound covering a range of frequencies such that the highest is twice the lowest. The Octave Bands used in this standard are those defined in ANSI Standard S1.11.

3.4 O*ne-Third Octave Band*. A band of sound covering a range of frequencies such that the highest frequency is the cube root of two times the lowest frequency. The One-Third Octave Bands used in this standard are those defined in ANSI Standard S1.11.

3.5 *Operating Conditions.* Those conditions specified for a particular installation. In general, they are those parameters listed in the job specification sheets for the particular equipment. Examples of parameters to be recorded are found on data forms in Appendix C.

3.6 *Representative "A"-Weighted Sound Pressure Level.* An average "A"-Weighted Sound Pressure Level from a measurement made with a majority of measurement locations not affected by nearby reflective surfaces.

3.7 *Representative High Limit "A"-Weighted Sound Pressure Levels.* An average "A"-Weighted Sound Pressure Level from a measurement made with a majority of measurement locations affected by reflections from nearby surfaces. The value represents an upper bound to the representative "A"-weighted value.

3.8 *Representative High Limit Octave Band Sound Pressure Level.* An average Octave Band Sound Pressure Level calculated from a measurement made with more than two key measurement locations affected by reflections from nearby surfaces.

3.9 *Representative Octave Band Sound Pressure Levels.* An average Octave Band Sound Pressure Level calculated from a measurement made with two or less key measurement locations affected by reflections from nearby surfaces.

3.10 *"Shall" or "Should."* "Shall" or "Should," shall be interpreted as follows:

3.10.1 *Shall.* Where "shall" or "shall not" is used for a provision specified, that provision is mandatory if compliance with the standard is claimed.

3.10.2 *Should.* "Should" is used to indicate provisions which are not mandatory but which are desirable as good practice.

3.11 *Sound Pressure Level.* The Sound Pressure Level (L_p), in decibels (dB), of a sound is 20 times the logarithm to the base 10 of the ratio of a given pressure to a reference pressure. The reference pressure (P_o) used in this standard is 20 micropascals.

$$L_p = 20 \cdot \log_{10} (p/P_o)$$

where p is the measured RMS (root mean square) sound pressure, Pa.

3.11.1 *One-Third Octave Band Sound Pressure Level.* A Sound Pressure Level measured when using a one-third octave band filter as defined in Section 3.4.

3.11.2 *Octave Band Sound Pressure Level.* A Sound Pressure Level measured when using an octave band filter as defined in Section 3.3.

3.12 *Uncertain Measurement.* A point where sound energy of other sources causes the observed value to be above its true value.

3.13 *Valid Measurement.* A point where other equipment or adjacent surfaces do not significantly affect the value observed.

Section 4. Instruments

4.1 *Sound Level Meter.* A meter meeting the requirements of the Type 1 meter described in ANSI S1.4 is to be used.

4.2 *Frequency Analyzer.* An octave or one-third octave band filter set meeting the requirements for Class II or III filters respectively, of ANSI S1.11 is to be used.

4.3 *Calibration.* During each series of measurements, an acoustical calibrator with an accuracy of ±0.5 dB shall be applied to the microphone for checking the calibration of the entire measuring system at one or more frequencies over the frequency range of interest. The calibrator shall be checked at the manufacturer's recommended intervals or at least once every year to verify that its output has not changed. In addition, an electrical calibration of the instrumentation system over the entire frequency range of interest shall be performed periodically as recommended by the manufacturer, but at intervals of not more than two years.

Section 5. Sound Measurements and Calculation Procedures

5.1 *Measurements.*

5.1.1 *Measurement Points.* The measurement points shall be determined relative to a reference parallelepiped, which is the smallest imaginary rectangular parallelepiped that will enclose the machine (Figure 1). Minor projections from the machine are disregarded in determining the size of the reference parallelepiped.

The measurement points shall be positioned on the surface of a measurement parallelepiped whose planes are one meter out from the vertical sides of the reference parallelepiped. Key Measurement Points are located at the center of each vertical plane of the measurement parallelepiped. The remaining measurement points are at one meter intervals on the measurement planes starting from the key points. All measurement points are at a height of 1.5 meters from the floor. If the shortest distance between two measurement points at a corner of the measurement parallelepiped is less than one meter, the point nearest to the corner shall be eliminated. The total number of points on the measurement parallelepiped is N.

5.1.2 *Operation of Sound Level Meter.* The sound level meter shall be used in the slow response position. The instrument manufacturer's recommendations shall be followed in using the meter and in determining the correct microphone orientation for the flattest frequency response.

5.1.3 *Data to be Taken.* "A"-weighted sound pressure level measurements shall be taken at all measurement points. Octave band measurements (63 through 8000 Hz Octave Bands) shall be made at the four Key Measurement Points.

A full set of measurements shall be taken with the test unit operating. A second full set of data shall be obtained with the test unit off and all other equipment in the area operating as before to establish the background sound levels.

5.1.4 *Valid Measurement Points.* A valid measurement point cannot be closer than one meter to a wall or other plane surface larger than 1 square meter. A measurement shall not be recorded at any measurement point that does not meet this criterion. The number of invalid measurement points is N_1.

5.1.5 *Pure Tones.* When pure tones are generated by the operating machine, interference patterns may affect the measured values. If the "A"-Weighted Sound Pressure Level or any Octave Band Sound Pressure Level varies 6 dB or more within an area of 0.5 meter radius of the measuring point and on the surface of the measurement parallelepiped, the highest and lowest values observed within this area shall be recorded. If variations are less than 6 dB, the value obtained at the specified measurement point shall be recorded.

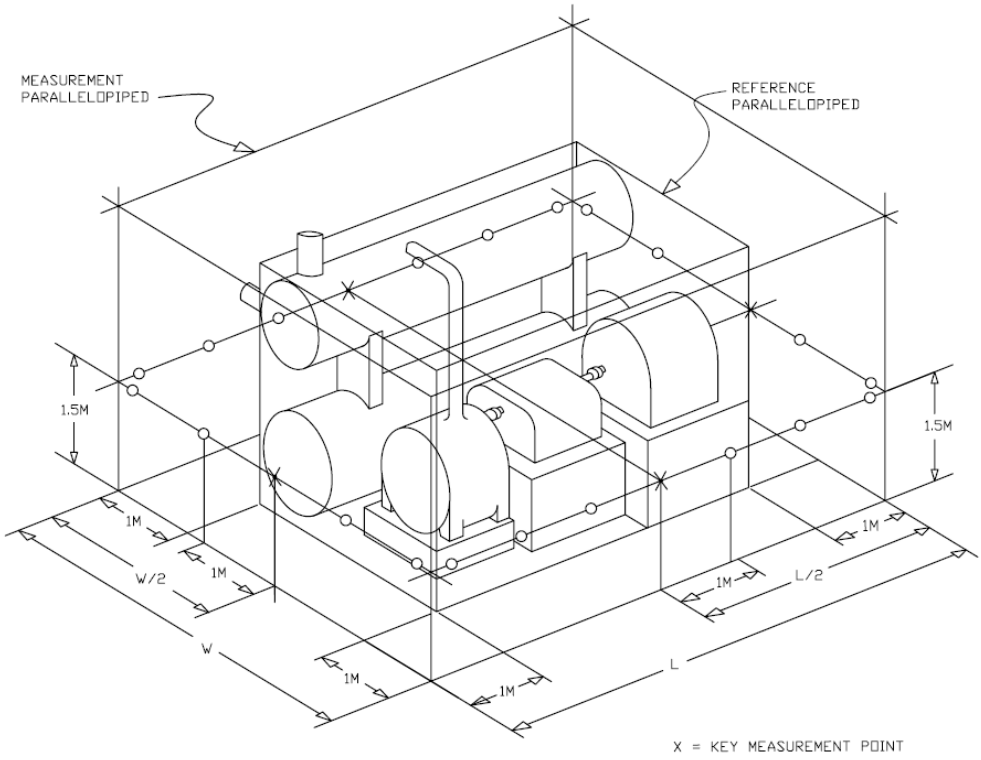


Figure 1. Test Unit Measurement Points

5.2 *Calculation Procedures.*

5.2.1 *Uncertain Measurements Due to Background Noise.* Any "A"-Weighted or Octave Band Sound Pressure Level taken with the test unit operating must be at least 6 dB above the corresponding level with the test unit off and other equipment operating. Any level which does not meet this criterion shall be marked uncertain by the use of an asterisk (*). The number of uncertain measurement points is N_U.

5.2.2 *Pure Tones.* Where the highest and lowest values were recorded for a measurement point as specified in 5.1.5, the value used in the calculations for this point shall be the highest value minus 3 dB.

5.2.3 *Representative "A"-Weighted Sound Pressure Level.* If half or more of the measurement points remain (that is, if $N - N_U - N_1 \geq N/2$) after applying the limitations of 5.1.4 and 5.2.1, the Representative "A"- Weighted Sound Pressure Level (A_R) shall be calculated using Equation 1. However, if less than half remain, the Representative High Limit "A"-Weighted Sound Pressure Level shall be calculated per 5.2.5.

5.2.4 *Representative Octave Band Sound Pressure Levels.* If two or more key measuring points remain after applying the limitations of 5.1.4 and 5.2.1, the Representative Octave Band Sound Pressure Levels (OB_R) shall be calculated using Equation 1. However, if less than two remain the Representative High Limit Octave Band Sound Pressure Level shall be calculated per 5.2.6.

5.2.5 *Representative High Limit "A"-Weighted Sound Pressure Levels.* If half or more of the measurement points can be obtained by adding the uncertain to the valid measurement points (that is, if $N - N_1 \geq N/2$), then a Representative High Limit "A"-Weighted Sound Pressure Level (A_H) can be calculated using Equation 1 below with $N_U = O$. If this criteria cannot be met, neither a Representative "A"-Weighted Sound Pressure Level nor Representative High Limit "A"- Weighted Sound Pressure Level can be obtained.

5.2.6 *Representative High Limit Octave Band Sound Pressure Level.* If two or more Key Measurement Points can be obtained by adding the uncertain points to the valid measurement points a representative high limit Octave Band Sound Pressure Level Octave Band Sound Pressure Level (OB_H) can be calculated using Equation 1. If this criteria cannot be met, neither Representative Octave Band Sound Pressure Level nor Representative High Limit Octave Band Sound Pressure Levels can be obtained.

5.2.7 *Sound Pressure Level Averaging Equation.*

$$L = 10 \cdot \log_{10} \left[\sum_{i=1}^{n} 10^{L_i/10} \right] - 10 \cdot \log_{10} n \qquad 1$$

Where: L = Representative or high limit sound pressure level logarithmic average rounded off to the nearest 0.5 dB)
L_i = Sound Pressure Level at the measured points
n = Number of points to be averaged = $(N - N_U - N_1)$

Section 6. Machinery Sound Specifications and Data Presentation

6.1 *Sound Level Specifications.* Information required for specifying machinery sound levels should include the following:

a. Machine description.

b. Desired Representative "A"-Weighted Sound Pressure Level (A_R).

c. If desired, optional Representative Octave Band Sound Pressure Level (OB_R).

d. Operating Conditions at which (A_R) and (OB_R) are specified (Section 6).

6.2 *Data Presentation.* When a sound test is conducted in accordance with this standard, a report shall be supplied and it shall include the information in 6.2.1, 6.2.2 and 6.2.3. In addition, the data defined in 6.2.4 should be provided when specified by the user.

6.2.1 Statement that the test was conducted in accordance with ARI Standard 575.

6.2.2 Description of the machine, the Operating Conditions and a sketch showing the test layout and microphone locations (see Appendix D for form and sample calculation).

6.2.3 Representative "A"-Weighted Sound Pressure Level (A_R) or Representative High Limit "A"-Weighted Sound Pressure Level (A_H) as calculated per 5.2. A_H will be reported only if the data for computing A_R cannot be obtained. If the latter course is followed, the reasons that the A_R cannot be obtained shall be submitted to the user.

6.2.4 Representative Octave Band Sound Pressure Levels at (OB_R) or Representative High Limit Octave Band Sound Pressure Levels (OB_H), in the 63 Hz through 8000 Hz bands, inclusive, as the calculated high limit. OB_H levels, calculated per 5.2, shall only be reported in the case that OB_R levels cannot be obtained. If the latter course is followed, the reasons that the lower value OB_R cannot be obtained shall be submitted to the user.

Section 7. System Operating Conditions

7.1 *Operating Conditions for Test.* Sound tests shall be made with the machine operating at design Operating Conditions. If this operating point cannot be obtained, the sound test may be made at some other steady state condition mutually agreed upon by the parties concerned. This condition shall clearly be described in the test report. See Appendix C for examples of typical recording forms.

Section 8. Conformance Conditions

8.1 *Conformance.* While conformance with this standard is voluntary, conformance shall not be claimed or implied for products or equipment within the standard's *Purpose* (Section 1) and *Scope* (Section 2) unless such product claims meet all of the requirements of the standard and all of the testing and rating requirements are measured and reported in complete compliance with the standard. Any product that has not met all the requirements of the standard cannot reference, state, or acknowledge the standard in any written, oral, or electronic communication.

APPENDIX A. REFERENCES – NORMATIVE

A1 Listed here are all standards, handbooks and other publications essential to the formation and implementation of the standard. All references in this appendix are considered as part of the standard.

A1.1 ANSI Standard S1.4-1983 (R2006)/ANSI S1.4a-1985 (R2006), *American National Standard Specification for Sound Level Meters, 2006,* American National Standards Institute, 25 West 43rd Street, 4th Floor, New York, NY 10036, U.S.A.

A1.2 ANSI Standard S1.11-2004, *Specification for Octave-Band and Fractional-Octave Band Analog and Digital Filters, 2004,* American National Standards Institute, 25 West 43rd Street, 4th Floor, New York, NY 10036, U.S.A.

A1.3 ANSI Standard S1.13-2005, *Measurement of Sound Pressure Levels in Air,* American National Standards Institute, 25 West 43rd Street, 4th Floor, New York, NY 10036, U.S.A.

A1.4 *ASHRAE Terminology of Heating, Ventilation, Air Conditioning and Refrigeration,* Second Edition, 1991, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., 1791 Tullie Circle N.E., Atlanta, GA 30329, U.S.A.

APPENDIX B. REFERENCES – INFORMATIVE

None.

APPENDIX C. OPERATING CONDITIONS – INFORMATIVE

The following data forms shown in this appendix are intended as a guide to ensure that adequate data are recorded. Because of the wide range of machinery which can be expected to be installed in building machinery spaces, a universal data form is not practical. If the attached forms are not adequate, one should be tailored to meet individual requirements.

FORM C1. CENTRIFUGAL CHILLER OPERATIONAL DATA RECORDING FORM PER ARI STANDARD 575

MACHINE SPECIFICATIONS:

Model: _____ Manufacturer: _____ Serial Number: _____

Rated Compressor Speed: _____ rpm Capacity: _____ tons [kW]

Rated Load Current: _____ A Voltage: _____ V

Type of Driver: _____ Refrigerant: _____

Auxiliaries, such as Gears: _____

Comments: _____

TEST CONDITIONS:

Suction Temperature/Pressure	_____	°F [°C]/	_____	psig [kPag]
Chilled Water Temperature In/Out	_____	°F [°C]/	_____	°F [°C]
Chilled Water Pressure In/Out	_____	psig [kPag]/	_____	psig [kPag]
Discharge Temperature/Pressure	_____	°F [°C]/	_____	psig [kPag]
Condenser Water Temperature In/Out	_____	°F [°C]/	_____	°F [°C]
Condenser Water Pressure In/Out	_____	psig [kPag]/	_____	psig [kPag]
Interstage(s) Temperature/Pressure	_____	°F [°C]/	_____	psig [kPag]
	_____	°F [°C]/	_____	psig [kPag]

Compressor Speed	_____	rpm
Compressor Capacity Control Position	_____	%
Driver Speed	_____	rpm
Electric Motor Current and Voltage	_____ A	_____ V
Steam Turbine Pressures:		
Before Control Valve	_____	psig [kPag]
Steam Chest	_____	psig [kPag]
Condenser	_____	psig [kPag]
Atmospheric Pressure	_____	in Hg [kPa]

FORM C2. RECIPROCATING, SCREW OR SCROLL CHILLER OPERATIONAL DATA RECORDING FORM PER ARI STANDARD 575

MACHINE SPECIFICATIONS:

Model: _____ Manufacturer: _____ Serial Number: _____

Rated Compressor Speed: _____ rpm Capacity: _____ tons [kW]

Rated Load Current: _____ A Voltage: _____ V

Type of Driver: _____ Refrigerant: _____

Auxiliaries, such as Gears: _____

Comments: _____

TEST CONDITIONS:

Suction Temperature/Pressure	_____	°F [°C]/	_____	psig [kPag]
Chilled Water Temperature In/Out	_____	°F [°C]/	_____	°F [°C]
Chilled Water Pressure In/Out	_____	psig [kPag]/	_____	psig [kPag]
Discharge Temperature/Pressure	_____	°F [°C]/	_____	psig [kPag]
Condenser Water Temperature In/Out	_____	°F [°C]/	_____	°F [°C]
Condenser Water Pressure In/Out	_____	psig [kPag]/	_____	psig [kPag]
Number of Compressors	_____			
Number and Location of Compressors Running	_____			
	_____			
Compressor Speed or Unloading Stage	_____	rpm		
Electric Motor Current and Voltage – Compressor 1	_____	A	_____	V
2	_____	A	_____	V
3	_____	A	_____	V
4	_____	A	_____	V

FORM C3. ABSORPTION CHILLER OPERATIONAL DATA RECORDING FORM PER ARI STANDARD 575

MACHINE SPECIFICATIONS:

Model: _____ Manufacturer: _____ Serial Number: _____

Pump speed: _____ rpm Capacity: _____ tons [kW]

Heat Source: Steam: ☐ Hot Water: ☐ Direct Fired ☐

Rated Steam Pressure:_____ psig[kPag] Rated Hot Water Temperature:_____ °F [°C]

Type and Location of Control Valve: _____ Valve Position _____ % open

Comments:

TEST CONDITIONS:

Chilled Water Temperature In/Out	_____ °F [°C]/	_____ °F [°C]
Chilled Water Pressure In/Out	_____ psig [kPag]/	_____ psig [kPag]
Condenser Water Temperature—Absorber In/Out	_____ °F [°C]/	_____ °F [°C]
Condenser Water Pressure—Absorber In/Out	_____ psig [kPag]/	_____ psig [kPag]
Condenser Water Temperature—Condenser In/Out	_____ °F [°C]/	_____ °F [°C]
Condenser Water Pressure—Condenser In/Out	_____ psig [kPag]/	_____ psig [kPag]
Capacity Control Valve	_____	
Steam (Hot Water) Pressure at Control Valve Upstream/Downstream	psig [kPag]/	_____ psig [kPag]
Atmospheric Pressure	_____	in Hg [kPa]
Steam (Hot Water) Temperature at Control Valve Upstream/Downstream	_____ °F [°C]/	_____ °F [°C]

FORM C4. PUMP OPERATIONAL DATA RECORDING FORM PER ARI STANDARD 575

MACHINE SPECIFICATIONS:

Model: _____ Manufacturer: _____ Serial Number: _____

Rated Pump Speed: _____ rpm Capacity: _____ GPM [L/s]

Rated Load Current: _____ A Voltage: _____ V

Type of Driver: _____ Type of Pump: _____

Auxiliaries, such as Gears: _____

Comments: _____

TEST CONDITIONS:

Fluid Being Pumped _____

Suction Temperature/Pressure _____ °F [°C]/ _____ psig [kPag]

Discharge Temperature/Pressure _____ °F [°C]/ _____ psig [kPag]

Pump Speed _____ rpm

Driver Speed _____ rpm

Electric Motor Current and Voltage _____ A _____ V

Note: If there are more than one pump please use multiple forms.

APPENDIX D. SOUND LEVEL RECORDING FORMAT PER ARI STANDARD 575 – INFORMATIVE

FORM D1. SOUND TEST DATA FORMAT

Sketch Showing Microphone Locations, Orientation of Test Unit, Key Measurement Points, and Surroundings

Tested By: _____ Reported By: _____ Date: _____

APPENDIX E – EXAMPLE OF SOUND LEVEL RECORDING FORMAT PER ARI STANDARD 575 – INFORMATIVE

Unit Type _____
Model Number _____
Serial Number

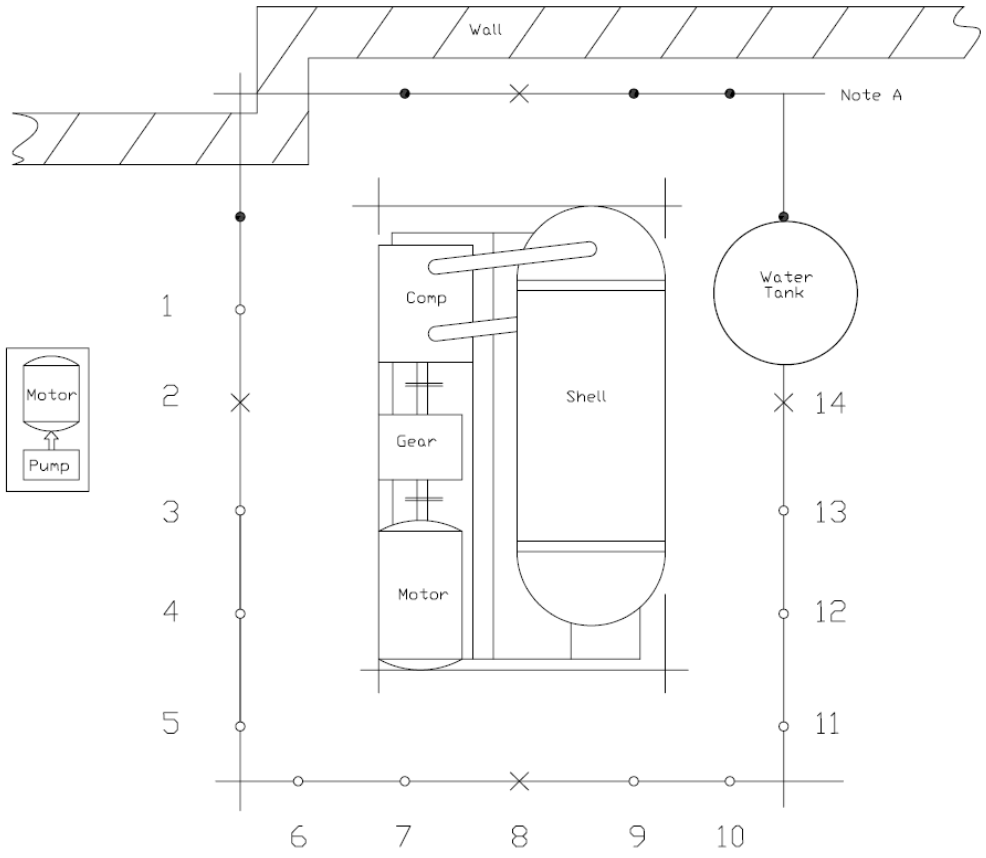
Measurement Position		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
dBA	Test Unit ON	89	88	87	89	91	90	90	90	90	88	87	87	87													
dBA	Test Unit OFF	80	84 70	82 70	81 68	80	81	80	78	79	80	80	80	80													

Notes B & D

A-Weighted Sound Pressure Level dBA A_R _____ or A_H _____

Hz	Octave Band Sound Pressure Levels at Key Measurement Points								Note C Average Octave Band Level
	Key Location (2)		Key Location (8)		Key Location ( )		Key Location ( )		
	Test Unit ON	Test Unit OFF	Test Unit ON—Note C	Test Unit OFF	Test Unit ON	Test Unit OFF	Test Unit ON	Test Unit OFF	
63	77*	75	81*	76					OB_H 79.5*
125	83	70	84	70					OB_R 83.5
250	85	72	87	71					OB_R 865
500	86	74	88	71		NO MEASUREMENTS CAN BE MADE AT THESE LOCATIONS Note A			OB_R 87
1000	85	73	86	74					OB_R 85.5
2000	80 - 87	72	77*	72					OB_H 81.5*
4000	70 - 84*	68 - 82	60 - 82*	60 - 81					OB_H 80*
8000	73	55	73	56					OB_R 73

*Indicates uncertain measurements (see 5.2.1 of standard)
Note B
Notes B & C



E1 – Example Sketch Showing Microphone Locations, Orientation of Test Unit, Key Measurement Points and Surroundings

Tested By:_____ Reported By: _____ Date:_____

NOTE A: No measurements can be taken at these points because they are less than 1 meter from large surfaces (see 5.1.4).

NOTE B: Two values are recorded because of the pure tones present (see 5.1.5). The value used in the calculations shall be 3 dB below the highest value (see 5.2.2).

NOTE C: A Valid Measurement must be 6 dB above the ambient (see 5.2.1). Final results using these values less than 6 dB above background result in representative high limit values.

NOTE D: The level of the ambient here is 84 - 3 = 81 dB. This is 7 dB below the measured value and is an acceptable measurement.

NOTE E: Thirteen Valid Measurements exist out of a possible 24 measurements. This is greater than half, and a value of A_R can be obtained. See the last statement of 5.2.3.

E2. SAMPLE CALCULATIONS

Sample calculation for a water chiller where the measurement procedure is complicated by

1) The close proximity of a wall,
2) The close proximity of a water tank,
3) A pure tone generated in the gear box at 2,000 Hz,
4) A pure tone generated by an adjacent pump at 4,000 Hz,
5) High background level in the 63 Hz band.

To obtain the representative "A"- Weighted Sound Pressure Level:

(Note D)

$$A_R = 10\cdot\log[10^{(89/10)}+10^{(88/10)}+10^{(87/10)}+10^{(89/10)}+10^{(91/10)}+10^{(90/10)}+10^{(90/10)}+10^{(90/10)}+10^{(90/10)}+10^{(88/10)}+10^{(87/10)}+10^{(88/10)}+10^{(87/10)}] -10\cdot\log(13)$$

$$A_R = 100.1 - 11.1$$

$$= 89.0 \text{ dB (Note E)}$$

To obtain the representative Octave Band Sound Pressure at 1 Meter:

For the 63 Hz Band:

(Note C)

$$OB_H = 10\cdot\log\,(10^{(77*/10)}+10^{(81*/10)})-10\cdot\log\,(2)$$
$$OB_H = 79.4 \text{ dB; use } 79.5 \text{ dB}$$

For the 125 Hz Band:

$$OB_R = 10\cdot\log\,(10^{(83/10)}+10^{(84/10)})-10\cdot\log(2)$$

$$OB_R = 83.4 \text{ dB; use } 83.5 \text{ dB}$$

For the 2000 Hz Band:

(Note B)

$$OB_H = 10\cdot\log\,(10^{[(87-3)/10]}+10^{(77*/10)})-10\cdot\log\,(2)$$

$$OB_H = 81.7 \text{ dB; use } 81.5 \text{ dB}$$

$$OB_H = 10\cdot\log\,(10^{[(84-3*)/10]}+10^{[(82-3*)/10]})-10\cdot\log\,(2)$$

$$OB_H = 80.1 \text{ dB; use } 80.0 \text{ dB}$$