AHRI Standard 575

2017 Standard for

Method of Measuring Machinery Sound Within an Equipment Space

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Note:

This standard supersedes ANSI/AHRI Standard 575-2008.

Foreword

This document establishes a uniform method of measuring and recording 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.

If ratings or specifications for sound power levels of water-cooled chillers are needed, AHRI Standard 1280 defines the proper procedure to obtain this information.

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 be served by sound data expressed in terms of Sound Pressure Level measured close to the equipment.

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

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METHOD OF MEASURING MACHINERY SOUND WITHIN AN EQUIPMENT SPACE

Section 1. Purpose

1.1 *Purpose.* The purpose of this standard is to establish for machinery installed in a mechanical equipment space: definitions; instruments; sound measurement and calculation procedures; machinery sound specifications and data presentation; system operating conditions; and conformance conditions. 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. Furthermore, this standard provides an indication of occupational exposure.

2.2 *Exclusions*. Measurements for sound power ratings for water-cooled chillers shall be conducted according to AHRI Standard 1280.

Section 3. Definitions

All terms in this document will follow the standard industry definitions in the ASHRAE Terminology website (https://www.ashrae.org/resources--publications/free-resources/ashrae-terminology) 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.* Locations 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.

3.4 *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.

3.5 *Representative A-weighted Sound Pressure Level (A_R).* An average A-weighted Sound Pressure Level from a measurement made with a majority of measurement points not affected by nearby reflective surfaces.

3.6 *Representative High Limit A-weighted Sound Pressure Levels (A_H).* An average A-weighted Sound Pressure Level from a measurement made with a majority of measurement points affected by reflections from nearby surfaces. The value represents an upper bound to the representative A-weighted value.

3.7 *Representative High Limit Octave Band Sound Pressure Level (OB_H).* An average Octave Band Sound Pressure Level calculated from a measurement made with more than two Key Measurement Points affected by reflections from nearby surfaces.

3.8 *Representative Octave Band Sound Pressure Levels (OB_R).* An average Octave Band Sound Pressure Level calculated from a measurement made with two or less Key Measurement Points affected by reflections from nearby surfaces.

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

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

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

3.10 *Sound Pressure.* The difference between the pressure produced by an acoustic wave and the ambient air pressure. This quantity is a function of the source, its surroundings and distance to the receiver. It is measured by a microphone and perceived by the human ear.

3.11 *Sound Pressure Level.* Ratio of the Sound Pressure to a reference of 20 micropascals, expressed in decibels. The reference of 20 micropascals is the threshold of human hearing.

3.11.1 *Octave Band Sound Pressure Level.* A Sound Pressure Level measured when using an octave band filter as defined in ANSI/ASA Standard S1.11 Part 1.

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

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

Section 4. Instruments

4.1 *Sound Pressure Measurement Hardware.* A meter meeting the requirements of the Type 1 meter described in ANSI Standard S1.4 or an equivalent spectrum analyzer, data acquisition system and microphone(s) combination shall be used.

4.2 *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, shown in 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 Measurement Points. All measurement points are at a height of 1.5 m 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.

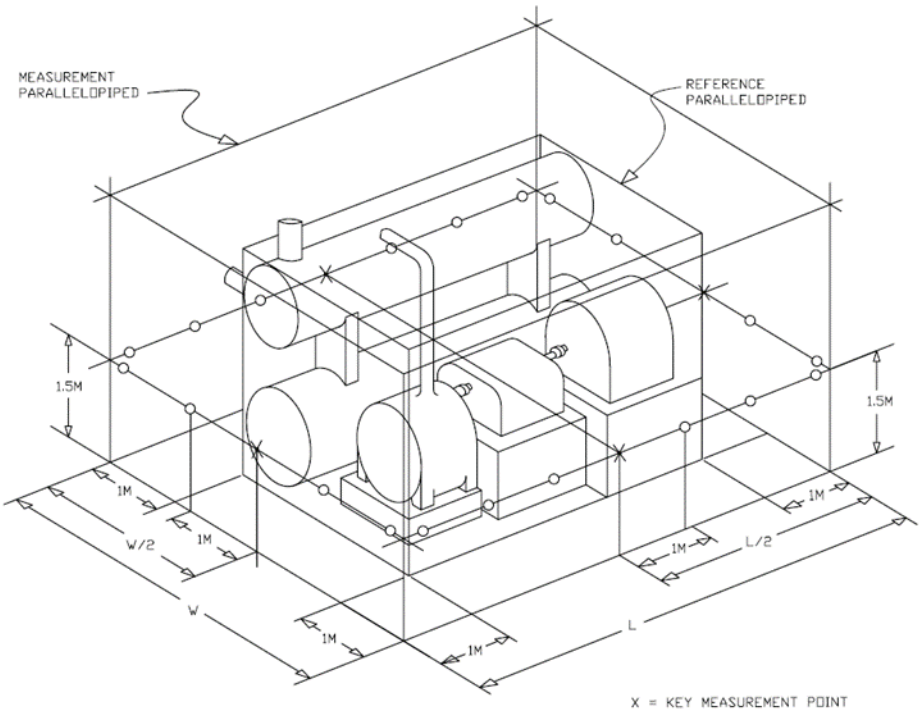

Figure 1. Test Unit Measurement Points

5.1.2 *Measurement Time Interval.* An integrating, averaging device is preferred and the signal shall be averaged for a minimum of 8 seconds. If a sound level meter is used it shall be set in the slow response position. The instrument manufacturer's recommendations shall be followed in using the sound level meter and in determining the correct microphone orientation for the flattest frequency response.

5.1.3 *Data to be Taken.* At a minimum, A-weighted sound pressure level measurements shall be taken at all measurement points. Octave band measurements (63 through 8,000 Hz octave band center frequencies) shall be made at the four Key Measurement Points. The octave band center frequencies are listed in Table 1.

Table 1. Octave Band Center Frequencies

Octave Band	Center Frequency, Hz
1	63
2	125
3	250
4	500
5	1,000
6	2,000
7	4,000
8	8,000

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.

5.2 *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 *Representative A-weighted Sound Pressure Level (A_R).* 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 Sections 5.1.4 and 5.2.1, A_R shall be calculated using Equation 1. However, if less than half remain, A_H shall be calculated per Section 5.2.4.

5.2.3 *Representative Octave Band Sound Pressure Levels (OB_R).* If two or more Key Measurement Points remain after applying the limitations of Sections 5.1.4 and 5.2.1, OB_R, shall be calculated using Equation 1. However, if less than two remain OB_H shall be calculated per Section 5.2.5.

5.2.4 *Representative High Limit A-weighted Sound Pressure Levels (A_H).* If half or more of the measurement points can be obtained by adding the uncertain to the Valid Measurement Points (that is, if $N - N_1 \geq N/2$), A_H can be calculated using Equation 1 below with $N_U = 0$. If this criteria cannot be met, neither A_R nor A_H can be obtained.

5.2.5 *Representative High Limit Octave Band Sound Pressure Level (OB_H).* If two or more Key Measurement Points can be obtained by adding the uncertain points to the Valid Measurement Points OB_H can be calculated using Equation 1. If this criteria cannot be met, neither OB_R nor OB_H can be obtained.

5.2.6 *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 to the nearest 0.5 dB
L_i = Sound Pressure Level at the measured points, dB
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:

6.1.1 Machine description.
6.1.2 A_R.
6.1.3 If desired, optional OB_R.
6.1.4 Operating Conditions at which, A_R, and OB_R, are specified within 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 Sections 6.2.1, 6.2.2 and 6.2.3. In addition, if specified by the user, the data defined in Section 6.2.4 shall be provided.

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

6.2.2 Description of the machine, the Operating Conditions and a sketch or an image showing the test layout and microphone locations, orientation of test unit, key measurement points, and surroundings. The valid and invalid measurement points shall be included in the description. (see Appendix D for sample calculation).

6.2.3 A_R or A_H as calculated per Section 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 the A_R cannot be obtained shall be submitted to the user.

6.2.4 OB_R, or OB_H, in the 63 Hz through 8,000 Hz bands, inclusive, as the calculated high limit. OB_H levels, calculated per Section 5.2, shall only be reported in the case that OB_R levels cannot be obtained. If the latter course is followed, the reasons 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/AHRI Standard 1280-2014, *Sound Power Rating of Water-cooled Chillers*, 2014, Air-Conditioning, Heating, and Refrigeration Institute, 2111 Wilson Boulevard, Suite 500, Arlington, VA 22201, U.S.A.

A1.2 ANSI/ASA Standard S1.11 Part 1-2014, *American National Standard Electroacoustics – Octave-band and Fractional-octave-band Filters – Part 1: Specifications, 2014,* Acoustical Society of America, 1305 Walt Whitman Road, Suite 300, Melville, NY 11747, U.S.A.

A1.3 ANSI/ASA Standard S1.4 Part 3-2014, *American National Standard Electroacoustics - Sound Level Meters - Part 3: Periodic Tests,* 2014*,* Acoustical Society of America, 1305 Walt Whitman Road, Suite 300, Melville, NY 11747, U.S.A.

A1.4 ANSI/ASA Standard S1.13-2005 (R2010)*, American National Standard Measurement of Sound Pressure Levels in Air,* 2010*,* Acoustical Society of America,1305 Walt Whitman Road, Suite 300, Melville, NY 11747, U.S.A.

A1.5 *ASHRAE Terminology,* https://www.ashrae.org/resources--publications/free-resources/ashrae-terminology, 2017, 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

B1 Listed here are standards, handbooks and other publications which may provide useful information and background but are not considered essential. References in this appendix are not considered part of the standard.

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 AHRI STANDARD 575

MACHINE SPECIFICATIONS:

Model: _____ Manufacturer: _____ Serial Number: _____

Rated Compressor Speed: _____ rpm Capacity: _____ ton_R [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 AHRI STANDARD 575

MACHINE SPECIFICATIONS:

Model: _____ Manufacturer: _____ Serial Number: _____

Rated Compressor Speed: _____ rpm Capacity: _____ ton_R [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]/	_____	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 AHRI STANDARD 575

MACHINE SPECIFICATIONS:

Model: _____ Manufacturer: _____ Serial Number: _____

Pump speed: _____ rpm Capacity: _____ ton_R [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 AHRI 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. EXAMPLE OF SOUND LEVEL RECORDING FORMAT PER AHRI STANDARD 575 – INFORMATIVE

Unit Type _____
Model Number _____
Serial Number _____

Measurement Points		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
A-weighted Sound Pressure Level (A_R or A_H), dBA	Test Unit On	89	88	87	89	91	90	90	90	90	88	87	87	87											
	Test Unit OFF	80	81	82	81	80	81	80	78	79	80	80	80	80											

Hz	Octave Band Sound Pressure Levels at Key Measurements Points								Average Octave Band Level
	Key Measurement Points (2)		Key Measurement Points (8)		Key Measurement Points ( )		Key Measurement Points ( )		
	Test Unit ON	Test Unit OFF	Test Unit ON	Test Unit OFF	Test Unit ON	Test Unit OFF	Test Unit ON	Test Unit OFF	
63	77* (Note B)	75	81* (Note B)	76					OB_H 79.5* (Note B)
125	83	70	84	70					OB_R 83.5
250	85	72	87	71					OB_R 86.5
500	86	74	88	71		NO MEASUREMENTS CAN BE MADE AT THESE LOCATIONS (Note A)			OB_R 87.0
1,000	85	73	86	74					OB_R 85.5
2,000	80	72	77*	72					OB_H 79.0*
4,000	84* (Note B)	82	82* (Note B)	81					OB_H 83.0*
8,000	73	55	73	56					OB_R 73.0
*Indicates Uncertain Measurements Points (see Section 5.2.1 of standard)									

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

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

Note C: 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 Section 5.2.2.

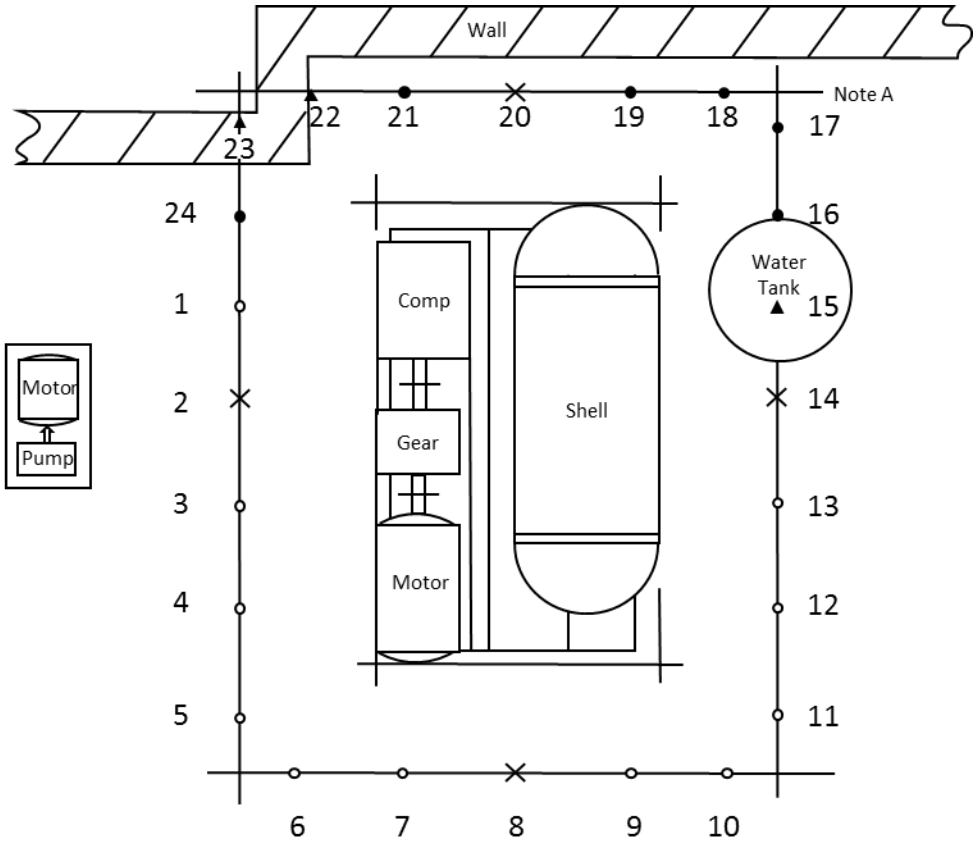

Figure D1. Example Sketch Showing Microphone Locations, Orientation of Test Unit, Key Measurement Points and Surroundings

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) High background level in the 63 Hz band.

To obtain the Representative A-weighted Sound Pressure Level (A_R):

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

$$A_R = 100.1 - 11.1$$

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

To obtain the Representative Octave Band Sound Pressure Level (OB_R) or Representative High Limit Octave Band Sound Pressure Level (OB_H) at 1 Meter:

For the 63 Hz Band:

(Note B)

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

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 2,000 Hz Band:

$$OB_H = 10\cdot\log (10^{[(80)/10]} +10^{(77*/10)})-10\cdot\log (2)$$

$$OB_H = 78.8 \text{ dB; use } 79.0* \text{ dB}$$

For the 4,000 Hz Band:

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

$$OB_H = 83.1 \text{ dB; use } 83.0* \text{ dB}$$