1997
STANDARD for

APPLICATION OF SOUND RATING LEVELS OF OUTDOOR UNITARY EQUIPMENT

AIR-CONDITIONING &
REFRIGERATION
INSTITUTE

Standard 275

4301 NORTH FAIRFAX DRIVE • ARLINGTON, VIRGINIA 22203

IMPORTANT

SAFETY RECOMMENDATIONS

It is strongly recommended that the product be designed, constructed, assembled and installed in accordance with nationally recognized safety requirements, appropriate for products covered by this standard.

ARI, as a manufacturer's trade association, uses its best efforts to develop standards, employing state-of-the-art and accepted industry practices. However, ARI does not certify or guarantee safety of any products, components or systems designed, tested, rated, installed or operated in accordance with these standards or that any test conducted under its standards will be non-hazardous or free from risk.

Note:

This Standard supersedes ARI Standard 275-84.

Price $15.00 (M) $30.00 (NM)
Printed in U.S.A.

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APPENDICES

APPLICATION OF SOUND RATING LEVELS OF OUTDOOR UNITARY EQUIPMENT

Section 1. Purpose

1.1 *Purpose.* The purpose of this standard is to establish for outdoor unitary equipment: definitions, procedures for estimating A-Weighted sound pressure levels, and recommended application practices.

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 the outdoor sections of factory-made air-conditioning and heat pump equipment, as defined in Section 3 and ARI Standard 210/240 when rated in accordance with ARI Standard 270.

Section 3. Definitions

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

3.2 *Sound Rating Level.* That number which is assigned to equipment rated in accordance with ARI Standard 270.

3.2.1 *Standard Sound Rating Level*. That number assigned to equipment rated at Standard Rating Conditions in accordance with ARI Standard 270.

3.2.2 *Application Sound Rating Level.* A number assigned to equipment rated in accordance with ARI Standard 270 at conditions other than Standard Rating Conditions.

3.3 *A-Weighted Sound Pressure Level.* As used herein, the sound pressure level, as measured on the "A" scale of a sound level meter manufactured in accordance with the provisions of ANSI Standard S1.4.

3.4 *C-Weighted Sound Pressure Level*. As used herein, the sound pressure level, as measured on the "C" scale of a sound level meter manufactured in accordance with the provisions of ANSI Standard S1.4.

3.5 "Shall," "Should," "Recommended," or "It Is Recommended." "Shall," "should," "recommended," or "it is recommended" shall be interpreted as follows:

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

3.5.2 *Should, Recommended, or It Is Recommended*. "Should," "recommended," or "it is recommended" is used to indicate provisions which are not mandatory but which are desirable as good practice.

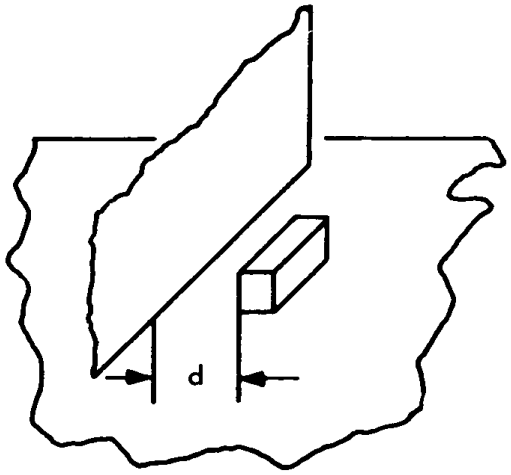
Section 4. Procedure for Estimating A-Weighted Sound Pressure Levels

4.1 *Introduction.* ARI Standard 270 establishes a method of rating outdoor unitary equipment in terms of ARI Sound Rating Levels. The sound level of outdoor unitary equipment in various applications is dependent not only upon the ARI Sound Rating Level but also upon several significant factors related to the application of the equipment. These factors include equipment location, barrier shielding, sound path, and distance, as described in 4.1.1 through 4.1.4 and Table 1. Quantitative values for each of these factors are established to adjust the sound rating level. The summation of the sound rating levels and applied adjustments equal the estimated A-Weighted sound pressure level. The rating method in ARI Standard 270 incorporates an adjustment which is applied in the presence of tones. This method may result in slightly higher predicted sound levels than measured sound levels when following the procedures described in this standard.

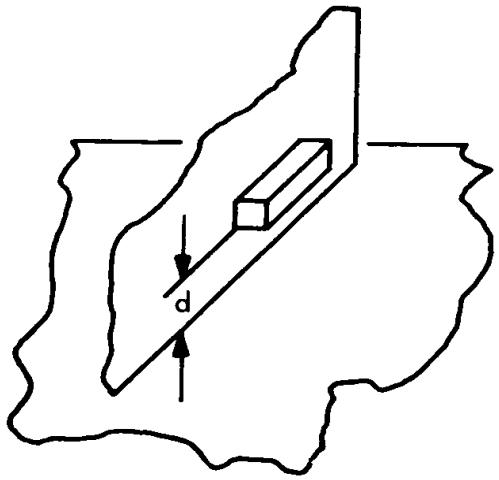
4.1.1 *Equipment Location Factor*. This factor takes into consideration the effect of walls and other reflective surfaces adjacent to the equipment. Factors for typical equipment locations are given in Item 1, Table 1, and described with sketches.

Table 1. Application Factors for Estimating A-Weighted Sound Pressure Levels

1. Equipment Location Factor	Factor Value
a. Equipment on ground or roof or in side of building wall with *no* adjacent reflective surface within 10 ft. [3 m] (d greater than 10 ft. [3 m])	0 dB
b. Equipment on ground or roof or in side of building wall with a *single* adjacent reflective surface within 10 ft. [3 m] (d less than 10 ft. [3 m])	3 dB

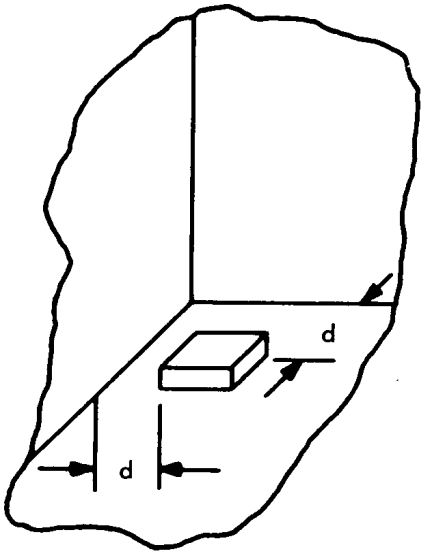


On Ground or Roof
Single Reflective Surface

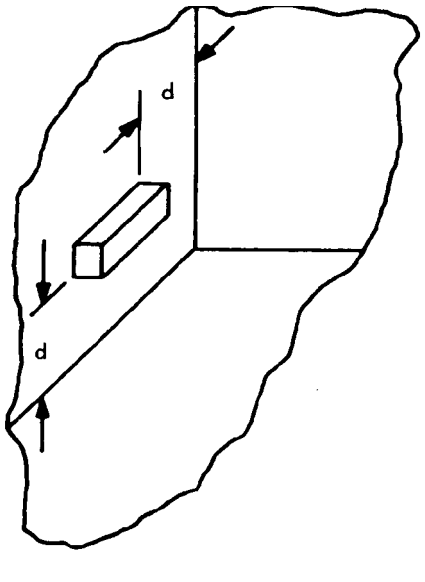


In Side of Building
Single Reflective Surface

c. Equipment on ground or roof or in side of building wall within 10 ft. [3 m] of *two* adjacent walls forming an inside corner (d less than 10 ft. [3 m] to both surfaces)	6 dB

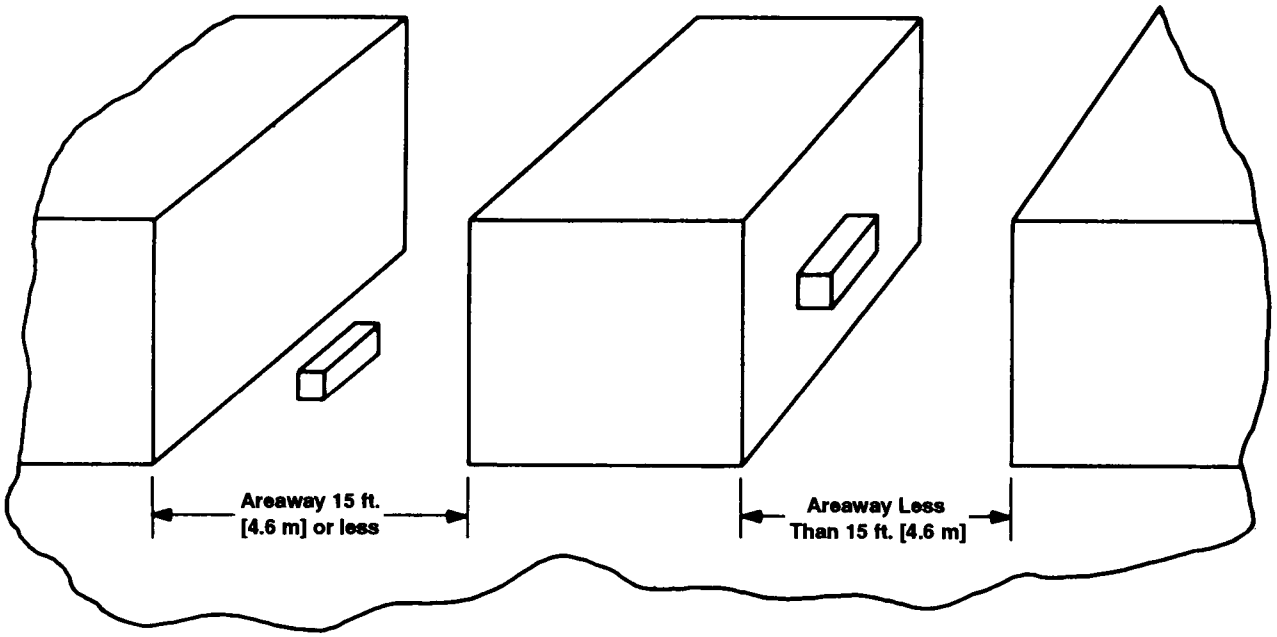


On Ground or Roof
Two Adjacent Reflecting Surfaces



In Side of Building
Two Adjacent Reflecting Surfaces

Table 1. Application Factors for Estimating A-Weighted Sound Pressure Levels (Continued)	
1. Equipment Location Factor (continued)	Factor Value
d. Equipment on ground or roof or in side of building wall and between two opposite reflecting surface less than 15 ft. [4.6 m] apart	6 dB



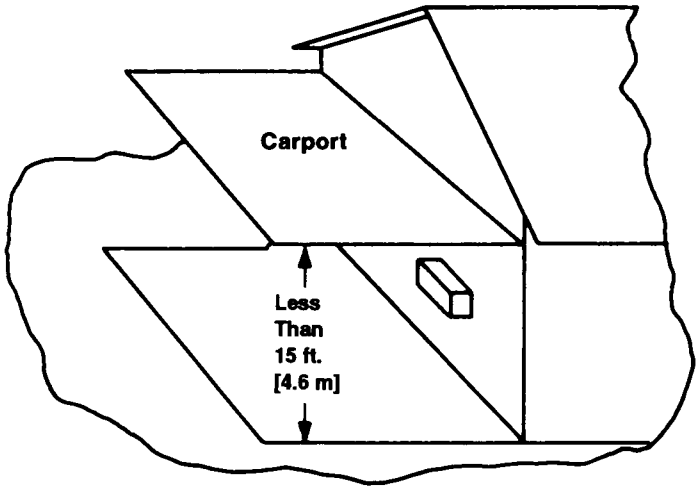
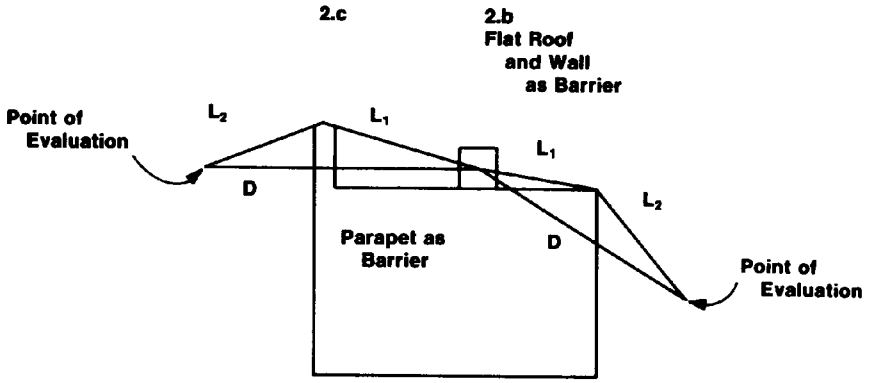
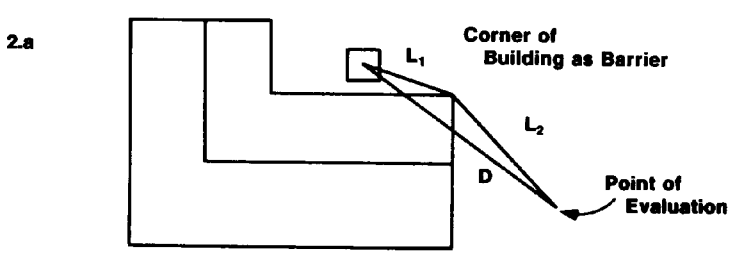


Table 1. Application Factors for Estimating A-Weighted Sound Pressure Levels (Continued)

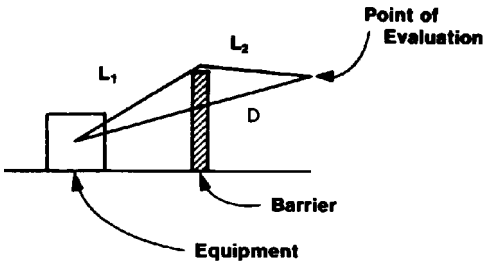
2. Barrier Shielding Factor (see sketches below). Sound reduction benefits can be gained when a solid structure obstructs the sound path. These structures could be:

a. Corner of building
b. Corner of flat roof and wall
c. Parapet around flat roof
d. Heavy continuous wall





$L = L_1 + L_2 - D$, where:

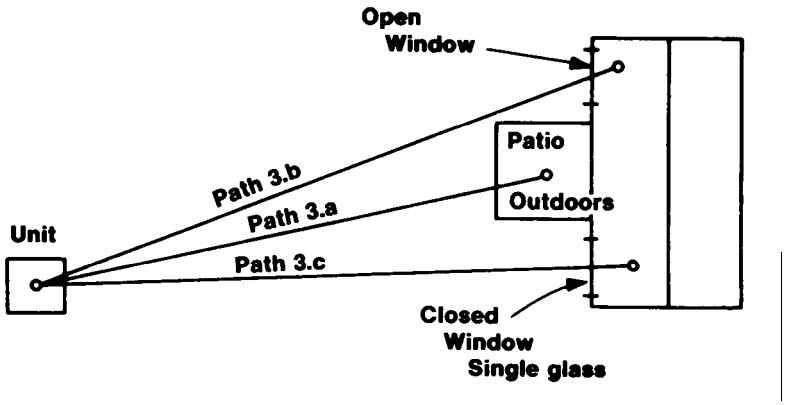


$L_1 + L_2$ = Distance from equipment point of evaluation around barrier (Use minimum $L_1 + L_2$ value.)

D = Direct distance from equipment to point of evaluation with no barrier. Determine D by layout sketch.

L ft. [m]	Factor Value
0.5 [0.15]	4 dB
1 [0.3]	7 dB
2 [0.6]	10 dB
3 [0.9]	12 dB
6 [1.8]	15 dB
12 [3.7]	17 dB

Table 1. Application Factors for Estimating A-Weighted Sound Pressure Levels (Continued)	
3. Sound Path Factor	Factor Value
a. To a point of evaluation outdoors	0 dB
b. To room through open window(s) or open door(s)	10 dB
c. To room through closed single glass window(s) or door	17 dB
d. To room through closed double glass window(s) or solid wall (not illustrated)	23 dB



4.1.2 *Barrier Shielding Factor*. This factor accounts for the sound reduction benefit of any solid structure that obstructs the line of sight (or sound) from the equipment location to the point of evaluation. Such a barrier may be the corner of a building, the edge of a roof, or a heavy wall of masonry, etc., built for the specific purpose of shielding noise from a unit to an area of concern. See Item 2, Table 1, for sketches and the normal barrier factors.

4.1.3 *Sound Path Factor*. This factor adjusts for the path of sound from the unit to the point of evaluation, which may be to the outdoors only, to a room through open windows, to a room through closed windows, or through a wall. See Item 3, Table 1.

4.1.4 *Distance Factor*. The direct distance, D, from the equipment location to the point of evaluation is a very significant application factor in determining the estimated A-Weighted sound pressure levels resulting from the operation of outdoor equipment in any installation. The distance factor is obtained from Table 2.

Table 2. Distance Factor		
ft.	[m]	Factor Value (dB)
4	1.2	9.5
5	1.5	11.5
6	1.8	13.0
7	2.1	14.5
8	2.4	15.5
9	2.7	16.5
10	3.0	17.5
15	4.6	21.0
20	6.1	23.5
25	7.6	25.5
30	9.1	27.0
40	12.2	29.5
50	15.2	31.0
60	18.3	33.0
70	21.3	34.5
80	24.4	35.5
90	27.4	36.5
100	30.5	37.5
125	38.1	39.5
150	45.7	41.0
175	53.3	42.5
200	61.0	43.5
400	122.0	49.5

4.2 *Procedure for Estimating Sound Pressure Levels - Single Unit Installation.* The basic procedure for estimating A-Weighted sound pressure levels at a given point of evaluation consists of combining the sum of the application and evaluation factors with the Sound Rating Level for the equipment:

	Sound Rating Level from ARI 270	_____
+	Equipment Location Factor	_____
–	Barrier Shielding Factor	_____
–	Sound Path Factor	_____
–	Distance Factor	_____
	Estimated A-Weighted Sound Pressure Level	_____ dB*

4.3 *Procedure for Estimating Sound Levels-Multiple Unit Installation.* Estimated sound levels for multiple unit installations at any point of interest can be determined by combining the effects of each unit at the point of interest. The procedure for multi-unit installations follows that used for single units except for the additional procedure used to combine numbers.

4.3.1 The combined level for all units is determined as follows:

1. Determine the numerical difference between the largest and next largest levels.
2. Using Table 3, find the proper value and add it to the larger number. This combines the two largest numbers.
3. Determine the numerical difference between this combined number and the third largest level. Again, using Table 3, find the proper value and add it to the combined number.
4. Continue this combining procedure until the value to be added from Table 3 becomes 0.0 or until all numbers have been combined.
5. The resulting single number represents the effect of all units at the point of evaluation. (See Example 4.5.4)

Table 3. Values Used for Combining Numbers for Multi-Unit Installations

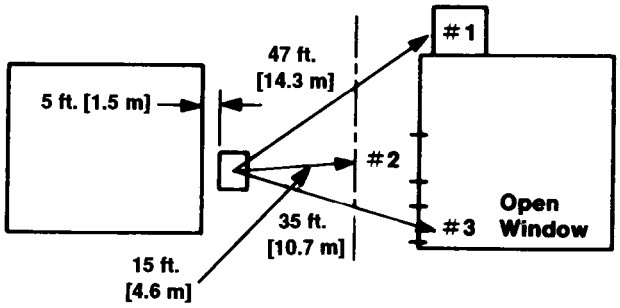
Difference Between Numbers (dB)	Value to be Added to Larger Number (dB)
0.0 to 0.5	3.0
1.0 to 1.5	2.5
2.0 to 3.0	2.0
3.5 to 5.0	1.5
5.5 to 7.0	1.0
greater than 7.0	0.0

4.4 *Points of Evaluation.* The calculation procedures described in 4.2 and 4.3 should be made for each area of concern to evaluate the installation from an acoustic standpoint (see 4.5, Examples). Measured A-Weighted sound pressure levels shall be within ± 5 dB of estimated levels when background levels are at least 5 dB below measured values. This estimation error accounts for the effect of the tone adjustment applied during the rating procedure of ARI Standard 270, as well as inaccuracies in the estimation procedure itself. To obtain the background level, readings shall be made with the unit not operating. The effects of environmental conditons on estmated sound levels are not included in this procedure.

* Rounded to the nearest whole dB value.

4.5 *Examples.*

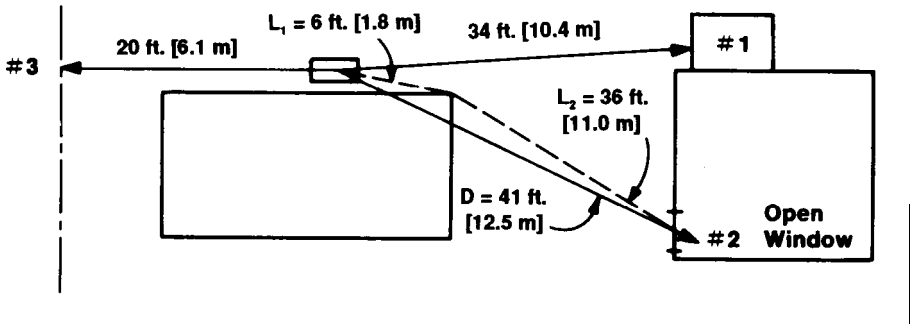
4.5.1 *Installation with No Barriers and One Reflective Surface.*



Sound Rating Level of Unit - 68 dB

Line	Distance from equipment to evaluation point 1. 47 ft. [14.3 m] 2. 15 ft. [4.6 m] 3. 35 ft. [10.7 m]	Evaluation Points		
		1	2	3
1	Unit Sound Rating Level (ARI Standard 270)	68	68	68
2	Equipment Location Factor (Table 1, Item 1)	3	3	3
3	Add Lines 1 and 2	71	71	71
4	Barrier Shielding Factor (Table 1, Item 2)	0	0	0
5	Sound Path Factor (Table 1, Item 3)	0	0	10
6	Distance Factor (Table 2)	31	21	28
7	Add Lines 4, 5 and 6	31	21	38
8	Estimated A-Weighted Sound Pressure Level (Subtract Line 7 from Line 3)	40	50	33

4.5.2 *Installation with Barriers.*

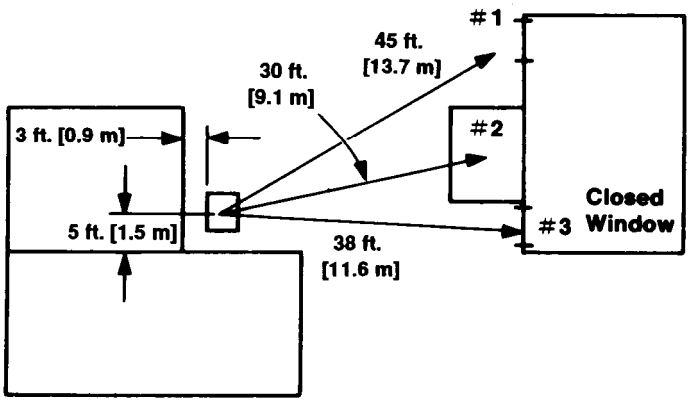


Sound Rating Level of Unit - 70 dB

$L = L_1 + L_2 - D$

Line	Distance from equipment to evaluation point 1. 34 ft. [10.4 m] 2. 41 ft.[12.5 m] 3. 20 ft. [6.1 m]	Evaluation Points		
		1	2	3
1	Unit Sound Rating Level (ARI Standard 270)	70	70	70
2	Equipment Location Factor (Table 1, Item 1)	3	3	3
3	Add Lines 1 and 2	73	73	73
4	Barrier Shielding Factor (Table 1, Item 2)	0	7	0
5	Sound Path Factor (Table 1, Item 3)	0	10	0
6	Distance Factor (Table 2)	28	29.5	23.5
7	Add Lines 4, 5 and 6	28	46.5	23.5
8	Estimated A-Weighted Sound Pressure Level (Subtract Line 7 from Line 3)	45	26.5	49.5
9	Estimated A-Weighted Sound Pressure Level Rounded to Nearest Whole Number	45	27	50

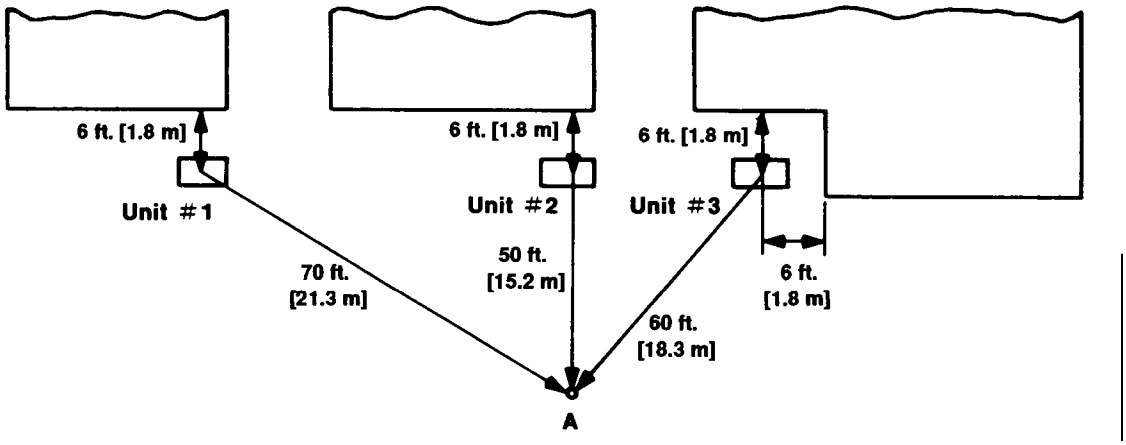
4.5.3 *Installation with Two Reflective Surfaces.*



Sound Rating Level of Unit - 71 dB

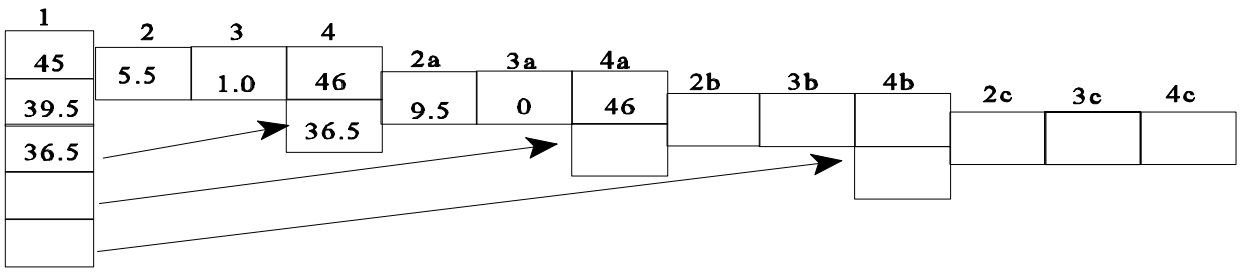
Line	Distance from equipment to evaluation point 1. 45 ft.[13.7 m] 2. 30 ft. [9.1 m] 3. 38 ft. [11.6 m]	Evaluation Points		
		1	2	3
1	Unit Sound Rating Level (ARI Standard 270)	71	71	71
2	Equipment Location Factor (Table 1, Item 1)	6	6	6
3	Add Lines 1 and 2	77	77	77
4	Barrier Shielding Factor (Table 1, Item 2)	0	0	0
5	Sound Path Factor (Table 1, Item 3)	0	0	17
6	Distance Factor (Table 2)	30.5	27	29
7	Add Lines 4, 5 and 6	30.5	27	46
8	Estimated A-Weighted Sound Pressure Level (Subtract Line 7 from Line 3)	46.5	50	31
9	Estimated A-Weighted Sound Pressure Level Rounded to Nearest Whole Number	47	50	31

4.5.4 *Multiple Units.*



Sound Rating Level of Unit #1 - 68 dB
Sound Rating Level of Unit #2 - 68 dB
Sound Rating Level of Unit #3 - 72 dB

Line	Distance from equipment to evaluation point: 1. 70 ft. [21.3 m] 2. 50 ft. [15.2 m] 3. 60 ft. [18.3 m]	Units		
		1	2	3
1	Sound Rating Level of Units (ARI Standard 270)	68	68	72
2	Equipment Location Factor (Table 1, Item 1)	3	3	6
3	Add Lines 1 and 2	71	71	78
4	Barrier Shielding Factor (Table 1, Item 2)	0	0	0
5	Sound Path Factor (Table 1, Item 3)	0	0	0
6	Distance Factor (Table 2)	34.5	31.5	33
7	Add Lines 4, 5 and 6	34.5	31.5	33
8	Estimated A-Weighted Sound Pressure Level (Subtract Line 7 from Line 3)	36.5	39.5	45
9	Estimated A-Weighted Sound Pressure Level Rounded to Nearest Whole Number	37	40	45



10	Estimated Combined A-Weighted Sound Pressure Level at Point A	46

4.5.5 *Calculation Procedure for Multiple Units.*

1. Calculate estimated A-Weighted sound pressure level for each unit.

2. List estimated level for each unit in Column 1, starting with the largest number first and second largest next, etc.

3. Enter in Column 2, the difference of values between the two largest.

4. Enter in Column 3, the value to be added to the largest value from Table 3.

5. Enter in Column 4, the new value.

6. If there are more than two units, repeat above procedure 3 through 5, starting in Column 2a. Continue until a single value exists. Note that the third entry in Column 1 is transferred to Column 4 as indicated by the arrow, the fourth to Column 4a, etc.

Section 5. Recommended Practices

5.1 *Unit Selection*. Sizing should be adequate to handle the heat gains established by use of ASHRAE GRP158 Cooling and Heating Load Calculation Manual or equivalent. More than slight oversizing should be avoided, as this will result in excessive cycling (the end results being both poor thermal control and objectionable acoustical behavior).

5.2 *Location*. Outdoor units should be placed on sites chosen to minimize sound heard by building occupants and/or neighbors. This is accomplished by choosing a location that results in the lowest equipment location factor, the highest barrier shielding factor, and the greatest distance to sound sensitive areas. (See Section 4 and Table 1).

5.2.1 *Barrier Shielding*. Section 4.1.2 and Table 1 address the sound reduction which would be estimated when barriers exist between a sound source and a point of observation. Using these data, advantage should be taken of any possible barriers offered by existing structures. If a barrier is to be constructed specifically for this purpose, more accurate results can be obtained if the noise eminating from the installed equipment is measured before the barrier design is finalized. Measurements should be made on both the "A" and "C" scales of a standard sound level meter. The difference between these two readings may be used with Table 4 to obtain a better estimate of sound reduction than would be possible without such measurements. As an example, if the C-Weighted level is 60 dB and the A-Weighted level is 55 dB, a barrier (for which L = 2 for the location under consideration) would be expected to provide a reduction of 13 dB instead of 10 dB as indicated in Table 1, with a resultant A-weighted sound pressure level of 42 dB.

5.2.2 *Orientation*. Many items of equipment have a directional pattern of sound radiation. In the absence of such data, it can be assumed that sound will be radiated most strongly in directions normal to the surfaces through which air enters and leaves the equipment. Where permitted by other installation details, the directions of maximum sound radiation from the equipment should be oriented towards the least sensitive locations on the site.

5.2.3 *Multiple Unit Locations*. When the sound level for a combination of units exceeds the desired value at the point of evaluation, changes in unit location or sound path should be made to the individual unit that produced the highest single contribution to the sound level. This may not be the unit with the highest sound rating level. When reduction in the combined sound level is required in cases where several units produce equal individual sound levels (they differ by less than 2 dB), changes must be considered for each of these in order to make an overall improvement. Recalculating the combined sound level assuming several possible changes will quickly indicate the most desirable modifications.

5.3 *Installation*.

5.3.1 *Mounting*. Equipment should be mounted on a substantial foundation. Precast concrete slabs may be used for smaller units, in which case, care should be taken to assure a firm, distributed support for the slab. Equipment intended for mounting in a wall or on a roof should be installed in accordance with the manufacturer's recommendations. It should be ascertained that the building structure at the point of attachment is sufficiently strong and rigid to accept the added load. Equipment which is not intended for mounting to the building structure should not be rigidly attached to a wall or other structure of substantial size which may radiate sound.

Table 4. Expected Reduction with Barrier

L (Path Line Difference Defined in Table 1)	Measurement Without Barrier in Place (C-Weighted Sound Power Level minus A-Weighted Sound Power Level)							
	0 - 2	3 - 4	5 - 6	7 - 8	9 - 10	11 - 12	13 - 14	15 - 16
0.5	8	8	7	6	5	4	3	1
1	12	11	10	9	8	6	5	3
2	15	14	13	12	11	10	8	6
3	17	16	15	14	12	11	10	8
6	20	19	18	17	16	14	13	11
12	23	22	21	20	18	17	16	14

5.3.2 *Isolation.* Equipment mounted to the building structure should employ a system to isolate vibrations from that structure. An isolation system is desirable in all other cases except possibly the unit mounted to a small foundation slab provided solely for this purpose. (In this case, the manufacturer's recommendations regarding attachment should be followed.) In many cases the manufacturer may have designed isolation into the equipment, or may provide such isolation as an available accessory, or may provide specific recommendations for achieving such isolation. In the absence of such direction, isolators should be chosen in accordance with good practice. (The ASHRAE Handbook, HVAC Applications Volume, Chapter 43 is a reference for further discussion of isolation).

5.3.3 *Connections.* Ductwork, piping, and electrical conduit all provide potential short circuits to an isolation mount by making rigid connections between the equipment and the building structure. Providing flexible connections in each of these will prove effective in reducing sound transmission. Where flexible connections are not provided, it is desirable to resiliently support electrical service lines and refrigerant piping from the building structure. As a minimum requirement, direct firm contact between such components and the basic building structure should be avoided. Sealing of space between refrigerant lines and the holes provided through walls or roofs should be done with flexible material.

5.3.4 *Start-Up.* When placed in operation, the equipment should:

1. Be adjusted to operate on a recommended cycle for expected conditions (i.e., not cycling excessively).

2. Be properly charged, for efficient operation and cycling.

3. Have all shipping retainers or tie-downs removed, as specified in installation instructions.

4. Have all cabinet elements, access panels, etc., properly and securely fastened in place.

5. Be provided with electrical power within the nameplate specifications and tolerances.

Many of these conditions are necessary for proper thermal performance, but all can also affect sound generated by equipment.

Section 6. Voluntary Conformance

6.1 *Conformance.* While conformance with this standard is completely volunary, applications and installations represented as being in accordance with this standard shall conform with all the provisions thereof.

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 part of the standard.

A1.1 ANSI Standard S1.4-1983, *Specification for Sound Level Meters*, 1983, American National Standards Institute, 11 West 42nd Street, New York, NY 10036, U.S.A.

A1.2 ARI Standard 210/240-94, *Unitary Air Conditioning & Air-Source Heat Pump Equipment*, 1994, Air-Conditioning & Refrigeration Institute, 4301 North Fairfax Drive, Suite 425, Arlington, VA 22203, U.S.A.

A1.3 ARI Standard 270-95, *Sound Rating of Outdoor Unitary Equipment*, 1995, Air-Conditioning & Refrigeration Institute, 4301 North Fairfax Drive, Suite 425, Arlington, VA 22203, U.S.A.

A1.4 ASHRAE *Terminology of Heating, Ventilation, Air Conditioning and Refrigeration*, American Society of Heating, Refrigerating and Air-Conditioning Engineers, 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.

B1.1 ASHRAE GRP158, *Cooling and Heating Load Calculation Manual*, Second Edition, American Society of Heating, Refrigerating and Air-Conditioning Engineers, 1791 Tullie Circle N.E., Atlanta, GA 30329, U.S.A.

B1.2 ASHRAE Handbook, *Applications Volume*, 1996, American Society of Heating, Refrigerating and Air-Conditioning Engineers, 1791 Tullie Circle N.E., Atlanta, GA 30329, U.S.A.

TAB

TYPE TO BE USED ON THE COVER

TAB

275-97

40

37

5.0

1.5

46.5

37.0

Areaway 15 ft. [4.6 m] or less

Areaway Less Than 15 ft. [4.6 m]

Less Than 15 ft. [4.6 m]

5 ft. [1.5 m]

47 ft. [14.3 m]

15 ft. [4.6 m]

35 ft. [10.7 m]

L_1 = 6 ft. [1.8 m]

20 ft. [6.1 m]

D = 41 ft. [12.5 m]

34 ft. [10.4 m]

L_2 = 36 ft. [11.0 m]

3 ft. [0.9 m]

45 ft. [13.7 m]

38 ft. [11.6 m]

30 ft. [9.1 m]

70 ft. [21.3 m]

50 ft. [15.2 m]

60 ft. [18.3 m]

6 ft. [1.8 m]

6 ft. [1.8 m]

6 ft. [1.8 m]

6 ft. [1.8 m]