02PD017

JOHN W. HEY & COMPANY

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Rapid City, SD 57701

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May 22, 2002

Williams & Associates Architecture, Inc
125 E Colorado Blvd., Suite 2A
Spearfish, SD 57783

RECEIVED
MAY 22 2002
Rapid City
Planning Department

ATTN: Steve

RE: Slingsby/Wright Clinic
Rapid City, South Dakota
Mechanical Equipment Sound Concerns

Gentlemen:

The purpose of this letter is to respond to the comments generated by the Rapid City Planning Department with regard to the sound level of the rooftop HVAC equipment. Enclosed is sound power data for the largest rooftop unit being located on the roof along with data for a residential condensing unit for comparison.

The overall sound power in db(a) for each are:

Residential condensing unit	83
10 ton packaged roof top unit	87

Dd stands for decibels and is on a logarithmic scale. Each 10 db is 10 times more watts of energy, but to the human ear 10 db is perceived as 2 times the sound.

I have performed an evaluation of the sound levels for three locations for three units based on the 1997 ARI standard 275, Application of Sound Rating Levels of Outdoor Unitary Equipment:

Location #1	Top of Hill
Location #2	Property line Northeast
Location #3	Property line North

The tables are enclosed, the highest individual sound power was 54 db on the north side of the building at location 3, which is commercial to commercial.

The combined effect of all the units is harder to evaluate, from table 3 the additive effect is based on the differences in sound levels. The additive effect is greater if the units are all at the same level and less if the difference is greater.

From Location #1, on the hill, there are seven units that are visible, if they were all 87 db then the additive effect result in a level of 95 db or an additional 8 db. But the units are not all the same due to capacity and manufacturing differences. The actual additive effect is estimated to be approx. 5 db. With 5 db added to the highest calculated level the result would be **52** db at the north property line.

In the absence of a sound ordinance, I contacted the City of Sioux Falls, they reportedly require systems to comply with the following levels by taking a time weighted reading for 10 minutes at the property line or 50 ft from the building with a hand held meter reading db(a):

Commercial districts	65 db night and day
Residential	60 db day 55 db night

It is my opinion that the unitary rooftop unit concept is a quieter option than a central system primarily due to the type of sound generated. The small compressors which are located in insulated cabinets are less dynamic that a large reciprocating compressor found with a central system. The higher pitch sounds of the condenser fan do not have the energy to project as far a the larger chiller fans and are the same fans found on residential condensing units.

Please contact me if there are any questions or if additional information is required.

Sincerely,

JOHN W. HEY, P.E.

ADOC\WILL\SLINGSBY\soundrec

REGISTERED PROFESSIONAL ENGINEER
REG. NO.
3016
JOHN W.
HEY
SOUTH DAKOTA

SOUND EVALUATION

SLINGSBY WRIGHT CLINIC
RAPID CITY, SDAK

DATE: 5/21/2002

EVALUATION POINT LOCATION 1 (ON HILL)

LINE	ITEM	UNIT1	UNIT2	UNIT 3
	DISTANCE IN FT TO EQUIPMENT FROM EVALUATION POINT	200	200	260
1	UNIT SOUND RATING LEVEL	87	87	87
2	EQUIPMENT LOCATION FACTOR (TABLE 1.1)	3	0	3
3	ADD LINE 1 AND 2	90	87	90
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)	43.5	43.5	45.3
7	ADD LINES 4,5 AND 6)	43.5	43.5	45.3
8	ESTIMATED WEIGHTED SOUND PRESSURE LEVEL SUBTRACT FLINE 7 FROM LINE 3 dB (a)	**46.5**	**43.5**	**44.7**

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EVALUATION POINT LOCATION 3 (PROPERTY LINE NORTH)

		UNIT1	UNIT2	UNIT 3
DISTANCE IN FT TO EQUIPMENT FROM EVALUATION POINT		80	60	85
LINE	ITEM			
1	UNIT SOUND RATING LEVEL	87	87	87
2	EQUIPMENT LOCATION FACTOR(TABLE 1.1)	0	0	0
3	ADD LINE 1 AND 2	87	87	87
4	BARRIER SHIELDING FACTOR (TABLE 1, ITEM 2)	10	0	0
5	SOUND PATH FACTOR (TABLE 1, ITEM 3)	0	0	0
6	DISTANCE FACTOR (TABLE 2)	35.5	33	36
7	ADD LINES 4,5 AND 6)	45.5	33	36
8	ESTIMATED WEIGHTED SOUND PRESSURE LEVEL SUBTRACT FLINE 7 FROM LINE 3 dB (a)	**41.5**	**54**	**51**

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SOUND EVALUATION

SLINGSBY WRIGHT CLINIC
RAPID CITY, SDAK

DATE: 5/21/2002

EVALUATION POINT LOCATION 2 (PROPERTY LINE)

LINE	ITEM	UNIT1	UNIT2	UNIT 3
	DISTANCE IN FT TO EQUIPMENT FROM EVALUATION POINT	140	140	200
1	UNIT SOUND RATING LEVEL	87	87	87
2	EQUIPMENT LOCATION FACTOR(TABLE 1.1)	3	0	3
3	ADD LINE 1 AND 2	90	87	90
4	BARRIER SHIELDING FACTOR (TABLE 1, ITEM 2)	7	4	0
5	SOUND PATH FACTOR (TABLE 1, ITEM 3)	0	0	0
6	DISTANCE FACTOR (TABLE 2)	40	40	43.5
7	ADD LINES 4,5 AND 6)	47	44	43.5
8	ESTIMATED WEIGHTED SOUND PRESSURE LEVEL SUBTRACT FLINE 7 FROM LINE 3 dB (a)	**43**	**43**	**46.5**

JOHN W. HEY P.E.

York Unitary Products Group

YORK INTERNATIONAL

5-10-2002

To: Lance – O'Connor Co. @ Fax 605-348-9215

Subj: **Outdoor Sound Power Ratings**

The following outdoor sound power ratings are based on nominal full load operation at a 95 F ambient.

Model	Octave Band Centerline Frequency, Hertz								db(A)
	65	125	250	500	1,000	2,000	4,000	8,000	
	Sound Power Level, db(10)-12 Watts								
Res Condr H4CR090	82	83	81	80	79	74	71	66	83
10 ton RTU DM102	87	88	86	84	82	76	74	69	87

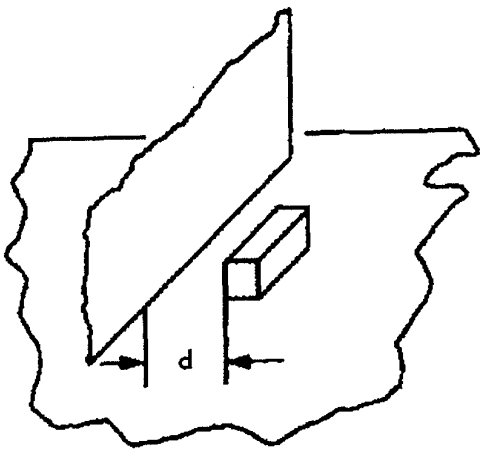
George Simonson – UPG Technical Service

Post-it® Fax Note 7671	Date 5-10-02	# of pages ▶ 5
To John Hey	From G	
Co./Dept.	Co. O'C	
Phone #	Phone #	
Fax #	Fax #	

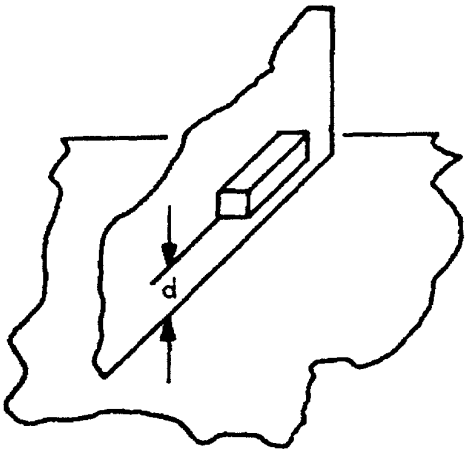
P.O. Box 1592, York, Pennsylvania USA 17405-1592 • Telephone (717)771-7890

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

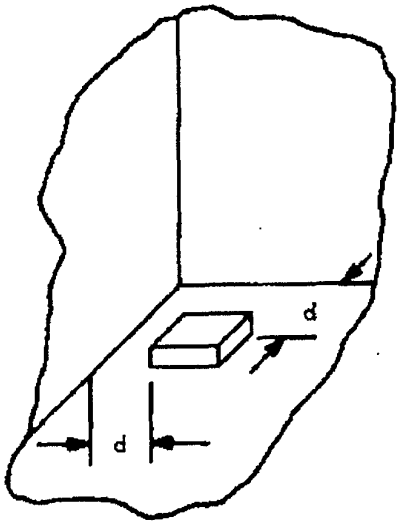


On Ground or Roof
Single Reflective Surface

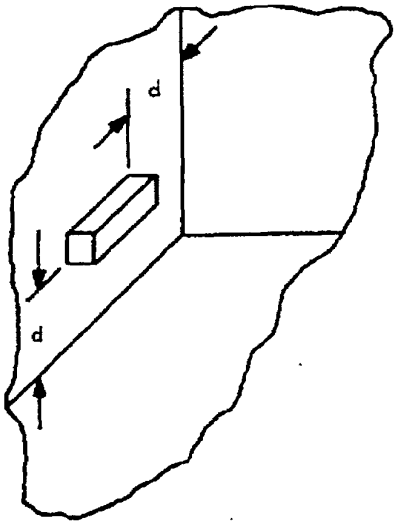


In Side of Building
Single Reflective Surface

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



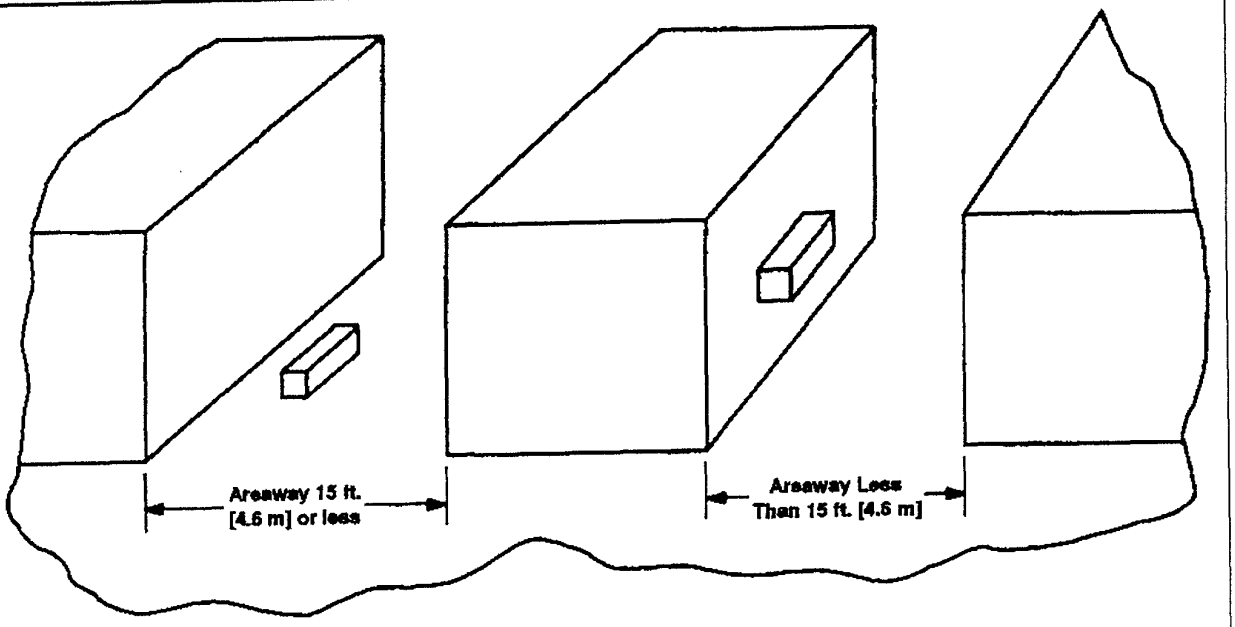
On Ground or Roof
Two Adjacent Reflecting Surfaces



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



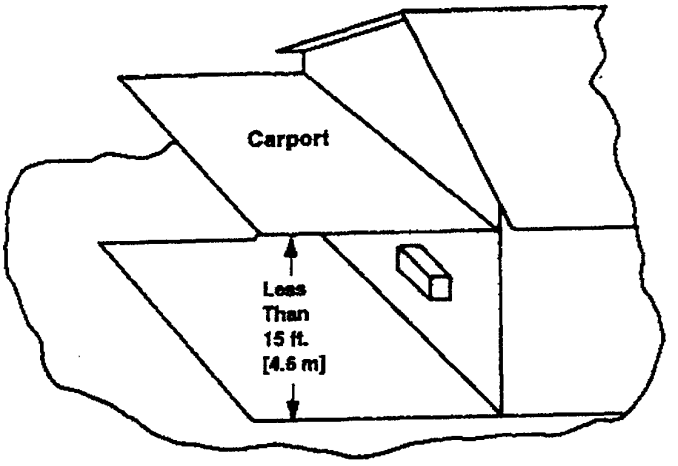
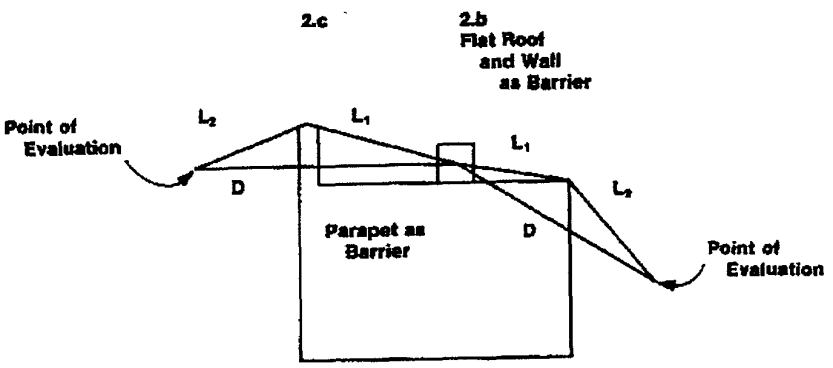
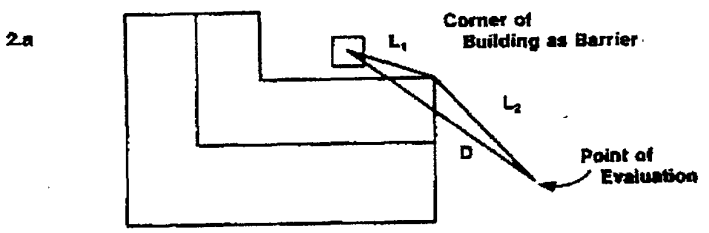


Table 1. Application Factors for Estimating A-Weighted Sound Pressure Levels (Continued)

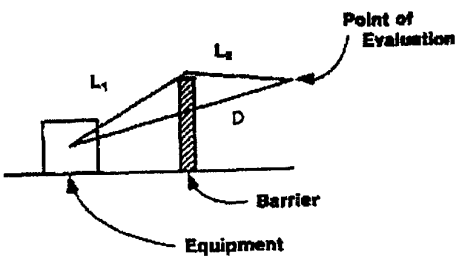
2. Barrier Shielding Factor (see sketches below). Sound reduction benefits can be gained when a solid structure obstructs the sound path. These structures could be:

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:



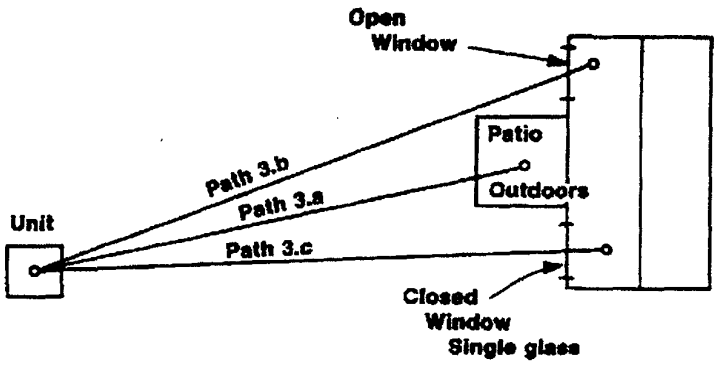
L ft. [m]	Factor Value
0.5 [0.15]	4 dB
1 [0.3]	7 dB
2 [0.6]	10 dB
3 [0.9]	12 dB
6 [1.8]	15 dB
12 [3.7]	17 dB

$L_1 + L_2$ = 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.

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:

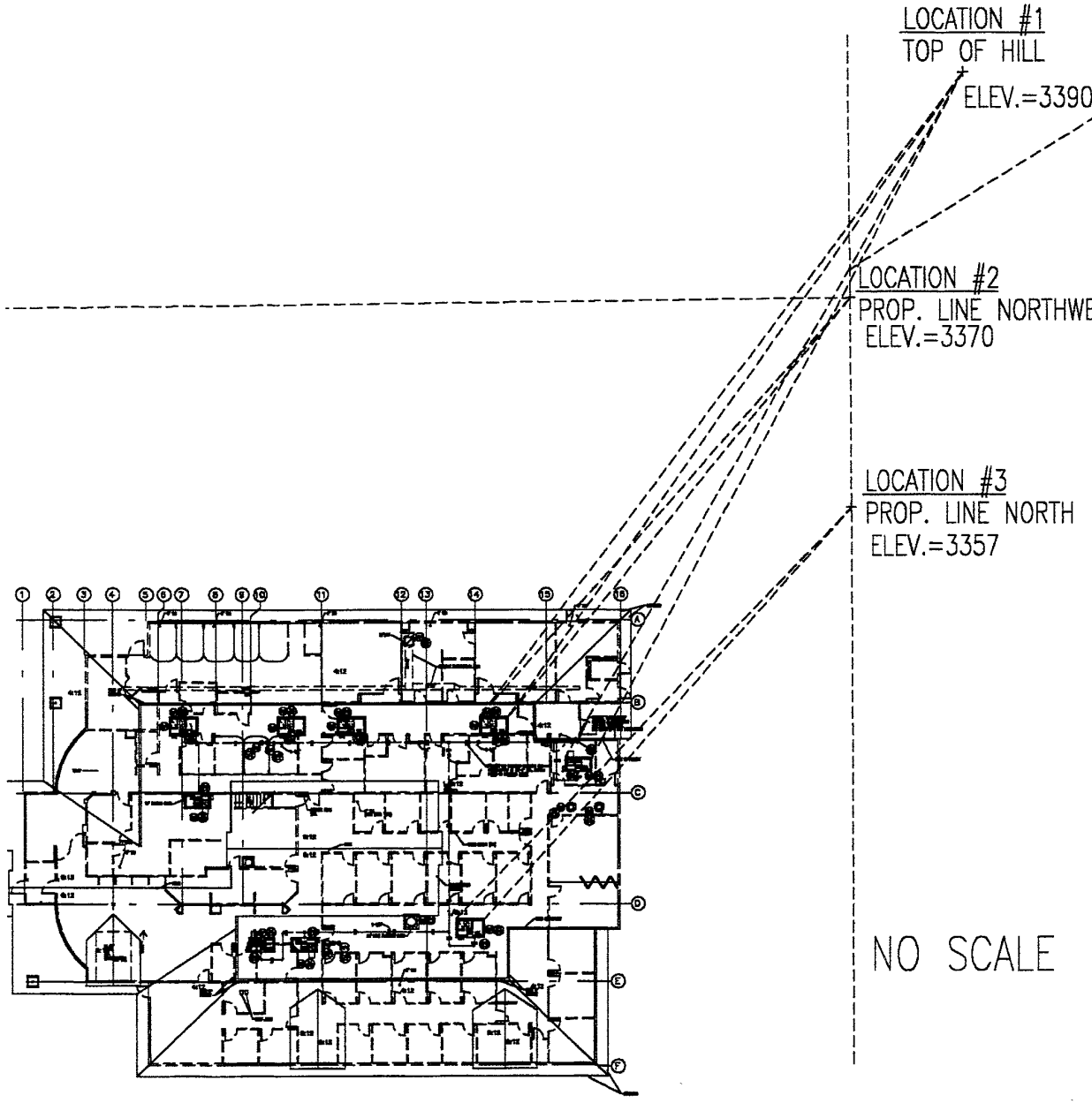
1. Determine the numerical difference between the largest and next largest levels.
2. Using Table 3, find the proper value and add it to the larger number. This combines the two largest numbers.
3. Determine the numerical difference between this combined number and the third largest level. Again, using 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)

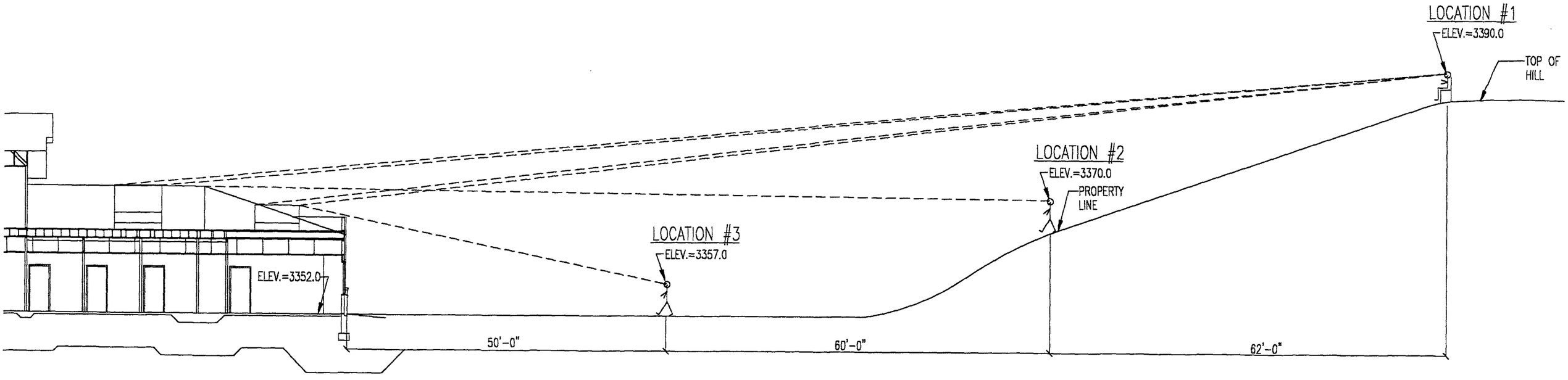
Table 3. Values Used for Combining Numbers for Multi-Unit Installations

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.


LOCATION #1
TOP OF HILL
ELEV.=3390
LOCATION #2
PROP. LINE NORTHWE
ELEV.=3370
LOCATION #3
PROP. LINE NORTH
ELEV.=3357
NO SCALE
ROOF PLAN - MECHANICAL



NO SCALE

LINES NOT TRUE SCALE