ACOUSTICAL SPECIFICATIONS FOR TERMINAL UNITS

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INTRODUCTION

With the release of Appendix-E to ARI 885-98 ('Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Air Outlets'), ARI is now requiring that manufacturers who show calculated NC values use the tables in the appendix to perform those calculations. ARI Standard 885-98 provides the most current application factors for converting rated sound power to a predicted room sound pressure level. It replaces the 1990 version, and has slightly different calculations for radiated sound, includes updated ASHRAE tables and a new Environmental Effect. The 885 standard provides a number of equations and tables available elsewhere, but puts them all in one document, and includes some unique tables as well. It also includes examples and diagrams to make the process easier to use. The calculations have been repeatedly verified in tests and mock-ups, and should be accurate to within 3dB in most properly defined applications.

Application Assumptions

ARI 885-98 Discharge / < 300 cfm	Octave Bands					
	2	3	4	5	6	7
Env Effect	2	1	0	0	0	0
Duct Lining, 5ft, 8x8 x1"	2	6	12	25	29	18
End Reflection	9	5	2	0	0	0
Power Division (0 outlets)	0	0	0	0	0	0
5Ft, 8in. Flex Duct	6	10	18	20	21	12
Space Effect	5	6	7	8	9	10
Total Attenuation*	24	28	39	53	59	40

ARI 885-98 Discharge 300-700 cfm	Octave Bands					
	2	3	4	5	6	7
Env Effect	2	1	0	0	0	0
Duct Lining, 5ft, 12x12 x1"	2	4	10	20	20	14
10" End Reflection	9	5	1	0	0	0
Power Division (2 outlets)	3	3	3	3	3	3
5Ft, 8in. Flex Duct	6	10	18	20	21	12
Space Effect	5	6	7	8	9	10
Total Attenuation*	27	29	40	51	53	39

ARI 885-98 Discharge >700 cfm	Octave Bands					
	2	3	4	5	6	7
Env Effect	2	1	0	0	0	0
Duct Lining, 5ft, 15x15 x1"	2	3	9	18	17	12
End Reflection	9	5	2	0	0	0
Power Division (3 outlets)	5	5	5	5	5	5
5Ft, 8in. Flex Duct	6	10	18	20	21	12
Space Effect	5	6	7	8	9	10
Total Attenuation*	29	30	41	51	52	39

ARI 885-98 Radiated	Octave Bands					
	2	3	4	5	6	7
Mineral Tile space/ceiling effect	16	18	20	26	31	36
Environ. Effect	2	1	0	0	0	0
Total dB reduction	18	19	20	26	31	36

Figure 1

Historically, most sound levels are both specified and reported as either dBA or NC. A dBA value is the average of all sound frequencies weighted against a standard curve, and is, as a result, essentially useless as a sound descriptor or diagnostic. NC (Noise criteria) is a better descriptor but has some shortcomings, especially as a predictor of speech privacy. The use of RC (room criteria) has been proposed as a better descriptor, and has been substituted for NC in recent ASHRAE handbooks.

In the mid frequencies, NC and RC result in similar ratings. RC has the advantage of an additional Letter (or Letters) to describe high (H) and low frequency rumble (R) and vibration (V) characteristics. Unfortunately, when used to rate the performance of VAV terminals, or any device that is predominant in the low frequencies, significant differences between products can be masked by this rating scheme. Other descriptors have also been proposed including RC MkII and NCB. These often require measurements in the 63 Hz or lower octave bands. The 20,000 Cu.Ft. reverb room required for these measurements isn't available, and VAV terminals do not produce significant sound levels in these lower frequencies, in any case. As a result, VAV box manufacturers will likely continue to rate products in NC units.

Speech privacy is a condition where an occupant sitting at his or her desk can hear adjacent conversations, but does not understand enough of them to be distracted by the conversations. Surveys of occupants have shown that preferred background sound levels to achieve speech privacy do not correspond well with NC curves, and are the basis of the change to RC ratings. Lack of acoustical privacy, and distraction due to poor acoustics are one of the highest complaints from building occupants today.

The table below shows 5 different room sound spectra. The high and low speech privacy spectra reflect survey data taken during the development of open office acoustical criteria. An RC=40(N) is the mean RC level meeting this criteria. Also listed are NC 35 and 40 spectra.

	2	3	4	5	6	7
Suggested Room sound pressures	125	250	500	1000	2000	4000
High Speech Privacy	57	53	48	43	37	31
Low Speech Privacy	52	49	44	37	32	20
RC 40	60	55	45	40	35	33
NC40	55	50	44	41	39	38
NC35	52	45	40	36	34	32

Figure 2

SPECIFYING SOUND LEVELS

Often, specifications list a maximum space NC value as a design criterion. The supplier of a VAV terminal, however, cannot guarantee sound levels without knowing a number of acoustical parameters, including inlet static pressure, length of lining, ceiling type and plenum depth, etc. Also, the equipment supplier cannot control installation details. What is really required is the opposite, a not-to-exceed sound power specification value. We can accomplish this by starting with a desired room sound pressure level, and then adding the expected acoustical deductions to that value, creating a maximum allowable sound power requirement.

If one starts with one of the room sound pressure curves from the table above, and applies ARI 885's Appendix E "standard" assumptions, one can develop a "standard" acoustical specification with a high expectation of the space actually meeting the required sound levels. If there is no duct lining allowed, as happens in health care and other applications, the 885 tables must be modified slightly. Below are suggested specifications for both lined and unlined duct applications:

Recommended, Based on ARI 885-98, with 5' duct lining

			Maximum Radiated Sound Power Level, dB, at Band No. and Center Freq., Hz						
All sizes	All inlets	Fan and 100% Primary	2 125	3 250	4 500	5 1,000	6 2,000	7 4,000	per ARI 885-98*
Minimum			70	64	60	62	65	68	NC=35
Maximum Speech Privacy			75	72	68	69	68	67	RC=42N
Maximum			78	74	65	66	66	69	RC=40N

			Maximum Discharge Sound Power Level, dB, at Band No. and Center Freq., Hz						
All sizes	All inlets	Fan and 100% Primary	2 125	3 250	4 500	5 1,000	6 2,000	7 4,000	per ARI 885-98*
Minimum			80	75	80	87	85	70	NC=35
Maximum Speech Privacy			85	83	88	94	88	69	RC=42N
Maximum			88	85	85	91	86	71	RC=40N

Recommended, Based on ARI 885-98, no duct lining

			Maximum Radiated Sound Power Level, dB, at Band No. and Center Freq., Hz						
All sizes	All inlets	Fan and 100% Primary	2 125	3 250	4 500	5 1,000	6 2,000	7 4,000	per ARI 885-98*
Minimum			70	64	60	62	65	68	NC=35
Maximum Speech Privacy			75	72	68	69	68	67	RC=42N
Maximum			78	74	65	66	66	69	RC=40N

			Maximum Discharge Sound Power Level, dB, at Band No. and Center Freq., Hz						
All sizes	All inlets	Fan and 100% Primary	2 125	3 250	4 500	5 1,000	6 2,000	7 4,000	per ARI 885-98*
Minimum			78	71	71	69	68	58	NC=35
Maximum Speech Privacy			83	79	79	76	71	57	RC=42N
Maximum			86	81	76	73	69	59	RC=40N

Figure 3

By utilizing values from the above tables in an acoustical specification, (and listing the required design inlet static pressure) a design engineer will be providing a specification based on the most current data, and free from any commercial / product bias, with a high probability of achieving an acceptable space.