CARNES®
Tech Talk

AWARE
a● ware'
Adj.
apprised;
informed;
cognizant;
conscious

THIS ISSUE: **Room Criteria (RC)**
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Overview:

You may notice that Carnes' newly published SK performance data includes both NC (Noise Criteria) as well as RC (Room Criteria) information. This Tech Talk describes both NC and RC and discusses the differences.

Background:

The standard for summarizing the sound generated by HVAC systems has historically been Noise Criteria, aka NC. ASHRAE's *1993 Fundamentals* defines NC as "a series of standardized curves that define a maximum allowable sound pressure level for each frequency band in order to achieve a level of occupant acceptance."

Some product groups have required more detailed information (e.g. fans and air terminals) because of certification requirements by AMCA, ARI and others, but for Diffusers, Registers and Grilles, NC has been the standard tool used by engineers to determine acceptable sound levels. NC provided a way to analyze sound that was easy to deal with, and was an improvement on previous methods.

NC is now being replaced by RC (Room Criteria) as an improved method of summarizing and describing sound. ASHRAE defines RC as "a series of curves designed especially for establishing HVAC system design goals with close approximation to a well balanced sound spectrum." Starting with the *1995 ASHRAE Applications Handbook* ASHRAE refers to NC in the past tense and the chart recommending sound levels for different rooms (Chapter 43, page 5) is given in RC.

As we'll see, RC provides a more accurate summary of the overall sound level, as well as a separate assessment of the quality of the sound. This results in a better tool for the engineer to use in designing the system.

To understand the difference between NC and RC, let's first cover some sound basics, go to NC calculation and then to RC calculation.

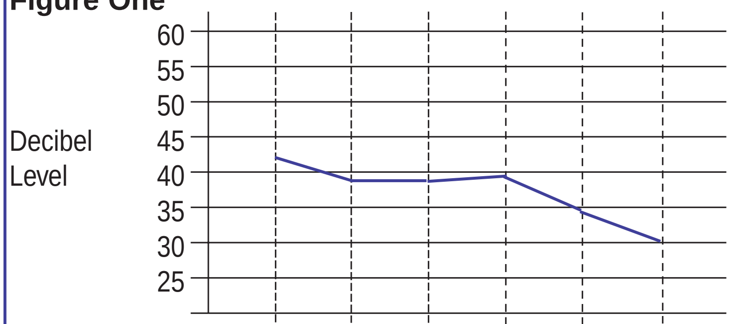
Following will be a comparison of the two methods and some tips on designing a system using the improvements that RC represents.

Acoustics Basics

When Carnes tests a diffuser, register or grille (D,R&G), air is sent through the product at a preset flow and the sound it makes is measured in a reverberant chamber. Precise measurements are made in decibels (db) at a series of frequencies known as octave band center frequencies. The smaller the frequency number, the lower the tone. To the average human ear 20 hz is the lower threshold of audible sound, and 20,000 hz is the upper threshold. D,R&G generate most audible sound between 125 hz and 4,000 hz. For each flow, the decibel levels are plotted on a graph which yields information similar to Figure One. This is the raw data from which both NC and RC are calculated.

In Table One and the subsequent examples, we'll use an SKTJ model, size 12" x 12", operating at 700 CFM. During this discussion the standard 10db room attenuation assumption (as per ARI Standard 885) will be subtracted out from the raw data.

Figure One



Octave Band >	2	3	4	5	6	7	
CenterFrequency >	125	250	500	1000	2000	4000	(Hz)
Raw Data >	42	38	38	39	34	30	(db)

Determining the NC Value (Figure 2)

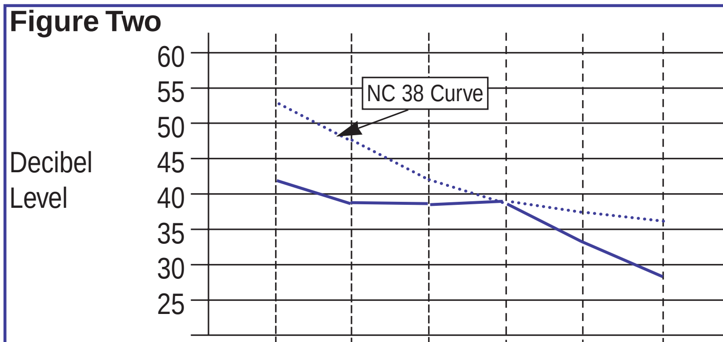
◇The NC curve is then applied to the octave band data. The NC value is determined by the point at which the raw data first contacts the NC curve. In our example at right, the NC curve for NC 38 contacts the raw data the the 1000hz frequency.

This method has 2 limitations:

◇<u>First</u>, if the NC level is determined by a single contact point which is significantly higher than the rest of the sound pressures, the overall level of background sound may be too quiet to mask unwanted speech and activity noises because the db levels on either side of the contact point drop off too rapidly.

◇<u>Second</u>, if the raw data closely matches the shape of the NC curve, the sound will have either a rumble or hiss character.

Figure Two



Octave Band >	2	3	4	5	6	7	
CenterFrequency >	125	250	500	1000	2000	4000	(Hz)
Raw Data >	42	38	38	39	34	30	(db)

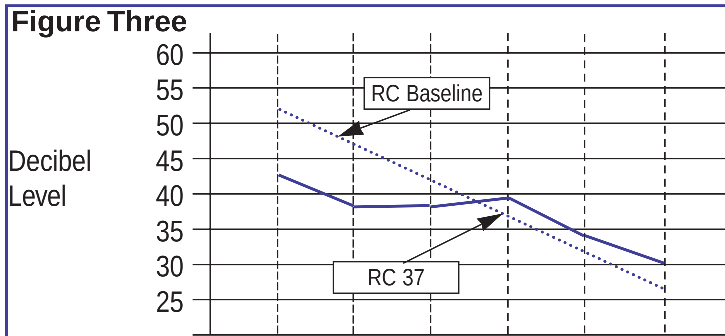
Determining the RC Value (Figure 3)

From the same raw data, we figure the RC value.

◇First we average the db levels at 500, 1000 and 2000 hz. <u>This is the RC value</u>. In our example at right, the RC value is 37.

◇Then we plot the line sloping down 5 db, using the RC value at 1000 Hz as a starting point. This is the RC Baseline, which we will use to figure the <u>RC Quality</u> of the sound.

Figure Three



Octave Band >	2	3	4	5	6	7	
CenterFrequency >	125	250	500	1000	2000	4000	(Hz)
Raw Data >	42	38	38	39	34	30	(db)
RC Base Line >	52	47	42	37	32	27	(db)

Determining the RC Quality (Figure 4)

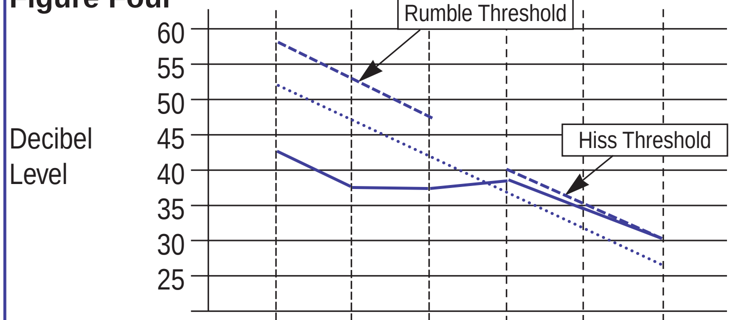
◇To determine whether it has a Neutral (N), Hiss (H) or Rumble (R) quality, we draw a rumble threshold line 5db above the 125, 250 and 500 hz Baseline values, and a Hiss threshold line 3db above the 1000, 2000 and 4000 hz Baseline.

◇If the raw data goes above the Hiss Threshold, then the RC quality is "H". If it goes above the Rumble Threshold, the RC quality is "R". If neither occurs, the RC quality is "N".

◇In our example at right, no values exceed the thresholds, so the quality is "N".

◇There is another threshold for lower frequencies called RV (Rumble/Vibrate), but it applies to machinery generating sound at much lower frequencies than air outlets will.

Figure Four



Octave Band >	2	3	4	5	6	7	
CenterFrequency >	125	250	500	1000	2000	4000	(Hz)
Raw Data >	42	38	38	39	34	30	(db)
RC Baseline >	52	47	42	37	32	27	(db)
"R" Threshold >	57	52	47	- - -	- - -	- - -	(db)
"H" Threshold >	- - -	- - -	- - -	40	35	30	(db)

Comparison of NC and RC.

A. Accuracy of representation.

RC is a more accurate representation of the sound being generated. Where NC will only give an overall number based on a single contact point, the RC value is based on three values, a more accurate representation of the sound being generated. RC therefore gives a more precise tool to use in designing a system.

B. Information on sound quality.

RC gives information on sound quality as well. NC is geared just to provide overall sound level, while RC provides additional information on sound quality. This better enables the engineer to spot and prevent problems at the design stage, rather than having to problem-solve after the system is installed and running.

◇*Example*. After the building owner moves in, there are complaints about noise coming from the diffusers at full flow. VAV sound and other factors are not a problem. CFM flows correlated to the catalog sound data show an NC level within the acceptable range. But the RC data shows that the diffuser sound has a hiss characteristic at that CFM. Hissing sounds are perceived as more audible and objectionable at the same sound pressure level. This tells us to resize the diffuser and/or alter the CFM through the use of more or fewer outlets, and knowing this in advance would prevent a lot of rework and redesign.

Applying RC data in designing the system.

Recommended RC levels for various applications vary slightly from the recommended NC levels. Carnes publishes recommended RC levels as well as recommended NC levels in the new edition of the "Square and Rectangular Louvered Face Diffusers" Catalog (D-70L). ASHRAE publishes a similar chart in *1995 ASHRAE Applications* in Chapter 43 (Sound and Vibration Control) on page 43.5.

The general acoustic guide in designing a system is that the sound should be at the correct level and neutral in quality (N), OR the units should be placed so that attenuation factors render the sound so quiet that the sound quality is irrelevant. For example, a unit that operates at an RC of 30H is acceptable if it is 20 feet off the floor in a large room, but the same unit in a 8' x 8' x 9' office is unacceptable. As another example, a unit operating at an RC of 14H is probably acceptable in a 8" x 8" x 9" small office because it is so quiet. Following are some rules of thumb to use if the selected unit doesn't look good acoustically.

<u>Rule of Thumb #1: If it has an "H", look to the next size up.</u>

Example:

- The designer is supplying 400 cfm to a room through a 4-way square diffuser and wants a 19 foot throw to a terminal velocity of 50 fpm.
- The Carnes SK Louvered Face diffuser, size 9" x 9" will throw to a 50 fpm terminal velocity at 19 feet, with an RC of 30H.
- Look at the <u>next size larger</u> and see that the 12" x 12" size will deliver the same cfm at the same throws, but the RC is now 18N.

<u>Rule of Thumb #2: If it has an "R", look to the next size down.</u>

Example:

- The designer is supplying 1200 cfm through a 4-way square diffuser, and wants a 32 foot throw to a terminal velocity of 50 fpm.
- The Carnes SK Louvered Face diffuser, size 24" x 24" will throw to a terminal velocity of 50 fpm at 32 feet, with an RC of 15R.
- Look at the <u>next size smaller</u> and see that the 21" x 21" size will deliver the same cfm at the same throws, but the RC is now 21N, a little louder, but now neutral in quality.

Further Reading.

1993 Fundamentals Handbook, Chapter 7*, Sound and Vibration.*

1995 ASHRAE Applications Handbook, Chapter 43*, Sound and Vibration Control.*

Acoustics, 1986*, L. L. Beranek*

Carnes Tech Talk, October 1993*, Edition 3, VAV and Sound*