



An Introduction to Noise Control in Buildings

An Online Continuing Education Course for Engineers

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An Introduction to Noise Control in Buildings

J. Paul Guyer, P.E., R.A.

1. INTRODUCTION

This is an introduction to noise control in buildings. It is not an in-depth treatment, but it will introduce designers to some important principles and terminology. In simple applications on real projects the information provided here will give designers a good start in addressing acoustic control issues. For more acoustically complex projects designers will need to apply more detailed principles. There are excellent acoustical engineering treatises available commercially and from government agencies to provide practitioners with the necessary guidance in applying these more rigorous methods.

2. NOISE CRITERIA

2.1 General. This section includes data and discussions on generally acceptable indoor noise criteria for acceptable living and working environments. These criteria can be used to evaluate the suitability of existing indoor spaces and spaces under design.

2.2 Noise Criteria In Buildings. Room Criteria (RC) and Noise Criteria (NC) are two widely recognized criteria used in the evaluation of the suitability of intrusive mechanical equipment noise into indoor occupied spaces. The Speech Interference Level (SIL) is used to evaluate the adverse effects of noise on speech communication.

2.2.1 Noise Criterion (NC) Curves. Figure 1 presents the NC curves. NC curves have been used to set or evaluate suitable indoor sound levels resulting from the operation of building mechanical equipment. These curves give sound pressure levels (SPLs) as a function of the octave frequency bands. The lowest NC curves define noise levels that are quiet enough for resting and sleeping, while the upper NC curves define rather noisy work areas where even speech communication becomes difficult and restricted. The curves within this total range may be used to set desired noise level goals for almost all normal indoor functional areas. In a strict interpretation, the sound levels of the mechanical equipment or ventilation system under design should be equal to or be lower than the selected NC target curve in all octave bands in order to meet the design goal. In practice, however, an NC condition may be considered met if the sound levels in no more than one or two octave bands do not exceed the NC curve by more than one or two decibels.

2.2.2 Room Criterion (RC) Curves. Figure 2 presents the Room Criterion (RC) curves. RC curves, like NC curves, are currently being used to set or evaluate indoor sound levels resulting from the operation of mechanical equipment. The RC curves differ from the NC curves in three important respects. First, the low frequency range has been extended to include the 16 and 31.5 Hz octave bands. Secondly, the high frequency range at 2,000 and 4,000 Hz is significantly less permissive, and the 8,000 Hz octave band has been omitted since most mechanical equipment

produces very little noise in this frequency region. And thirdly, the range over which the curves are defined is limited from RC 25 to RC 50 because; 1) applications below RC 25 are special purpose and expert consultation should be sought and; 2) spaces above RC 50 indicate little concern for the quality of the background sound and the NC curves become more applicable.

Table 1 lists representative applications of the NC curves. The evaluation of the RC curves is different than that for the NC curves. In general the sound levels in the octave bands from 250 to 2,000 Hz are lower than those of the NC curves. Should the octave band sound levels below 250 Hz be greater than the criteria a potential “rumble” problem is indicated. As a check on the relative rumble potential, the following procedure is recommended:

- Sum the sound pressure levels in the octave bands from 31.5 through 250 Hz on an energy basis.
- Sum the sound pressure levels in the octave bands from 500 through 4,000 Hz on an energy basis.
- Subtract the high frequency sum (step 2) from the low frequency sum (step 1).
- If the difference is +30 dB or greater, a positive subjective rating of rumble is expected, if the difference is between +25 and +30 dB a subjective rating of rumble is possible, if the difference is less than +20 dB a subjective rating of rumble is unlikely.

Also indicated on the RC curves (Figure 2) are two regions where low frequency sound, with the octave band levels indicated, can induce feelable vibration or audible rattling in light weight structures.

2.2.3 Speech interference levels. The speech interference level (SIL) of a noise is the arithmetic average of the SPLs of the noise in the 500-, 1000-, and 2000-Hz octave bands. The approximate conditions of speech communication between a speaker and listener can be estimated from Table 2 when the SIL of the interfering noise is known. Table 2 provides “barely acceptable” speech intelligibility, which implies that a few words or syllables will not be understood but that the general sense of the discussion will be conveyed or that the listener will ask for a repetition of portions missed.

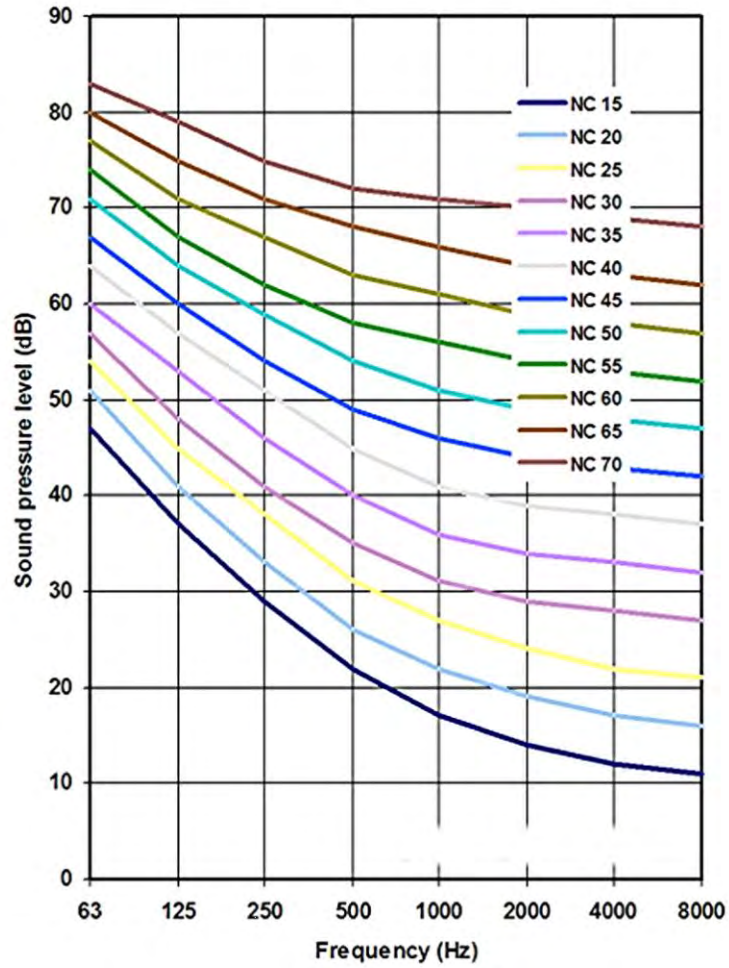


Figure 1 Noise Criterion (NC) Curves

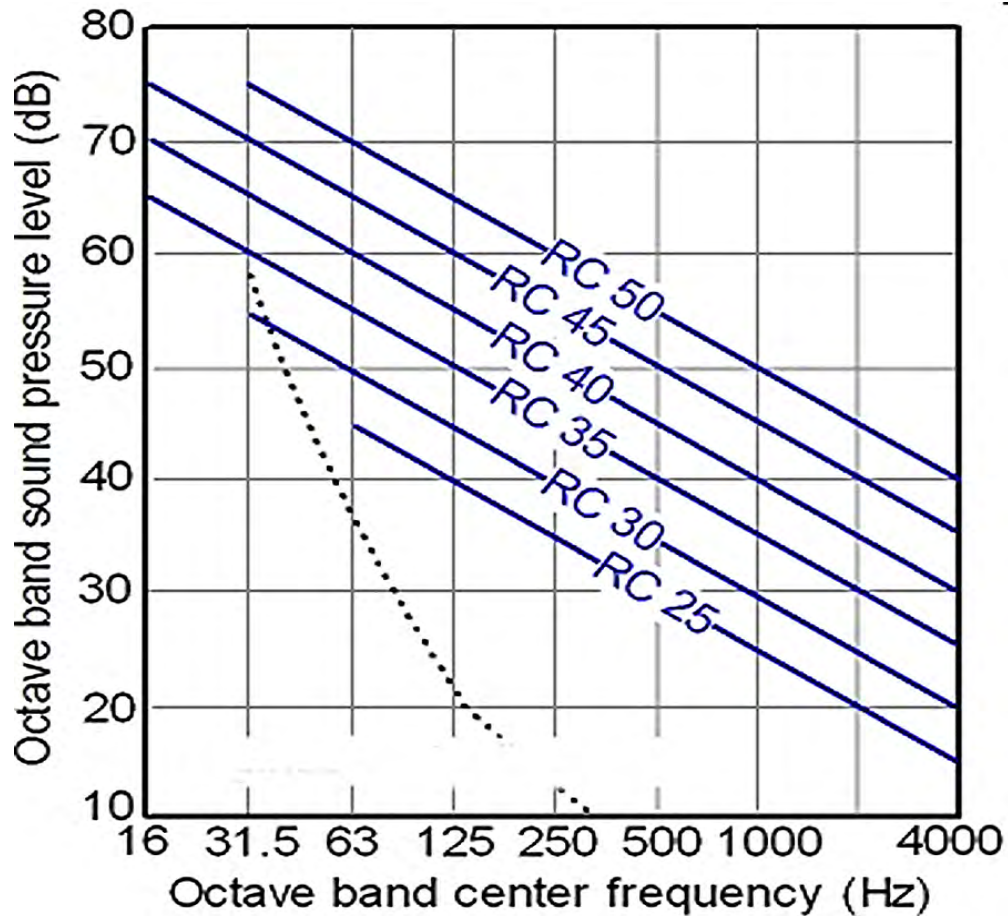


Figure 2 Room Criterion (RC) Curves

Table 1. Representative Applications of the NC Curves

Category	Area (and Acoustic) Requirements	Noise Criterion ^a
1	Bedrooms, sleeping quarters, hospitals, residences, apartments, hotels, motels, etc. (for sleeping, resting, relaxing).	NC-20 to NC-30
2	Auditoriums, theaters, large meeting rooms, large conference rooms, radio studios, churches, chapels, etc. (for very good listening conditions).	NC-15 to NC-30
3	Private offices, small conference rooms, classrooms, etc.	NC-30 to NC-35
4	Offices, classrooms, etc.	NC-35 to NC-40
5	Offices, classrooms, etc.	NC-40 to NC-50
6	Offices, classrooms, etc.	NC-45 to NC-65

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Distance (ft.)	Noise Level (dB)	Whispering	Normal Conversation	Shouting
1/2			86	92
1		74	80	86
2	62	68	74	80
4	56	62	68	74
6	53	59	65	71
8	50	56	62	68
10	48	54	60	66
12	46	52	58	64
16	44	50	56	62

3. SOUND DISTRIBUTION INDOORS

3.1 Sound Pressure level In a Room. The sound pressure levels at a given distance or the sound power levels for individual equipment items can often be obtained from equipment suppliers. Once the characteristics of the sound source have been determined, then the sound level at any location within an enclosed space can be estimated. In an outdoor “free field” (no reflecting surfaces except the ground), the sound pressure level (SPL) decreases at a rate of 6 dB for each doubling of distance from the source. In an indoor situation, however, all the enclosing