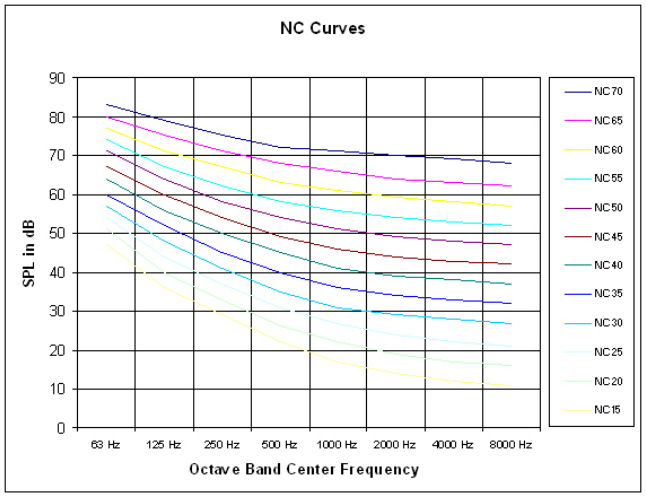
Noise Curve

Measurements with XL2

XL2 Audio and Acoustic Analyzer with M4260 Measurement Microphone

Noise curves are a common way to measure and specify audio noise in buildings and occupied spaces. Their purpose is to produce a single value representation of a complete sound spectrum. This application note describes how to measure noise curves with the XL2 Audio and Acoustic Analyzer.

Background noise may have several undesirable effects. Noise can be an annoyance that creates fatique and negatively affects productivity, safety and the ability to communicate. Therefore standard methodologies for quantifying noise have been developed. Noise curves reflect different standardized means of creating a single number rating for the background noise spectrum in a space. Different rooms, locations, regulations and applications may allow different acceptable noise ratings. In many cases, we want the background noise not to interfere with various ongoing activities, e.g. the noise of an office air-conditioning system should not interfere with telephone calls or conversations. But in other cases, special noise may also be tolerated or even introduced at higher levels, for example to create acoustic „privacy", or to help mask other more irritating noise sources.



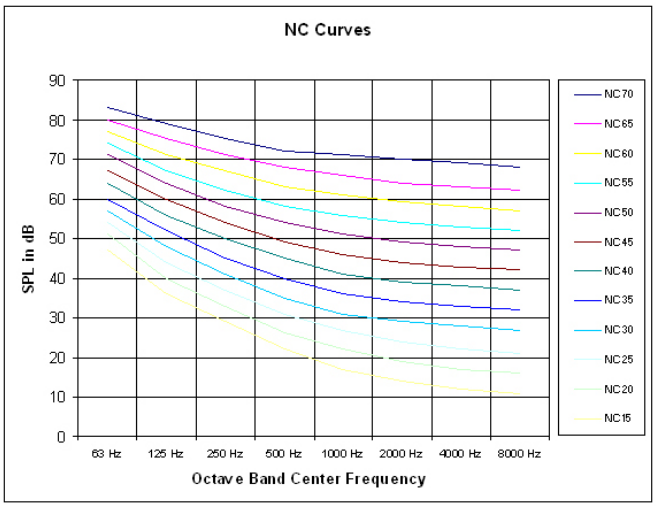
NC Noise Curves

Noise Curves serve as uniform measuring standards and are referred by many noise regulations covering a variety of locations from concert halls, rock concerts, lecture rooms and offices to clay target shooting ranges. The major four different types of noise curves are described here:

- Noise Criterion Curves (NC)
- Noise Rating Curves (NR)
- Preferred Noise Criterion Curves (PNC)
- Room Criteria Curves (RC)

Noise Criterion Curves (NC)

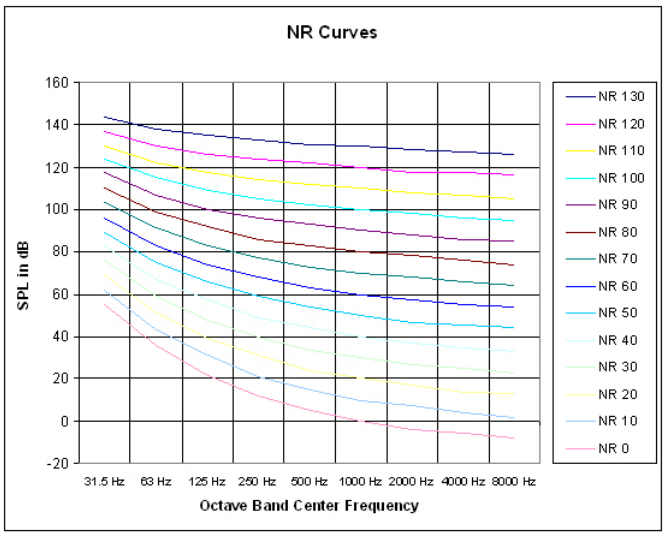
Noise Criterion curves (NC) are the first such curves developed in the world, and are classified with ASA and ANSI specifications. They are particularly used in various acoustic spaces for quantitatively rating residual noise and interference from all sources, including HVAC (Heating, Ventilation, Air Conditioning).



NC Noise Curves

Noise Rating Curves (NR)

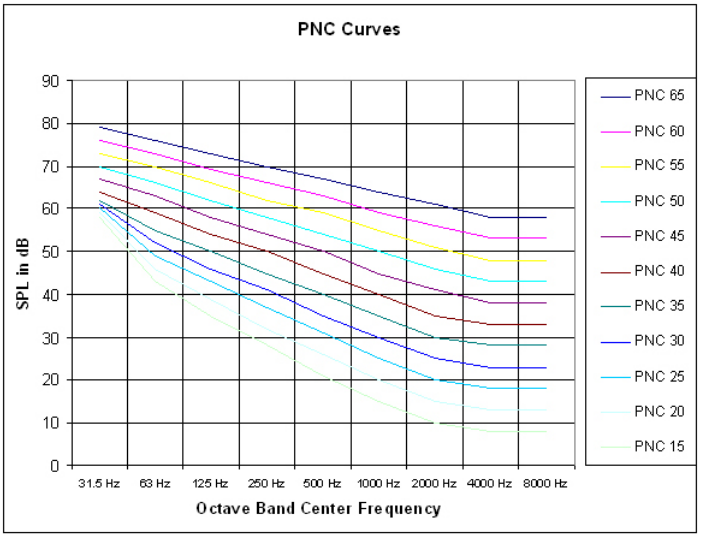
In Europe, Noise Rating curves (NR) are commonly used for regulatory purposes. They were developed as an ISO standard to determine the acceptable indoor environment for hearing preservation, speech communication and annoyance.



NR Noise Rating Curves

Preferred Noise Criterion Curves (PNC)

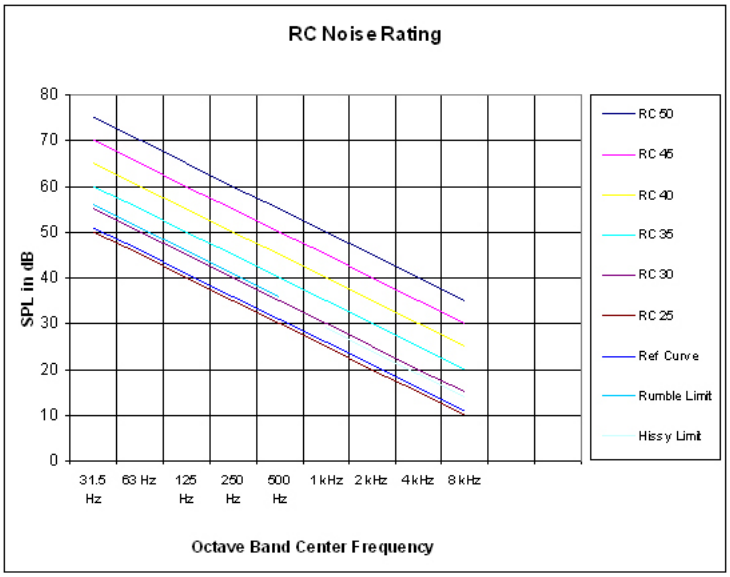
PNC curves are a later refinement of the NC curves, and are often used to judge the acceptability of ventilation and other background broadband noise. PNC curves are generally superior to NC curves for critical uses such as in studios, concert & lecture halls but are less often used because the PNC criteria at lower frequencies are more stringent than those of the NC curves. PNC includes a measurement for the 31.5 Hz band, with NC curves stopping at the 63 Hz band. Over time, as air ventilation systems become mandatory within new buildings, PNC curves are less often used, since NC curves are more tolerant of low frequency rumble.



PNC Noise Curves

Room Criteria Curves (RC)

RC curves measure background noise in a building over the frequency range 16 Hz to 4000 Hz. This rating system was independently developed by structural and mechanical systems engineering organizations for use in evaluating both structure-borne and airborne noise. It relies on the determination of the mid-frequency average level and then plotting the perceived balance between high and low frequency sound.



RC Noise Curves

How to use the Noise Curves

The noise curve is a single numerical index commonly used to define design goals for the maximum allowable noise in a given space. The noise curve spectrum consists of a family of curves that define the maximum allowable octave-band sound pressure level corresponding to a chosen design goal. Different noise curves are obtained and distinguished by the noise curve numbers.

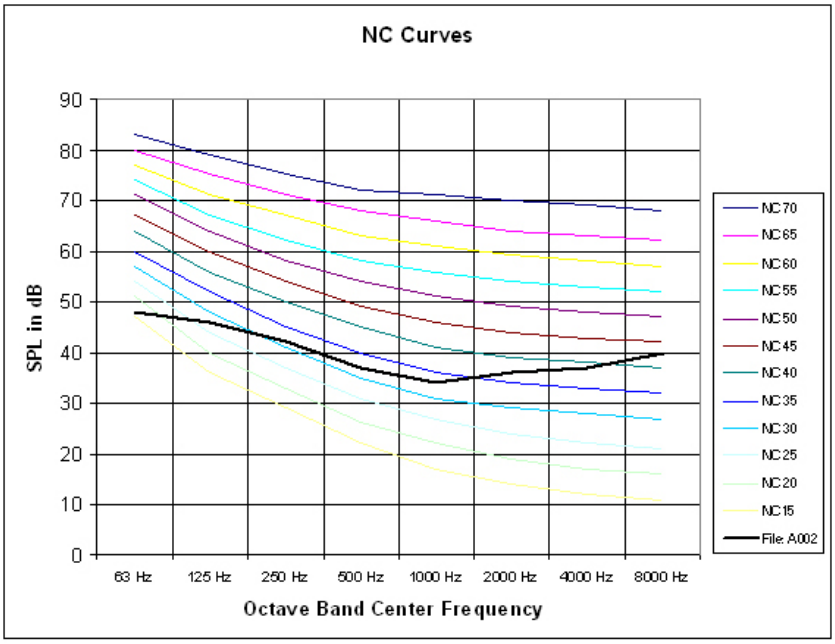
Example - Estimating NC - Noise Criterion

The curve rating can be obtained by plotting the octave band levels for a given noise spectrum. The noise spectrum is specified as having a curve rating equal to the lowest noise curve, which is not exceeded by the spectrum.

For example, the Noise Criterion - NC - of a noise spectrum like

- 62.5 Hz : 48 dB
- 125 Hz : 46 dB
- 250 Hz : 42 dB
- 500 Hz : 37 dB
- 1000 Hz : 34 dB
- 2000 Hz : 36 dB
- 4000 Hz : 37 dB
- 8000 Hz : 40 dB

indicated as the black line in the diagram below, is NC 45 (the NC 45 line is the first line from below that is not touched by the black line).



NC Noise Curves with Sample Result

Measurement Range of NTi Audio Microphones

- M4260: Noise levels higher or equal to NC30, NR40
- M2210: Noise levels higher or equal to NC20, NR20

For measurements lower than these ranges other microphones with higher sensitivity are required.

How to Measure the Noise Curves with XL2 Audio and Acoustic Analyzer

- Connect the measurement microphone to the XL2 Audio and Acoustic Analyzer.
- Power up the NTi Audio XL2 Audio and Acoustic Analyzer and load the "NoiseCurves" Profile (or choose: SLMeter, RTA-page with 1/1 octave resolution and Z filter).
- Perform the noise measurement at typical room positions and record the individual test results in the internal memory.
- Transfer the measurement files to the PC via USB.
- Start the Noise Curves Application Tool and enable Excel macros (depending on Excel version).
- Select the worksheet tab of interest and load the previously recorded measurement data.
- The noise curve results are displayed automatically.
- Please see the "Instructions" page in the XL2 Noise Curves Applications Tool for more detailed instructions.

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Acknowledgments:

Audio Support Northwest, Tigard, Oregon, USA

The Engineering ToolBox, www.engineeringtoolbox.com

Appendix:

Recommended Noise Criterion - NC

The noise in different types of rooms should not exceed the Noise Criterion limits listed below:

Type of Room - Space Type	Recommended NC Level	Equivalent Sound Level
	NC Curve	dBA
Apartments	25-35	35-45
Assembly Halls	25-30	35-40
Churches	30-35	40-45
Courtrooms	30-40	40-50
Factories	40-65	50-75
Private Residences	25-35	35-45
Restaurants	40-45	50-55
TV Broadcast studies	15-25	25-35
Recording Studios	15-20	25-30
Concert and recital halls	15-20	25-30
Sport Stadiums	45-55	55-65
Sound broadcasting	15-20	25-30
Movie motion picture theaters	30-35	40-45
Libraries	35-40	40-50
Hotels/Motels		
- Individual rooms or suites	25-35	35-45
- Meeting or banquet rooms	25-35	35-45
- Halls, corridors, lobbies	35-40	50-55
Offices		
- Conference rooms	25-30	35-40
- Open-plan areas	35-40	45-50
- Business machines/computers	40-45	50-55
Hospitals and Clinics		
- Private rooms	25-30	35-40
- Operating rooms	25-30	35-40
- Public areas	35-40	45-50
Schools		
- Lecture and classrooms	25-30	35-40
- Open-plan classrooms	35-40	45-50

Recommended Noise Rating - NR - Levels

The Noise Rating level for different uses should not exceed the Noise Ratings indicated in the table below:

Noise rating curve	Application
NR 25	Concert halls, broadcasting and recording studios, churches
NR 30	Private dwellings, hospitals, theatres, cinemas, conference rooms
NR 35	Libraries, museums, court rooms, schools, hospitals operating theaters and wards, apartments, hotels, offices
NR 40	Halls, corridors, cloakrooms, restaurants, night clubs, offices, shops
NR 45	Department stores, supermarkets, canteens, general offices
NR 50	Typing pools, offices with business machines
NR 60	Light engineering works
NR 70	Foundries, heavy engineering works