RP 141-2005
Revision of RP 141-1995

SMPTE RECOMMENDED PRACTICE

Background Acoustic Noise Levels in Theaters and Review Rooms

1 Scope

1.1 This practice provides measurement methods and recommended maximum levels for indoor background sound pressure levels in theaters and review rooms. The practice is limited to the noise of heating, ventilating, and air conditioning systems, intrusive noise from the projector(s) associated with the theater, and noise from any other mechanical or electrical equipment in the theater building. The practice is intended for application when the background noise is essentially a steady-state sound, without strong time-varying components.

1.2 The practice does not cover intrusive noise from other sources outside the theater, such as airplanes, highway traffic, adjacent theaters, or the like.

1.3 The practice does not cover noise resulting from the operation of the sound system in the theater.

1.4 The practice does not cover vibration of the theater; i.e., movement of the building below 20 Hz.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this practice. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this practice are encouraged to investigate the possibility of applying the most recent edition of the standards indicated below.

ANSI S1.4-1983 (R2001), Specifications for Sound Level Meters

ANSI S1.11-2004, Specifications for Octave-Band and Fractional Octave-Band Analog and Digital Filters

ANSI S1.13-1995, Measurement of Sound Pressure Levels in Air

3 Test conditions

3.1 The air-handling system of the theater must be brought to the noisiest state in which it is used during screenings, generally ‘‘on,’’ with cooling compressors operating. Any other mechanical or electrical equipment, such as projector exhaust fans, sump pumps, transformers, or the like, within the theater building should be brought to the noisiest state that will occur
during screenings. The projector system should be running normally, with film. Power to the theater sound system should be turned off.

3.2 Measurements shall conform with ANSI S1.13, and shall be made with a type 1 meter as specified in ANSI S1.4, and a class II octave band filter or class III third-octave band filter in accordance with ANSI S1.11.

3.3 The measurement system shall be set to ‘‘slow’’ reading.

Approved December 16, 2005

3.4 The measurement system shall be calibrated immediately before use by means of an acoustic calibrator accurate to within ± 1/2 dB for sound pressure level.

3.5 At high frequencies, room background noise levels are often in the same range as ordinary measurement equipment noise. Therefore, care should be used to ensure that the measured levels are not influenced in any band by noise in the measurement instrument(s) by testing the measurement instrument(s) under all relevant conditions, including switch settings of any attenuators or gain controls. Do not report noise levels at or below the capability of the instrumentation in use.

4 Measurements

4.1 Measurements shall be recorded in octave bands over the range from 31.5 Hz to 16 kHz as sound pressure level (SPL).

4.1.1 The preferred octave band center frequencies are 31.5, 63, 125, 250, and 500 Hz, and 1, 2, 4, 8, and 16 kHz.

4.1.2 If third-octave band measuring equipment is available rather than octave band or switchable bandwidth equipment, measurements may be made in third-octave bands and converted to octave bands by logarithmic addition of three bands (one at the octave band center and the two surrounding it):

$$\text{Octave band SPL} = 10 \log_{10} \left[10^{\frac{L1}{10}} + 10^{\frac{L2}{10}} + 10^{\frac{L3}{10}} \right]$$

where $L1$ = SPL of first 1/3 octave, $L2$ = SPL of second 1/3 octave, and $L3$ = SPL of third 1/3 octave.

4.2 The measurements to be recorded shall be made by averaging at a sufficient number of locations to provide averages with standard deviations under 2 dB, usually six locations chosen at random within the seating area at seated ear height at least 1.2 m (4 ft) from any wall surface will suffice unless there is an unusual spatial distribution of background noise. If the total range of the measurements in an octave band is less than 4 dB, then arithmetic averaging may be used; if more than 4 dB, then the average must be done logarithmically. Some review rooms may be so small that strong room modes will influence the low-frequency band measurements. Thus a small standard deviation may be unobtainable. In such cases, the low-frequency bands may not be reliably reported, and therefore must be neglected in any calculations.

4.3 Plot the spectrum resulting from the recorded measurements on octave band noise criteria graph paper such as that shown in figure 1. The point of the highest excursion of the background noise spectrum compared to the noise criteria curves is the NC rating. (Note that the original NC curves [see 6.1] have been extrapolated to the 31.5-Hz and the 16-kHz octave band for the purposes of this practice.)

5 Recommended levels

5.1 The maximum desirable noise criteria ratings by classification are:

A. Review room and premier showing:	NC-20 to NC-25
B. First-run theaters:	NC-25 or better
C. Sub-run theaters:	NC-30 or better
F. Sub-acceptable, which can lead to dialog intelligibility problems and complaints:	NC-40 or worse

5.2 The classifications above should be applied to the highest use of a theater; that is, if a theater is used for both first and sub-runs, classification B should apply.

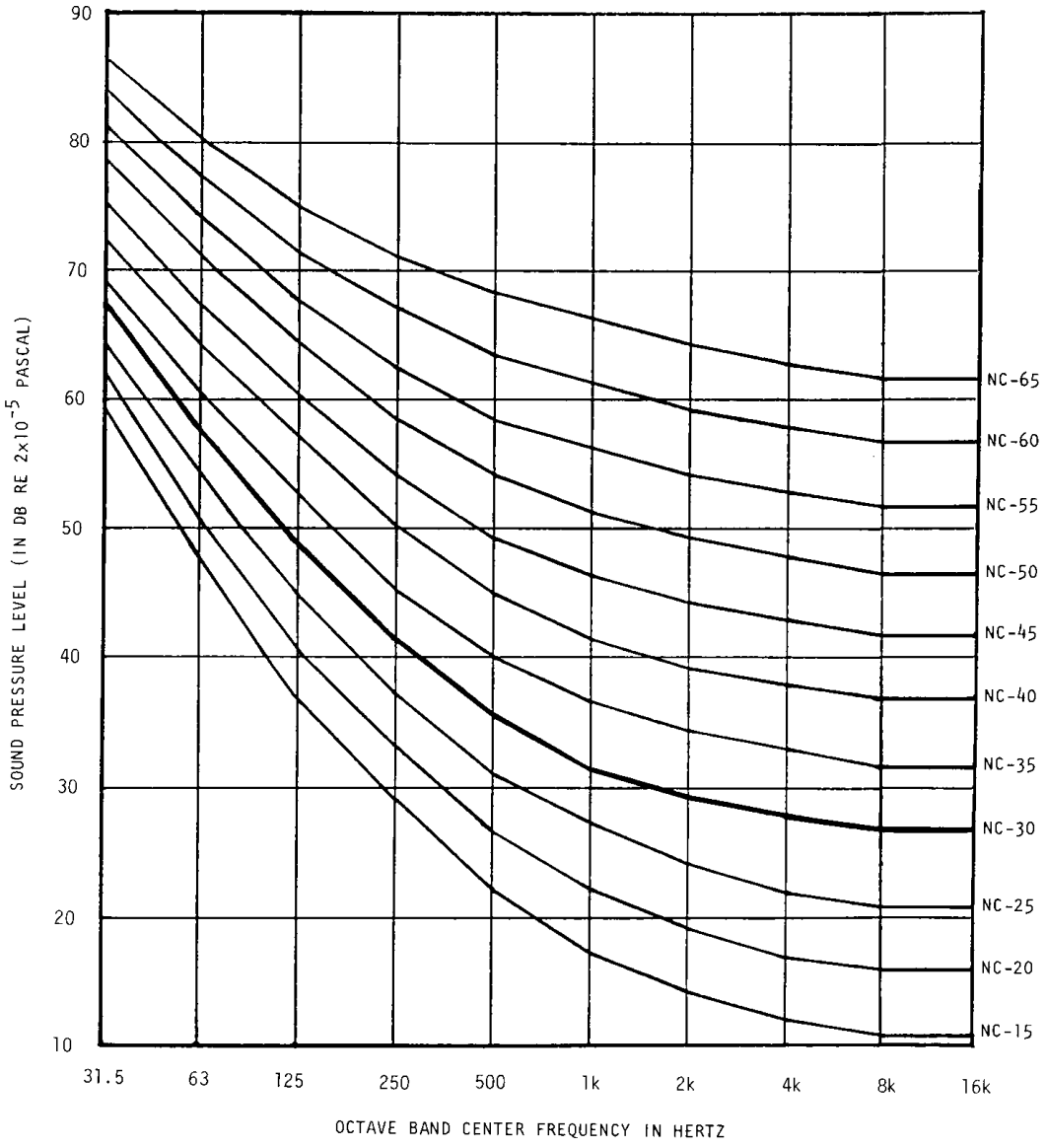

Figure 1 – Octave band noise criteria graph paper

Annex A (informative)
Additional data

A.1 The noise criteria curves are to be used for rating indoor noise levels. The curves, if followed as design criteria, do not result in neutral sounding background noise spectra. Many listeners observe that an NC spectrum sounds too rumbly and too hissy, having too much very low- and very high-frequency energy. A constant sloped spectrum at -5 dB/octave from low to high frequencies has been observed as producing a more neutral sounding spectrum and is probably more suitable for design purposes (see 6.2).

A.2 The NC rating of a space does not represent the spectrum of the background noise; valuable information about the ''quality'' of the noise in a space is missing from any single number rating. It may be useful to retain records of the complete spectrum, since there exist methods to further characterize the noise, such as the RC method, which may yield more information. In particular, spectra with narrow band concentrations of energy sound tonal; subjectively, they might be increased in rating by as much as 8 dB relative to the continuous spectrum, depending upon how far above the average spectrum the tonal component lies.

A.3 Too little noise in a theater or review room may be a problem as well as too much. With too much noise, detail is obscured and, ultimately, intelligibility suffers. With too little noise, intermittent intrusive noise may become audible and annoying; therefore, it is advisable to use reasonable background noise levels to mask intrusive noise sources.

A.4 Dubbing studios are advised that if the background noise levels in studios are much lower than those in theaters, low level sounds which are audible in the dubbing studio may be inaudible in theaters because of masking.

A.5 As a guide to whether high levels of vibration are present, measurement of the linear weighting of a type I sound level meter compared with the octave band sound pressure level can provide useful information: if the level of the linear measurement exceeds the logarithmically added sum of the band levels from 31.5 Hz to 16 kHz by more than 3 dB, then vibration which may be detectable by the audience is present.

A.6 As a practical matter, large diameter microphones are useful for measuring the sometimes very low theater noise levels due to their low self noise, but large diameter microphones also show relatively strong diffraction effects at high frequencies. To obtain an adequate spatial average at high frequencies, the microphone should be rotated at least about a line perpendicular to the floor and a line perpendicular to the sidewalls to obtain the average reading at each location for the high-frequency bands.

Annex B (informative)
Bibliography

Beranek, Leo L., ed., Noise and Vibration Control. McGraw-Hill Book Company, New York, 1971, p. 565.

Blazier, Warren E., Jr., ''Revised noise criteria for application in the acoustical design and rating of HVAC systems,'' Noise Control Engineering, vol. 16, no. 2 (March-April 1981), pp 64-73.