



*Randy Zimmerman, Chief Engineer at Titus, takes CES participants on a guided tour of the lab in which acoustics are tested at Titus.*

## Sound Advice – Part One

When answering questions regarding the acoustical performance of our products, it often becomes apparent that people are trying to comply with specifications that they may not completely understand. For that reason, I think it may be worthwhile to share some practical information regarding building acoustics that I've learned over the years.

### SOUND POWER VS. SOUND PRESSURE

The first thing to understand is the difference between sound power ( $L_w$ ) and sound pressure ( $L_p$ ). Sound power is the raw sound energy created by a product. We measure sound power in the controlled environment of our reverberant chamber with a known room effect or room absorption. Sound pressure is the sound that is heard or can be measured by a sound meter. All sound meters use microphones which are nothing more than high speed pressure transducers.

Sound Pressure ( $L_p$ ) = Sound Power ( $L_w$ ) – Room Effect or Attenuation

Therefore the sound pressure that you measure is what's leftover after some amount of raw sound energy has been absorbed or attenuated by the environment. This makes it easy to understand why same product will sound louder in a room with a tile floor than it would in a room with carpeting.

Although the sound power is the same, the carpeting adds attenuation resulting in a lower sound pressure level.

### SPECIFYING IN TERMS OF NC

Many equipment schedules list maximum acceptable noise criteria (NC) levels, without ever describing the radiated or discharge sound path. This is known as an 'open spec', because it's probably possible to meet the NC requirements under some unspecified condition. A better way to insure compliance with acoustical goals is to specify maximum allowable sound power levels.

It's not unusual to see equipment schedules where individual rooms are shown with various maximum allowable sound levels like NC22, NC23, NC25, NC28, etc. This typically occurs when the engineer takes sound data from a product selection program rather than providing the desired maximum room sound level. For instance, the desired sound level could be NC30 or NC35 and all of the random NC levels shown in the schedule would suffice. It therefore shouldn't be necessary to try and match every NC level.

There's nothing magic about NC levels being specified in multiples of 5, but that's the way acoustical specifications are usually written. There's an audible difference between NC35 and NC40, whereas there's no distinguishing between NC35 and NC36. Sound levels for rooms in a building should

be based on the room use. Here are some normal sound levels for a typical office building:

- ◇ NC30 – Maximum sound level for a conference room.
- ◇ NC35 – Maximum sound level for a private offices with walls and a door.
- ◇ NC40 – Ideal sound level for open office areas with cubicles.
- ◇ NC45 – Maximum sound level for hallways, restrooms, utility rooms

Conference rooms are typically the quietest rooms for improved communication and clarity of speech. Supervisors generally need a quiet place for talking privately on the phone or meeting with employees. Employees in cubicles can work more efficiently when they have a slightly higher sound level that blocks out distractions from coworkers and provides speech privacy. Hallways and utility rooms are transitory spaces and therefore are not typically sound sensitive. Restrooms often use exhaust fans to create a higher background level for privacy.

It's not obvious to some people, but it's helpful to remember that equipment doesn't always need to be located over the room being served. For instance, if you need a fan-powered terminal that can move 3000 CFM to a large conference room and you can't find one that won't exceed NC30, the best thing to do is locate it over a hallway or utility room.

These same sound levels used in office buildings can also be applied to more specialized buildings. For instance, a police station:

- ◇ NC30 – Maximum sound level for an interview room or briefing room
- ◇ NC35 – Maximum sound level for the captain's office.
- ◇ NC40 – Ideal sound level for the detectives' office or 9-1-1 call center
- ◇ NC45 – Maximum sound level for the evidence room, equipment room or locker room.

By remembering that the room NC level should match the room's use and occupancy, sound levels can easily be recommended for nearly any type of building except especially sound critical applications like recording studios and performance halls.

NC15 represents the threshold of human hearing and is generally accepted to be total silence for adults with average hearing ability.

## MULTIPLE SOUND SOURCES

It's important to understand that sometimes multiple sound sources are additive and others times they're not. For instance, if you put two identical NC20 diffusers side-by-

side, the resulting sound level should be NC23, because doubling a sound source adds 3 points. If you put the same two NC20 diffusers at opposite ends of a large room, the resulting sound level should be NC20, because diffusers more than 10 feet from a listener are rarely audible and therefore rarely additive. If you put an NC20 diffuser into a room with a background level of NC30, the resulting sound level should be NC30. This is because a sound that is 10 dB or roughly 10 NC points louder than another sound will mask the lower sound.

## DIFFUSER SOUND LEVELS

If office buildings usually require sound levels over a range of NC30-45, why is it common practice to select grilles, registers and diffusers at sound levels as low as NC20-25? That's because these products are generally quiet when properly sized and they rarely contribute to the resulting sound level of a room. They end up being buried in the background sound of other noisier equipment.

It's interesting to note that these products generally create their highest sound levels in octave bands 4-6 (500-2000 Hz). These are known as the 'speech interference bands' because these are the same frequencies used for human speech. Therefore a loud grille, register or diffuser would be likely to create a sound spectrum that would be difficult to talk over.

Manufacturers publish NC application data for grilles, registers and diffusers based on 10 dB of room absorption across all octave bands. This is a good approximation for a standard office installation with carpeted floors and some furniture. For other applications such as large rooms or rooms with highly reflective surfaces, the resulting room sound level must be calculated from sound power data. This sound power data is available in our TEAMS program.

## SOUND DIFFERENCES

It's important to remember that a sound difference of 1-2 NC points is usually inaudible. So it's unlikely that anyone could hear a difference between an NC35 and an NC37 product. It's easier to hear differences in sound levels when low frequency sounds dominate. For instance, an NC40 fan box sounds twice as loud as an NC35 fan box.

I hope you find this information helpful.



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