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TECH TIP: IMPACT OF CEILING TYPE ON TERMINAL UNIT RADIATED SOUND

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In a previous Tech Tip – Terminal Unit Liner Acoustical Considerations – I discussed the impact that liner selection can have on radiated and discharge sound from terminal units. The article discussed the impact on sound caused by selecting a solid metal liner to prevent fiberglass particles from being entrained in the discharge air stream.

Many times I have seen ceilings either removed from rooms or changed to a cloud type to add the perception of volume to the space. Many design engineers do not consider the impact on the room sound levels when a ceiling is removed. And most designers do not consider the impact of changing both liner and ceiling type and the resultant change in the overall room sound levels.

As you are aware, to obtain an NC rating for a terminal unit, the discharge and radiated sound pressure levels obtained by testing in a reverberant sound chamber are converted by taking the sound power data and applying the attenuation factors from Appendix E, in the AHRI Standard 885 "Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Air Outlets". In the online AHRI certification database, most manufacturers only rate their standard construction terminal which uses a fiberglass liner. So when a design engineer selects a different liner, the catalog data for many suppliers may not take into account this shift in NC values. For more on this, please see the previously mentioned Tech Tip – Terminal Unit Liner Acoustical Considerations.

The Appendix E attenuation factors that are used to estimate NC levels for terminal units include attenuation for a suspended acoustical ceiling (see **Table 1**). A common mistake made by design engineers is that they fail to account for the lowered attenuation of sound when the ceiling type is either changed to a solid surface, such as drywall, or when the ceiling is removed (or becomes a 'cloud').

I looked at the impact that ceiling type has on the occupied sound levels and compiled the following tables for the gain or loss in the calculated NC value for the radiated sound based on no ceiling, mineral fiber acoustical ceiling, and drywall ceiling. I kept the same room physical characteristics as the basis used in the Appendix E attenuation factors and just changed the ceiling type. That is to say, the terminal is mounted five feet above the occupant who is standing in a 2,400 ft^3 space.

Table 1: Typical Sound Attenuation Values, dB (from AHRI Standard 885, Appendix E)

Diffusers: Deduct 10 dB in all Octave Bands to compute diffuser NC						
VAV Terminals: Radiated Sound Ceiling Plenum Noise Sources: Total deduct from Sound Power to Predict Room Sound Pressure (Includes Environmental Effect), dB						
Assumes, 3 ft [0.9 m] deep plenums with non-bounded sides						
	Octave Band Mid Frequency, Hz					
	125	250	500	1000	2000	4000

Table 2: SDV14 Terminal with Standard 1" thick Fiberglass Liner, NC Value by Ceiling Type

NC Value determined using AHRI Standard 885, Appendix E attenuation factors	Estimated Room Radiated NC by Ceiling Type		
	Mineral Fiber	Drywall Ceiling	No Ceiling (Terminal Exposed)
30	30	24	43

The size 14 single duct terminal shown in **Table 2** was selected with a volume flow rate of 2,400 cfm at a differential static of 1.25 inches w.c. across the damper. As you can see, removing the ceiling and selecting a terminal using the standard attenuation factors will result in a louder space than anticipated. A rise of 7 NC is enough to generate sound complaints. Changing the ceiling type can have a very large impact on the occupant perception of how much sound is being generated by the terminal units. In this case, the removal of the ceiling raises the space NC values by 13 and although the resulting NC is below 45, this gain in NC may result in occupant complaint.

In fan powered terminals, combining the liner change and change of ceiling treatment can have a much larger impact than anticipated, particularly if the design engineer calls for all NC values in the submittal to be based on the attenuation factors in Appendix E of the AHRI 885 Standard.

Table 3 shows a fan powered terminal, model FDCA 3010, with 1,090 cfm fan and primary valve volume flow rate at a differential static of 1.25 inches w.c. across the primary air valve damper. Since liner type has a large impact on the amount of radiated sound from a fan powered terminal due to the return air opening, liner types are also varied and reported.

When a design engineer uses a non-fiberglass liner, and/or non-mineral fiber ceiling type, they should consider specifying the specific attenuation factors that are to be used for calculating the NC values as the default values can easily lead to a space with unexpected sound levels.

Table 4 shows the radiated sound power deductions for various ceiling types. It is suggested that the design engineer place the appropriate radiated sound power deductions for the project ceiling type and require that NC values on submittals be calculated using the specified values.

For more information on this and other aspects of terminal unit selection, please see the Price HVAC Handbook or contact the Price Applications Engineering Team.

Table 3: FDCA3010, NC by Ceiling and Liner Type

Liner Type (1" thick)	NC value determined using Appendix E attenuation factors	Estimated Room Radiated NC by Ceiling Type		
		Mineral Fiber	Drywall Ceiling	No Ceiling (Terminal Exposed)
1.5 lb/ft^3 fiberglass	33	33	27	46
FoilBoard	34	34	27	47
FiberFree	36	36	28	49
Solid Metal	36	36	30	49

Table 4: Radiated Sound Power Deductions for various ceiling types

Ceiling Type	Density (lb/ft^3)	Thickness (inch)	Weight (lb/ft^2)	Octave Band Mid Frequency, Hz					
				120	250	500	1000	2000	4000
Mineral Fiber*	20	0.63	1	18	19	20	26	31	36
Mineral Fiber	10	0.63	0.5	17	18	19	25	30	33
Glass Fiber	4	1.97	0.6	18	16	17	17	18	19
Gypsum Board Tiles	43	0.51	1.8	18	19	18	21	22	22
Solid Gypsum Board	43	0.51	1.8	23	26	25	27	27	28

*Ceiling type used in AHRI 885-2008, Appendix E