Engineering E-Update

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A Common Loophole in Silencer Testing

The sole purpose behind a test standard is to establish a means by which data is uniformly obtained and communicated. In North America, ASTM E477 is the most common standard used for the testing and cataloging of silencers. Not everyone is familiar with this standard and the numerous revisions; the resultant ambiguity is exploited by some manufacturers.

ASTM E477 has been revised eight times since its establishment in 1973, with the last revision in 2006. When a specification reads "Must be tested in accordance with ASTM E477", **a loophole is left open for a manufacturer** to provide a silencer tested by any set of ASTM E477 standards established since its inception.

A silencer will "perform differently" relative to the revision of the standard which is used to calculate performance. This loophole may allow a manufacturer to provide a lower-cost silencer that in reality does not meet the expectations of the designer or the requirements of the project. Nonetheless, they did "technically" provide products which were tested in accordance with ASTM E477.

The disparity in testing methods under the various revisions to the standard **can mean the difference between NC 35 and NC 50.**

"Price Noise Control can provide performance data in accordance with any of the ASTM E477 Dynamic Insertion Loss (DIL) calculation methods."

Cleve L. Doyen, Noise Control Product Manager

A Little Bit of Background. . .

When evaluating the sound levels in an occupied space the designer starts with the sound levels provided by the equipment supplier and then deducts the duct system attenuation to determine what the sound levels will be for the particular space in question. Additional attenuation is often required to reduce the sound levels to an acceptable criteria for the intended use of that space.

Typically a silencer will be selected that will provide the required insertion loss to achieve the design goal. **Insertion Loss** (IL) is a measure of how much the sound levels are reduced after the silencer is installed in the system. **Dynamic Insertion Loss** (DIL) measures the change in sound levels taking into account the effects of airflow.

$$DIL = Lp - Lp'$$

Lp = Sound Pressure of the Base System

Lp' = Sound Pressure of the System with silencer installed

The ASTM E477 standard defines the requirements and procedures for testing the dynamic insertion loss, self-generated noise, and pressure drop.

How do the versions of the test standards differ?

Before 1996

Before 1996, the calculation of octave band insertion loss was based on difference of the **overall** octave band sound levels of the empty and silenced duct. Laboratory acoustic measurements are typically measured in 1/3rd octave bands. Each octave band is made up of three 1/3rd octave band values logarithmically **added** together.

The 1980 revision of the ASTM E477 specification reads:

8.1.5. To obtain the insertion loss in octave bands, combine the three one-third octave band sound pressure levels in each octave band with and without the test specimen in place as follows:

Where:

Lc = the combined octave band level

$$L_c = 10 \log \left[\sum_{i=1}^{3} 10^{L_i/10} \right]$$

Li = an individual one-third octave band level

$$DIL = Lp_{Empty,Octave} - Lp'_{Silenced,Octave}$$

The insertion loss of the silencer is frequency dependant therefore the results could vary depending on the sound source.

1996 & On

The 1996 revision of ASTM E477 modified the calculation of DIL to be based on the logarithmic **average** of the 1/3rd octave band insertion losses.

$$IL_{oct,cf} = -10 \log \left[1/3 \sum_{B=B_{c-1}}^{B_{c+1}} 10^{-IL_B/10} \right]$$

Where:

$IL_{oct,cf}$ = IL in preferred octave band center frequency

IL_B = IL in three adjacent 1/3rd octave bands designated BC-1, BC, and BC+1

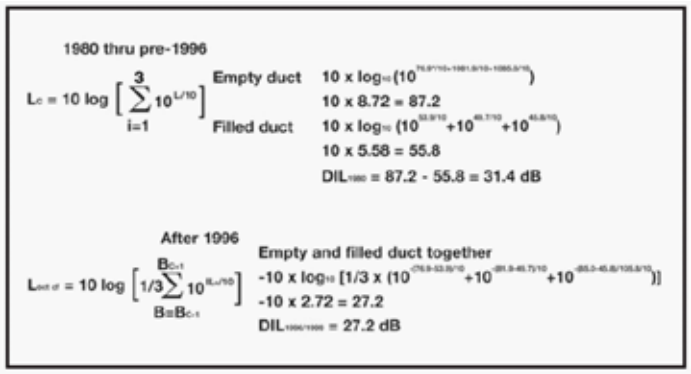
This change eliminates any influence of the sound source on the calculation of the octave band DIL and ensures that the reported performance is the realistic attenuation that would be achieved when installing a silencer into a system.

Comparison

Shown is the difference in DIL that can result from the same measured test data calculated according to different versions of the test standard.

Combined 8 Octave Bands As a Result of the Same Raw 1/3 Test Data											
Standard	Model	Velocity	" sp	63	125	250	500	1K	2K	4K	8K
1980	RL36/1B	+750	0.06	3	3	13	23	25	22	14	11
Post-1996	RL36/1B	+750	0.06	3	3	9	19	24	19	13	10
			Difference of:	**0**	**0**	**4**	**4**	**1**	**3**	**1**	**1**

A sample calculation from the AMCA Article *Why Specify AMCA 1011-03 and ASTM E477-99* demonstrates how the calculated insertion losses compare.



For instance, from the same raw data a silencer calculated:

- by the 1973 standard will have a combined insertion loss of 34dB
- by the 1980 standard, a 31dB insertion loss, and
- by the 1996 standard, a 27 dB insertion loss.

Closing the Loophole

Some engineers are in fact aware of this issue, and a common response has been: `I've never had a problem with it in the past." Depending on the scale of the project and the scope of the design, there may not have been a perceived problem, but this issue is very real.

When specifying a project, communication is the key to achieving the acoustical performance in the system that the designer requires. To protect the designer against this concern, a specification should be written as:

"Tested in accordance with the latest revision of ASTM E477."

or, even more specifically, as:

"Tested in accordance with the ASTM E477-06a standard."

The most current revision is ASTM E477-06a. These revisions typically occur every six years with the next due to release in 2012. **All Price Noise Control products are tested in accordance with ASTM E477-06a.**

A further summary of the major revisions made to ASTM E477 are as follows:

1973 DIL Calculation Method
- Octave Band based DIL calculation
- Masks impact of each 1/3 Octave band
- Duct system not well defined
- Reverberation room qualification based solely on ASTM E90

1980 DIL Calculation Method
- Octave Band based DIL calculation
- Caps 1/3 Octave band variance to 5dB max
- Reduces masking effects of 1973 method

1996/1999 DIL Calculation Method
- DIL is calculated based on Logarithmic average of 1/3rd Octave Band values
- Accounts for 1/3 Octave band impact -> No masking effect
- Duct system defined -> Minimum 14 gauge
- Reverberation room qualification based on ASTM E90 & ANSI S12.31
- PD defined as 'Total Pressure Drop' -> No credit for empty duct