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August 11, 2009

Mr. Brian LaValley, *Process Engineer*
Evergreen Solar, Inc.
259 Cedar Hill Street
Marlborough, MA 01752

Subject: Circumferential Drive Sound Wall

Dear Brian,

It is our understanding that a 20-foot high wall along the edge of the perimeter drive surrounding the facility was considered early in facility design. We also understand that the facility designer determined that facility sound in the community would meet DEC sound level requirements, so that the 20-foot wall was not required. Once Evergreen Solar began operations and sound levels were found to exceed the DEC limits, the DEC ordered the wall to be constructed to mitigate sound in nearby residential areas. To our knowledge, it was anticipated that the wall would need to run at least the full length of the building along the south side of the paved area at the rear of the facility.

It was determined by Cavanaugh Tocci Associates, Inc. that control of facility sound would be best accomplished by installation of silencing on certain equipment, partially enclosing other equipment, and reducing fan speeds as operating requirements would permit, as well as construction of barriers built close to sound producing equipment. This letter addresses sound barrier design in general and specifically why barriers taller than 20 feet (24-foot high and taller) have been built close to primary noise sources, and why the barriers that have been constructed are more effective in reducing sound in the community than the originally proposed 20-foot long perimeter sound barrier.

Sound barriers, built to reduce sound, provide a noise reduction expressed in decibels, dB. An important rule-of-thumb is that a barrier must break the line-of-sight between a noise source and a receptor. The more the barrier penetrates through the line-of-sight, the greater the barrier noise reduction. Appendix A provides a detailed explanation of noise barriers and provides a nomograph for estimating barrier noise reduction for the special case of a barrier either close to the source or close to a receiver. This nomograph is applicable to barriers built around Evergreen Solar remediation equipment as these noise barriers are close to the source and far from receptors.

A 20-foot tall barrier built at the pavement edge would provide a negligible break in line-of-sight between many sources and receptors. As discussed in Appendix A, such barriers would provide a small ratio “H”. The resulting barrier noise reduction for a pavement-edge barrier would be small. Moreover, the geometry would be such that relatively minor atmospheric conditions, such as wind and temperature gradients, could offset the barrier attenuation otherwise obtained in neutral atmospheric conditions. Barriers situated close to noise sources, with much higher “H” values, provide much higher barrier noise reductions, which are less prone to atmospheric effects. In the case of Evergreen Solar remediation equipment, the barriers surrounding the SDX silicon dust collectors are 24-feet tall and within a few feet of these fans; those around the VOC compound are 30-feet tall and are also much closer to noise sources than would have been a pavement-edge barrier.

Even in the case of the gas delivery area, the approximate 20-foot high noise barrier constructed there is considerably closer to the radiating noise source (the truck tank) than would have been a 20-foot pavement-edge noise barrier. In addition, the noise barrier situated adjacent to the gas delivery truck has been modified to enhance its performance through the addition of doors and an overhang.

This discussion of noise barriers has been general, but illustrates the point that the taller noise barriers that have been constructed close to operating equipment in order to provide considerably better noise reduction than would a barrier located further away at the pavement-edge. The originally proposed noise barrier would not have broken the line-of-sight from many noise sources to residential receptors, and thus would not have provided the required noise reduction.

If I can provide any further information, please do not hesitate to contact me. Thank you.

Yours sincerely,
CAVANAUGH TOCCI ASSOCIATES, INC.

Gregory C. Tocci

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Appendix A

Noise Barriers

(from the forthcoming 2nd Edition of *Architectural Acoustics—Principles and Practice*, Ed. William J. Cavanaugh, Gregory C. Tocci, John Wilkes, John Wiley and Sons, NY)

Noise Barriers

A noise barrier is a wall, screen, building, or other impervious structure that breaks the line-of-sight between a source and receiver. The more a barrier penetrates through the line-of-sight between a source and a receiver, the greater the barrier attenuation. Figure 3.7 contains a chart that can be used to estimate the insertion loss of a noise barrier in octave band frequencies ranging between 63 and 8000 Hz. Insertion loss is the amount in decibels that sound is reduced when a barrier, or other noise reduction method, is added to or inserted into a noise source-receiver path. The horizontal axis in the chart of Figure 3.7 is octave band frequency in Hertz. The vertical axis is noise barrier insertion loss (IL) in decibels. The chart presents a family of lines with corresponding quantities ranging between 0.5 and 32. These quantities are the ratio of the square of the effective barrier height divided by the distance between the source and the barrier. This chart only applies to a point source and conditions where the receiver is located much further from the barrier than the source. It should be noted that the chart can also be used for the inverse situation where the receiver is close to the barrier and the source is much further away. The chart cannot be used where the barrier is located midway between the source and receiver. For this more general situation, a more complex mathematical relationship is needed and can be found in Beranek and Ver[i] or Bell and Bell[ii].

The IL relationship of Figure 3.7 is limited to outdoor or "outdoor-like" situations where the receiver is a point source. Indoors, sound reflections from ceilings reduces barrier IL from what would otherwise been obtained outdoors. In the case of a line source, the estimated noise reduction using Figure 3.7 would be about 3 dB lower than determined for a point source. Examples of a line source are continuous traffic on a road or a row of exhaust fans along the roof of a building.

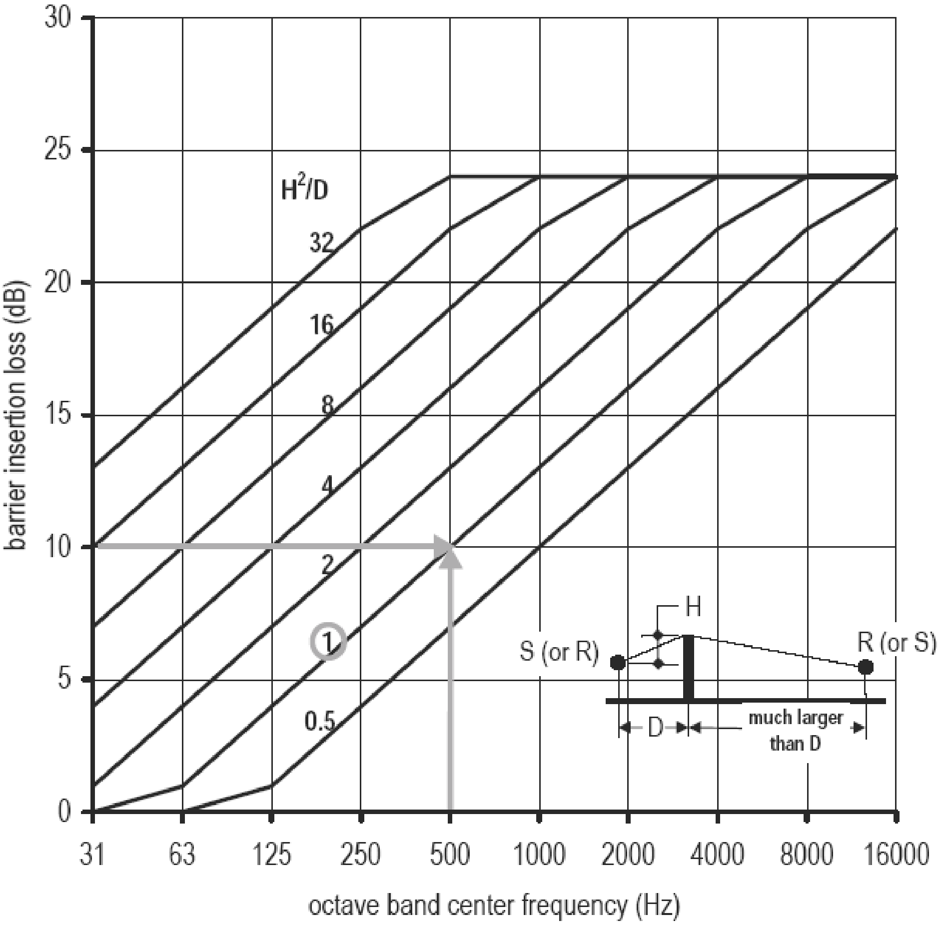

Figure 3.7: *Nomograph for estimating noise barrier insertion loss (IL) for a barrier located close to the source and far from the receiver, or conversely, close to the receiver and far from the source.*

Figure 3.8 provides an example of using the barrier nomograph of Figure 3.7. Figure 3.8 depicts an outdoor air-cooled chiller situated at the bottom of a hill. At the top of the hill is a residence overlooking the chiller. The chiller produces sound that needs to be reduced at the residence by about 10 dB in the 500 Hz octave frequency band. (Normally, the nomograph would be used for all octave frequency bands that need to be reduced. Use of the nomograph here for illustration purposes has been limited to sound at 500 Hz.)

There are several important points to note in Figure 3.8 concerning noise barrier attenuation performance and the use of the nomograph of Figure 3.7. The source and receptor locations selected for analysis are the physically highest locations—the top of the fan guard in the case of the chiller and the dormer in the case of the residence. The barrier needs to be set far enough away from the chiller to permit maintenance access and to avoid re-circulating of warm air back into the chiller intake grilles. The chiller manufacturer usually provides guidance on minimum required clearances for barriers and other structures. The ability of a barrier to reduce noise is related to the amount that it penetrates the line-of-sight between the source and receptor. The portion of barrier below the intersection with the line-of-sight is important, but does not contribute directly to the barrier attenuation attained. The nomograph is applicable only to those situations where the barrier is either close to the source or to the receptor. In the case of Figure 3.8, the barrier is considerably closer to the chiller than it is to the residence.

Assume that the barrier should be constructed 16 feet from the chiller centerline, and that a 10 dB reduction is required at 500 Hz. To determine the effective barrier height, i.e. the amount by which the barrier must penetrate through the line-of-sight, the value of H^2/D must be determined. H is the effective barrier height and D is the distance between the source and noise barrier. Referring to Figure 3.7, find the characteristic curve at the intersection of 10 dB on the vertical axis and 500 Hz on the horizontal axis. The closest characteristic curve has a H^2/D value of 1. H is calculated as follows:

$$\frac{H^2}{D} = \frac{H^2}{16} = 1 \qquad H = 4 \text{ feet}$$

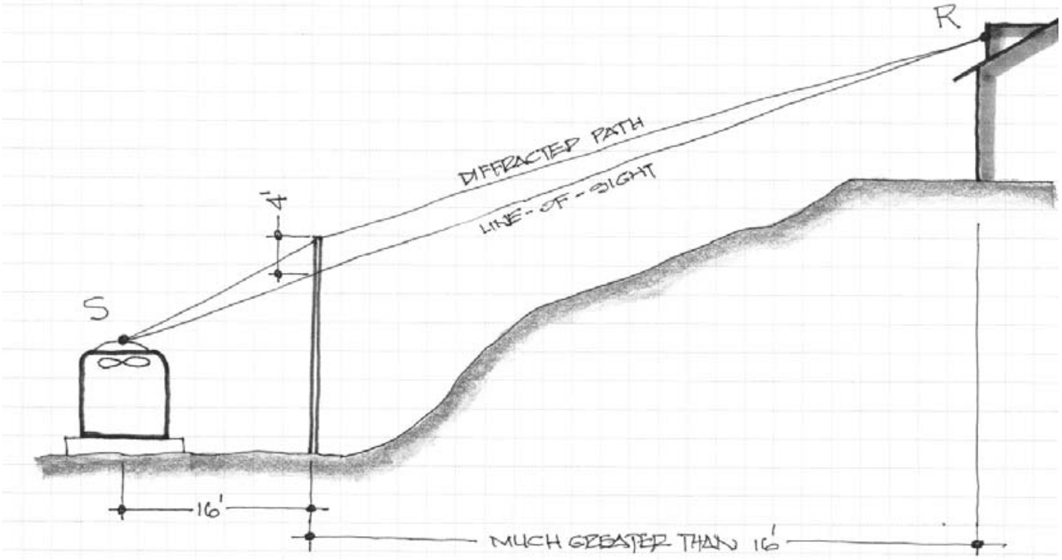

Figure 3.8: *Barrier calculation example.*

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[i] Beranek, L. L., and Ver, I., Noise and Vibration Control Engineering---Principles and Applications, John Wiley & Sons, New York, 2006, pp. 119 ff.

[ii] Bell, L. H., and Bell, D. H.; Industrial Noise Control---Fundamentals and Applications, Marcel Dekker, New York, 1993 pp. 116--122.