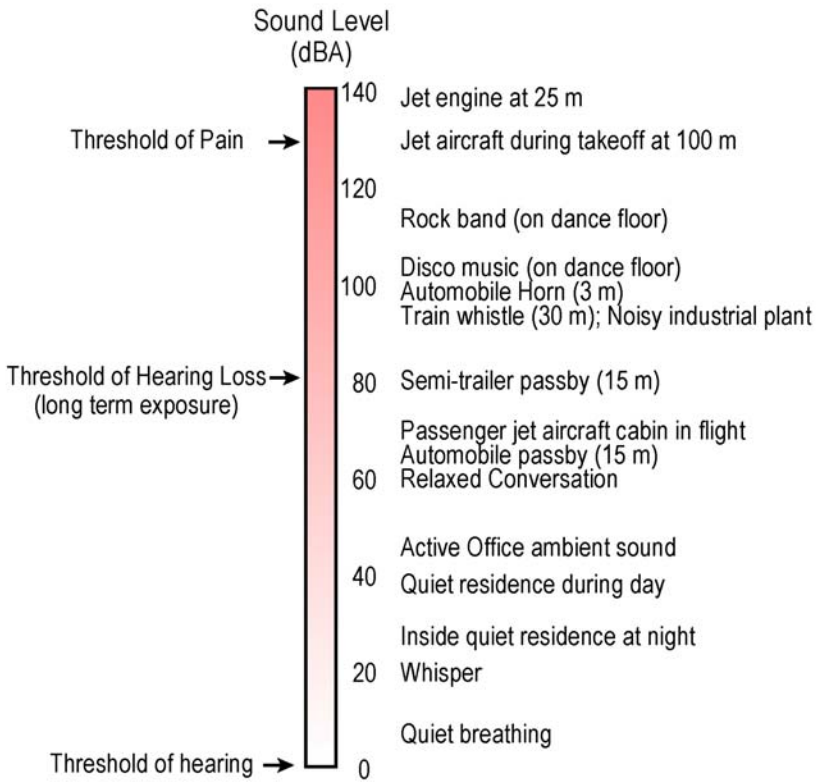
A Guide to the Control of Noise Exposure to Residential Dwellings

by:
Doug Whicker, P.Eng.
BKL Consultants Ltd.
308 - 1200 Lynn Valley Road
North Vancouver, BC
V7J 2A2
whicker@bkl.ca

Noise exposure to residential dwellings can come from a number of exterior sources ranging from aircraft overhead to the neighbour's barking dog. While the physical geometry from noise source to receiver is important, the nature of the noise generally is not. The issue involved in this discussion is how can one reduce noise to areas within the residential dwelling unit and to outdoor amenity spaces associated with the unit.

Acoustics Basics

In general, for the purposes of evaluating the significance of most noise, the level is measured in decibels using an 'A' weighting filter. The resulting unit is abbreviated dBA. The scale is referenced to the threshold of hearing for the average individual and the 'A' weighting filter is used as it approximates the frequency (pitch) response of human hearing. Different activities produce different sound levels as shown on the following graphic:



Sound Level in dBA of Typical Activities

A simple way of assessing decibels is to understand the approximate relationship between sound level measured in decibels and human perception of loudness. Typically, a person cannot detect a change in sound level of 1 dBA; a change of 3 dBA is a just perceptible change in level; a change of 5 dBA is clearly noticeable; and a change of 10 dBA is typically considered to be equivalent to a doubling or halving of loudness. In general, these relative changes are considered realistic regardless of the sound level provided it remains within the range of hearing of the individual listening to the sound.

Outdoor Amenity Spaces

There are two methods that can readily be employed to reduce the noise penetration to outdoor amenity spaces (yards, patios, balconies). The first involves the construction of a barrier to the noise at a logical location relative to the space being protected. For example, to protect a yard, a solid fence around the yard may be appropriate, to protect a patio a “solid one side” gazebo or other structure may fit the bill. For a balcony, a solid balcony railing (whether opaque or clear glazed) is a logical approach.

Gazebo

For all of these barriers to be effective they must substantially or completely block line of sight between the source of the noise and the receiver. This means that if the source is physically higher in elevation than the receiver, the benefits that can be obtained may be limited as the barrier height necessary to block line of sight may be impractical.

As the benefits to be derived from a barrier are seldom more than around 10 dBA, the weight of the barrier is quite nominal. In fact, the physical requirement for the barrier usually are more substantial than the acoustical requirements. For acoustical reasons, the barrier needs to be solid (no holes, or gaps between boards) and needs to have a weight of at least 10 kg/m^2 (2 psf). This means that the barrier can be constructed of 16 mm (⅝”) plywood, or 4 mm or thicker glass. For a railing barrier, glazing is generally the right direction, but the glass should be tempered for safety reasons.

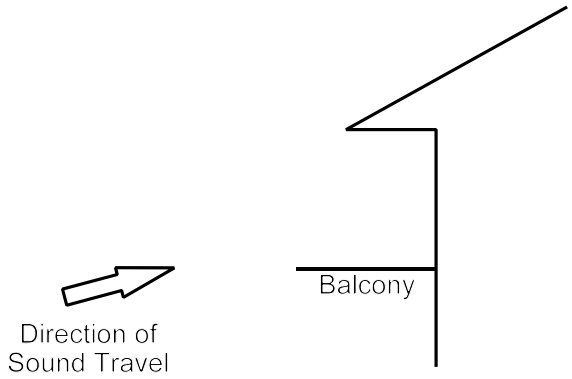
Example of a glass barrier

A second method that can be used to reduce outdoor noise is local application of sound absorbing surfaces. This involves the installation of an acoustical panel to absorb sound that might otherwise be reflected back to the listener. Typically, the only practical surfaces outdoors that can be treated are the soffits of any roof overhangs extending over a balcony or patio. This treatment is particularly effective when the balcony or patio has an effective noise barrier around it.

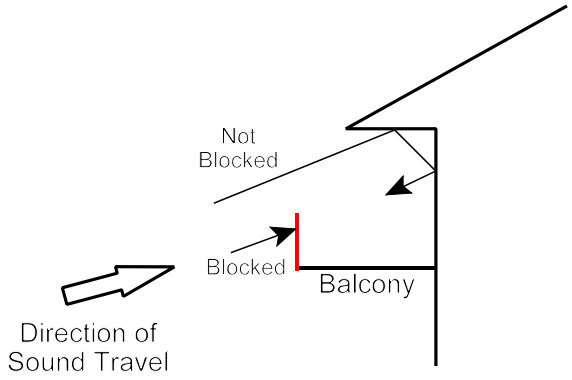
A quick note about sound absorption. Glass fibre or other porous materials absorb sound; Styrofoam does not. Don't use Styrofoam for acoustic reasons!

The following graphic illustrates the benefits that can be obtained by balcony barriers and soffit treatment for typical conditions:

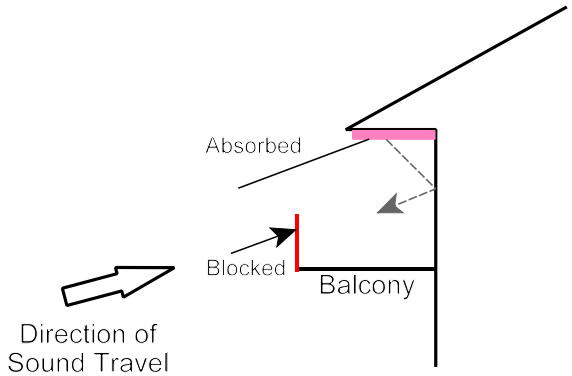
Balcony Barriers



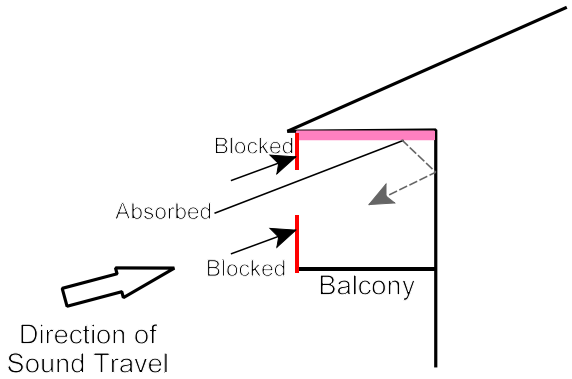
The basic balcony with no sound absorbing soffit and an open balcony railing (not shown) has zero decibels of excess attenuation.



Add a solid balcony railing and the attenuation will typically increase by 3 dBA. This is limited by the reflections back from the house behind.



The addition of an absorptive soffit will add another 2 decibels to the attenuation making 5 dBA reduction in total



Where additional barrier height can be added or where a barrier extending down from the soffit can be considered, the attenuation goes up further. How much improvement is gained will depend on how much area can be closed.

BKL Consultants Ltd.

Residential Interiors

Noise from the outside enters residences through a number of pathways. The primary path is windows. Other paths include walls, roofs and vents. Remember, that bathroom exhaust fan is almost always vented to the outdoors with no acoustical attenuation. The bird perched on the rain cap can be clearly heard. This section will talk about each path and the steps that can be taken to improve their noise isolation.

Windows

As stated previously, windows are the primary method by which sound from the outdoors gets into the residence. The windows themselves are limited by how heavy and how airtight they are. For example, double glazed windows provide better noise isolation than single glazed windows, and fixed windows provide better noise isolation than openable windows. If improvements in interior noise isolation are desired, the first place to look at improving are the windows.

Open Windows

Windows, when they are open, are going to let sound in and changing window weight or type is not going to have any influence. There are some limited opportunities to install a glazing barrier on stand offs in front of the window openings but due to reflections these will not be particularly effective.

Depending on the direction of the sound relative to the window, a hinged casement window can sometimes use the window panel to act as a noise barrier with modest benefits, but if significant noise reductions are required, the windows have to be kept closed.

Closed Windows

With closed windows, the better the window and the better the seal, the better the noise isolation. Thus, a non-opening window is better than the equivalent window that opens. For an open window, a hinged casement window with appropriate weather tight seals will perform better acoustically than a slider window. To make sure that windows are going to perform adequately, we recommend that all windows supplied on a project are specified to meet the A3 performance rating for Air Tightness found in the CSA standard CAN/CSA-A440-M00, or latest revision. This should make sure that openable windows are provided with reasonable gasketing. We do not recommend the use of window louvres as they cannot be closed to maintain an airtight seal.

With regards to window glazing, more is better. The building code requires that all windows provided for new residential construction be double glazed for energy conservation reasons. Acoustically, this can help as well as “standard” thermal double glazed windows perform better than typical single glazed panes. Generally, the greater the airspace between the panes and the heavier the glass that makes up the panes, the greater the noise isolation.

Approximate Noise Isolation Rating

Glass Type	Noise Isolation Rating (dB)
3/6/3	30
3/9/3	31
3/12/3	32
4/6/4	32
4/12/4	33
6/12/3	34
6/12/6	35
6.3L/6/4	37
6.3L/12/4	39
6.3L/6/6.3L	40
6.3L/12/6.3L	42
4/6/4/50/4/6/4	44

Note: glass thickness/airspace/glass thickness in mm

L = Laminated glass with minimum 0.030" PVB interlayer

As you can see from the above table, the use of one or more panes of laminated glass can significantly improve the noise isolation of the window. This treatment is often used when the exposure to noise is sufficiently high that normal glazing is inadequate. However, there is a cost premium to use laminated glass. Another option for providing high noise isolation through windows is the use of two sets of double glazed windows or the use of a "storm" window. This involves installing a second window in the same opening with an airspace of at least 50 mm (2") airspace between the windows. In this situation, it is reasonable that one or both of the windows are sliders as it facilitates opening them should that be desired. An issue that has to be addressed if double sets of windows are installed is how does one clean the inside faces of the two window sets. This may require the use of customized framing to make one or the other of the window sets removable for cleaning.

Building Walls and Roof

First of all, for anything other than aircraft overflight noise, roofs are seldom an issue. The real issue can be walls, especially if a lightweight exterior such as vinyl siding is employed. If noise penetration through the walls is suspect, then the noise isolation potential of the walls can be increased by several means. However, don't forget our original comment that windows are usually the most significant noise path. There should be no need to upgrade walls with any windows in them unless you are also upgrading the windows substantially. Also, there should be no need to upgrade an existing heavy wall construction such as a poured concrete wall, a masonry wall, a solid brick wall (full brick facing) or a wall with a 19 mm (3/4") thick stucco coating.

However, if you do decide to upgrade the walls, one of the simplest and least expensive measures is simply to double up on the wallboard on the inside of the wall. A little bit of filling, taping and painting and the addition of an extra layer of wallboard to the inside of the wall should improve that path by around 3 to 5 dBA. If you are planning to replace the existing siding, a layer of exterior grade wallboard applied to the wall under the new siding can produce similar results. Unfortunately, they are not directly additive. Doing both will likely only give you 5 to 7 dBA overall improvement. If you really have to block a lot of noise from the outside, you should look at upgrading the exterior siding to something significant such as brick facing or other heavy cladding. Optionally, you can look at stripping the wallboard from the inside of the wall, making sure that your wall insulation and vapour barrier are up to date and then strap the inside studs with a good quality resilient channel (Bailey West Mantane is the only one we would look at right now) and then add two layers of 16mm (5/8") gypsum wallboard to the resilient channels, taking care not to short-circuit their isolation.

A quick comment on resilient channels: Regardless of what you might be told, resilient channels should **NEVER** be placed between layers of wallboard or between wallboard and plywood or other solid panels. The channels are not the problem; it's the small airspace created that for technical reasons beyond this brief commentary, actually degrades the acoustical performance such that you would basically waste your money with the install. If you are putting resilient channels into a wall or ceiling, you have to remove any existing wallboard and fasten the channels to the studs or joists. For further information on this you can look at the following document:

http://bkl.ca/sites/bkl/files/resilient_channel_in_floor_assemblies.pdf

Building ventilation

Ventilation systems are common in most residential buildings. It's just that we don't necessary appreciate that they are actually ventilation systems. However, the kitchen exhaust fan, the bathroom exhaust fans and the cloths dryer exhaust fans all remove air from the house. Normally, this air is replaced in the house through natural air leakage around windows, doors, and leaks in the facade. However, with more and more attention being paid to air tight construction to meet energy conservation standards, means have to be provided to allow air into the dwelling. These can often be small vents in the wall, or soffit and may be code requirements, especially if the dwelling has gas heat or a gas hot water tank.

If windows are required to be kept closed for control of noise, then these ventilation systems have to be relied on and perhaps enhanced to provide air changes in both summer and winter. In the summer, the need is increased as the ventilation air will be required to keep the house cool in both day and night. Modifications or additions can be made to these ventilation systems to provide the necessary cooling air. In winter, this air movement will bring in fresh cold air that will add to your heating bill. This can be reduced considerably by including an air-to-air heat exchanger in the design of any ventilation upgrades. This heat exchanger will transfer the heat from the outgoing air being exhausted to preheat the fresh air being

brought in from the outside. These heat exchangers are available from your local building supply centre.

ecoENERGY Retrofits

Fortunately, a lot of the things that might be done to reduce noise transmission into a dwelling, also reduce heat transfer and vice versa. Thus, there may be grants and incentives available to encourage you to make your home more energy efficient. We have appended information on the Federal Government's ecoENERGY program and on some BC Hydro incentives that you might want to consider. Upgrading windows to make them more energy efficient will more than likely upgrade them acoustically as well.

For information on the Federal Government's ecoENERGY program or the BC Hydro Energy Star Program please click on any of the following links.

http://www.oee.nrcan.gc.ca/publications/infosource/pub/ecoenergy-retrofit-homes/retrofit-qualify-grant.pdf

http://www.oee.nrcan.gc.ca/english/index.cfm?attr=4

http://www.oee.nrcan.gc.ca/corporate/retrofit-summary.cfm?attr=0

http://www.bchydro.com/rx_files/pshome/pshome1592.pdf

http://www.bchydro.com/powersmart/reno/reno8621.html

This guide has been prepared to give the residential homeowner some ideas about improvements that they can consider to reduce noise exposure to their outdoor and indoor spaces. It is general in nature and is not necessarily the complete answer to every situation. If you plan to spend significant amounts of money on upgrades to your residence, we strongly recommend that you seek competent advice on your particular situation.