

Sound Insulation of Residences and Other Buildings Exposed to Aircraft Noise

A quick guide to best practices and tools for planning sound insulation projects



This brochure is not a definitive design guide. Users of this brochure should consult local building officials and sound attenuation professionals for project planning and development.

Prepared By:



Compatible Land Use and Sound Insulation



Through the Air Installations Compatible Use Zones (AICUZ) Program, the Department of Defense (DoD) works with neighboring communities to promote land use and development that are compatible with aircraft operations. The AICUZ Program recommends sound insulation of residences and other structures with noise sensitive uses when located within areas of high noise levels near an airfield.

Structures located near military airfields and civilian airports are exposed to aircraft noise that can interfere with people's regular indoor activities. Sound can enter a structure through exterior elements, including walls, roofs, doors, windows, range exhaust ducts, and chimneys. Using proven construction techniques and materials in structures can reduce interior noise to levels that most people would find acceptable. While sound insulation does not guarantee sound elimination, indoor noise levels can be reduced by using proper renovation and construction techniques.



Reducing the level of aircraft noise experienced by occupants of residential and non-residential structures is known by a variety of terms. For consistency, the term “sound insulation” is used throughout this brochure. Sound insulation is defined as reducing the sound level inside a building through the use of specific building construction materials, methods, and component assemblies that provide noise reduction.

Aircraft Noise and Noise Exposure Contours

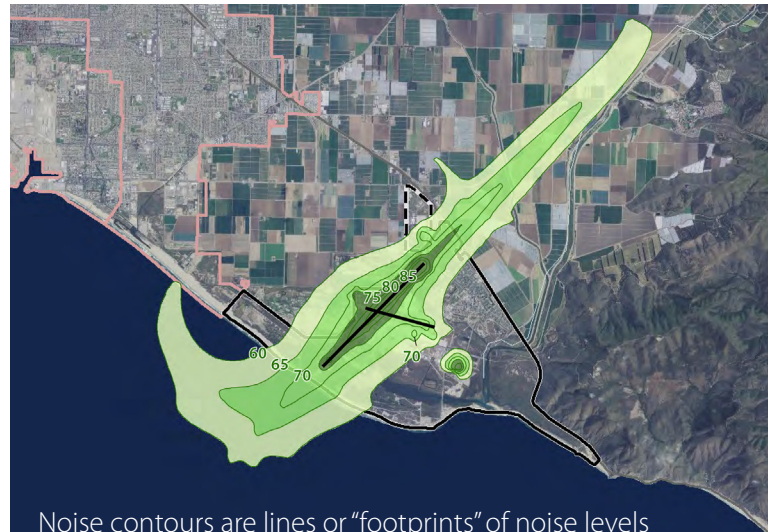


Aircraft noise levels are measured in A-weighted decibels (dBA), which represent the acoustic energy of sound vibrations expressed in terms of sound pressure. For brevity, the measurements are often expressed as “dB.”

Aircraft noise exposure in a community is portrayed using noise contour maps. Noise contour maps can be found within an AICUZ Study. The contour maps are produced by DoD noise models and define areas of average noise levels around military airfields.

The acoustic metric used for noise contour maps is the Day-Night Average Sound Level (DNL); the Community Noise Equivalent Level (CNEL) is used in the state of California. The DNL/CNEL is a cumulative measure of community noise exposure and results from averaging the A-weighted sound pressure level over 24 hours for aircraft operations taking place on an average day. For air installation noise contours, the average day is determined by analyzing flight activity over the period of one full year. The DNL/CNEL gives an indication of the year-round average noise exposure for a community.

The DoD, through the AICUZ Program, recommends compatible land use in areas with a noise exposure level of 65 dB DNL/CNEL and higher. A military airfield's AICUZ Study provides noise contour maps and compatible use recommendations to neighboring communities for planning and zoning and proposed development in the noise contours.



Noise contours are lines or “footprints” of noise levels drawn around a noise source.

Aircraft noise levels are depicted visually as noise contour lines that connect points of equal DNL/CNEL value. AICUZ noise contour maps typically depict contour levels of 65 dB DNL/CNEL and above in 5 dB increments.

Noise Level Reduction (NLR)



By reducing interior noise levels through sound insulation, aircraft noise is less likely to interfere with daily activities, such as talking on the phone, watching TV, or sleeping.

The first step in determining a noise level reduction (NLR) goal is to determine the exterior noise level, typically by finding where the structure is located relative to an AICUZ map of DNL/CNEL contours.

The second step in determining an NLR goal is to establish a desired interior noise level. The DoD AICUZ Program recommends that NLR be at least 25 dB for noise sensitive uses located between the 65 and 70 dB DNL/CNEL noise contours and at least 30 dB for noise sensitive uses located between the 70 and 75 dB DNL/CNEL noise contours. These NLRs would be equivalent to achieving indoor noise levels of less than 45 dB DNL/CNEL.

The final step in determining an NLR goal is to subtract the desired interior noise level from the highest exterior DNL/CNEL value.

$$\begin{array}{ccccc} \text{NLR} & = & \text{Exterior Day-Night Average Sound Level (DNL/CNEL)} & - & \text{Interior Day-Night Average Sound Level (DNL/CNEL)} \\ \text{Noise Level Reduction (NLR)} & & \text{Exterior Day-Night Average Sound Level (DNL/CNEL)} & & \text{Interior Day-Night Average Sound Level (DNL/CNEL)} \end{array}$$

Sound travels from the exterior to the interior of a building by penetrating the building perimeter through the building's solid structural elements or via openings. Openings in the building (which provide air infiltration paths through windows, vents, and gaps) allow sound to travel directly into the building's interior. Basically, any place that air enters a home, sound will also enter.



Sound Insulation Estimator

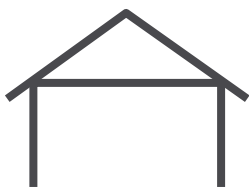
Construction varies throughout the country. Sound insulation costs depend on the particular type of construction and structural renovations, the selected indoor noise level reduction goal, and choice of building materials. The Naval Facilities Engineering Command (NAVFAC) has updated the Sound Insulation Estimator CD, the supplement to the 2005 Guidelines for Sound Insulation of Residences Exposed to Aircraft Operations, to enable users to input the style of room construction and determine the recommended scope and approximate cost of sound insulation. To obtain a free copy of the program, contact the nearest Naval Air Installation point-of-contact (POC) or other POC listed on the back of this brochure.

Best Practices for Sound Insulation Planning:

- **Construction Materials** - Understand how to use Sound Transmission Class (STC) ratings to evaluate construction methods and materials. Two different construction methods or components may have identical STC ratings and yet may block aircraft noise differently because of their response to different sound frequencies.
- **Room Characteristics** - Evaluate the sound absorption characteristics of the room finishes and furnishings. Rooms with soft surfaces such as carpeted floors, long curtains, and upholstered furniture, contribute to a lower interior noise level compared with a room with hard surfaces, such as cabinets and hard floor covering.
- **Construction Methods** - Combine building elements for a balanced design. The acoustical performance depends on the combined performances of each of the elements. If any of the components has poor insulation properties then the overall performance can be weakened. As a rule of thumb, if a weaker element will be included in the design, its size should be kept to a minimum.
- **Cost** - Consider the costs and construction requirements for the sound insulation project. Some sound insulation treatments can be inexpensive and implemented by the homeowner, while others are larger in scale, more expensive, and most likely would be completed by a professional.

How Sound Gets In & Sound Insulation Techniques:

Walls, Ceilings, Attics and Roofs



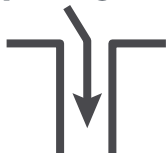
- Add mass to walls and ceilings, insulate wall panel elements, or add absorptive materials between studs and joists. The ceilings of top-floor rooms may need to be modified to provide increased noise protection.
- Consider using brick and concrete block walls, which generally need little to no modifications. Sided wood-framed walls and some stucco wood-framed walls require improvements in higher noise zones.
- The use of cathedral ceilings is strongly discouraged for homes exposed to aircraft noise. Attics provide a more efficient noise buffer than cathedral ceilings or flat built-up roofs.
- Roof improvements could include baffles in the attic vents, extra insulation to absorb sound reverberating in the attic space, and an upgraded roof deck.

Windows and Doors



- Improve the acoustical performance of exterior windows to lower the overall sound transmission into the structure. Design modification options include using thicker glass and wider airspaces between the panes of glass. Specialized acoustical windows provide maximum sound insulation and should be used in the loudest environments. The two most common types of acoustical windows are a double-pane window with a storm unit attached or an assembly of two single- or double-pane windows connected.
- Consider the door composition, door weight, presence/type of fixed window panels, and quality of seals and weather stripping. Also consider how tightly they seal when evaluating doors for sound insulation. Solid core or heavy doors provide better sound insulation than hollow or lightweight doors.

Gaps and Cracks (Openings)



- Seal gaps and cracks. Use weather-stripping. Implementing good weatherization techniques and caulking around window and door openings is crucial to effective sound insulation.
- Reduce the number of openings on exterior walls and roofs. Put baffles on open-air vents.

Energy Efficiencies and Additional Resources



Sound insulation efforts are in line with the general market trend toward better performing buildings. While sound insulation projects are not, by design, energy efficiency projects, minimizing sound transmission through the building exterior can also improve a building's energy performance. Efficiency opportunities for sound insulation treatments include using energy-efficient products, lowering energy usage for ventilation systems, and minimizing air infiltration.

The U.S. Department of Energy recommends that a residential remodeling project begin with a home energy assessment or home energy audit. Both federal and local government agencies offer financial incentives to the property owner to increase energy efficiency. Incentives can range from personal, property sales, and corporate tax credits, to rebates, grants, and loans.

Energy Efficiency Resources:



Energy Star

www.energystar.gov



U.S. Department of Energy

www.energy.gov/eere/wipo/weatherization-assistance-program



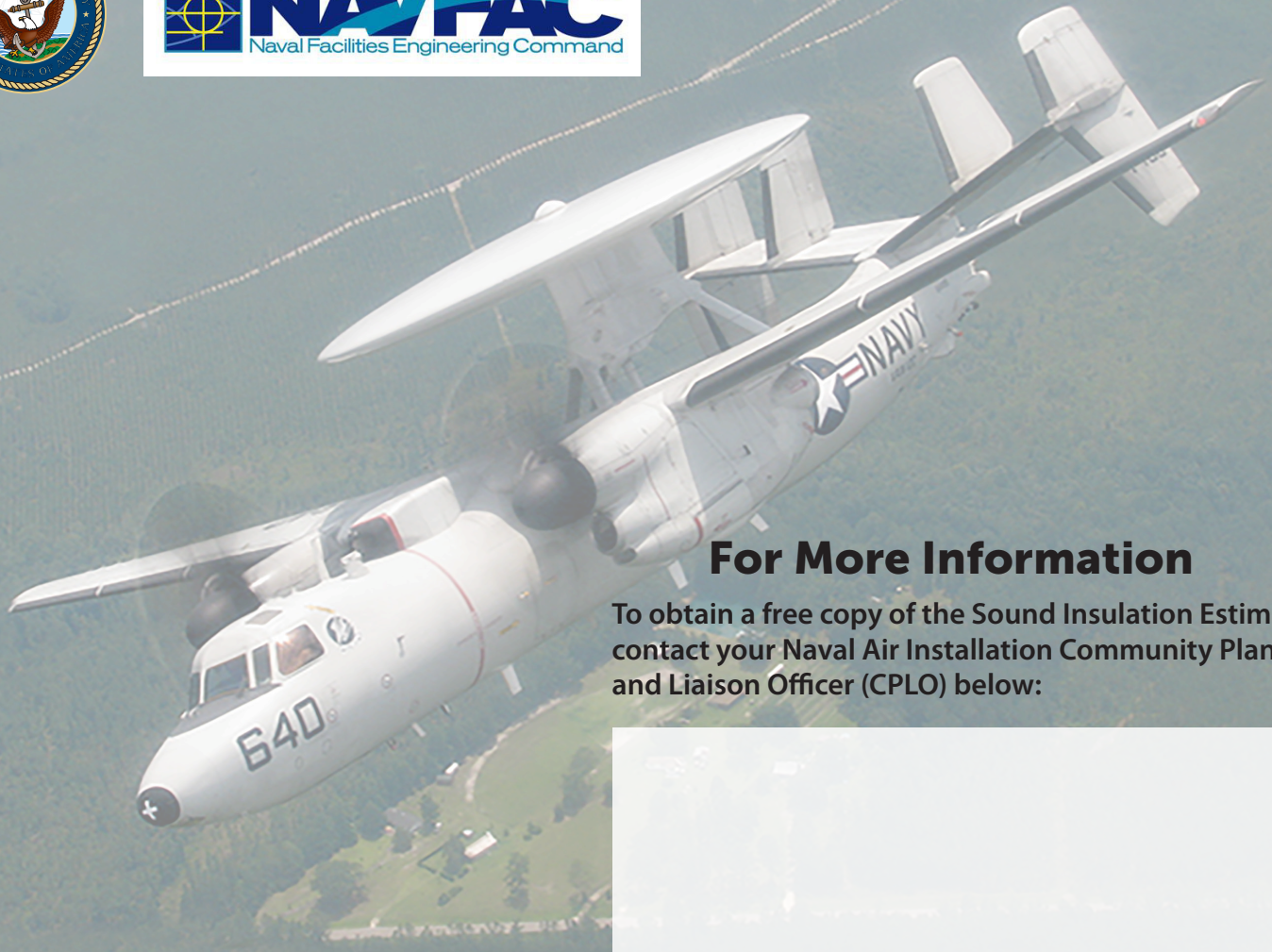
LEED

www.usgbc.org/LEED



Content for this brochure was derived from a variety of sources, including:

- Guidelines for Sound Insulation of Residences Exposed to Aircraft Operations, NAVFAC 2005
Includes a supplemental computer program, Sound Insulation Estimator, which enables the user to input the style of room construction and determine the recommended scope and approximate cost of sound insulation. NAVFAC updated this cost estimator in 2017 in conjunction with this brochure.
- Airport Cooperative Research Program (ACRP), Report No. 89: Guidelines for Airport Sound Insulation Programs, 2013
- Office of the Chief of Naval Operations Instruction (OPNAVINST 11010.36C) "Air Installations Compatible Use Zones Program," dated October 9, 2008



For More Information

To obtain a free copy of the Sound Insulation Estimator, contact your Naval Air Installation Community Planning and Liaison Officer (CPLO) below:

