Sound Insulation for Homes around Civil and Military Airports:
A Guide for Communities, Developers and Homeowners

BASF Building a Safer Florida
Dear Reader:

Sound is a part of our daily lives. We wake up to alarms, listen to the radio or watch the news on the television before we leave home.

Some sounds are pleasant – a laughing child, a purring kitten or a musical play. Others are not—sirens screeching down the highway, the rattle of the garbage truck on the street in the early morning or the roar of aircraft departing the nearby airport at night. When sounds are unwanted they are referred to as “noise”.

In quality of life surveys, regardless of whether you live in the city or the country, one negative always rises to the top—noise. We prepared this primer in cooperation with the Department of Defense in order to discuss one approach to a better sound environment - sound insulation in homes. Not only does sound insulation in a home reduce outside noise, it saves money by increasing heating and air conditioning efficiency.

if you have any questions please contact us at (850) 222-2772 or info@buildingasaferflorida.org.

Sincerely,

BUILDING A SAFER FLORIDA
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Framing the Issue

Military Airports and Urban Encroachment

All military bases attract development. People who work on the base want to live nearby while businesses wish to provide services to the base and its workforce. When incompatible development proceeds near a military airport, the affected parties soon try to seek relief through changes in flight operations that could adversely affect the flying mission. The military wants to be a good neighbor to the surrounding communities but they also need to train their aircrews. This training must be realistic – they must train the way they fight.

As one of its initiatives under the Air Installations Compatible Use Zones (AICUZ) program the Department of Defense (DoD) promotes the use of sound insulation of homes in high noise zones. In the 1990s the Federal Aviation Administration and United States Navy worked with Wyle Laboratories to produce a sound insulation guide for new and existing homes. This document, updated by the Navy in 2005, is the basis for this primer. While the impetus for this primer may be development around military bases, civil airports also share this challenge. Unhappy neighbors can force changes at civil airports that can affect scheduling and tempo of operations—this, in turn, may affect one of the major economic engines in your community. Residential sound insulation “reduces” airport noise impacts – and quiet neighbors make good neighbors!

This primer is designed to:

- Inform community governments, developers and public on the benefits of sound insulation for new and existing homes.
- Provide a software tool that provides sound insulation cost estimates.
- Promote sound insulation guidelines in building codes.
- Provide an example of state legislation on sound insulation.
The Issue: Aircraft Noise

Communities located near civilian and military airports experience many economic benefits, but are also exposed to aircraft noise. Depending on the level of exposure, the noise may interfere with typical daily indoor activities, such as watching television, talking on the telephone and sleeping.

A builder or homeowner can, however, reduce the level of indoor noise exposure and improve energy efficiency of existing and new homes through the use of proper techniques and materials.

Sound Insulation

What can it do?¹

Residential sound insulation can reduce interference from outside noises, such as passing aircraft. Phone conversations are less likely to be interrupted; people are less likely to miss the sound of a baby crying in the other room, and less likely to be awoken from a sound sleep by a late night departure. This all improves the quality of life – as well as the relationship between the airport and its neighbors.

Sound insulation and energy efficiency programs lead to:

- Improved indoor acoustics;
- Healthier indoor air quality;
- Reduced GHG emissions and carbon footprint;
- More household utility and cash flow savings.

Sound insulation and energy efficiency programs have a lot in common. Both share common techniques and materials used to reduce noise and seal air leaks that waste energy. When successfully implemented, both programs provide homeowner satisfaction. As part of an energy efficiency program, such as Energy Star®, you can save 20-30% -- or more on energy use and in costs. According to the National Renewable Energy Laboratory (NREL), these savings could even top 40-50%. This would save the homeowner an estimated average of $300-$750 a year!

Energy performance retrofits, including insulation, have a direct and matching impact on reducing residential Greenhouse Gas (GHG) emissions. According to the Department of Energy’s (DOE) Buildings Energy Handbook (2007), energy consumption for a single home produces 25,000 pounds of CO₂ emissions annually. Cumulatively residential homes are responsible for 17% of end-user GHG emissions in the United States.

¹ Excerpted from Rachami and Norris, 2008.
How it works

Sound Insulation Basics

Aircraft noise can be a source of annoyance. Whether it’s the rumble of departing airliners, the high pitched whine of jet fighters; the throbbing of helicopters or the drone of private planes; aircraft noise is a part of our lives. While we may become accustomed to the constant flow of highway traffic, we hear aircraft overflights as distinct events, often capable of disrupting speech or other activities.

Everybody responds to noise differently. Some people living near airports may be annoyed by aircraft overflights, while others may not. Proper sound insulation will, however, reduce noise inside a home to levels that most people find acceptable. They will still hear some aircraft since sound insulation is not sound elimination. People will know when an aircraft is passing overhead but, with implementation of the techniques discussed in this document, the noise should not interfere with normal daily indoor activities. While the people most sensitive to noise may continue to be annoyed, many others will find relief if their homes are sound insulated through proper renovation and construction techniques. Sound insulation of homes has proven to be very effective at mitigating adverse noise impacts across the country. For this reason, many civilian airports undertake sound insulation programs.

The DoD and other Federal agencies have found that noise exposure below 65 DNL – Day Night Average Sound Level (or 65 CNEL – Community Noise Equivalent Level) is generally compatible with residential development. At 65 DNL and higher, however, homes may need varying levels of sound insulation treatment to ensure that indoor noise levels are sufficiently reduced.

Federal guidelines recommend an interior noise level goal of 45 decibels (dB). The amount of sound insulation required varies depending on the location of the home in the noise zones. If it is in the 65-70 DNL noise zone, 25 dB of acoustical treatment is required to meet this goal. For 70-75 DNL, a 30 dB noise level reduction is required, and so on. Reducing the DNL/CNEL noise levels through sound insulation reduced interior noise to a level where aircraft overflights no longer interfere with daily activities, such as watching TV, reading, talking on the phone, or sleeping.

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2 While DNL is used throughout the United States, the CNEL metric is used in California. For purposes of this primer, they are interchangeable.
Sound transmission

Sound energy consists of a complex series of vibrations that travels through the air, water, the walls of your home, or some other medium. When the vibrations reach your inner ear, and if they are loud enough of within the range of your hearing, you perceive it as sound.

Sound transmission in your home starts with noise at the exterior wall. Some sound energy will be reflected away and some will make the wall vibrate. The vibrating wall radiates sound into the airspace within the wall, which in turn sets the interior finish surface vibrating, while losing some energy in the airspace. The interior finish surface then radiates sound through the air inside the home. Some vibration also bypasses the airspace in the walls by traveling through studs and edge connections.

Openings in the home (which permit airflow through windows, vents, and leaks) allow sound to travel directly into the interior. Outdoor noise enters a home through walls, roofs, doors, windows, range exhaust ducts, chimneys, etc. The most important, or controlling, sound paths must be addressed to achieve a significant noise reduction. Different types of homes may require different levels of sound insulation to achieve interior noise level goals. The more windows and doors in a room, and the larger the openings, the more noise will enter. Typical sound insulation modifications include:

- **Windows** – Windows generally allow more noise intrusion than walls. Replacing them is often the single most important modification that can be made to a home. Use acoustical windows, or add acoustical storm windows over existing windows. Open windows significantly reduce the benefits of sound insulation.

- **Doors** – Doors are comparable to windows in the amount of sound they allow
to enter a home. Many typical residential doors require modification or substitution to provide the necessary protection from aircraft noise. Solid core or heavy doors protect better than hollow, light-weight doors. Acoustical doors or acoustical storm doors should be used to achieve maximum noise level reduction. These products are heavier than typical doors and have a special type of weather stripping.

- **Walls and Ceilings** – In general, brick is a better sound insulator than siding – and more energy efficient! For homes with lightweight walls and ceilings it is often necessary to add layers of gypsum board or other materials to walls and ceilings in order to meet the acoustical design goals.

- **Skylights** – Traditional skylights provide little sound insulation. For skylights the recommended modifications are to add secondary interior glass panels, replace the units with special acoustical skylights, or simply remove them.

- **Fireplaces** – All openings to the outside, including chimneys, reduce the effects of sound insulation. Recommended modifications for fireplaces are to either install an acoustical chimney-top damper or tight-fitting glass doors over the fireplace.

- **Air Conditioners** - Through-window or through-wall air conditioners allow easy sound transmission should be removed to achieve the noise reduction goal.

- **Exhaust Fans** - Kitchen range hood or in-wall fans that duct to the exterior are a significant noise leak. Replacing them with ductless models is the best course of action.

- **Ventilation** - When a house is sound insulated it is necessary to close windows to achieve the benefits of the modifications. To replace the cooling and ventilating effects of open windows, air conditioning and/or ventilation systems should be provided.

**Variations in Homes**

The amount of sound insulation required varies from old to new homes and also on the type of construction. New homes require different sound insulation treatments than existing houses for three reasons. First, they
allow the flexibility of selecting more appropriate materials instead of replacing existing materials. Second, many older construction methods are not encountered with new construction. Third, it is easier to meet sound insulation goals with new construction than with a retrofit.

The principle features that differentiate homes for sound insulation purposes are:

- Exterior wall material (brick, concrete block, insulating concrete forms, siding, stucco, etc.),
- Type of roof structure (flat built-up roof, attic, or cathedral ceiling),
- Type of foundation (basement, crawlspace, pylons, or slab),
- Number of stories,
- Size and number of windows and doors, and
- Type of home (single-family, duplex, townhouse, apartment, or manufactured home).

In addition to the features noted above, other characteristics influence the final noise reduction of the home, including:

- Attached garages and large wrap-around porches may provide shielding from noise for those sides of the home.
- The use of cathedral ceilings or flat built-up roofs without an attic is strongly discouraged because an attic provides a more effective noise buffer.
- Openings or penetrations such as chimneys, whole house attic fans, pet doors, and through-wall heating and air conditioning units are strongly discouraged because they allow noise infiltration.
Sound insulation costs vary widely depending upon:

- **Airport Noise Zone:** The higher the noise zone the greater the sound insulation needed, resulting in a higher cost.

- **Interior Noise Level Goal:** The elected indoor noise goal level also influences the cost of sound insulation. Normally, the indoor level is 45 dB. Normal construction will normally provide 15-20 dB of noise level reduction. While this cost can be considerable in retrofitting old homes, use of proper materials in new construction could add little cost to the construction.

- **Home Construction:** Type of construction and age of the home also influence sound insulation costs.

- **Region of the Country:** Homes built for weather extremes may require less sound insulation. HUD research shows that one of the determinants of home construction cost is whether the home is located in a rural or urban area. Costs are higher in cities than in rural communities, and also differ between geographic regions.

- **Availability of contractors familiar with sound insulation construction,** and

- **Number of residences sound insulated at one time:** There is an economy of scale when multiple residences of the same type are sound insulated at the same time.

On average the cost to sound insulate an existing home to achieve 25 to 35 dB of noise level reduction can vary between $15,000 and $45,000 (Wyle Laboratories, 2005). For new construction, the cost to build a sound insulated home is only slightly higher than the cost to build a standard home. Some design considerations may have no cost associated with them, such as locating bedrooms away from the flight path.
Case Study: Florida Legislation on Airport Noise and Sound Insulation

**Issue**

Civil and Military airports have long recognized and been concerned about their operational impacts on neighboring communities. Noise complaints from nearby residents can also restrict training and operations and are subject of conflict between airports and their neighbors. While a range of options are available to prevent and manage noise impacts, adopting proactive noise control measures during the planning process is the most effective.

**Starting at a Local Level – Naval Air Station Jacksonville**

Naval Air Station (NAS) Jacksonville was established on October 15, 1945, along the St. Johns River in Jacksonville, Florida. While the Station calls the City of Jacksonville home, so do thousands of nearby residents. Since first initiating their Air Installations Compatible Use Zones (AICUZ) Program in 1979 NAS Jacksonville has proactively worked with the Jacksonville community to promote compatible land use in vicinity of the Station and manage operational impacts on its neighbors.

**Opportunities & Accomplishments**

- Prior to 2004 the City of Jacksonville’s building code, consistent with the International Building Code, and similar to many other North American cities, did not require structures in vicinity of its civilian and military airports to meet a specified goal or standard for sound insulation. NAS Jacksonville recognized an opportunity and decided to ask the City to consider amending their ordinances.

- In 2004 the Station worked with the City of Jacksonville to obtain a Florida Defense Alliance grant to update the City’s Airport Zoning
ordinance. The Mayor’s Office, Military Affairs, Public Works, Legal and Planning Offices, Jacksonville Aviation Authority, NAS Jacksonville, Naval Station Mayport and Northeast Florida Builders and Realtors Associations worked together to craft the updated ordinance. Not only did the City include compatible land use requirements for civilian and military airports in the ordinance update, it also added sound attenuation standards for construction in airport noise zones.

- In 2007, the City of Jacksonville adopted the ordinance, helping to prevent incompatible development and manage noise impacts near airports in their jurisdiction. The ordinance not only included the two military airports but also applied to the three civilian airports in the city, including Jacksonville International Airport.
- The City of Jacksonville’s 2007 sound attenuation requirements benefited local government, property owners and the community. It gave local government a tool to enforce compliance with noise attenuation requirements, provided measures to improve the quality of life for persons living and working near airports, and, as a side benefit, increased the number of energy efficient homes.

**Building on Success – Florida Military Base Commanders**

Based on the success of the City’s ordinance and seeing benefits statewide, NAS Jacksonville approached the Florida Military Base Commanders Forum about sponsoring a similar amendment to the Florida Building Code. The Forum was supportive of the effort because it would reduce noise in new construction near their military air installations.

**The State Legislation – Florida Building Code**

In 2010 NAS Jacksonville supported by the Florida Military Base Commanders Forum, sponsored a revision of the Florida Building Code. The proposed amendment included prescriptive sound attenuation provisions for new construction in the proximity of major civilian and military airports when required by a Florida county or local government.
Opportunities and Accomplishments

- All major civilian and military airports in the State had defined noise zones as required by the Code, but only a few had prescriptive sound attenuation provisions to achieve noise reduction levels required in county or local government zoning ordinances.
- Approved by the State Building Commission in December 2010 Florida became the first State in the Nation to include sound attenuation guidelines for construction around its civilian and military airports. The effort was the result of teamwork between the Navy, State of Florida and City of Jacksonville.

Lesson Learned

The Florida sound insulation legislation was a collaborative effort between many government and non-governmental stakeholders. The legislation not only resulted in new or strengthened partnerships, but more importantly, provided measures to improve the quality of life for persons living and working near civilian and military airports while increasing home energy efficiency.

Conclusion

Civilian and military airports are an important part of local economies. Airports promote growth. Growth incompatible with an airport’s operations can degrade the flying mission as people with noise concerns seek changes in operations.

While noise in the vicinity of an airport is a fact of life to those living nearby, proper sound insulation can increase the quality of life by reducing noise impacts. Sound insulation can also make homes more energy efficient, reducing energy consumption and limiting greenhouse gas emissions while saving the homeowners money. It also makes it easier for airports – civilian and military – to do their job.

Cities like Jacksonville, Florida have incorporated sound insulation requirements into ordinance. Recently, the State of Florida amended State code, including prescriptive sound attenuation provisions for new construction in the proximity of major civilian and military airports when required by a Florida county or local government.

Everyone wins through incorporation of sound insulations – homeowners, developers, the airports, and the environment.
For more information on sound insulation requirements, see the U.S. Navy’s “Guidelines for Sound Insulation of Residences Exposed to Aircraft Operations,” published in 2005. For information on the synergism of sound insulation with energy efficiency, see excellent paper by Rachami and Norris, “A Synergistic Green Approach to Conducting Federal Aviation Administration (FAA) and Department of Energy (DOE) Residential Retrofit Programs,” published by Wyle Laboratories in 2008. The References section of this primer provides links to both papers.

**Glossary of Terms**

AICUZ  Air Installations Compatible Use Zones Program  
BASF  Building a Safer Florida  
CNEL  Community Noise Equivalent Level  
CO₂  Carbon Dioxide  
dB  Decibel  
dBA  “A” weighted decibel  
DOE  Department of Energy  
DNL  Day-Night Average Sound Level  
FAA  Federal Aviation Administration  
GHG  Green House Gas  
JLUS  Joint Land Use Study  
NLR  Noise level Reduction  
STC  Standard Transmission Class
References

National Renewable Energy Laboratory (NREL), Home Performance with ENERGY STAR: Utility Bill Analysis on Homes Participating in Austin Energy’s Program. 2007
http://www.nrel.gov/docs/fy07osti/41903.pdf


http://www.eia.doe.gov/oiaf/1605/ggrpt/index.html

http://www.fican.org/pdf/Wyle_Sound_Insulation.pdf
Appendix A: Section 3113 of the Florida Building Code

AIRPORT NOISE

3113.1 The Aviation Safety and Noise Abatement Act of 1979 14 CFR part 150 (US Department of Transportation) including revisions through January 2005 and hereby adopted as a guideline for establishing airport noise control. When required by a local government by local ordinance to provide noise attenuation in a new structure or addition to an existing structure near an airport in the area of the local government, the applicant must provide either:

1. a testing certificate from an accredited noise testing lab that a new structure or addition to an existing structure built to submitted engineering plans will achieve an average minimum dBA reduction equal to or greater than the reduction required;

2. an engineering judgment signed and sealed by an engineer licensed in the State of Florida that the structure or addition built to the submitted engineering plans will achieve an average minimum dBA reduction equal to or greater than the reduction required; or

Appendix B: Noise Contours Explained

Communities near civilian and military airports are exposed to varying levels of noise depending on how close they are to the air installation and whether or not they experience direct overflights on a regular basis. Generally, the closer a home is to a flight corridor, the louder the noise will be. Most airports typically document the levels of noise exposure around their facility using computer-generated noise contours.

Noise levels around civilian and military airports are generally expressed in Day-Night Average Sound Level (DNL) contours (except in California). DNL represents the average noise exposure of all aircraft events that occur at or near an airport. It considers those characteristics of noise that people most notice – how loud the events are and the number and length of events all are ways to describe the noise energy. Additionally, a 10 dB penalty is added to the DNL calculation between 10 p.m. and 7 a.m. to account for the added intrusiveness of sounds that occur during normal sleeping hours. DNL is calculated based upon the type of aircraft, number of operations, engine power settings, flight tracks, altitude, the time of day, and even environmental factors such as temperature and humidity.

For airports in California the Community Noise Equivalent Level (CNEL) is used in lieu of the DNL to represent noise contours. CNEL is very similar to DNL except that it includes an additional 5 dB penalty for noise that occurs in the evening from 7 p.m. to 10 p.m.

DNL is presented on maps as noise contours – lines connecting points of equal value. The area between the noise contours is referred to as a noise zone. The DoD provides land use guidelines for these zones along with recommend Noise level Reduction (sound insulation). Civilian airports use similar guidelines.

Most civilian airports prepared noise contour maps as part of the Part 150 studies. The maps are available to the public at each airport.
The DoD provides noise contour maps for all military airports. These maps are found in Air Installations Compatible Use Zones (AICUZ) studies, for the Navy, Marine Corps and Air Force, Operational Noise Management Plan (ONMP) for the Army, and Joint Land Use Studies for the Department of Defense. You can find out where to obtain a noise contour map for a nearby military airport by contacting the installation’s Public Affairs Officer.
Who Is Building a Safer Florida

In 2001 Florida passed a Unified Building Code that required design and construction licensees to comply with standards that would make buildings more resistant to the devastation of hurricanes and other weather disasters.

Building a Safer Florida (BASF), made up of the State’s major design and construction organizations, serves as a clearinghouse for accurate, accessible and uniform information that helps architects, engineers, builders, contractors and other building professionals comply with the Florida Unified Building Code.

BASF also partners with government agencies, State universities and other groups involved with the Florida Building Code to provide the education and resources that licensees need to help build a safer Florida.

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