

**BURLINGTON INTERNATIONAL AIRPORT
PART 150 NOISE COMPATIBILITY PROGRAM UPDATE
TECHNICAL PAPER – RESIDENTIAL SOUND INSULATION PROGRAMS
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Residential Sound Insulation Programs

The purpose of a Residential Sound Insulation Program (RSI Program) is to reduce interior noise levels in a home. This is accomplished by applying acoustical treatments designed to reduce aircraft noise. The treatments include, but are not limited to, upgrading windows, doors and ventilation systems. While sound insulation cannot reduce the noise in the surrounding area, it does provide a place for individuals to be able to enjoy their home and children to be able to study.

The process for designing and implementing a sound insulation program is defined by the Federal Aviation Administration (FAA) in accordance with Appendix R “Noise Compatibility Planning/Projects” of the Federal Aviation Administration Order 5100.38D Airport Improvement Program Handbook¹ (AIP Handbook)

The RSI Program offers a selection of treatments that are tailored specifically to each dwelling. Acoustical treatments include standard door and window styles and finishes, as well as alternative modifications, when required. Owner’s selections, which will be incorporated into the proposed modifications, include choice of style, color and finish from available manufacturer’s offerings. Post-construction average interior noise levels should not exceed a measurable 45-decibel (dB) Day-Night Average Sound Level (DNL) in the habitable portions of the dwelling. A 5-dB improvement relative to pre-construction levels is also a stated objective of the RSI Program.

1.0 Determining Eligibility

1.1 Federal Requirements

An airport sponsor may implement a RSI Program if it is contained in an approved 14 CFR part 150 Noise Compatibility Program (NCP).

The identified eligible properties must be within the 65 dB DNL noise level or higher for which the land use is not considered to be compatible (49 USC § 47502, as implemented by Table 1 of Appendix A in 14 CFR part 150). Properties located below this threshold will not be eligible for mitigation funding unless a lower local standard is adopted by the jurisdiction or the FAA has approved “block rounding” in the NCP.

Prior to the implementation of the RSI Program, the airport sponsor must comply with the eligibility criteria and program requirements set forth in Appendix R.

¹ FAA Order 5100.38D “Airport Improvement Program Handbook”, Appendix R “Noise Compatibility Planning/Projects”, effective date September 30, 2014.

1.2 Developing an Acoustical Test Plan

The first step in developing an RSI Program is for the program sponsor to develop an Acoustical Testing Plan (ATP) for FAA review. The ATP is to include protocols for the initial testing, FAA review of initial testing results, special circumstances and the final testing phase. Testing methods for determining interior noise levels are outlined in the FAA's adopted guidance² per Advisory Circular 150/5000-9A, *Announcement of Availability – Report No. DOT/FAA/PP/92-5, Guidelines for the Sound Insulation of Residents Exposed to Aircraft Noise*, issued in 1992. The key steps in an ATP for a residential sound insulation program are:

- **Neighborhood Surveys:** Housing surveys are first conducted to characterize neighborhood homes by type (e.g. age, size, construction type, etc.), and a representative sample of the various types identified is then selected to be included in the initial testing phase³.
- **Pre-construction Acoustical Testing:** Measurements of existing acoustical performance of the structure are conducted using either an artificial noise source or actual in-situ aircraft noise events, for determining the existing interior DNL.
- **Determine Compatible and Non-Compatible Structures:** Analyze test data to determine if the average of the aircraft interior noise levels in all habitable rooms is greater than, equal to or less than 45 dB DNL.
- **Determine Required Sound Insulation Improvement:** Determine the improvement in outdoor-to-indoor noise level reduction (NLR) needed to provide an interior noise level that meets FAA requirements.
- **Design Full Sound Insulation Package for Eligible Structures:** Design primary acoustical treatments that will meet FAA noise reduction goals for non-compatible structures. Separate sound insulation packages are required for residences constructed with siding and residences constructed with brick⁴. In addition to lowering average interior noise levels from aircraft to below 45 dB DNL, acoustical treatment packages must also be designed to achieve an improvement in the NLR of at least 5 dB⁵.
- **Design Alternate Treatment Package for Eligible Structures:** Design secondary treatment packages for compatible structures that are eligible for purposes of “neighborhood equity” or that require

² “Guidelines for the Sound Insulation of Residences Exposed to Aircraft Operations”, which is attached to FAA Advisory Circular AC150/5000-9a

³ FAA Order 5100.38D Appendix R, Table R-4 “Pre- and Post-Testing Criteria for Noise Insulation Projects”, c. “First Step – Initial Testing” Paragraph (3): “Once the sponsor has characterized the diversity of the residences in the noise contour, it will select a representative sample of each type of similarly-constructed residences for testing, which based on industry review is typically 10% to 30%. Testing in this case means that the sponsor develops and installs a sound insulation package that the sponsor believes will reduce the interior noise level in the residence for each type of construction.”

⁴ FAA Order 5100.38D Appendix R, Table R-4 “Pre- and Post-Testing Criteria for Noise Insulation Projects”, c. “First Step – Initial Testing” Paragraph (4): “In a neighborhood where the residences are made of either brick or wood siding, the sponsor will develop two different packages – one for the brick residences and one for the siding residences.”

⁵ FAA Order 5100.38D Appendix R, Table R-6 “Noise Compatibility Planning/Project Requirements”, g. “Noise Mitigation Measures for Residences” Paragraph (4): “The sound insulation package must provide a reduction in indoor noise level of at least 5 dB and bring the average interior noise level below 45 dB.”

the installation of continuous positive ventilation in order to receive the benefits of the structure's existing sound insulation by having windows and doors always closed.

- **Install Sound Insulation Packages:** Once approved by the FAA, the designed primary sound insulation packages are installed at the sample set of eligible structures.
- **Post-Construction Acoustical Testing:** Following the installation of sound insulation packages, structures that had primary acoustical treatments installed are re-tested to determine if noise reduction goals are met as required by the FAA.

1.3 Eligibility Testing/Pre-testing Process

1.3.1 Eligibility Criteria

When an owner applies to participate in an RSI Program, a property title search may be completed to verify ownership and to make sure there are no tax liens, easements or other encumbrances associated with the property which would cause it to be ineligible. Additional conditions of the RSI Program follow current FAA guidelines, as currently described in Appendix R, Table R-6 of the AIP Handbook:

- Structures typically must have been constructed prior to October 1, 1998
- Structures typically must be located within the current FAA-approved DNL 65 dB noise contour
- Structures must be experiencing a logarithmic (energy) average interior DNL of 45 dB or greater in habitable rooms with all prime and storm windows and doors closed

The AIP Handbook allows some specific exceptions to the first two guidelines above that, if needed, would be coordinated with FAA including block rounding.⁶

1.3.2 Pre-construction Testing Process

Outdoor-to-indoor NLR measurements are conducted using either an artificial noise source e (i.e. loudspeaker) or actual aircraft noise events. Artificial noise source testing has a number of practical advantages over aircraft overflight noise testing, which have resulted in it becoming the most commonly employed test method. The artificial source method, compared to the actual aircraft method, limits interruption to the property owners and inhabitants/users of the tested interior spaces. An artificial noise source allows measurements to be made at the properties during a brief measurement period, independent from the reliance on aircraft overflights and without the need for multiple sound level meters to simultaneously measure aircraft noise in all habitable rooms. The aircraft overflight method generally requires that no persons be present inside the home for the several hour of the test duration.

⁶ Appendix R of the AIP Handbook allows some exceptions as discussed in Section R-9 "Block Rounding," R-10 "Neighborhood Equity." In addition, Table R-6, g(7) and i(6) states "The structure must have been built prior to October 1, 1998 unless the sponsor has demonstrated to the ADO that no published noise contours existed at that time. New non-compatible land uses created by subsequent airport development may also be eligible for funding consideration. The October 1, 1998 date is based on the FAA Final Policy on Part 150 Approval of Noise Mitigation Measures: Effect on the Use of Federal Grants for Noise Mitigation Projects, 63 Federal Register 16409 (April 3, 1998)."

During an artificial noise source test, an acoustical consultant uses a specialized field monitoring kit that includes a signal generator and public announcement (PA) type loudspeaker to produce a noise source of equal energy in each octave band or one-third octave band (known in the acoustics field as “pink noise”) at an approximate overall sound level of 90 to 100 dB as measured at the exterior building façade under test.

The loudspeaker is vertically positioned either on a tripod or placed on the ground unless there is compelling evidence that the roof/ceiling element of the room under test has the potential to contribute to the interior sound level from aircraft operations. Examples of compelling reasons include: existence of weak elements within the roof/ceiling structure, such as sky lights; relatively light weight materials to make up the roof structure; limited airspace between the roof and ceiling, e.g., vaulted ceilings and flat roofs; and limited or no use of insulation in the space between the roof and ceiling. In these instances, the speaker will be lifted above the roofline of the home to obtain both exterior façade and roof exposure through the use of an industrial grade hoisting device, such as a bucket truck, scissors lift or mobile crane.

With the loudspeaker placed to provide sufficiently uniform sound across the façade, room, or element, octave band or one-third octave band sound level measurements are made both on the exterior and in the interior of the structure using both time and spatial averaging of sound levels. Additional measurements are conducted without the loudspeaker in operation to provide background or ambient sound levels.

2.0 Development of Policy and Procedures

Upon FAA approval of the ATP, the airport sponsor will develop a policy and procedures manual (PPM) which will describe the RSI Program’s purpose, goals and typical modifications, project planning and management, construction contract bid and award cycle, the construction process, eligible spaces, architectural, mechanical, electrical and other types of treatments, and building code requirements.

2.1 Prioritization of Homes

The PPM will define how to prioritize homes beginning with the homes in the highest noise levels and working outward to the RSI Program boundary. Many programs also use the following criteria:

- Length of residency
- Ownership vs. rental property
- Contiguous blocks vs. by noise level

2.2 Pace of Program

The pace of the RSI Program is defined by the airport sponsor’s ability to match grant funding from the FAA as well as the FAA’s ability to provide grant funding. The airport sponsor will work with the FAA’s Airports District Office (ADO) to develop a capital programs work plan.

Sound insulation programs are often developed based upon FAA grant cycles. Typically, a grant is issued for the design and bidding of a group of homes. A second grant is issued for the construction of the homes based upon the lowest responsible bid received by the airport sponsor. A typical design, bid and construction cycle is approximately 12-18 months depending upon the size of the construction contract.

2.3 Building Code Compliance

Understanding the local and state building code is a key component to the implementation. Appendix R is very specific on the types of treatments that are eligible for grant reimbursement.⁷ Understanding what, if any items, may need to be undertaken to meet code compliance is necessary to inform the program participants who may be responsible for these costs. Examples of the types of items that may be required by code but are not necessary to the reduction of interior noise levels are:

- Smoke detectors
- Carbon Monoxide monitors
- Electrical upgrades
- Egress

Working with the local building officials, the airport sponsor can determine what will be required in order to obtain a building permit. Any potential issues can be discussed with the owner during the design phase of the process.

2.4 Types of Treatments

Per Appendix R of the AIP Handbook, allowable sound insulation measures include the replacement of windows and doors, the addition or replacement of caulking and weather stripping, and the installation of central air-conditioning or ventilation systems in structures without an existing system⁸. Central air-conditioning or ventilation systems are a necessary component in sound insulated structures, as they allow for windows to remain closed year-round.

Additional measures may be included as part of the treatment package with approval from the local FAA ADO. Additional treatment measures that may be employed following ADO approval include:

- Addition of attic and/or wall insulation
- Addition of extra layers of wall and/or ceiling board
- Removal or treatment of through-wall A/C units
- Removal of mail slots, pet doors, milk chutes
- Treatment of chimneys, fireplaces, exhaust vents

2.5 By Noise Contour Level

The sound insulation measures included in a treatment package are selected in order to achieve a target NLR value based on the DNL to which a structure is exposed. The exterior DNL value assigned to a residence is the upper end of the corresponding DNL interval, as outlined in Section 3.4.1 of the 1992 Guidelines (FAA 1992). For example, residences in the DNL 65 to 70 dB interval are assigned an exterior DNL of 70 dB.

⁷ FAA Order 5100.38D, Appendix R, Table R-6 “Noise Compatibility Planning/Project Requirements”, g. “Factors to Consider For Justification and Eligibility” Paragraph (6): “The following measures are allowable: window and door replacement, caulking, weather-stripping, and installing central air ventilation so that the windows can be kept closed only if the structure does not already have a central air ventilation system. The use of other measures is not allowable unless the ADO has approved the use of the measures in advance.”

⁸ FAA Order 5100.38D Appendix R, Table R-6 “Noise Compatibility Planning/Project Requirements”, g. “Factors to Consider For Justification and Eligibility” Paragraph (6): “The following measures are allowable: window and door replacement, caulking, weather-stripping, and installing central air ventilation so that the windows can be kept closed only if the structure does not already have a central air ventilation system. The use of other measures is not allowable unless the ADO has approved the use of the measures in advance.”

Sound insulation programs generally target a post-construction NLR value of approximately 30 dB for residences exposed to DNL between 65 and 70 dB, and a 35 dB NLR for residences exposed to DNL between 70 and 75 dB. Achieving a post-construction NLR of 35 dB and higher generally requires that treatment packages include at least some of the additional measures mentioned in Section 3.1. Sound insulating residences exposed DNL greater than 75 dB (i.e. target NLR values of 40 dB and higher) may be infeasible in some neighborhoods. When it is feasible, the materials and measures required to achieve very high NLR values may be impractical to implement and/or aesthetically undesirable to homeowners.

65 to 70 dB DNL treatment package:

A treatment package for a residence exposed to a DNL between 65 and 70 dB (i.e. target NLR of 30 dB) would typically include:

- Triple pane assembly windows and sliding glass doors (i.e. double-glazed prime with single glazed storm)
- Solid-core wood prime exterior doors with a single-pane storm door
- Additional ceiling insulation where existing insulation is insufficient
- Treatment or removal other sound infiltration weak points such as through-wall A/C units, mail slots, exhaust vents, etc.

70 to 75 dB DNL treatment package:

A treatment package for a residence exposed to a DNL between 70 and 75 dB (i.e. target NLR of 35 dB) would include measures similar to the 30 dB NLR package, but would require materials with increased sound insulation performance. The level of performance required to achieve an NLR of 35 dB is near the upper limit for many residential products, and commercial or custom made product may have to be used. The treatment of exterior walls and ceilings with an additional interior gypsum board layer may also be required to achieve the target NLR.

75 dB DNL and greater treatment package:

In most cases, treatment packages for residences exposed to DNL greater than 75 dB (i.e. target NLR values of 40 dB and higher) require the use of high performance commercial products and the addition of either multiple layers of gypsum board to wall and ceiling surfaces or double wall construction. Available commercial products which meet the performance requirements may be aesthetically less desirable to some homeowners than the residential products used in treatment packages targeting lower NLR values. Double wall construction increases wall thickness by several inches, thus somewhat reducing the total area of rooms with treated walls.

Sound insulation treatments are not recommended for homes in this noise level. The preferred noise mitigation method is the acquisition of the property and the relocation of the residents.

2.6 Secondary Treatments

For those homes which do not have continuous positive ventilation and when acoustically tested have an interior noise level less than 45 dB DNL, the FAA allows for installation of secondary treatments in

order to provide neighborhood equity and to allow the residents to have proper air circulation while they have the doors and windows closed.

If these types of homes are identified during the ATP process, the airport sponsor will work with the FAA to obtain approval for a positive ventilation package as described in Appendix R.⁹

3.0 Implementation of Program

The airport sponsor will develop a grant application for the design of a group of homes. Upon receipt of the grant funding, the airport's consultant team will begin the sound insulation process.

3.1 Overall Timeframe

The sound insulation process for a typical package of 50 homes takes approximately 12 -18 months from initial homeowner outreach to completion of the construction contract. This timeframe can vary depending upon the number of homes included in the construction package and the timing of the grant cycle.

3.2 Design

The design process is comprised of a number steps including homeowner outreach, assessment visits, design of an acoustical treatment package for each home and development of construction documents.

- **Application:** Eligible property owners, will be sent a Program Application Package explaining the sound insulation process and an application for participation.
- **Assessment Visit:** The assessment visit is conducted by the program team at the property. During the visit, the program team will explain the RSI Program in detail, document the home's existing conditions, draw floor plans and measure all windows and doors. The mechanical/electrical engineer will conduct a detailed evaluation of the home, including existing heating and air conditioning systems, electrical service, and potential safety or code issues.
- **Design Phase:** The program team will meet with the owners either at their home or at the RSI Program office to review the recommended construction plans and scope of work for the property. This will include floor plans of the home, recommended treatment package, and homeowner pre-work, if any.
- **Homeowner Participation Agreement:** Once the owners have agreed to the recommended scope of work, they will execute the homeowner participation agreement. The homeowner participation agreement is a contract between the airport sponsor and the property owner describing the work to be undertaken and the responsibilities of each party. This may also include the execution of an avigation easement, if required.
- **Development of Construction Documents:** All participating properties are placed into a construction package. The program team will develop a set of bid documents that conform to FAA,

⁹ FAA Order 5100.38D Appendix R, Table R-6 "Noise Compatibility Planning/Project Requirements", h. "Noise mitigation Measures for Residences (Positive Ventilation Package Only)" Paragraph (3): "A Continuous Positive Ventilation System is the allowable package for these residences. The sponsor must also provide detailed information about the ventilation package including costs of the package compared to the cost of a standard noise insulation package. The sponsor may recommend an air conditioning system in lieu of ventilation-only."

state and local bidding requirements. These documents will be sent to the FAA for concurrence and permission to bid the construction contract.

3.3 Bid

The final design and construction package is released to interested contractors for public bidding by the airport sponsor. The bids are evaluated and the work will be awarded to the most responsive, responsible qualified contractor.

A grant application for the construction of these homes is submitted to the FAA along with the successful contractor's bid.

3.4 Construction

Upon receipt of a grant for the construction of the homes, the program team will begin the construction process.

- **Pre-Construction Activities:** The selected contractor and the RSI Program team members will schedule an appointment with each property owner to review the specific scope of work for your home. The contractor will measure each window and door opening. The contractor will develop a construction schedule and provide product submittals and shop drawings. Upon approval of these submittals by the program team, the contractor will order the customized products. The contractor will pull construction permits for each of the homes.
- **Pre-Construction Walk-Through:** The contractor and program team will visit the home 48 hours before the start of construction. During this visit, the contractor will review with owner the scope of work for the home, take pre-construction photographs, and ensure the property has been prepared for construction.
- **Construction Process:** The program team will notify the owner of their construction start date. The construction process takes approximately 30 days. The contractor will need access to the property during normal business weekday hours. There will not be any work on weekends, holidays or in the evening. The contractor will be required to reach substantial completion of the scope of work for the property within 10 days. After substantial completion, the contractor will be given additional time to finalize the scope of work and conduct the necessary permit inspections.
- **Final Construction Inspection:** The program team and the property owner will conduct a final inspection of the residence. Upon final inspection and approval, the homeowner will receive a warranty package for all work performed.

3.5 Post Testing

The noise reduction goals for residential sound insulation programs are outlined in Appendix R of the AIP Handbook:

- Provide an exterior-to-interior NLR improvement of at least 5 dB
- Reduce the average interior DNL sound level to 45 dB or below

The 5-dB improvement goal exists to provide a noticeable reduction of aircraft noise levels to residents.

Post-construction acoustical testing is conducted on a sampling of structures that had acoustical treatments installed. The use of random sampling to select homes for the testing may be augmented with selection of specific individual homes based on their acoustically significant interior and exterior features.

The acoustical consultant analyzes the testing results to determine if the installed treatments meet the RSI Program's acoustical goals. Any instances where these goals are not met are investigated and adjustments to the acoustical treatments may be recommended to ensure that the RSI Program goals are ultimately met. Overall, the post-construction acoustical testing is intended to provide quality control and assurance.

Furnishings such as sofas, beds, carpeting, and curtains have some effect on the amount of sound absorption within a home, and can therefore impact interior noise level measurements. As such, homeowners should not modify furnishings between the occurrence of pre-construction and post-construction noise testing.

The AIP Handbook (Appendix R, Table R-4, c.5) also requires that: "The sponsor will then measure the interior noise levels and prepare a summary report detailing the effectiveness of the design package, make recommendations for any changes to the package, lists the before and after interior noise level data, and submits the package to the ADO". Therefore, a post-construction acoustical testing summary report documenting the achieved noise level reductions and post-construction interior aircraft noise levels, noting any unique circumstances, is prepared and submitted to the ADO.

3.6 Closeout

Upon completion of the work and verification of the acoustical goals being met by the RSI Program, the airport sponsor will close out the construction contract and the grant.

[END OF MEMORANDUM]