County of Wayne Noise Overlay Design Manual

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The purpose of this manual is to assist designers and builders in the design and construction of structures in the County of Wayne Airport Overlay District. It is not designed to replace the requirements of the North Carolina Building Code.

The manual includes construction standards that are created to reduce noise inside structures. The goal for noise levels is based on standards developed by the Federal Aviation Administration, U.S. Department of Transportation, U.S. Department of Defense and the Federal Interagency Committee on Urban Noise.

The manual is divided into three sections. The first sections provides a review of how sound enters a building, basic design guides and building elements such as windows, doors and walls. The second section presents specific design requirements based on the noise reduction recommendations found in the Air Installation Compatible Use Zone (AICUZ) Study. The final section contains of list of vendors and manufactures that sell or produce a product that meets a specified level of noise attenuation. The list is not intended to be complete and will be updated as new materials are certified and assigned a Sound Transmission Class (STC) rating.

Noise Control Basics

Measuring Units for Noise

Noise control or acoustics can be measured in many different ways. This section will review several to help the designer or builder to better understand the basic concepts.

Aircraft noise is generally expressed in terms of it's A-weighted sound level, in units called "decibels". The abbreviation for decibels is "dB". However, it is often seen as "dBA" or "dB(A)" in order to reflect the inclusion of the A-weighted process.

The noise exposure around airfields in Wayne County is delineated in terms of Day-Night Average Sound Level, which is abbreviated by "DNL" in text and L_{dn}" in equations. DNL is an indication of the average A-weighted sound level of all aircraft and other noise sources occurring during a 24 hour period. The sound reducing properties of various building materials are described by Sound Transmission Class (STC).

Noise Reduction Goals

Total soundproofing of a structure, in particular a dwelling, such that noise from aircraft is not heard, is usually not practical or cost-effective. In areas surrounding airfields the goal is to reduce interior noise to an acceptable level. An acceptable level is one where the noise level would not interfere with normal indoor activities.

The U.S. Department of Defense and other Federal agencies have established land use compatibility guidelines for areas exposed to high noise. The guidelines suggest that residential use be discouraged in areas above the 65DNL contour. This design guide follows those suggestions by requiring a 25 dB noise level reduction for outside to inside noise in areas between 65 and 70 DNL. A 30 dB noise reduction will be required in areas between 70 and 75 DNL. The 75 and above area will require a 35 dB noise reduction. For structures that are built on a contour line the requirements of the more restrictive area will apply. This design guide assumes that a typical structure built in Wayne County will provide a noise level reduction of 20 dB.

The noise level in a particular room is dependent upon the location of the room in the structure, wall openings, and the amount of sound absorption material within the room. Material such as upholstered furniture, drapes, and carpeting absorb sound while hard surfaces do not. The exterior noise is transmitted through the walls, (where it is reduced subject to construction materials), and into the rooms where it is further modified.

A typical structure in Wayne County will provide 20 to 25 dB of noise reduction. An acoustically modified structure can provide up to 35 dB of noise reduction. An attempt to provide greater than 35 dB of noise reduction is usually not practical for a residence and difficult for other structures.

Sound Insulation Concepts

Sound travels from exterior to interior areas through two basic ways: through solid elements such as walls, windows and doors and through the air. Figure 1 below shows sound moves through a typical brick veneer wall. The amount of sound energy transmitted through a wall, roof or floor can be limited in several ways. The most important way is to close any air infiltration gaps or openings. This includes keeping doors and windows closed and putting baffles on air vents. Secondly, better materials can be used in construction. Some do a better job of deflecting sound energy. A third way is to add mass to exterior and interior panels.

Heavier building materials generally do a better job at reducing sound energy. A fourth way could be to isolate the panel elements by increasing separation, thus widening the air cavity, resiliently mounting the interior panels, or mounting the interior or exterior panels on different studs. A final way to reduce sound transmission would be to increase the amount or quality of absorptive materials between studs or joists.

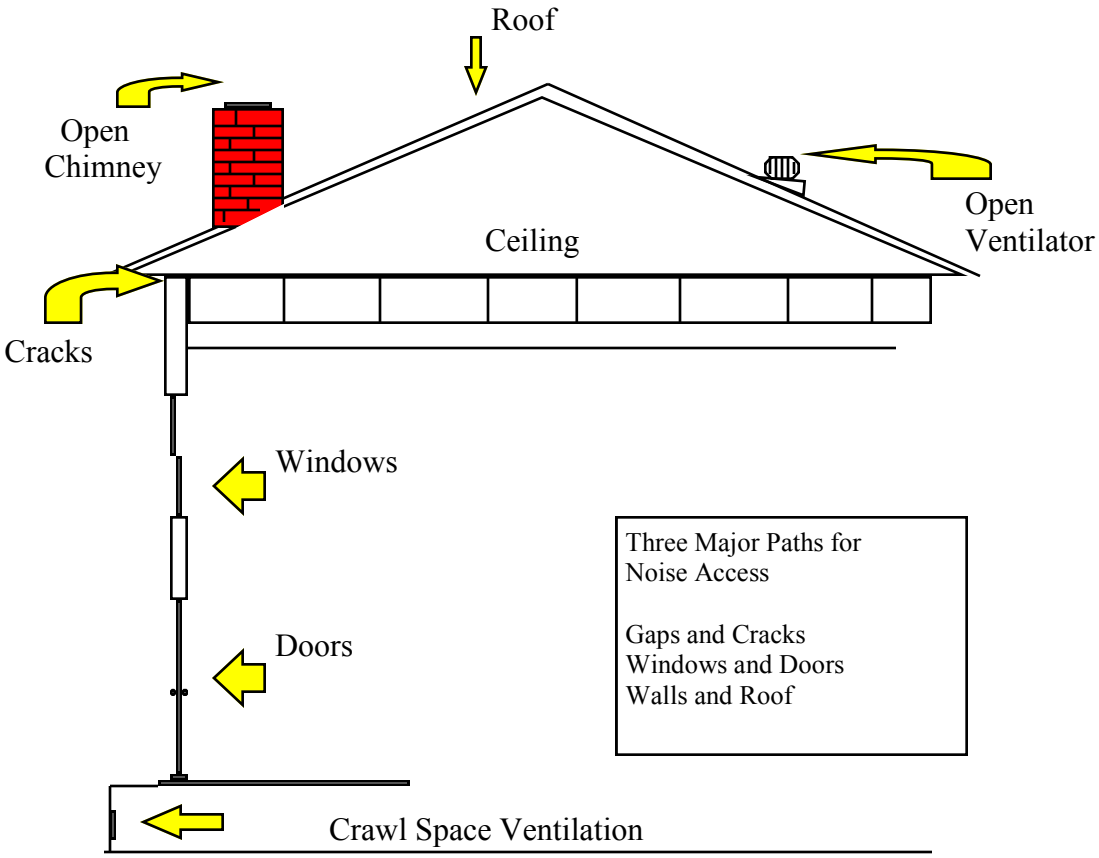


Figure 1

Structural design must be keyed upon addressing the sound paths. The ideal design will focus eliminating the weak links in sound transmission. Windows generally are the weakest link in the design process. The more windows that a wall contains will result in the opportunity for higher noise in the structure. Even with a brick wall, a poorly constructed or installed window will allow more to pass than a vinyl wall with a high STC window that is well installed.

The STC rating is a measure of the material's ability to deflect sound. The higher the STC rating, the better insulator. Windows with a high STC rating will make the biggest difference in the structure. Doors with high ratings are second in importance. In the highest noise area, above 75 DNL, ceilings and exterior walls may require special construction.

Thermal windows and doors while being excellent ways to conserve energy are not always the best way to reduce sound vibrations. Even good thermal windows that have a low STC rating will be a weak link in sound reduction.

Building Design

Sound Transmission Class (STC) ratings are the most frequently used method to indicate the acoustical performance of building materials. Different construction methods or building materials may have the same STC rating and at the same time block aircraft noise at different levels. The materials may respond differently to high and low frequencies. When selecting a construction material it is important to use one that will block the low frequencies of aircraft. This guide will recommend products that are currently available to block aircraft noise.

A building's ability to reduce noise is dependent upon the results of the all the structural elements. One weak element can severely hamper the noise reduction in a building. A large pane of glass in a well designed wall can eliminate any advantages of the wall. A solid door that is not properly sealed is no better than a hollow core door. The design of a structure should obtain the desired noise reduction level, without harming aesthetics, or greatly increasing costs.

Weatherstripping

Weatherstripping and caulking are crucial to effective sound insulation. A rating reduction of two to four points can be the result of poor weather-stripping . This is generally not an issue at the time of inspection, but property owners must continue to check and repair as needed weather-stripping and caulking. For noise reduction purposes, neoprene weather-stripping is preferred over felt or other hard types.

Windows

One of the weakest parts in a building element for noise reduction is windows. One of the simplest ways to improve the acoustical performance of a structure is to increase the sound reduction capability of the windows. This can be accomplished through thicker glass or wider space between the panes. Windows that are designed for sound reduction are often needed in the highest noise area.

Window units should be 3/4 inch to 1 inch thick, and have at least one pane of laminated glass at least 1/4 inch thick. The use of laminated glass will provide a much better noise reduction performance than standard glass. Tempered glass while better than standard glass does not perform as well as laminated glass. An STC of 24 to 29 can be obtained with off the shelf thermopane windows. Upgraded acoustical windows can have STC ratings as high as 36.

In order to reach an STC 36 changes will be required to the window assembly. A combination system which uses a storm window along with a double pane window or an assembly of two single or double pane windows connected together will reach the desired level. An STC level above 36 up to a level in the 50's can also be purchased. However, they are considerably more expensive than standard windows.

Any type of window is acceptable for noise reduction provided it stays tightly closed and has the desired STC rating. Fixed windows have the best performance while casement windows have the lowest. The best acoustical windows will not adequately reduce noise if improperly installed. The window must be designed to tightly fit in the opening. Using insulation to fill in the voids in not acceptable.

Doors

An equally weak link to windows in building design when trying to reduce noise are doors. Typical residential doors are generally not satisfactory in reducing noise. The ability of a door to reduce noise is dependent upon at least four factors. Those include:

- Door composition: insulated metal or fiberglass, sliding glass; core material, additional internal insulation, etc.
- Door weight.
- Presence and type of fixed window panes.
- Quality of seals and weather-stripping and how tightly they seal.

The STC rating of a door is greatly reduced when glass panels are included. This can be tempered by having thicker glass or smaller openings. Storm doors can improve the STC rating of an exterior door by five to nine points and even higher with special acoustical storm doors. The doors must be mounted year round and have thick glass with a solid core.

Doors with a rating above STC 29, called acoustical doors, are similar in appearance to standard doors. The high cost of those doors when compared with standard doors leads many residential owners to use a standard door with an acoustical storm door. The specialized construction of the acoustical doors provides a substantial difference above standard doors. The doors often have special seals on all sides. The increased weight of the door requires a heavy duty door frame and hinges.

Sliding glass doors should be avoided as much as possible. The doors provide a difficult setting for sound proofing. Acoustical sliding doors are manufactured, but they are expensive, heavy and require a high threshold. An alternative is to use two doors. However, this option requires opening a primary and secondary door along with additional framing to support the additional width. Good weather-stripping is a must on both options.

Sidelights and transoms in doors and windows must not be forgotten. They will have a separate rating than the door or main window and should be treated as a separate window.

Doors must be installed correctly to take full advantage of sound attenuation properties. An acoustical door that is not properly sealed will be no better than a standard door that fits snuggly in the opening and is well sealed. As with any building product the door seals must be regularly maintained. Doors must not have openings such as mail slots or pet openings.

Walls

The exterior walls in a structure provide the greatest opportunity for noise transmission. The type of construction will be driven by the noise in the area, construction costs, aesthetics and ultimately owners choice. Vinyl or hardboard walls require special designs for the framing. Masonry walls can usually be built with standard construction practices.

The ability of an exterior wall to deflect or reduce is controlled by several factors in addition to the outer cover. The size, number and spacing of studs; the amount and type of insulation; the interior wall cover; the use of resilient channels all play a part in noise reduction. In Wayne County most homes are either siding such as vinyl, gypsum board, cement board or brick veneer on wood frame construction. The framing is normally 1/2 inch nominal OSB or plywood sheathing on 2x4 or 2x6 studs spaced 16 inches on center

with batt insulation, and 1/2 inch gypsum board at the interior.

The spacing of studs up to 24 inches on center will improve a walls acoustical performance due to increased air space. At the same time closer stud spacing due to windows or doors will decrease acoustical performance. The use of plywood or OSB on the inside of wood studs behind gypsum board should not have a negative affect on the wall's STC rating.

Three major designs can be used in wall design to reduce outside noise. One design would involve the use of resilient channels. These 1/2 inch metal strips are attached to the studs and provide a framing for the interior gypsum board. Attaching the gypsum board to the resilient channel instead of the stud lowers interior noise by reducing vibration inside of the wall. Care must be taken during installation to avoid using screws too long that will make contact with the studs. The use of resilient channels can improve a walls STC rating by seven points. A second alternative would be to use 2 x 6 studs in along with the resilient channels. The increased wall cavity will allow additional insulation and reduce the STC rating by 11 points. A third design would involve the use of staggered 2 x 4 studs on two rows. The two rows of studs would allow the exterior and interior finishes to be attached to separate studs. This design method would reduce the STC rating by 13 points. studs. On walls with multiple windows or doors which require 2 x 6 studs, a 2 x 8 base should be used to allow the two rows to continue.

In all walls fiberglass batts or blankets that meet or exceed the minimum building code requirements should be used. The insulation should be held firmly in place between the studs but should not be over packed as this may reduce acoustical performance. Blown in insulation should be avoided in walls. The settling that naturally occurs over time will lower acoustical ratings.

Table 1. Wall Designs and STC Ratings

Wall Type	Exterior Side	Structure	Interior Side	STC Rating
Resilient Channel on 2 x 4 studs	Vinyl or Hardboard Siding, Wood sheathing	2 x 4 16" O.C. with batt insulation	RC on studs, 1 layer 1/2" gypsum board	43 increases to 58 with brick veneer
Resilient Channel on 2 x 6 studs	Siding, Wood sheathing	2 x 6 16" O.C. with batt insulation	RCD on studs, 1 layer 1/2" gypsum board	47
Staggered 2 x 4 stud on 2 x 6 base	Siding, Wood sheathing	2 x 4 16" O.C. for each row (staggered on 2 x 6 base plate) with batt insulation	1 layer 1/2" gypsum board (attached only to interior side studs)	49
Staggered 2 x 4 stud on 2 x 8 base	Siding, Wood sheathing	2 x 6 16" O.C. for each row (staggered on 2 x 8 base plate) with batt insulation	1 layer 1/2" gypsum board (attached only to interior side studs)	50

Ceilings and Roofs

In addition to walls, doors and windows, ceilings and roofs play an important part in sound reduction. A standard vented, insulated, wood truss roof with asphalt shingles and gypsum board interior ceiling will have an STC rating of 45. By adding resilient channels to the interior ceiling the STC rating may be increased to 55.

Vaulted ceilings can create noise problems due to the lack of airspace between the ceiling and roof. A minimum of 14" should be maintained throughout the roof frame in order to provide adequate sound reduction. Roofs with exposed beams should be avoided except in industrial or commercial settings.

Attic ventilation while being necessary for certain type roofs creates problems for noise reduction. The opening that allows the movement of air also allows the movement of noise. Acoustical louvers are available from building material suppliers to baffle the sound passing through gable end vents. Built in place baffles may also be used provided they do not impede the flow of air. Whole house fans should be not be used.

The addition of insulation to an attic space is the most visible form of sound reduction. However, the type of insulation is an important factor in acoustics. A higher thermal rating will not necessarily do a better job in reducing noise. Insulation acts as a sound absorber not as a sound reflector. Therefore, it in order to increase the sound reduction capability of a roof or ceiling thicker insulation must be used. Skylights will need specially designed seals and glass or should otherwise be avoided.

Floors and Crawl Spaces

The best floor type for noise reduction is a concrete slab. This type floor requires no additional treatment. However, floors built over crawl spaces require the installation of devices to reduce noise. Floor vents that are required in the NC Building Code for structures with closed in crawl spaces will need to have noise control louvers in the vent openings. Masonry walls are the preferred method to close in a crawl spacing. Other materials, such as vinyl, will necessitate the need a construct a barrier panel. The barrier panel could be precast concrete panels, wood framing closed in with plywood., or other suitable material. Crawl space doors should also be insulated and well sealed.

Mechanical Systems and Building Penetration

Heating, ventilation, air conditioning (HVAC) systems do not by themselves reduce the noise entering a structure. They are a part of the overall noise reduction plan by allowing windows and doors to remain closed. As discussed earlier the weak link in noise reduction is window and door openings. A 50% drop in noise reduction can occur due to open windows.

Window air conditioners, through the wall or floor air conditioners, ventilators, or heaters must not be used. This includes fireplaces, woodstoves and whole house fans. Gas lines or refrigerant pipes may pass through the walls or floor.

Duct work for air intake or exhaust must be designed so that no line of sight exists between outside and inside. At least two 90 degree bends must be included in the design. Devices to bring in fresh air may be needed in well insulated houses. The fresh air systems allow the replenishment of air to occur when heating or cooling systems are not needed. Active ventilators may be needed in some structures.

Costs

The bottom line figure for building a structure in a high noise area will include the cost to meet the requirements in this design guide. The size, design and location will all be important factors in estimating costs. Building material that is available locally or preferred will also influence costs. Table 2 shows the additional costs that may occur in construction of structure designed to reduce noise. Some of the STC standards suggested in this guide are not included in Table 2. Those products with lower STC ratings are considered off the shelf and no additional cost would be incurred. Replacement windows sold by many vendors have an STC 28 rating.

Table 2 - Additional Costs for Sound Insulation

Item	Unit	Average Additional Unit Cost
30” x 48” STC 36 window	Each	$ 66.00
36” x 72” STC 36 window	Each	$ 91.00
30” x 48” STC 40 window	Each	$ 147.00
36” x 72” STC 40 window	Each	$ 203.00
30” x 48” STC 44 window	Each	$ 195.00
36” x 72” STC 44 window	Each	$ 270.00
STC 29 swinging acoustical storm door	Each	$ 150.00
STC 34 swinging acoustical prime door	Each	$ 486.00
STC 40 swinging acoustical prime door	Each	$ 873.00
6’-0” x 6’-8” STC 34 sliding glass door	Each	$ 437.00
6’-0” x 6’-8” STC 37 sliding glass door	Each	$ 1,312.00
6’-0” x 6’-8” secondary sliding glass door	Each	$ 500.00
Second layer of gypsum board on walls	Square-foot	$ 0.70
Resilient channels in walls	Square-foot	$ 1.10
Second layer of gypsum board on sloped ceilings	Square-foot	$ 1.41
Resilient channels in sloped ceilings	Square-foot	$ 2.31
Staggered 2 x 4 wood studs	Square-foot	$ 1.68
Cover over attic pull down stairs	Each	$ 400.00

Noise Contour Map

Area in proximity of Seymour Johnson Air Force Base showing noise contours.

65 ldn

70 ldn

75 ldn

80 ldn

Material Selection

The information shown in the following sections may be used to assist the designer/builder in making choices for types of materials. The information is divided into building units such as walls, windows, doors and roofs. When designing or building a structure each habitable room should be considered separately. These recommendations also apply to non-habitable rooms which are connected to a habitable room without a door. Either Table 3 on the next page or one of the following sections may be used on a structure but not both on the same structure .

When using the Table 3 first determine the noise contour for the location of the structure. The noise contour map on page 11 may be used for this purpose. Next determine the exterior wall type. Concrete block and insulated concrete should be considered the same as brick. When a wall is divided between two types of material, the one with the weakest sound reduction capabilities should be used. When using the table the number of exterior walls shown is for each individual room. Two story exterior walls should be counted as two walls. Walls exceeding twelve feet in height count as two walls.

The wall recommendations apply only to the exterior wall of a room. The suggested modifications are resilient channel (RC), staggered studs (Stag), or staggered studs with an extra layer of gypsum board (Stag2). The door and window STC ratings are for those that open to the exterior, a screened in porch, or garage. The roof modifications are only for the roof/ceiling in the top floor of the structure.

When using the following three sections in lieu of Table 3 the designer/builder should again first determine the noise contour for the property. The three sections show suggested construction methods for each building unit.

Table 3 Material Selection Chart

NLR	Wall Type	Exterior Walls	Window & Door Ratio	Wall	Window	Door	Roof
25	Wood, Vinyl, Alumi-num	1	<25% 25% - 40% > 40%	None None None	STC 26 STC 28 STC 30	None None STC 29	None None None
		2 or greater	<20% 20% - 35% > 35%	None None None	STC 28 STC 30 STC 32	None STC 29 STC 29	None None None
	Brick	1	<40% >=40%	None None	STC 26 STC 30	None STC 29	None None
		2 or greater	< 20% 20% - 30% >30% - 75% >75%	None None None None	STC 26 STC 28 STC 30 STC 32	None None STC 29 STC 29	None None None None
30	Wood, Vinyl, Alumi-num	1	<20% 20% - 30% >30% - 50% >50%	None None RC RC	STC 32 STC 34 STC 32 STC 34	STC 31 STC 34 STC 31 STC 34	2 layers of gypsum board
		2	<20% >=20%	RC RC	STC 34 STC 34	STC 31 STC 34	2 layers of gypsum
		3 or greater	<20% 20% - 70% >70%	RC RC RC	STC 34 STC 34 STC 36	STC 31 STC 34 STC 34	2 layers of gypsum board
	Brick	1	<20% 20% - 50% >50%	None None None	STC 30 STC 32 STC 34	STC 29 STC 31 STC 34	2 layers of gypsum board
		2	<20% >=20%	None None	STC 34 STC 34	STC 31 STC 34	2 layers of gypsum board
		3 or greater	<20% 20% - 70% > 70%	None None None	STC 34 STC 34 STC 36	STC 31 STC 34 STC 34	2 layers of gypsum board
35	Wood	1	<25% >=25%	RC Stag	STC 36 STC 40	STC 34 STC 40	RC RC
	Vinyl, Alumi-num	2 or greater	<15% 15% - 20% >20% - 30% >30%	RC Stag Stag Stag2	STC 38 STC 38 STC 42 STC 42	STC 37 STC 37 STC 37 STC 40	RC RC RC RC
	Brick	1	<15% 15% - 25% >25% - 50% >50%	None None None None	STC 34 STC 36 STC 38 STC 40	STC 34 STC 34 STC 37 STC 40	RC RC RC RC
		2 or greater	<15 % 15% - 20% >20% - 30% >30%	None None None None	STC 40 STC 40 STC 44 STC 44	STC 37 STC 40 STC 40 STC 43	RC RC RC RC

Section One—For construction in areas greater than or equal to 65 dnl and less than 70 dnl requiring an outside to inside noise reduction of up to 25 db.

General

1. Brick veneer, masonry blocks, or stucco exterior walls shall be constructed airtight. All joints shall be grouted or caulked airtight.
2. At the penetration of exterior walls by pipes, ducts, or conduits, the space between the wall and pipes, ducts or conduits shall be caulked or filled with mortar.
3. Window and / or through the wall ventilation units shall not be used.
4. Through the wall / door mailboxes shall not be used.

Exterior walls

1. Exterior walls, other than as described in this Section, shall have a laboratory sound transmission class rating of at least STC – 34.
2. Masonry walls having surface weight of at least 25 pounds per square foot do not require a furred (stud) interior wall. At least one surface of concrete block walls shall be plastered or painted with heavy paint.
3. Stud walls shall be at least 4 inches in nominal depth and shall be finished on the outside with siding- on – sheathing, stucco, or brick veneer.
    - Interior surface of exterior stud walls shall be of gypsum board or plaster at least ½ inch thick, installed on studs.
    - Continuous composition board, plywood or gypsum board sheathing at least ½ thick shall cover the exterior side of the wall studs behind wood, or metal siding. Asphalt or wood shake shingles are acceptable in lieu of siding.
    - Sheathing panels shall be butted tightly and covered on the exterior with overlapping building paper. The top and bottom edges of the sheathing shall be sealed.
    - Insulation material at least 2 inches thick shall be installed continuously throughout the cavity space behind the exterior sheathing and between the wall studs. Insulation shall be glass fiber or mineral wool.

Windows

1. Windows, other than as described in this Section, shall have a laboratory sound transmission class rating of at least STC – 28.
2. Glass shall be at least 3/16 inches thick.
3. All operable windows shall be weather stripped and airtight when closed so that air infiltration will not exceed 0.5 cubic feet per minute per foot of crack length.
4. Glass of fixed sash windows shall be sealed in and airtight manner with a nonhardening sealant, or a soft elastomer gasket or glazing tape.
5. The perimeter of window frames shall be sealed airtight to the exterior wall construction with a nonhardening joint sealant.
6. The total area of glass in exterior windows and doors in sleeping spaces shall not exceed 20 percent of the floor area.

Doors

1. Doors, other than as described in this Section shall have a laboratory sound transmission class rating of at least STC – 28.
2. All exterior side-hinged doors shall be solid – core wood or insulated hollow metal at least 1 ¾ inch thick and shall be fully weather-stripped.
3. Exterior sliding doors shall be weather stripped with an efficient airtight gasket system. The glass in the siding doors shall be at least 3/16 inch thick.
4. Glass in doors shall be sealed in an airtight non-hardening sealant, or in a soft elastomer gasket or glazing tape.
5. The perimeter of doorframes shall be sealed airtight to the exterior wall construction.

Roofs

1. Combined roof and ceiling construction, other than as described in this and the following subsection, shall have a laboratory sound transmission class rating of at least STC-34.
2. With an attic or rafter space at least 6 inches deep, and with a ceiling below, the roof shall consist of closely butted ½ inch composition board, plywood, or gypsum board sheathing topped by roofing as required.

3. If the underside of the roof is exposed, or if the attic or rafter spacing is less than six inches, the roof construction shall have a surface weight of at least 25 pounds per square foot. Rafters, joists, or other framing may not be included in the surface weight calculation.
4. Window or dome skylights shall have a laboratory sound transmission class rating of at least STC – 28.

Ceiling

1. Gypsum board or plaster ceilings shall be at least ½ inch thick. Ceilings shall be substantially airtight, with a minimum number of penetrations.
2. Glass fiber or wool insulation shall be at least two inches thick shall be provided above the ceiling between joists.

Floors

1. Openings to any crawl space below the floor of the lowest occupied rooms shall not exceed two percent of the floor area of the occupied rooms.

Ventilation

1. A mechanical ventilation system shall be installed that will provide the minimum air circulation and fresh air supply requirements for various uses in occupied rooms, as specified in the North Carolina Building Code, without the need to open any windows, doors, or other openings to the exterior.
2. Gravity vent openings in the attic shall not exceed code minimum in number and size.
3. If a fan is used for forced ventilation, the attic inlet and discharge openings shall be fitted with sheet metal transfer ducts of at least 20 gauge steel, which shall be lined with one inch thick coated glass fiber, and shall be at least five foot long with one 90 degree bend.
4. All vent ducts connecting the interior space to the outdoors, excepting domestic range exhaust ducts, shall contain at least a five foot length of internal sound absorbing duct lining. Each duct shall be provided with a bend in the duct such that there is no direct line of sight.
5. Duct lining shall be coated glass fiber duct at least one inch thick.

6. Domestic range exhaust ducts connecting the interior space to the outdoors shall contain a baffle plate across the exterior termination, which allows proper ventilation. The dimensions of the baffle plate should extend at least one diameter beyond the line of sight into the vent duct.
7. Fireplaces shall be provided with well-fitted dampers.

Section Two— For construction in areas greater than or equal to 70 dnl and less than 75 dnl requiring an outside to inside noise reduction of up to 30 decibels.

General

1. Brick veneer, masonry blocks, or stucco exterior walls shall be constructed airtight. All joints shall be grouted or caulked airtight.
2. At the penetration of exterior walls by pipes, ducts, or conduits, the space between the wall and pipes, ducts or conduits shall be caulked or filled with mortar.
3. Window and / or through the wall ventilation units shall not be used.
4. Through the wall / door mailboxes shall not be used.
5. Operational vented fireplaces shall not be used.
6. All sleeping spaces shall be provided with either a sound absorbing ceiling or a carpeted floor.

Exterior walls

1. Exterior walls, other than as described in this Section, shall have a laboratory sound transmission class rating of at least STC – 39
2. Masonry walls having surface weight of at least 40 pounds per square foot do not require a furred (stud) interior wall. At least on surface of concrete block walls shall be plastered or painted with heavy “bridging” paint.

3. Stud walls shall be at least 4 inches in nominal depth and shall be finished on the outside with siding- on – sheathing, stucco, or brick veneer.
    a. Interior surface of exterior stud walls shall be of gypsum board or plaster at least ½ inch thick, installed on studs. The gypsum board or plaster may be fastened rigidly to the studs if the exterior is brick veneer or stucco. If the exterior is siding on sheathing, the interior gypsum board or plaster must be fastened resiliently to the studs.
    b. Continuous composition board, plywood or gypsum board sheathing at least ½ thick shall cover the exterior side of the wall studs behind wood, or metal siding. The sheathing and facing shall weigh a minimum of four pounds per square foot.
    c. Sheathing panels shall be butted tightly and covered on the exterior with overlapping building paper. The building paper can be omitted provided the sheathing panels have tightly fitted tongue and groove or lay and gap joints. The top and bottom edges of the sheathing shall be sealed.
    d. Insulation material at least 2 inches thick shall be installed continuously throughout the cavity space behind the exterior sheathing and between the wall studs. Insulation shall be glass fiber or mineral wool.

Windows

1. Windows, other than as described in this Section, shall have a laboratory sound transmission class rating of at least STC – 33.
2. Glass shall be at least 1/8 inch thick. Panes of glass shall be separated by a minimum 1/3-inch air space.
3. Double glazed windows shall employ a fixed sash or efficiently weather-stripped operable sash. The sash shall be rigid and weather-stripped with material that is compressed airtight when the window is closed so that air infiltration will not exceed 0.5 cubic foot per minute per foot of crack length.
4. All operable windows shall be weather stripped and airtight when closed so that air infiltration will not exceed 0.5 cubic feet per minute per foot of crack length.
5. Glass of fixed sash windows shall be sealed in and airtight manner with a nonhardening sealant, or a soft elastomer gasket or glazing tape.

6. The perimeter of window frames shall be sealed airtight to the exterior wall construction with a nonhardening joint sealant.
7. The total area of glass in exterior windows and doors in sleeping spaces shall not exceed 20 percent of the floor area.

Doors

1. Doors, other than as described in this Section shall have a laboratory sound transmission class rating of at least STC – 33.
2. Double door construction is required for all door openings to the exterior. Openings fitted with side-hinged doors shall have one solid –core wood or insulated hollow metal core door at least 1 ¾ inch thick separated by an airspace at least 4 inches from another door, which can be a storm door. Both doors shall be tightly fitted and fully weather-stripped.
3. The glass of double glazed sliding doors shall be separated by a minimum ¼ inch air space. Each sliding frame shall be provided with an efficiently airtight weather stripping material that is compressed airtight when the door is closed so that air infiltration will not exceed 0.5 cubic foot per minute of crack length.
4. The glass in the siding doors shall be at least 3/16 inch thick. Glass of double sliding doors shall not be equal in thickness.
5. Glass in doors shall be sealed in an airtight non-hardening sealant, or in a soft elastomer gasket or glazing tape.
6. The perimeter of doorframes shall be sealed airtight to the exterior wall construction with a nonhardening joint sealant.

Roofs

1. Combined roof and ceiling construction, other than as described in this and the following subsection, shall have a laboratory sound transmission class rating of at least STC-44.
2. With an attic or rafter space at least 6 inches deep, and with a ceiling below, the roof shall consist of closely butted ½ inch composition board, plywood, or gypsum board sheathing topped by roofing as required.

3. If the underside of the roof is exposed, or if the attic or rafter spacing is less than six inches, the roof construction shall have a surface weight of at least 40 pounds per square foot. Rafters, joists, or other framing may not be included in the surface weight calculation.
4. Window or dome skylights shall have a laboratory sound transmission class rating of at least STC – 33.

Ceiling

1. Gypsum board or plaster ceilings at least ½ inch thick shall be provided where required by Roofs # 2 (above). Ceilings shall be substantially airtight, with a minimum number of penetrations.
2. Glass fiber or wool insulation shall be at least two inches thick shall be provided above the ceiling between joists.

Floors

1. The floor of the lowest occupied rooms shall be slab on fill, below grade or over a fully enclosed basement. All door and window openings in the fully enclosed basement shall be tightly fitted.

Ventilation

1. A mechanical ventilation system shall be installed that will provide the minimum air circulation and fresh air supply requirements for various uses in occupied rooms, as specified in the North Carolina Building Code, without the need to open any windows, doors, or other openings to the exterior.
2. Gravity vent openings in the attic shall not exceed code minimum in number and size. The openings shall be fitted with transfer ducts at least three feet in length containing internal sound absorbing duct lining. Each duct shall have a lined 90-degree bend in the duct such that there is no direct line of sight into the attic.
3. If a fan is used for forced ventilation, the attic inlet and discharge openings shall be fitted with sheet metal transfer ducts of at least 20 gauge steel, which shall be lined with one inch thick coated glass fiber, and shall be at least five foot long with one 90 degree bend.

4. All vent ducts connecting the interior space to the outdoors, excepting domestic range exhaust ducts, shall contain at least a ten feet length of internal sound absorbing duct lining. Each duct shall be provided with a bend in the duct such that there is no direct line of sight through the duct lining from the venting cross section to the room opening cross section.
5. Duct lining shall be coated glass fiber duct at least one inch thick.
6. Domestic range exhaust ducts connecting the interior space to the outdoors shall contain a baffle plate across the exterior termination that allows proper ventilation. The dimensions of the baffle plate should extend at least one diameter beyond the line of sight into the vent duct.
7. Building heating units with flues or combustion air vents shall be located in a closet, attached garage or other room closed off from the occupied space by doors.
8. Doors between occupied space and attached garage or mechanical equipment areas shall be solid core wood or 20 gauge steel hollow metal at least 1-3/4 inch and shall be fully weather-stripped.

Section Three—For construction in areas greater than or equal to 75 dnl and less than 80 dnl requiring an outside to inside noise reduction of up to 35 db.

General

1. Brick veneer, masonry blocks, or stucco exterior walls shall be constructed airtight. All joints shall be grouted or caulked airtight.
2. At the penetration of exterior walls by pipes, ducts, or conduits, the space between the wall and pipes, ducts or conduits shall be caulked or filled with mortar.
3. Window and / or through the wall ventilation units shall not be used.
4. Through the wall / door mailboxes shall not be used.
5. Operational vented fireplaces shall not be used.

6. All sleeping spaces shall be provided with either a sound absorbing ceiling or a carpeted floor.
7. No glass or plastic skylights shall be used.

Exterior walls

1. Exterior walls, other than as described in this Section, shall have a laboratory sound transmission class rating of at least STC – 49.
2. Masonry walls having surface weight of at least 75 pounds per square foot do not require a furred (stud) interior wall. At least on surface of concrete block walls shall be plastered or painted with heavy "bridging" paint.
3. Stud walls shall be at least 4 inches in nominal depth and shall be finished on the outside with siding- on – sheathing, stucco, or brick veneer.
    a. Interior surface of exterior stud walls shall be of gypsum board or plaster at least ½ inch thick, installed on studs. The gypsum board or plaster may be fastened rigidly to the studs if the exterior is brick veneer. If the exterior is siding on sheathing or stucco, the interior gypsum board or plaster must be fastened with resilient channels to the studs.
    b. Continuous composition board, plywood or gypsum board sheathing shall cover the exterior side of the wall studs behind wood, or metal siding. The sheathing and facing shall weigh a minimum of four pounds per square foot.
    c. Sheathing panels shall be butted tightly and covered on the exterior with overlapping building paper. The building paper can be omitted provided the sheathing panels have tightly fitted tongue and groove or lay and gap joints. The top and bottom edges of the sheathing shall be sealed.
    d. Insulation material at least 3 inches thick shall be installed continuously throughout the cavity space behind the exterior sheathing and between the wall studs. Insulation shall be glass fiber or mineral wool.

Windows

1. Windows, other than as described in this Section, shall have a laboratory sound transmission class rating of at least STC – 38.

2. Double glazed windows shall employ a fixed sash. Glass of double glazed windows shall be at least 1/8 inch thick. Panes of glass shall be separated by a minimum 1/3-inch air space and shall not be equal in thickness.
3. Glass of fixed sash windows shall be sealed in and airtight manner with a nonhardening sealant, a soft elastomer gasket, glazing tape or equivalent airtight adhesive.
4. The perimeter of window frames shall be sealed airtight to the exterior wall construction with a nonhardening joint sealant
5. The total area of glass in exterior windows and doors in sleeping spaces shall not exceed 20 percent of the floor area.

Doors

1. Doors, other than as described in this Section shall have a laboratory sound transmission class rating of at least STC – 38.
2. Double door construction is required for all door openings to the exterior. Openings fitted with side-hinged doors shall have one solid – core wood or insulated hollow metal core door at least 1 ¾ inch thick separated by a vestibule at lest three feet in length. Both doors shall be tightly fitted and fully weather-stripped.
3. The glass of double glazed sliding doors shall be separated by a minimum ¼ inch air space. Each sliding frame shall be provided with an efficiently airtight weather stripping material that is compressed airtight when the door is closed so that air infiltration will not exceed 0.5 cubic foot per minute of crack length.
4. The glass in the siding doors shall be at least 3/16 inch thick. Glass of double sliding doors shall not be equal in thickness.
5. Glass in doors shall be sealed in an airtight non-hardening sealant, or in a soft elastomer gasket or glazing tape.
6. The perimeter of doorframes shall be sealed airtight to the exterior wall construction with a nonhardening joint sealant.

Roofs

1. Combined roof and ceiling construction, other than as described in this and the following subsection, shall have a laboratory sound transmission class rating of at least STC-49.
2. With an attic or rafter space at least 6 inches deep, and with a ceiling below, the roof shall consist of closely butted ½ inch minimum composition board, plywood, or gypsum board sheathing topped by roofing as required.
3. If the underside of the roof is exposed, or if the attic or rafter spacing is less than six inches, the roof construction shall have a surface weight of at least 75 pounds per square foot. Rafters, joists, or other framing may not be included in the surface weight calculation.

Ceiling

1. Gypsum board or plaster ceilings at least ½ inch thick shall be provided where required by Roofs # 2 (above). Ceilings shall be substantially airtight, with a minimum number of penetrations. The ceiling panels shall be mounted on resilient clips or channels. A non-hardening sealant shall be used to seal gaps between the ceiling and walls around the ceiling perimeter.
2. Glass fiber or wool insulation shall be at least 3 - ½ inches thick shall be provided above the ceiling between joists.

Floors

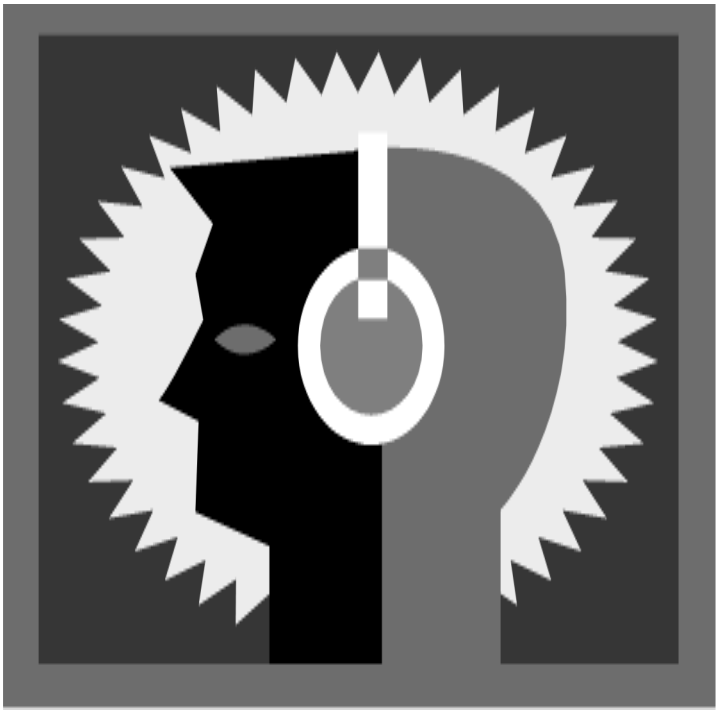
1. The floor of the lowest occupied rooms shall be slab on fill or below grade.

Ventilation

1. A mechanical ventilation system shall be installed that will provide the minimum air circulation and fresh air supply requirements for various uses in occupied rooms, as specified in the North Carolina Building Code, without the need to open any windows, doors, or other openings to the exterior.
2. Gravity vent openings in the attic shall not exceed code minimum in number and size. The openings shall be fitted with transfer ducts at least six feet in length containing internal sound absorbing duct lining. Each duct shall have a lined 90-degree bend in the duct such that there is no direct line of sight into the attic.

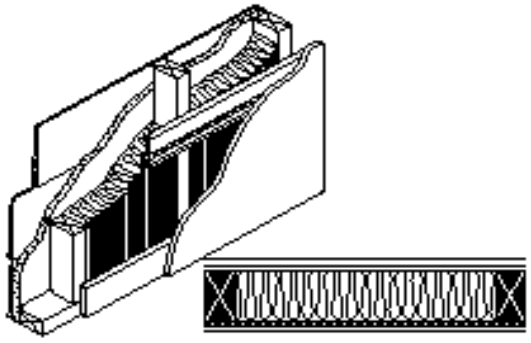
lining. Each duct shall be provided with a with a lined 90 degree bend in the duct such that there is no direct line of sight through the duct from the venting cross section to the room opening cross section.

5. Duct lining shall be coated glass fiber duct at least one inch thick.
6. Domestic range exhaust ducts connecting the interior space to the outdoors shall contain a baffle plate across the exterior termination that allows proper ventilation. The dimensions of the baffle plate should extend at least one diameter beyond the line of sight into the vent duct. The baffle plate shall be of the same material and thickness as the vent duct material.
7. Building heating units with flues or combustion air vents shall be located in a closet, attached garage or other room closed off from the occupied space by doors.
8. Doors between occupied space and attached garage or mechanical equipment areas shall be solid core wood or 20 gauge steel hollow metal at least 1-3/4 inch thick and shall be fully weather-stripped.



Exterior Walls

STC-47 (Figure 2)

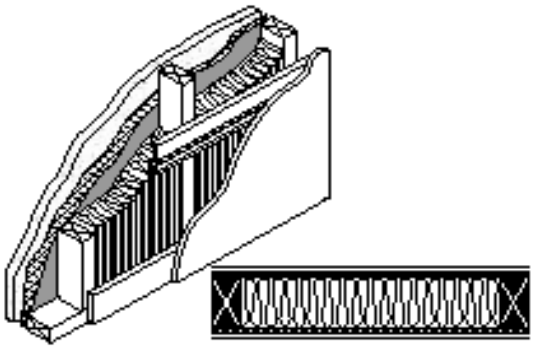


Exterior frame wall, ¾"x10" redwood siding, ½" sheathing, 2x4 studs, 16" o.c., resilient channel, ½" gypsum board, one thickness (3½"- 4") fiber glass batt insulation.

Fire Rating - NR

Variation	Construction	STC	Fire Rating
19A	*No insulation*	43	NR
19B	*No resilient channel* (3½"-4") fiber glass batt	39	NR
19C	*No resilient channel* *No insulation*	37	NR

STC-57 (Figure 3)

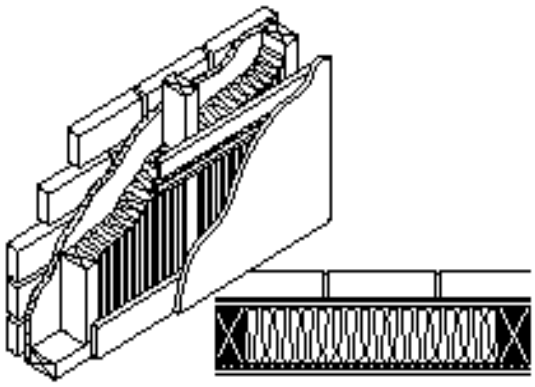


Exterior ⅞" stucco, 1" woven mesh and no.15 felt paper and, 2x4 studs, 16" o.c., resilient channel, ½" gypsum board, one thickness (3½"- 4") fiber glass batt insulation.

Fire Rating - NR

Variation	Construction	STC	Fire Rating
20A	*No insulation*	49	NR
20B	*No resilient channel* (3½"-4") fiber glass batt	46	NR

STC-58 (Figure 4)

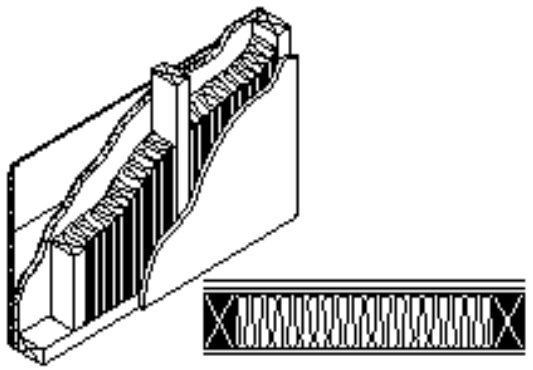


Exterior brick veneer, 1" air space, ¾" insulative sheathing, 2x4 studs, 16" o.c., resilient channel, ½" gypsum board, one thickness (3½"- 4") fiber glass batt insulation.

Fire Rating - NR

Variation	Construction	STC	Fire Rating
21A	*No insulation*	54	NR
21B	*No resilient channel* (3½"-4") fiber glass batt	56	NR

STC-40 (Figure 5)



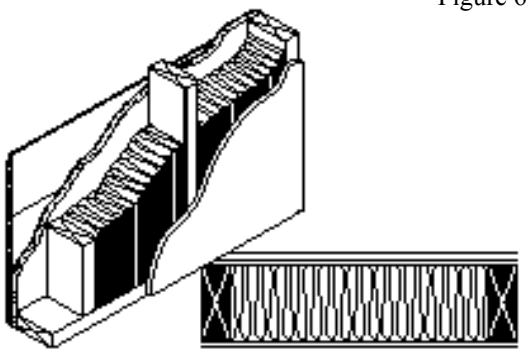
Exterior ½"x10" hardwood lap siding ⅜" foil faced foam sheathing, 2x4 studs, 16" o.c., ½" gypsum board, one thickness (3½"- 4") fiber glass batt insulation.

Fire Rating - NR

Variation	Construction	Finish*	STC	Fire Rating
22A	*No insulation*		36	NR

STC -39

Figure 6



Exterior ⅜"x10" hardwood lap siding, ⅜" foil faced foam sheathing, 2x6 studs, 16" o.c., ½" gypsum board, one thickness (5½") fiber glass batt insulation.

Fire Rating - NR

Variation	Construction	STC	Fire Rating
23A	*No insulation*	38	NR
23B	*With resilient channel* (5½") fiber glass batt	45	NR

Figure 7

Ceiling Fixtures

- Surface mount any ceiling fixtures on resiliently mounted gypsum ceilings.
- Make sure openings around boxes are sealed air tight.
- Don't use recessed or "hi-hat" type fixtures without boxing in the fixture.

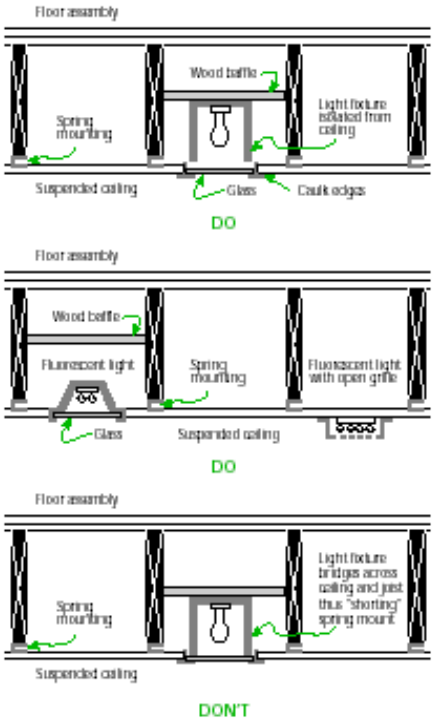
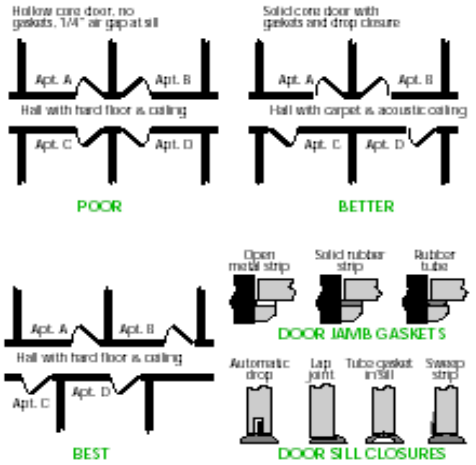


Figure 8

Recommended Construction Methods for Controlling Sound

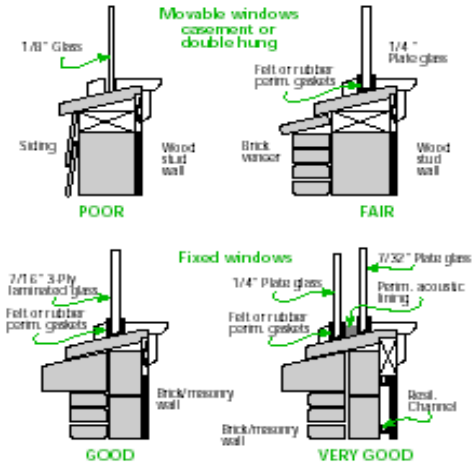
Doors

- Stagger doors across hallways and use gasketing.
- Avoid sliding doors in areas where sound control is desired.
- Use doors of solid wood or insulated cores wherever privacy is an important consideration; hollow-core doors will not be as effective.



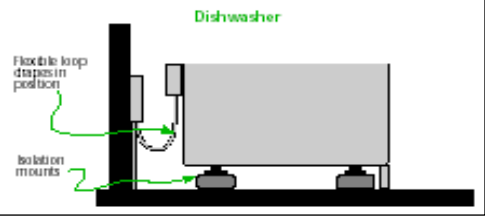
Windows

- Minimize the size of windows facing noisy areas.
- Separate windows to reduce cross-talk.
- Arrange casement windows so sound is not reflected into adjoining units.
- Make sure movable windows close tightly and are weather-stripped.
- Use thick glass, insulating glass or storm windows to help reduce sound transmission through windows.



Wiring

- Wire each apartment as a unit; avoid penetration of walls or floors between apartments.
- Caulk holes (made by wiring) that penetrate connecting structures; use elastic, non-hardening caulk or dry packing.
- Connect vibrating equipment with flexible wiring.



(Figure 9)

Insulated Duct Systems

- Use performed fiber glass ducts or fiber glass duct liners to quiet fan noise and the sounds of air rushing through the ducts.

See chart below for an acoustical comparison between uninsulated (bare) ducts and various types of insulated ducts. For more information on insulated duct systems contact NAIMA and request a copy of publication number: *AH121, A Guide to Insulated Duct Systems.*

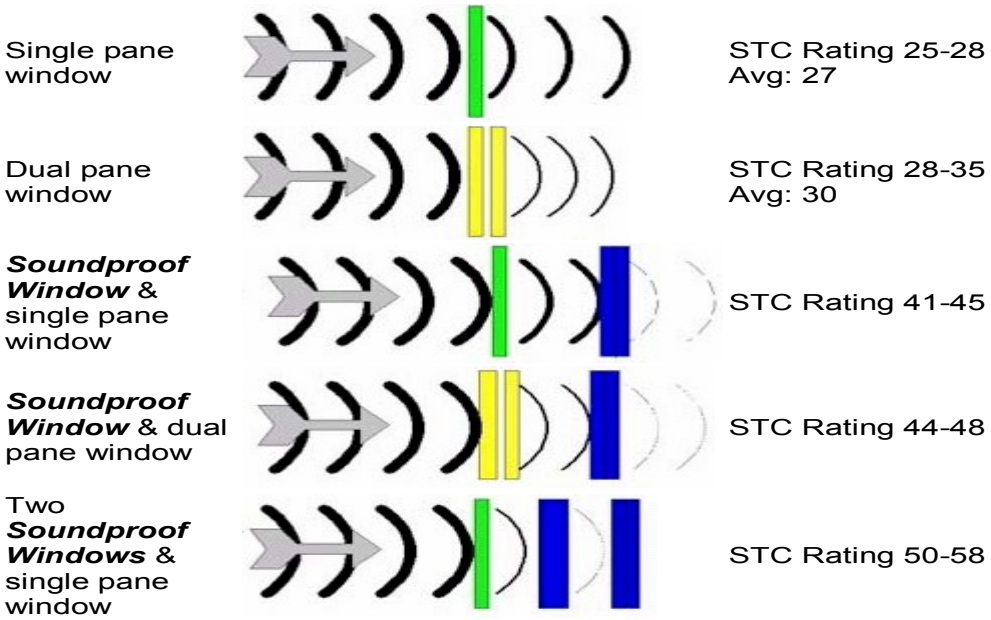
Duct Noise Attenuation Loss (dB/Lf)

Description	Sound Frequency 125	250	500	1000	2000	4000
Bare Sheet Metal[1] No perceived noise reduction.	.1	.1	.1	.1	.1	.1
Wrapped Sheet Metal[1] No perceived noise reduction.	.2	.2	.2	.2	.2	.2
Lined Sheet Metal (1" thick)[2] Significant perceived noise reduction.	.3	.7	1.9	5.3	4.8	2.3
Fiber Glass Air Duct (1" thick)[3] Very significant reduction. Perceived noise reduced to less than ½ original level.	.4	1.4	3.3	3.9	5.0	3.7

1. Version 1.1, 1978 ASHRAE Transactions, Vol 84, Part 1, p.122
2. ASHRAE HVAC Systems & Applications HandBook, 1987, Ch. 52
3. Noise Control Manual, O.C. 6th Edition, 1986

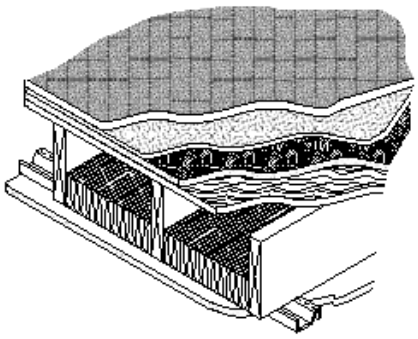
(Figure 10)

TABLE OF NOISE REDUCTION



Floors

STC-53 IIC-73 (Figure 11)



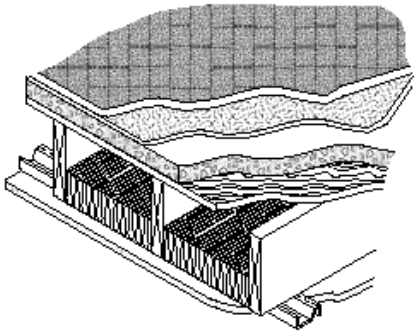
Wood Floor

Carpet and pad, ⅜" particle board, ⅝" plywood subfloor, 2x10 joists 16" o.c., one thickness (3½"- 4") fiber glass batt insulation, resilient channel, ½" Type X gypsum board.

Fire Rating - 1 hr.

Variation	Construction	IIC	STC	Fire Rating
25A	*No resilient channel* *No insulation*	60	42	NR
25B	*½" plywood floor* ⅜" plywood subfloor	72	50	NR
25C	*Vinyl floor* *instead of carpet and pad*	49	50	NR

STC-58 IIC-74 (Figure 13)



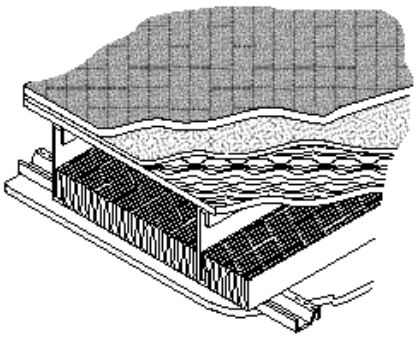
Concrete Floor

Carpet and pad, 1½" lightweight concrete floor, ⅝" plywood subfloor, 2x10 joists 16" o.c., one thickness (3½"- 4") fiber glass batt insulation, resilient channel, ½" Type X gypsum board.

Fire Rating - 1 hr. est.

Variation	Construction	IIC	STC	Fire Rating
26A	*No resilient channel* *No insulation*	59	47	NR
26B	*2x8 joists,* *1⅝" lightweight concrete floor*	74	53	NR
26C	*2x8 joists,* *Vinyl floor* *instead of carpet and pad*	47	50	NR

STC-56 IIC-71 (Figure 12)



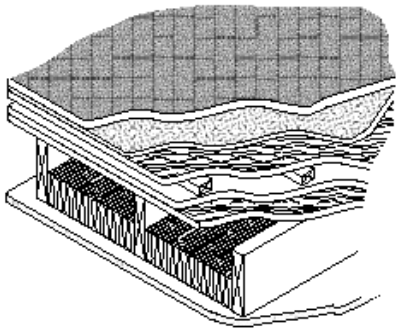
Steel Joist Floor

Carpet and pad, ¾" T&G plywood subwood subfloor, steel joists (7¼", 18 ga.) 24" o.c., one thickness (3½"- 4") fiber glass batt insulation, resilient channel, ⅝" gypsum board.

Fire Rating - NR

Variation	Construction	IIC	STC	Fire Rating
27A	*No resilient channel* *No insulation*	57	43	NR

STC-51 IIC-78 (Figure 14)



Plywood Floor

Carpet and pad, ⅝" plywood floor, 2" x 3" furring, ½" sound deadening board, ½" plywood subfloor, 2x8 wood joists, one thickness (3½"- 4") fiber glass batt insulation, ⅝" Type X gypsum board.

Fire Rating - NR

Variation	Construction	IIC	STC	Fire Rating
28A	*With vinyl floor* *instead of carpet* *and pad*	49	52	NR

This list represents a partial list of typical suppliers of acoustical products. Other manufacturers not listed may have comparable products and prices. The list does not imply a product endorsement or recommendation by the County of Wayne. Other manufactures and vendors will be added at a later date.

INSULATION

CertainTeed Headquarters
PO Box 860
750 E Swedesford Road
Valley Forge,PA 19482
Tel. 800-233-8990
www.certainteed.com

Knauf Fiberglass
One Knauf Drive
Shelbyville, IN 46176
Tel: 800-825-4434
Fax: 317-398-3675
www.knauffiberglass.com

Johns Manville
P.O. Box 5108
Denver CO. 80217-5108
Tel. 800-654-3103
www.jm.com

Owens Corning Fiberglass Corp.
One Owens Corning Parkway
Toledo, Ohio 43659
Tel. 800-438-7465 (800-GET-PINK)
www.owenscorning.com

DOORS

Algona Hardwoods
1001 Perry Street
Algona, WI 54201
Tel. 800-678-8910
www.algonahardwoods.com

Krieger Specialty Products
9880 Gregg Road
Pico, CA 90660
Tel. 866-203-5060
www.kriegerproducts.com

Armaclad, Inc.
P.O. Box 70
Waynesboro, PA 17268
Tel. 800-541-6666
www.armaclad.com

Graham Architectural Products
1551 Mt. Rose Avenue
York, PA. 17403-2909
Tel. 800-755-6274
www.grahamarch.com

Buell Door Company
5200 East Grand Avenue Suite 500
Dallas, TX 75223
Tel. 800-566-0155
www.buelldoor.com

Harvey Industries
1400 Main Street
Waltham, MA 02154
Tel. 800-942-7839
www.harveyind.com

Ceco Door Products
9159 Telecom Drive
Milan, TN 38358
Tel. 888-232-6366
www.cecodoor.com

Industrial Acoustics Company
1160 Commerce Avenue
Bronx, NY 10462
Tel. 718-931-8000
www.industrialacoustics.com

Eggers Industries
P.O. Box 1050
Neenah, WI 54957-1050
Tel. 920-722-6444
www.eggersindustries.com

Jeld-wen
19618 Wildwood Drive
West Linn, OR 97068
Tel. 877-783-2057
www.jeld-wen.com

Doors—continued

Jamison Door Company
55 J.V. Jamison Drive
P.O. Box 70
Hagerstown, MD 21741-0070
Tel. 800-532-3667
www.jamison-door.com

Krieger Specialty Products
4880 Gregg Road
Pico Rivera CA 90660
Tel. 866-203-5060
www.kriegerproducts.com

Larson Doors
Tel. 800-352-3360
www.larsondoors.com

Marshfield Door Systems, Inc.
1401 East 4th Street
Marshfield, WI 54449-7780
Tel. 800-869-3667
www.marshfieldfoors.com

Mohawk Flush Doors, Inc.
980 Point Township Road
P.O. Box 112
Northmberland PA 17857-0112
Tel. 570-473-3557
www.mohawkdoors.com

Mon-Ray, Inc.
801 Boone Avenue North
Minneapolis, MN 55427
Tel. 800-544-3646
www.monray.com

Overly Door Company
574 West Otterman Street
Greensburg, PA 15601
Tel. 800-979-7300
www.overly.com

P.H. Tech Corp.
144 Ferry Street
Buncher Industrial Park
Leetsdale, PA 15056
www.phtech.ca

Pioneer Industries
171 South Newman Street
Hackensack NJ 07601
Tel. 201-933-1900
www.pionerindustries.com

Rehau Incorporated
P.O. Box 1706
Leesburg, VA 20177
Tel. 800-247-9445
www.rehau.com

Republic Windows and Doors
930 West Evergreen Avenue
Chicago, IL 60622
Tel. 800-248-1775
www.republicwindows.com

Torrance Aluminum
22580 Perry Street
Perris, CA 92570
Tel. 909-943--0430
www.torrancealuminum.com

Vancouver Door Company
203 5th Street, N.W.
P.O. Box 1418
Puyallup, WA 98371
Tel 800-999-3667
www.vancouverdoorco.com

Wausau Window and Wall Systems
1415 West Street
Wausau WI 54401
Tel. 715-845-2161
www.wausauwindows.com

Whisper-Like
P.O. Box 2949
Toledo, OH 43606
Tel. 800-227-8246
www.whisper-like.com

Windor Supply and Manufacturing
4237 S. 74th Avenue
Tulsa, OK 74145
Tel. 800-324-1947
www.windor.com

Duct and Fan Controls

Acoustical Surfaces, Inc.
123 Columbia Court North, Suite 201
Chaska, MN 55318
Tel: 800-448-0737

Aeroacoustic Corporation
3300 Corporation Way
Darlington, SC 29532
Tel. 843-398-1006
www.aeroacoustic.com

Industrial Acoustics Company
1160 Commerce Avenue
Bronx, NY 10462
Tel. 718-931-8000
www.industrialacoustics.com

McGill Airflow Corporation
One Mission Park
Groveport, OH 43125
Tel. 614-836-9981
www.mcgillairflow.com

Door Seals and Weatherstripping

National Guard Products, Inc.
4985 East Rains Road
Memphis, TN 38118
Tel. 800-647-7874
www.ngpinc.com

Pemko Manufacturing Co.
5535 Distribution Co.
Memphis, TN 38141
Tel. 800-824-3018
www.pemko.com

Zero International, Inc.
415 Concord Avenue
Bronx, NY 10455
Tel. 800-635-5335
www.zerointernational.com

Windows

Century Manufacturing, Inc.
4620 Andrews Street
North Las Vegas, NV 89031
Tel. 800-654-7027
www.windowtech.com

Graham Architectural Products
1551 Mt. Rose Avenue
York, PA. 17403-2909
Tel. 800-755-6274
www.grahamarch.com

Harvey Industries, Inc.
1400 Main Street
Waltham, MA 02154
Tel. 800-942-7839
www.harveyind.com

Jeld-wen
19618 Wildwood Drive
West Linn, OR 97068
Tel. 877-783-2057
www.jeld-wen.com

Lowen, Inc.
6465 East Johns Crossing, Suite 400
Duluth, GA 30097
Tel. 800-563-9367
www.loewen.com

Milgard Windows
965 5th Avenue, East
Tacoma, WA 98424
Tel. 800-645-4273 (800-MIL-GARD)
www.milgard.com

Windows continued

Industrial Acoustics Company
1160 Commerce Avenue
Bronx, NY 10462
Tel. 718-931-8000
www.industrialacoustics.com

Mon-Ray, Inc.
801 Boone Avenue North
Minneapolis, MN 55427
Tel. 800-544-3646
www.monray.com

NRG, Inc.
22520 Ecorse Road
Taylor, MI 48180
Tel. 312-295-4100

St. Cloud Window, Inc.
P.O. Box 1577
St. Cloud, MN 56302
Tel. 800-383-9311
www.stcloudwindow.com

Peerless Products, Inc
2403 S. Main Street
Fort Scott, KS 66701
Tel. 866-420-4000
www.peerlessproducts.com

Therm-o-lite
635 S. Lafayette Blvd.
South Bend, IN 46601
Tel. 574-234-4004
www.therm-o-lite-windows.com

Rehau Incorporated
P.O. Box 1706
Leesburg, VA 20177
Tel. 800-247-9445
www.rehau.com

Torrance Aluminum
22580 Perry Street
Perris, CA 92570
Tel. 909-943--0430
www.torrancealuminum.com

Republic Windows and Doors
930 West Evergreen Avenue
Chicago, IL 60622
Tel. 800-248-1775
www.republicwindows.com

Wausau Window and Wall Systems
1415 West Street
Wausau WI 54401
Tel. 715-845-2161
www.wausauwindows.com

Wall and Ceiling Treatments

National Gypsum Company
2001 Rexford Road
Charlotte, NC 28211
Tel. 704-365-7300
www.nationalgypsum.com

Quiet Solution, Inc.
522 Almanor Avenue
Sunnyvale CA 94085
Tel. 800-797-8438
www.quietsolution.com

PAC International
10680 S.W. Industrial Way
Tualatin, OR 97062-9502
Tel. 866-774-2100
www. pac-intl.com

USG
125 South Franklin
Chicago, IL 60606
Tel. 312-606-4000
www.usg.com

Independent Certified Acoustical Testing Laboratories

This list represents a partial list of certified acoustical testing laboratories. The list does not imply an endorsement or recommendation by the County of Wayne. The National Voluntary Laboratory Accreditation Program maintains a list of certified laboratories on their website. http://ts.nist.gov/ts/htdocs/210/214/scopes/acots.htm

Acoustic Systems
Acoustical Research Facility
415 East Street Elmo Road
P.O. Box 3610
Austin, TX 78764
Tel: 512-444-1961
www.acousticssystems.com

Architectural Testing Inc
130 Derry Ct.
York, PA 17402
Tel. 717-764-7700
www.archtest.com

Intertek Testing Services
3933 US Route 11
Cortland, NY 13045
Tel. 607-758-6215
www.intertek.com

Johns Manville Technical Center
10100 West Ute Avenue
Littleton, CO 80162
Tel. 303-978-3611
www.jm.com/mtc/appliedtechnology

National Gypsum Co.
(NGC) Testing Services
1650 Military Road
Buffalo NY 14217-1198
Tel. 716-873-9750
www.ngctestingservices.com

Orfield Laboratories, Inc
2709 E. 25th Street
Minneapolis, MN 55406
Tel. 612-721-2455
www.orfieldlabs.com

Riverbark Acoustical Labs, Inc
1512 S. Batavia Avenue
Geneva, IL 60134
Tel. 630-232-0104
www.riverbark.alionscience.com

Steelcase Acoustical Test Laboratory
P.O. Box 1967
Mail Stop CD2WO6
Grand Rapids, MI 49501
Tel. 616-698-5527

Stork-Twin City Testing
662 Cromwell Avenue
St. Paul, MN 55114-1776
Tel. 651-645-3601
www.storkct.com

United States Gypsum Co.
(USG0 Research Construction
Systems Laboratory
700 N. Highway 45
Libertyville, IL

Western Electro-Acoustic Lab, Inc
25132 Rye Canyon Loop
Santa Clarita CA 91355
Tel. 661-775-3741

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