U.S. Department of Housing and Urban Development
Office of Community Planning and Development

Noise Notebook

Chapter 4
Supplement

Sound Transmission Class Guidance

Table of Contents

Sound Transmission Class Guidance

Introduction

The Noise Guidebook, pages 33-37, provides an elementary discussion of STC, provides some STC ratings for common building materials and limited exterior and interior wall construction configurations, and describes a method to determine composite STC value of a wall containing a window or door. This update provides for an understanding of STC and provides an expanded material and construction classification for both internal and external building materials and typical construction patterns.

The intent of this chapter is not to endorse anyone building manufacturer or product over another but to keep HUD Environmental staff and other interested persons advised on the STC values of current building materials and practices which can be applied to HUD supported housing activities. Additional subsections on specific types of building materials, construction techniques and STC values will be periodically added.

As stated in the Noise Guidebook, "STC is used as a measure of a material's ability to reduce sound," and effectively mitigate any adverse noise levels that could impede a person's use of a residential or commercial structure. The higher the STC value, the greater the sound attenuation and presumably the quieter the structure's interior. In addition to STC, another interior building measuring technique to evaluate sound impact or absorption between floors is the Impact Isolation Class (IIC). Both techniques will be fully discussed after a brief explanation of the following basic principals related to sound.

What Is Sound

Sound is indicated in two ways: frequency and intensity. Frequency, the high or low pitch of sound, is expressed as the number of vibrations or cycles per second. One vibration or cycle per second is a hertz (Hz). For example on a piano the middle C note has a frequency of 262 Hz and the total range of a piano has a frequency of 27 Hz to 4186 Hz, well within the 16 to 20,000 Hz range of the human ear. The sound created by the piano is heard by the human ear by air pressure created by vibration. The greater the pressure, the greater the loudness or intensity of the sound heard by the human ear. Loudness is expressed in decibels (dB). The decibel is one-tenth of a "Bel," a unit named for Alexander Graham Bell. Since the ear is more sensitive to sound in the middle range of frequencies, loudness (intensity) is determined at a frequency of 1,000 Hz. On the decibel scale, 0 dB indicates a level of sound at 1,000 Hz, a sound just barely audible to person with normal unimpaired hearing.

The A-weighted scale of a sound meter is designed to adjust the sensitivity of a sound meter to sounds of different frequencies that closely approximate how the human ear might respond to moderate sound levels in the 1,000 to 4,000 Hz range. The A-weighted sound level is used extensively for measuring community and transportation noises.

The Sound Transmission Class (STC), measured in decibels, is used to measure building material's ability to absorb sound. The STC can be used to measure sound absorption for both external building walls and internal walls in single and multifamily structures. The STC is measured by positioning a representative sample of the building material midway in an acoustical chamber, dividing the chamber in half or into two rooms. One section of the chamber contains the sound source and the other section the sound receiving equipment. The test procedure calls for a steady sound in the source room and measuring the sound level in both the source and receiving rooms. Differences in sound levels in the rooms determines the transmission loss characteristics of the material tested. For example, if a generated sound level of 80 dB is measured in the source room and 30 dB is measured in the adjacent receiving room, the tested material has a sound reduction intensity (STC) of 5OdB.

The Impact Isolation Class (IIC), measured in decibels, is the classification system used to determine sound *impact* from floor to ceiling in a structure. The IIC is not to be used to measure airborne sound penetration or absorption in walls. The IIC numerical rating efficiency increases with improved impact isolation performance of the floor and its component sub flooring and materials. The rating scale values are generally equivalent to the airborne sound transmission loss. The impact of steps or vibrations on a floor and the reverberation of that noise in the room below is dependent upon the type, density and thickness of the floor and ceiling material, its absorption material, and quality of construction. A separate section on common floor materials and construction patterns to illustrate both the STC and IIC ratings is included.

Sound Reduction In Structures

Four general techniques for controlling noise in single-family and multifamily structures are:

1. Elimination of the cause or source of the noise,
2. Employ materials which absorb sound rather than reflect noise,
3. Use sound barriers in building layout to prevent sound from being transmitted from one adjoining area into another, and

4. Use design considerations to mask or absorb the noise.

A description of each technique and its applicability follows.

1. ELIMINATION:
The elimination of a noise source may be impractical or impossible to achieve, whether emanating from within or outside the structure. Examples include the operation of mechanical equipment within the dwelling unit, excessive corridor noise, air conditioning/heating system, elevators, exhaust fans, and outdoor transportation sounds such as automotive traffic, aircraft overflights, and commercial or industrial activities. Some noise reduction could be achieved through sound reduction or absorption techniques, but total elimination of these sounds may be impossible.

2. ABSORPTION:
Sound absorption control is the reduction of sound emanating from a source within a room. The extent of control depends upon the efficiency of the room's surfaces in absorbing rather than reflecting sound waves. A surface, which could theoretically absorb 100% of the sound would have a sound absorption coefficient of 1.0. A surface absorbing 35% of the sound would have a coefficient of 0.35. The effectiveness of wall construction as a means of sound absorption is tested in a similar manner as that of STC. If a generated sound level of 80 dB is observed in one room and 30 dB is measured in an adjacent room, the reduction in sound absorption for the intervening wall is 50 dB. In choosing the type of construction material for interior walls to absorb sound transmission, porosity and density of the material should be considered. Resistance to sound transmission increases with unit weight and decreases with porosity. For example, unpainted, open textured concrete block exhibits improved resistance to sound passage after sealing the surface with plaster or paint. The sealing of the pores result in a reduction in the sound absorption of the block. In multifamily structures using concrete block partitions to separate public areas such as stairwells and corridors from adjacent living areas, sound transmission reduction is achieved through plastering or painting the surface of the residential unit or living area on the opposite side of the partition. The sound is absorbed by the concrete masonry's unpainted side and its transmission is prevented into the residential unit or living area by the plaster or paint on the other side.

However, all of the design elements that are employed to control sound can be nullified through poor or improper construction practices. Sound leakage will occur through any opening in a wall. An improperly fitted door or window is a prime source of sound leakage, as well as openings around ducts, pipes and electrical outlets which are improperly fitted or sealed.

3. SOUND BARRIERS:
Prudent building layout can be effective in controlling noise in single-family and multifamily housing. Sound waves can be prevented from being transmitted from one adjoining area to another. Closets, stairways and corridors can be used as buffers against airborne sound transmission between apartments or bedrooms. Concrete blocks or solid partitions can be employed to separate boiler rooms, air conditioning units, work areas or noisy public areas such as stairwells, corridors or lobbies from adjacent living areas. Partitions designed to absorb sound on one side and to retain sound absorption on the other can effectively block or reduce sound transmission into living areas intended for quiet use. The barrier should have a high sound absorption coefficient on one side and an equally high sound retention coefficient on the reverse side to effective. For example, unpainted porous concrete block would have a high sound absorption coefficient and a high noise retention coefficient on the reverse side if the porous surface in the living unit was effectively sealed by plaster or paint. Similarly, noise originators such as cloths washing machines, central heaters, and other noisy major appliances can be placed in a basement or utility rooms that are physically isolated from other living areas by walls or floors to absorb or block the emitted sounds.

4. DESIGN:
Design factors is the last major element to consider in controlling noise in single-family and multifamily structures. Design considerations offer the most infinite prospects for controlling noise due to the numerous types of building designs. For example, adjacent apartments can be arranged to have quiet areas (bedrooms or living rooms) abut and have noisy areas (kitchens and bathrooms) next to similar noisy areas. Apartment door openings into the same hallway can be staggered to reduce sound penetration into the unit directly across the hall. Since sound travels in a straight line, some of the sound from one doorway would be absorbed or diffused into the wall building material of the unit directly across the hall.

Windows should be placed as far away as possible from common walls. The closer the windows are to each other, the more sound will pass from one apartment to another. Medicine cabinets in opposite bathroom partitions should be offset. Cabinets placed back-to-back will transmit almost as much noise as an opening. Heating/cooling ducts are like speaking tubes, carrying noise from one room to another. Techniques should be employed to trap or splinter sound or have turns in the ducts to reduce noise transference.

Noise producing equipment should be kept as far as possible from living areas and especially the bedrooms. Flexible connectors should be used to couple mechanical equipment to pipes and ducts. Pipes and ducts should not be firmly connected to parts of a building that could serve as sounding boards but be supported by resilient connections to solid supports. Where pipes and ducts pass through walls and floors, they should be isolated by gaskets. The acoustical integrity of a building or a building section with an otherwise adequate STC rating can be significantly reduced by a small hole or crack in the exterior wall or any other path that allows sound to bypass the exterior or interior walls and flow into other areas of the structure.

Weather and Sound

Air will attenuate noise at high frequencies usually from 1,000 Hz upwards. Sound absorption by air changes with wind speed, temperature and humidity. For example, wind blowing at slower speeds near the ground surface than at higher elevations will produce a bending of the sound upwards, resulting in less noise at ground level. Temperature gradients have a similar effect because the velocity of sound increases with the higher temperatures. If the temperature is higher near the ground than in the upper layers (usually the case during the day), the sound waves higher above the ground will travel slower and the sound will be bent upwards resulting in quieter conditions at ground level. The reverse is true at night, the temperature is lower near the ground, sound will bend towards the ground, increasing noise at the ground level. Wind and temperature- gradient effects can also account for the occasional freak reception of sounds over long distances, especially train whistles. The sound has been bent upwards by a temperature or wind gradient and after traveling some way at high level is bent down again by a reverse gradient.

Weather conditions can produce substantial variations of as much as +- 10 dB. For example, fog causes an increase in the absorption in the air. A moderately dense fog, visibility 150 feet, gives extra attenuation of 1 to 3 dB per 300 feet, depending on frequency. Similarly, snow forms an absorbent layer on the ground, which affects ground reflection, thereby reducing the sound level.

Weather can also be a significant source of noise in a structure. Common irritants are wind and rain. Wind whistling around a building, into ventilation grilles, screens or past other external architectural or artistic features can result in disturbing noise. Similarly, the impact of rain on lightweight roofing, gutters or skylights can produce high internal noise levels.

STC Ratings for Wall, Floor and Window Materials and Assemblies

Appendix A illustrates sound transmission class ratings for wall, floor, window and door assemblies. The data used in this section is compiled from laboratory reports and various technical and trade literature publications received by this Office. Each item has an assigned STC rating, an accompanying sketch and a brief description of its composition or assembly. In addition, where possible, an Impact Isolation Class (IIC) rating has been assigned to floors to determine sound impact from floor to ceiling. Appendix A is a guide designed to aid HUD Housing and Environmental personal in determining STC values for most common housing construction practices and materials used in residential construction. The STC information can be used to supplement acoustical measurements by providing approximate interior noise levels for existing or proposed dwellings located in high noise areas by deducting the STC value from the exterior noise level. The data could also be used to advise HUD clients in determining and achieving compliance with the noise criteria stated in 24 CFR Part 51 B through the use of common construction materials and techniques to achieve noise attenuation for new construction and rehabilitation.

The appendix is divided into the following subsections:

1. WALLS
    - Exterior
    - Interior
2. FLOORS
    - Wood
    - Concrete
3. WINDOWS
4. DOORS
    - Exterior
    - Interior

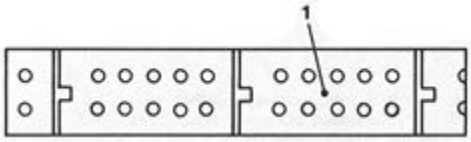
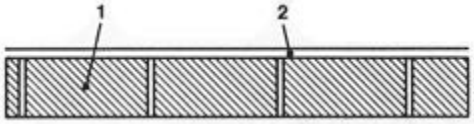
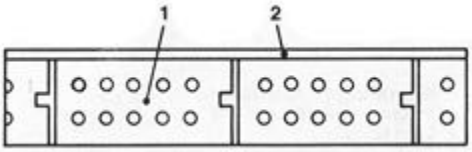
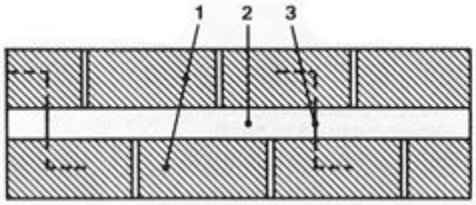
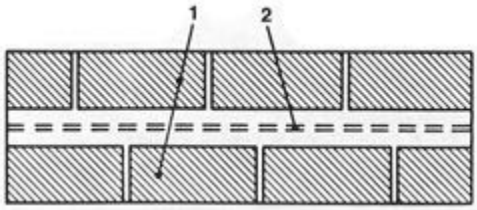
A bibliography of the reports, manufacturer's catalogs, technical papers, testing laboratories and other publications used in compiling this data is listed in the Appendix B.

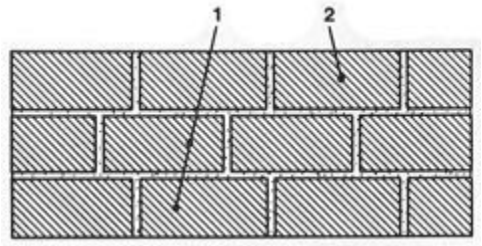
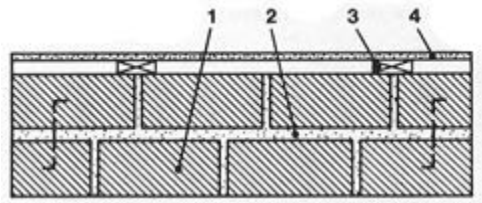
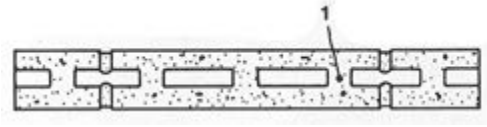
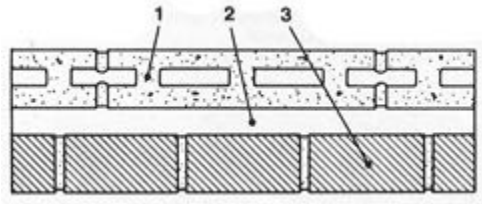
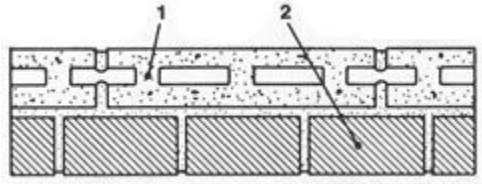
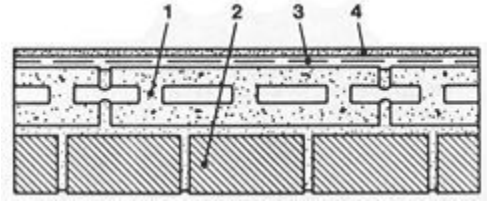
Appendix A STC Ratings

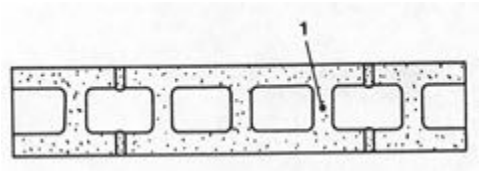
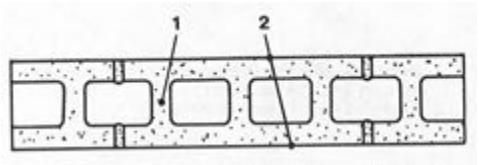
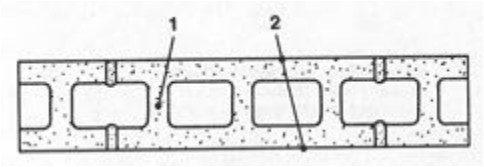
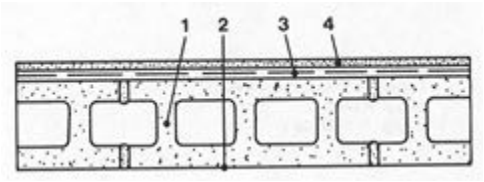
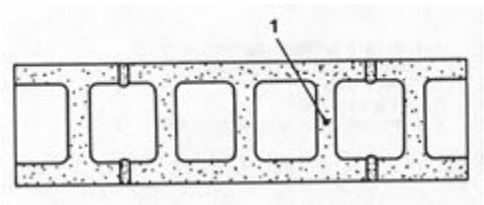
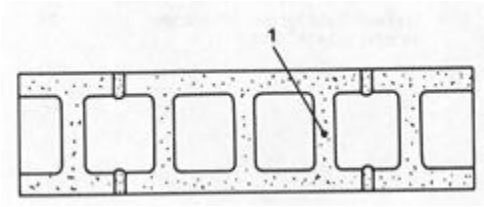
Appendix A

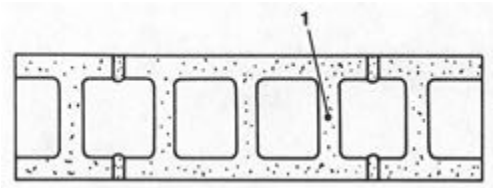
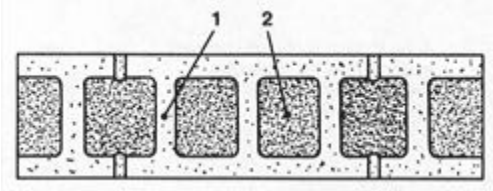
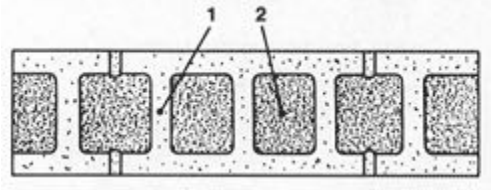
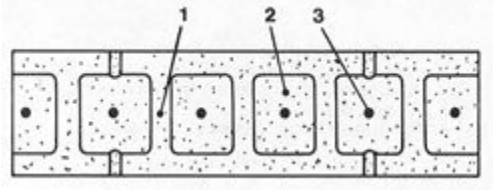
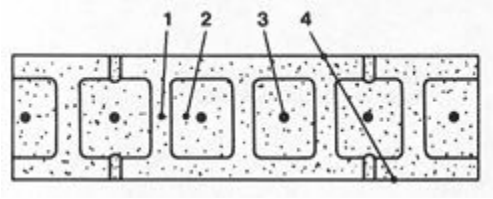
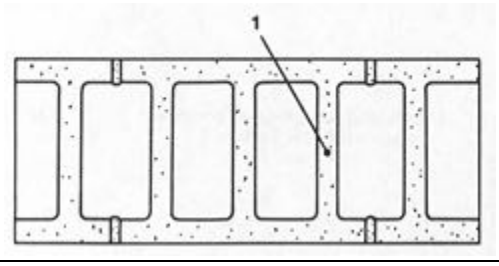
STC Ratings

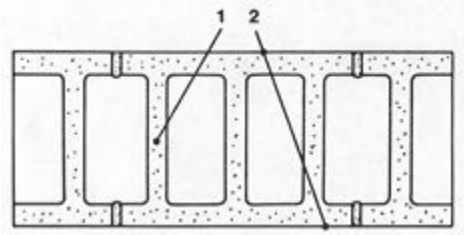
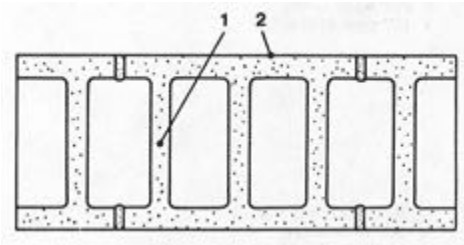
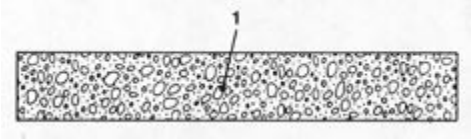
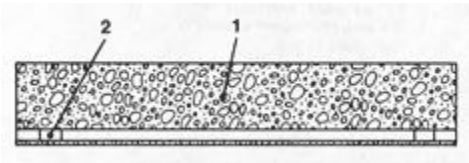
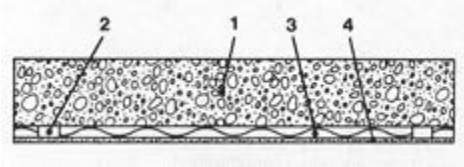
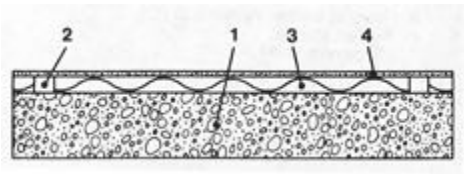
Walls: Exterior

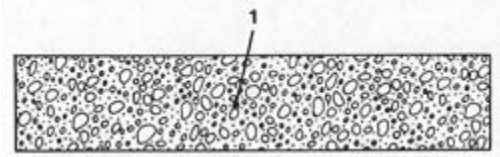
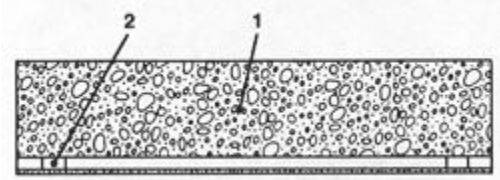
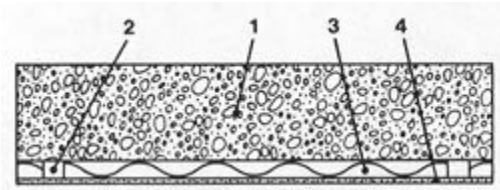
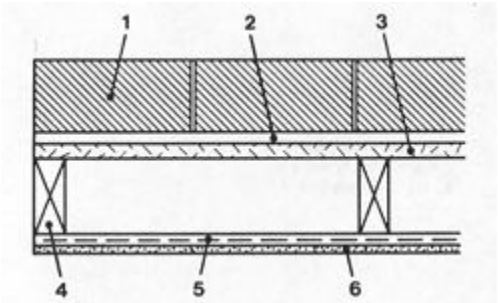
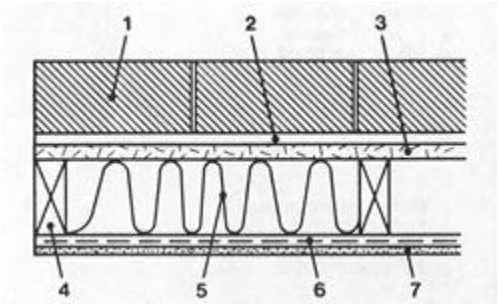
Sketch	Brief Description	STC
	1. 4” face brick, mortared together.	45
	1. Hollow core brick, mortared together.	51
	1. Common brick, mortared together. 2. ½” gypsum/sand plaster.	50
	1. Hollow core brick, mortared together. 2. ½” gypsum/sand plaster.	53
	1. Face brick, mortared together. 2. 2” air space. 3. Metal ties.	50
	1. Brick, mortared together. 2. 2 ¼” cavity filled with concrete grout and #6 bars vertically 48”o.c. and #5 bars horizontally 30”o.c.	59

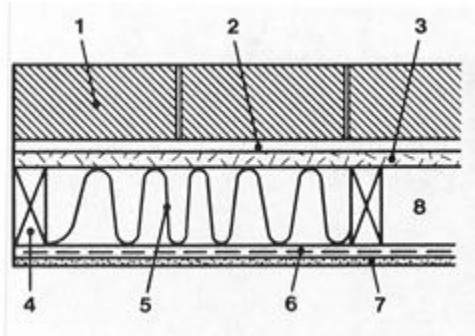
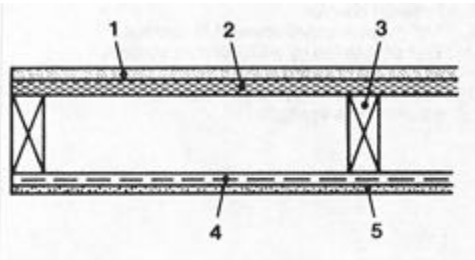
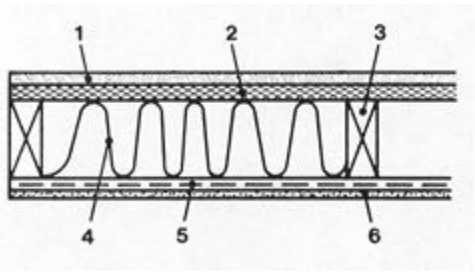
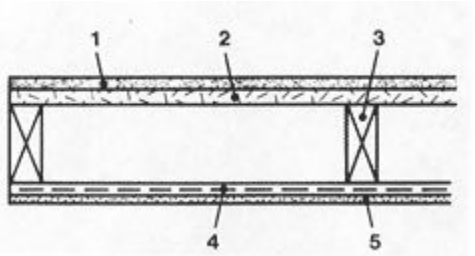
Sketch	Brief Description	STC
	1. Common brick, mortared together. 2. Face brick, mortared together.	59
	1. Common brick, mortared together. 2. ¾″ mortar-filled cavity with metal Z ties 24″o.c. in both directions. 3. 1x3″ furring strips 16″o.c. and nailed vertically into mortar joints 12″o.c. 4. ½″ gypsum board nailed 8″o.c. along edges and 12″o.c. in field.	53
	1. 4x8x16″ 3-cell lightweight concrete masonry units (17 lbs./block).	40
	1. 4x8x18″ 3-cell lightweight concrete masonry units (19 lbs./block). 2. 2″ air cavity. 3. Common brick, mortared together.	54
	1. 4x8x18″ 3-cell lightweight concrete masonry units (19 lbs./block). 2. Common brick, mortared together. (brick headers after every second course of block to tie the withes together).	51
	1. 4x8x18″ 3-cell lightweight concrete masonry units (19 lbs./block). 2. Common brick, mortared together. 3. Resilient channels. 4. ½″ gypsum board screwed to channels.	56

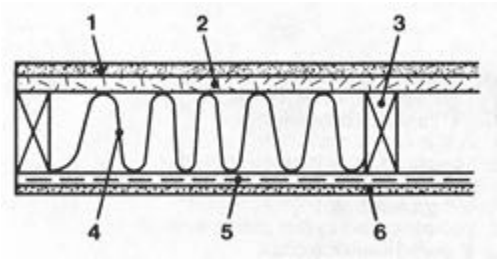
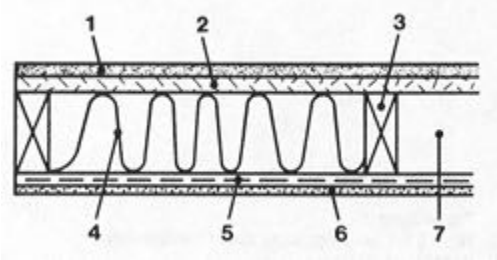
Sketch	Brief Description	STC
	1. 6x8x16″ 3-cell lightweight concrete masonry units (21 lbs./block).	44
	1. 6x8x16″ 3-cell lightweight concrete masonry units (21 lbs./block). 2. Paint both sides with primer-sealer coat and finish coat of latex.	46
	1. 6x8x18″ 3-cell dense concrete masonry units (36 lbs./block). 2. Paint both sides with primer-sealer coat and finish coat of latex.	48
	1. 6x8x16″ 3-cell lightweight concrete masonry units (21 lbs./block). 2. Paint, primer-sealer coat and finish coat of latex. 3. Resilient channels, 24″o.c. 4. ½″ gypsum board screwed to channels.	53
	1. 8x8x16″ 3-cell lightweight concrete masonry units (28 lbs./block).	45
	1. 8x8x18″ 3-cell lightweight concrete masonry units (34 lbs./block).	49

Sketch	Brief Description	STC
	1. 8x8x18″ 3-cell lightweight concrete masonry units (38 lbs./block).	49
	1. 8x8x18″ 3-cell lightweight concrete masonry units (34 lbs./block). 2. Expanded mineral loose-fill insulation.	51
	1. 8x8x18″ 3-cell lightweight concrete masonry units (38 lbs./block). 2. Expanded mineral loose-fill insulation.	51
	1. 8x8x18″ 3-cell lightweight concrete masonry units (33 lbs./block). 2. Grout in cells. 3. #5 bar in each cell.	48
	1. 8x8x18″ 3-cell lightweight concrete masonry units (33 lbs./block). 2. Grout in cells. 3. #5 bar each cell. 4. Paint two coats flat latex each side.	55
	1. 12x8x16″ 3-cell lightweight concrete masonry units (43 lbs./block).	39

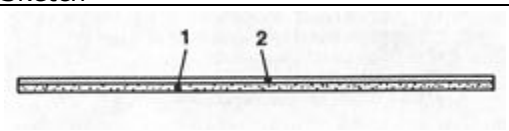
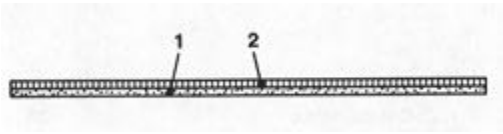
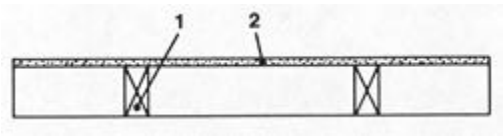
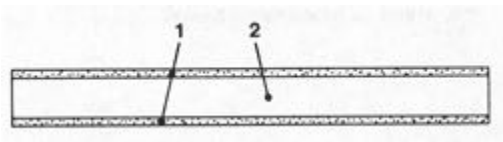
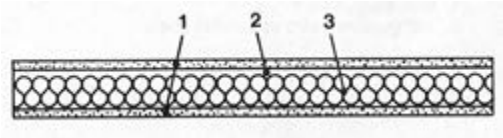
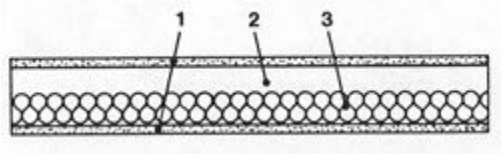
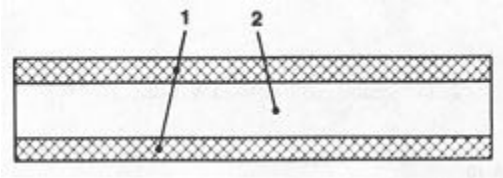
Sketch	Brief Description	STC
	1. 12x8x16. 3-cell lightweight concrete masonry units (43 lbs./block). 2. Paint both sides with 3 coats of latex block filler.	50
	1. 12x8x16” 3-cell lightweight concrete masonry units (43 lbs./block). 2. Paint one side only with 3 coats latex block filler.	51
	1. 6” cast concrete wall (71 psf).	57
	1. 6” cast concrete wall. 2. “Z” furring channels. 3. ½” gypsum board.	59
	1. 6” cast concrete wall. 2. “Z” furring channels. 3. 1”, 8-pcf rockwool. 4. ½” gypsum board.	62
	1. 6” cast concrete wall. 2. 2x2” wood furring. 3. 1 ½” 4-pcf rockwool. 4. ½” gypsum board.	63

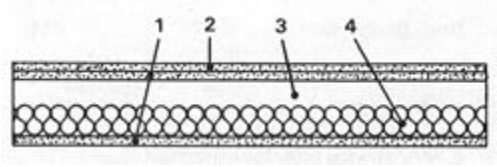
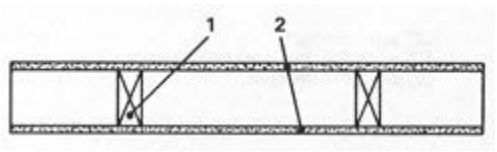
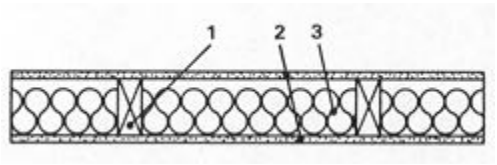
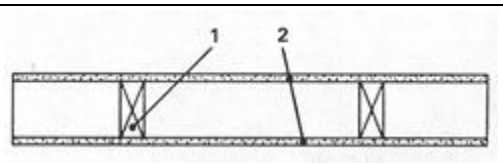
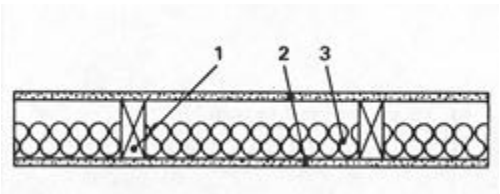
Sketch	Brief Description	STC
	1. 8″ cast concrete wall (96.6 psf).	58
	1. 8″ cast concrete wall. 2. 2x2″ wood furring. 3. ½″ gypsum board.	59
	1. 8″ cast concrete wall. 2. 2x2″ wood furring. 3. 1 ½″, 4 psf rockwall. 4. ½″ gypsum board.	63
	1. Face brick. 2. ½″ air space, with metal ties. 3. ¾″ insulation board sheathing. 4. 2x4″ studs 16″o.c. 5. Resilient channel. 6. ½″ gypsum board.	54
	1. Face brick. 2. ½″ air space, with metal ties. 3. ¾″ insulation board sheathing. 4. 2x4″ studs 16″o.c. 5. Fiberglas building insulation (3 ½″). 6. Resilient channel. 7. ½″ gypsum board.	56

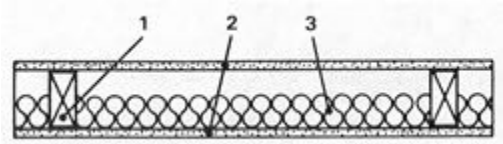
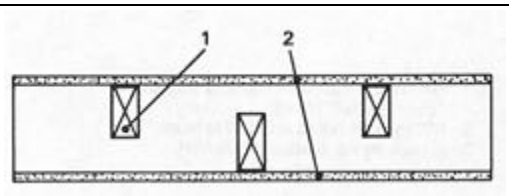
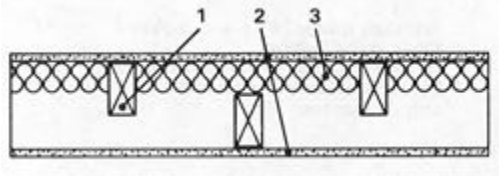
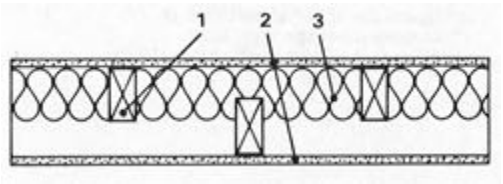
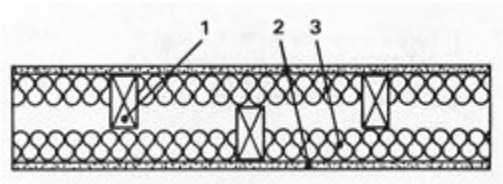
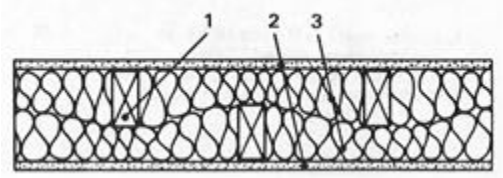
Sketch	Brief Description	STC
	1. Face brick (9x14’ wall). 2. ½” air space, with metal ties. 3. ¾” insulation board sheathing. 4. 2x4” studs 16”o.c. 5. Fiberglas building insulation (3 ½”). 6. Resilient channel. 7. ½” gypsum board. 8. Wall penetrated by 6x5' picture window 1” glazed insulating glass.	39
	1. 7/8” stucco. 2. No.15 felt building paper and 1” wire mesh. 3. 2x4” studs 16”o.c. 4. Resilient channel. 5. ½” gypsum board screwed to channel.	49
	1. 7/8” stucco. 2. No.15 felt building paper and 1” wire mesh. 3. 2x4” studs 16”o.c. 4. Fiberglas building insulation (3 ½”). 5. Resilient channel. 6. ½” gypsum board screwed to channel.	57
	1. 5/8 x 10” redwood siding. 2. ½” insulation board sheathing. 3. 2x4” wood studs 16”o.c. 4. Resilient channel. 5. ½” gypsum board screwed to channel.	43

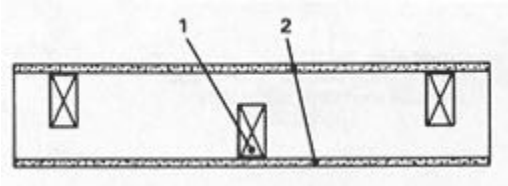
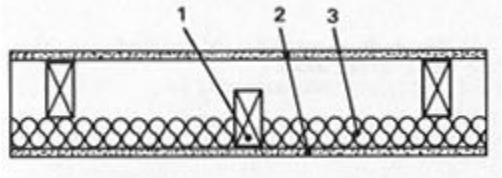
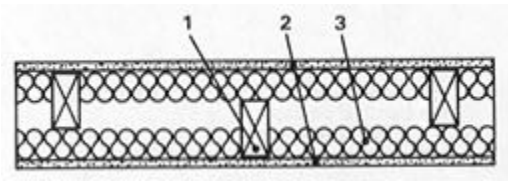
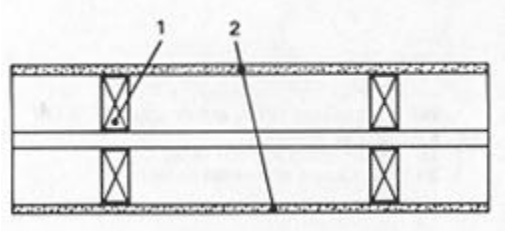
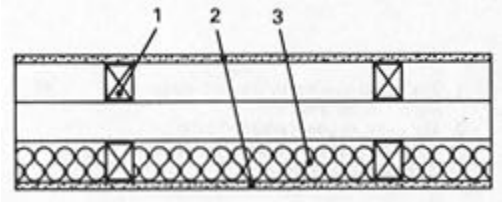
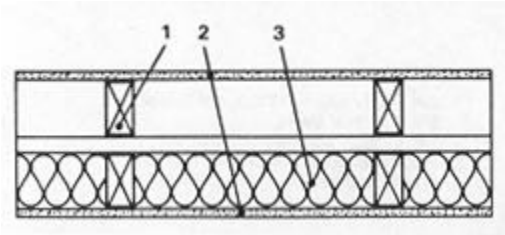
Sketch	Brief Description	STC
	1. 5/8x10” redwood siding. 2. ½” insulation board sheathing. 3. 2x4” wood studs 16”o.c. 4. Fiberglas building insulation (3 ½”). 5. Resilient channel. 6. ½” gypsum board screwed to channel.	47
	1. 5/8x10” redwood siding (9x14' wall). 2. ½” insulation board sheathing. 3. 2x4” wood studs 16.o.c. 4. Fiberglas building insulation (3 ½”). 5. Resilient channel. 6. ½” gypsum board screwed to channel. 7. a. Wall penetrated by a 6x5' picture window, 1” glazed insulating glass. b. Wall penetrated by a 6x5' 16 panel window, glazed single strength.	(a.38) (b.35)

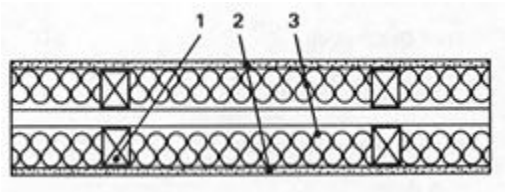
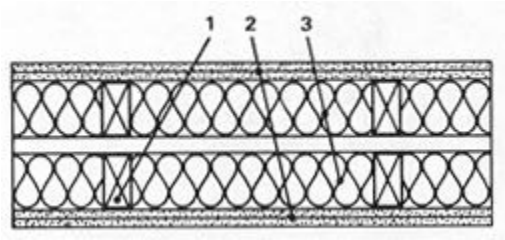
WALLS: Interior: Wooden Studs

Sketch	Brief Description	STC
	1. ½″ gypsum board. 2. 3/16″ plywood laminated with contact cement.	28
	1. ½″ gypsum board. 2. ½″ wood-fiber board laminated with gypsum joint compound.	30
	1. 2x4″ studs, 16″o.c. 2. 5/8″ gypsum board screwed to studs.	28
	1. ½″ gypsum board, no studs. 2. 2 ½″ air space.	30
	1. ½″ gypsum board, no studs. 2. 2 ½″ air space. 3. 2″ thick sound attenuation blanket.	44
	1. ½″ gypsum board, no studs. 2. 3 5/8″ air space. 3. 2″ thick sound attenuation blanket.	45
	1. 1 3/8″ thick wood-fiber board nailed to 2x4″ plates top and bottom and painted both sides. 2. 3 ½″ air cavity.	44

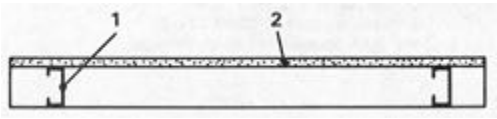
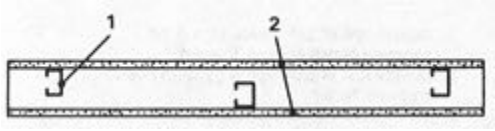
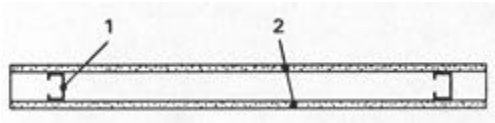
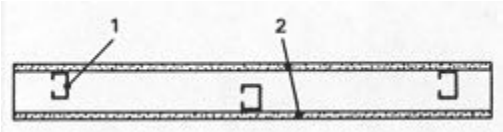
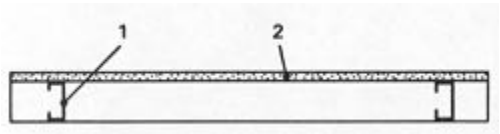
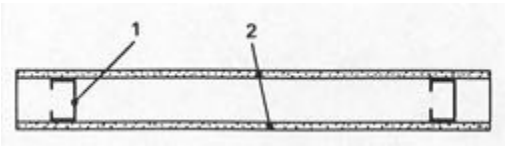
Sketch	Brief Description	STC
	1. ½″ gypsum board, no studs. 2. ½″ gypsum board laminated to base layer with gypsum joint compound. 3. 3 5/8″ air cavity. 4. 2″ thick sound attenuation blanket.	48
	1. 2x4″ studs, 16″o.c. 2. 3/8″ gypsum board nailed to studs.	35
	1. 2x4″ studs, 16″o.c. 2. 3/8″ gypsum board nailed to studs. 3. 3″ thick sound attenuation blanket.	41
	1. 2x4″ studs, 16″o.c. 2. ½″ gypsum board screwed to studs.	34
	1. 2x4″ studs, 16″o.c. 2. ½″ gypsum board screwed to studs. 3. 2″ thick sound attenuation blanket.	37
	1. 2x4″ studs, 24″o.c. 2. ½″ gypsum board screwed to studs.	36

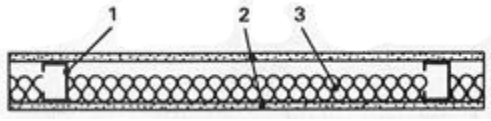
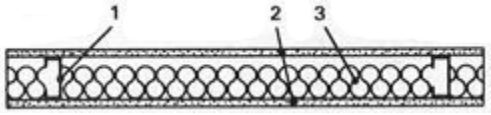
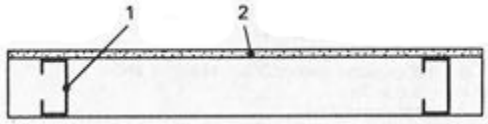
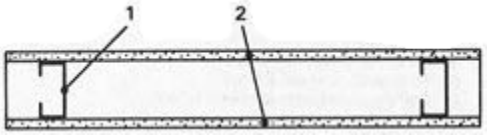
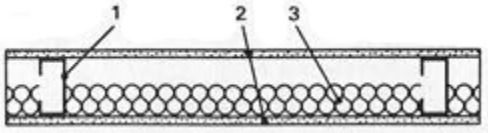
Sketch	Brief Description	STC
	1. 2x4”studs, 24”o.c. 2. ½” gypsum board screwed to studs. 3. 2” thick sound attenuation blanket.	40
	1. 2x4” studs spaced 16”o.c. and staggered 8”o.c. on 2x6” plates. 2. ½” gypsum board screwed 12”o.c.	39
	1. 2x4” studs spaced 16”o.c. and staggered 8”o.c. on 2x6” plates. 2. ½” gypsum board screwed 12”o.c. 3. 2 ¼” thick sound attenuation blanket.	48
	1. 2x4” studs spaced 16”o.c. and staggered 8”o.c. on 2x6” plates. 2. ½” gypsum board screwed 12”o.c. 3. 3 ½” thick sound attenuation blanket.	49
	1. 2x4” studs spaced 16”o.c. and staggered 8”o.c. on 2x6” plates. 2. ½” gypsum board screwed 12”o.c. 3. 2 ¼” thick sound attenuation blankets in both stud cavities.	49
	1. 2x4” studs spaced 16”o.c. and staggered 8”o.c. on 2x6” plates. 2. ½” gypsum board screwed 12”o.c. 3. 3 ½” thick sound attenuation blankets in both stud cavities.	51

Sketch	Brief Description	STC
	1. 2x4″ studs spaced 24″o.c. and staggered 12″o.c. on 2x6″ plates. 2. ½″ type X gypsum board screwed 12″o.c.	42
	1. 2x4″ studs spaced 24″o.c. and staggered 12″o.c. on 2x6″ plates. 2. ½″ gypsum board screwed to studs. 3. 2″ thick sound attenuation blanket.	46
	1. 2x4″ studs spaced 24″o.c. and staggered 12″o.c. on 2x6″ plates. 2. ½″ type X gypsum board screwed 12″o.c. 3. 2″ thick sound attenuation blankets in both stud cavities.	48
	1. Double row of 2x4″ studs 16″o.c. on separate plates spaced 1″ apart. 2. ½″ type X gypsum board screwed 12″o.c.	47
	1. Double row of 2x3″ studs 16″o.c. on 2x3″ plates spaced 2 ½″ apart. 2. ½″ gypsum board screwed 16″o.c. 3. 2 ¼″ thick sound attenuation blanket.	55
	1. Double row of 2x4″ studs 16″o.c. on separate plates spaced 1″ apart. 2. ½″ type X gypsum board screwed 12″o.c. 3. 3 ½″ thick sound attenuation blanket.	56

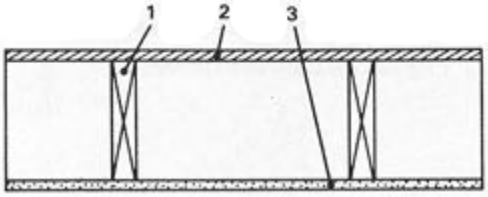
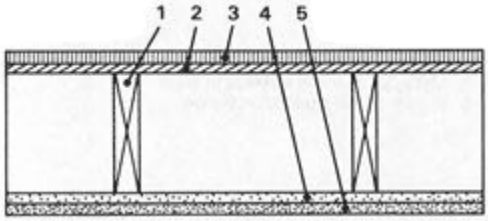
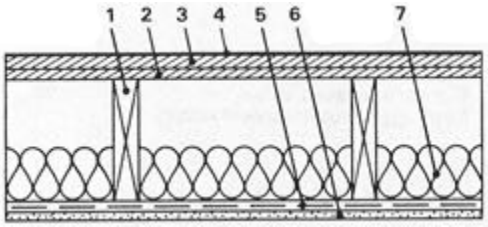
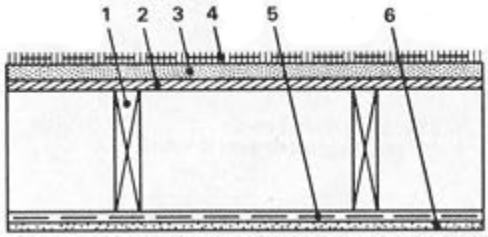
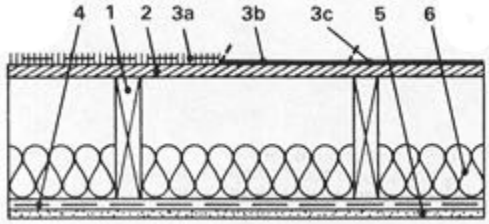
Sketch	Brief Description	STC
	1. Double row of 2x4″ studs 16″o.c. on separate plates spaced 1″ apart. 2. ½″ gypsum board screwed 12″o.c. 3. 2 ¼″ thick sound attenuation blankets in both stud cavities.	56
	1. Double row of 2x4″ studs 16.o.c. on separate plates spaced 1″ apart. 2. Double row of 5/8″ type X gypsum board screwed 16.o.c. 3. 3 ½″ thick sound attenuation blankets in both stud cavities.	63

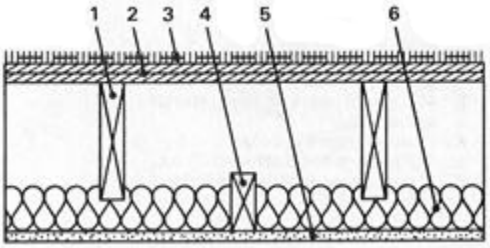
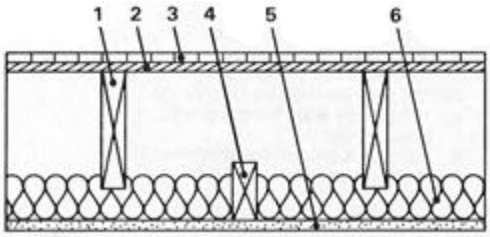
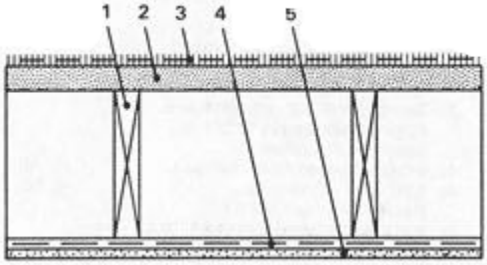
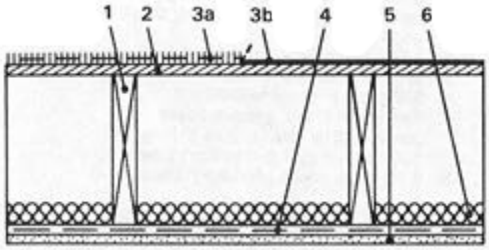
WALLS: Interior: Metal Studs

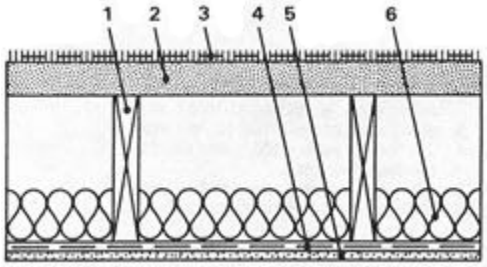
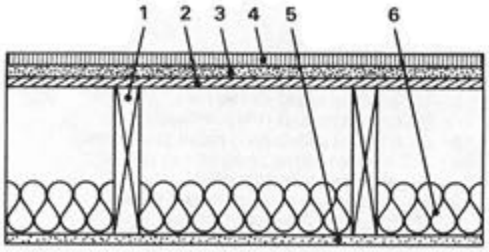
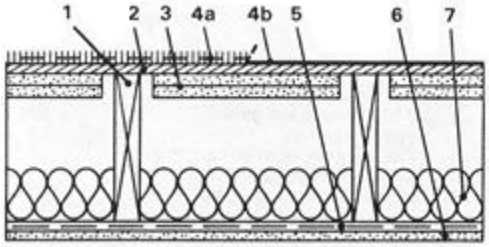
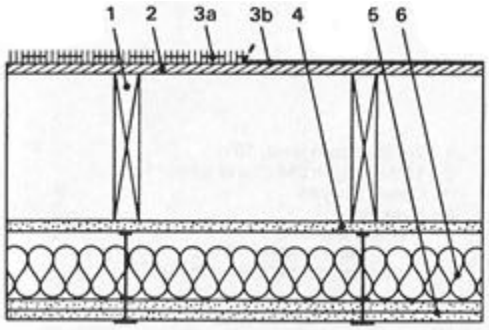
Sketch	Brief Description	STC
	1. 1 5/8″ metal studs, 24″o.c. 2. 1/2. vinyl-faced gypsum board screwed to studs.	27
	1. 1 5/8″ metal studs spaced 24″o.c. and staggered 12″o.c. on 2 ½″ metal tracks. 2. 1/2″ gypsum board screwed to studs.	34
	1. 1 5/8″ metal studs, 24″o.c. 2. 5/8″ gypsum board screwed 12″o.c. at edges and 24″o.c. in field.	37
	1. 1 5/8″ metal studs spaced 24″o.c. and staggered 12″o.c. on 21/2″ metal channels. 2. 5/8″ gypsum board screwed to studs.	38
	1. 2 ½″ metal studs, 24″o.c. 2. 1/2″ vinyl-faced gypsum board screwed to studs.	27
	1. 2 1/2″ metal studs, 24″o.c. 2. 5/8″ gypsum board screwed to studs.	37

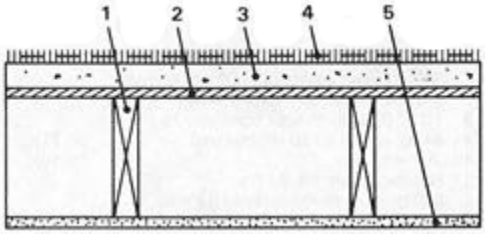
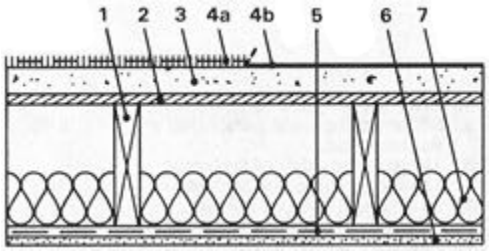
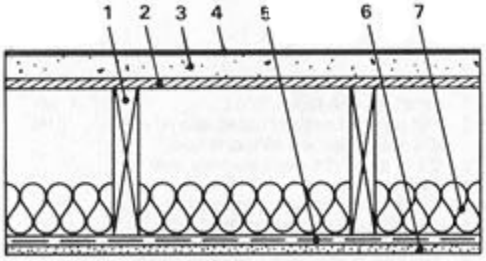
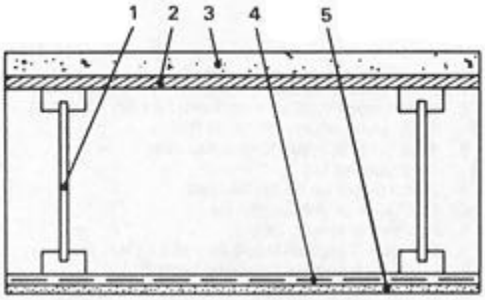
Sketch	Brief Description	STC
	1. 2 ½” metal studs, 24”o.c. 2. 5/8” gypsum board screwed 12”o.c. at edges and 24”o.c. in field. 3. 1 ½” thick sound attenuation blanket.	42
	1. 2 ½” metal studs, 24”o.c. 2. ½” gypsum board screwed to studs. 3. 2” thick sound attenuation blanket.	44
	1. 3 5/8” metal studs, 24”o.c. 2. 1/2. gypsum board screwed to studs.	27
	1. 3 5/8” metal studs, 24”o.c. 2. ½” gypsum board screwed to studs.	36
	1. 3 5/8” metal studs, 24”o.c. 2. ½” gypsum board screwed to studs. 3. 2” thick sound attenuation blanket.	44

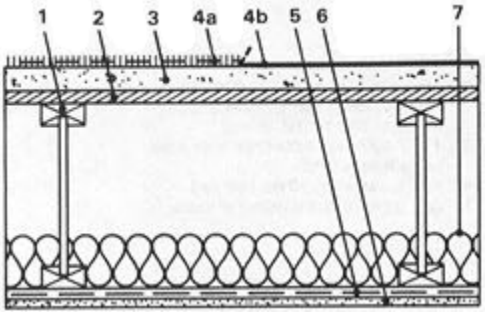
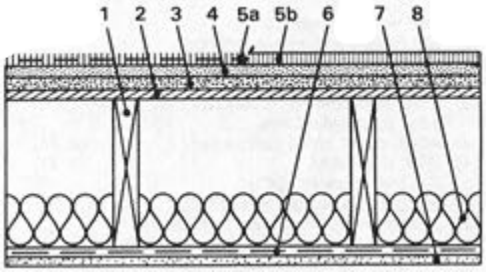
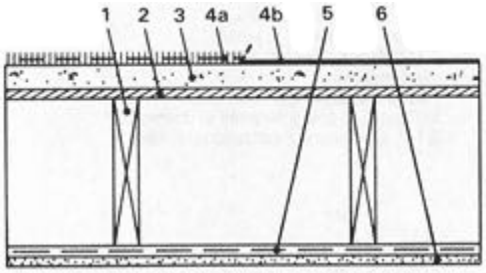
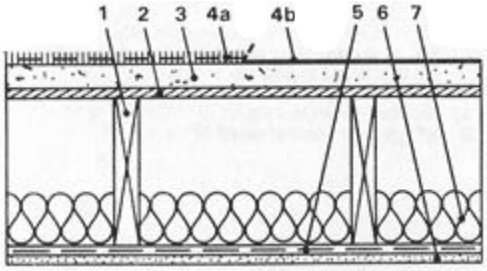
Floors: Wood

Sketch	Brief Description	STC (IIC)
	1. 2x8″ wooden joists, 16″o.c. 2. 7/8″ tongue and groove nailed to joints. 3. 3/8″ gypsum nailed to joints.	NA (32)
	1. 2x8″ wooden joists, 16″o.c. 2. ½″ plywood nailed. 3. 25/32″ hardwood flooring. 4. 1/2″ gypsum nailed to joists. 5. Ceiling tire.	NA (37)
	1. 2x8″ wooden joists, 16″o.c. 2. 5/8″ tongue and groove plywood nailed with 8d nails 6″o.c. 3. 3/8″ plywood stapled 3″o.c. at edges and 6″o.c. in field. 4. .075″ sheet vinyl. 5. Resilient channels, 24″o.c. 6. 5/8″ gypsum board screwed 12″o.c. 7. 3″ thick sound attenuation blanket.	46 (44)
	1. 2x8″ wooden joists, 16″o.c. 2. 5/8″ plywood nailed with 8d nails. 3. ½″ nominal wood-fiber board glued to plywood. 4. 44 oz. carpet on 50 oz. pad. 5. Resilient channels, 24″o.c. 6. 5/8″ gypsum board screwed 12″o.c.	48 (65)
	1. 2x8″ wooden joists, 16″o.c. 2. 19/32″ tongue and groove plywood nailed with 8d nails 6″o.c. at edges and 10″o.c. in field. 3. a. 44 oz. carpet on 40 oz. hair pad. b. .075″ sheet vinyl. c. 1/16″ sheet vinyl. 4. Resilient channels, 24″o.c. 5. 5/8″ gypsum board screwed 12″o.c. 6. 3″ thick sound attenuation blanket.	48 (a. 69) (b. 45) (c.43)

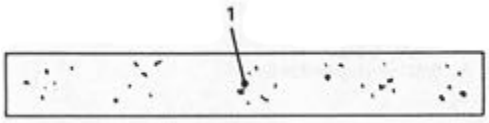
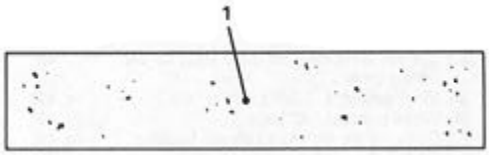
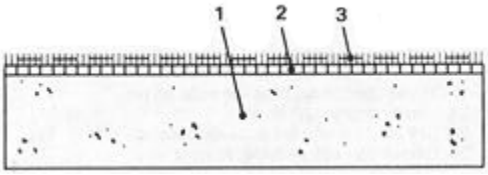
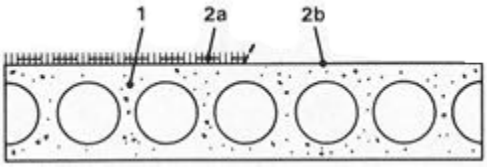
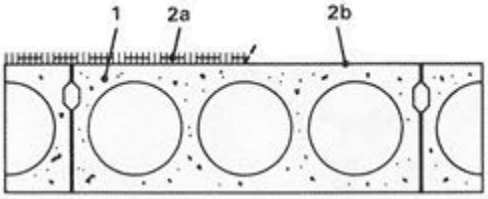
Sketch	Brief Description	STC (IIC)
	1. 2x8″ wooden joists, 16″o.c. 2. 1 1/8″ tongue and groove plywood nailed 6″o.c. at edges and 16″o.c. in field. 3. 44 oz. wool carpet on 40 oz. hair pad. 4. 2x4″ ceiling joists, 16″o.c. and staggered between floor joists. 5. 5/8″ gypsum board nailed to 2x4″ joists. 6. 3″ thick sound attenuation blanket.	53 (80)
	1. 2x8″ wooden joists, 16″o.c. 2. 1/2″ plywood nailed with 8d nails 6″o.c. at edges and 16″o.c. in field. 3. 25/32″ wood strip flooring nailed to sub floor. 4. 2x4″ wooden ceiling joists, 16″o.c. and staggered between floor joists. 5. 5/8″ gypsum board nailed to 2x4″ joists. 6. 3″ thick sound attenuation blanket.	54 (45)
	1. 2x10″ wooden joists, 16″o.c. 2. 1 11/32″ tongue and groove wood-fiber board. 3. 44 oz. wool carpet on 40 oz. hair pad. 4. Resilient channels, 24″o.c. 5. 5/8″ gypsum screwed 12″o.c.	49 (68)
	1. 2x10″ wooden joists, 16″o.c. 2. 19/32″ tongue and groove plywood. 3. a. Carpet and pad. b. Vinyl tile. 4. Resilient channels, 24″o.c. 5. 5/8″ gypsum screwed 12″o.c. 6. 1″ thick sound attenuation blanket.	51 (a. 74) (b.51)

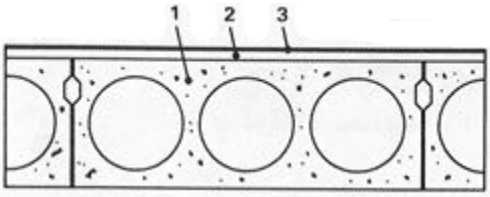
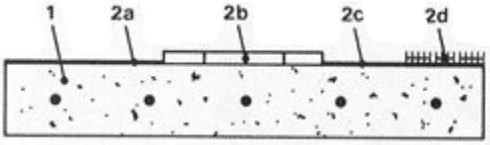
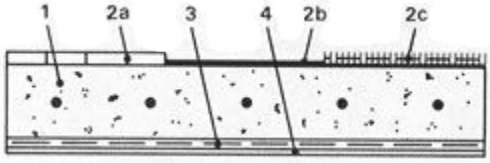
Sketch	Brief Description	STC (IIC)
	1. 2x10″ wooden joists, 16″o.c. 2. 1 11/32″ tongue and groove wood-fiber board. 3. 40 oz. wool carpet on 80 oz. sponge rubber pad. 4. Resilient channels, 24″o.c. 5. 1/2″ gypsum board screwed 12″o.c. 6. 3″ thick sound attenuation blanket.	50 (72)
	1. 2x10″ wooden joists, 16″o.c. 2. 5/8″ plywood sub floor glued to joists, nailed with 8d nails 12″o.c. 3. ¼″ particleboard glued to plywood. 4. ½″ parquet wood flooring glued to particleboard. 5. ½″ type-X gypsum board screwed 12″o.c. 6. 3″ thick sound attenuation blanket.	43 (NA)
	1. 2x10″ wooden joists, 16″o.c. 2. 5/8″ tongue and groove plywood nailed with 8d nails 6″o.c. along edges and 10″o.c. in field. 3. Two layers of 5/8″ gypsum board attached with screws 12″o.c. to underside of sub floor. 4. a. 44 oz. carpet on 40 oz. hair pad. b. 1/16″ vinyl asbestos tile. 5. Resilient channels, 24″o.c. 6. 5/8″ gypsum board screwed 12″o.c. 7. 3 ½″ thick sound attenuation blanket.	56 (a. 74) (b.50)
	1. 2x10″ wooden joists, 16″o.c. 2. 5/8″ tongue and groove plywood nailed with 8d nails 6″o.c. along edges and 10″o.c. in field. 3. a. 44 oz. carpet on 40 oz. hair pad. b. 1/16″ vinyl asbestos tile. 4. 5/8″ gypsum board nailed 7″o.c. 5. Two layers of 5/8″ gypsum board suspended by wire hangers 5″ long in a 2x4' heavy-duty T grid ceiling system. 6. 3 ½″ thick sound attenuation blanket.	49 (a. 68) (b.47)

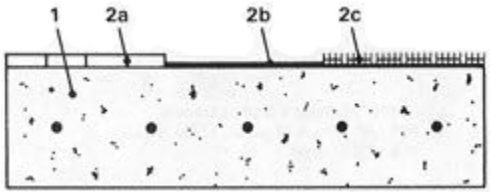
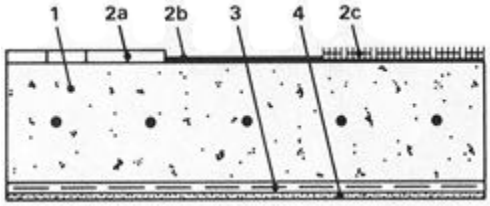
Sketch	Brief Description	STC (IIC)
	1. 2x8″ wooden joists, 16″o.c. 2. 5/8″ tongue and groove plywood nailed to joists with 8d nails 6″o.c. at edges and 10″o.c. in field. 3. 1 5/8″ lightweight concrete over 4 mil. polyethylene film. 4. 44 oz. carpet on 40 oz. hair pad. 5. 5/8″ gypsum board nailed to joists.	47 (66)
	1. 2x8″ wooden joists, 16″o.c. 2. 5/8″ tongue and groove plywood nailed to joists with 8d nails 6″o.c. at edges and 10″o.c. in field. 3. 1 5/8″ thick lightweight concrete over 4 mil. polyethylene film. 4. a. 44 oz. carpet on 40 oz. hair pad. b. .075″ sheet vinyl. 5. Resilient channels, 24″o.c. 6. 5/8″ gypsum board screwed 12″o.c. 7. 3″ thick sound attenuation blanket.	53 (a. 74) (b. 47)
	1. 2x10″ wooden joists. 16″o.c. 2. 5/8″ plywood nailed to joists. 3. 3. 1 ½″ thick lightweight concrete, 13 psf. 4. Cushioned vinyl. 5. Resilient channels, 24″o.c. 6. 5/8″ gypsum board screwed to channels. 7. 3 ½″ thick sound attenuation blanket.	NA (51)
	1. Plywood web I-beams 12″ deep and 24″o.c. 2. 3/4″ plywood sub floor nailed with 6d nails 6″o.c. at edges and 10″o.c. in field. 3. 1 ½″ thick lightweight concrete, 15 psf. 4. Resilient channels, 24″o.c. 5. 5/8″ gypsum board screwed 12″o.c.	57 (NA)

Sketch	Brief Description	STC (IIC)
	1. Plywood web I-beams 12″ deep and 24″o.c. 2. 3/4″ plywood sub floor nailed with 6d nails 6″o.c. at edges and 10″o.c. in field. 3. 1 1/2″ thick lightweight concrete, 15 psf. 4. a. 44 oz. carpet on 40 oz. hair pad. b. .07″ vinyl tile. 5. Resilient channels, 24.o.c. 6. 5/8″ gypsum board screwed 12″o.c. 7. 3″ thick sound attenuation blanket.	58 (a. 77) (b. 50)
	1. 2x10″ wooden joists, 16″o.c. 2. 5/8″ plywood glued to joists, nailed with 8d nails 12″o.c. 3. ¼″ particleboard glued to plywood. 4. ½″ fiberboard glued to particleboard. 5. a. 76 oz. carpet on 50 oz. hair pad. b. 1/2″ parquet wood flooring. 6. Resilient channels, 24″o.c. 7. ½″ type-X gypsum board screwed 12″o.c. 8. 3″ thick sound attenuation blanket.	51 (NA)
	1. 2x10″ wooden joists, 16″o.c. 2. 5/8″ plywood sub floor nailed with 8d nails 6″o.c. along edges, 10″o.c. in field. 3. 1 1/2″ thick lightweight concrete over 15 lb. asphalt felt. 4. a. 20 oz. carpet on 40 oz. hair pad. b. 1/16″ thick vinyl-asbestos tile. 5. Resilient channels, 24″o.c. 6. ½″ type-X gypsum board screwed 12″o.c.	56 (NA)
	1. 2x10″ wooden joists, 16″o.c. 2. 5/8″ plywood sub floor nailed with 8d nails 6″o.c. along edges, 10″o.c. in field. 3. 1 ½″ thick lightweight concrete over 15 lb. asphalt felt. 4. a. 20 oz. carpet on 40 oz. hair pad. b. 1/16″ thick vinyl-asbestos tile. 5. Resilient channels, 24″o.c. 6. 5/8″ type-X gypsum board screwed 12″o.c. 7. 3 ½″ thick sound attenuation blanket.	61 (NA)

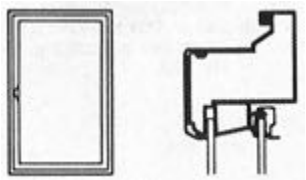
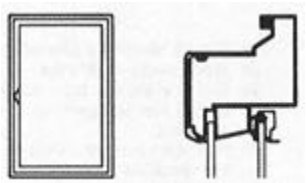
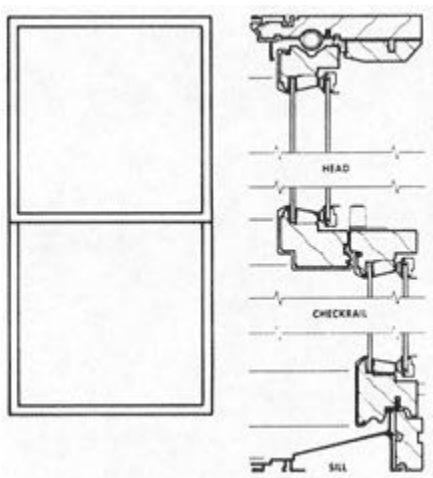
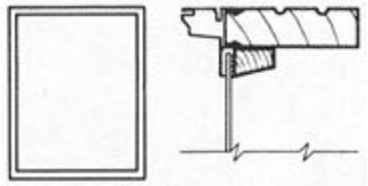
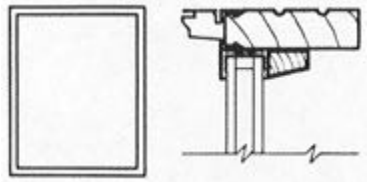
FLOORS: Concrete

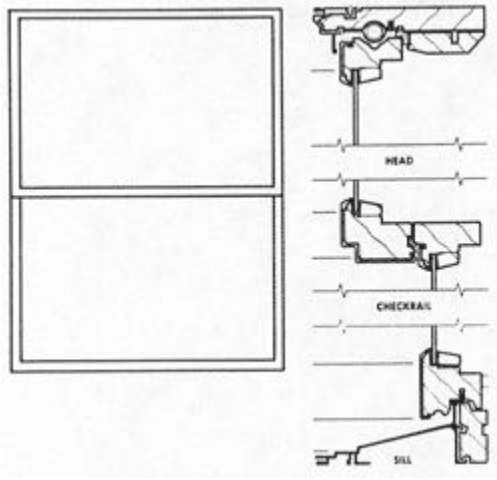
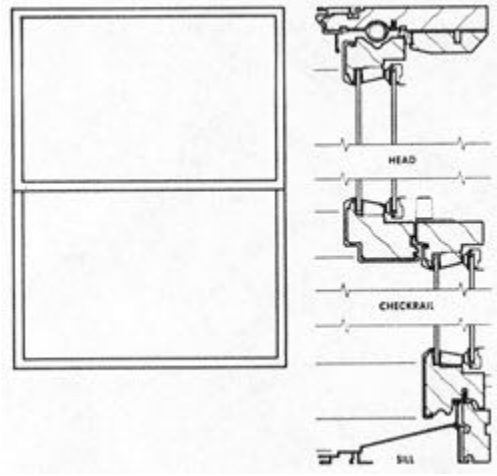
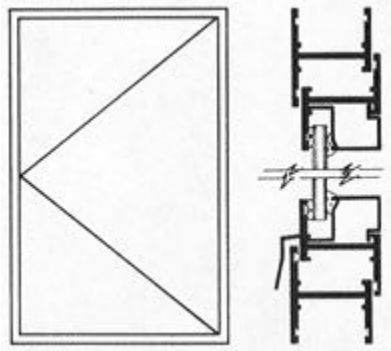
Sketch	Brief Description	STC (IIC)
	1. 4” thick concrete slab, 54 psf.	44 (25)
	1. 6” thick concrete slab, 75 psf.	55 (34)
	1. 6” thick concrete slab. 2. ½” wood-fiber board glued to concrete. 3. 44 oz. carpet on 40 oz. hair pad.	NA (81)
	1. 6” thick hollow-core concrete panel, 45 psf. 2. a. Carpet and pad. b. No floor covering.	48 (a. 69) (b. 23)
	1. 8” thick hollow-core concrete panel, 57 psf. 2. a. 66 oz. carpet on 50 oz. hair pad. b. No floor covering.	50 (a. 74) (b. 28)

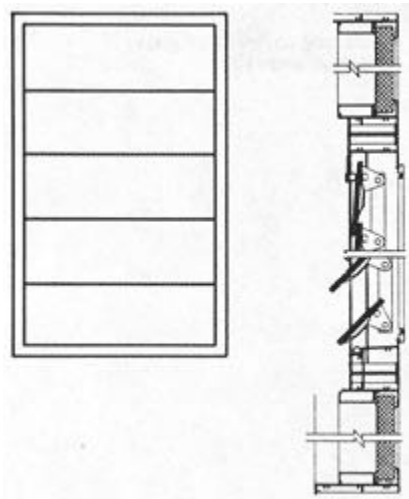
Sketch	Brief Description	STC (IIC)
	1. 8″ thick hollow-core concrete panels, 57 psf. 2. 1/4″ inorganic felt-supported underlayment board, .6 psf. 3. 3/32″ vinyl-asbestos tile.	50 (51)
	1. 3″ thick reinforced concrete slab, 35 psf, ceiling bare. 2. a. Vinyl asbestos, 0.08″ thick. b. Wood parquet 1/2″ thick. c. Soft vinyl tile with foam plastic backing. d. Carpet over soft padding, at least ¼″ thick.	45 (a. 42) (b.45) (c. 49) (d. 70)
	1. 3″ thick reinforced concrete slab, 35 psf. 2. a. Wood parquet ½″ thick. b. Soft vinyl tile with foam plastic backing. c. Carpet over soft padding, at least ¼″ thick. 3. Resilient furring channels on ½″ fiberglass blanket. 4. ½″ gypsum board.	56 (a.51) (b. 55) (c. 70)

Sketch	Brief Description	STC (IIC)
	1. 5″ thick reinforced concrete slab, 55 psf. ceiling bare. 2. a. Wood parquet ½″ thick. b. Soft vinyl tile with foam plastic backing. c. Carpet over soft padding, at least ¼″ thick.	51 (a. 46) (b. 50) (c. 70)
	1. 5″ thick reinforced concrete slab, 55 psf. 2. a. Wood parquet ½″ thick. b. Soft vinyl tile with foam plastic backing c. Carpet over soft padding, at least ¼″ thick. 3. Resilient furring channels on ½″ fiberglass blankets. 4. ½″ gypsum board.	56 (a. 51) (b. 55) (c. 75)

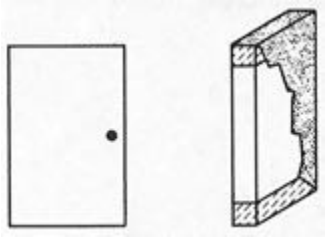
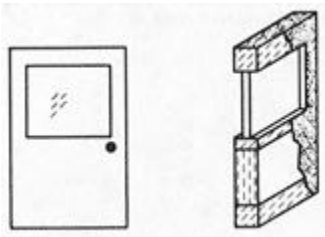
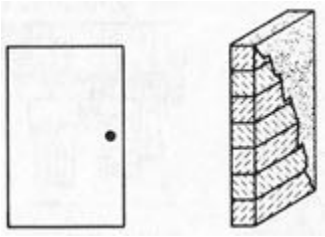
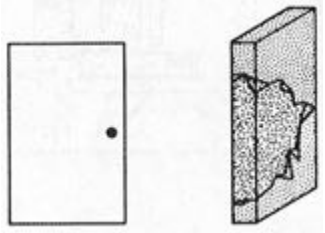
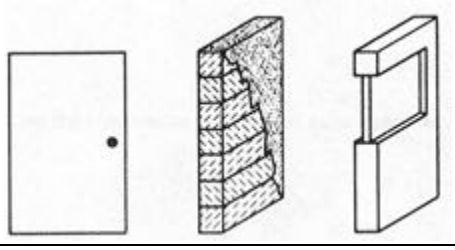
WINDOWS

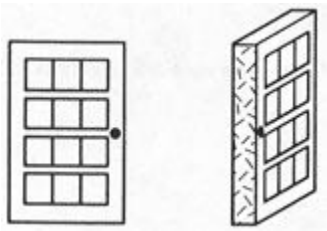
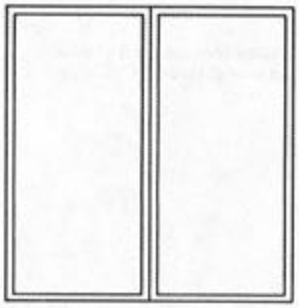
Sketch Front / Cross Section	Brief Description	STC
	30x48” aluminum clad casement, two 1/8” panels of glass, 13/16” apart in a wood frame.	29
	30x48” aluminum clad casement, one 3/32” panel and one 1/8” panel, 13/16” apart in a wood frame.	31
	32x24x24” aluminum double-hung windows (32” wide with 24” high upper sash and a 24” high lower sash), each sash has one 3/32” panel and one 1/8” panel, 13/16” apart in a wood frame.	29
	6x5' picture window glazed double strength, single panel.	29
	6x5' picture window plus storm sash, glazed double strength single panel, 3 ¾” separation between panels.	38

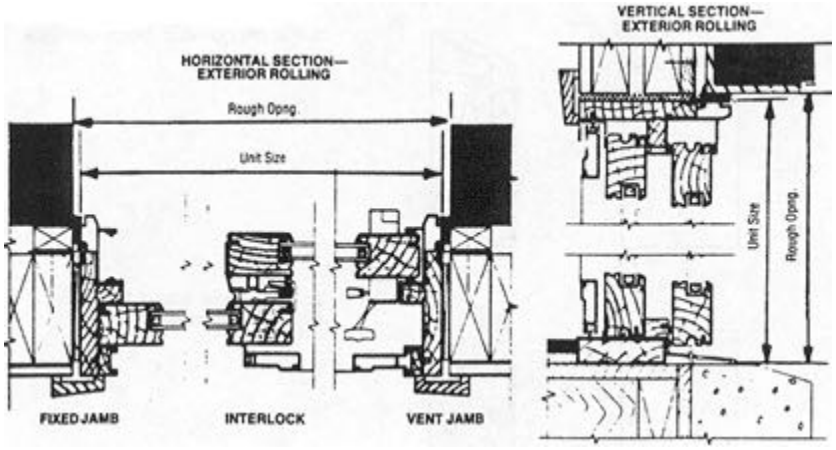
Sketch Front / Cross Section	Brief Description	STC
	3x5' double hung window, 7/16” glazed insulating glass, single panel.	26
	3x5' double hung window, 7/16” glazed insulating glass, single panel plus storm sash, glazed single strength, single sealed separation between panels: upper 1 ½”, lower 2 13/16”.	35
	3x4' awning window, glazed double strength, cranked shut.	24

Sketch Front / Cross Section	Brief Description	STC
	3x4' jalousie window, glazed ¼” glass, 4 ½” wide louvers with ½” in overlap, cranked tight shut.	20

DOORS: Exterior

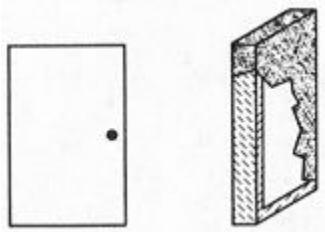
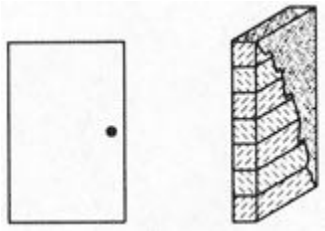
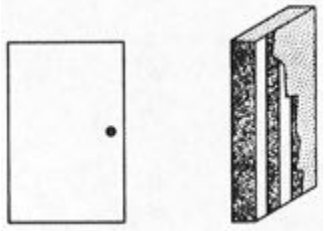
Sketch Front / Cross Section	Brief Description	STC
	3x7' hollow-core wood door, 1 ¾” thick.	20
	3x7' hollow-core door, 1 3/4” thick, 30% of area glazed with 1/8” glass.	19
	3x7' solid-core wood door, 1 ¾” thick.	27
	3x7' steel-faced door, 1 ¾” thick, rigid polyurethane core.	26
	3x7' solid-core wood door, 1 ¾” thick plus an aluminum storm door, glazed single strength.	34

Sketch Front / Cross Section	Brief Description	STC
	3x7' wood French door, 12 lights glazed single strength, mounted in frame, brass weather strip.	26
	6x6' sliding glass doors, ¾" insulating glass (2 pieces 1/8" tempered glass), one door opens, other is permanent in place.	28



*All exterior doors are sealed with a weathering strip around the frame. Interior doors do not have a weather strip and are not flush to the floor to permit the installation of a carpet.

DOORS: Interior

Sketch Front / Cross Section	Brief Description	STC
	3x7' solid-core wood door, 1 ¾" thick, weight 1.5 lb/ft .	17
	3x7' solid-core wood door, 1 ¾" thick, weight 4.0 lb/ft .	20
	3x7' hollow-core steel door, 1 ¾" thick, weight 5.0 lb/ft .	17

Appendix B References

Appendix B
General References

Books:

Acoustical and Thermal Performance of Exterior Residential Walls. Doors and Windows; NBS Building Science Series 77, U.S. Department of Commerce/National Bureau of Standards, 1975.

Acoustics Noise and Buildings; Parkin, Humphreys and Cowell; Faber and Faber; London; 1979.

Airborne Sound Transmission Loss, Characteristics of Wood Frame Construction; Fred F. Rudder, Jr.; USDA, Forest Service; General Technical Report FPL-43.

Handbook of Architectural Acoustics and Noise Control; Michael Retting; Tab Book; Blue Ridge Summit, Pa.; 1979.

Quieting: A Practical Guide to Noise Controls; U.S. Department of Commerce/National Bureau of Standards; NBS Handbook 119; 1976.

Institutions and Organizations:

Amerada Architectural Glass.
DeSco Windows.
Georgia-Pacific.
Industrial Acoustics Company.
National Concrete Masonry Association.
Office of Noise Control; California Department of Health Services.
Overly Manufacturing Company.
Paella Products.
Portland Cement Association.
U.S. Gypsum Company.

Testing Laboratories:

Cedar Knolls Acoustical Laboratories.
Geiger and Hamme.
Kaiser Gypsum.
Kodaras Acoustical.
National Institute of Standards and Technology.
National Research Council of Canada.
Riberbank Acoustical Laboratories.