APA

The Engineered Wood Association

DESIGN/CONSTRUCTION GUIDE

NOISE-RATED SYSTEMS

A P A

The Engineered Wood Association

DO THE RIGHT THING RIGHT™

Wood is good. It is the earth's natural, energy efficient and renewable building material.

Engineered wood is a better use of wood. It uses less wood to make more wood products.

That's why using APA trademarked I-joists, glued laminated timbers, laminated veneer lumber, plywood and oriented strand board is the right thing to do.

A few facts about wood.

- ***We're not running out of trees.*** One-third of the United States land base – 731 million acres – is covered by forests. About two-thirds of that 731 million acres is suitable for repeated planting and harvesting of timber. But only about half of the land suitable for growing timber is open to logging. Most of that harvestable acreage also is open to other uses, such as camping, hiking, hunting, etc.

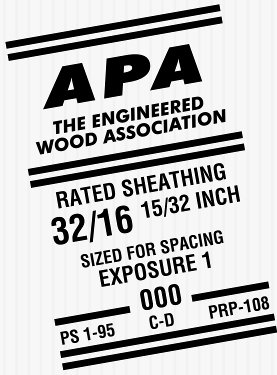
- ***We're growing more wood every day.*** American landowners plant more than two billion trees every year. In addition, millions of trees seed naturally. The forest products industry, which comprises about 15 percent of forestland ownership, is responsible for 41 percent of replanted forest acreage. That works out to more than one billion trees a year, or about three million trees planted every day. This high rate of replanting accounts for the fact that each year, 27 percent more timber is grown than is harvested.

- ***Manufacturing wood is energy efficient.*** Wood products made up 47 percent of all industrial raw materials manufactured in the United States, yet consumed only 4 percent of the energy needed to manufacture all industrial raw materials, according to a 1987 study.

Material	Percent of Production	Percent of Energy Use
Wood	47	4
Steel	23	48
Aluminum	2	8

- ***Good news for a healthy planet.*** For every ton of wood grown, a young forest produces 1.07 tons of oxygen and absorbs 1.47 tons of carbon dioxide.

Wood. It's the right product for the environment.



NOTICE:
The recommendations in this guide apply only to panels that bear the APA trademark. Only panels bearing the APA trademark are subject to the Association's quality auditing program.

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Whether in quiet suburbs or clamorous cities, apartment and office dwellers share a common interest: insistence on protection against noise from the neighbors, from traffic, from playgrounds and from scores of other sources. Proper insulation against intruding sound is therefore imperative in any high-quality multi-unit project.

This booklet from APA – The Engineered Wood Association is designed to help you avoid the costly mistake of poor acoustics, the result of which can be a high vacancy rate. It includes basic information on the types, measurement and control of noise, the results of acoustical tests on various plywood construction systems, and a report on field construction versus laboratory tests conducted by the Pacific Northwest Forest Range Experiment Station of the U.S. Forest Service.

For additional information on noise-resistant structural-use panel assemblies, or for assistance with specific design problems, contact the nearest APA regional field office listed on the back cover.

CONTENTS

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FACTS ON NOISE CONTROL

Noise originating outside an office or apartment is controlled largely by the location of the site, by the floor plan, and by landscaping. Background noise of this type is an important consideration because it helps mask intermittent intruding sounds. For example, an intruding noise which would be intolerable in a quiet suburb might go unnoticed in a busy city where traffic hum may mask noises from an adjoining room without the background noise itself seeming unpleasant. (Of course, a sudden, obtrusive noise, as distinguished from a general level of background noise, is disturbing in any context.)

Because of the reduced level of background noise, suburban garden office/apartment projects will usually require higher levels of sound insulation than those in a busier environment.

Noise between units and within a unit is controlled through construction methods and materials that interrupt sound transmission paths. Such noises are transmitted through airborne paths or by impact and structural vibrations.

Types of Noise

Airborne noises, such as traffic, voices, television, etc., penetrate through walls, doors and other structural elements. Open windows, cracks around doors, heating and ventilating ducts, and other imperfectly sealed openings may also "leak" airborne noise.

Structural vibrations are set up from the vibrations of mechanical apparatus such as heating fans and plumbing fixtures. Unless plumbing is properly isolated (as by acoustically designed hangers), annoying sounds can be transmitted throughout the entire structure.

Impact sounds are produced by falling objects, footfalls and mechanical impacts. Since the most annoying and critical impact sounds are transmitted through the floor, floor constructions are rated for impact noise reduction, as well as for sound transmission.

Building Design

The proper design and layout of the building can do much to eliminate noise problems. Consideration should be given to such points as location and orientation of the building, landscaping, segregation of "quiet" areas, and offsetting of entrance doors.

Good construction can minimize sound problems, but all details must be carefully watched. Sound leaks can be sealed with nonporous, permanently resilient materials, such as acoustical caulking materials and acoustically designed gaskets and weatherstripping. Piping penetrations can be wrapped or caulked. Airborne and impact noise can be controlled through properly designed and constructed wall and floor assemblies.*

*Many helpful planning and construction points on preventing acoustical problems are given in a publication by the National Association of Home Builders Research Foundation entitled "Acoustical Manual – Apartment and Home Construction." Another good reference is "Sound, Noise, and Vibration Control," by Lyle Yerges, 1969, Van Nostrand-Reinhold.

Noise Measurement

The ability of walls and floors to reduce noise is measured over the most important part of the hearing range (from 125 to 4,000 cycles per second) and the results reduced to a Sound Transmission Class, or STC number. Sound Transmission Class [STC] is determined in accordance with *ASTM E90* and *ASTM E413*. Field Sound Transmission Class [FSTC] is determined in accordance with *ASTM E336*.

The significance of STC numbers is illustrated in the following chart from the Acoustical and Insulation Materials Association. (In comparing rated constructions, remember that 3 db is the smallest difference that the human ear can clearly detect. Thus differences of 1 or 2 points may be considered negligible. Also note that even this general comparison is valid only with respect to a given level of background noise.)

In addition to being rated for airborne sound transmission, floors are also rated by IIC (Impact Insulation Class) or INR (Impact Noise Rating). Impact Insulation Class [IIC] is determined in accordance with *ASTM E492*.

IIC values rate the capacity of floor assemblies to control impact noise such as footfalls. The IIC rating is replacing the earlier INR system. It's easier to use and to compare with the STC system since most floors require about equal STC and IIC values. INR ratings can be approximately converted (±2 db) to IIC ratings by the (algebraic) addition of 51 db.

A few codes specify minimum acceptable ratings. Minimum values range from IIC and STC 45 to 50. However, limits are often a matter of judgment.

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STC RATINGS

25
Normal speech can be understood quite clearly.

30
Loud speech can be understood fairly well.

35
Loud speech audible but not intelligible.

42
Loud speech audible as a murmur.

45
Must strain to hear loud speech.

48
Some loud speech barely audible.

50
Loud speech not audible

The best way to reduce impact noise is to cover a floor with a resilient surfacing material such as carpet and padding. Where a hard surface finish flooring is used, a resiliently mounted ceiling system is effective, as is insulation board sandwiched between the subfloor and the underlayment.

Flanking Paths

Acoustical ratings do not reflect the effect of noise which bypasses, or "flanks" the specific construction. "Flanking" can increase noise transmission significantly. For example, a heating duct in a partition normally having an STC of 48 could reduce the STC for the combination to around 30, if it were not properly isolated.

Other significant flanking paths occur through back-to-back electrical and plumbing outlets, and joist spaces continuous over partitions. All flanking paths should be taken into account and eliminated if at all possible. Otherwise sound reduction by floor and wall construction may prove ineffective.

As illustrated by field tests (page16), actual construction can closely approximate the sound insulation values of test panels, if installed carefully under adequate supervision. Improper installation, on the other hand, can destroy the sound-insulating values of the best designs.

Advantages of Wood Structural Panels

Use of light-frame construction systems challenges designers to insulate against noise rather than simply relying on the massiveness of heavy walls and floors. Excellent levels of noise control can be achieved with good acoustical design in wood-frame structures surfaced with wood structural panels. Sound control can be achieved by applying floor and wall materials over isolated air spaces that absorb sound. The addition of resilient channels also greatly reduces sound transmission. Acoustically rated constructions of the type shown in this brochure are suggested since simple design procedures are not available.

Wood structural panels are excellent for this type of construction. Large panel size reduces the number of joints and cracks that can "leak" airborne noise. Wood structural panels are also an exceptionally good base for resilient coverings that cut impact noise. They are available, versatile and easy to adjust when necessary to compensate for building imperfections. A number of typical assemblies are shown in the following pages.

ACOUSTICAL LABORATORY TESTING

The construction assemblies shown in this section have been tested and rated for sound resistance according to standard test methods by recognized acoustical laboratories. **SOME ASSEMBLIES CONTAIN PROPRIETARY PRODUCTS, SO TEST SPONSORS SHOULD BE CONTACTED FOR ADDITIONAL CONSTRUCTION DETAILS.**

Note: While the listed assemblies were tested using plywood, it is believed that other wood structural panels (oriented strand board [OSB] and COM-PLY®) may be substituted on a thickness for thickness basis. Because of their substantially similar strength and stiffness properties and slightly higher density, use of these other wood structural panel products in lieu of plywood should not compromise the STC or IIC of the tested systems.

The sound transmission and impact ratings shown for these constructions are well within the range of acceptable ratings for multifamily residential and nonresidential buildings. They should apply to actual construction provided that recognized precautions are taken for preventing flanking noise and sound leaks, and provided the construction actually conforms to the assembly which has been tested.

However, quality of workmanship, material and conditions at the site may vary widely. Because APA – The Engineered Wood Association has no control over these elements, it cannot warrant or assume responsibility for performance to rated levels.

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In interpreting these tables, there are some modifications that can be made without changing sound-insulating properties.

1. Species and grade of wood structural panels and lumber can be changed.

2. Width of studs can be 3" or 4" nominal, and depths of joists can vary from 8" to 12" nominal.

3. OSB and COM-PLY may be substituted for plywood on a thickness for thickness basis. See Note.

4. 1/2", 19/32" and 5/8" thicknesses can be interchanged, either in wood structural panels or gypsum wallboard.

5. Glass fiber or mineral wool insulation can be substituted.

6. Resilient channels can be used on one or both sides of a wall.

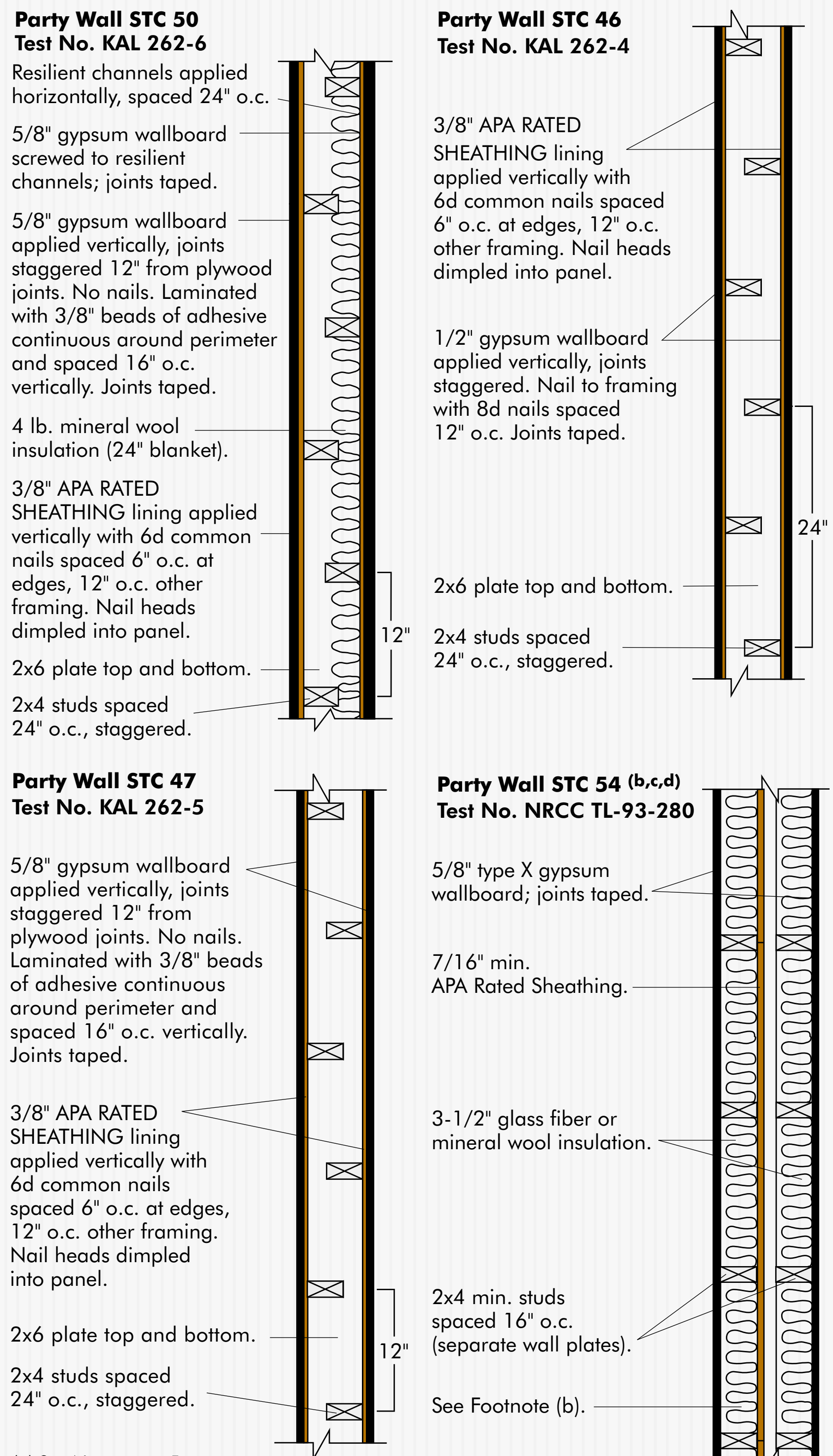
Major modifications in thickness, or cumulative changes can, of course, alter a rated system's sound insulation properties.

Acoustical ratings for wall constructions are shown in Figure 1. This section shows four constructions for party walls, two for bearing walls, and one for an exterior wall.

The floor/ceiling assemblies shown in Tables 1-6 on pages 8 through 15 are presented in tabular form to show sound transmission and impact ratings for various modifications of six basic constructions.

FIGURE 1

LABORATORY RATINGS FOR WALLS[a]



(a) See Note, page 5.

(b) STC 51 if insulation is omitted from sheathed side of assembly.

(c) One-hour fire-rated load-bearing wall per Underwriters Laboratories Inc. Design No. U341 and 1995 National Building Code of Canada [see Footnote (d)].

(d) Ref: 1995 National Building Code of Canada, Table A-9.10.3.1.A (Wall No. W13a and W13c).

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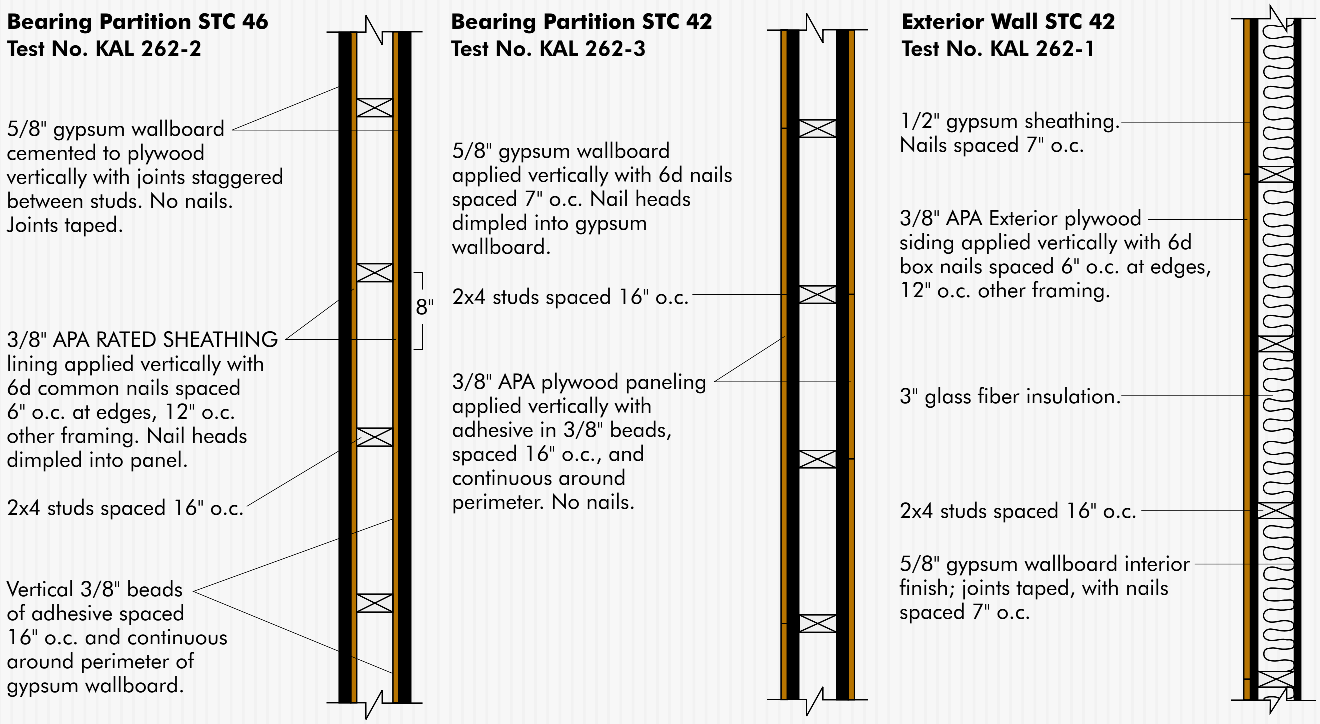
FIGURE 1 (CONTINUED)

LABORATORY RATINGS FOR WALLS[a]



(a) See Note, page 5.
(b) STC 51 if insulation is omitted from sheathed side of assembly.
(c) One-hour fire-rated load-bearing wall per Underwriters Laboratories Inc. Design No. U341 and 1995 National Building Code of Canada [see Footnote (d)].
(d) Ref: 1995 National Building Code of Canada, Table A-9.10.3.1.A (Wall No. W13a and W13c).

Minor modifications may be incorporated in acoustically-rated floor and wall assemblies to conform to requirements for a one-hour fire-resistance rating. (See Underwriters Laboratories Fire Resistance Directory.) Within certain limits, such modifications should have a minimum effect on the acoustical ratings shown. In any event, the governing code should be consulted with respect to fire resistance requirements.

Walls and partitions having wood structural panels nailed directly to the framing will develop excellent racking resistance, which is often important in apartment and office designs requiring shear walls.

TEST SPONSORS

APA	*APA – The Engineered Wood Association,* Tacoma, Washington
USDA	USDA Forest Service, Wood Construction Research, Seattle, Washington
ISU	Iowa State University, and USDA Forest Service, Division of Forest Economics and Marketing Research, Washington, D.C.
NBS	National Bureau of Standards, Washington, D.C. (Now National Institute of Standards and Technology – NIST)
USG	United States Gypsum Company, Chicago, Illinois
W	Weyerhaeuser Company, Dierks Division, Hot Springs, Arkansas
WWPA	Western Wood Products Association, Portland, Oregon
GC	Gyp-Crete Corporation* Hamel, Minnesota *(Now Maxxon Corp.)
NRCC	National Research Council of Canada, Ottawa, Ontario, Canada
CCA	Cellular Concrete Association (Inactive)

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TABLE 1

LABORATORY RATINGS FOR FLOORS
CONVENTIONAL WOOD JOIST FLOOR WITH RESILIENT FINISH FLOOR

Test number & sponsor	Finish floor	Deck[(a)]	Gypsum wallboard ceiling	Insulation	STC	IIC	Weight (lbs/sq ft)
Case 1 NBS-728A NBS	1/8" vinyl asbestos tile on 1/2" plywood underlayment	5/8" Rated Sheathing subfloor on 2x joists at 16" o.c.	1/2" nailed to joists	None	37	34	9.0
Case 2 NBS-728B NBS	1/4" foam rubber pad & 3/8" nylon carpet on 1/2" plywood underlayment	5/8" Rated Sheathing subfloor on 2x joists at 16" o.c.	1/2" nailed to joists	None	37	56	approx. 9.5
Case 3 KAL-224-1 & 2 APA	.075 vinyl sheet on 3/8" plywood underlayment	5/8" Rated Sheathing subfloor on 2x joists at 16" o.c.	5/8" screwed to resilient channels	3" glass fiber	46	46	8.9
Case 4 KAL-224-32 & 33 APA	1/16" vinyl sheet	19/32" T&G Sturd-I-Floor on 2x joists at 16" o.c.	5/8" screwed to resilient channels	3" glass fiber	48	45	7.8
Case 5 KAL-224-3 & 4 APA	44 oz. gropoint carpet and 40 oz. hair pad	19/32" T&G Sturd-I-Floor on 2x joists at 16" o.c.	5/8" screwed to resilient channels	3" glass fiber	48	69	8.6
Case 6 CK 6512-8 USG	44 oz. gropoint carpet and 40 oz. hair pad, on 25/32" oak	1/2" Rated Sheathing subfloor on 2x joists at 16" o.c.	1/2" screwed to resilient channels	3" mineral wool	50	71	9.5
Case 7 G&H-APA-1ST APA	Vinyl tile	19/32" T&G Sturd-I-Floor glued to 2x joists at 16" o.c.	5/8" screwed to resilient channels	1" mineral wool stapled to side of joists and bottom of subfloor	51	51	approx. 9.4
	Carpet & pad					74	10.2

(a) See Note, page 5.

CASE 5 – ILLUSTRATED

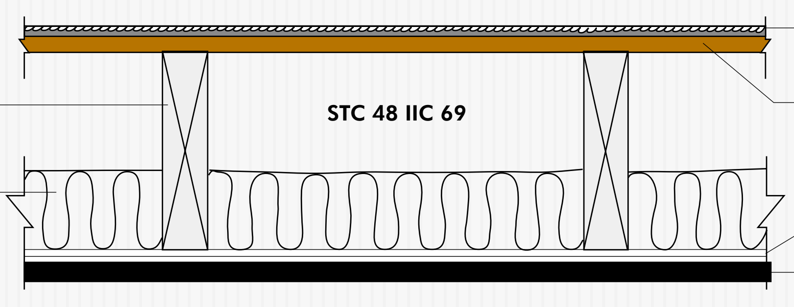

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TABLE 2

LABORATORY RATINGS FOR FLOORS
FLOORING ON SLEEPERS

Test number & sponsor	Finish floor	Deck(a)	Gypsum wallboard ceiling	Insulation	STC	IIC	Weight (lbs/sq ft)
Case 1 KAL-224-7 & 8 APA	44 oz. carpet and 40 oz. pad	19/32" T&G Sturd-I-Floor nailed to 2x3 sleepers which in turn were glued halfway between joists to 1/2" insulation board stapled to 1/2" Rated Sheathing subfloor on 2x joists at 16" o.c.	5/8" screwed to channels	3" glass fiber	52	78	11.7
Case 2 KAL-224-9 & 10 APA	25/32" wood-strip flooring nailed to wood sleepers	Sleepers glued, halfway between joists, to 1/2" insulation board stapled to 1/2" Rated Sheathing subfloor on 2x joists at 16" o.c.	5/8" screwed to channels	3" glass fiber	53	51	13.0
Case 3 KAL-736-8 & 9 ISU	25/32" wood-strip flooring nailed to wood sleepers	Sleepers glued to 3" wide strips of 1/2" sound board glued, halfway between joists, to 1/2" Rated Sheathing subfloor on 2x joists at 16" o.c.	5/8" screwed to channels	3" batts between joists; 1-1/2" blanket between sleepers	55	51	11.3
Case 4 R-TL 70-61 R-IN 70-9 W	Vinyl flooring glued to 1/2" plywood underlayment	Underlayment over 1x3 furring strips halfway between joists, on top of 1/2" sound board over 5/8" Rated Sheathing subfloor on 2x joists at 16" o.c.	5/8 screwed to channels	3" glass fiber	57	56	11.6
Case 5 R-TL 71-279 R-IN 71-19 WWPA	.070 vinyl	19/32" T&G Sturd-I-Floor stapled over 2x2 sleepers glued halfway between joists, to 1/2" Rated Sheathing subfloor glued to 2x joists at 16" o.c.	5/8" screwed to channels	3" glass fiber between joists; 1-1/2" sand between sleepers	59	56	20.2

(a) See Note, page 5.

CASE 4 – ILLUSTRATED

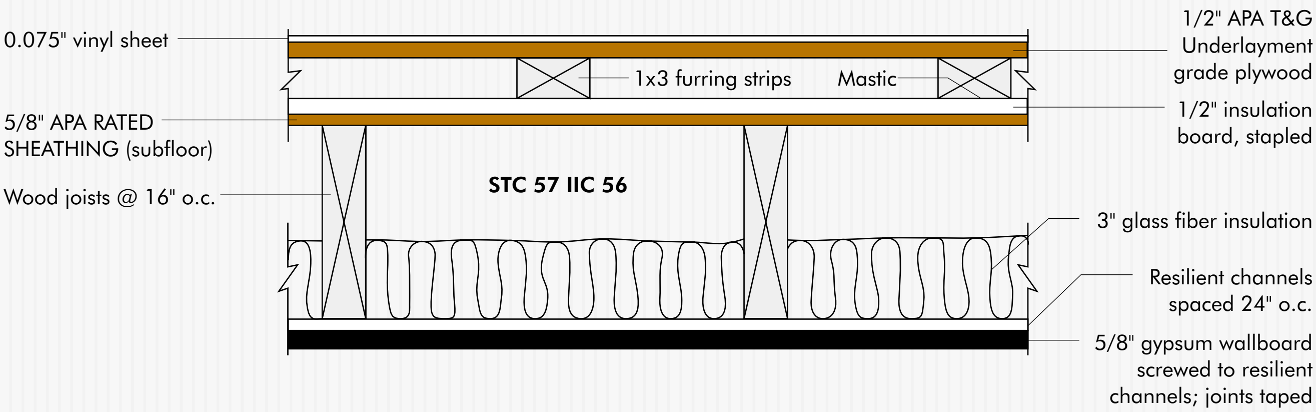

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TABLE 3

LABORATORY RATINGS FOR FLOORS
LIGHTWEIGHT AND GYPSUM CONCRETE OVER CONVENTIONAL WOOD JOIST FLOOR

Test number & sponsor	Finish floor	Deck[a]	Gypsum wallboard ceiling[b]	Insulation	STC[c]	IIC	Weight (lbs/sq ft)
Case 1 G&H-USDA-1ST	None	1-1/2" of 100-pcf cellular concrete over 5/8" Rated Sheathing subfloor on 2x joists at 16" o.c.	5/8" nailed to joists	None	48		21.0
USDA	Carpet and pad					68	
Case 2 G&H-USDA-3ST	None	1-1/2" of 100-pcf cellular concrete over 5/8" Rated Sheathing subfloor on 2x joists at 16" o.c.	5/8" screwed to resilient channels	None	55		20.0
USDA	Carpet and pad					67	
Case 3 G&H-USDA-2ST	None	1-1/2" of 100-pcf cellular concrete over 5/8" Rated Sheathing subfloor on 2x joists at 16" o.c.	5/8" screwed to resilient channels	3" glass fiber	58		20.5
USDA	Carpet and pad					67	
Case 4 G&H-USDA-5ST USDA	None	1-1/2" of 100-pcf cellular concrete over 5/8" Rated Sheathing subfloor on 2x joists at 16" o.c.	5/8" mineral-fiber acoustical tile on suspension system hung from resilient channels	3" glass fiber	59		22.2
Case 5 G&H-USDA-6ST USDA	None	1-1/2" of 100-pcf cellular concrete over 5/8" Rated Sheathing subfloor on 2x joists at 16" o.c.	5/8" mineral-fiber acoustical tile on suspension system hung from joists	3" glass fiber	58		22.1
Case 6 G&H-USDA-9ST	.075 vinyl sheet	1-1/2" of 100-pcf cellular concrete on 1/2" sound board over 5/8" Rated Sheathing subfloor on 2x joists at 16" o.c.	5/8" screwed to resilient channels	3" glass fiber	59	52	22.0
USDA	Carpet and pad					72	22.4
Case 7 KAL-224-29 & 30 APA	44 oz. carpet and 40 oz. pad	1-5/8" of 75-pcf perlite/sand concrete over 5/8" Rated Sheathing subfloor on 2x joists at 16" o.c.	5/8" nailed to joists	None	47	66	18.4
Case 8 KAL-224-31 & 34 APA	.075 vinyl sheet	1-5/8" of 75-pcf perlite/sand concrete over 5/8" Rated Sheathing subfloor on 2x joists at 16" o.c.	5/8" screwed to resilient channels	3" glass fiber	50	47	17.9
Case 9 KAL-224-27 & 28 APA	44 oz. carpet and 40 oz. pad	1-5/8" of 75-pcf perlite/sand concrete over 5/8" Rated Sheathing subfloor on 2x joists at 16" o.c.	5/8" screwed to resilient channels	3" glass fiber	53	74	18.5
Case 10 KAL-736-12 & 13 ISU	5/16" wood block set in mastic	1-5/8" of 60-pcf lightweight concrete on 1/2" insulation board over 1/2" Rated Sheathing subfloor on 2x joists at 16" o.c.	5/8" screwed to resilient channels	3" batt	54	53	18.8

(continued on page 11)

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TABLE 3 (Continued)

LABORATORY RATINGS FOR FLOORS
LIGHTWEIGHT AND GYPSUM CONCRETE OVER CONVENTIONAL WOOD JOIST FLOOR (continued)

Test number & sponsor	Finish floor	Deck[(a)]	Gypsum wallboard ceiling[(b)]	Insulation	STC[(c)]	IIC	Weight (lbs/sq ft)
Case 11 BBN 670602 & 670601 USG	None	5/8" gypsum concrete over 5/8" Rated Sheathing subfloor on 2x joists at 16" o.c.	1/2" screwed to resilient channels	3" mineral wool	56	54	14.5
Case 12 R-TL 81-16 R-IN 81-1 & -2	None	3/4" of 111-pcf gypsum concrete over 5/8" Rated Sheathing subfloor on 2x joists at 16" o.c.	1/2" Type X screwed to resilient channels	3-1/2" glass fiber	60		12.9
	0.10" cushioned vinyl					55	
GC	0.09" vinyl sheet					49	
Case 13 R-TL 81-17	None	3/4" of 111-pcf gypsum concrete over 5/8" Rated Sheathing subfloor on 2x joists at 16" o.c.	1/2" Type X screwed to resilient channels	None	58		12.7
R-IN 81-3 GC	0.10" cushioned vinyl					50	
Case 14 R-TL 81-19 R-IN 81-6	None	3/4"[(d)] of 111-pcf gypsum concrete over 5/8" Rated Sheathing subfloor on 2x joists at 16" o.c.	1/2" Type X screwed to joists	None	50		12.6
GC	Carpet and pad					56	
Case 15 IAL 5-761-	None	3/4" of 105-pcf gypsum concrete over 5/8" Rated Sheathing subfloor on 2x joists at 16" o.c.	5/8" screwed to resilient channels	2-1/2" glass fiber	60*		15.0
1 & 2 GC	72 oz. carpet and 46 oz. pad					79	
Case 16 IAL 5-761-	None	3/4" of 105-pcf gypsum concrete over 5/8" Rated Sheathing subfloor on 2x joists at 16" o.c.	5/8" screwed to resilient channels	None	55		15.0
3 & 4 GC	72 oz. carpet and 48 oz. pad					75	
Case 17 IAL 6-019-1 & 6-035	None	1" of 111.5-pcf gypsum concrete on 1/2" of 24.9-pcf sheathing over 5/8" Rated Sheathing subfloor on 2x joists at 16" o.c.	1/2" Type X screwed to joists	None	50		16.0
GC	60 oz. carpet and 24 oz. pad					75	

(continued on page 12)

CASE 9 – ILLUSTRATED

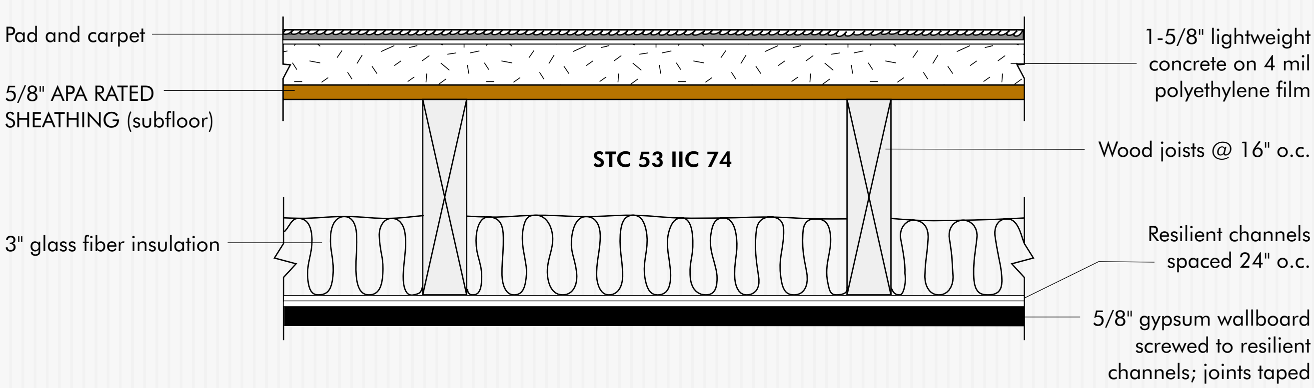

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TABLE 3 (Continued)

LABORATORY RATINGS FOR FLOORS
LIGHTWEIGHT AND GYPSUM CONCRETE OVER CONVENTIONAL WOOD JOIST FLOOR (continued)

Test number & sponsor	Finish floor	Deck[a]	Gypsum wallboard ceiling[b]	Insulation	STC[c]	IIC	Weight (lbs/sq ft)
Case 18 R-IN 81 -11, -12, -13 & -14	0.36" foam-back parquet	1-3/8" of 106-pcf gypsum concrete over 5/8" Rated Sheathing subfloor on 2x joists at 16" o.c.	1/2" Type X screwed to resilient channels	3-1/2" glass fiber		55	18.2
	0.31" regular parquet					51	
	1/8" VA tile					51	
	0.09" vinyl sheet					51	
Case 19 R-IN 81-8 & -10 GC	39 oz. glued carpet	1-3/8" of 106-pcf gypsum concrete over 5/8" Rated Sheathing subfloor on 2x joists at 16" o.c.	1/2" Type X screwed to joists	None		46	17.9
			1/2" Type X screwed to resilient channels			51	
Case 20 G&H CA-6MT CCA-7MT	.063" vinyl-asbestos tile	1-1/2" of 100-pcf cellular concrete over 5/8" Rated Sheathing subfloor on 2x10 joists at 16" o.c.	5/8" fire-rated nailed to joists	None	49	33	22.3
CCA	Carpet and pad				48	63	22.0
Case 21 G&H CCA-8MT CCA-9MT	.063" vinyl-asbestos tile	1-1/2" of 100-pcf cellular concrete over 5/8" Rated Sheathing subfloor on 2x10 joists at 16" o.c.	5/8" fire-rated screwed to resilient furring over 5/8" fire-rated nailed to joists	None	55	43	24.8
CCA	Carpet and pad				54	63	25.5
Case 22 G&H CCA-10MT CCA-11MT	.063" vinyl-asbestos tile	1-1/2" of 100-pcf cellular concrete over 5/8" Rated Sheathing subfloor on 2x10 joists at 16" o.c.	5/8" fire-rated screwed to resilient furring screwed to joists	None	58	37	22.4
CCA	Carpet and pad					73	23.1
Case 23 G&H CCA-12MT CCA-13MT	.063" vinyl-asbestos tile	1-1/2" of 100-pcf cellular concrete over 5/8" Rated Sheathing subfloor on 2x10 joists at 16" o.c.	5/8" fire-rated screwed to resilient furring screwed to joists	3-1/2" glass fiber	61	46	22.6
CCA	Carpet and pad					79	23.3
Case 24 G&H CCA-14MT CCA-15MT	.063" vinyl-asbestos tile	1-1/2" of 100-pcf cellular concrete over 5/8" Rated Sheathing subfloor on 2x10 joists at 16" o.c.	1/2" fire-rated screwed to resilient furring screwed to joists	3-1/2" glass fiber	60	47	22.0
CCA	Carpet and pad					73	22.7
Case 25 G&H CCA-16MT CCA-17MT	.063" vinyl-asbestos tile	1-1/2" of 100-pcf cellular concrete over 5/8" Rated Sheathing subfloor on 2x10 joists at 16" o.c.	1/2" fire-rated screwed to resilient furring screwed to joists	None	56	37	21.8
CCA	Carpet and pad					70	22.5

(a) See Note, page 5.
(b) Except Cases 4 and 5.
(c) Asterisk (*) indicates values are for Field Sound Transmission Class (FSTC).
(d) Manufacturer recommends 1" thickness.

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TABLE 4

LABORATORY RATINGS FOR FLOORS SEPARATE CEILING JOIST

Test number & sponsor	Finish floor	Deck[a]	Gypsum wallboard ceiling	Insulation	STC	IIC	Weight (lbs/sq ft)
Case 1 KAL-224-14 & 15 APA	44 oz. carpet and 40 oz. pad	1-1/8" T&G Sturd-I-Floor 48 oc on 2x joists at 16" o.c.	5/8" nailed to separate ceiling joists	3" glass fiber	51	80	10.7
Case 2 KAL-224-12 & 13 APA	25/32" hardwood strip	1/2" Rated Sheathing subfloor on 2x joists 16" o.c.	5/8" nailed to separate 2x joists	3" glass fiber	53	45	11.0
Case 3 R-TL 68-15 R-IN 68-1 & -2 ISU	25/32" hardwood strip "Standard carpet" on 25/32" hardwood strip	2x3 sleepers, glued to 3" wide strips of 1/2" sound board nailed above the floor joists to 1/2" Rated Sheathing subfloor on 2x joists 16" o.c.	5/8" nailed to separate ceiling joists	1-1/2" glass fiber between sleepers plus 3" glass fiber between floor joists	54	50 69	13.2 14.0

(a) See Note, page 5.

CASE 1 – ILLUSTRATED

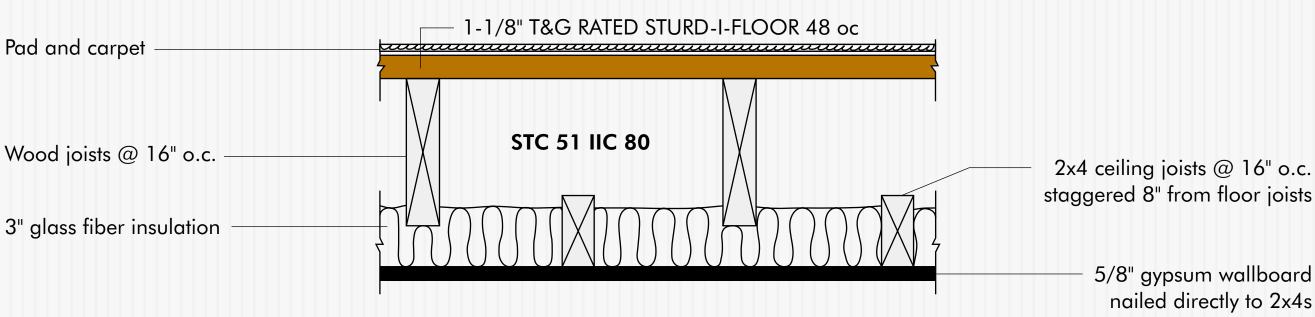

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TABLE 5

LABORATORY RATINGS FOR FLOORS
PANEL/INSULATION-BOARD SANDWICH

Test number & sponsor	Finish floor	Deck[a]	Gypsum wallboard ceiling	Insulation	STC	IIC	Weight (lbs/sq ft)
Case 1 NBS-719 NBS	3/32" vinyl sheet on 1/2" plywood underlayment	Underlayment nailed through 1/2" insulation board, to 5/8" Rated Sheathing subfloor on 2x joists at 16" o.c.	5/8" screwed to 1x2 furring strips on resilient clips	None	50	48	9.3
Case 2 NBS-718 NBS	3/32" vinyl sheet on 1/2" plywood underlayment	Underlayment glued to 1/2" insulation board, which is in turn stapled to 5/8" Rated Sheathing subfloor on 2x joists at 16" o.c.	5/8" screwed to 1x2 furring strips on resilient clips	None	52	49	9.6
Case 3 KAL-736-10 & 11 ISU	5/16" wood block flooring glued to 1/2" plywood underlayment	Underlayment glued to 1/2" sound board over 1/2" Rated Sheathing subfloor on 2x joists at 16" o.c.	5/8" screwed to resilient channels	3" batt	54	51	11.5
Case 4 R-TL 70-71 R-IN 70-10 W	Carpet and pad on 1/2" plywood underlayment	Underlayment over 1/2" sound board over 5/8" Rated Sheathing subfloor on 2x joists at 16" o.c.	5/8" screwed to resilient channels	3" glass fiber	55	72	10.7
Case 5 R-TL 70-72 R-IN 70-11 W	Vinyl flooring on 1/2" plywood underlayment	Underlayment over 1/2" sound board over 5/8" Rated Sheathing subfloor on 2x joists at 16" o.c.	5/8" screwed to resilient channels	3" glass fiber	58	55	10.8

(a) See Note, page 5.

CASE 2 – ILLUSTRATED

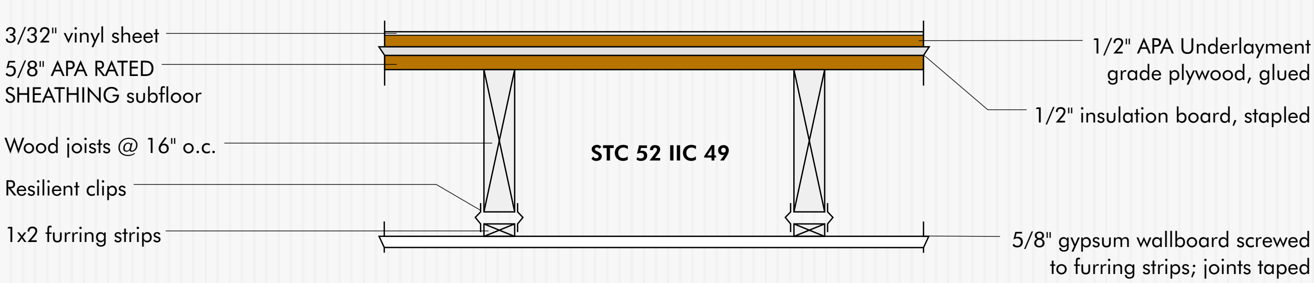

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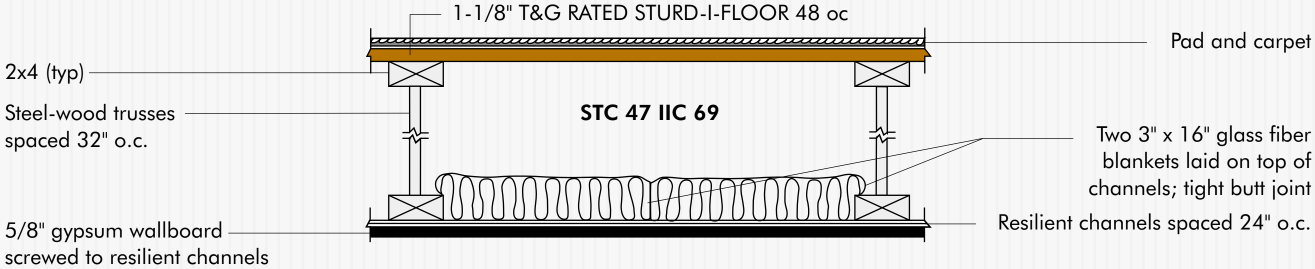
TABLE 6

LABORATORY RATINGS FOR FLOORS
LONG SPAN JOISTS

Test number & sponsor	Finish floor	Deck[a]	Gypsum wallboard ceiling	Insulation	STC[b]	IIC	Weight (lbs/sq ft)
Case 1 KAL-224 -37 & -38 APA	44 oz. carpet and 40 oz. pad	1-5/8" of 100-pcf cellular concrete over 5/8" Rated Sheathing subfloor on steel-wood trusses at 16" o.c.	5/8" nailed to joists	None	46	62	20.4
Case 2 KAL-224 -35 & -36 APA	44 oz. carpet and 40 oz. pad	1-1/8" T&G Sturd-I-Floor 48 oc on steel-wood trusses at 32" o.c.	5/8" screwed to resilient channels	3" glass fiber	47	69	10.5
Case 3 G&H USDA -11ST	Vinyl tile	1-1/2" of 100-pcf cellular concrete over 3/4" Rated Sheathing subfloor on plywood-webbed I-beams at 24" o.c.	5/8" screwed to resilient channels	3" glass fiber	58	50	21.0
G&H USDA -11xST	Carpet and pad					77	
USDA	None			None	57		20.7
Case 4 IAL 5-905-1	None	1" of 106-pcf gypsum concrete over 5/8" Rated Sheathing subfloor on steel-wood trusses at 19.2" o.c.	5/8" nailed to joists	None	51*		13.2
& -3 GC	0.174" of 29.6-pcf linoleum					52	
Case 5 IAL 5-905-2	None	3/4" of 106-pcf gypsum concrete over 5/8" Rated Sheathing subfloor on steel-wood trusses at 19.2" o.c.	5/8" screwed to resilient channels	None	62*		12.5
GC	0.174" of 29.6-pcf linoleum					61	
Case 6 IAL 6-442-2, -3 & -5 GC	None	3/4" of 106-pcf gypsum concrete over 3/4" T&G Rated Sheathing subfloor on open-web wood trusses 24" o.c.	5/8" Type X screwed to resilient channels	None	58*		14.8
	Linoleum					53	
	50 oz. carpet and 50 oz. pad					74	15.5

(a) See Note, page 5.
(b) Asterisk (*) indicates values are for Field Sound Transmission Class (FSTC).

CASE 2 – ILLUSTRATED



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FIELD TESTS

Field tests prove laboratory sound ratings can be achieved in practice. Table 7 on the following page shows results of field tests made by the U.S.D.A. Forest Service.* A number of tests performed in apartment buildings in the Seattle area have shown that in general, field STC values can indeed closely approach laboratory values if all personnel involved are careful in installation. The following are excerpts from a paper by J. B. Grantham and T. B. Heebink, entitled "Field/Laboratory STC Ratings of Wood-Framed Partitions," printed in "Sound and Vibration" for October, 1971.

"For the 16 field tests that could be compared with laboratory tests of comparable wall constructions, the average difference between predicted and actual performance was 3-1/2 points. With two cases of flanking and one of leaking corrected, the average difference was 2-1/2 points."

Values were even closer for floors. The paper goes on to state that "The average of the FSTC's** determined for 15 field-tested floor-ceiling assemblies was only one point lower than the average of the STC's based on laboratory tests of eight related assemblies.

"Comparisons…between impact sound insulation measured in the laboratory and in the field are more limited than those of airborne sound insulation, but indicate that laboratory and field impact noise ratings are of the same general magnitude."

These findings refute the common belief that actual field construction cannot approximate the behavior of the laboratory-tested samples. Actually, Mr. Grantham states in his paper, "The comparison of field-measured insulation of 21 walls and 15 floors with laboratory tests of similar wall and floor constructions reveals that the sound insulation predicted by laboratory tests can be closely approximated in the field unless serious oversights in construction contribute to sound leaks or flanking. It is, of course, still true that these ratings are not achieved without determined effort at every stage in the design and construction process."

The entries near the bottom of the table should be of particular interest for manufactured housing. They illustrate the actual field test values for sound insulation in a modular motel. Plywood sheathing was used in both floor-ceiling and wall construction, primarily because of its excellent resistance to racking during transportation and erection. In tests of comparative constructions, the wall with plywood sheathing produced acoustic isolation just slightly better than an otherwise identical construction using fiberboard sheathing.

*Wood Construction Research, Pacific Northwest Forest Range Experiment Station, Seattle, Washington

**Field Sound Transmission Class.

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TABLE 7

FIELD TESTS OF SOUND INSULATION COMPARED WITH LABORATORY TESTS(1)

	Laboratory tests			Field tests		
Details of basic construction	**STC**	**IIC**	**Test Ref.**	**FSTC**	**IIC**	**Field modifications or conditions**
Conventional wood joists. Subfloor, insulation, ceiling on resilient channels.	46	46	KAL224-1 & -2	46	44	1-1/8" T&G plywood subfloor
Tile flooring.				51	41	1/2" fiberboard over 3/4" plywood
Conventional wood joists; lightweight concrete topping over plywood subfloor. Ceiling nailed; no insulation. Carpet flooring.	47	66	KAL224-29 & -30	47		
				44		Possible perimeter leaks
	48	68	G&H-USDA-1ST	49	63	
			G&H-LCR-1MT	48	66	
				48	71	
Ceiling on resilient channels; no insulation. Carpet flooring.	55	67	G&H-USDA-3ST	52	74	
1-1/2" glass fiber. Carpet flooring.	58	67	G&H-USDA-2ST	56	75	Corrected a leak through fireplace
1/2" sound board under concrete; 3" insulation. Carpet flooring.	59	72	G&H-USDA-9ST	57	77	
1/2" sound board under ceiling channels; 3" insulation.	56		G&H-USDA-4ST	57	78	Carpet flooring
Long-span joists. Particleboard on 3/4" plywood; no insulation; ceiling nailed. Carpet flooring.	48	62	R-TL 70-48 R-IN 70-7	45	70	
Stressed-skin panels. Lightweight concrete over factory-glued panels;(2) ceiling on resilient channels.				56		
Floor-ceiling assembly, as achieved by stacking modular units. Plywood floor on upper unit. No "roof," but 3" insulation and nailed gypsum wallboard ceiling on lower unit.	53	45	KAL-224-12 & -13(3)	49	42	No finish floor. 3/8" plywood on 1/2" sound board "roof" on top of joists of lower unit.
	51	80	KAL-224-14 & -15(4)			
Party wall. Achieved by assembling modular units with 1" space between. Each wall with 5/8" gypsum wallboard, 2x3 studs spaced 16" o.c., insulation, and 1/2" sound deadening board.	49			47		
Same, but with glued plywood instead of the sound deadening board.	50					

(1) Floors carpeted except as noted.

(2) Stressed-skin panels had 5/8" top skin, 2x8 stringers, 2x4 T-flanges on bottom, no bottom skin.

(3) Hardwood flooring (25/32") over 1/2" subfloor.

(4) Carpet and pad over 1-1/8" subfloor.

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Each construction panel shall be identified with the appropriate trademark of *APA – The Engineered Wood Association* and shall meet the requirements of APA performance standards or Voluntary Product Standard PS 1-95, *Construction and Industrial Plywood* or Voluntary Product Standard PS 2-92, *Performance Standard for Wood-Based Structural-Use Panels*. All panels with edge or surface permanently exposed to the weather shall be Exterior type, except panels identified as Exposure 1 may be used for roof sheathing where they are exposed on the underside, such as eaves.

Panel thickness, grade, and Group number or Span Rating shall be equal to or better than that shown on the drawings. Application shall be in accordance with the recommendations of *APA – The Engineered Wood Association*.

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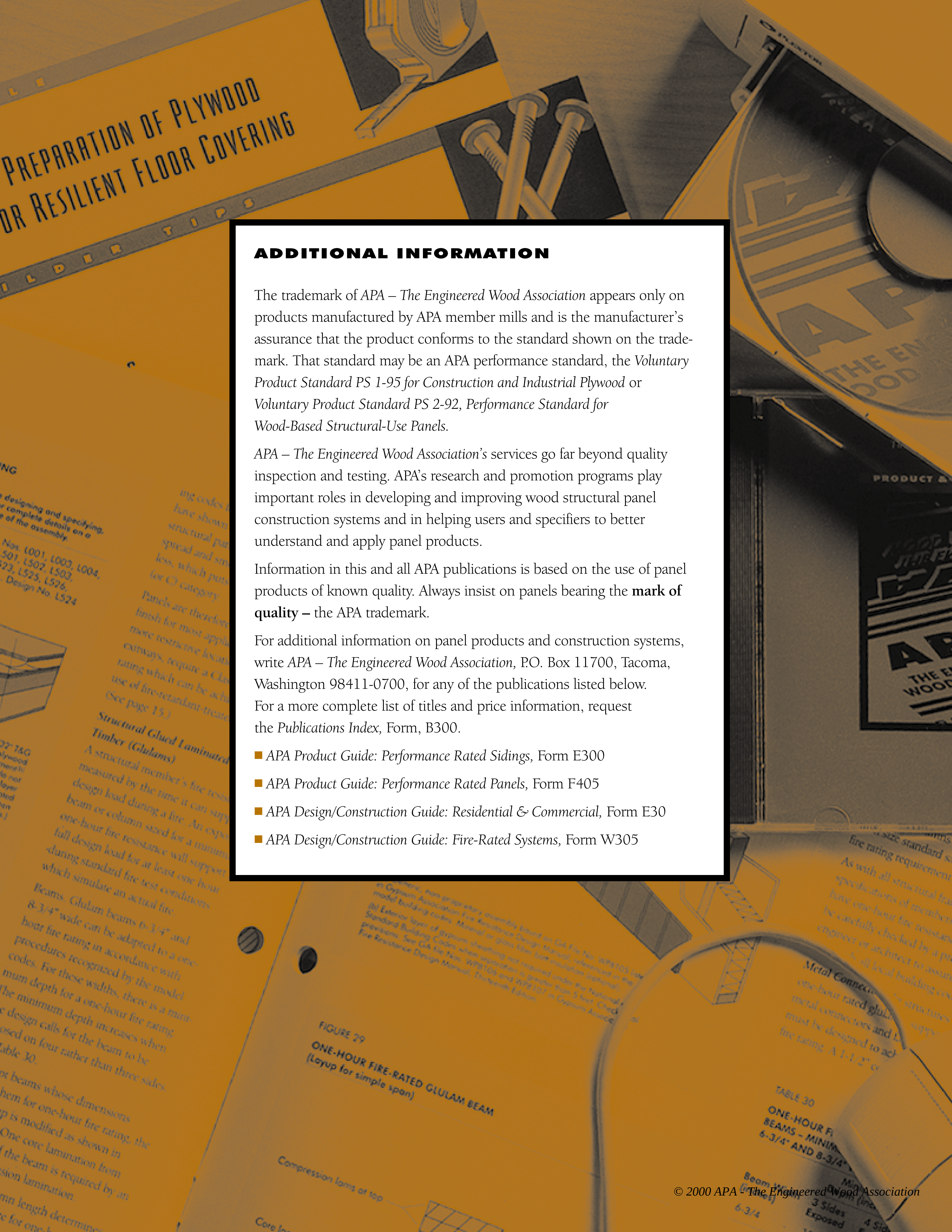

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- *APA Product Guide: Performance Rated Sidings,* Form E300
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- *APA Design/Construction Guide: Residential & Commercial,* Form E30
- *APA Design/Construction Guide: Fire-Rated Systems,* Form W305

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NOISE-RATED SYSTEMS

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Form No. W460N/Revised August 2000/0300

A P A

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