RESEARCH PROJECT ON THE NOISE ISOLATION

PROVIDED BY FLOOR/CEILING ASSEMBLIES

IN WOOD CONSTRUCTION
EXECUTIVE SUMMARY
RESEARCH PROJECT ON THE NOISE ISOLATION PROVIDED BY FLOOR/CEILING ASSEMBLIES IN WOOD CONSTRUCTION

EXECUTIVE SUMMARY

MJM ACOUSTICAL CONSULTANTS INC. has been selected by the Canada Mortgage & Housing Corporation to conduct the first phase of a research project on the sound isolation provided by floor/ceiling assemblies in wood constructions. This report contains the results of our findings. The main objective of this first phase was to investigate the acoustical performance of different materials to be incorporated from the underside of the floor/ceiling assemblies. These include the sound absorptive materials in the floor cavity along with ceiling finishes and installation methods. All the airborne and impact sound insulation tests have been conducted at the laboratories of the National Research Council of Canada under the direction of Dr. A.C.C. Warnock. The results of these tests are presented in table_no_1 appearing at the end of this summary; this table contains a schematic representation of the assemblies tested and their detailed composition, complete with their Sound Transmission Class (STC) and Impact Insulation Class (IIC) ratings.

In resumé, the conclusions reached during the first phase of the study are outlined in the paragraphs below.

- The spacing of the joists à 16 in. c.c. seems to generate a sub panel resonance in the plywood subfloor, at 160 Hz.
In many of the floor tested the STC rating was governed by the low transmission loss at this frequency.

- The four different types of resilient furrings tested provided an almost identical sound isolation performance.

- Resilient furrings are highly recommended in the construction of floor/ceiling assemblies separating dwellings. The use of wood furrings is not advisable since the mechanical coupling it provides between the floor and the ceiling greatly reduced the performance of the assemblies tested.

- Doubling the mass of a drywall ceiling installed on resilient furrings led to an improvement of roughly 5 dB in the STC rating and in the transmission loss at all frequencies. Doubling the mass of a drywall ceiling on wood furrings led to no improvement in the STC rating, and in the transmission loss at low frequencies for which the mechanical coupling was important; it also led to an improvement of 3 points in the IIC rating.

- Filling the joists cavity with different types of materials provides approximately the same performance in terms of STC. Benocoustics, the "acoustical" blown-in material manufactured by Benolec, did not provide a significantly better performance than a standard cellulose blown-in attic insulation. It is not recommended to pay a premium for this material.

- The insertion of a wood fiber board between the joists and resilient furrings is often encountered on site, this practice did not provide any improvements in terms of STC.
- The most efficient way of improving the performance of an existing floor/ceiling assembly, is to build an additional ceiling under it. In the present study, a ceiling consisting in 1/2 in. drywall, fastened to 2 1/2 in. standard metal studs, with batt insulation between the studs, provided the best results: an improvement of 15 STC points.

- The independently joisted floor/ceiling measured in this study tested STC 40, whereas the more conventional floor/ceiling assembly built with resilient furrings tested around STC 45. The use of independantly joisted ceilings is not recommended.

- Many of the assemblies tested with compositions which conform to that specified in table 9.10.3.B of the NBC, 1985 edition, (floors no 7A to 7F of this study) did not comply with the STC 45 minimum requirement referred to in section 9.11 of the code.

A second phase to complete this research project will be undertaken shortly to answer some of the questions raised during the first phase and to investigate the benefit to be gained by installing different materials from the top of the assembly.
<table>
<thead>
<tr>
<th>TEST No.</th>
<th>SCHEMATIC REPRESENTATION</th>
<th>COMPOSITION</th>
<th>STC</th>
<th>IIC</th>
<th>RATING</th>
<th>RATING</th>
</tr>
</thead>
</table>
| 1       | ![Diagram](image1)       | BASIC FLOOR ASSEMBLY  
- 5/8 in. thick plywood  
- 2 in. x 10 in. joists @ 16 in. c.c.  
NOTE: This basic floor assembly remained the same throughout the study; changes have been made only on the materials composing the cavity sound absorption and the ceilings to obtain the assemblies described below. | 24 | 20 |        |        |
| 2       | ![Diagram](image2)       | - 5/8 in. thick plywood  
- 2 in. x 10 in. joists @ 16 in. c.c.  
- 1 in. x 2 in. wood furring strips @ 24 in. c.c.  
- 1/2 in. gypsum board screwed to the 1 in. x 2 in. wood furrings. | 38 | 37 |        |        |
| 3       | ![Diagram](image3)       | - 5/8 in. thick plywood  
- 2 in. x 10 in. joists @ 16 in. c.c.  
- Space between the joists filled with different blown-in insulation materials  
- 1 in. x 2 in. wood furring strips @ 24 in. c.c.  
- 1/2 in. gypsum board screwed to the 1 in. x 2 in. wood furrings. | 49 | 44 |        |        |
| 3A      | ![Diagram](image4)       | --------------  
- Cellulose blown-in attic insulation: WEATHERSHIELD by Thermo-Cell Insulation Ltd. | 48 | 45 |        |        |
| 3B      | ![Diagram](image5)       | --------------  
- Mineral blown-in attic insulation: RED TOP manufactured by CGC. | 44 | 41 |        |        |
| 4       | ![Diagram](image6)       | - 5/8 in. thick plywood  
- 2 in. x 10 in. joists @ 16 in. c.c.  
- 3 1/2 in. glass fiber batt insulation between floor joists.  
- 1 in. x 2 in. wood furring strips.  
- 1/2 in. gypsum board screwed to the 1 in. x 2 in. wood furrings. | 37 | 32 |        |        |
<p>| 4A      | <img src="image7" alt="Diagram" />       | - Wood furrings @ 24 in. c.c. | 44 | 41 |        |        |
| 4B      | <img src="image8" alt="Diagram" />       | - Wood furrings @ 16 in. c.c. | 37 | 32 |        |        |</p>
<table>
<thead>
<tr>
<th>TEST No.</th>
<th>SCHEMATIC REPRESENTATION</th>
<th>COMPOSITION</th>
<th>STC</th>
<th>IIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td><img src="image1" alt="Diagram" /></td>
<td>- 5/8 in. thick plywood&lt;br&gt;- 2 in. x 10 in. joists @ 16 in. c.c.&lt;br&gt;- 1 in. x 2 in. wood furring strips @ 24 in. c.c.&lt;br&gt;- 1/2 in. gypsum board screwed to the 1 in. x 2 in. wood furrings.&lt;br&gt;- 2 1/2 in. Standard metal studs (25 GA.) spaced 24 in. c.c. and screwed to the wood furrings.&lt;br&gt;- 2 1/2 in. thick pink glass fibre insulation between the studs&lt;br&gt;- 1/2 in. gypsum board screwed to the metal studs</td>
<td>53</td>
<td>45</td>
</tr>
<tr>
<td>6</td>
<td><img src="image2" alt="Diagram" /></td>
<td>- 5/8 in. thick plywood&lt;br&gt;- 2 in. x 10 in. joists @ 16 in. c.c.&lt;br&gt;- 1 in. x 2 in. wood furring strips @ 24 in. c.c.&lt;br&gt;- 1/2 in. gypsum board screwed to the 1 in. x 2 in. wood furrings.&lt;br&gt;- 2 in x 3 in. installed on the flat side at 24 in. c.c., and screwed to the wood furring strips.&lt;br&gt;- 1 1/2 in. thick glass fiber batt insulation between the wood blockings @ 24 in. c.c.&lt;br&gt;- 1/2 in. thick resilient metal channel screwed to the wood blockings.&lt;br&gt;- 1/2 in. gypsum board screwed to the resilient furrings.</td>
<td>46</td>
<td>42</td>
</tr>
<tr>
<td>7</td>
<td><img src="image3" alt="Diagram" /></td>
<td>- 5/8 in. thick plywood&lt;br&gt;- 2 in. x 10 in. joists @ 16 in. c.c.&lt;br&gt;- 3 1/2 in. glass fiber batt insulation between floor joists.&lt;br&gt;- different types of 1/2 in. thick resilient metal channel screwed to the joists @ different spacings.&lt;br&gt;- 1/2 in. gypsum board screwed to the resilient furrings.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7A</td>
<td><img src="image4" alt="Diagram" /></td>
<td>- Resilient furrings by PICHETTE METAL @ 24 in. c.c.</td>
<td>44</td>
<td>43</td>
</tr>
<tr>
<td>7B</td>
<td><img src="image5" alt="Diagram" /></td>
<td>- Resilient furrings by RL METAL @ 24 in. c.c.</td>
<td>44</td>
<td>43</td>
</tr>
<tr>
<td>7C</td>
<td><img src="image6" alt="Diagram" /></td>
<td>- Resilient furrings by TREBORD @ 24 in. c.c.</td>
<td>44</td>
<td>43</td>
</tr>
<tr>
<td>7D</td>
<td><img src="image7" alt="Diagram" /></td>
<td>- Resilient furrings RC-1 by CGC, @ 24 in. c.c.</td>
<td>45</td>
<td>44</td>
</tr>
<tr>
<td>7E</td>
<td><img src="image8" alt="Diagram" /></td>
<td>- Resilient furrings RC-1 by CGC, @ 16 in. c.c.</td>
<td>44</td>
<td>42</td>
</tr>
<tr>
<td>7F</td>
<td><img src="image9" alt="Diagram" /></td>
<td>- Resilient furrings RC-1 by CGC, @ 16 in. c.c., installed parallel to the joists.</td>
<td>45</td>
<td>42</td>
</tr>
<tr>
<td>TEST No.</td>
<td>SCHEMATIC REPRESENTATION</td>
<td>COMPOSITION</td>
<td>STC</td>
<td>IIC</td>
</tr>
<tr>
<td>---------</td>
<td>--------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-------</td>
<td>-----</td>
</tr>
</tbody>
</table>
| 8       | ![Image](image1.png)    | - 5/8 in. thick plywood  
- 2 in. x 10 in. joists @ 16 in. c.c.  
- 3 1/2 in. glass fiber batt insulation between floor joists.  
- 1 in. x 2 in. wood furring strips @ 16 in. c.c.  
- 2 x 1/2 in. gypsum boards screwed to the 1 in. x 2 in. wood furrings. | 37    | 35  |
| 9       | ![Image](image2.png)    | - 5/8 in. thick plywood  
- 2 in. x 10 in. joists @ 16 in. c.c.  
- 3 1/2 in. glass fiber batt insulation between floor joists.  
- Resilient furrings RC-1 by CGC, screwed to the joists @ 24 in. c.c.  
- 2 x 1/2 in. gypsum boards screwed to the resilient furrings. | 50    | 49  |
| 10      | ![Image](image3.png)    | - 5/8 in. thick plywood  
- 2 in. x 10 in. joists @ 16 in. c.c.  
- 3 1/2 in. glass fiber batt insulation between floor joists.  
- 1/2 in. wood fiber board screwed directly to the underside of the joists  
- Resilient furrings RC-1 by CGC, screwed to the joists @ 24 in. c.c.  
- 1/2 in. gypsum board screwed to the resilient furrings. | 45    | 42  |
| 11      | ![Image](image4.png)    | - 5/8 in. thick plywood  
- 2 in. x 10 in. joists @ 16 in. c.c.  
- Different types of sound absorptive materials to completely fill the cavity between the joists.  
- Resilient furrings RC-1 by CGC, screwed to the joists @ 24 in. c.c.  
- 1/2 in. gypsum board screwed to the resilient furrings. |       |     |
<p>| 11A     | <img src="image5.png" alt="Image" />    | - 3 layers of 3 1/2 in. pink glass fiber batt insulation. | 51    | 46  |
| 11B     | <img src="image6.png" alt="Image" />    | - Cellulose blown-in attic insulation: WEATHERSHEILD by Thermo-Cell Insulation Ltd. | 49    | 47  |
| 11C     | <img src="image7.png" alt="Image" />    | - Acoustical blown-in insulation: BENOCoustics by Benolec. | 51    | 47  |</p>
<table>
<thead>
<tr>
<th>TEST No.</th>
<th>SCHEMATIC REPRESENTATION</th>
<th>COMPOSITION</th>
<th>STC</th>
<th>IIC</th>
<th>RATING</th>
<th>RATING</th>
</tr>
</thead>
</table>
| 12      | ![Schematic Diagram]     | - 5/8 in. thick plywood  
- 2 in. x 10 in. joists @ 16 in. c.c.  
- 3 1/2 in. glass fiber batt insulation between floor joists.  
- 2 in. x 6 in. ceiling joists supported by the common 2 in. x 10 in. plate at the perimeter of the test opening.  
- 1/2 in. gypsum board screwed directly to the ceiling joists. | 40 | 38 |
# Research Project on the Noise Isolation Provided by Floor/Ceiling Assemblies in Wood Construction

## Table of Contents

1.0 Introduction .................................................. p. 1
2.0 Objectives of the Study ..................................... p. 2
3.0 Analysis of the Results ..................................... p. 3 to 11
   3.1 Airborne Noise Isolation ................................
       .1 Sub-panels resonance related to joists spacing .... p. 3
       .2 Wood furrings VS resilient furrings ............... p. 4
       .3 Resilient furrings ....................................... p. 4
       .4 Doubling the mass of the drywall ..................... p. 5
       .5 Filling the joists cavity with absorption .......... p. 5 to 6
       .6 Blown-in sound absorptive material ................. p. 7
       .7 Doubling the drywall of filling the cavity ....... p. 7
       .8 Wood fiber board ......................................... p. 7 to 8
       .9 Improving existing situations ........................ p. 8
       .10 Independently joisted ceilings ....................... p. 9
       .11 National building code requirements ................ p. 10
   3.2 Impact Noise Isolation .................................... p. 11 to 14
       .1 Wood furrings VS resilient furrings ............... p. 12
       .2 Improvement by adding one layer ..................... p. 12
       .3 Filling the joist cavity with absorption ........... p. 12 to 13
       .4 Added ceilings .......................................... p. 13 to 14
       .5 Independantly joisted ceiling ........................ p. 14
4.0 Conclusions ................................................. p. 14 to 16

Annexes I, II, III
RESEARCH PROJECT ON THE NOISE ISOLATION PROVIDED BY FLOOR/CEILING ASSEMBLIES IN WOOD CONSTRUCTION

1.0 INTRODUCTION

MJM ACOUSTICAL CONSULTANTS INC. has been retained by the CANADA MORTAGE & HOUSING CORPORATION to conduct a research project on the noise isolation provided by floor/ceiling assemblies in wood structures. The project has been planned in two phases by the CMHC: the first phase is dedicated to researching the acoustical performance of different ceiling assemblies and sound absorptive materials in the joist cavity; the second phase will be dedicated to investigate the effect of different floor treatments, and to complete the aspects which were left unanswered in the first phase of the research project. This report outlines the results of the Sound Transmission Loss and Impact Insulation tests performed during Phase I. The tests were conducted at the acoustical laboratories of the NATIONAL RESEARCH COUNCIL OF CANADA under the supervision of Dr. A.C.C. Warnock, and under the direction of the undersigned.

The results of the measurements performed during the research project are summarized in the table no 1 appearing in the executive summary of this report. This table contains a graphic representation of the floors tested, complete with their description and the STC and IIC ratings measured. The numbering used in this table to designate the floor/ceiling assemblies will be used throughout the report to refer quickly to the assemblies being discussed.
2.0 OBJECTIVES OF THE STUDY

The study was planned and conducted to attain two objectives:

1) To provide builders and construction professionals with practical information on the acoustical performance of different materials and techniques.

2) To provide acousticians with reliable data which could allow them to deduct the insertion losses resulting from adding and deleting materials.

The builders and construction professionals should find most of the information which should be of interest to them in section 3.0 entitled ANALYSIS OF THE RESULTS and in ANNEX I which contains the graphs pertaining to this section.

Acousticians will refer to ANNEX II for the complete information pertaining to all the tests performed on the 21 assemblies tested. This portion of the report was prepared by Dr. A.C.C. Warnock of the NATIONAL RESEARCH COUNCIL OF CANADA.

3.0 ANALYSIS OF THE RESULTS

It is well documented that the main factors influencing the airborne sound isolation performance of a floor/ceiling assembly are:

- the mass and rigidity of the floor and ceiling membranes composing the assembly;
the amount of mechanical coupling between these membranes;
the depth of the floor cavity, and the presence of sound absorption in it.

The floor/ceiling assemblies tested in this study, were selected in an endeavour to isolate the noise isolation contribution of the different materials and methods of installation entering in the composition of the assemblies tested. Our findings are summarized in the paragraphs below. The graphs of ANNEX I illustrating our comments are referenced in the right margin.

3.1 AIRBORNE NOISE ISOLATION

.1 Sub-panel resonance related to joists spacings

We have noticed the presence of a dip, at 160 Hz, in the transmission loss of many floor/ceiling assemblies tested. This dip is believed to be caused by a sub-panel resonance developing in the plywood subfloor when it is supported by 2" X 10" joists at 16 in. c.c. In many instances, the STC rating of the floor/ceiling assemblies was governed by the 8 dB rule at this frequency; successful attempts at damping this resonance resulted in an increase of the STC of the floor.

- 3 -
.2 Wood furrings VS resilient furrings

Assemblies built with wood furrings (floor no 4A) and resilient furrings (floor no 7A to 7D) provided identical STC ratings when spaced at 24 in. c.c. with a spacing of 16 in. c.c. the STC rating of the assembly with wood furrings (floor 4B) is 7 dB below that of the assembly with resilient furrings (floor 7E). Since most drywall installers recommend a furring spacing of 16 in. c.c. to avoid any bowing of the drywall when it is installed on the ceiling, the use of resilient furrings is highly recommended in the composition of interdwelling floor/ceiling assemblies.

.3 Resilient furrings

Tests were conducted on four different resilient furrings (floors 7A to 7D) currently installed in the Montreal region. The results of these tests indicated that the resilient furrings tested can be considered equivalent. Changing the spacing of the furrings from 24 in. (floor 7D) to 16 in. (floor 7E) or installing them parallel to the joists does not significantly affect their acoustical performance.
Full scale drawings showing the configuration of the furrings tested are appended in Annexe III of this report.

.4 Doubling the mass of the drywall

If the ceiling of an assembly is installed on wood furrings (floor no 8), one cannot by doubling the drywall on the ceiling, improve the STC rating of this assembly nor its sound transmission loss at low frequency. However, the addition of a drywall layer on a ceiling installed on resilient furrings (floor no 9) results in an improvement of roughly 5 dB at all frequencies, and in an increase of the STC rating of 5 points. A difference of 13 STC points exists between a double drywall ceiling installed on resilient furrings at 24 in.c.c. and a double drywall ceiling installed on wood furrings at 16 in.c.c.

.5 Filling the joists cavity with absorption

With the wood furrings spaced at 24 in. (floors 3A & 3B), filling the joist cavity with cellulose or mineral attic insulation resulted in an improvement of approximately 10 STC points when compared to no absorption in the cavity.
(floor no 2), and 4 to 5 STC points when compared to placing glass fiber batt insulation 3 1/2 in. thick in the joist cavity (floor 4A). Based on the measurements performed on floors no 4A & 4B with the cavity partially filled with absorption, it is expected that with a spacing of 16 in. c.c. between the wood furrings, the improvement resulting from filling the joist cavity would be somehow reduced. However, this remains to be quantified in Phase II of the study.

Replacing the wood furrings at 24 in. c.c. (floor no 3A) by resilient furrings (floor 11B) on an assembly filled with cellulose insulation led to no improvement of STC. However, for frequencies above 160 Hz, the increase in the transmission loss was significant and could reach as much as 10 to 12 dB at mid frequencies.

Assemblies built with resilient furrings, having their cavity filled with either glass fiber batt insulation, or cellulose blown-in insulation (floors no 11A, 11B, 11C) showed similar STC rating; however, the cellulose blown-in insulation provided a better transmission losses at mid-frequencies, than the glass fiber batt insulation.

- 6 -
.6 Blown in sound absorptive material

The three blown in insulation materials tested were found equivalent; among the material tested was Benocoustic (floor 11C) which is sold as a patented acoustical product. In general its special" composition of cellulose fiber and solid aggregates did not provide any significant improvement over the standard blown in attic thermal insulation.

.7 Doubling the drywall or filling the cavity

On an assembly built with resilient furrings, doubling the drywall (floor no 9) appears to be equivalent to filling the cavity with sound absorptive materials (floors no 11A, 11B, 11C).

.8 Wood fiber board

The insertion of a fiber board between the joists and the resilient furrings is often encountered on site (floor no 10). When compared with an assembly build without wood fiber board (floor 7D for example), it was found that this practice resulted in:

- no improvement at low frequency
- a slight degradation at mid frequency
- a slight improvement at high frequencies
- no improvement in terms of STC rating

In conclusion, installing a ceiling composed of 2 layers of drywall screwed to the resilient furrings represents a more effective solution to improve the sound transmission loss of a floor/ceiling assembly.

9 Improving existing situations

The complaints with regards to existing situations concerns the transmission of both impact and airborne noise. The mitigating measures usually adopted is the injection of loose fill cellulose or mineral insulation in the floor cavity (floor 3A or 3B) or the construction of a new drywall ceiling (floor no 5 & 6). Both solutions were investigated.

As mentioned earlier, it was found that filling the cavity of the basic floor with cellulose or mineral loose fill insulation resulted in an improvement of 10 dB at merely all frequencies. However, since the effect of the spacing of the furrings or the absence of furrings on the improvement obtained is yet to be determined, one cannot expect
to obtain the above improvement in all conditions encountered on sites.

Two types of added ceilings were tested. The first consisted in a layer of 1/2 in. drywall fastened to 2 1/2" standard metal channel studs which are screwed to the underside of the basic floor assembly; batt insulation was inserted in the stud cavity (floor no 5). This added ceiling provided an improvement of 15 points over the STC rating of the basic floor assembly. It appears to be the most effective way to increase the sound isolation of floors during the transformation of older multidwelling buildings into condominiums.

Another technique of building an additional ceiling using wood blockings and resilient furrings was also investigated (floor no 6) but proved to be not as effective at low frequencies.

.10 Independently joisted ceilings

Among the surprises of this study is the very poor performance of the independently joisted drywall ceiling (floor no 12) compared to the more conventional drywall ceiling installed
on resilient furrings (floors no 7A to 7F). As a matter of fact, the independently joisted construction tested 4 to 5 STC points below the floors constructed with resilient furrings. Several tests have been performed by the NRC on the independantly joisted assembly to validate the measured sound transmission losses. These results were also compared to those of a study conducted in the laboratories of the Norwegian Building Research Institute; which objective was to compare the acoustical performance of a "Hoop and Batten" ceiling construction to that of an independently joisted ceiling (1). The results quoted in the above study were consistent with those which were obtained at the NRC laboratories.

We therefore conclude that the use of independantly joisted floor assemblies is not advisable between dwellings.

11 National building code requirements

Floor composition no 7 of the present report is indicated in table 9.10.3.B of the NBC 1985 edition as having a STC rating between 45 and 50. It is interesting to note that five tests out of seven performed on this type of
floor failed to meet the TC 45 minimum requirement contained in paragraph 9.11.21 of the National Building Code, 1985 edition.

3.2 **IMPACT NOISE ISOLATION**

Since the floor finishes are more likely to have a greater influence on the impact insulation performance of floor/ceiling assemblies, this aspect will be treated in more details during the second phase of this study. Our comments concerning the isolation of impact noise by means of adding sound absorption or modifying the ceiling composition and method of installation are outlined in the paragraphs below.

When referring to the graphs referenced in the right margin, one must bear in mind that the better performance is achieved by a floor when its impact sound pressure level in ordinate is low; i.e. the lower curves on the graphs are those of the assembly offering the best impact insulation performance.

The standard for measuring the Impact Sound Isolation provided by floor/ceiling assemblies (ASTM E 492) has been criticized by many acousticians because it is not possible to correlate the subjective evaluation of the impact insulation provided
by a floor, with the results of objective measurements made in accordance with this standard. These criticisms mainly originate from the fact that the impacts generated by the tapping machine bear no resemblance with that produced by a human being. Consequently, until a new standard is developed, care must be exercised when using IIC ratings to specify the amount of Impact Noise Isolation provided by a floor/ceiling assembly.

.1 Wood furrings VS resilient furrings

Resilient furrings provide superior impact noise isolation than wood furrings.

.2 Improvement by adding one layer of drywall to an existing ceiling

Adding a layer of drywall on the ceiling of an assembly built with wood furrings at 16 in. c.c. (floor no 8) led to an improvement of 3 IIC points. When the same layer is applied on a ceiling with resilient furrings (floor no 9) an improvement of 5 IIC points resulted.

.3 Filling the joist cavity with absorption

For assemblies built with wood (3A & 3B) and resilient furrings (floors 11A,
filling the joist cavity with sound absorption resulted in an improvement of only 3 to 4 IIC points when compared with placing 3 1/2 batt insulation in the cavity.

All sound absorptive material used provided overall performances which can be considered equivalent.

At low frequency, doubling the drywall of a ceiling mounted on resilient furrings provided a slightly better performance than filling the cavity with absorption. However the two assemblies can be considered equivalent.

4. Added ceilings

In terms of IIC, filling the joist cavity of an existing floor with blown-in insulation (floor no 3A) seems to provide the same degree of Impact Noise Isolation than adding a drywall ceiling screwed to 2.5 in. metal channel studs with the cavity etween the studs filled with batt insulation (floor no 5). However, as shown on graph 29, starting a 160 Hz, the performance of the added ceiling is clearly superior. As for the airborne transmission loss test, the added ceiling on wood blockings and
resilient furrings (floor no 6) provided a slightly inferior IIC performance than the ceiling on metal studs (floor no 5).

5 Independently joisted ceiling

The independently joisted ceiling (floor no 12) provided a impact insulation performance similar to that of the basic floor (floor no 2) built with wood furrings with no batt insulation in the cavity.

4.0 CONCLUSIONS

1. The spacing of the joists à 16 in. c.c. seems to generate a sub panel resonance in the plywood subfloor, at 160 Hz. In many of the floor tested the STC rating was governed by the low transmission loss at this frequency.

2. The four different types of resilient furrings tested provided an almost identical sound isolation performance.

3. Resilient furrings are highly recommended in the construction of floor/ceiling assemblies separating dwellings. The use of wood furrings is not advisable since the mechanical coupling it provides between the floor and the ceiling greatly reduced the performance of the assemblies tested.
Doubling the mass of a drywall ceiling installed on resilient furring led to an improvement of roughly 5 dB in the STC rating and in the transmission loss at all frequencies. Doubling the mass of a drywall ceiling on wood furring led to no improvement in the STC rating, and in the transmission loss at low frequencies for which the mechanical coupling was important; it also led to an improvement of 3 points in the IIC rating.

Filling the joists cavity with different types of materials provides approximately the same performance in terms of STC. Benocoustics, the "acoustical" blown-in material manufactured by Benolec, did not provide a significantly better performance than a standard cellulose blown-in attic insulation. It is not recommended to pay a premium for this material.

The insertion of a wood fiber board between the joists and resilient furring is often encountered on site, this practice did not provide any improvements in terms of STC.

The most efficient way of improving the performance of an existing floor/ceiling assembly, is to build an additional ceiling under it. In the present study, a ceiling consisting in 1/2 in. drywall, fastened to 2 1/2 in. standard metal studs, with batt insulation between the studs, provided the best results: an improvement of 15 STC points.
.8 The independently joisted floor/ceiling measured in this study tested STC 40, whereas the more conventional floor/ceiling assembly built with resilient furrings tested around STC 45. The use of independantly joisted ceilings is not recommended.

.9 Many of the assemblies tested with compositions which conform to that specified in table 9.10.3.B of the NBC, 1985 edition, (floors no 7A to 7F of this study) did not comply with the STC 45 minimum requirement referred to in section 9.11 of the code.

.10 The presence of sound absorption in the joist cavity along with the mass and the resilient installation of the ceiling favourably affect the Impact Sound Isolation provided by a floor/ceiling assembly. The combined effect of these parameters with those related to the installation of the floor finishes will be addressed in more details in Phase II of this study.

Respectfully submitted
February 15, 1989
Revised April 11, 1990
MJM ACOUSTICAL CONSULTANTS INC.

Michel Morin, architect
President
WOOD FURRINGS VS RESILIENT FURRINGS
AT SPACING OF 24 in. C.C.

TRANSMISSION LOSS, dB

FREQUENCY, HZ

□ TL MJM #4A
+ TL MJM #7D

Wood furrings
24 in. c.c.
STC 44

Resilient furrings
24 in. c.c.
STC 45

Graph no 1
WOOD FURRINGS VS RESILIENT FURRINGS

AT SPACING OF 16 in. C.C.

TRANSMISSION LOSS, dB

FREQUENCY, Hz

○ TL MJM #4B
    Wood furrings
    16 in. c.c.
    STC 37

+ TL MJM #7E
    Resilient furrings
    16 in. c.c.
    STC 44

Graph no 2
COMPARISON BETWEEN 4 RESILIENT FURRINGS
INSTALLATED AT 24 in. C.C.

TRANSMISSION LOSS, dB

31.5 63 125 250 500 1K 2K 4K 8K 16K

FREQUENCY, Hz

Pichette
Metal
STC 44

RL Metal
STC 44

Trebold
STC 44

CGC RC-1
STC 45

Graph no 3
RESILIENT FURRINGS – VARIOUS SPACINGS

24 in. - 16 in. - PARALL TO JOISTS

TRANSMISSION LOSS, dB

FREQUENCY, Hz

MJM #7D
Resilient furrings
24 in. c.c.
STC 45

MJM #7E
Resilient furrings
16 in. c.c.
STC 44

MJM #7F
Resilient furrings
parallel to
joists
STC 44

Graph no 4
COMPARISON BETWEEN 2 LAYERS VS 1 LAYER

DRYWALL CEILING ON WD FUR. Ø 16 in C.C.

FREQUENCY, Hz

TRANSMISSION LOSS, db

□ TL MJM #8
+ TL MJM # 4B

2 layers of drywall
STC 37

1 layer of drywall
STC 37

Graph no 5
CEILING WITH 2 LAYERS VS 1 LAYER
OF DRYWALL ON RESILIENT FURRINGS

TRANSMISSION LOSS, dB

FREQUENCY, Hz

□ TL MJM #9

+ TL MJM #7D

2 layers of drywall
STC 50

1 layer of drywall
STC 45

Graph no 6
2 LAYERS OF DRYWALL ON CEILING

RES. FUR. @ 24 in. VS WD. FUR. @ 16 in.

TRANSMISSION LOSS, dB

FREQUENCY, Hz

△ TL MJM #9

+ TL MJM #8

2 layers of drywall on resilient furrings
24 in. c.c.
STC 50

2 layers of drywall on wood furrings
16 in. c.c.
STC 37

Graph no 7
SOUND ABSORPTION IN CAVITY

NONE - GFB 3 1/2 IN. - CELL 10 IN.

TRANSMISSION LOSS, DB

FREQUENCY, Hz

31.5  63  125  250  500  1K  2K  4K  8K  16K

Graph no 8

- TL MJM #2
  No absorption in cavity; wood furrings 24 in.c.c. STC 38

- TL MJM #4A
  Pink glass fiber batt insulation; 3 1/2" thick Placed between joists; wood furrings 24 in.c.c. STC 44

- TL MJM #3A
  Cavity between joists filled with cellulose attic insulation; wood furrings 24 in.c.c. STC 49
EFFECT OF SPACING – WOOD FURRINGS

16 PO. C.C VS 24 PO C.C.

TRANSMISSION LOSS, dB

31.5  63   125  250  500  1K  2K  4K  8K  16K

FREQUENCY, Hz

□ TL MJM #4B  + TL MJM #4A

Wood furrings
16 in.c.c.  Wood furrings
STC 37    24 in.c.c.
STC 44

Graph no 9
Cavity Filled with Blown-in Insulation

Wood Furrings vs Resilient Furrings

Transmission Loss, dB

Frequency, Hz

(| TL MJM #3A |
| Wood furrings |
| 24 in. c.c. |
| STC 49 |

( + TL MJM #11B |
+ Resilient furrings |
| 24 in. c.c. |
| STC 49 |

Graph no 10
COMPARISON BETWEEN DIFFERENT TYPES OF
SOUND ABSORBITIVE MATERIALS IN CAVITY

TRANSMISSION LOSS, dB

FREQUENCY, Hz

31.5  63  125  250  500  1K  2K  4K  8K  16K

□ TL MJM #11A
3 layers
of 3 1/2"
glass fiber
batt insulation
STC 51

+ TL MJM #11B
cellulose
blown in
Attic insulation
STC 49

○ TL MJM #11C
Benocoustic
blown in
insulation
STC 51

Graph no 11
CAVITY FILLED WITH BLOWN IN MATERIAL

CELLULOSE VS MINERAL - WOOD FURRINGS

TRANSMISSION LOSS, dB

FREQUENCY, Hz

○ TL MJM #3A
+ TL MJM #3B

Cellulose blown in
Attic insulation;
Wood furrings
24 in. c.c.
STC 49

Mineral blown in
Attic insulation;
Wood furrings
24 in. c.c.
STC 48

Graph no. 12
DOUBLE DRYWALL CEILING VS CAVITY FILLED

CELLULOSE BLOWN-IN ATTIC INSULATION

TRANSMISSION LOSS, dB

31.5  63  125  250  500  1K  2K  4K  8K  16K

FREQUENCY, Hz

Double drywall ceiling on resilient furr.; 3 1/2" glass fiber insulation in cavity STC 50

Single drywall ceiling on resilient furr.; cavity filled with cellulose blown-in Attic insulation; STC 51

Graph no 13
DOUBLE DRYWALL CEILING VS CAVITY FILLED
WITH GLASS FIBER BATT INSULATION

TRANSMISSION LOSS, dB
31.5 63 125 250 500 1K 2K 4K 8K 16K

FREQUENCY, Hz

TL MJM #9
Double drywall ceiling on resilient furrings;
3 1/2" glass fiber batt insulation in cavity
STC 50

TL MJM #11A
Single drywall ceiling on resilient furrings;
cavity filled with 3 layers of 3 1/2"
in glass fiber batt insul.
STC 51

Graph no 14
EFFECT OF ADDING WOOD FIBER BOARD
BETWEEN JOISTS AND RESILIENT FURNINGS

TRANSMISSION LOSS, dB

FREQUENCY, Hz

With wood Fiber board STC 45

Without wood Fiber board STC 45

Graph no 15
COMPARISON BETWEEN 3 TYPES OF CEILINGS

COMPOSED OF DRYWALL ON RESIL. FURRINGS

TRANSMISSION LOSS, DB

FREQUENCY, Hz

31.5  63  125  250  500  1K 2K 4K 8K 16K

TL MJM #10

Fiber board between the joists and the resilient furrings; 1 layer of drywall attached to fur. STC 45

TL MJM #7D

1 layer of drywall screwed to resilient furrings screwed to joists STC 45

TL MJM #9

2 layers of drywall screwed to resilient furrings screwed to joists STC 50

Graph no 16
BLOWN-IN INSULATION VS ADDED CEILING

IMPROVEMENT TO EXISTING SITUATION

TRANSITION LOSS, dB

FREQUENCY, Hz

TL MJM #2

Basic floor assembly
STC 38

TL MJM #3A

Basic floor assembly with cavity filled with cellulose blown in attic insulation; STC 49

TL MJM #5

Added ceiling on 2.5 in. metal studs with batt insulation between studs; STC 53

Graph no 17
CORRECTIVE MEASURE ON EXISTING FLOOR

DRYWALL - GLASSFIBER - 2.5 in. STUDS

- FREQUENCY, Hz
- TRANSMISSION LOSS, dB

Graph no 18
CORRECTIVE MEASURE ON EXISTING FLOOR

DRYWALL - 2" x 3" - RES. FUR. - GFB INS

TRANSMISSION LOSS, dB

FREQUENCY, Hz

□ TL MJM #2

+ TL MJM #6

Before Corrective Measures
STC 38

After Corrective Measures
STC 46

Graph no 19
CORRECTIVE MEASURE ON EXISTING FLOOR

COMPARISON BETWEEN ADDED CEILING

FREQUENCY, Hz

TRANSMISSION LOSS, dB

Graph no 20
INDEPENDANTLY JOISTED DRYWALL CEILING

VS DRYWALL ON RESILIENT FURRINGS.

TRANSMISSION LOSS, dB

FREQUENCY, Hz

31.5  63  125  250  500  1K  2K  4K  8K  16K

- TL MJM #12

Indepedently joisted ceiling
STC 40

+ TL MJM #7E

Drywall ceiling on resilient furrings
STC 45

Graph no 21
IMPACT INSULATION - DOUBLE DRYWALL

ON WOOD FURRINGS @ 16 in. C.C.

IMPACT SOUND PRESSURE LEVEL, dB

31.5  63  125  250  500  1K  2K  4K  8K  16K

FREQUENCY, Hz

○ MJM #2
Basic floor assembly
IIC 37

+ MJM #49
1 layer of drywall batt insulation
IIC 32

○ MJM #8
2 layers of drywall batt insulation
IIC 35

Graph no 23
IMPACT INSULATION BY CEILINGS

2 LAYERS VS 1 LAYER OF DRYWALL

IMPACT SOUND PRESSURE LEVEL, dB

FREQUENCY, Hz

- MJM #2
Basic floor assembly with wood furrings 24 in. c.c. IIC 37

- MJM #7D
Adding glass fiber batt insulation and drywall on resilient furr. 24 in. c.c. IIC 44

- MJM #9
Adding glass fiber batt insulation and 2 layers of drywall on resilient furr. 24 in.c.c. IIC 49

Graph no 24
IMPACT INSULATION - SOUND ABSORPTION

PARTIAL VS COMPLETE FILL - WD. FURR.

IMPACT SOUND PRESSURE LEVEL, dB

FREQUENCY, Hz

□ MJM #2
Basic floor assembly
IIC 37

+ MJM #4A
Wood furrings
24 in. c.c.
3 1/2 in.
batt insula-
tion in
cavity
IIC 41

◊ MJM #5A
Wood furrings
24 in. c.c.
cavity filled
with cellulose
IIC 44

Graph no 25
IMPACT INSULATION - SOUND ABSORPTION

EFFECT OF ABSORP. W/ RES. FURRINGS

IMPACT SOUND PRESSURE LEVEL, dB

31.5  63  125  250  500  1K  2K  4K  8K  16K

30  40  50  60  70  80  90

FREQUENCY, Hz

Basic floor assembly  IIC 37

3 1/2 batt insulation in cavity  IIC 44

cavity filled with cellulose blown in attic insulation  IIC 47

Graph no 26
IMPACT INSULATION -- BLOWN-IN INSULATION

CAVITY FILLED W/ 3 DIFF. MATERIALS

IMPACT SOUND PRESSURE LEVEL, dB

FREQUENCY, Hz

24 in. c.c.
3 layers of batt insulation
IIC 46

Standard blown in cellulose
Attic insulation
IIC 47

Benocosmetics
IIC 47

Graph no 27
IMPACT INSULATION – EXISTING STRUCTURE

IMPROVEMENT BY MODIFICATIONS TO CEILING

IMPACT SOUND PRESSURE LEVEL, dB

FREQUENCY, Hz
31.5 63 125 250 500 1K 2K 4K 8K 16K

Basic floor assembly IIC 32
Blown in cellulose insulation IIC 44
Added drywall ceiling 2 1/2 steel studs IIC 45

Graph no 29
EXISTING STRUCTURES - IMPACT INSULATION

IMPROVEMENT WITH ADDED CEILINGS

IMPACT SOUND PRESSURE LEVEL, dB

20 30 40 50 60 70 80 90

31.5 63 125 250 500 1K 2K 4K 8K 16K

Basic floor assembly
IIC 37

Added ceiling with 2 1/2" metal studs
IIC 45

Added ceiling with wood blockings and resilient furrings
IIC 42

Graph no 30
IMPACT INSULATION BY CEILINGS

IND. JOISTED CEILING VS RES. FURRINGS

IMPACT SOUND PRESSURE LEVEL, dB

FREQUENCY, Hz

MJM #2
Basic Floor assembly
IIC 37

MJM #7D
Glass fiber batt insulation and
drywall on resilient furrings
IIC 44

MJM #12
Glass fiber batt insulation and
drywall on independent ceiling joists
IIC 38

Graph no 31
ANNEX II
CLIENT REPORT

for

MJM Acoustical Consultants Inc.
6555 Côte des Neiges, Suite 440
Montreal, P.Q. H3S 2A6

Airborne and Impact Sound Transmission Through a Wood Joist Floor With Different Ceiling Systems and Sound Absorbers

Author

A.C.C. Warnock

Approved

J.D. Quirt
Section Head

Approved

W.A. Dalgliesh
Head, Quality Assurance

Report No. CR-5738.1
Report Date: 10 February 1989
Contract No. CR-5738
Reference: Application for test dated 8 July 1988
Section: Acoustics

This report may not be reproduced in whole or in part without the written consent of both the client and the National Research Council Canada.
The sound transmission data presented in this report were collected as part of a measurement series to examine the effects of different methods of attaching drywall to the underside of a wood joist floor. The effects of different sound absorbing materials were also examined. The sound transmission and impact transmission data are presented in graphical and tabular form at the end of this report.

Measurement Facilities

In the IRC acoustical facility the floor test opening measures 2.4 × 2.4 m. The upper room has a volume of 120 m³ while the lower room has a volume of 65 m³. Each room contains 9 calibrated GenRad electret condenser microphones, four incoherently excited random noise sources and fixed and moving diffusing panels. For airborne and impact sound transmission the receiving room is the lower room.

Measurement Procedures

Measurements are controlled by a Data General Nova 4 computer interfaced to a GenRad 1921 real time analyzer. Five sound decays are averaged to get reverberation time at each of the nine microphone positions. These times are averaged to get reverberation times for the room.

Sound pressure levels are measured for 15 seconds at each microphone position and then averaged to get the mean value for the room.

Measurements and calculations of sound transmission were made in accordance with the requirements of ASTM E90.

Measurements of impact sound transmission were made in accordance with the requirements of ASTM E492 using the standard tapping machine and the prescribed four impact positions on the floor.

Basic Floor Description

A rectangular frame formed from 2 × 10 in. (38 × 235 mm) wood joists was bolted directly to the concrete of the upper part of test opening. 2 × 10 in. (38 × 235 mm) joists at 16 centres were attached to this frame using joist hangers and toe-nails. 5/8 in. (16 mm) tongued and grooved plywood was screwed on top of the joists with screws 16 in. (400 mm) on centres. All peripheral and other gaps were caulked to form an airtight seal. All other materials and systems were attached to this basic floor. The weight per unit area of the basic floor was 4.82 lb/ft² (23.5 kg/m²).

Materials

Four different types of sound absorbing materials were used. These were:

- Weathershield Cellulose Fibre Attic Insulation by Thermo-Cell Insulation Ltd.
- Red Top Mineral Fibre Insulation by Canadian Gypsum Corporation
- Benocoustic acoustical insulation by Benolec.
- R12 glass fibre insulation batts by Fiberglas Canada Ltd.

The densities used in each case are given in the individual reports in Appendix A.
Four types of resilient metal furring were used. These were manufactured by:

- Pichette metal
- RL Metal
- Trebord
- Canadian Gypsum Corporation

Summary of Results

For convenience Table 1 gives a short description of each floor tested, the IRC test identifiers and the STC and IIC ratings.

Appendix A repeats the description for each floor system tested, tabulates and plots the data for sound transmission loss and impact sound transmission. For each test, in the frequency ranges governed by the appropriate standard, the required confidence limits were satisfied. To avoid needless repetition, however, the measured confidence limits are not given in this report.
<table>
<thead>
<tr>
<th>Floor Number</th>
<th>Description</th>
<th>Test Number</th>
<th>STC</th>
<th>Test Number</th>
<th>IIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>- 5/8 in. thick plywood</td>
<td>491</td>
<td>24</td>
<td>38</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>- 2 in. x 10 in. joists @ 16 in. c.c.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>- 5/8 in. thick plywood</td>
<td>493</td>
<td>38</td>
<td>39</td>
<td>37</td>
</tr>
<tr>
<td></td>
<td>- 2 in. x 10 in. joists @ 16 in. c.c.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- 1 in. x 2 in. wood furring strips @ 24 in. c.c.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- 1/2 in. gypsum board screwed to the 1 in. x 2 in. wood furring</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3A</td>
<td>- 5/8 in. thick plywood</td>
<td>497</td>
<td>49</td>
<td>43</td>
<td>44</td>
</tr>
<tr>
<td></td>
<td>- 2 in. x 10 in. joists @ 16 in. c.c.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- cellulose blown-in attic insulation: WEATHERSHIELD by Thermo-Cell Insulation Ltd.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- 1 in. x 2 in. wood furring strips @ 24 in. c.c.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- 1/2 in. gypsum board screwed to the 1 in. x 2 in. wood furring</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3B</td>
<td>- 5/8 in. thick plywood</td>
<td>496</td>
<td>48</td>
<td>42</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>- 2 in. x 10 in. joists @ 16 in. c.c.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- mineral blown-in attic insulation: RED TOP manufactured by CGC</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- 1 in. x 2 in. wood furring strips @ 24 in. c.c.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- 1/2 in. gypsum board screwed to the 1 in. x 2 in. wood furring</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4A</td>
<td>- 5/8 in. thick plywood</td>
<td>495</td>
<td>44</td>
<td>41</td>
<td>41</td>
</tr>
<tr>
<td></td>
<td>- 2 in. x 10 in. joists @ 16 in. c.c.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- 3 1/2 in. glass fiber batt insulation between floor joists</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- 1 in. x 2 in. wood furring strips @ 24 in. c.c.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- 1/2 in. gypsum board screwed to the 1 in. x 2 in. wood furring</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4B</td>
<td>- 5/8 in. thick plywood</td>
<td>530</td>
<td>37</td>
<td>63</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>- 2 in. x 10 in. joists @ 16 in. c.c.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- 3 1/2 in. glass fiber batt insulation between floor joists</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- 1 in. x 2 in. wood furring strips @ 16 in. c.c.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- 1/2 in. gypsum board screwed to the 1 in. x 2 in. wood furring</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Floor Number</td>
<td>Description</td>
<td>Test Number</td>
<td>STC</td>
<td>Test Number</td>
<td>IIC</td>
</tr>
<tr>
<td>--------------</td>
<td>------------------------------------------------------------------------------</td>
<td>-------------</td>
<td>-----</td>
<td>-------------</td>
<td>-----</td>
</tr>
<tr>
<td>5</td>
<td>5/8 in. thick plywood</td>
<td>498</td>
<td>53</td>
<td>44</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>2 in. x 10 in. joists @ 16 in. c.c.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 in. x 2 in. wood furring strips @ 24 in. c.c.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1/2 in. gypsum board screwed to the 1 in. x 2 in. wood furring</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 1/2 in. standard metal studs (25 ga.) spaced 24 in. c.c. and screwed to the wood furring</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 1/2 in. thick glass fibre insulation between the studs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1/2 in. gypsum board screwed to the metal studs</td>
<td>499</td>
<td>46</td>
<td>45</td>
<td>42</td>
</tr>
<tr>
<td>6</td>
<td>5/8 in. thick plywood</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 in. x 10 in. joists @ 16 in. c.c.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 in. x 2 in. wood furring strips @ 24 in. c.c.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1/2 in. gypsum board screwed to the 1 in. x 2 in. wood furring</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 in. x 3 in. wood studs installed on the flat side and screwed to the wood furring strips</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 1/2 in. thick glass fiber batt insulation between the wood studs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1/2 in. deep resilient metal channel screwed to the wood studs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1/2 in. gypsum board screwed to the resilient furring</td>
<td>505</td>
<td>44</td>
<td>47</td>
<td>43</td>
</tr>
<tr>
<td>7A</td>
<td>5/8 in. thick plywood</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 in. x 10 in. joists @ 16 in. c.c.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3 1/2 in. glass fiber batt insulation between floor joists</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>PICHETTE METAL</strong> 1/2 in. deep resilient metal furring screwed to the joists @ 24 in. c.c.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1/2 in. gypsum board screwed to the resilient furring</td>
<td>506</td>
<td>44</td>
<td>48</td>
<td>43</td>
</tr>
<tr>
<td>7B</td>
<td>5/8 in. thick plywood</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 in. x 10 in. joists @ 16 in. c.c.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3 1/2 in. glass fiber batt insulation between floor joists</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>RL METAL</strong> 1/2 in. deep resilient metal furring screwed to the joists @ 24 in. c.c.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1/2 in. gypsum board screwed to the resilient furring</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7C</td>
<td>5/8 in. thick plywood</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 in. x 10 in. joists @ 16 in. c.c.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3 1/2 in. glass fiber batt insulation between floor joists</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>TREBORD</strong> 1/2 in. deep resilient metal furring screwed to the joists @ 24 in. c.c.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1/2 in. gypsum board screwed to the resilient furring</td>
<td>507</td>
<td>44</td>
<td>49</td>
<td>43</td>
</tr>
<tr>
<td>Floor Number</td>
<td>Description</td>
<td>Test Number</td>
<td>STC</td>
<td>Test Number</td>
<td>IIC</td>
</tr>
<tr>
<td>--------------</td>
<td>------------------------------------------------------------------------------</td>
<td>-------------</td>
<td>-----</td>
<td>-------------</td>
<td>-----</td>
</tr>
<tr>
<td>7D</td>
<td>- 5/8 in. thick plywood</td>
<td>514</td>
<td>45</td>
<td>51</td>
<td>44</td>
</tr>
<tr>
<td></td>
<td>- 2 in. x 10 in. joists @ 16 in. c.c.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- 3 1/2 in. glass fiber batt insulation between floor joists</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- CGC RC-1 1/2 in. deep resilient metal furring screwed to the joists @ 24 in. c.c.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- 1/2 in. gypsum board screwed to the resilient furring</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7E</td>
<td>- 5/8 in. thick plywood</td>
<td>529</td>
<td>44</td>
<td>62</td>
<td>42</td>
</tr>
<tr>
<td></td>
<td>- 2 in. x 10 in. joists @ 16 in. c.c.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- 3 1/2 in. glass fiber batt insulation between floor joists</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- CGC RC-1 1/2 in. deep resilient metal furring screwed to the joists @ 16 in. c.c.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- 1/2 in. gypsum board screwed to the resilient furring</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7F</td>
<td>- 5/8 in. thick plywood</td>
<td>565</td>
<td>45</td>
<td>69</td>
<td>42</td>
</tr>
<tr>
<td></td>
<td>- 2 in. x 10 in. joists @ 16 in. c.c.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- 3 1/2 in. glass fiber batt insulation between floor joists</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- CGC RC-1 1/2 in. deep resilient metal furring screwed parallel to the joists @ 16 in. c.c.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- 1/2 in. gypsum board screwed to the resilient furring</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>- 5/8 in. thick plywood</td>
<td>566</td>
<td>37</td>
<td>70</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>- 2 in. x 10 in. joists @ 16 in. c.c.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- 1 in. x 2 in. wood furring strips @ 24 in. c.c.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- 2 x 1/2 in. gypsum board screwed to the 1 in. x 2 in. wood furring</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>- 5/8 in. thick plywood</td>
<td>515</td>
<td>50</td>
<td>52</td>
<td>49</td>
</tr>
<tr>
<td></td>
<td>- 2 in. x 10 in. joists @ 16 in. c.c.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- 3 1/2 in. glass fiber batt insulation between floor joists</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- resilient furring RC-1 by CGC, screwed to the joists @ 24 in. c.c.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- 2 x 1/2 in. gypsum board screwed to the resilient furring</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Floor Number</td>
<td>Description</td>
<td>Test Number</td>
<td>STC</td>
<td>Test Number</td>
<td>IIC</td>
</tr>
<tr>
<td>--------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-------------</td>
<td>-----</td>
<td>-------------</td>
<td>-----</td>
</tr>
</tbody>
</table>
| 10           | - 5/8 in. thick plywood  
- 2 in. x 10 in. joists @ 16 in. c.c.  
- 3 1/2 in. glass fiber batt insulation between floor joists  
- 1/2 in. wood fiber board screwed directly to the underside of the joists  
- resilient furring RC-1 by CGC, screwed to the joists @ 24 in. c.c.  
- 1/2 in. gypsum board screwed to the resilient furring                                           | 527         | 45  | 60          | 42  |
| 11A          | - 5/8 in. thick plywood  
- 2 in. x 10 in. joists @ 16 in. c.c.  
- 3 layers of 3 1/2 in. glass fiber batt insulation  
- resilient furring RC-1 by CGC, screwed to the joists @ 24 in. c.c.  
- 1/2 in. gypsum board screwed to the resilient furring                                           | 563         | 51  | 67          | 46  |
| 11B          | - 5/8 in. thick plywood  
- 2 in. x 10 in. joists @ 16 in. c.c.  
- cellulose blown-in attic insulation: WEATHERSHIELD by Thermo-Cell Insulation Ltd.  
- resilient furring RC-1 by CGC, screwed to the joists @ 24 in. c.c.  
- 1/2 in. gypsum board screwed to the resilient furring                                           | 525         | 49  | 58          | 47  |
| 11C          | - 5/8 in. thick plywood  
- 2 in. x 10 in. joists @ 16 in. c.c.  
- acoustical blown-in insulation: BENOCOUSTICS by Benolec  
- resilient furring RC-1 by CGC, screwed to the joists @ 24 in. c.c.  
- 1/2 in. gypsum board screwed to the resilient furring                                           | 569         | 51  | 71          | 47  |
| 12           | - 5/8 in. thick plywood  
- 2 in. x 10 in. joists @ 16 in. c.c.  
- 3 1/2 in. glass fiber batt insulation between floor joists  
- 2 in. x 6 in. ceiling joists supported by the common 2 in. x 10 in. plate at the perimeter of the test opening  
- 1/2 in. gypsum board screwed directly to the ceiling joists                                           | 532         | 40  | 64          | 38  |
APPENDIX A

*Individual Sound Transmission Loss and Impact Sound Level Data*
Floor 1: TL-88-491

- 5/8 in. thick plywood
- 2 in. x 10 in. joists @ 16 in. c.c.
- Weight/Unit Area = 4.8 lbs/ft² (23.5 kg/m²)
Floor 1: II-88-38
- 5/8 in. thick plywood
- 2 in. x 10 in. joists @ 16 in. c.c.
- Weight/Unit Area = 4.8 lbs/ft² (23.5 kg/m²)
Floor 2: TL-88-493

- 5/8 in. thick plywood
- 2 in. x 10 in. joists @ 16 in. c.c.
- 1 in. x 2 in. wood furring strips @ 24 in. c.c.
- 1/2 in. gypsum board screwed to the 1 in. x 2 in. wood furring
- Weight/Unit Area = 6.7 lbs/ft² (32.5 kg/m²)
Floor 2: II-88-39

- 5/8 in. thick plywood
- 2 in. × 10 in. joists @ 16 in. c.c.
- 1 in. × 2 in. wood furring strips @ 24 in. c.c.
- 1/2 in. gypsum board screwed to the 1 in. × 2 in. wood furring
- Weight/Unit Area = 6.7 lbs/ft² (32.5 kg/m²)
Floor 3a: TL-88-497

- 5/8 in. thick plywood
- 2 in. x 10 in. joists @ 16 in. c.c.
- cellulose blown-in attic insulation: WEATHERSHIELD by Thermo-Cell Insulation Ltd. - 68.0 kg/m³ (4.2 lb/ft³)
- 1 in. x 2 in. wood furring strips @ 24 in. c.c.
- 1/2 in. gypsum board screwed to the 1 in. x 2 in. wood furring
- Weight/Unit Area = 9.9 lbs/ft² (48.0 kg/m²)
Floor 3a: II-88-43

- 5/8 in. thick plywood
- 2 in. x 10 in. joists @ 16 in. c.c.
- cellulose blown-in attic insulation: WEATHERSHIELD by Thermo-Cell Insulation Ltd. - 68.0 kg/m³ (4.2 lb/ft³)
- 1 in. x 2 in. wood furring strips @ 24 in. c.c.
- 1/2 in. gypsum board screwed to the 1 in. x 2 in. wood furring
- Weight/Unit Area = 9.9 lbs/ft² (48.0 kg/m²)
Floor 3b: TL-88-496

- 5/8 in. thick plywood
- 2 in. x 10 in. joists @ 16 in. c.c.
- mineral blown-in attic insulation: RED TOP manufactured by CGC - 70.0 kg/m³ (4.4 lb/ft³)
- 1 in. x 2 in. wood furring strips @ 24 in. c.c.
- 1/2 in. gypsum board screwed to the 1 in. x 2 in. wood furring
- Weight/Unit Area = 10.0 lbs/ft² (48.5 kg/m²)
**Floor 3b: II-88-42**

- 5/8 in. thick plywood
- 2 in. x 10 in. joists @ 16 in. c.c.
- mineral blown-in attic insulation: RED TOP manufactured by CGC- 70.0 kg/m³ (4.4 lb/ft³)
- 1 in. x 2 in. wood furring strips @ 24 in. c.c.
- 1/2 in. gypsum board screwed to the 1 in. x 2 in. wood furring
- Weight/Unit Area = 10.0 lbs/ft² (48.5 kg/m²)
Floor 4a: TL-88-495

- 5/8 in. thick plywood
- 2 in. × 10 in. joists @ 16 in. c.c.
- 3 1/2 in. glass fiber batt insulation between floor joists
- 1 in. × 2 in. wood furring strips @ 24 in. c.c.
- 1/2 in. gypsum board screwed to the 1 in. × 2 in. wood furring
- Weight/Unit Area = 7.0 lbs/ft² (34.0 kg/m²)
Floor 4a: II-88-41

- 5/8 in. thick plywood
- 2 in. x 10 in. joists @ 16 in. c.c.
- 3 1/2 in. glass fiber batt insulation between floor joists
- 1 in. x 2 in. wood furring strips @ 24 in. c.c.
- 1/2 in. gypsum board screwed to the 1 in. x 2 in. wood furring
- Weight/Unit Area = 7.0 lbs/ft² (34.0 kg/m²)
Floor 4b: TL-88-530

- 5/8 in. thick plywood
- 2 in. x 10 in. joists @ 16 in. c.c.
- 3 1/2 in. glass fiber batt insulation between floor joists
- 1 in. x 2 in. wood furring strips @ 16 in. c.c.
- 1/2 in. gypsum board screwed to the 1 in. x 2 in. wood furring
- Weight/Unit Area = 7.0 lbs/ft² (34.0 kg/m²)
Floor 4b: II-88-63

- 5/8 in. thick plywood
- 2 in. x 10 in. joists @ 16 in. c.c.
- 3 1/2 in. glass fiber batt insulation between floor joists
- 1 in. x 2 in. wood furring strips @ 16 in. c.c.
- 1/2 in. gypsum board screwed to the 1 in. x 2 in. wood furring
- Weight/Unit Area = 7.0 lbs/ft² (34.0 kg/m²)
Floor 5: TL-88-498

- 5/8 in. thick plywood
- 2 in. x 10 in. joists @ 16 in. c.c.
- 1 in. x 2 in. wood furring strips @ 24 in. c.c.
- 1/2 in. gypsum board screwed to the 1 in. x 2 in. wood furring
- 2 1/2 in. standard metal studs (25 ga.) spaced 24 in. c.c. and screwed to the wood furring
- 2 1/2 in. thick glass fibre insulation between the studs
- 1/2 in. gypsum board screwed to the metal studs
- Weight/Unit Area = 8.9 lbs/ft² (43.5 kg/m²)
Floor 5: II-88-44

- 5/8 in. thick plywood
- 2 in. x 10 in. joists @ 16 in. c.c.
- 1 in. x 2 in. wood furring strips @ 24 in. c.c.
- 1/2 in. gypsum board screwed to the 1 in. x 2 in. wood furring
- 2 1/2 in. standard metal studs (25 ga.) spaced 24 in. c.c. and screwed to the wood furring
- 2 1/2 in. thick glass fibre insulation between the studs
- 1/2 in. gypsum board screwed to the metal studs
- Weight/Unit Area = 8.9 lbs/ft² (43.5 kg/m²)
Floor 6: TL-88-499

- 5/8 in. thick plywood
- 2 in. x 10 in. joists @ 16 in. c.c.
- 1 in. x 2 in. wood furring strips @ 24 in. c.c.
- 1/2 in. gypsum board screwed to the 1 in. x 2 in. wood furring
- 2 in. x 3 in. wood studs installed on the flat side and screwed to the wood furring strips
- 1 1/2 in. thick glass fiber batt insulation between the wood studs
- 1/2 in. deep resilient metal channel screwed to the wood studs
- 1/2 in. gypsum board screwed to the resilient furring
- Weight/Unit Area = 9.1 lbs/ft² (44.5 kg/m²)
Floor 6: II-88-45

- 5/8 in. thick plywood
- 2 in. x 10 in. joists @ 16 in. c.c.
- 1 in. x 2 in. wood furring strips @ 24 in. c.c.
- 1/2 in. gypsum board screwed to the 1 in. x 2 in. wood furring
- 2 in. x 3 in. wood studs installed on the flat side and screwed to the wood furring strips
- 1 1/2 in. thick glass fiber batt insulation between the wood studs
- 1/2 in. deep resilient metal channel screwed to the wood studs
- 1/2 in. gypsum board screwed to the resilient furring
- Weight/Unit Area = 9.1 lbs/ft² (44.5 kg/m²)
Floor 7a: TL-88-505

- 5/8 in. thick plywood
- 2 in. x 10 in. joists @ 16 in. c.c.
- 3 1/2 in. glass fiber batt insulation between floor joists
- Pichette metal 1/2 in. deep resilient metal furring screwed to the joists @ 24 in. c.c.
- 1/2 in. gypsum board screwed to the resilient furring
- Weight/Unit Area = 7.0 lbs/ft² (34.0 kg/m²)
Floor 7a: II-88-47

- 5/8 in. thick plywood
- 2 in. x 10 in. joists @ 16 in. c.c.
- 3 1/2 in. glass fiber batt insulation between floor joists
- Pichette metal 1/2 in. deep resilient metal furring screwed to the joists @ 24 in. c.c.
- 1/2 in. gypsum board screwed to the resilient furring
- Weight/Unit Area = 7.0 lbs/ft² (34.0 kg/m²)
Floor 7b: TL-88-506

- 5/8 in. thick plywood
- 2 in. x 10 in. joists @ 16 in. c.c.
- 3 1/2 in. glass fiber batt insulation between floor joists
- RL metal 1/2 in. deep resilient metal furring screwed to the joists @ 24 in. c.c.
- 1/2 in. gypsum board screwed to the resilient furring
- Weight/Unit Area = 7.0 lbs/ft² (34.0 kg/m²)
Floor 7b: II-88-48

- 5/8 in. thick plywood
- 2 in. x 10 in. joists @ 16 in. c.c.
- 3 1/2 in. glass fiber batt insulation between floor joists
- RL metal 1/2 in. deep resilient metal furring screwed to the joists @ 24 in. c.c.
- 1/2 in. gypsum board screwed to the resilient furring
- Weight/Unit Area = 7.0 lbs/ft² (34.0 kg/m²)
Floor 7c: TL-88-507

- 5/8 in. thick plywood
- 2 in. x 10 in. joists @ 16 in. c.c.
- 3 1/2 in. glass fiber batt insulation between floor joists
- Trebord 1/2 in. deep resilient metal furring screwed to the joists @ 24 in. c.c.
- 1/2 in. gypsum board screwed to the resilient furring
- Weight/Unit Area = 7.0 lbs/ft² (34.0 kg/m²)
Floor 7c: II-88-49

- 5/8 in. thick plywood
- 2 in. x 10 in. joists @ 16 in. c.c.
- 3 1/2 in. glass fiber batt insulation between floor joists
- Trebord 1/2 in. deep resilient metal furring screwed to the joists @ 24 in. c.c.
- 1/2 in. gypsum board screwed to the resilient furring
- Weight/Unit Area = 7.0 lbs/ft² (34.0 kg/m²)
Floor 7d: TL-88-514

- 5/8 in. thick plywood
- 2 in. x 10 in. joists @ 16 in. c.c.
- 3 1/2 in. glass fiber batt insulation between floor joists
- CGC RC-1 1/2 in. deep resilient metal furring screwed to the joists @ 24 in. c.c.
- 1/2 in. gypsum board screwed to the resilient furring
- Weight/Unit Area = 7.0 lbs/ft² (34.0 kg/m²)
Floor 7d: II-88-51

- 5/8 in. thick plywood
- 2 in. x 10 in. joists @ 16 in. c.c.
- 3 1/2 in. glass fiber batt insulation between floor joists
- CGC RC-1 1/2 in. deep resilient metal furring screwed to the joists @ 24 in. c.c.
- 1/2 in. gypsum board screwed to the resilient furring
- Weight/Unit Area = 7.0 lbs/ft² (34.0 kg/m²)
**Floor 7e:** TL-88-529

- 5/8 in. thick plywood
- 2 in. x 10 in. joists @ 16 in. c.c.
- 3 1/2 in. glass fiber batt insulation between floor joists
- CGC RC-1 1/2 in. deep resilient metal furring screwed to the joists @ 16 in. c.c.
- 1/2 in. gypsum board screwed to the resilient furring
- Weight/Unit Area = 7.0 lbs/ft² (34.0 kg/m²)

<table>
<thead>
<tr>
<th>Frequency (Hz)</th>
<th>Transmission Loss (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>63</td>
<td>21</td>
</tr>
<tr>
<td>80</td>
<td>17</td>
</tr>
<tr>
<td>100</td>
<td>22</td>
</tr>
<tr>
<td>125</td>
<td>24</td>
</tr>
<tr>
<td>160</td>
<td>23</td>
</tr>
<tr>
<td>200</td>
<td>31</td>
</tr>
<tr>
<td>250</td>
<td>38</td>
</tr>
<tr>
<td>315</td>
<td>44</td>
</tr>
<tr>
<td>400</td>
<td>46</td>
</tr>
<tr>
<td>500</td>
<td>48</td>
</tr>
<tr>
<td>630</td>
<td>52</td>
</tr>
<tr>
<td>800</td>
<td>53</td>
</tr>
<tr>
<td>1000</td>
<td>57</td>
</tr>
<tr>
<td>1250</td>
<td>58</td>
</tr>
<tr>
<td>1600</td>
<td>59</td>
</tr>
<tr>
<td>2000</td>
<td>58</td>
</tr>
<tr>
<td>2500</td>
<td>56</td>
</tr>
<tr>
<td>3150</td>
<td>52</td>
</tr>
<tr>
<td>4000</td>
<td>55</td>
</tr>
<tr>
<td>5000</td>
<td>61</td>
</tr>
<tr>
<td>6300</td>
<td>65</td>
</tr>
</tbody>
</table>

**STC 44**
Floor 7e: II-88-62

- 5/8 in. thick plywood
- 2 in. x 10 in. joists @ 16 in. c.c.
- 3 1/2 in. glass fiber batt insulation between floor joists
- CGC RC-1 1/2 in. deep resilient metal furring screwed to the joists @ 16 in. c.c.
- 1/2 in. gypsum board screwed to the resilient furring
- Weight/Unit Area = 7.0 lbs/ft² (34.0 kg/m²)
Floor 7f: TL-88-565

- 5/8 in. thick plywood
- 2 in. x 10 in. joists @ 16 in. c.c.
- 3 1/2 in. glass fiber batt insulation between floor joists
- CGC RC-1 1/2 in. deep resilient metal furring screwed to the parallel to the joists @ 16 in. c.c.
- 1/2 in. gypsum board screwed to the resilient furring
- Weight/Unit Area = 7.0 lbs/ft² (34.0 kg/m²)
Floor 7f: II-88-69

- 5/8 in. thick plywood
- 2 in. x 10 in. joists @ 16 in. c.c.
- 3 1/2 in. glass fiber batt insulation between floor joists
- CGC RC-1 1/2 in. deep resilient metal furring screwed parallel to the to the joists @ 16 in. c.c.
- 1/2 in. gypsum board screwed to the resilient furring
- Weight/Unit Area = 7.0 lbs/ft² (34.0 kg/m²)
Floor 8: TL-88-566

- 5/8 in. thick plywood
- 2 in. x 10 in. joists @ 16 in. c.c.
- 1 in. x 2 in. wood furring strips @ 24 in. c.c.
- 2 x 1/2 in. gypsum board screwed to the 1 in. x 2 in. wood furring
- Weight/Unit Area = 8.8 lbs/ft² (43.0 kg/m²)
Floor 8: II-88-70

- 5/8 in. thick plywood
- 2 in. x 10 in. joists @ 16 in. c.c.
- 1 in. x 2 in. wood furring strips @ 24 in. c.c.
- 2 x 1/2 in. gypsum board screwed to the 1 in. x 2 in. wood furring
- Weight/Unit Area = 8.8 lbs/ft² (43.0 kg/m²)
Floor 9: TL-88-515

- 5/8 in. thick plywood
- 2 in. × 10 in. joists @ 16 in. c.c.
- 3 1/2 in. glass fiber batt insulation between floor joists
- resilient furring RC-1 by CGC, screwed to the joists @ 24 in. c.c.
- 2 x 1/2 in. gypsum board screwed to the resilient furring
- Weight/Unit Area = 8.7 lbs/ft² (42.6 kg/m²)
Floor 9: II-88-52

- 5/8 in. thick plywood
- 2 in. x 10 in. joists @ 16 in. c.c.
- 3 1/2 in. glass fiber batt insulation between floor joists
- resilient furring RC-1 by CGC, screwed to the joists @ 24 in. c.c.
- 2 x 1/2 in. gypsum board screwed to the resilient furring
- Weight/Unit Area = 8.7 lbs/ft² (42.6 kg/m²)
Floor 10: TL-88-527

- 5/8 in. thick plywood
- 2 in. x 10 in. joists @ 16 in. c.c.
- 3 1/2 in. glass fiber batt insulation between floor joists
- 1/2 in. wood fiber board screwed directly to the underside of the joists
- resilient furring RC-1 by CGC, screwed to the joists @ 24 in. c.c.
- 1/2 in. gypsum board screwed to the resilient furring
- Weight/Unit Area = 7.6 lbs/ft^2 (37.0 kg/m^2)

STC 45
Floor 10: II-88-60

- 5/8 in. thick plywood
- 2 in. x 10 in. joists @ 16 in. c.c.
- 3 1/2 in. glass fiber batt insulation between floor joists
- 1/2 in. wood fiber board screwed directly to the underside of the joists
- resilient furring RC-1 by CGC, screwed to the joists @ 24 in. c.c.
- 1/2 in. gypsum board screwed to the resilient furring
- Weight/Unit Area = 7.6 lbs/ft² (37.0 kg/m²)
Floor 11a: TL-88-563

- 5/8 in. thick plywood
- 2 in. x 10 in. joists @ 16 in. c.c.
- 3 layers of 3 1/2 in. glass fiber batt insulation
- resilient furring RC-1 by CGC, screwed to the joists @ 24 in. c.c.
- 1/2 in. gypsum board screwed to the resilient furring
- Weight/Unit Area = 7.4 lbs/ft² (36.1 kg/m²)
Floor 11a:  II-88-67

- 5/8 in. thick plywood
- 2 in. x 10 in. joists @ 16 in. c.c.
- 3 layers of 3 1/2 in. glass fiber batt insulation
- resilient furring RC-1 by CGC, screwed to the joists @ 24 in. c.c.
- 1/2 in. gypsum board screwed to the resilient furring
- Weight/Unit Area = 7.4 lbs/ft² (36.1 kg/m²)
Floor 11b: TL-88-525

- 5/8 in. thick plywood
- 2 in. x 10 in. joists @ 16 in. c.c.
- cavity filled with cellulose blown-in attic insulation: WEATHERSHIELD by Thermo-Cell Insulation Ltd. - 58.0 kg/m³ (3.6 lb/ft³)
- resilient furring RC-1 by CGC, screwed to the joists @ 24 in. c.c.
- 1/2 in. gypsum board screwed to the resilient furring
- Weight/Unit Area = 9.4 lbs/ft² (46.0 kg/m²)
Floor 11b: II-88-58

- 5/8 in. thick plywood
- 2 in. x 10 in. joists @ 16 in. c.c.
- cavity filled with cellulose blown-in attic insulation: WEATHERSHIELD by Thermo-Cell Insulation Ltd. - 58.0 kg/m³ (3.6 lb/ft³)
- resilient furring RC-1 by CGC, screwed to the joists @ 24 in. c.c.
- 1/2 in. gypsum board screwed to the resilient furring
- Weight/Unit Area = 9.4 lbs/ft² (46.0 kg/m²)

IIC 47
Floor 11c: TL-88-569

- 5/8 in. thick plywood
- 2 in. x 10 in. joists @ 16 in. c.c.
- cavity filled with acoustical blown-in insulation: BENOCOUSTICS by Benolec 59.0 kg/m³ (3.7 lb/ft³)
- resilient furring RC-1 by CGC, screwed to the joists @ 24 in. c.c.
- 1/2 in. gypsum board screwed to the resilient furring
- Weight/Unit Area = 9.4 lbs/ft² (46.0 kg/m²)
Floor 11c: II-88-71

- 5/8 in. thick plywood
- 2 in. x 10 in. joists @ 16 in. c.c.
- cavity filled with acoustical blown-in insulation: BENOCOUSTICS by Benolec - 59.0 kg/m³ (3.7 lb/ft³)
- resilient furring RC-1 by CGC, screwed to the joists @ 24 in. c.c.
- 1/2 in. gypsum board screwed to the resilient furring
- Weight/Unit Area = 9.4 lbs/ft² (46.0 kg/m²)
Floor 12: TL-88-532

- 5/8 in. thick plywood
- 2 in. x 10 in. joists @ 16 in. c.c.
- 3 1/2 in. glass fiber batt insulation between floor joists
- 2 in. x 6 in. ceiling joists supported by the common 2 in. x 10 in. plate at the perimeter of the test opening
- 1/2 in. gypsum board screwed directly to the ceiling joists
- Weight/Unit Area = 8.2 lbs/ft² (40.0 kg/m²)
Floor 12:  II-88-64

- 5/8 in. thick plywood
- 2 in. x 10 in. joists @ 16 in. c.c.
- 3 1/2 in. glass fiber batt insulation between floor joists
- 2 in. x 6 in. ceiling joists supported by the common 2 in. x 10 in. plate at the perimeter of the test opening
- 1/2 in. gypsum board screwed directly to the ceiling joists
- Weight/Unit Area = 8.2 lbs/ft² (40.0 kg/m²)
ANNEX III
RESILIENT FURRINGS MANUFACTURED BY TREBORD

RESILIENT FURRINGS MANUFACTURED BY P.H. METALS

RESILIENT FURRINGS MANUFACTURED BY PICHETTE