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Hoeller, Christoph; Zeitler, Berndt; Sabourin, Ivan

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Airborne and Impact Sound Insulation Data for Cold-Formed Steel-Framed Walls and Floors

Christoph Hoeller, Berndt Zeitler, Ivan Sabourin

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15 February 2018

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Airborne and Impact Sound Insulation Data for Cold-Formed Steel-Framed Walls and Floors

Author

Christoph Hoeller, Ph.D.
Research Officer

Approved

Philip Rizcallah, P.Eng.
Program Leader
Building Regulations and Market Access
NRC Construction

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Summary

This report presents the results of an extensive series of direct sound insulation tests of cold-formed steel-framed walls and floors.

The direct airborne sound insulation of 30 walls with cold-formed steel framing was measured in accordance with ASTM E90-09. The walls had steel studs with a depth of 92 mm (3-5/8”) or 152 mm (6”), and with a steel thickness of 1.09 mm (0.043”) or 1.37 mm (0.054”). Other parameters that were investigated included the number of layers and thickness of gypsum board, the cavity insulation, the stud spacing, and the use of resilient channels. The test results for some non-standard wall configurations that were tested for research purposes (e.g. for walls with gypsum board on one side only) are also included in this report.

The direct airborne and impact sound insulation of 17 floors with cold-formed steel framing was measured in accordance with ASTM E90-09 and ASTM E492-09, respectively. The floors had steel joists with a depth of 254 mm (10”) or 317 mm (12.5”), and with a steel thickness of 1.37 mm (0.054”). The top surface of the floor/ceiling assemblies was composed of a corrugated steel deck with poured gypsum concrete, while the bottom surface was composed of a gypsum board ceiling on resilient channels. The influence of the joist depth and the number of layers and thickness of the ceiling gypsum board was investigated, as well as the influence of several floor coverings (e.g. laminate or carpet).

The report presents the detailed specimen descriptions and specimen properties and the results from the standardized tests according to ASTM E90-09 and ASTM E492-09. Brief analyses of the parameters affecting the sound insulation of the steel-framed assemblies are provided.

The tests presented in this report were part of a large research study that also included an investigation into the flanking sound transmission in cold-formed steel-framed buildings. The results of that study are described in the NRC Research Report RR-337, “Apparent Sound Insulation in Cold-Formed Steel-Framed Buildings” [1]. The NRC Research Report RR-337 also includes some of the airborne sound insulation results presented here, albeit without listing the detailed specimen descriptions and specimen properties that are provided in this report.

1. Sound Insulation of CFS-Framed Walls

The sound insulation properties of 30 cold-formed steel-framed wall assemblies for mid-rise construction were measured in the NRC Construction Wall Sound Transmission Facility, in accordance with the requirements of ASTM E90-09 [2]. The facility and the test method are described in Appendix A.

The first wall that was tested was chosen as reference assembly. It was constructed from 152 mm (6”) deep cold-formed steel studs spaced 406 mm (16”) on centres, with resilient channels on one side spaced 406 mm (16”) on centres and 152 mm (6”) thick glass fibre batts in the wall cavity. The sheathing consisted of one layer of 15.9 mm (5/8”) gypsum board type X on each side. The reference assembly achieved a Sound Transmission Class (STC) rating of 49.

Based on the reference assembly described above, a parametric study was conducted to investigate the importance of various wall members. The following parameters were examined: the number of layers and thickness of gypsum board, the cavity insulation, the stud spacing and stud depth, the steel thickness of the studs, and the use of resilient channels. Some further tests were conducted to investigate the influence of flat strap bracing and bridging channels. The test results for some non-standard wall configurations that were tested for research purposes (e.g. for walls with gypsum board on one side only) are also included in this report.

This section is divided into three parts:

Section 1.1 provides a tabulated overview of the wall assemblies that were tested as part of this study. Table 2 contains short descriptions and drawings of all wall assemblies together with their measured STC rating and a reference to the page where the detailed test report can be found.

Section 1.2 provides the detailed test reports which list the construction details, material properties, test conditions, and test results for each specimen.

Section 1.3 provides brief analyses of parameters affecting the sound insulation of cold-formed steel-framed wall assemblies.

1.1 Overview of Tested Wall Assemblies

Table 2 provides an overview of all wall assemblies that were tested as part of this study. Each row contains the specimen identifier, a sketch and a short code describing the specimen, the measured Sound Transmission Class (STC) rating of the specimen, and the page number where the detailed test report can be found.

A coding system is used in the table to avoid long descriptions of the wall constructions. Each surface layer in a wall is coded as follows:

- An integer representing the number of layers of material; if the number of layers is one, the leading 1 is omitted
- A sequence of letters to indicate the material in the layer (see Table 1 below)
- A number representing the thickness in mm of each sheet or element in the layer
- Underscores separating the codes for each layer

The coding system is also applied to elements that do not constitute surface layers such as joists, studs, and resilient metal channels. For such elements, the number following the letters is the depth of each element (the dimension along the axis perpendicular to the surface of the assembly) and the number in parentheses following the depth code is the separation between adjacent elements.

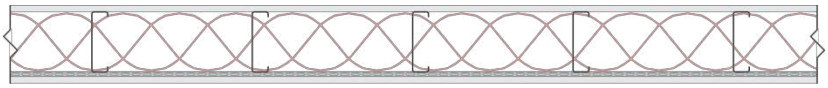
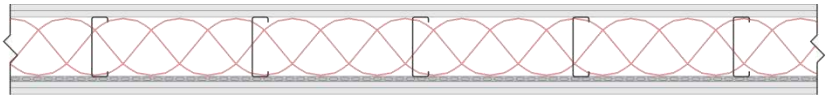
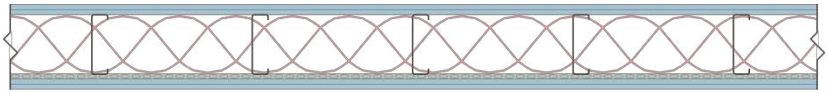
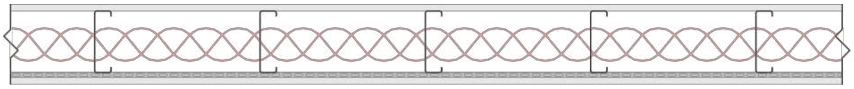
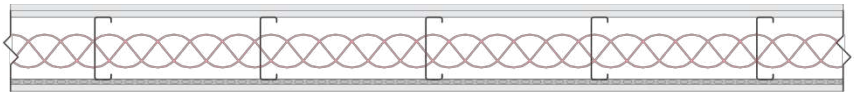
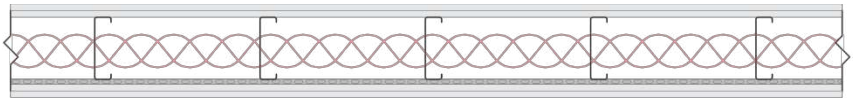
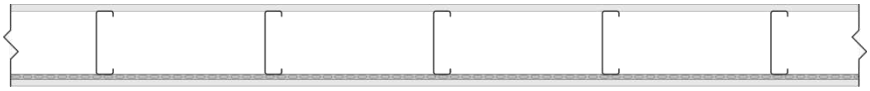
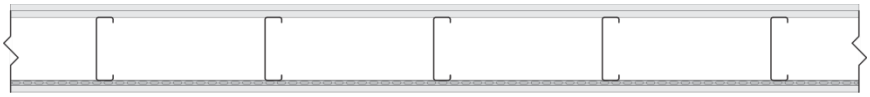
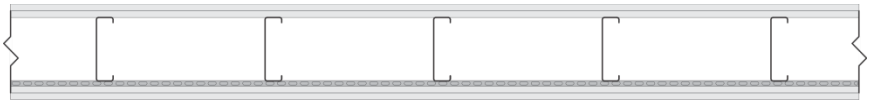
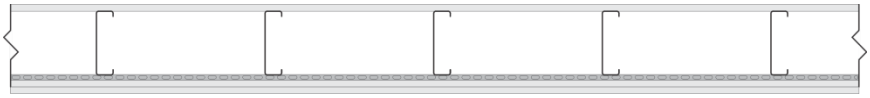
Table 1: Examples of the codes used to identify materials and describe constructions

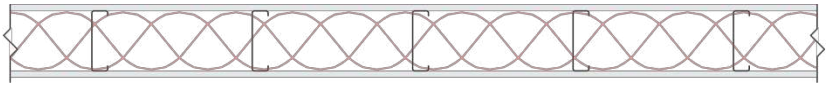
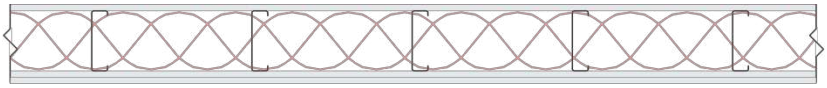
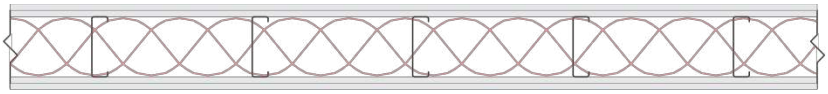
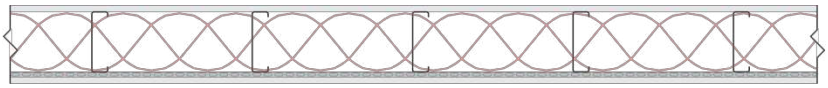
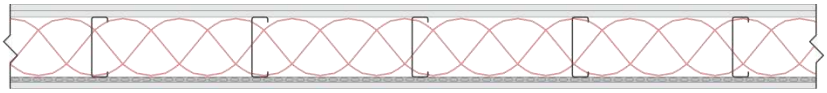
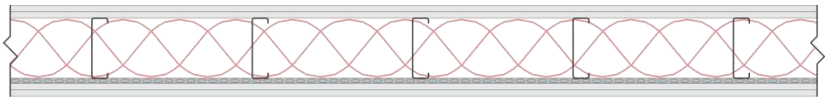
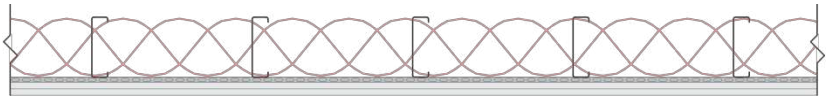
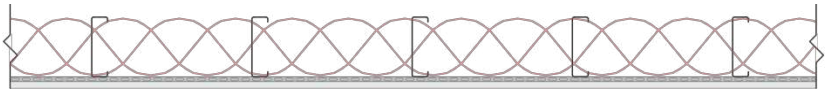
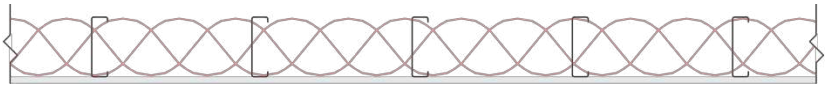
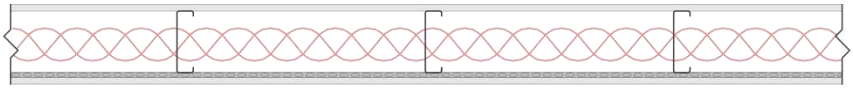
Code	Material
Gxx	Gypsum board “xx” mm thick
GFBxx	Glass fibre batts “xx” mm thick
SSxx(ss)	Cold-formed steel (CFS) studs with nominal depth of “xx” mm, spaced “ss” mm on centres
RCxx(ss)	Resilient metal channels with nominal depth of “xx” mm, spaced “ss” mm on centres

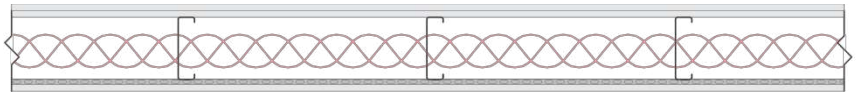
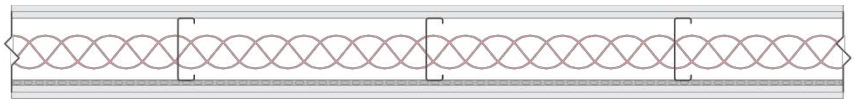
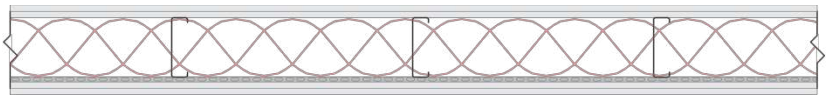
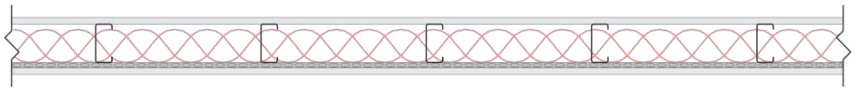
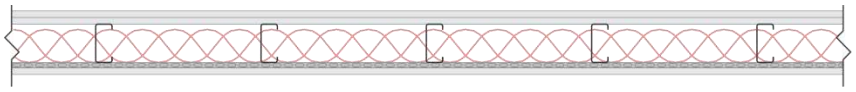
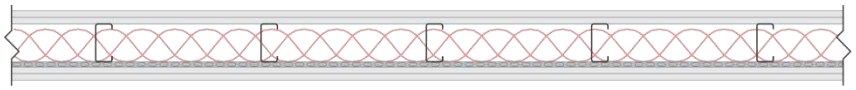
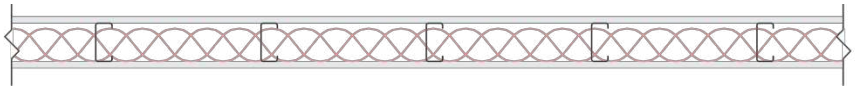
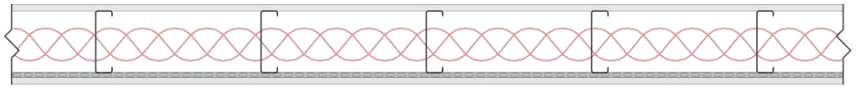
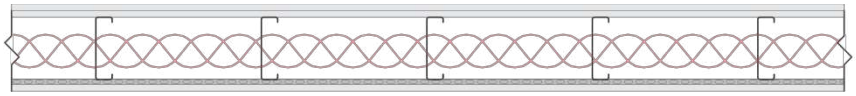
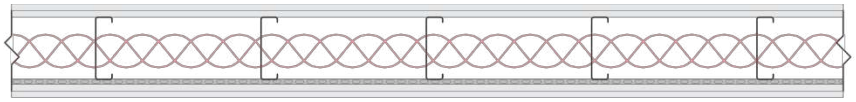
Note that the coding system is a convenience and actual dimensions may not be exactly as coded. For example, the nominal 16 mm thick gypsum board would be labelled by the manufacturer as 5/8” or 15.9 mm thick.

For brevity, not all pertinent parameters are included in the short codes. For example, the thickness of the steel in the CFS studs is not indicated. This information is given separately in the specimen descriptions in Section 1.2.

Table 2: List of Wall Assemblies

Specimen	Sketch and Short Code	STC	Page
A1-005007-01W	 G16_SS152(406)_GFB152_RC13(406)_G16	**49**	7
A1-005007-02W	 2G16_SS152(406)_GFB152_RC13(406)_2G16	**58**	11
A1-005007-03W	 2G13_SS152(406)_GFB152_RC13(406)_2G13	**57**	15
A1-005007-04W	 G16_SS152(406)_GFB92_RC13(406)_G16	**49**	19
A1-005007-05W	 2G16_SS152(406)_GFB92_RC13(406)_G16	**53**	23
A1-005007-06W	 2G16_SS152(406)_GFB92_RC13(406)_2G16	**57**	27
A1-005007-07W	 G16_SS152(406)_RC13(406)_G16	**42**	31
A1-005007-08W	 2G16_SS152(406)_RC13(406)_G16	**47**	35
A1-005007-09W	 2G16_SS152(406)_RC13(406)_2G16	**53**	39
A1-005007-10W	 G16_SS152(406)_RC13(406)_2G16	**48**	43

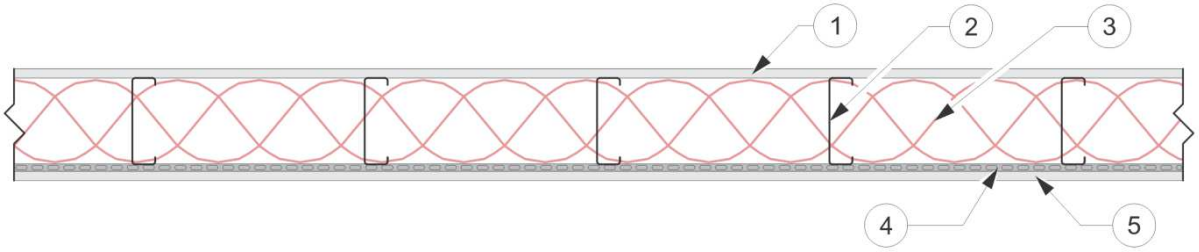
Specimen	Sketch and Short Code	STC	Page
A1-005007-11W	 G16_SS152(406)_GFB152_G16	**42**	47
A1-005007-12W	 G16_SS152(406)_GFB152_2G16	**45**	51
A1-005007-13W	 2G16_SS152(406)_GFB152_2G16	**48**	55
A1-005007-14W	 G16_SS152(406)_GFB152_RC13(406)_G16	**48**	59
A1-005007-15W	 2G16_SS152(406)_GFB152_RC13(406)_G16	**54**	63
A1-005007-16W	 2G16_SS152(406)_GFB152_RC13(406)_2G16	**57**	67
A1-005007-17W	 SS152(406)_GFB152_RC13(406)_2G16	**43**	71
A1-005007-18W	 SS152(406)_GFB152_RC13(406)_G16	**38**	75
A1-005007-19W	 SS152(406)_GFB152_G16	**37**	79
A1-005007-20W	 G16_SS152(610)_GFB92_RC13(406)_G16	**50**	83

Specimen	Sketch and Short Code	STC	Page
A1-005007-21W	 2G16_SS152(610)_GFB92_RC13(406)_G16	**55**	87
A1-005007-22W	 2G16_SS152(610)_GFB92_RC13(406)_2G16	**59**	91
A1-005007-23W	 2G16_SS152(610)_GFB152_RC13(406)_2G16	**60**	95
A1-005007-24W	 G16_SS92(406)_GFB92_RC13(406)_G16	**45**	99
A1-005007-25W	 2G16_SS92(406)_GFB92_RC13(406)_G16	**52**	103
A1-005007-26W	 2G16_SS92(406)_GFB92_RC13(406)_2G16	**57**	107
A1-005007-27W	 G16_SS92(406)_GFB92_G16	**38**	111
A1-005007-28W	 G16_SS152(406)_GFB152_RC13(406)_G16	**50**	115
A1-005007-29W	 2G16_SS152(406)_GFB152_RC13(406)_G16	**54**	119
A1-005007-30W	 2G16_SS152(406)_GFB152_RC13(406)_2G16	**58**	123

1.2 Detailed Test Reports

The following pages contain the detailed test reports for the 30 wall assemblies that were tested as part of this study. Each report presents the detailed specimen descriptions, material properties, test conditions, and test results.

Wall assembly 01W: G16_SS152(406)_GFB152_RC13(406)_G16



Description	One layer of 15.9 mm (5/8”) gypsum board Type X, attached on each side of 152 mm (6”) deep steel studs spaced 406 mm (16”) o.c., with resilient channels on one side spaced 406 mm (16”) o.c. and 152 mm (6”) deep glass fibre insulation (R-20) in the cavity.
Side 1	• **(1)** One layer of 15.9 mm (5/8”) gypsum board Type X, installed vertically, directly attached to the studs using 32 mm (1-1/4”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • Joints of Side 1 gypsum boards staggered by at least one stud spacing from joints of Side 2 gypsum boards • Gaps along the joints and the perimeter of gypsum boards caulked and taped with aluminum tape
Framing & Cavity Insulation	• Base track and top track (steel thickness: 1.37 mm/0.054”) attached to test frame using four 19 mm (3/4”) screws (#10 wafer head) • **(2)** 152 mm (6”) deep steel C-studs (steel thickness: 1.37 mm/0.054”) spaced 406 mm (16”) o.c., attached to base track and top track using 19 mm (3/4”) screws (#10 pan head) • One through-the-knockout bridging channel, attached to each stud using 140 mm (5-1/2”) bridging clips • Flat-strap steel cross-bracing, attached on Side 1 to each stud using 19 mm (3/4”) screws (#10 pan head) • **(3)** Cavities between studs filled with 406 mm (16”) wide by 152 mm (6”) thick glass fibre insulation (R-20), cut in half to accommodate bridging channel
Side 2	• **(4)** 13 mm resilient channels installed horizontally using 19 mm (3/4”) screws (#10 wafer head), spaced 406 mm (16”) o.c. and installed according to ASTM C754-11 • **(5)** One layer of 15.9 mm (5/8”) gypsum board Type X, installed vertically, attached to resilient channels using 32 mm (1-1/4”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • Joints of Side 1 gypsum boards staggered by at least one stud spacing from joints of Side 2 gypsum boards • Gaps along the joints and the perimeter of gypsum boards caulked and taped with aluminum tape

Specimen Properties

Element	Actual thickness (mm)	Mass (kg)	Mass/length, area or volume
Gypsum Board	15.9	97.8	11.0 kg/m²
Flat Strap	1	3.0	0.3 kg/m
Steel Studs	152	65.0	2.7 kg/m
Steel Tracks	152 *	16.6	2.3 kg/m
C Channel Bridging	1 *	1.9	0.5 kg/m
Angle Bracket	1 *	10.8	1.1 kg/piece
Glass Fibre Insulation	152 *	12.4	9.2 kg/m³
Resilient Channels	13	5.6	0.2 kg/m
Gypsum Board	15.9	97.8	11.0 kg/m²
Total	**197.8**	**310.9**	

* Element thickness does not contribute to total thickness (i.e. in cavity)

ASTM E90 Test Results – Airborne Sound Transmission Loss

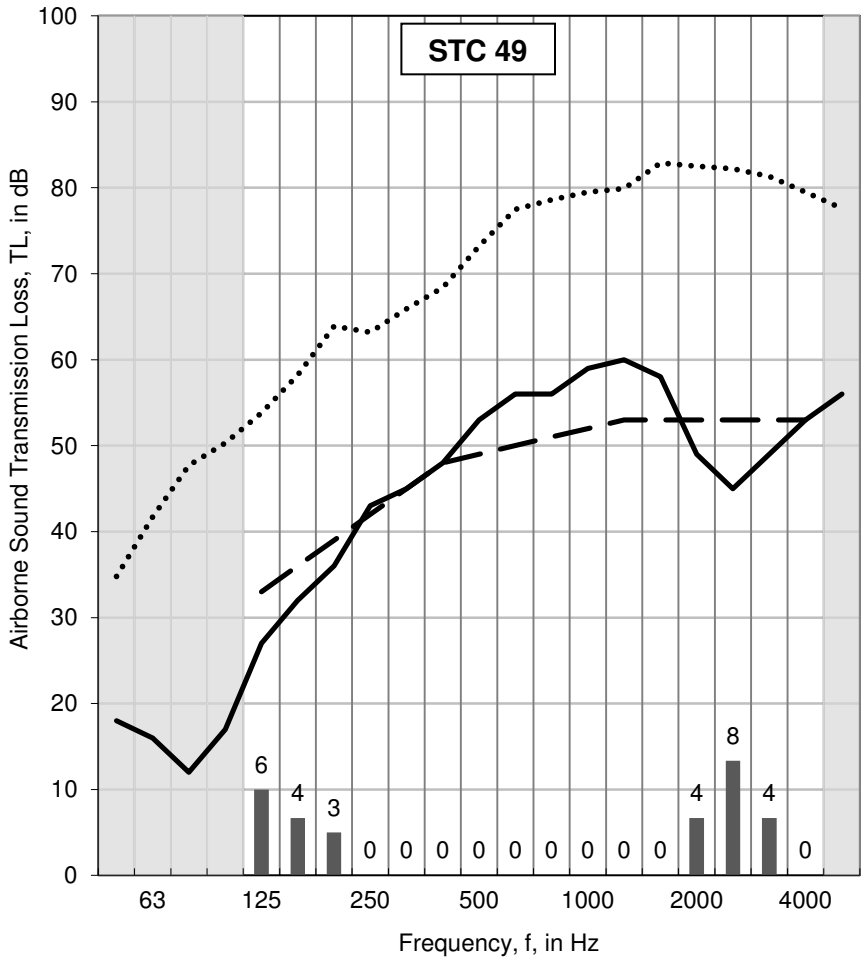
Client: CSSBI **Test ID:** TLA-14-041

Specimen ID: A1-005007-01W **Date of Test:** 15 August 2014

Room	Volume (m³)	Air Temperature (°C)	Humidity (%)
Large	255.8	19.4 to 19.5	56.4 to 56.5
Small	140.7	19.6 to 19.7	55.5 to 56.0

Area of test specimen:	8.92 m^2
Mass of test specimen:	310.9 kg

f (Hz)	TL (dB)
50	18
63	16
80	12
100	17
125	27
160	32
200	36
250	43
315	45
400	48
500	53
630	56
800	56
1000	59
1250	60
1600	58
2000	49
2500	45
3150	49
4000	53
5000	56
Sound Transmission Class (STC)	**49**



Sum of Deficiencies (dB)
29
Max. Deficiency (dB)
8 dB at 2500 Hz

For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Airborne sound transmission loss measurements were conducted in accordance with the requirements of ASTM E90-09, "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements."**

In the graph:
The solid line is the measured sound transmission loss for this specimen. The dashed line is the STC contour fitted to the measured values according to ASTM E413-10. The dotted line (may be above the displayed range) is 10 dB below the flanking limit established for this facility. For any frequency band where the measured transmission loss is above the dotted line, the reported value is potentially limited by flanking transmission via laboratory surfaces, and the true value may be higher than that measured. Bars at the bottom of the graph show deficiencies where the measured data are less than the reference contour as described in the fitting procedure for the STC, defined in ASTM E413-10. The shaded cells in the table and areas in the graph are outside the STC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. The reported values have been corrected according to the procedure outlined in ASTM E90-09. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level, in which case, the corrected values provide an estimate of the lower limit of airborne sound transmission loss.

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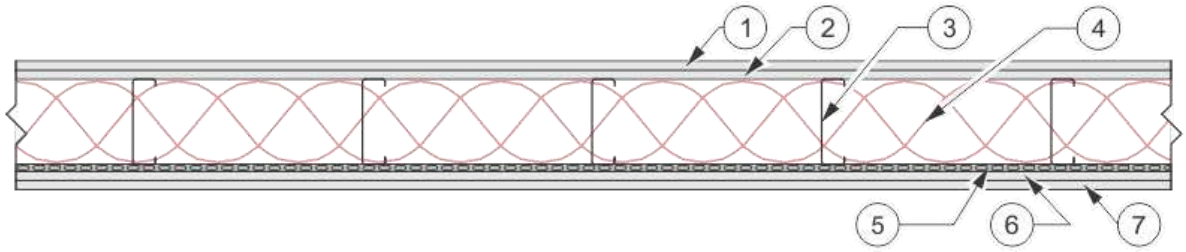
Wall assembly 02W: 2G16_SS152(406)_GFB152_RC13(406)_2G16



Description	Two layers of 15.9 mm (5/8”) gypsum board Type X, attached on each side of 152 mm (6”) deep steel studs spaced 406 mm (16”) o.c., with resilient channels on one side spaced 406 mm (16”) o.c. and 152 mm (6”) deep glass fibre insulation (R-20) in the cavity.
Side 1	• Two layers of 15.9 mm (5/8”) gypsum board Type X, installed vertically • **(2)** Base layer attached to the studs using 32 mm (1-1/4”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • **(1)** Face layer attached to base layer and studs using 41 mm (1-5/8”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • Screws from base layer to face layer offset by 152 mm (6”) • Joints of base layer Side 1 gypsum boards staggered by at least one stud spacing from joints of base layer Side 2 gypsum boards • Joints of face layer staggered by at least one stud spacing from joints of base layer • Gaps along the joints and the perimeter of face layer gypsum boards caulked and taped with aluminum tape
Framing & Cavity Insulation	• Base track and top track (steel thickness: 1.37 mm/0.054”) attached to test frame using four 19 mm (3/4”) screws (#10 wafer head) • **(3)** 152 mm (6”) deep steel C-studs (steel thickness: 1.37 mm/0.054”) spaced 406 mm (16”) o.c., attached to base track and top track using 19 mm (3/4”) screws (#10 pan head) • One through-the-knockout bridging channel, attached to each stud using 140 mm (5-1/2”) bridging clips • Flat-strap steel cross-bracing, attached on Side 1 to each stud using 19 mm (3/4”) screws (#10 pan head) • **(4)** Cavities between studs filled with 406 mm (16”) wide by 152 mm (6”) thick glass fibre insulation (R-20), cut in half to accommodate bridging channel
Side 2	• **(5)** 13 mm resilient channels installed horizontally using 19 mm (3/4”) screws (#10 wafer head), spaced 406 mm (16”) o.c. and installed according to ASTM C754-11 • Two layers of 15.9 mm (5/8”) gypsum board Type X, installed vertically

	• **(6)** Base layer attached to resilient channels using 32 mm (1-1/4") screws (#6 scavenger head) spaced 305 mm (12") o.c. at the perimeter and in the field • **(7)** Face layer attached to base layer and resilient channels using 41 mm (1-5/8") screws (#6 scavenger head) spaced 305 mm (12") o.c. at the perimeter and in the field • Screws from base layer to face layer offset by 152 mm (6") • Joints of base layer Side 1 gypsum boards staggered by at least one stud spacing from joints of base layer Side 2 gypsum boards • Joints of face layer staggered by at least one stud spacing from joints of base layer • Gaps along the joints and the perimeter of face layer gypsum boards caulked and taped with aluminum tape

Specimen Properties

Element	Actual thickness (mm)	Mass (kg)	Mass/length, area or volume
Gypsum Board	15.9	97.8	11.0 kg/m²
Gypsum Board	15.9	97.8	11.0 kg/m²
Flat Strap	1	3.0	0.3 kg/m
Steel Studs	152	65.0	2.7 kg/m
Steel Tracks	152 *	16.6	2.3 kg/m
C Channel Bridging	1 *	1.9	0.5 kg/m
Angle Bracket	1 *	10.8	1.1 kg/piece
Glass Fibre Insulation	152 *	12.4	9.2 kg/m³
Resilient Channels	13	5.6	0.2 kg/m
Gypsum Board	15.9	97.8	11.0 kg/m²
Gypsum Board	15.9	97.8	11.0 kg/m²
Total	**229.6**	**506.5**	

* Element thickness does not contribute to total thickness (i.e. in cavity)

ASTM E90 Test Results – Airborne Sound Transmission Loss

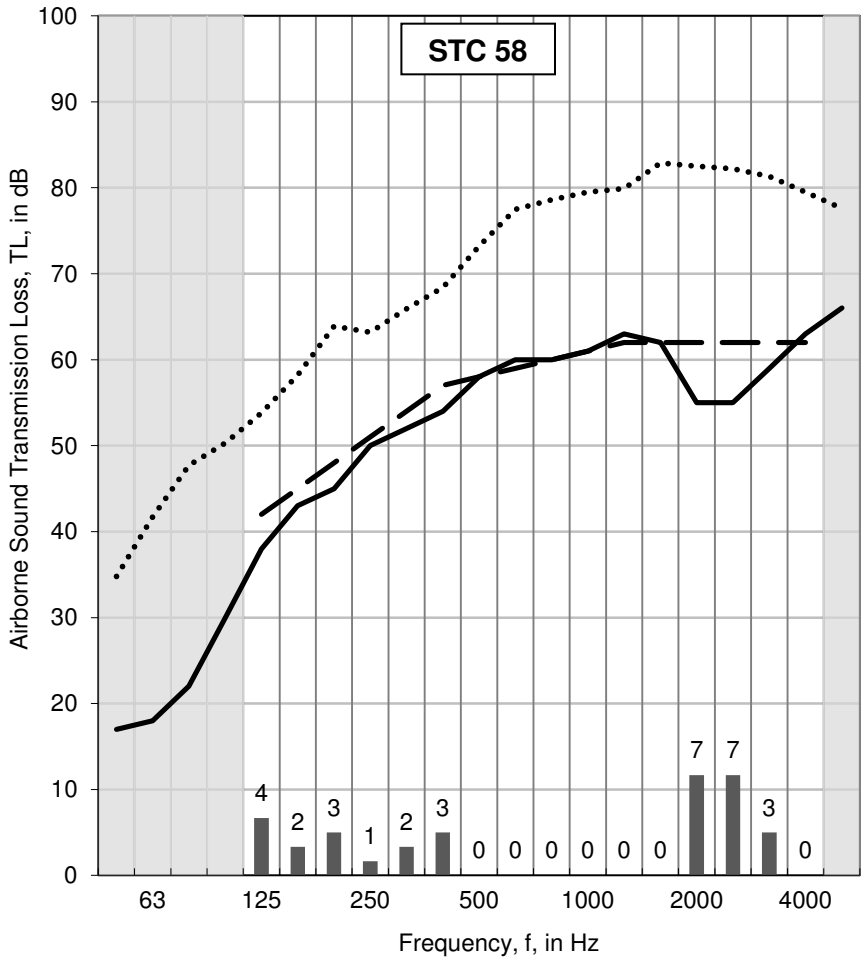
Client: CSSBI **Test ID:** TLA-14-042

Specimen ID: A1-005007-02W **Date of Test:** 15 August 2014

Room	Volume (m³)	Air Temperature (°C)	Humidity (%)
Large	255.6	19.7 to 19.8	54.4 to 55.2
Small	140.6	19.8 to 19.9	55.4 to 56.3

Area of test specimen:	8.92 m^2
Mass of test specimen:	506.5 kg

f (Hz)	TL (dB)
50	17
63	18
80	22
100	30
125	38
160	43
200	45
250	50
315	52
400	54
500	58
630	60
800	60
1000	61
1250	63
1600	62
2000	55
2500	55
3150	59
4000	63
5000	66
Sound Transmission Class (STC)	**58**



Sum of Deficiencies (dB)
32
Max. Deficiency (dB)
7 dB at 2000 Hz and 2500 Hz

For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Airborne sound transmission loss measurements were conducted in accordance with the requirements of ASTM E90-09, "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements."**

In the graph:
The solid line is the measured sound transmission loss for this specimen. The dashed line is the STC contour fitted to the measured values according to ASTM E413-10. The dotted line (may be above the displayed range) is 10 dB below the flanking limit established for this facility. For any frequency band where the measured transmission loss is above the dotted line, the reported value is potentially limited by flanking transmission via laboratory surfaces, and the true value may be higher than that measured. Bars at the bottom of the graph show deficiencies where the measured data are less than the reference contour as described in the fitting procedure for the STC, defined in ASTM E413-10. The shaded cells in the table and areas in the graph are outside the STC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. The reported values have been corrected according to the procedure outlined in ASTM E90-09. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level, in which case, the corrected values provide an estimate of the lower limit of airborne sound transmission loss.

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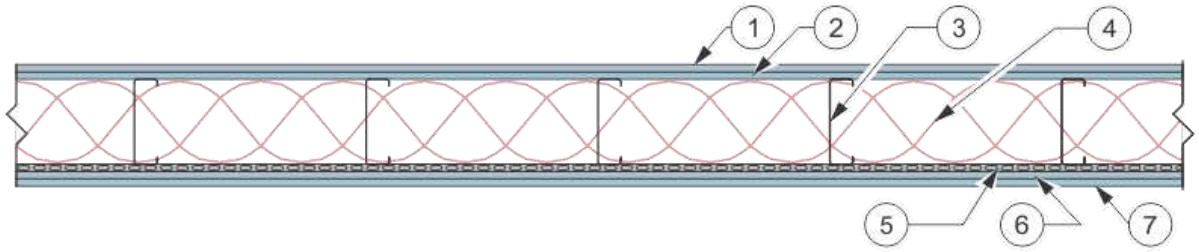
Wall assembly 03W: 2G13_SS152(406)_GFB152_RC13(406)_2G13



Description	Two layers of 12.7 mm (1/2”) gypsum board Firecode C Type X, attached on each side of 152 mm (6”) deep steel studs spaced 406 mm (16”) o.c., with resilient channels on one side spaced 406 mm (16”) o.c. and 152 mm (6”) deep glass fibre insulation (R-20) in the cavity.
Side 1	• Two layers of 12.7 mm (1/2”) gypsum board Firecode C Type X, installed vertically • **(2)** Base layer attached to the studs using 32 mm (1-1/4”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • **(1)** Face layer attached to base layer and studs using 41 mm (1-5/8”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • Screws from base layer to face layer offset by 152 mm (6”) • Joints of base layer Side 1 gypsum boards staggered by at least one stud spacing from joints of base layer Side 2 gypsum boards • Joints of face layer staggered by at least one stud spacing from joints of base layer • Gaps along the joints and the perimeter of face layer gypsum boards caulked and taped with aluminum tape
Framing & Cavity Insulation	• Base track and top track (steel thickness: 1.37 mm/0.054”) attached to test frame using four 19 mm (3/4”) screws (#10 wafer head) • **(3)** 152 mm (6”) deep steel C-studs (steel thickness: 1.37 mm/0.054”) spaced 406 mm (16”) o.c., attached to base track and top track using 19 mm (3/4”) screws (#10 pan head) • One through-the-knockout bridging channel, attached to each stud using 140 mm (5-1/2”) bridging clips • Flat-strap steel cross-bracing, attached on Side 1 to each stud using 19 mm (3/4”) screws (#10 pan head) • **(4)** Cavities between studs filled with 406 mm (16”) wide by 152 mm (6”) thick glass fibre insulation (R-20), cut in half to accommodate bridging channel
Side 2	• **(5)** 13 mm resilient channels installed horizontally using 19 mm (3/4”) screws (#10 wafer head), spaced 406 mm (16”) o.c. and installed according to ASTM C754-11

	• Two layers of 12.7 mm (1/2”) gypsum board Firecode C Type X, installed vertically • **(6)** Base layer attached to resilient channels using 32 mm (1-1/4”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • **(7)** Face layer attached to base layer and resilient channels using 41 mm (1-5/8”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • Screws from base layer to face layer offset by 152 mm (6”) • Joints of base layer Side 1 gypsum boards staggered by at least one stud spacing from joints of base layer Side 2 gypsum boards • Joints of face layer staggered by at least one stud spacing from joints of base layer • Gaps along the joints and the perimeter of face layer gypsum boards caulked and taped with aluminum tape

Specimen Properties

Element	Actual thickness (mm)	Mass (kg)	Mass/length, area or volume
Gypsum Board	12.7	89.4	10.0 kg/m²
Gypsum Board	12.7	89.4	10.0 kg/m²
Flat Strap	1	3.0	0.3 kg/m
Steel Studs	152	65.0	2.7 kg/m
Steel Tracks	152 *	16.6	2.3 kg/m
C Channel Bridging	1 *	1.9	0.5 kg/m
Angle Bracket	1 *	10.8	1.1 kg/piece
Glass Fibre Insulation	152 *	12.4	9.2 kg/m³
Resilient Channels	13	5.6	0.2 kg/m
Gypsum Board	12.7	89.4	10.0 kg/m²
Gypsum Board	12.7	89.4	10.0 kg/m²
Total	**216.8**	**472.9**	

* Element thickness does not contribute to total thickness (i.e. in cavity)

ASTM E90 Test Results – Airborne Sound Transmission Loss

Client: CSSBI **Test ID:** TLA-14-043

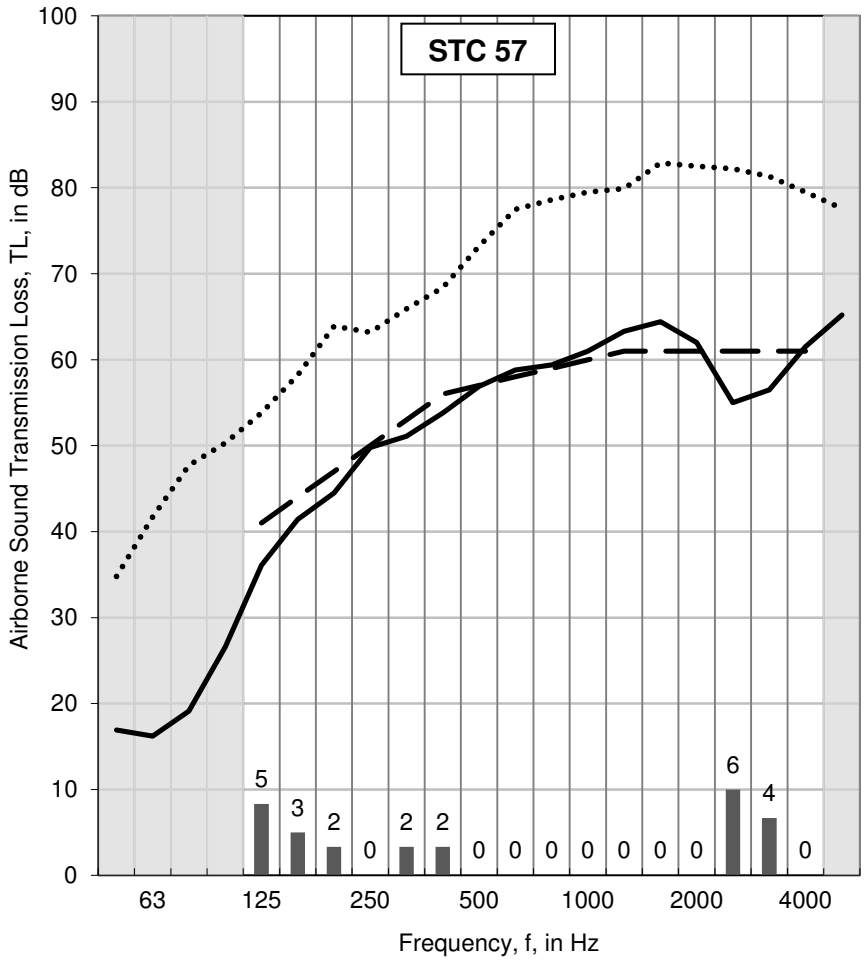
Specimen ID: A1-005007-03W **Date of Test:** 18 August 2014

Room	Volume (m³)	Air Temperature (°C)	Humidity (%)
Large	255.7	19.9 to 20.0	53.3 to 54.3
Small	140.6	20.0 to 20.1	59.0 to 59.3

Area of test specimen:	8.92 m^2
Mass of test specimen:	472.9 kg

f (Hz)	TL (dB)
50	17
63	16
80	19
100	27
125	36
160	41
200	45
250	50
315	51
400	54
500	57
630	59
800	59
1000	61
1250	63
1600	64
2000	62
2500	55
3150	57
4000	62
5000	65
Sound Transmission Class (STC)	**57**

Sum of Deficiencies (dB)
24
Max. Deficiency (dB)
6 dB at 2500 Hz



For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Airborne sound transmission loss measurements were conducted in accordance with the requirements of ASTM E90-09, "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements."**

In the graph:
The solid line is the measured sound transmission loss for this specimen. The dashed line is the STC contour fitted to the measured values according to ASTM E413-10. The dotted line (may be above the displayed range) is 10 dB below the flanking limit established for this facility. For any frequency band where the measured transmission loss is above the dotted line, the reported value is potentially limited by flanking transmission via laboratory surfaces, and the true value may be higher than that measured. Bars at the bottom of the graph show deficiencies where the measured data are less than the reference contour as described in the fitting procedure for the STC, defined in ASTM E413-10. The shaded cells in the table and areas in the graph are outside the STC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. The reported values have been corrected according to the procedure outlined in ASTM E90-09. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level, in which case, the corrected values provide an estimate of the lower limit of airborne sound transmission loss.

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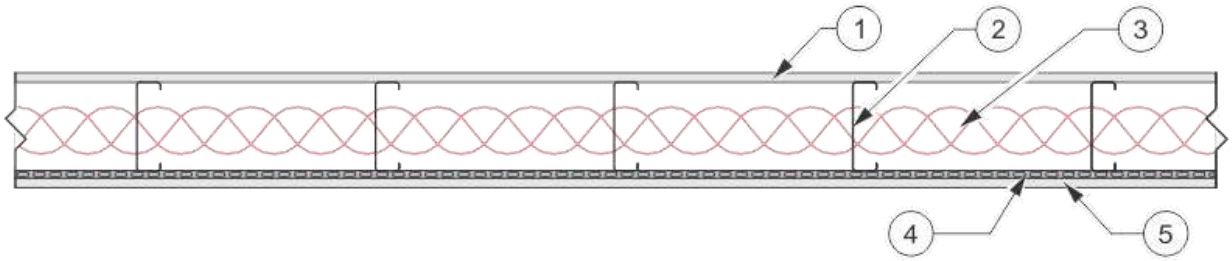
Wall assembly 04W: G16_SS152(406)_GFB92_RC13(406)_G16



Description	One layer of 15.9 mm (5/8”) gypsum board Type X, attached on each side of 152 mm (6”) deep steel studs spaced 406 mm (16”) o.c., with resilient channels on one side spaced 406 mm (16”) o.c. and 92 mm (3-5/8”) deep glass fibre insulation (R-12) in the cavity.
Side 1	• **(1)** One layer of 15.9 mm (5/8”) gypsum board Type X, installed vertically and directly attached to the studs using 32 mm (1-1/4”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • Joints of Side 1 gypsum boards staggered by at least one stud spacing from joints of Side 2 gypsum boards • Gaps along the joints and the perimeter of gypsum boards caulked and taped with aluminum tape
Framing & Cavity Insulation	• Base track and top track (steel thickness: 1.37 mm/0.054”) attached to test frame using four 19 mm (3/4”) screws (#10 wafer head) • **(2)** 152 mm (6”) deep steel C-studs (steel thickness: 1.37 mm/0.054”) spaced 406 mm (16”) o.c., attached to base track and top track using 19 mm (3/4”) screws (#10 pan head) • One through-the-knockout bridging channel, attached to each stud using 140 mm (5-1/2”) bridging clips • Flat-strap steel cross-bracing, attached on Side 1 to each stud using 19 mm (3/4”) screws (#10 pan head) • **(3)** Cavities between studs filled with 406 mm (16”) wide by 92 mm (3-5/8”) thick glass fibre insulation (R-12), cut in half to accommodate bridging channel
Side 2	• **(4)** 13 mm resilient channels installed horizontally using 19 mm (3/4”) screws (#10 wafer head), spaced 406 mm (16”) o.c. and installed according to ASTM C754-11 • **(5)** One layer of 15.9 mm (5/8”) gypsum board Type X, installed vertically, attached to resilient channels using 32 mm (1-1/4”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • Joints of Side 1 gypsum boards staggered by at least one stud spacing from joints of Side 2 gypsum boards • Gaps along the joints and the perimeter of gypsum boards caulked and taped with aluminum tape

Specimen Properties

Element	Actual thickness (mm)	Mass (kg)	Mass/length, area or volume
Gypsum Board	15.9	97.8	11.0 kg/m²
Flat Strap	1	3.0	0.3 kg/m
Steel Studs	152	65.0	2.7 kg/m
Steel Tracks	152 *	16.6	2.3 kg/m
C Channel Bridging	1 *	1.9	0.5 kg/m
Angle Bracket	1 *	10.8	1.1 kg/piece
Glass Fibre Insulation	92 *	8.5	10.4 kg/m³
Resilient Channels	13	5.6	0.2 kg/m
Gypsum Board	15.9	97.8	11.0 kg/m²
Total	**197.8**	**307.0**	

* Element thickness does not contribute to total thickness (i.e. in cavity)

ASTM E90 Test Results – Airborne Sound Transmission Loss

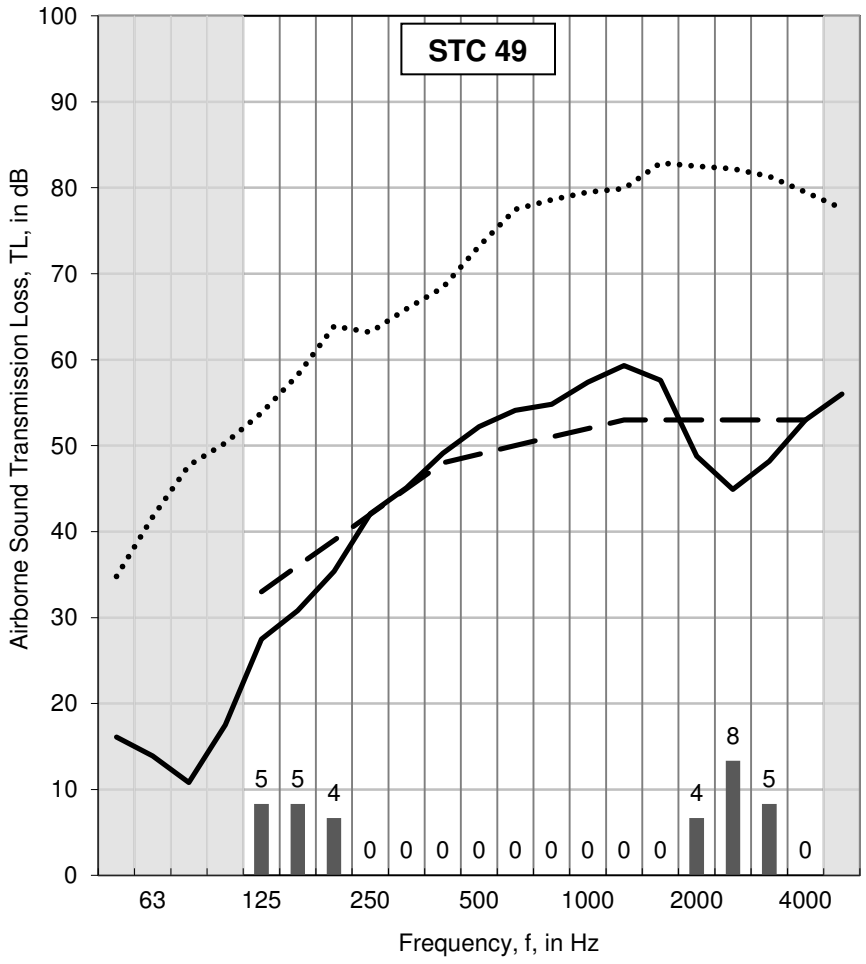
Client: CSSBI **Test ID:** TLA-14-044

Specimen ID: A1-005007-04W **Date of Test:** 19 August 2014

Room	Volume (m³)	Air Temperature (°C)	Humidity (%)
Large	255.7	20.1 to 20.1	55.7 to 56.1
Small	140.7	20.1 to 20.2	57.7 to 58.4

Area of test specimen:	8.92 m^2
Mass of test specimen:	307.0 kg

f (Hz)	TL (dB)
50	16
63	14
80	11
100	18
125	28
160	31
200	35
250	42
315	45
400	49
500	52
630	54
800	55
1000	57
1250	59
1600	16
2000	49
2500	45
3150	48
4000	53
5000	56
Sound Transmission Class (STC)	**49**



Sum of Deficiencies (dB)
31
Max. Deficiency (dB)
8 dB at 2500 Hz

For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Airborne sound transmission loss measurements were conducted in accordance with the requirements of ASTM E90-09, "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements."**

In the graph:
The solid line is the measured sound transmission loss for this specimen. The dashed line is the STC contour fitted to the measured values according to ASTM E413-10. The dotted line (may be above the displayed range) is 10 dB below the flanking limit established for this facility. For any frequency band where the measured transmission loss is above the dotted line, the reported value is potentially limited by flanking transmission via laboratory surfaces, and the true value may be higher than that measured. Bars at the bottom of the graph show deficiencies where the measured data are less than the reference contour as described in the fitting procedure for the STC, defined in ASTM E413-10. The shaded cells in the table and areas in the graph are outside the STC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. The reported values have been corrected according to the procedure outlined in ASTM E90-09. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level, in which case, the corrected values provide an estimate of the lower limit of airborne sound transmission loss.

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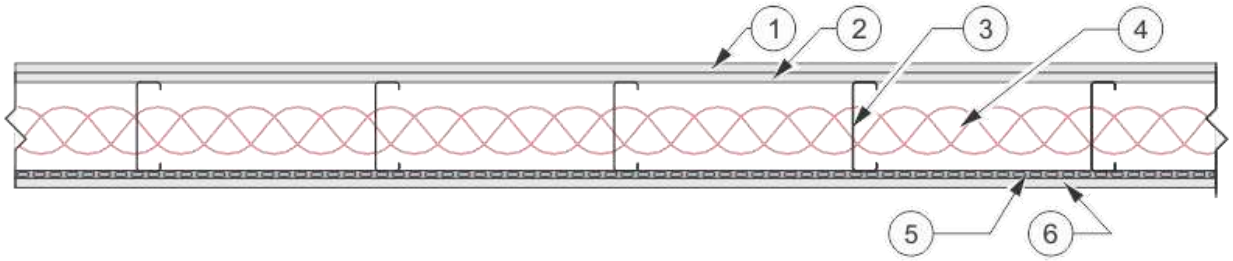
Wall assembly 05W: 2G16_SS152(406)_GFB92_RC13(406)_G16



Description	Two layers of 15.9 mm (5/8”) gypsum board Type X, directly attached to one side of 152 mm (6”) deep steel studs spaced 406 mm (16”) o.c., and one layer of 15.9 mm (5/8”) gypsum board Type X attached to resilient channels spaced 406 mm (16”) o.c. on the other side, with 92 mm (3-5/8”) deep glass fibre insulation (R-12) in the cavity.
Side 1	• Two layers of 15.9 mm (5/8”) gypsum board Type X, installed vertically • **(2)** Base layer attached to the studs using 32 mm (1-1/4”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • **(1)** Face layer attached to base layer and studs using 41 mm (1-5/8”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • Screws from base layer to face layer offset by 152 mm (6”) • Joints of base layer Side 1 gypsum boards staggered by at least one stud spacing from joints of base layer Side 2 gypsum boards • Joints of face layer staggered by at least one stud spacing from joints of base layer • Gaps along the joints and the perimeter of face layer gypsum boards caulked and taped with aluminum tape
Framing & Cavity Insulation	• Base track and top track (steel thickness: 1.37 mm/0.054”) attached to test frame using four 19 mm (3/4”) screws (#10 wafer head) • **(3)** 152 mm (6”) deep steel C-studs (steel thickness: 1.37 mm/0.054”) spaced 406 mm (16”) o.c., attached to base track and top track using 19 mm (3/4”) screws (#10 pan head) • One through-the-knockout bridging channel, attached to each stud using 140 mm (5-1/2”) bridging clips • Flat-strap steel cross-bracing, attached on Side 1 to each stud using 19 mm (3/4”) screws (#10 pan head) • **(4)** Cavities between studs filled with 406 mm (16”) wide by 92 mm (3-5/8”) thick glass fibre insulation (R-12), cut in half to accommodate bridging channel
Side 2	• **(5)** 13 mm resilient channels installed horizontally using 19 mm (3/4”) screws (#10 wafer head), spaced 406 mm (16”) o.c. and installed according to ASTM C754-11

	• **(6)** One layer of 15.9 mm (5/8”) gypsum board Type X, installed vertically and attached to resilient channels using 32 mm (1-1/4”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • Joints of Side 1 gypsum boards staggered by at least one stud spacing from joints of Side 2 gypsum boards • Gaps along the joints and the perimeter of gypsum boards caulked and taped with aluminum tape

Specimen Properties

Element	Actual thickness (mm)	Mass (kg)	Mass/length, area or volume
Gypsum Board	15.9	97.8	11.0 kg/m²
Gypsum Board	15.9	97.8	11.0 kg/m²
Flat Strap	1	3.0	0.3 kg/m
Steel Studs	152	65.0	2.7 kg/m
Steel Tracks	152 *	16.6	2.3 kg/m
C Channel Bridging	1 *	1.9	0.5 kg/m
Angle Bracket	1 *	10.8	1.1 kg/piece
Glass Fibre Insulation	92 *	8.5	10.4 kg/m³
Resilient Channels	13	5.6	0.2 kg/m
Gypsum Board	15.9	97.8	11.0 kg/m²
Total	**213.7**	**404.8**	

* Element thickness does not contribute to total thickness (i.e. in cavity)

ASTM E90 Test Results – Airborne Sound Transmission Loss

Client: CSSBI **Test ID:** TLA-14-045

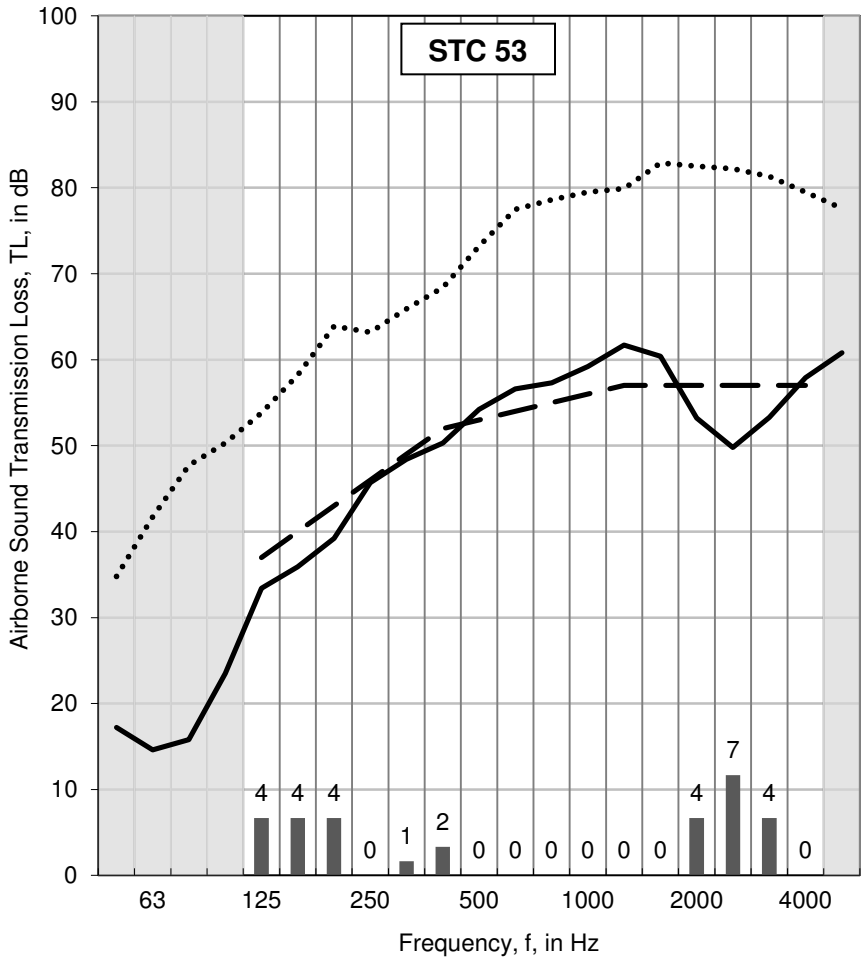
Specimen ID: A1-005007-05W **Date of Test:** 27 August 2014

Room	Volume (m³)	Air Temperature (°C)	Humidity (%)
Large	255.7	20.3 to 20.3	64.7 to 65.0
Small	140.6	19.8 to 19.9	64.4 to 64.9

Area of test specimen:	8.92 m^2
Mass of test specimen:	404.8 kg

f (Hz)	TL (dB)
50	17
63	15
80	16
100	24
125	33
160	36
200	39
250	46
315	48
400	50
500	54
630	57
800	57
1000	59
1250	62
1600	60
2000	53
2500	50
3150	53
4000	58
5000	61
Sound Transmission Class (STC)	**53**

Sum of Deficiencies (dB)
30
Max. Deficiency (dB)
7 dB at 2500 Hz



For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Airborne sound transmission loss measurements were conducted in accordance with the requirements of ASTM E90-09, "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements."**

In the graph:
The solid line is the measured sound transmission loss for this specimen. The dashed line is the STC contour fitted to the measured values according to ASTM E413-10. The dotted line (may be above the displayed range) is 10 dB below the flanking limit established for this facility. For any frequency band where the measured transmission loss is above the dotted line, the reported value is potentially limited by flanking transmission via laboratory surfaces, and the true value may be higher than that measured. Bars at the bottom of the graph show deficiencies where the measured data are less than the reference contour as described in the fitting procedure for the STC, defined in ASTM E413-10. The shaded cells in the table and areas in the graph are outside the STC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. The reported values have been corrected according to the procedure outlined in ASTM E90-09. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level, in which case, the corrected values provide an estimate of the lower limit of airborne sound transmission loss.

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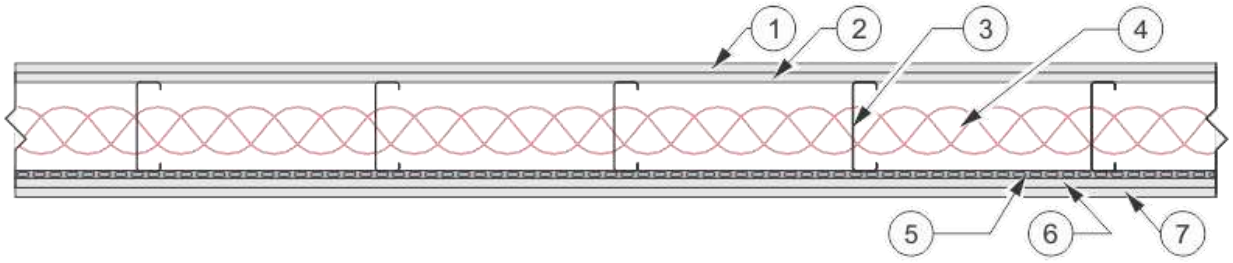
Wall assembly 06W: 2G16_SS152(406)_GFB92_RC13(406)_2G16



Description	Two layers of 15.9 mm (5/8”) gypsum board Type X, attached on each side of 152 mm (6”) deep steel studs spaced 406 mm (16”) o.c., with resilient channels on one side spaced 406 mm (16”) o.c. and 92 mm (3-5/8”) deep glass fibre insulation (R-12) in the cavity.
Side 1	• Two layers of 15.9 mm (5/8”) gypsum board Type X, installed vertically • **(2)** Base layer attached to the studs using 32 mm (1-1/4”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • **(1)** Face layer attached to base layer and studs using 41 mm (1-5/8”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • Screws from base layer to face layer offset by 152 mm (6”) • Joints of base layer Side 1 gypsum boards staggered by at least one stud spacing from joints of base layer Side 2 gypsum boards • Joints of face layer staggered by at least one stud spacing from joints of base layer • Gaps along the joints and the perimeter of face layer gypsum boards caulked and taped with aluminum tape
Framing & Cavity Insulation	• Base track and top track (steel thickness: 1.37 mm/0.054”) attached to test frame using four 19 mm (3/4”) screws (#10 wafer head) • **(3)** 152 mm (6”) deep steel C-studs (steel thickness: 1.37 mm/0.054”) spaced 406 mm (16”) o.c., attached to base track and top track using 19 mm (3/4”) screws (#10 pan head) • One through-the-knockout bridging channel, attached to each stud using 140 mm (5-1/2”) bridging clips • Flat-strap steel cross-bracing, attached on Side 1 to each stud using 19 mm (3/4”) screws (#10 pan head) • **(4)** Cavities between studs filled with 406 mm (16”) wide by 92 mm (3-5/8”) thick glass fibre insulation (R-12), cut in half to accommodate bridging channel
Side 2	• **(5)** 13 mm resilient channels installed horizontally using 19 mm (3/4”) screws (#10 wafer head), spaced 406 mm (16”) o.c. and installed according to ASTM C754-11 • Two layers of 15.9 mm (5/8”) gypsum board Type X, installed vertically

	• **(6)** Base layer attached to resilient channels using 32 mm (1-1/4”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • **(7)** Face layer attached to base layer and resilient channels using 41 mm (1-5/8”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • Screws from base layer to face layer offset by 152 mm (6”) • Joints of base layer Side 1 gypsum boards staggered by at least one stud spacing from joints of base layer Side 2 gypsum boards • Joints of face layer staggered by at least one stud spacing from joints of base layer • Gaps along the joints and the perimeter of face layer gypsum boards caulked and taped with aluminum tape

Specimen Properties

Element	Actual thickness (mm)	Mass (kg)	Mass/length, area or volume
Gypsum Board	15.9	97.8	11.0 kg/m²
Gypsum Board	15.9	97.8	11.0 kg/m²
Flat Strap	1	3.0	0.3 kg/m
Steel Studs	152	65.0	2.7 kg/m
Steel Tracks	152 *	16.6	2.3 kg/m
C Channel Bridging	1 *	1.9	0.5 kg/m
Angle Bracket	1 *	10.8	1.1 kg/piece
Glass Fibre Insulation	92 *	8.5	10.4 kg/m³
Resilient Channels	13	5.6	0.2 kg/m
Gypsum Board	15.9	97.8	11.0 kg/m²
Gypsum Board	15.9	97.8	11.0 kg/m²
Total	**229.6**	**502.6**	

* Element thickness does not contribute to total thickness (i.e. in cavity)

ASTM E90 Test Results – Airborne Sound Transmission Loss

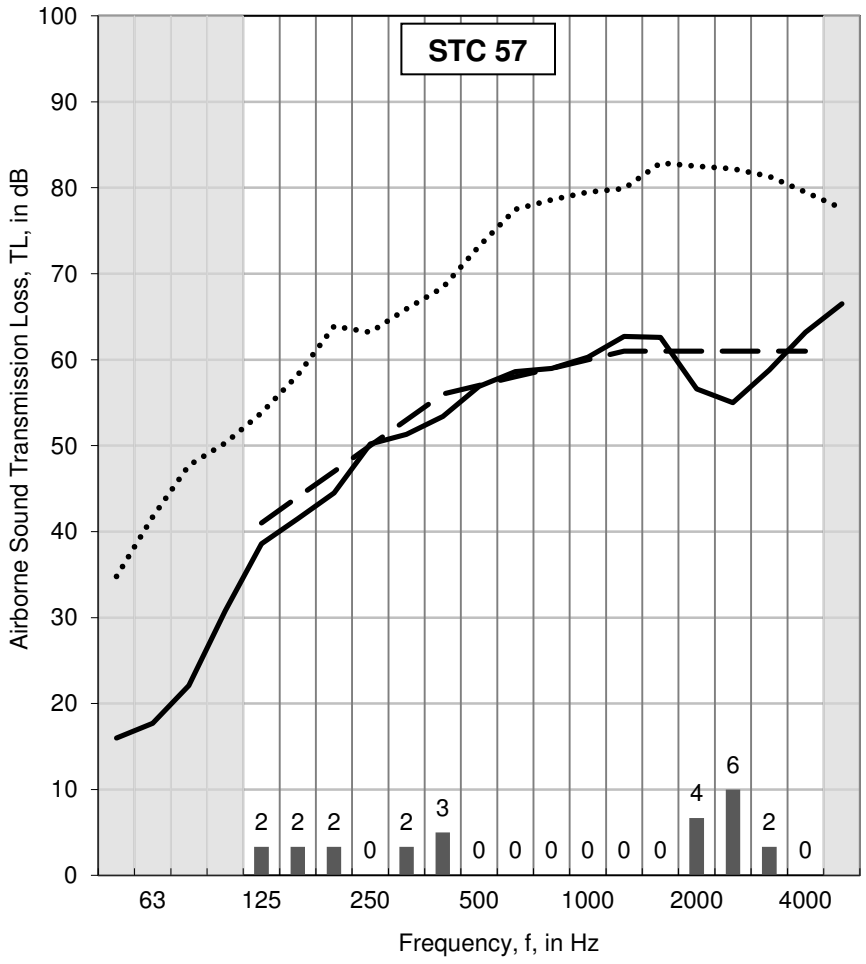
Client: CSSBI **Test ID:** TLA-14-046

Specimen ID: A1-005007-06W **Date of Test:** 28 August 2014

Room	Volume (m³)	Air Temperature (°C)	Humidity (%)
Large	255.6	20.2 to 20.3	62.7 to 64.1
Small	140.6	20.1 to 20.1	64.0 to 64.4

Area of test specimen:	8.92 m^2
Mass of test specimen:	502.6 kg

f (Hz)	TL (dB)
50	16
63	18
80	22
100	31
125	39
160	42
200	45
250	50
315	51
400	53
500	57
630	59
800	59
1000	60
1250	63
1600	63
2000	57
2500	55
3150	59
4000	63
5000	67
Sound Transmission Class (STC)	**57**



Sum of Deficiencies (dB)
23
Max. Deficiency (dB)
6 dB at 2500 Hz

For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Airborne sound transmission loss measurements were conducted in accordance with the requirements of ASTM E90-09, "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements."**

In the graph:
The solid line is the measured sound transmission loss for this specimen. The dashed line is the STC contour fitted to the measured values according to ASTM E413-10. The dotted line (may be above the displayed range) is 10 dB below the flanking limit established for this facility. For any frequency band where the measured transmission loss is above the dotted line, the reported value is potentially limited by flanking transmission via laboratory surfaces, and the true value may be higher than that measured. Bars at the bottom of the graph show deficiencies where the measured data are less than the reference contour as described in the fitting procedure for the STC, defined in ASTM E413-10. The shaded cells in the table and areas in the graph are outside the STC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. The reported values have been corrected according to the procedure outlined in ASTM E90-09. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level, in which case, the corrected values provide an estimate of the lower limit of airborne sound transmission loss.

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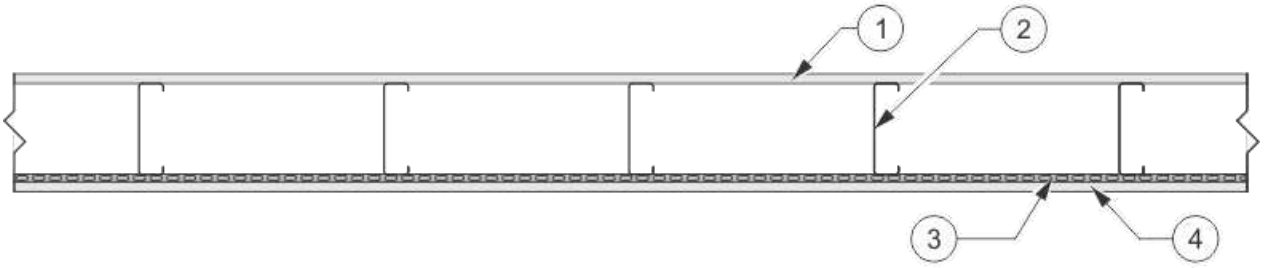
Wall assembly 07W: G16_SS152(406)_RC13(406)_G16



Description	One layer of 15.9 mm (5/8”) gypsum board Type X, attached on each side of 152 mm (6”) deep steel studs spaced 406 mm (16”) o.c., with resilient channels on one side spaced 406 mm (16”) o.c.
Side 1	• **(1)** One layer of 15.9 mm (5/8”) gypsum board Type X, installed vertically and directly attached to the studs using 32 mm (1-1/4”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • Joints of Side 1 gypsum boards staggered by at least one stud spacing from joints of Side 2 gypsum boards • Gaps along the joints and the perimeter of gypsum boards caulked and taped with aluminum tape
Framing & Cavity Insulation	• Base track and top track (steel thickness: 1.37 mm/0.054”) attached to test frame using four 19 mm (3/4”) screws (#10 wafer head) • **(2)** 152 mm (6”) deep steel C-studs (steel thickness: 1.37 mm/0.054”) spaced 406 mm (16”) o.c., attached to base track and top track using 19 mm (3/4”) screws (#10 pan head) • One through-the-knockout bridging channel, attached to each stud using 140 mm (5-1/2”) bridging clips • Flat-strap steel cross-bracing, attached on Side 1 to each stud using 19 mm (3/4”) screws (#10 pan head)
Side 2	• **(3)** 13 mm resilient channels installed horizontally using 19 mm (3/4”) screws (#10 wafer head), spaced 406 mm (16”) o.c. and installed according to ASTM C754-11 • **(4)** One layer of 15.9 mm (5/8”) gypsum board Type X, installed vertically attached to the resilient channels using 32 mm (1-1/4”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • Joints of Side 1 gypsum boards staggered by at least one stud spacing from joints of Side 2 gypsum boards • Gaps along the joints and the perimeter of gypsum boards caulked and taped with aluminum tape

Specimen Properties

Element	Actual thickness (mm)	Mass (kg)	Mass/length, area or volume
Gypsum Board	15.9	97.8	11.0 kg/m²
Flat Strap	1	3.0	0.3 kg/m
Steel Studs	152	65.0	2.7 kg/m
Steel Tracks	152 *	16.6	2.3 kg/m
C Channel Bridging	1 *	1.9	0.5 kg/m
Angle Bracket	1 *	10.8	1.1 kg/piece
Resilient Channels	13	5.6	0.2 kg/m
Gypsum Board	15.9	97.8	11.0 kg/m²
Total	**197.8**	**298.5**	

* Element thickness does not contribute to total thickness (i.e. in cavity)

ASTM E90 Test Results – Airborne Sound Transmission Loss

Client: CSSBI **Test ID:** TLA-14-047

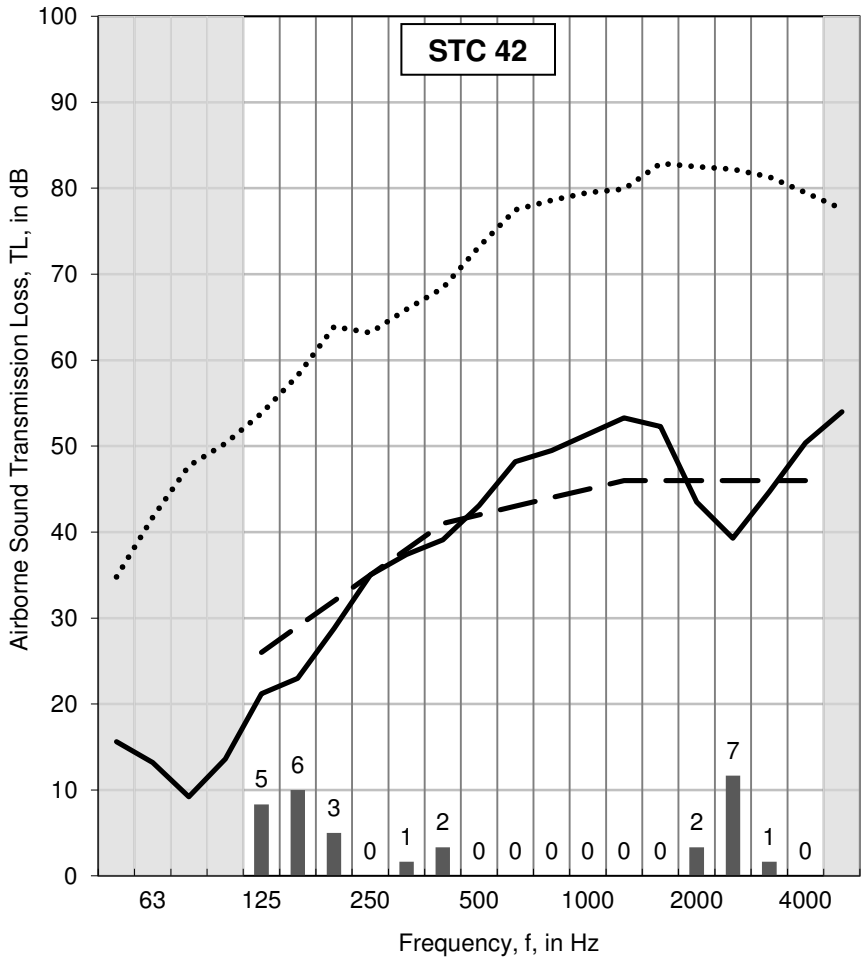
Specimen ID: A1-005007-07W **Date of Test:** 29 August 2014

Room	Volume (m³)	Air Temperature (°C)	Humidity (%)
Large	255.8	20.1 to 20.2	59.4 to 60.0
Small	140.7	19.9 to 20.0	59.5 to 59.8

Area of test specimen:	8.92 m^2
Mass of test specimen:	298.5 kg

f (Hz)	TL (dB)
50	16
63	13
80	9
100	14
125	21
160	23
200	29
250	35
315	37
400	39
500	43
630	48
800	50
1000	51
1250	53
1600	52
2000	44
2500	39
3150	45
4000	50
5000	54
Sound Transmission Class (STC)	**42**

Sum of Deficiencies (dB)
27
Max. Deficiency (dB)
7 dB at 2500 Hz



For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Airborne sound transmission loss measurements were conducted in accordance with the requirements of ASTM E90-09, "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements."**

In the graph:
The solid line is the measured sound transmission loss for this specimen. The dashed line is the STC contour fitted to the measured values according to ASTM E413-10. The dotted line (may be above the displayed range) is 10 dB below the flanking limit established for this facility. For any frequency band where the measured transmission loss is above the dotted line, the reported value is potentially limited by flanking transmission via laboratory surfaces, and the true value may be higher than that measured. Bars at the bottom of the graph show deficiencies where the measured data are less than the reference contour as described in the fitting procedure for the STC, defined in ASTM E413-10. The shaded cells in the table and areas in the graph are outside the STC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. The reported values have been corrected according to the procedure outlined in ASTM E90-09. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level, in which case, the corrected values provide an estimate of the lower limit of airborne sound transmission loss.

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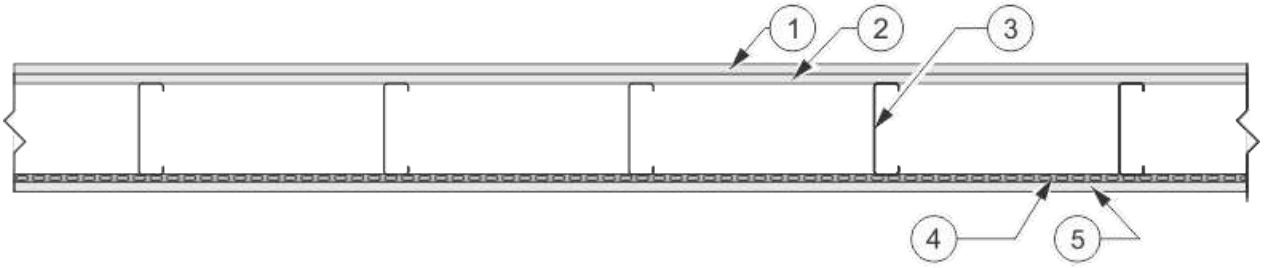
Wall assembly 08W: 2G16_SS152(406)_RC13(406)_G16



Description	Two layers of 15.9 mm (5/8”) gypsum board Type X, directly attached to one side of 152 mm (6”) deep steel studs spaced 406 mm (16”) o.c., and one layer of 15.9 mm (5/8”) gypsum board Type X attached to resilient channels spaced 406 mm (16”) o.c. on the other side.
Side 1	• Two layers of 15.9 mm (5/8”) gypsum board Type X, installed vertically • **(2)** Base layer attached to the studs using 32 mm (1-1/4”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • **(1)** Face layer attached to base layer and studs using 41 mm (1-5/8”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • Screws from base layer to face layer offset by 152 mm (6”) • Joints of base layer Side 1 gypsum boards staggered by at least one stud spacing from joints of base layer Side 2 gypsum boards • Joints of face layer staggered by at least one stud spacing from joints of base layer • Gaps along the joints and the perimeter of face layer gypsum boards caulked and taped with aluminum tape
Framing & Cavity Insulation	• Base track and top track (steel thickness: 1.37 mm/0.054”) attached to test frame using four 19 mm (3/4”) screws (#10 wafer head) • **(3)** 152 mm (6”) deep steel C-studs (steel thickness: 1.37 mm/0.054”) spaced 406 mm (16”) o.c., attached to base track and top track using 19 mm (3/4”) screws (#10 pan head) • One through-the-knockout bridging channel, attached to each stud using 140 mm (5-1/2”) bridging clips • Flat-strap steel cross-bracing, attached on Side 1 to each stud using 19 mm (3/4”) screws (#10 pan head)
Side 2	• **(4)** 13 mm resilient channels installed horizontally using 19 mm (3/4”) screws (#10 wafer head), spaced 406 mm (16”) o.c. and installed according to ASTM C754-11 • **(5)** One layer of 15.9 mm (5/8”) gypsum board Type X, installed vertically attached to the resilient channels using 32 mm (1-1/4”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • Joints of Side 1 gypsum boards staggered by at least one stud spacing

	from joints of Side 2 gypsum boards • Gaps along the joints and the perimeter of gypsum boards caulked and taped with aluminum tape

Specimen Properties

Element	Actual thickness (mm)	Mass (kg)	Mass/length, area or volume
Gypsum Board	15.9	97.8	11.0 kg/m²
Gypsum Board	15.9	97.8	11.0 kg/m²
Flat Strap	1	3.0	0.3 kg/m
Steel Studs	152	65.0	2.7 kg/m
Steel Tracks	152 *	16.6	2.3 kg/m
C Channel Bridging	1 *	1.9	0.5 kg/m
Angle Bracket	1 *	10.8	1.1 kg/piece
Resilient Channels	13	5.6	0.2 kg/m
Gypsum Board	15.9	97.8	11.0 kg/m²
Total	**213.7**	**396.3**	

* Element thickness does not contribute to total thickness (i.e. in cavity)

ASTM E90 Test Results – Airborne Sound Transmission Loss

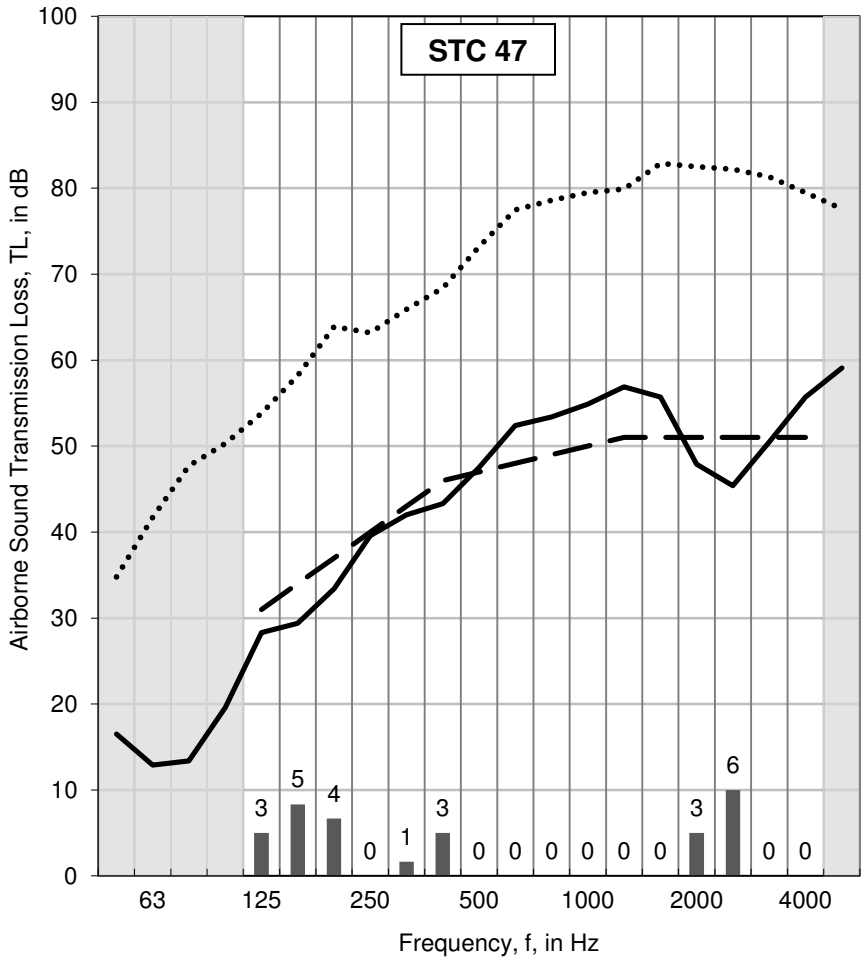
Client: CSSBI **Test ID:** TLA-14-048

Specimen ID: A1-005007-08W **Date of Test:** 29 August 2014

Room	Volume (m³)	Air Temperature (°C)	Humidity (%)
Large	256.7	20.1 to 20.2	60.3 to 60.4
Small	140.6	20.0 to 20.2	60.6 to 61.0

Area of test specimen:	8.92 m^2
Mass of test specimen:	396.3 kg

f (Hz)	TL (dB)
50	17
63	13
80	13
100	20
125	28
160	29
200	33
250	40
315	42
400	43
500	48
630	52
800	53
1000	55
1250	57
1600	56
2000	48
2500	45
3150	51
4000	56
5000	59
Sound Transmission Class (STC)	**47**



Sum of Deficiencies (dB)
25
Max. Deficiency (dB)
6 dB at 2500 Hz

For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Airborne sound transmission loss measurements were conducted in accordance with the requirements of ASTM E90-09, "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements."**

In the graph:
The solid line is the measured sound transmission loss for this specimen. The dashed line is the STC contour fitted to the measured values according to ASTM E413-10. The dotted line (may be above the displayed range) is 10 dB below the flanking limit established for this facility. For any frequency band where the measured transmission loss is above the dotted line, the reported value is potentially limited by flanking transmission via laboratory surfaces, and the true value may be higher than that measured. Bars at the bottom of the graph show deficiencies where the measured data are less than the reference contour as described in the fitting procedure for the STC, defined in ASTM E413-10. The shaded cells in the table and areas in the graph are outside the STC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. The reported values have been corrected according to the procedure outlined in ASTM E90-09. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level, in which case, the corrected values provide an estimate of the lower limit of airborne sound transmission loss.

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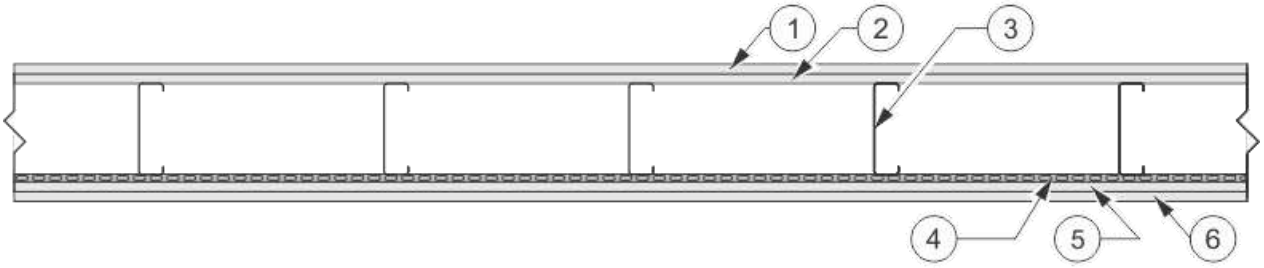
Wall assembly 09W: 2G16_SS152(406)_RC13(406)_2G16



Description	Two layers of 15.9 mm (5/8”) gypsum board Type X, attached on each side of 152 mm (6”) deep steel studs spaced 406 mm (16”) o.c., with resilient channels on one side spaced 406 mm (16”) o.c.
Side 1	• Two layers of 15.9 mm (5/8”) gypsum board Type X, installed vertically • **(2)** Base layer attached to the studs using 32 mm (1-1/4”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • **(1)** Face layer attached to base layer and studs using 41 mm (1-5/8”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • Screws from base layer to face layer offset by 152 mm (6”) • Joints of base layer Side 1 gypsum boards staggered by at least one stud spacing from joints of base layer Side 2 gypsum boards • Joints of face layer staggered by at least one stud spacing from joints of base layer • Gaps along the joints and the perimeter of face layer gypsum boards caulked and taped with aluminum tape
Framing & Cavity Insulation	• Base track and top track (steel thickness: 1.37 mm/0.054”) attached to test frame using four 19 mm (3/4”) screws (#10 wafer head) • **(3)** 152 mm (6”) deep steel C-studs (steel thickness: 1.37 mm/0.054”) spaced 406 mm (16”) o.c., attached to base track and top track using 19 mm (3/4”) screws (#10 pan head) • One through-the-knockout bridging channel, attached to each stud using 140 mm (5-1/2”) bridging clips • Flat-strap steel cross-bracing, attached on Side 1 to each stud using 19 mm (3/4”) screws (#10 pan head)
Side 2	• **(4)** 13 mm resilient channels installed horizontally using 19 mm (3/4”) screws (#10 wafer head), spaced 406 mm (16”) o.c. and installed according to ASTM C754-11 • Two layers of 15.9 mm (5/8”) gypsum board Type X, installed vertically • **(5)** Base layer attached to resilient channels using 32 mm (1-1/4”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • **(6)** Face layer attached to base layer and resilient channels using 41 mm

	(1-5/8”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • Screws from base layer to face layer offset by 152 mm (6”) • Joints of base layer Side 1 gypsum boards staggered by at least one stud spacing from joints of base layer Side 2 gypsum boards • Joints of face layer staggered by at least one stud spacing from joints of base layer • Gaps along the joints and the perimeter of face layer gypsum boards caulked and taped with aluminum tape

Specimen Properties

Element	Actual thickness (mm)	Mass (kg)	Mass/length, area or volume
Gypsum Board	15.9	97.8	11.0 kg/m²
Gypsum Board	15.9	97.8	11.0 kg/m²
Flat Strap	1	3.0	0.3 kg/m
Steel Studs	152	65.0	2.7 kg/m
Steel Tracks	152 *	16.6	2.3 kg/m
C Channel Bridging	1 *	1.9	0.5 kg/m
Angle Bracket	1 *	10.8	1.1 kg/piece
Resilient Channels	13	5.6	0.2 kg/m
Gypsum Board	15.9	97.8	11.0 kg/m²
Gypsum Board	15.9	97.8	11.0 kg/m²
Total	**229.6**	**494.1**	

* Element thickness does not contribute to total thickness (i.e. in cavity)

ASTM E90 Test Results – Airborne Sound Transmission Loss

Client: CSSBI **Test ID:** TLA-14-049

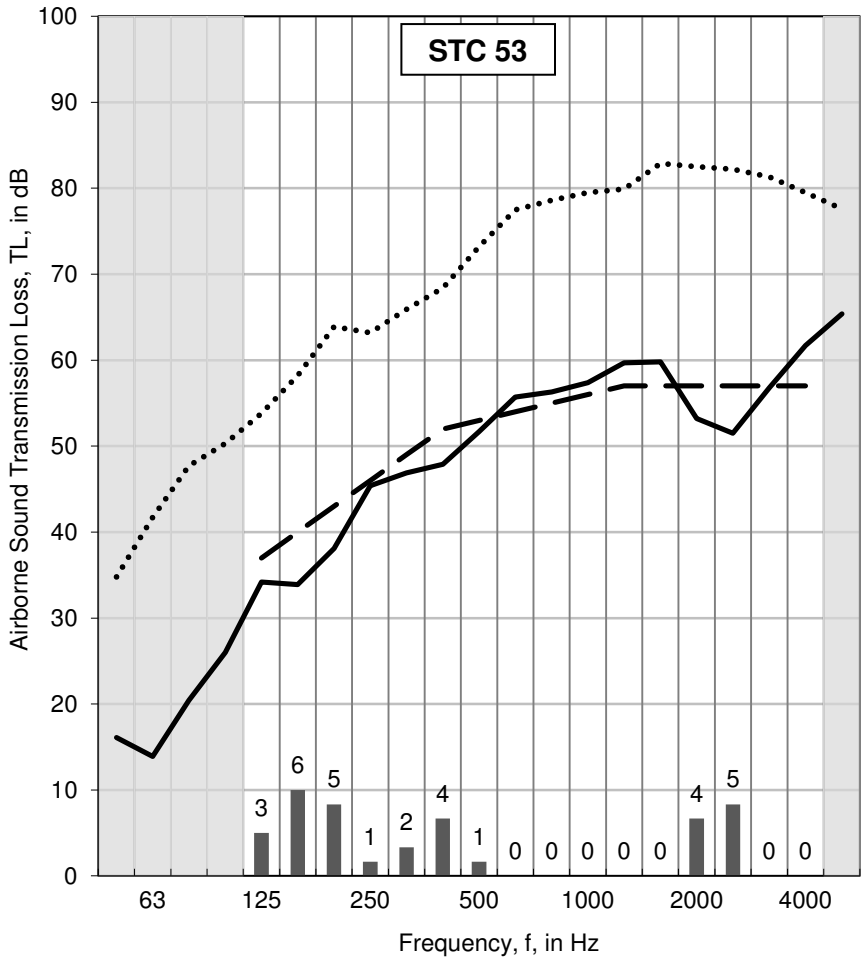
Specimen ID: A1-005007-09W **Date of Test:** 02 September 2014

Room	Volume (m³)	Air Temperature (°C)	Humidity (%)
Large	255.6	20.6 to 20.8	75.5 to 77.1
Small	140.6	20.6 to 20.6	66.9 to 69.5

Area of test specimen:	8.92 m^2
Mass of test specimen:	494.1 kg

f (Hz)	TL (dB)
50	16
63	14
80	20
100	26
125	34
160	34
200	38
250	45
315	47
400	48
500	52
630	56
800	56
1000	57
1250	60
1600	60
2000	53
2500	52
3150	57
4000	62
5000	65
Sound Transmission Class (STC)	**53**

Sum of Deficiencies (dB)
31
Max. Deficiency (dB)
6 dB at 160 Hz



For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Airborne sound transmission loss measurements were conducted in accordance with the requirements of ASTM E90-09, "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements."**

In the graph:
The solid line is the measured sound transmission loss for this specimen. The dashed line is the STC contour fitted to the measured values according to ASTM E413-10. The dotted line (may be above the displayed range) is 10 dB below the flanking limit established for this facility. For any frequency band where the measured transmission loss is above the dotted line, the reported value is potentially limited by flanking transmission via laboratory surfaces, and the true value may be higher than that measured. Bars at the bottom of the graph show deficiencies where the measured data are less than the reference contour as described in the fitting procedure for the STC, defined in ASTM E413-10. The shaded cells in the table and areas in the graph are outside the STC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. The reported values have been corrected according to the procedure outlined in ASTM E90-09. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level, in which case, the corrected values provide an estimate of the lower limit of airborne sound transmission loss.

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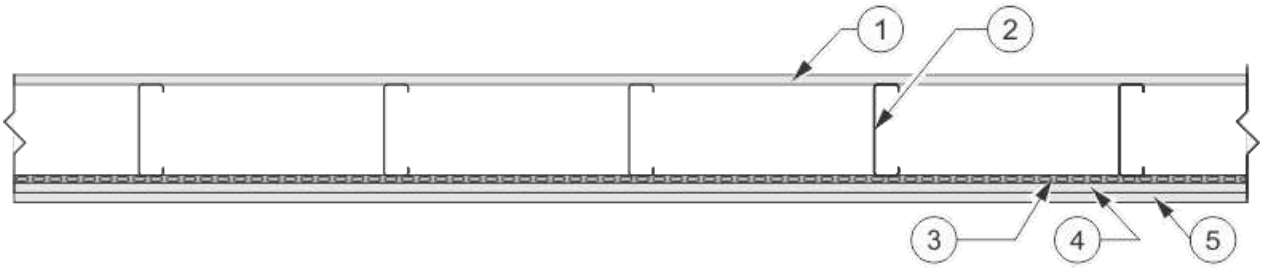
Wall assembly 10W: G16_SS152(406)_RC13(406)_2G16



Description	One layer of 15.9 mm (5/8") gypsum board Type X, directly attached on one side of 152 mm (6") deep steel studs spaced 406 mm (16") o.c., and two layers of 15.9 mm (5/8") gypsum board Type X attached to resilient channels spaced 406 mm (16") o.c. on the other side.
Side 1	• **(1)** One layer of 15.9 mm (5/8") gypsum board Type X, installed vertically and directly attached to the studs using 32 mm (1-1/4") screws (#6 scavenger head) spaced 305 mm (12") o.c. at the perimeter and in the field • Joints of Side 1 gypsum boards staggered by at least one stud spacing from joints of Side 2 gypsum boards • Gaps along the joints and the perimeter of gypsum boards caulked and taped with aluminum tape
Framing & Cavity Insulation	• Base track and top track (steel thickness: 1.37 mm/0.054") attached to test frame using four 19 mm (3/4") screws (#10 wafer head) • **(2)** 152 mm (6") deep steel C-studs (steel thickness: 1.37 mm/0.054") spaced 406 mm (16") o.c., attached to base track and top track using 19 mm (3/4") screws (#10 pan head) • One through-the-knockout bridging channel, attached to each stud using 140 mm (5-1/2") bridging clips • Flat-strap steel cross-bracing, attached on Side 1 to each stud using 19 mm (3/4") screws (#10 pan head)
Side 2	• **(3)** 13 mm resilient channels installed horizontally using 19 mm (3/4") screws (#10 wafer head), spaced 406 mm (16") o.c. and installed according to ASTM C754-11 • Two layers of 15.9 mm (5/8") gypsum board Type X, installed vertically • **(4)** Base layer attached to resilient channels using 32 mm (1-1/4") screws (#6 scavenger head) spaced 305 mm (12") o.c. at the perimeter and in the field • **(5)** Face layer attached to base layer and resilient channels using 41 mm (1-5/8") screws (#6 scavenger head) spaced 305 mm (12") o.c. at the perimeter and in the field • Screws from base layer to face layer offset by 152 mm (6") • Joints of base layer Side 1 gypsum boards staggered by at least one stud spacing from joints of base layer Side 2 gypsum boards • Joints of face layer staggered by at least one stud spacing from joints of

	base layer • Gaps along the joints and the perimeter of face layer gypsum boards caulked and taped with aluminum tape

Specimen Properties

Element	Actual thickness (mm)	Mass (kg)	Mass/length, area or volume
Gypsum Board	15.9	97.8	11.0 kg/m²
Flat Strap	1	3.0	0.3 kg/m
Steel Studs	152	65.0	2.7 kg/m
Steel Tracks	152 *	16.6	2.3 kg/m
C Channel Bridging	1 *	1.9	0.5 kg/m
Angle Bracket	1 *	10.8	1.1 kg/piece
Resilient Channels	13	5.6	0.2 kg/m
Gypsum Board	15.9	97.8	11.0 kg/m²
Gypsum Board	15.9	97.8	11.0 kg/m²
Total	**213.7**	**396.3**	

* Element thickness does not contribute to total thickness (i.e. in cavity)

ASTM E90 Test Results – Airborne Sound Transmission Loss

Client: CSSBI **Test ID:** TLA-14-050

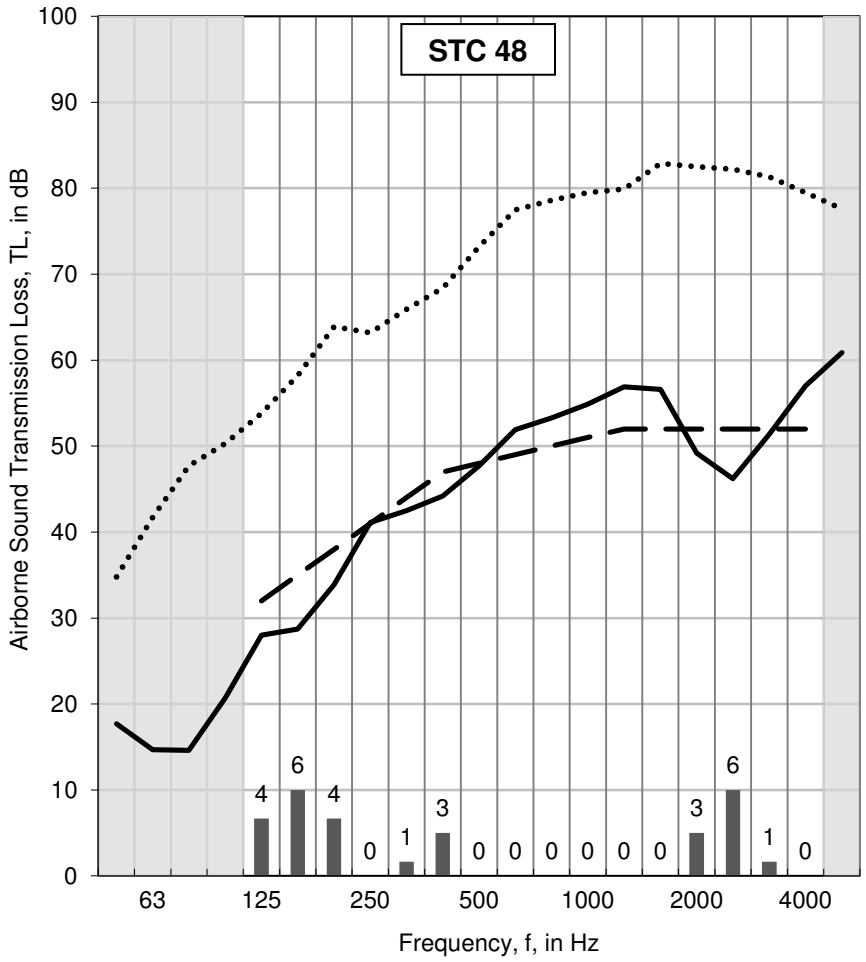
Specimen ID: A1-005007-10W **Date of Test:** 03 September 2014

Room	Volume (m³)	Air Temperature (°C)	Humidity (%)
Large	255.6	20.5 to 20.6	68.9 to 69.6
Small	140.7	20.7 to 20.8	66.3 to 67.0

Area of test specimen:	8.92 m^2
Mass of test specimen:	396.3 kg

f (Hz)	TL (dB)
50	18
63	15
80	15
100	21
125	28
160	29
200	34
250	41
315	43
400	44
500	48
630	52
800	53
1000	55
1250	57
1600	57
2000	49
2500	46
3150	51
4000	57
5000	61
Sound Transmission Class (STC)	**48**

Sum of Deficiencies (dB)
28
Max. Deficiency (dB)
6 dB at 160 Hz and 2500 Hz



For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Airborne sound transmission loss measurements were conducted in accordance with the requirements of ASTM E90-09, "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements."**

In the graph:
The solid line is the measured sound transmission loss for this specimen. The dashed line is the STC contour fitted to the measured values according to ASTM E413-10. The dotted line (may be above the displayed range) is 10 dB below the flanking limit established for this facility. For any frequency band where the measured transmission loss is above the dotted line, the reported value is potentially limited by flanking transmission via laboratory surfaces, and the true value may be higher than that measured. Bars at the bottom of the graph show deficiencies where the measured data are less than the reference contour as described in the fitting procedure for the STC, defined in ASTM E413-10. The shaded cells in the table and areas in the graph are outside the STC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. The reported values have been corrected according to the procedure outlined in ASTM E90-09. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level, in which case, the corrected values provide an estimate of the lower limit of airborne sound transmission loss.

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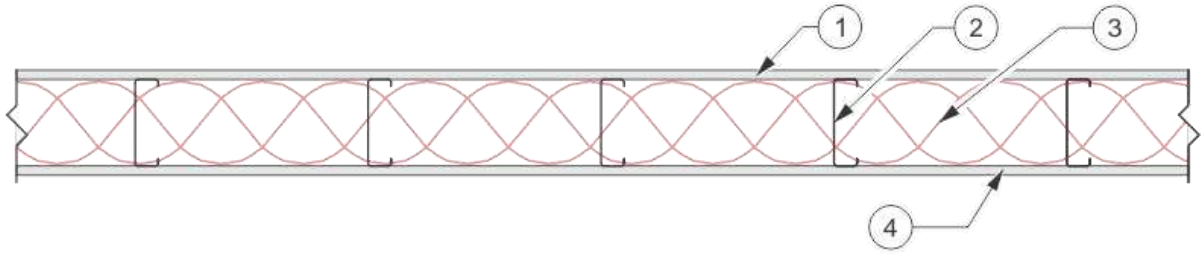
Wall assembly 11W: G16_SS152(406)_GFB152_G16



Description	One layer of 15.9 mm (5/8”) gypsum board Type X, attached on each side of 152 mm (6”) deep steel studs spaced 406 mm (16”) o.c., with 152 mm (6”) deep glass fibre insulation (R-20) in the cavity.
Side 1	• **(1)** One layer of 15.9 mm (5/8”) gypsum board Type X, installed vertically and directly attached to the studs using 32 mm (1-1/4”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • Joints of Side 1 gypsum boards staggered by at least one stud spacing from joints of Side 2 gypsum boards • Gaps along the joints and the perimeter of gypsum boards caulked and taped with aluminum tape
Framing & Cavity Insulation	• Base track and top track (steel thickness: 1.37 mm/0.054”) attached to test frame using four 19 mm (3/4”) screws (#10 wafer head) • **(2)** 152 mm (6”) deep steel C-studs (steel thickness: 1.37 mm/0.054”) spaced 406 mm (16”) o.c., attached to base track and top track using 19 mm (3/4”) screws (#10 pan head) • One through-the-knockout bridging channel, attached to each stud using 140 mm (5-1/2”) bridging clips • Flat-strap steel cross-bracing, attached on Side 1 to each stud using 19 mm (3/4”) screws (#10 pan head) • **(3)** Cavities between studs filled with 406 mm (16”) wide by 152 mm (6”) thick glass fibre insulation (R-20), cut in half to accommodate bridging channel
Side 2	• **(4)** One layer of 15.9 mm (5/8”) gypsum board Type X, installed vertically and directly attached to the studs using 32 mm (1-1/4”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • Joints of Side 1 gypsum boards staggered by at least one stud spacing from joints of Side 2 gypsum boards • Gaps along the joints and the perimeter of gypsum boards caulked and taped with aluminum tape

Specimen Properties

Element	Actual thickness (mm)	Mass (kg)	Mass/length, area or volume
Gypsum Board	15.9	97.8	11.0 kg/m²
Flat Strap	1	3.0	0.3 kg/m
Steel Studs	152	65.0	2.7 kg/m
Steel Tracks	152 *	16.6	2.3 kg/m
C Channel Bridging	1 *	1.9	0.5 kg/m
Angle Bracket	1 *	10.8	1.1 kg/piece
Glass Fibre Insulation	152 *	12.4	9.2 kg/m³
Gypsum Board	15.9	97.8	11.0 kg/m²
Total	**184.8**	**305.3**	

* Element thickness does not contribute to total thickness (i.e. in cavity)

ASTM E90 Test Results – Airborne Sound Transmission Loss

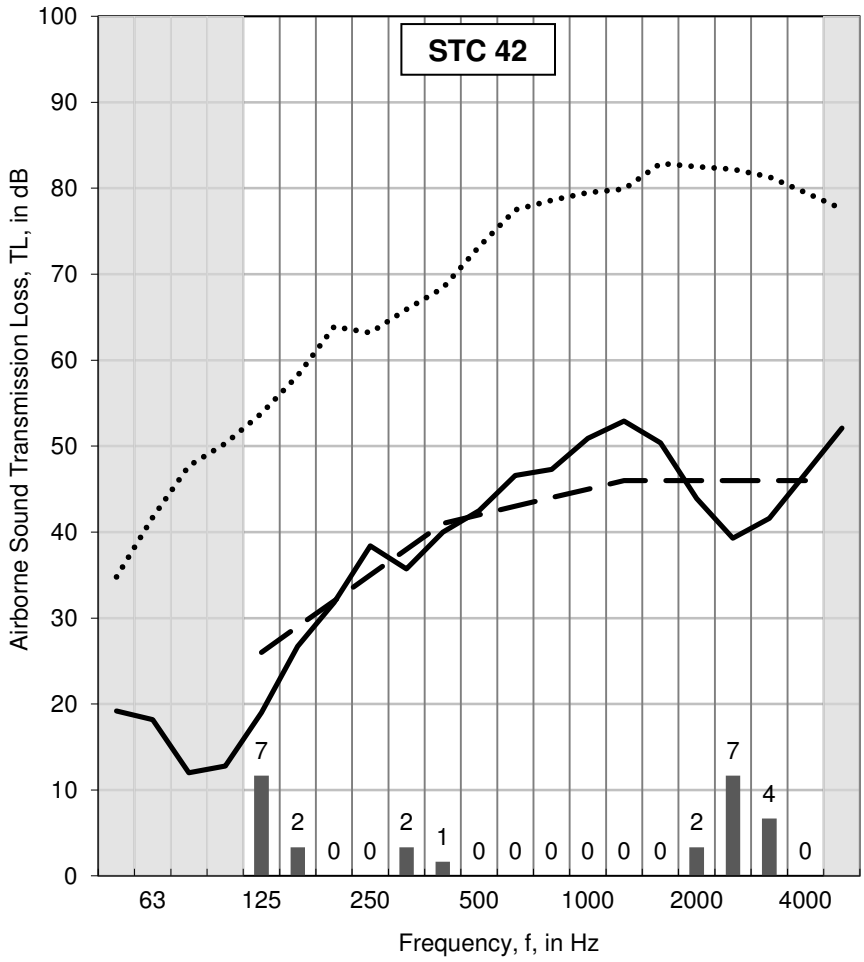
Client: CSSBI **Test ID:** TLA-14-051

Specimen ID: A1-005007-11W **Date of Test:** 03 September 2014

Room	Volume (m³)	Air Temperature (°C)	Humidity (%)
Large	255.9	20.6 to 20.8	64.1 to 65.1
Small	140.7	20.7 to 20.8	65.1 to 65.6

Area of test specimen:	8.92 m^2
Mass of test specimen:	305.3 kg

f (Hz)	TL (dB)
50	19
63	18
80	12
100	13
125	19
160	27
200	32
250	38
315	36
400	40
500	43
630	47
800	47
1000	51
1250	53
1600	50
2000	44
2500	39
3150	42
4000	47
5000	52
Sound Transmission Class (STC)	**42**



Sum of Deficiencies (dB)
25
Max. Deficiency (dB)
7 dB at 125 Hz and 2500 Hz

For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Airborne sound transmission loss measurements were conducted in accordance with the requirements of ASTM E90-09, "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements."**

In the graph:
The solid line is the measured sound transmission loss for this specimen. The dashed line is the STC contour fitted to the measured values according to ASTM E413-10. The dotted line (may be above the displayed range) is 10 dB below the flanking limit established for this facility. For any frequency band where the measured transmission loss is above the dotted line, the reported value is potentially limited by flanking transmission via laboratory surfaces, and the true value may be higher than that measured. Bars at the bottom of the graph show deficiencies where the measured data are less than the reference contour as described in the fitting procedure for the STC, defined in ASTM E413-10. The shaded cells in the table and areas in the graph are outside the STC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. The reported values have been corrected according to the procedure outlined in ASTM E90-09. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level, in which case, the corrected values provide an estimate of the lower limit of airborne sound transmission loss.

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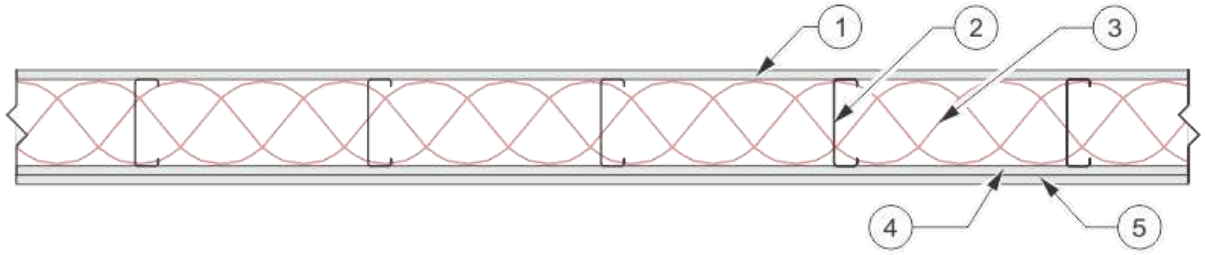
Wall assembly 12W: G16_SS152(406)_GFB152_2G16



Description	One layer of 15.9 mm (5/8”) gypsum board Type X, directly attached on one side of 152 mm (6”) deep steel studs spaced 406 mm (16”) o.c., and two layers of 15.9 mm (5/8”) gypsum board Type X, directly attached on the other side, with 152 mm (6”) deep glass fibre insulation (R-20) in the cavity.
Side 1	• **(1)** One layer of 15.9 mm (5/8”) gypsum board Type X, installed vertically and directly attached to the studs using 32 mm (1-1/4”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • Joints of Side 1 gypsum boards staggered by at least one stud spacing from joints of Side 2 gypsum boards • Gaps along the joints and the perimeter of gypsum boards caulked and taped with aluminum tape
Framing & Cavity Insulation	• Base track and top track (steel thickness: 1.37 mm/0.054”) attached to test frame using four 19 mm (3/4”) screws (#10 wafer head) • **(2)** 152 mm (6”) deep steel C-studs (steel thickness: 1.37 mm/0.054”) spaced 406 mm (16”) o.c., attached to base track and top track using 19 mm (3/4”) screws (#10 pan head) • One through-the-knockout bridging channel, attached to each stud using 140 mm (5-1/2”) bridging clips • Flat-strap steel cross-bracing, attached on Side 1 to each stud using 19 mm (3/4”) screws (#10 pan head) • **(3)** Cavities between studs filled with 406 mm (16”) wide by 152 mm (6”) thick glass fibre insulation (R-20), cut in half to accommodate bridging channel
Side 2	• Two layers of 15.9 mm (5/8”) gypsum board Type X, installed vertically • **(4)** Base layer directly attached to the studs using 32 mm (1-1/4”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • **(5)** Face layer attached to base layer and studs using 41 mm (1-5/8”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • Screws from base layer to face layer offset by 152 mm (6”) • Joints of base layer Side 1 gypsum boards staggered by at least one stud spacing from joints of base layer Side 2 gypsum boards • Joints of face layer staggered by at least one stud spacing from joints of

	base layer • Gaps along the joints and the perimeter of face layer gypsum boards caulked and taped with aluminum tape

Specimen Properties

Element	Actual thickness (mm)	Mass (kg)	Mass/length, area or volume
Gypsum Board	15.9	97.8	11.0 kg/m²
Flat Strap	1	3.0	0.3 kg/m
Steel Studs	152	65.0	2.7 kg/m
Steel Tracks	152 *	16.6	2.3 kg/m
C Channel Bridging	1 *	1.9	0.5 kg/m
Angle Bracket	1 *	10.8	1.1 kg/piece
Glass Fibre Insulation	152 *	12.4	9.2 kg/m³
Gypsum Board	15.9	97.8	11.0 kg/m²
Gypsum Board	15.9	97.8	11.0 kg/m²
Total	**200.7**	**403.1**	

* Element thickness does not contribute to total thickness (i.e. in cavity)

ASTM E90 Test Results – Airborne Sound Transmission Loss

Client: CSSBI **Test ID:** TLA-14-052

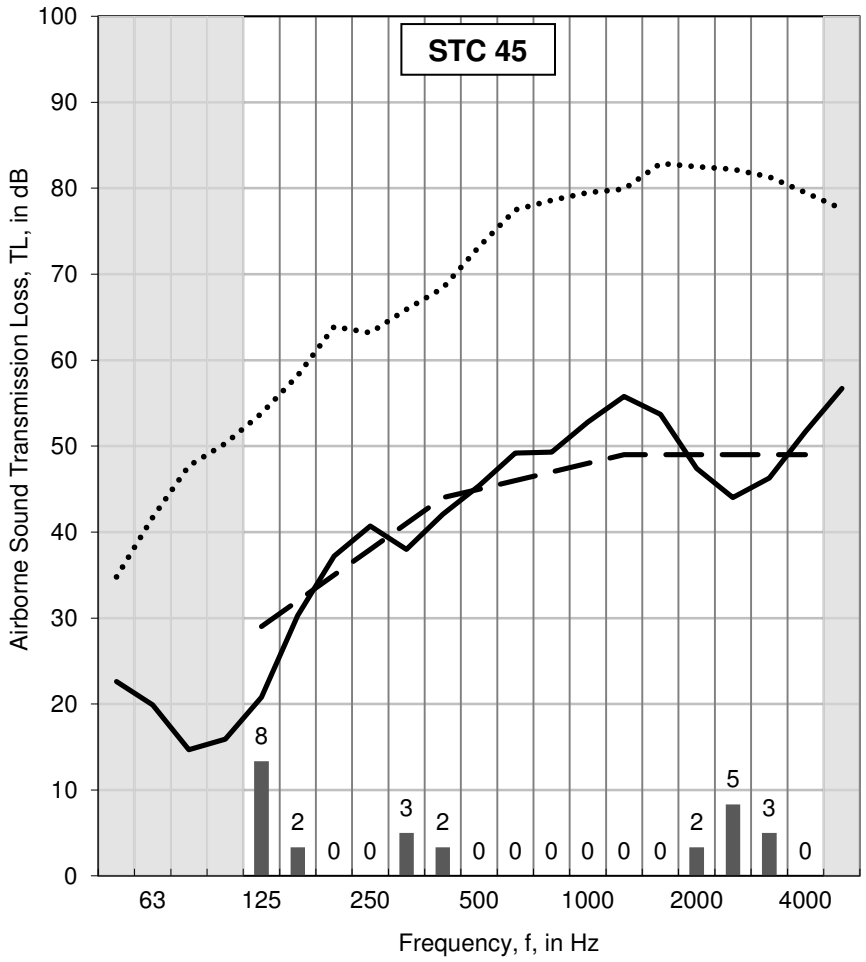
Specimen ID: A1-005007-12W **Date of Test:** 05 September 2014

Room	Volume (m³)	Air Temperature (°C)	Humidity (%)
Large	255.7	20.7 to 20.8	70.6 to 71.0
Small	140.7	20.8 to 20.9	65.2 to 66.1

Area of test specimen:	8.92 m^2
Mass of test specimen:	403.1 kg

f (Hz)	TL (dB)
50	23
63	20
80	15
100	16
125	21
160	30
200	37
250	41
315	38
400	42
500	45
630	49
800	49
1000	53
1250	56
1600	54
2000	47
2500	44
3150	46
4000	52
5000	57
Sound Transmission Class (STC)	**45**

Sum of Deficiencies (dB)
25
Max. Deficiency (dB)
8 dB at 125 Hz



For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Airborne sound transmission loss measurements were conducted in accordance with the requirements of ASTM E90-09, "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements."**

In the graph:
The solid line is the measured sound transmission loss for this specimen. The dashed line is the STC contour fitted to the measured values according to ASTM E413-10. The dotted line (may be above the displayed range) is 10 dB below the flanking limit established for this facility. For any frequency band where the measured transmission loss is above the dotted line, the reported value is potentially limited by flanking transmission via laboratory surfaces, and the true value may be higher than that measured. Bars at the bottom of the graph show deficiencies where the measured data are less than the reference contour as described in the fitting procedure for the STC, defined in ASTM E413-10. The shaded cells in the table and areas in the graph are outside the STC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. The reported values have been corrected according to the procedure outlined in ASTM E90-09. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level, in which case, the corrected values provide an estimate of the lower limit of airborne sound transmission loss.

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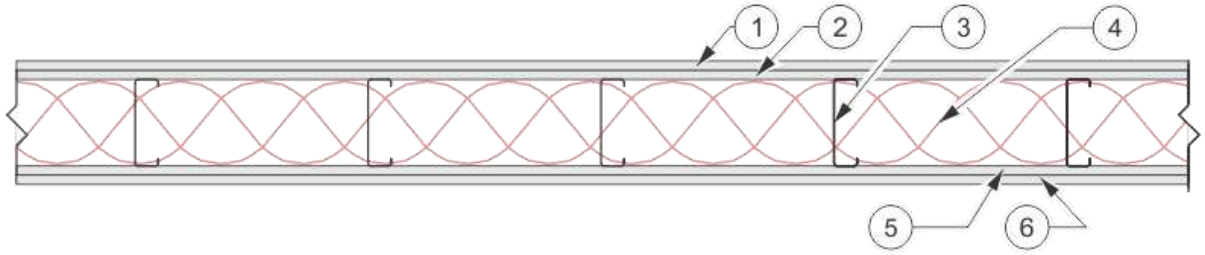
Wall assembly 13W: 2G16_SS152(406)_GFB152_2G16



Description	Two layers of 15.9 mm (5/8") gypsum board Type X, attached on each side of 152 mm (6") deep steel studs spaced 406 mm (16") o.c., with 152 mm (6") deep glass fibre insulation (R-20) in the cavity.
Side 1	• Two layers of 15.9 mm (5/8") gypsum board Type X, installed vertically • **(2)** Base layer attached to the studs using 32 mm (1-1/4") screws (#6 scavenger head) spaced 305 mm (12") o.c. at the perimeter and in the field • **(1)** Face layer attached to base layer and studs using 41 mm (1-5/8") screws (#6 scavenger head) spaced 305 mm (12") o.c. at the perimeter and in the field • Screws from base layer to face layer offset by 152 mm (6") • Joints of base layer Side 1 gypsum boards staggered by at least one stud spacing from joints of base layer Side 2 gypsum boards • Joints of face layer staggered by at least one stud spacing from joints of base layer • Gaps along the joints and the perimeter of face layer gypsum boards caulked and taped with aluminum tape
Framing & Cavity Insulation	• Base track and top track (steel thickness: 1.37 mm/0.054") attached to test frame using four 19 mm (3/4") screws (#10 wafer head) • **(3)** 152 mm (6") deep steel C-studs (steel thickness: 1.37 mm/0.054") spaced 406 mm (16") o.c., attached to base track and top track using 19 mm (3/4") screws (#10 pan head) • One through-the-knockout bridging channel, attached to each stud using 140 mm (5-1/2") bridging clips • Flat-strap steel cross-bracing, attached on Side 1 to each stud using 19 mm (3/4") screws (#10 pan head) • **(4)** Cavities between studs filled with 406 mm (16") wide by 152 mm (6") thick glass fibre insulation (R-20), cut in half to accommodate bridging channel
Side 2	• Two layers of 15.9 mm (5/8") gypsum board Type X, installed vertically • **(5)** Base layer directly attached to the studs using 32 mm (1-1/4") screws (#6 scavenger head) spaced 305 mm (12") o.c. at the perimeter and in the field • **(6)** Face layer attached to base layer and studs using 41 mm (1-5/8") screws (#6 scavenger head) spaced 305 mm (12") o.c. at the perimeter

	and in the field • Screws from base layer to face layer offset by 152 mm (6”) • Joints of base layer Side 1 gypsum boards staggered by at least one stud spacing from joints of base layer Side 2 gypsum boards • Joints of face layer staggered by at least one stud spacing from joints of base layer • Gaps along the joints and the perimeter of face layer gypsum boards caulked and taped with aluminum tape

Specimen Properties

Element	Actual thickness (mm)	Mass (kg)	Mass/length, area or volume
Gypsum Board	15.9	97.8	11.0 kg/m²
Gypsum Board	15.9	97.8	11.0 kg/m²
Flat Strap	1	3.0	0.3 kg/m
Steel Studs	152	65.0	2.7 kg/m
Steel Tracks	152 *	16.6	2.3 kg/m
C Channel Bridging	1 *	1.9	0.5 kg/m
Angle Bracket	1 *	10.8	1.1 kg/piece
Glass Fibre Insulation	152 *	12.4	9.2 kg/m³
Gypsum Board	15.9	97.8	11.0 kg/m²
Gypsum Board	15.9	97.8	11.0 kg/m²
Total	**216.6**	**500.9**	

* Element thickness does not contribute to total thickness (i.e. in cavity)

ASTM E90 Test Results – Airborne Sound Transmission Loss

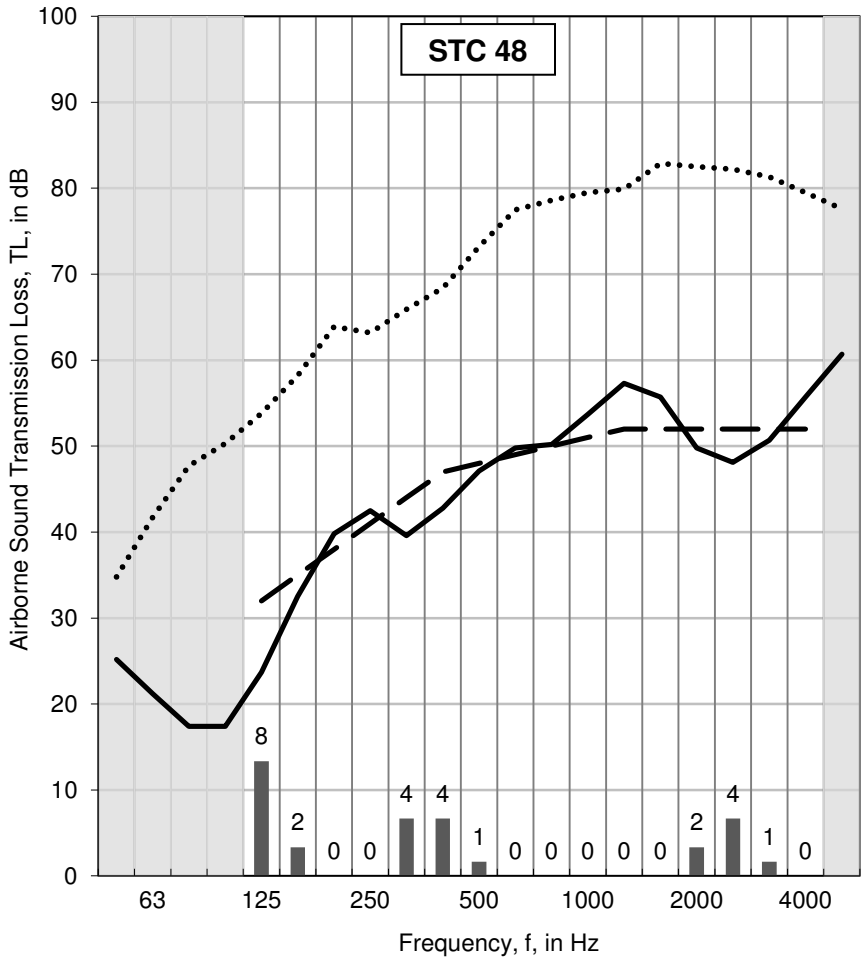
Client: CSSBI **Test ID:** TLA-14-053

Specimen ID: A1-005007-13W **Date of Test:** 05 September 2014

Room	Volume (m³)	Air Temperature (°C)	Humidity (%)
Large	255.7	20.8 to 20.8	71.6 to 72.6
Small	140.6	21.0 to 21.1	70.7 to 73.4

Area of test specimen:	8.92 m^2
Mass of test specimen:	500.9 kg

f (Hz)	TL (dB)
50	25
63	21
80	17
100	17
125	24
160	33
200	40
250	43
315	40
400	43
500	47
630	50
800	50
1000	54
1250	57
1600	56
2000	50
2500	48
3150	51
4000	56
5000	61
Sound Transmission Class (STC)	**48**



Sum of Deficiencies (dB)
26
Max. Deficiency (dB)
8 dB at 125 Hz

For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Airborne sound transmission loss measurements were conducted in accordance with the requirements of ASTM E90-09, "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements."**

In the graph:
The solid line is the measured sound transmission loss for this specimen. The dashed line is the STC contour fitted to the measured values according to ASTM E413-10. The dotted line (may be above the displayed range) is 10 dB below the flanking limit established for this facility. For any frequency band where the measured transmission loss is above the dotted line, the reported value is potentially limited by flanking transmission via laboratory surfaces, and the true value may be higher than that measured. Bars at the bottom of the graph show deficiencies where the measured data are less than the reference contour as described in the fitting procedure for the STC, defined in ASTM E413-10. The shaded cells in the table and areas in the graph are outside the STC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. The reported values have been corrected according to the procedure outlined in ASTM E90-09. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level, in which case, the corrected values provide an estimate of the lower limit of airborne sound transmission loss.

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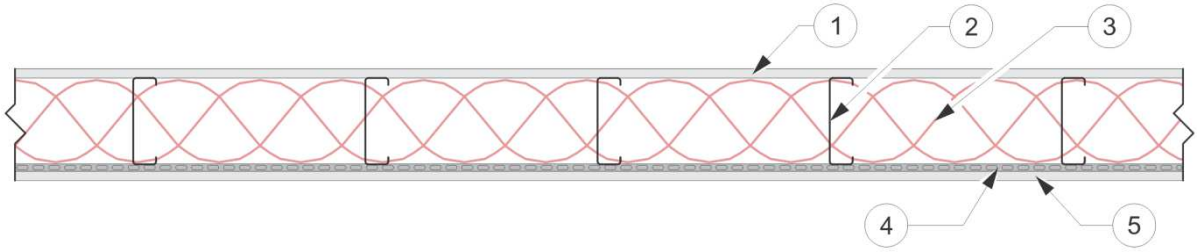
Wall assembly 14W: G16_SS152(406)_GFB152_RC13(406)_G16



Description	One layer of 15.9 mm (5/8”) gypsum board Type X, attached on each side of 152 mm (6”) deep steel studs spaced 406 mm (16”) o.c., with resilient channels on one side spaced 406 mm (16”) o.c. and 152 mm (6”) deep glass fibre insulation (R-20) in the cavity.
Side 1	• **(1)** One layer of 15.9 mm (5/8”) gypsum board Type X, installed vertically, directly attached to the studs using 32 mm (1-1/4”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • Joints of Side 1 gypsum boards staggered by at least one stud spacing from joints of Side 2 gypsum boards • Gaps along the joints and the perimeter of gypsum boards caulked and taped with aluminum tape
Framing & Cavity Insulation	• Base track and top track (steel thickness: 1.37 mm/0.054”) attached to test frame using four 19 mm (3/4”) screws (#10 wafer head) • **(2)** 152 mm (6”) deep steel C-studs (steel thickness: 1.37 mm/0.054”) spaced 406 mm (16”) o.c., attached to base track and top track using 19 mm (3/4”) screws (#10 pan head) • One through-the-knockout bridging channel, attached to each stud using 140 mm (5-1/2”) bridging clips • Flat-strap steel cross-bracing, attached on Side 1 to each stud using 19 mm (3/4”) screws (#10 pan head) • **(3)** Cavities between studs filled with 406 mm (16”) wide by 152 mm (6”) thick glass fibre insulation (R-20), cut in half to accommodate bridging channel
Side 2	• **(4)** 13 mm resilient channels installed horizontally using 19 mm (3/4”) screws (#10 wafer head), spaced 406 mm (16”) o.c. and installed according to ASTM C754-11 • **(5)** One layer of 15.9 mm (5/8”) gypsum board Type X, installed vertically, attached to resilient channels using 32 mm (1-1/4”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • Joints of Side 1 gypsum boards staggered by at least one stud spacing from joints of Side 2 gypsum boards • Gaps along the joints and the perimeter of gypsum boards caulked and taped with aluminum tape

Specimen Properties

Element	Actual thickness (mm)	Mass (kg)	Mass/length, area or volume
Gypsum Board	15.9	97.8	11.0 kg/m²
Flat Strap	1	3.0	0.3 kg/m
Steel Studs	152	65.0	2.7 kg/m
Steel Tracks	152 *	16.6	2.3 kg/m
C Channel Bridging	1 *	1.9	0.5 kg/m
Angle Bracket	1 *	10.8	1.1 kg/piece
Glass Fibre Insulation	152 *	12.4	9.2 kg/m³
Resilient Channels	13	5.6	0.2 kg/m
Gypsum Board	15.9	97.8	11.0 kg/m²
Total	**197.8**	**310.9**	

* Element thickness does not contribute to total thickness (i.e. in cavity)

ASTM E90 Test Results – Airborne Sound Transmission Loss

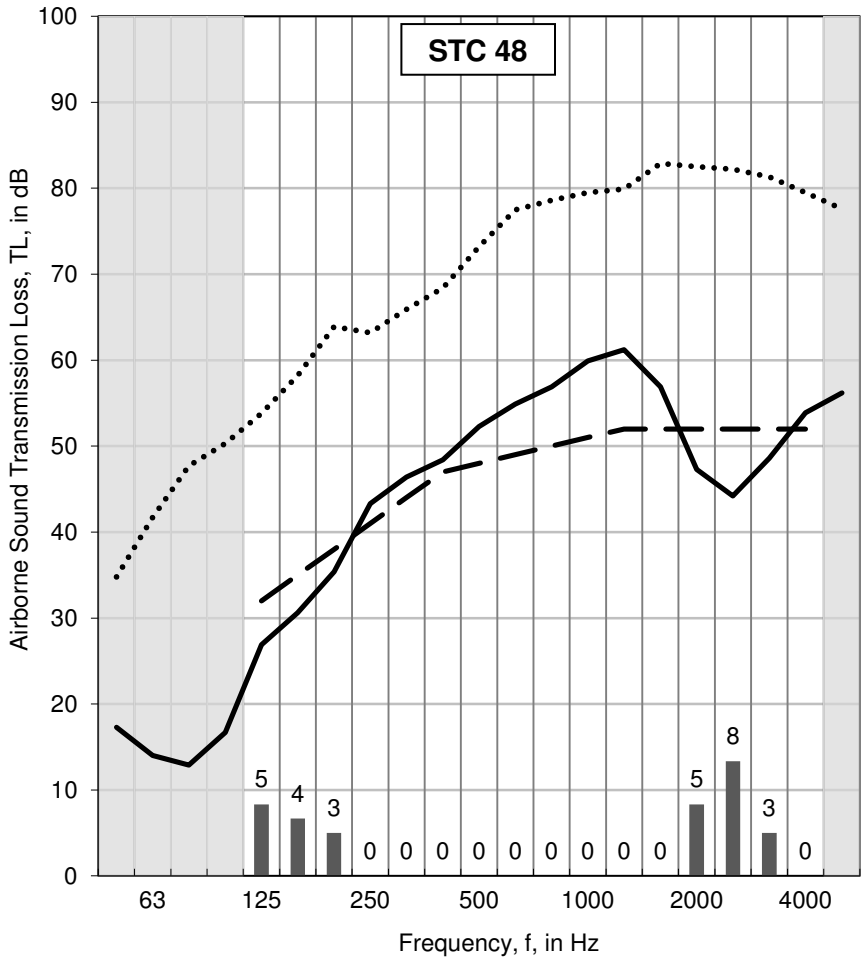
Client: CSSBI **Test ID:** TLA-14-055

Specimen ID: A1-005007-14W **Date of Test:** 10 September 2014

Room	Volume (m³)	Air Temperature (°C)	Humidity (%)
Large	256.1	20.5 to 20.6	67.2 to 67.3
Small	140.5	20.8 to 20.9	63.8 to 64.3

Area of test specimen:	8.92 m^2
Mass of test specimen:	310.9 kg

f (Hz)	TL (dB)
50	17
63	14
80	13
100	17
125	27
160	31
200	35
250	43
315	46
400	48
500	52
630	55
800	57
1000	60
1250	61
1600	57
2000	47
2500	44
3150	49
4000	54
5000	56
Sound Transmission Class (STC)	**48**



Sum of Deficiencies (dB)
28
Max. Deficiency (dB)
8 dB at 2500 Hz

For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Airborne sound transmission loss measurements were conducted in accordance with the requirements of ASTM E90-09, "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements."**

In the graph:
The solid line is the measured sound transmission loss for this specimen. The dashed line is the STC contour fitted to the measured values according to ASTM E413-10. The dotted line (may be above the displayed range) is 10 dB below the flanking limit established for this facility. For any frequency band where the measured transmission loss is above the dotted line, the reported value is potentially limited by flanking transmission via laboratory surfaces, and the true value may be higher than that measured. Bars at the bottom of the graph show deficiencies where the measured data are less than the reference contour as described in the fitting procedure for the STC, defined in ASTM E413-10. The shaded cells in the table and areas in the graph are outside the STC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. The reported values have been corrected according to the procedure outlined in ASTM E90-09. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level, in which case, the corrected values provide an estimate of the lower limit of airborne sound transmission loss.

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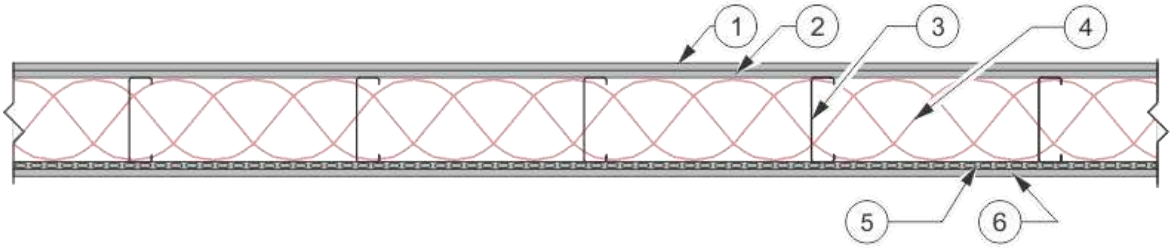
Wall assembly 15W: 2G16_SS152(406)_GFB152_RC13(406)_G16



Description	Two layers of 15.9 mm (5/8”) gypsum board Type X, directly attached to one side of 152 mm (6”) deep steel studs spaced 406 mm (16”) o.c., and one layer of 15.9 mm (5/8”) gypsum board Type X attached to resilient channels spaced 406 mm (16”) o.c. on the other side, with 92 mm (3-5/8”) deep glass fibre insulation (R-12) in the cavity.
Side 1	• Two layers of 15.9 mm (5/8”) gypsum board Type X, installed vertically • **(2)** Base layer attached to the studs using 32 mm (1-1/4”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • **(1)** Face layer attached to base layer and studs using 41 mm (1-5/8”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • Screws from base layer to face layer offset by 152 mm (6”) • Joints of base layer Side 1 gypsum boards staggered by at least one stud spacing from joints of base layer Side 2 gypsum boards • Joints of face layer staggered by at least one stud spacing from joints of base layer • Gaps along the joints and the perimeter of face layer gypsum boards caulked and taped with aluminum tape
Framing & Cavity Insulation	• Base track and top track (steel thickness: 1.37 mm/0.054”) attached to test frame using four 19 mm (3/4”) screws (#10 wafer head) • **(3)** 152 mm (6”) deep steel C-studs (steel thickness: 1.37 mm/0.054”) spaced 406 mm (16”) o.c., attached to base track and top track using 19 mm (3/4”) screws (#10 pan head) • One through-the-knockout bridging channel, attached to each stud using 140 mm (5-1/2”) bridging clips • Flat-strap steel cross-bracing, attached on Side 1 to each stud using 19 mm (3/4”) screws (#10 pan head) • **(4)** Cavities between studs filled with 406 mm (16”) wide by 152 mm (6”) thick glass fibre insulation (R-20), cut in half to accommodate bridging channel
Side 2	• **(5)** 13 mm resilient channels installed horizontally using 19 mm (3/4”) screws (#10 wafer head), spaced 406 mm (16”) o.c. and installed according to ASTM C754-11

	• **(6)** One layer of 15.9 mm (5/8”) gypsum board Type X, installed vertically and attached to resilient channels using 32 mm (1-1/4”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • Joints of Side 1 gypsum boards staggered by at least one stud spacing from joints of Side 2 gypsum boards • Gaps along the joints and the perimeter of gypsum boards caulked and taped with aluminum tape

Specimen Properties

Element	Actual thickness (mm)	Mass (kg)	Mass/length, area or volume
Gypsum Board	15.9	97.8	11.0 kg/m²
Gypsum Board	15.9	97.8	11.0 kg/m²
Flat Strap	1	3.0	0.3 kg/m
Steel Studs	152	65.0	2.7 kg/m
Steel Tracks	152 *	16.6	2.3 kg/m
C Channel Bridging	1 *	1.9	0.5 kg/m
Angle Bracket	1 *	10.8	1.1 kg/piece
Glass Fibre Insulation	152 *	12.4	9.2 kg/m³
Resilient Channels	13	5.6	0.2 kg/m
Gypsum Board	15.9	97.8	11.0 kg/m²
Total	**213.7**	**408.7**	

* Element thickness does not contribute to total thickness (i.e. in cavity)

ASTM E90 Test Results – Airborne Sound Transmission Loss

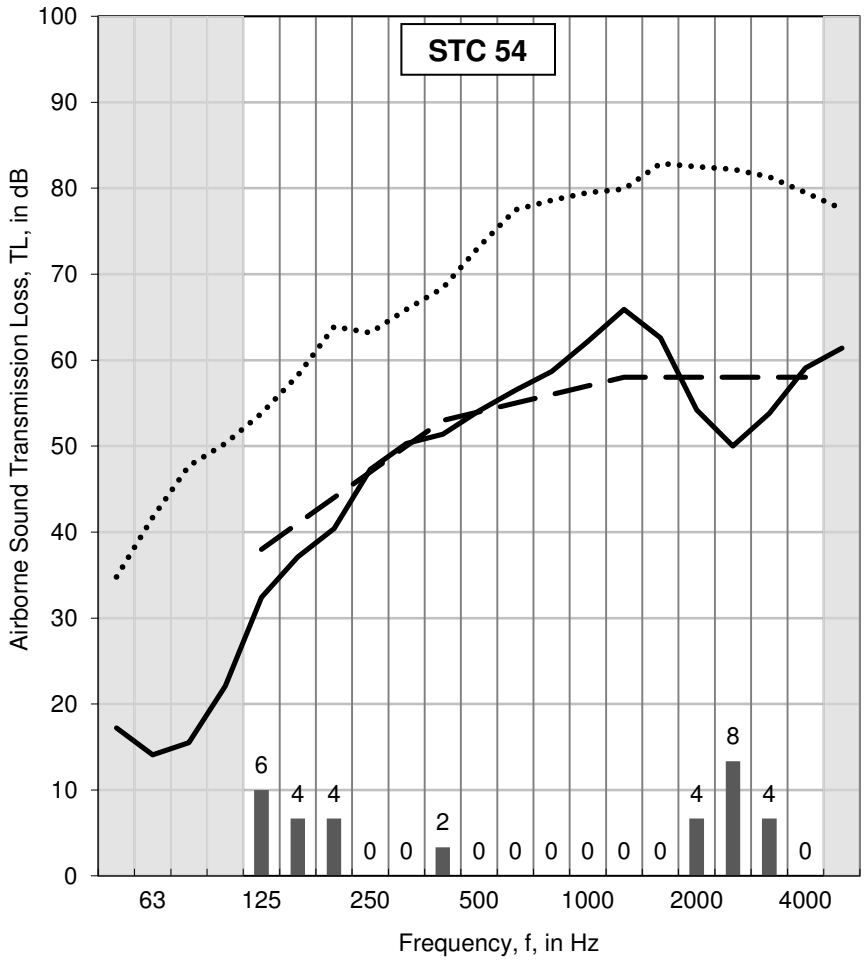
Client: CSSBI **Test ID:** TLA-14-056

Specimen ID: A1-005007-15W **Date of Test:** 11 September 2014

Room	Volume (m³)	Air Temperature (°C)	Humidity (%)
Large	256.1	20.4 to 20.6	69.9 to 72.5
Small	140.3	21.0 to 21.0	73.4 to 75.5

Area of test specimen:	8.92 m^2
Mass of test specimen:	408.7 kg

f (Hz)	TL (dB)
50	17
63	14
80	16
100	22
125	32
160	37
200	40
250	47
315	50
400	51
500	54
630	57
800	59
1000	62
1250	66
1600	63
2000	54
2500	50
3150	54
4000	59
5000	61
Sound Transmission Class (STC)	**54**



Sum of Deficiencies (dB)
32
Max. Deficiency (dB)
8 dB at 2500 Hz

For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Airborne sound transmission loss measurements were conducted in accordance with the requirements of ASTM E90-09, "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements."**

In the graph:
The solid line is the measured sound transmission loss for this specimen. The dashed line is the STC contour fitted to the measured values according to ASTM E413-10. The dotted line (may be above the displayed range) is 10 dB below the flanking limit established for this facility. For any frequency band where the measured transmission loss is above the dotted line, the reported value is potentially limited by flanking transmission via laboratory surfaces, and the true value may be higher than that measured. Bars at the bottom of the graph show deficiencies where the measured data are less than the reference contour as described in the fitting procedure for the STC, defined in ASTM E413-10. The shaded cells in the table and areas in the graph are outside the STC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. The reported values have been corrected according to the procedure outlined in ASTM E90-09. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level, in which case, the corrected values provide an estimate of the lower limit of airborne sound transmission loss.

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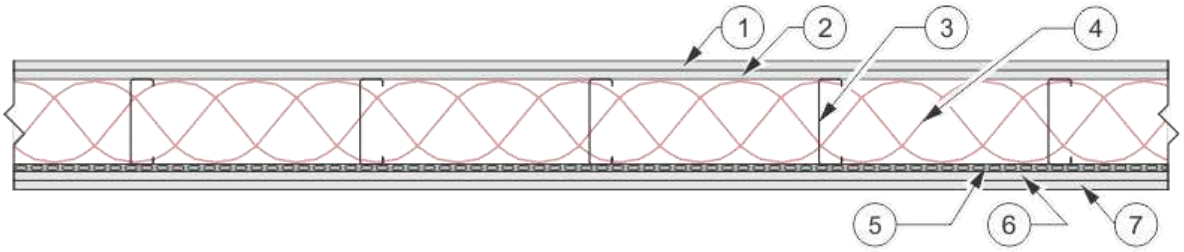
Wall assembly 16W: 2G16_SS152(406)_GFB152_RC13(406)_2G16



Description	Two layers of 15.9 mm (5/8”) gypsum board Type X, attached on each side of 152 mm (6”) deep steel studs spaced 406 mm (16”) o.c., with resilient channels on one side spaced 406 mm (16”) o.c. and 152 mm (6”) deep glass fibre insulation (R-20) in the cavity.
Side 1	• Two layers of 15.9 mm (5/8”) gypsum board Type X, installed vertically • **(2)** Base layer attached to the studs using 32 mm (1-1/4”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • **(1)** Face layer attached to base layer and studs using 41 mm (1-5/8”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • Screws from base layer to face layer offset by 152 mm (6”) • Joints of base layer Side 1 gypsum boards staggered by at least one stud spacing from joints of base layer Side 2 gypsum boards • Joints of face layer staggered by at least one stud spacing from joints of base layer • Gaps along the joints and the perimeter of face layer gypsum boards caulked and taped with aluminum tape
Framing & Cavity Insulation	• Base track and top track (steel thickness: 1.37 mm/0.054”) attached to test frame using four 19 mm (3/4”) screws (#10 wafer head) • **(3)** 152 mm (6”) deep steel C-studs (steel thickness: 1.37 mm/0.054”) spaced 406 mm (16”) o.c., attached to base track and top track using 19 mm (3/4”) screws (#10 pan head) • One through-the-knockout bridging channel, attached to each stud using 140 mm (5-1/2”) bridging clips • Flat-strap steel cross-bracing, attached on Side 1 to each stud using 19 mm (3/4”) screws (#10 pan head) • **(4)** Cavities between studs filled with 406 mm (16”) wide by 152 mm (6”) thick glass fibre insulation (R-20), cut in half to accommodate bridging channel
Side 2	• **(5)** 13 mm resilient channels installed horizontally using 19 mm (3/4”) screws (#10 wafer head), spaced 406 mm (16”) o.c. and installed according to ASTM C754-11 • Two layers of 15.9 mm (5/8”) gypsum board Type X, installed vertically

	• **(6)** Base layer attached to resilient channels using 32 mm (1-1/4”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • **(7)** Face layer attached to base layer and resilient channels using 41 mm (1-5/8”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • Screws from base layer to face layer offset by 152 mm (6”) • Joints of base layer Side 1 gypsum boards staggered by at least one stud spacing from joints of base layer Side 2 gypsum boards • Joints of face layer staggered by at least one stud spacing from joints of base layer • Gaps along the joints and the perimeter of face layer gypsum boards caulked and taped with aluminum tape

Specimen Properties

Element	Actual thickness (mm)	Mass (kg)	Mass/length, area or volume
Gypsum Board	15.9	97.8	11.0 kg/m²
Gypsum Board	15.9	97.8	11.0 kg/m²
Flat Strap	1	3.0	0.3 kg/m
Steel Studs	152	65.0	2.7 kg/m
Steel Tracks	152 *	16.6	2.3 kg/m
C Channel Bridging	1 *	1.9	0.5 kg/m
Angle Bracket	1 *	10.8	1.1 kg/piece
Glass Fibre Insulation	152 *	12.4	9.2 kg/m³
Resilient Channels	13	5.6	0.2 kg/m
Gypsum Board	15.9	97.8	11.0 kg/m²
Gypsum Board	15.9	97.8	11.0 kg/m²
Total	**229.6**	**506.5**	

* Element thickness does not contribute to total thickness (i.e. in cavity)

ASTM E90 Test Results – Airborne Sound Transmission Loss

Client: CSSBI **Test ID:** TLA-14-059

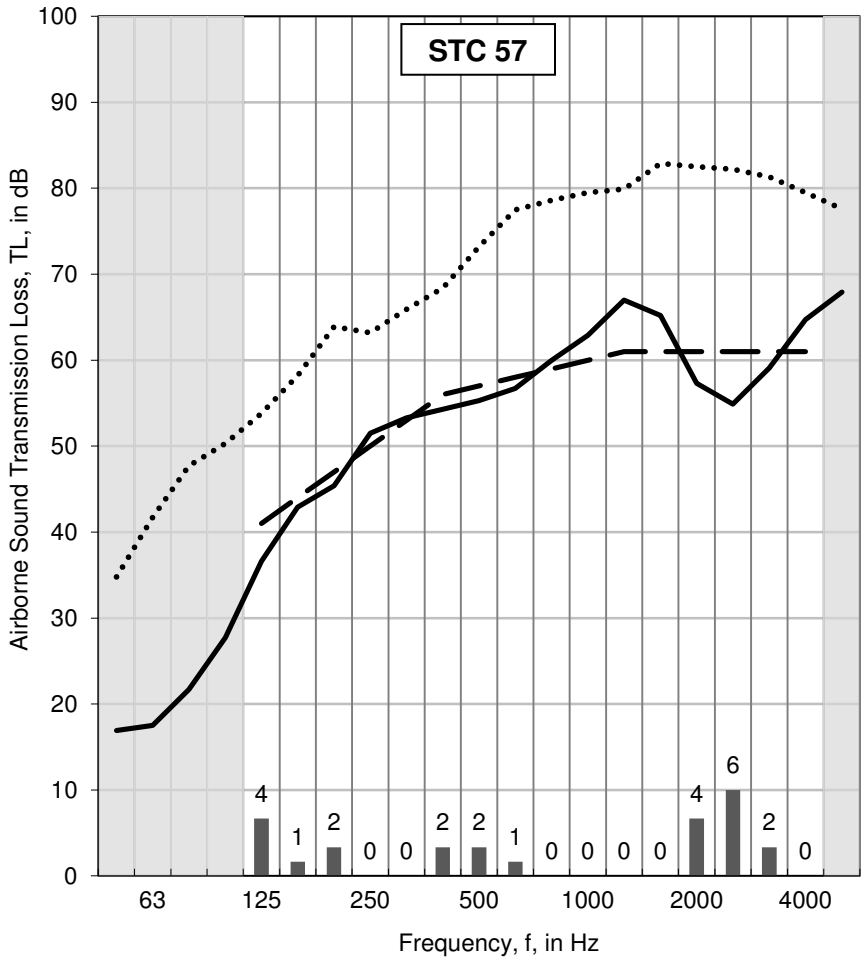
Specimen ID: A1-005007-16W **Date of Test:** 12 September 2014

Room	Volume (m³)	Air Temperature (°C)	Humidity (%)
Large	255.9	19.9 to 19.9	43.6 to 44.2
Small	140.3	20.7 to 20.8	65.9 to 66.9

Area of test specimen:	8.92 m^2
Mass of test specimen:	506.5 kg

f (Hz)	TL (dB)
50	17
63	18
80	22
100	28
125	37
160	43
200	45
250	52
315	53
400	54
500	55
630	57
800	60
1000	63
1250	67
1600	65
2000	57
2500	55
3150	59
4000	65
5000	68
Sound Transmission Class (STC)	**57**

Sum of Deficiencies (dB)
24
Max. Deficiency (dB)
6 dB at 2500 Hz



For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Airborne sound transmission loss measurements were conducted in accordance with the requirements of ASTM E90-09, "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements."**

In the graph:
The solid line is the measured sound transmission loss for this specimen. The dashed line is the STC contour fitted to the measured values according to ASTM E413-10. The dotted line (may be above the displayed range) is 10 dB below the flanking limit established for this facility. For any frequency band where the measured transmission loss is above the dotted line, the reported value is potentially limited by flanking transmission via laboratory surfaces, and the true value may be higher than that measured. Bars at the bottom of the graph show deficiencies where the measured data are less than the reference contour as described in the fitting procedure for the STC, defined in ASTM E413-10. The shaded cells in the table and areas in the graph are outside the STC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. The reported values have been corrected according to the procedure outlined in ASTM E90-09. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level, in which case, the corrected values provide an estimate of the lower limit of airborne sound transmission loss.

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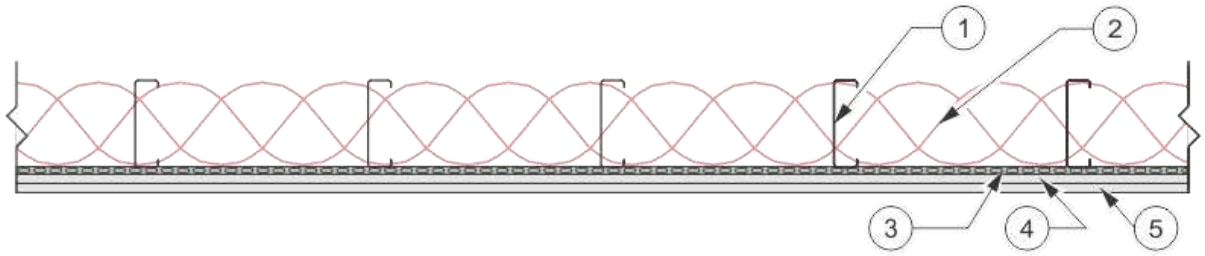
Wall assembly 17W: SS152(406)_GFB152_RC13(406)_2G16



Description	Two layers of 15.9 mm (5/8”) gypsum board Type X, attached on one side of 152 mm (6”) deep steel studs spaced 406 mm (16”) o.c., with resilient channels spaced 406 mm (16”) o.c. and 152 mm (6”) deep glass fibre insulation (R-20) in the cavity. No gypsum board attached on the other side.
Side 1	No sheathing on Side 1.
Framing & Cavity Insulation	• Base track and top track (steel thickness: 1.37 mm/0.054”) attached to test frame using four 19 mm (3/4”) screws (#10 wafer head) • **(1)** 152 mm (6”) deep steel C-studs (steel thickness: 1.37 mm/0.054”) spaced 406 mm (16”) o.c., attached to base track and top track using 19 mm (3/4”) screws (#10 pan head) • One through-the-knockout bridging channel, attached to each stud using 140 mm (5-1/2”) bridging clips • Flat-strap steel cross-bracing, attached on Side 1 to each stud using 19 mm (3/4”) screws (#10 pan head) • **(2)** Cavities between studs filled with 406 mm (16”) wide by 152 mm (6”) thick glass fibre insulation (R-20), cut in half to accommodate bridging channel
Side 2	• **(3)** 13 mm resilient channels installed horizontally using 19 mm (3/4”) screws (#10 wafer head), spaced 406 mm (16”) o.c. and installed according to ASTM C754-11 • Two layers of 15.9 mm (5/8”) gypsum board Type X, installed vertically • **(4)** Base layer attached to resilient channels using 32 mm (1-1/4”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • **(5)** Face layer attached to base layer and resilient channels using 41 mm (1-5/8”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • Screws from base layer to face layer offset by 152 mm (6”) • Joints of face layer staggered by at least one stud spacing from joints of base layer • Gaps along the joints and the perimeter of face layer gypsum boards caulked and taped with aluminum tape

Specimen Properties

Element	Actual thickness (mm)	Mass (kg)	Mass/length, area or volume
Flat Strap	1	3.0	0.3 kg/m
Steel Studs	152	65.0	2.7 kg/m
Steel Tracks	152 *	16.6	2.3 kg/m
C Channel Bridging	1 *	1.9	0.5 kg/m
Angle Bracket	1 *	10.8	1.1 kg/piece
Glass Fibre Insulation	152 *	12.4	9.2 kg/m^3
Resilient Channels	13	5.6	0.2 kg/m
Gypsum Board	15.9	97.8	11.0 kg/m^2
Gypsum Board	15.9	97.8	11.0 kg/m^2
Total	**197.8**	**310.9**	

* Element thickness does not contribute to total thickness (i.e. in cavity)

ASTM E90 Test Results – Airborne Sound Transmission Loss

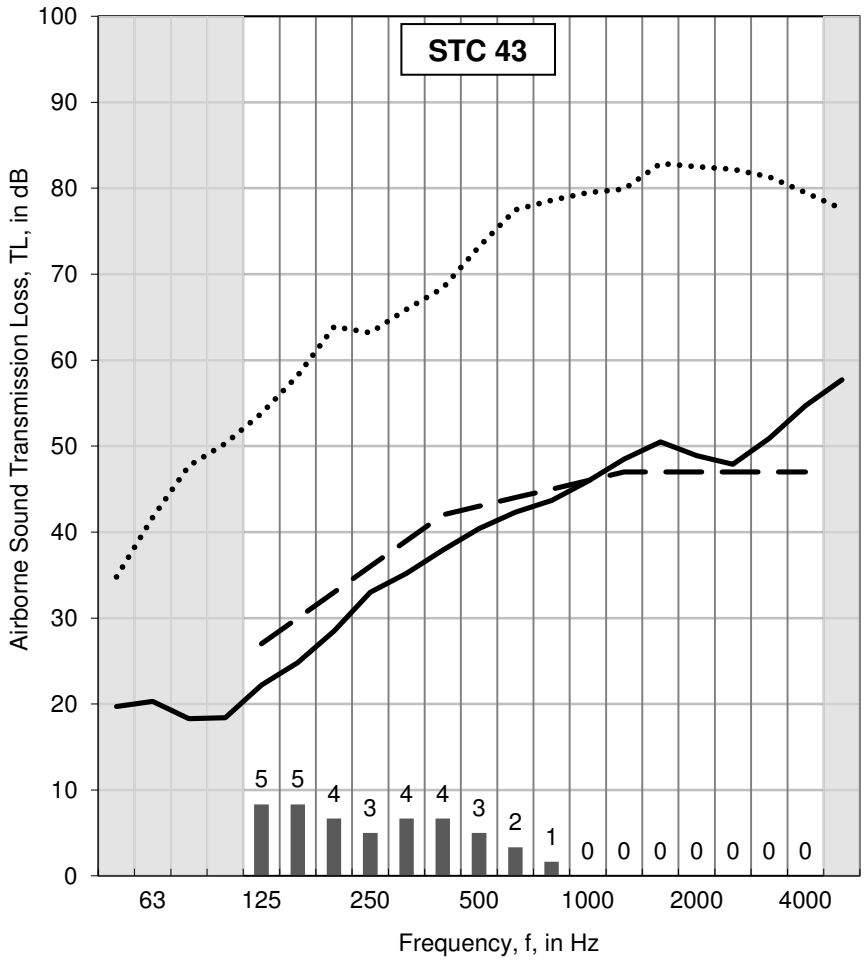
Client: CSSBI **Test ID:** TLA-14-060

Specimen ID: A1-005007-17W **Date of Test:** 12 September 2014

Room	Volume (m³)	Air Temperature (°C)	Humidity (%)
Large	255.9	19.9 to 20.0	42.3 to 42.7
Small	140.3	20.1 to 20.2	42.7 to 49.7

Area of test specimen:	8.92 m^2
Mass of test specimen:	310.9 kg

f (Hz)	TL (dB)
50	20
63	20
80	18
100	18
125	22
160	25
200	29
250	33
315	35
400	38
500	40
630	42
800	44
1000	46
1250	49
1600	51
2000	49
2500	48
3150	51
4000	55
5000	58
Sound Transmission Class (STC)	**43**



Sum of Deficiencies (dB)
31
Max. Deficiency (dB)
5 dB at 125 Hz and 160 Hz

For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Airborne sound transmission loss measurements were conducted in accordance with the requirements of ASTM E90-09, "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements."**

In the graph:
The solid line is the measured sound transmission loss for this specimen. The dashed line is the STC contour fitted to the measured values according to ASTM E413-10. The dotted line (may be above the displayed range) is 10 dB below the flanking limit established for this facility. For any frequency band where the measured transmission loss is above the dotted line, the reported value is potentially limited by flanking transmission via laboratory surfaces, and the true value may be higher than that measured. Bars at the bottom of the graph show deficiencies where the measured data are less than the reference contour as described in the fitting procedure for the STC, defined in ASTM E413-10. The shaded cells in the table and areas in the graph are outside the STC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. The reported values have been corrected according to the procedure outlined in ASTM E90-09. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level, in which case, the corrected values provide an estimate of the lower limit of airborne sound transmission loss.

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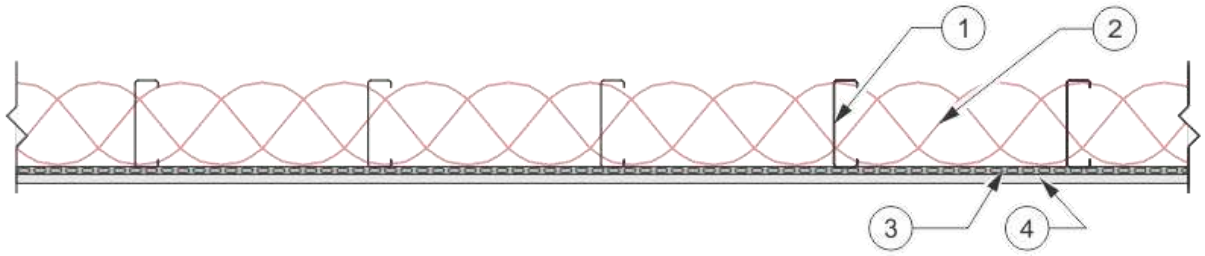
Wall assembly 18W: SS152(406)_GFB152_RC13(406)_G16



Description	One layer of 15.9 mm (5/8”) gypsum board Type X, attached on one side of 152 mm (6”) deep steel studs spaced 406 mm (16”) o.c., with resilient channels spaced 406 mm (16”) o.c. and 152 mm (6”) deep glass fibre insulation (R-20) in the cavity. No gypsum board attached on the other side.
Side 1	No sheathing on Side 1.
Framing & Cavity Insulation	• Base track and top track (steel thickness: 1.37 mm/0.054”) attached to test frame using four 19 mm (3/4”) screws (#10 wafer head) • **(1)** 152 mm (6”) deep steel C-studs (steel thickness: 1.37 mm/0.054”) spaced 406 mm (16”) o.c., attached to base track and top track using 19 mm (3/4”) screws (#10 pan head) • One through-the-knockout bridging channel, attached to each stud using 140 mm (5-1/2”) bridging clips • Flat-strap steel cross-bracing, attached on Side 1 to each stud using 19 mm (3/4”) screws (#10 pan head) • **(2)** Cavities between studs filled with 406 mm (16”) wide by 152 mm (6”) thick glass fibre insulation (R-20), cut in half to accommodate bridging channel
Side 2	• **(3)** 13 mm resilient channels installed horizontally using 19 mm (3/4”) screws (#10 wafer head), spaced 406 mm (16”) o.c. and installed according to ASTM C754-11 • **(4)** One layer of 15.9 mm (5/8”) gypsum board Type X, installed vertically and attached to resilient channels using 32 mm (1-1/4”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • Gaps along the joints and the perimeter of gypsum boards caulked and taped with aluminum tape

Specimen Properties

Element	Actual thickness (mm)	Mass (kg)	Mass/length, area or volume
Flat Strap	1	3.0	0.3 kg/m
Steel Studs	152	65.0	2.7 kg/m
Steel Tracks	152 *	16.6	2.3 kg/m
C Channel Bridging	1 *	1.9	0.5 kg/m
Angle Bracket	1 *	10.8	1.1 kg/piece
Glass Fibre Insulation	152 *	12.4	9.2 kg/m^3
Resilient Channels	13	5.6	0.2 kg/m
Gypsum Board	15.9	97.8	11.0 kg/m^2
Total	**181.9**	**213.1**	

* Element thickness does not contribute to total thickness (i.e. in cavity)

ASTM E90 Test Results – Airborne Sound Transmission Loss

Client: CSSBI **Test ID:** TLA-14-061

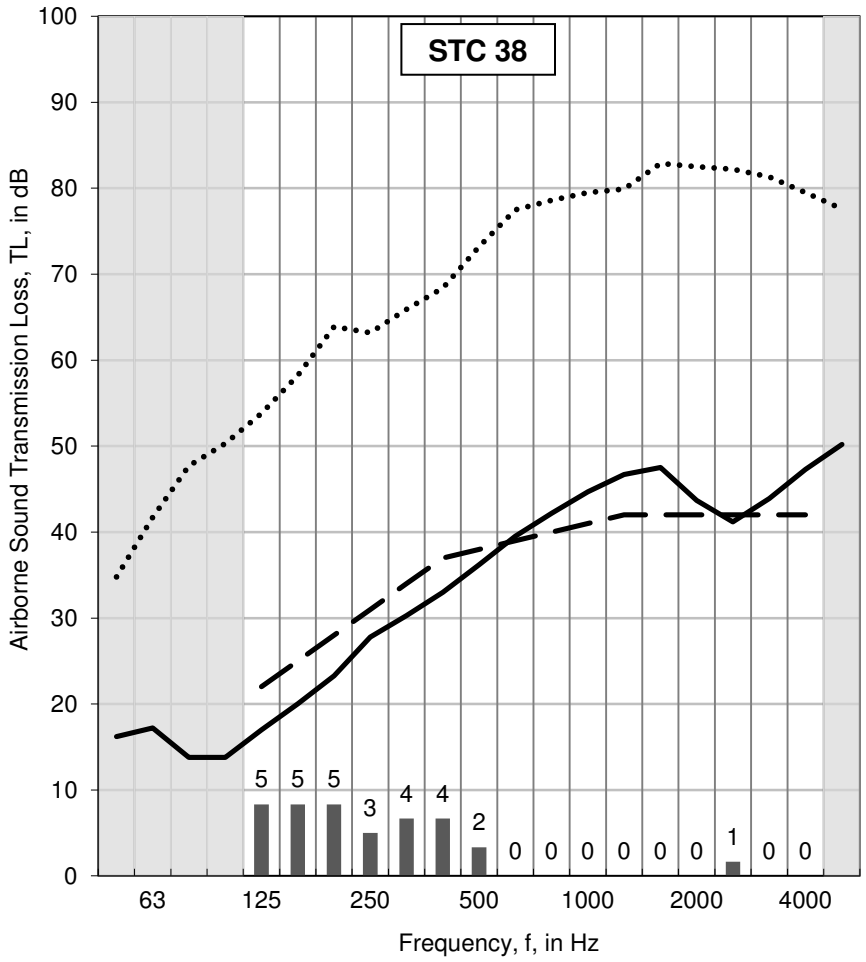
Specimen ID: A1-005007-18W **Date of Test:** 17 September 2014

Room	Volume (m^3)	Air Temperature (°C)	Humidity (%)
Large	255.9	19.5 to 19.6	47.7 to 48.7
Small	140.3	19.4 to 19.5	48.5 to 49.0

Area of test specimen:	8.92 m^2
Mass of test specimen:	213.1 kg

f (Hz)	TL (dB)
50	16
63	17
80	14
100	14
125	17
160	20
200	23
250	28
315	30
400	33
500	36
630	40
800	42
1000	45
1250	47
1600	48
2000	44
2500	41
3150	44
4000	47
5000	50
Sound Transmission Class (STC)	**38**

Sum of Deficiencies (dB)
29
Max. Deficiency (dB)
5dB at 125Hz, 160Hz and 200Hz



For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Airborne sound transmission loss measurements were conducted in accordance with the requirements of ASTM E90-09, "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements."**

In the graph:
The solid line is the measured sound transmission loss for this specimen. The dashed line is the STC contour fitted to the measured values according to ASTM E413-10. The dotted line (may be above the displayed range) is 10 dB below the flanking limit established for this facility. For any frequency band where the measured transmission loss is above the dotted line, the reported value is potentially limited by flanking transmission via laboratory surfaces, and the true value may be higher than that measured. Bars at the bottom of the graph show deficiencies where the measured data are less than the reference contour as described in the fitting procedure for the STC, defined in ASTM E413-10. The shaded cells in the table and areas in the graph are outside the STC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. The reported values have been corrected according to the procedure outlined in ASTM E90-09. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level, in which case, the corrected values provide an estimate of the lower limit of airborne sound transmission loss.

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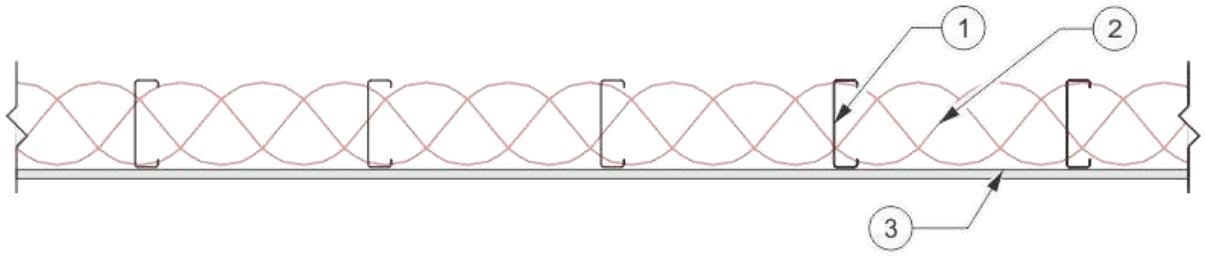
Wall assembly 19W: SS152(406)_GFB152_G16



Description	One layer of 15.9 mm (5/8”) gypsum board Type X, attached on one side of 152 mm (6”) deep steel studs spaced 406 mm (16”) o.c., and 152 mm (6”) deep glass fibre insulation (R-20) in the cavity. No gypsum board attached on the other side.
Side 1	No sheathing on Side 1.
Framing & Cavity Insulation	• Base track and top track (steel thickness: 1.37 mm/0.054”) attached to test frame using four 19 mm (3/4”) screws (#10 wafer head) • **(1)** 152 mm (6”) deep steel C-studs (steel thickness: 1.37 mm/0.054”) spaced 406 mm (16”) o.c., attached to base track and top track using 19 mm (3/4”) screws (#10 pan head) • One through-the-knockout bridging channel, attached to each stud using 140 mm (5-1/2”) bridging clips • Flat-strap steel cross-bracing, attached on Side 1 to each stud using 19 mm (3/4”) screws (#10 pan head) • **(2)** Cavities between studs filled with 406 mm (16”) wide by 152 mm (6”) thick glass fibre insulation (R-20), cut in half to accommodate bridging channel
Side 2	• **(3)** One layer of 15.9 mm (5/8”) gypsum board Type X, installed vertically and directly attached to the studs using 32 mm (1-1/4”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • Gaps along the joints and the perimeter of gypsum boards caulked and taped with aluminum tape

Specimen Properties

Element	Actual thickness (mm)	Mass (kg)	Mass/length, area or volume
Flat Strap	1	3.0	0.3 kg/m
Steel Studs	152	65.0	2.7 kg/m
Steel Tracks	152 *	16.6	2.3 kg/m
C Channel Bridging	1 *	1.9	0.5 kg/m
Angle Bracket	1 *	10.8	1.1 kg/piece
Glass Fibre Insulation	152 *	12.4	9.2 kg/m^3
Gypsum Board	15.9	97.8	11.0 kg/m^2
Total	**168.9**	**207.5**	

* Element thickness does not contribute to total thickness (i.e. in cavity)

ASTM E90 Test Results – Airborne Sound Transmission Loss

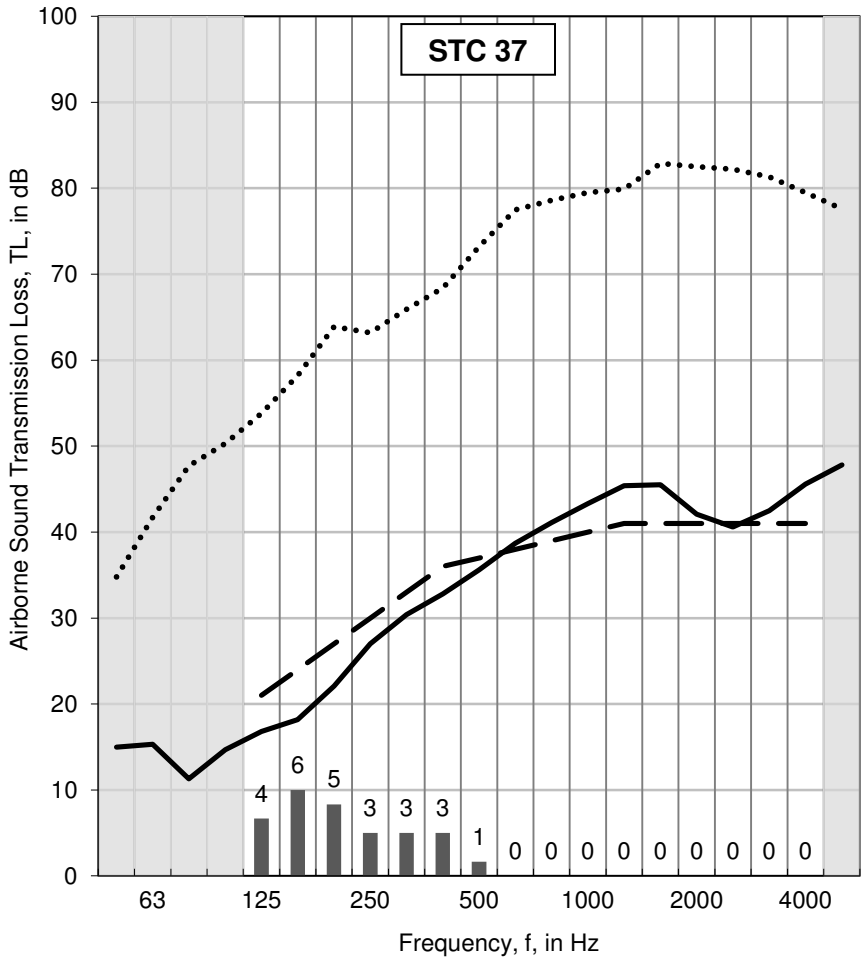
Client: CSSBI **Test ID:** TLA-14-062

Specimen ID: A1-005007-19W **Date of Test:** 18 September 2014

Room	Volume (m^3)	Air Temperature (°C)	Humidity (%)
Large	255.9	19.4 to 19.5	35.4 to 35.5
Small	140.3	19.2 to 19.3	37.2 to 39.6

Area of test specimen:	8.92 m^2
Mass of test specimen:	207.5 kg

f (Hz)	TL (dB)
50	15
63	15
80	11
100	15
125	17
160	18
200	22
250	27
315	30
400	33
500	36
630	39
800	41
1000	43
1250	45
1600	46
2000	42
2500	41
3150	43
4000	46
5000	48
Sound Transmission Class (STC)	**37**



Sum of Deficiencies (dB)
25
Max. Deficiency (dB)
6 dB at 160 Hz

For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Airborne sound transmission loss measurements were conducted in accordance with the requirements of ASTM E90-09, "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements."**

In the graph:
The solid line is the measured sound transmission loss for this specimen. The dashed line is the STC contour fitted to the measured values according to ASTM E413-10. The dotted line (may be above the displayed range) is 10 dB below the flanking limit established for this facility. For any frequency band where the measured transmission loss is above the dotted line, the reported value is potentially limited by flanking transmission via laboratory surfaces, and the true value may be higher than that measured. Bars at the bottom of the graph show deficiencies where the measured data are less than the reference contour as described in the fitting procedure for the STC, defined in ASTM E413-10. The shaded cells in the table and areas in the graph are outside the STC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. The reported values have been corrected according to the procedure outlined in ASTM E90-09. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level, in which case, the corrected values provide an estimate of the lower limit of airborne sound transmission loss.

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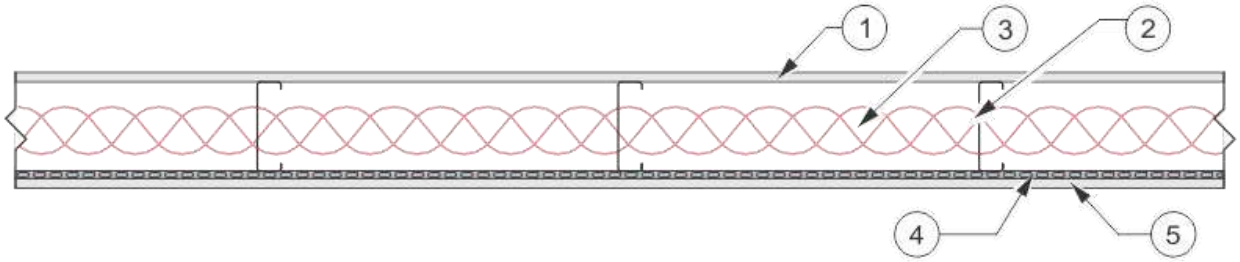
Wall assembly 20W: G16_SS152(610)_GFB92_RC13(406)_G16



Description	One layer of 15.9 mm (5/8”) gypsum board Type X, attached on each side of 152 mm (6”) deep steel studs spaced 610 mm (24”) o.c., with resilient channels on one side spaced 406 mm (16”) o.c. and 92 mm (3-5/8”) deep glass fibre insulation (R-12) in the cavity.
Side 1	• **(1)** One layer of 15.9 mm (5/8”) gypsum board Type X, installed vertically and directly attached to the studs using 32 mm (1-1/4”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • Joints of Side 1 gypsum boards staggered by at least one stud spacing from joints of Side 2 gypsum boards • Gaps along the joints and the perimeter of gypsum boards caulked and taped with aluminum tape
Framing & Cavity Insulation	• Base track and top track (steel thickness: 1.37 mm/0.054”) attached to test frame using four 19 mm (3/4”) screws (#10 wafer head) • **(2)** 152 mm (6”) deep steel C-studs (steel thickness: 1.37 mm/0.054”) spaced 610 mm (24”) o.c., attached to base track and top track using 19 mm (3/4”) screws (#10 pan head) • One through-the-knockout bridging channel, attached to each stud using 140 mm (5-1/2”) bridging clips • Flat-strap steel cross-bracing, attached on Side 1 to each stud using 19 mm (3/4”) screws (#10 pan head) • **(3)** Cavities between studs filled with 610 mm (24”) wide by 92 mm (3-5/8”) thick glass fibre insulation (R-12), cut in half to accommodate bridging channel
Side 2	• **(4)** 13 mm resilient channels installed horizontally using 19 mm (3/4”) screws (#10 wafer head), spaced 406 mm (16”) o.c. and installed according to ASTM C754-11 • **(5)** One layer of 15.9 mm (5/8”) gypsum board Type X, installed vertically and attached to resilient channels using 32 mm (1-1/4”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • Joints of Side 1 gypsum boards staggered by at least one stud spacing from joints of Side 2 gypsum boards • Gaps along the joints and the perimeter of gypsum boards caulked and taped with aluminum tape

Specimen Properties

Element	Actual thickness (mm)	Mass (kg)	Mass/length, area or volume
Gypsum Board	15.9	97.8	11.0 kg/m²
Flat Strap	1	3.0	0.3 kg/m
Steel Studs	152	65.0	2.7 kg/m
Steel Tracks	152 *	16.6	2.3 kg/m
C Channel Bridging	1 *	1.9	0.5 kg/m
Angle Bracket	1 *	7.6	1.1 kg/piece
Glass Fibre Insulation	92 *	7.2	8.8 kg/m³
Resilient Channels	13	5.6	0.2 kg/m
Gypsum Board	15.9	97.8	11.0 kg/m²
Total	**197.8**	**302.5**	

* Element thickness does not contribute to total thickness (i.e. in cavity)

ASTM E90 Test Results – Airborne Sound Transmission Loss

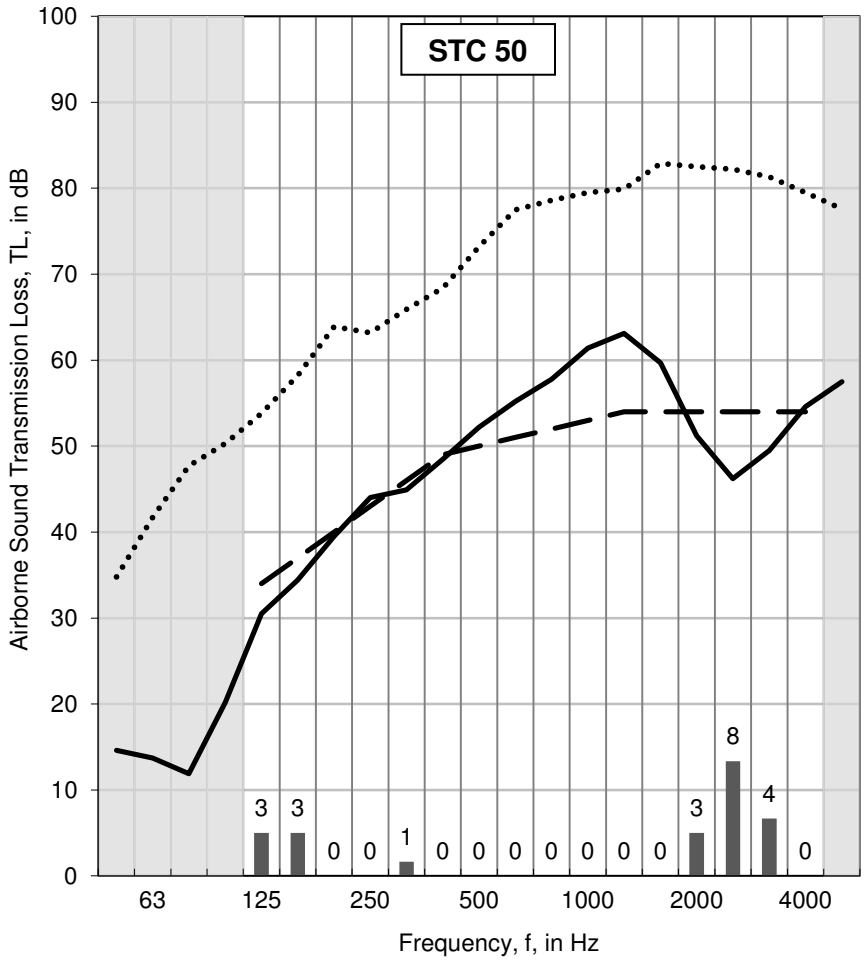
Client: CSSBI **Test ID:** TLA-14-063

Specimen ID: A1-005007-20W **Date of Test:** 22 September 2014

Room	Volume (m³)	Air Temperature (°C)	Humidity (%)
Large	256.0	19.5 to 19.6	42.5 to 42.9
Small	140.6	18.9 to 19.1	45.9 to 46.5

Area of test specimen:	8.92 m^2
Mass of test specimen:	302.5 kg

f (Hz)	TL (dB)
50	15
63	14
80	12
100	20
125	31
160	34
200	40
250	44
315	45
400	49
500	52
630	55
800	58
1000	61
1250	63
1600	60
2000	51
2500	46
3150	50
4000	55
5000	58
Sound Transmission Class (STC)	**50**



Sum of Deficiencies (dB)
22
Max. Deficiency (dB)
8 dB at 2500 Hz

For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Airborne sound transmission loss measurements were conducted in accordance with the requirements of ASTM E90-09, "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements."**

In the graph:
The solid line is the measured sound transmission loss for this specimen. The dashed line is the STC contour fitted to the measured values according to ASTM E413-10. The dotted line (may be above the displayed range) is 10 dB below the flanking limit established for this facility. For any frequency band where the measured transmission loss is above the dotted line, the reported value is potentially limited by flanking transmission via laboratory surfaces, and the true value may be higher than that measured. Bars at the bottom of the graph show deficiencies where the measured data are less than the reference contour as described in the fitting procedure for the STC, defined in ASTM E413-10. The shaded cells in the table and areas in the graph are outside the STC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. The reported values have been corrected according to the procedure outlined in ASTM E90-09. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level, in which case, the corrected values provide an estimate of the lower limit of airborne sound transmission loss.

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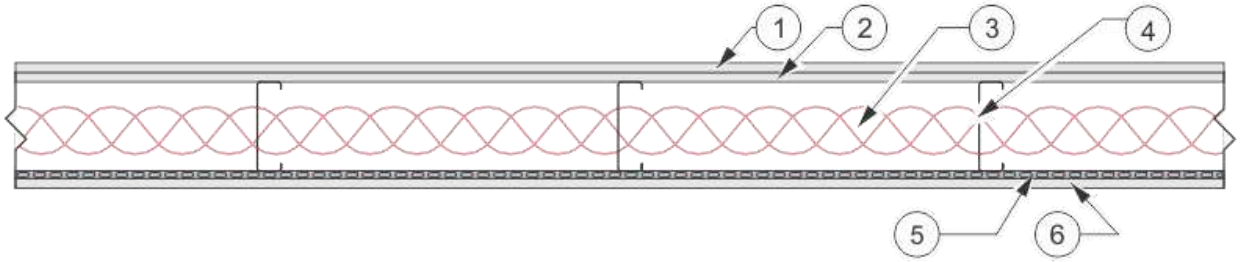
Wall assembly 21W: 2G16_SS152(610)_GFB92_RC13(406)_G16



Description	Two layers of 15.9 mm (5/8”) gypsum board Type X, directly attached to one side of 152 mm (6”) deep steel studs spaced 610 mm (24”) o.c., and one layer of 15.9 mm (5/8”) gypsum board Type X attached to resilient channels spaced 406 mm (16”) o.c. on the other side, with 92 mm (3-5/8”) deep glass fibre insulation (R-12) in the cavity.
Side 1	• Two layers of 15.9 mm (5/8”) gypsum board Type X, installed vertically • **(2)** Base layer attached to the studs using 32 mm (1-1/4”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • **(1)** Face layer attached to base layer and studs using 41 mm (1-5/8”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • Screws from base layer to face layer offset by 152 mm (6”) • Joints of base layer Side 1 gypsum boards staggered by at least one stud spacing from joints of base layer Side 2 gypsum boards • Joints of face layer staggered by at least one stud spacing from joints of base layer • Gaps along the joints and the perimeter of face layer gypsum boards caulked and taped with aluminum tape
Framing & Cavity Insulation	• Base track and top track (steel thickness: 1.37 mm/0.054”) attached to test frame using four 19 mm (3/4”) screws (#10 wafer head) • **(3)** 152 mm (6”) deep steel C-studs (steel thickness: 1.37 mm/0.054”) spaced 610 mm (24”) o.c., attached to base track and top track using 19 mm (3/4”) screws (#10 pan head) • One through-the-knockout bridging channel, attached to each stud using 140 mm (5-1/2”) bridging clips • Flat-strap steel cross-bracing, attached on Side 1 to each stud using 19 mm (3/4”) screws (#10 pan head) • **(4)** Cavities between studs filled with 610 mm (24”) wide by 92 mm (3-5/8”) thick glass fibre insulation (R-12), cut in half to accommodate bridging channel
Side 2	• **(5)** 13 mm resilient channels installed horizontally using 19 mm (3/4”) screws (#10 wafer head), spaced 406 mm (16”) o.c. and installed according to ASTM C754-11 • **(6)** One layer of 15.9 mm (5/8”) gypsum board Type X, installed vertically

	and attached to resilient channels using 32 mm (1-1/4”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • Joints of Side 1 gypsum boards staggered by at least one stud spacing from joints of Side 2 gypsum boards • Gaps along the joints and the perimeter of gypsum boards caulked and taped with aluminum tape

Specimen Properties

Element	Actual thickness (mm)	Mass (kg)	Mass/length, area or volume
Gypsum Board	15.9	97.8	11.0 kg/m²
Gypsum Board	15.9	97.8	11.0 kg/m²
Flat Strap	1	3.0	0.3 kg/m
Steel Studs	152	65.0	2.7 kg/m
Steel Tracks	152 *	16.6	2.3 kg/m
C Channel Bridging	1 *	1.9	0.5 kg/m
Angle Bracket	1 *	7.6	1.1 kg/piece
Glass Fibre Insulation	92 *	7.2	8.8 kg/m³
Resilient Channels	13	5.6	0.2 kg/m
Gypsum Board	15.9	97.8	11.0 kg/m²
Total	**213.7**	**400.3**	

* Element thickness does not contribute to total thickness (i.e. in cavity)

ASTM E90 Test Results – Airborne Sound Transmission Loss

Client: CSSBI **Test ID:** TLA-14-064

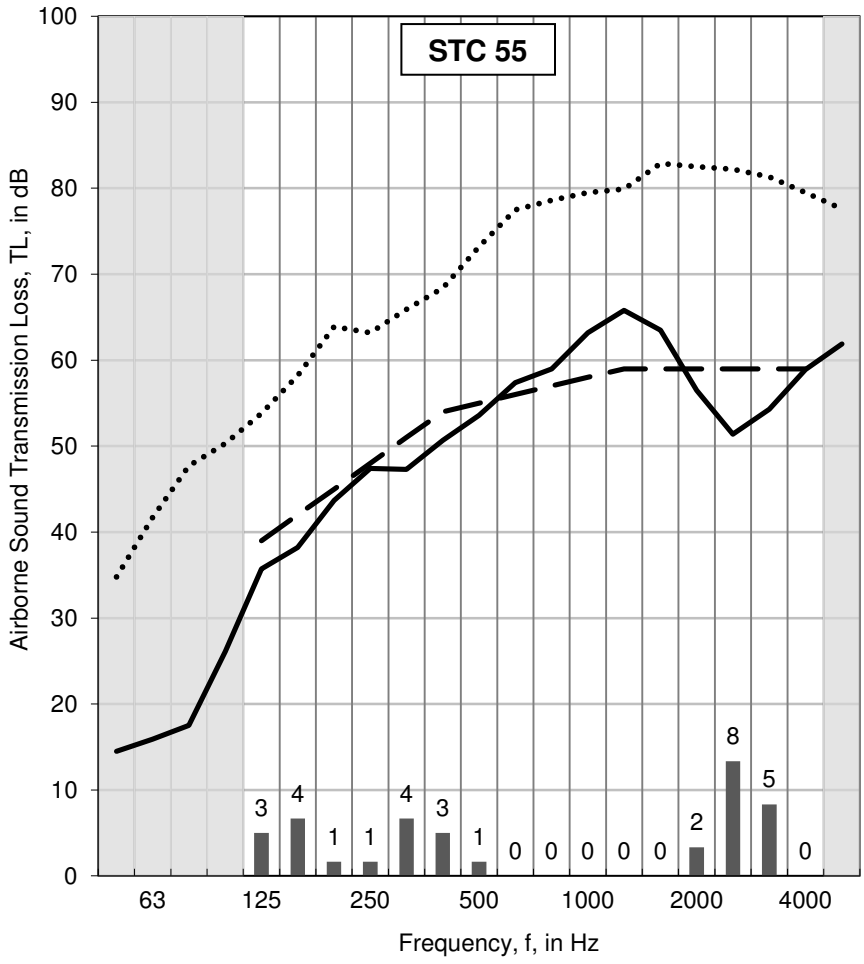
Specimen ID: A1-005007-21W **Date of Test:** 25 September 2014

Room	Volume (m³)	Air Temperature (°C)	Humidity (%)
Large	256.0	19.8 to 19.9	57.5 to 58.3
Small	140.6	19.2 to 19.3	59.9 to 60.4

Area of test specimen:	8.92 m^2
Mass of test specimen:	400.3 kg

f (Hz)	TL (dB)
50	15
63	16
80	18
100	26
125	36
160	38
200	44
250	47
315	47
400	51
500	54
630	57
800	59
1000	63
1250	66
1600	64
2000	57
2500	51
3150	54
4000	59
5000	62
Sound Transmission Class (STC)	**55**

Sum of Deficiencies (dB)
32
Max. Deficiency (dB)
8 dB at 2500 Hz



For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Airborne sound transmission loss measurements were conducted in accordance with the requirements of ASTM E90-09, "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements."**

In the graph:
The solid line is the measured sound transmission loss for this specimen. The dashed line is the STC contour fitted to the measured values according to ASTM E413-10. The dotted line (may be above the displayed range) is 10 dB below the flanking limit established for this facility. For any frequency band where the measured transmission loss is above the dotted line, the reported value is potentially limited by flanking transmission via laboratory surfaces, and the true value may be higher than that measured. Bars at the bottom of the graph show deficiencies where the measured data are less than the reference contour as described in the fitting procedure for the STC, defined in ASTM E413-10. The shaded cells in the table and areas in the graph are outside the STC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. The reported values have been corrected according to the procedure outlined in ASTM E90-09. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level, in which case, the corrected values provide an estimate of the lower limit of airborne sound transmission loss.

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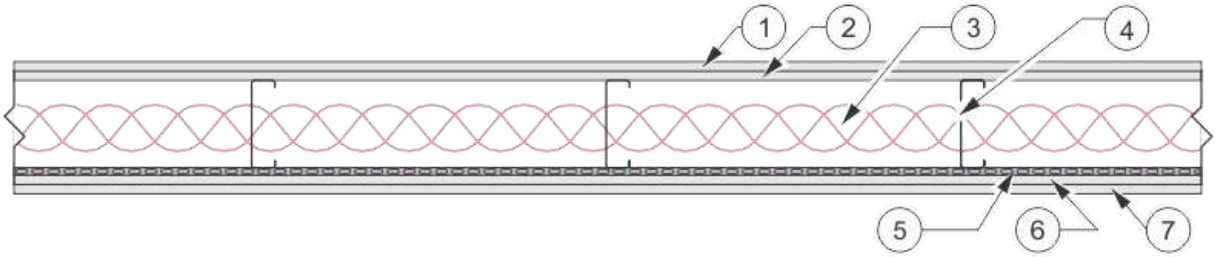
Wall assembly 22W: 2G16_SS152(610)_GFB92_RC13(406)_2G16



Description	Two layers of 15.9 mm (5/8") gypsum board Type X, attached on each side of 152 mm (6") deep steel studs spaced 406 mm (16") o.c., with resilient channels on one side spaced 406 mm (16") o.c. and 92 mm (3-5/8") deep glass fibre insulation (R-12) in the cavity.
Side 1	• Two layers of 15.9 mm (5/8") gypsum board Type X, installed vertically • **(2)** Base layer attached to the studs using 32 mm (1-1/4") screws (#6 scavenger head) spaced 305 mm (12") o.c. at the perimeter and in the field • **(1)** Face layer attached to base layer and studs using 41 mm (1-5/8") screws (#6 scavenger head) spaced 305 mm (12") o.c. at the perimeter and in the field • Screws from base layer to face layer offset by 152 mm (6") • Joints of base layer Side 1 gypsum boards staggered by at least one stud spacing from joints of base layer Side 2 gypsum boards • Joints of face layer staggered by at least one stud spacing from joints of base layer • Gaps along the joints and the perimeter of face layer gypsum boards caulked and taped with aluminum tape
Framing & Cavity Insulation	• Base track and top track (steel thickness: 1.37 mm/0.054") attached to test frame using four 19 mm (3/4") screws (#10 wafer head) • **(3)** 152 mm (6") deep steel C-studs (steel thickness: 1.37 mm/0.054") spaced 610 mm (24") o.c., attached to base track and top track using 19 mm (3/4") screws (#10 pan head) • One through-the-knockout bridging channel, attached to each stud using 140 mm (5-1/2") bridging clips • Flat-strap steel cross-bracing, attached on Side 1 to each stud using 19 mm (3/4") screws (#10 pan head) • **(4)** Cavities between studs filled with 610 mm (24") wide by 92 mm (3-5/8") thick glass fibre insulation (R-12), cut in half to accommodate bridging channel
Side 2	• **(5)** 13 mm resilient channels installed horizontally using 19 mm (3/4") screws (#10 wafer head), spaced 406 mm (16") o.c. and installed according to ASTM C754-11 • Two layers of 15.9 mm (5/8") gypsum board Type X, installed vertically • **(6)** Base layer attached to resilient channels using 32 mm (1-1/4") screws

	(#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • **(7)** Face layer attached to base layer and resilient channels using 41 mm (1-5/8”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • Screws from base layer to face layer offset by 152 mm (6”) • Joints of base layer Side 1 gypsum boards staggered by at least one stud spacing from joints of base layer Side 2 gypsum boards • Joints of face layer staggered by at least one stud spacing from joints of base layer • Gaps along the joints and the perimeter of face layer gypsum boards caulked and taped with aluminum tape

Specimen Properties

Element	Actual thickness (mm)	Mass (kg)	Mass/length, area or volume
Gypsum Board	15.9	97.8	11.0 kg/m²
Gypsum Board	15.9	97.8	11.0 kg/m²
Flat Strap	1	3.0	0.3 kg/m
Steel Studs	152	65.0	2.7 kg/m
Steel Tracks	152 *	16.6	2.3 kg/m
C Channel Bridging	1 *	1.9	0.5 kg/m
Angle Bracket	1 *	7.6	1.1 kg/piece
Glass Fibre Insulation	92 *	7.2	8.8 kg/m³
Resilient Channels	13	5.6	0.2 kg/m
Gypsum Board	15.9	97.8	11.0 kg/m²
Gypsum Board	15.9	97.8	11.0 kg/m²
Total	**229.6**	**498.1**	

* Element thickness does not contribute to total thickness (i.e. in cavity)

ASTM E90 Test Results – Airborne Sound Transmission Loss

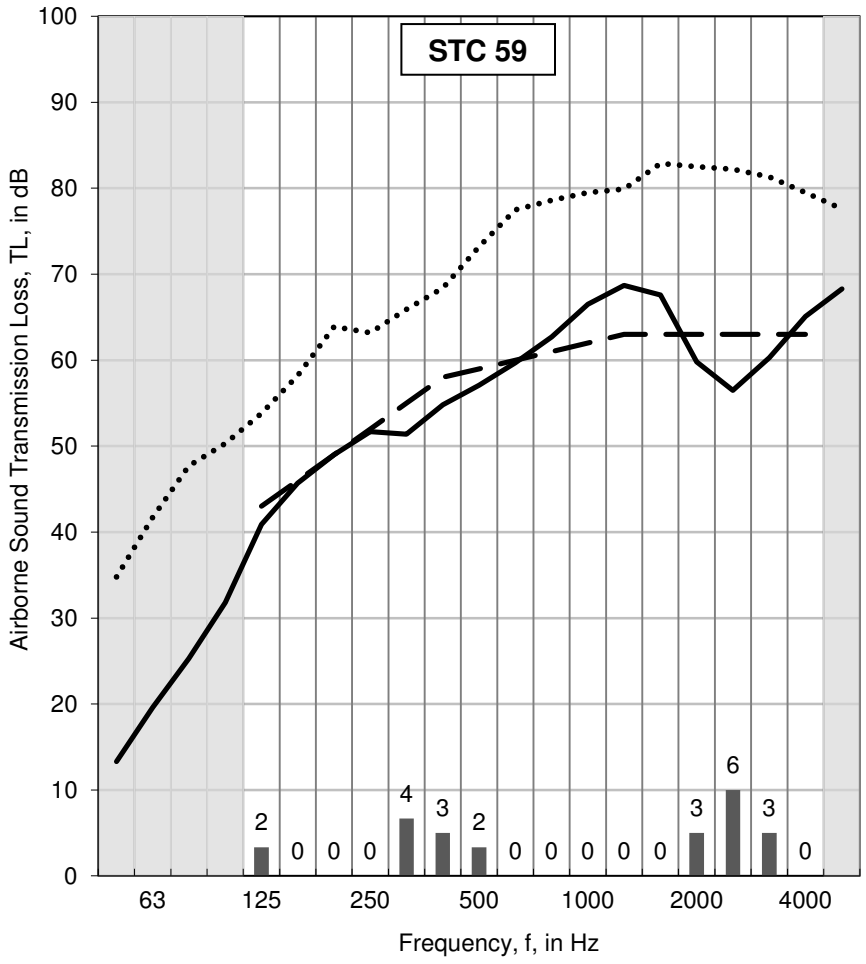
Client: CSSBI **Test ID:** TLA-14-065

Specimen ID: A1-005007-22W **Date of Test:** 26 September 2014

Room	Volume (m³)	Air Temperature (°C)	Humidity (%)
Large	254.0	20.1 to 20.2	62.7 to 63.1
Small	140.4	19.2 to 19.3	65.0 to 66.9

Area of test specimen:	8.92 m^2
Mass of test specimen:	498.1 kg

f (Hz)	TL (dB)
50	13
63	20
80	25
100	32
125	41
160	46
200	49
250	52
315	51
400	55
500	57
630	60
800	63
1000	67
1250	69
1600	68
2000	60
2500	57
3150	60
4000	65
5000	68
Sound Transmission Class (STC)	**59**



Sum of Deficiencies (dB)
23
Max. Deficiency (dB)
6 dB at 2500 Hz

For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Airborne sound transmission loss measurements were conducted in accordance with the requirements of ASTM E90-09, "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements."**

In the graph:
The solid line is the measured sound transmission loss for this specimen. The dashed line is the STC contour fitted to the measured values according to ASTM E413-10. The dotted line (may be above the displayed range) is 10 dB below the flanking limit established for this facility. For any frequency band where the measured transmission loss is above the dotted line, the reported value is potentially limited by flanking transmission via laboratory surfaces, and the true value may be higher than that measured. Bars at the bottom of the graph show deficiencies where the measured data are less than the reference contour as described in the fitting procedure for the STC, defined in ASTM E413-10. The shaded cells in the table and areas in the graph are outside the STC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. The reported values have been corrected according to the procedure outlined in ASTM E90-09. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level, in which case, the corrected values provide an estimate of the lower limit of airborne sound transmission loss.

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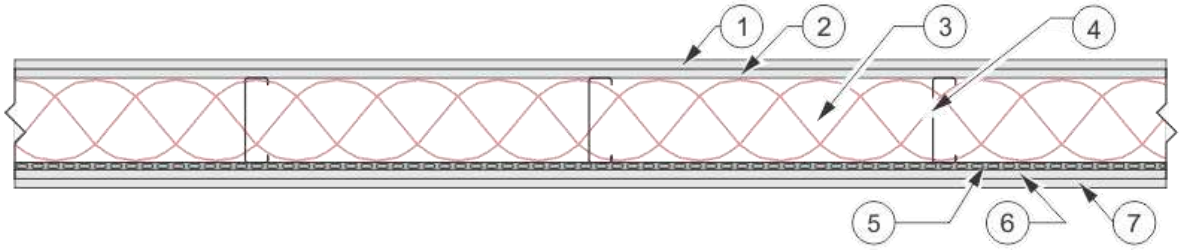
Wall assembly 23W: 2G16_SS152(610)_GFB152_RC13(406)_2G16



Description	Two layers of 15.9 mm (5/8”) gypsum board Type X, attached on each side of 152 mm (6”) deep steel studs spaced 406 mm (16”) o.c., with resilient channels on one side spaced 406 mm (16”) o.c. and 152 mm (6”) deep glass fibre insulation (R-20) in the cavity.
Side 1	• Two layers of 15.9 mm (5/8”) gypsum board Type X, installed vertically • **(2)** Base layer attached to the studs using 32 mm (1-1/4”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • **(1)** Face layer attached to base layer and studs using 41 mm (1-5/8”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • Screws from base layer to face layer offset by 152 mm (6”) • Joints of base layer Side 1 gypsum boards staggered by at least one stud spacing from joints of base layer Side 2 gypsum boards • Joints of face layer staggered by at least one stud spacing from joints of base layer • Gaps along the joints and the perimeter of face layer gypsum boards caulked and taped with aluminum tape
Framing & Cavity Insulation	• Base track and top track (steel thickness: 1.37 mm/0.054”) attached to test frame using four 19 mm (3/4”) screws (#10 wafer head) • **(3)** 152 mm (6”) deep steel C-studs (steel thickness: 1.37 mm/0.054”) spaced 610 mm (24”) o.c., attached to base track and top track using 19 mm (3/4”) screws (#10 pan head) • One through-the-knockout bridging channel, attached to each stud using 140 mm (5-1/2”) bridging clips • Flat-strap steel cross-bracing, attached on Side 1 to each stud using 19 mm (3/4”) screws (#10 pan head) • **(4)** Cavities between studs filled with 610 mm (24”) wide by 152 mm (6”) thick glass fibre insulation (R-20), cut in half to accommodate bridging channel
Side 2	• **(5)** 13 mm resilient channels installed horizontally using 19 mm (3/4”) screws (#10 wafer head), spaced 406 mm (16”) o.c. and installed according to ASTM C754-11 • Two layers of 15.9 mm (5/8”) gypsum board Type X, installed vertically • **(6)** Base layer attached to resilient channels using 32 mm (1-1/4”) screws

	(#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • **(7)** Face layer attached to base layer and resilient channels using 41 mm (1-5/8”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • Screws from base layer to face layer offset by 152 mm (6”) • Joints of base layer Side 1 gypsum boards staggered by at least one stud spacing from joints of base layer Side 2 gypsum boards • Joints of face layer staggered by at least one stud spacing from joints of base layer • Gaps along the joints and the perimeter of face layer gypsum boards caulked and taped with aluminum tape

Specimen Properties

Element	Actual thickness (mm)	Mass (kg)	Mass/length, area or volume
Gypsum Board	15.9	97.8	11.0 kg/m²
Gypsum Board	15.9	97.8	11.0 kg/m²
Flat Strap	1	3.0	0.3 kg/m
Steel Studs	152	65.0	2.7 kg/m
Steel Tracks	152 *	16.6	2.3 kg/m
C Channel Bridging	1 *	1.9	0.5 kg/m
Angle Bracket	1 *	7.6	1.1 kg/piece
Glass Fibre Insulation	152 *	12.4	9.2 kg/m³
Resilient Channels	13	5.6	0.2 kg/m
Gypsum Board	15.9	97.8	11.0 kg/m²
Gypsum Board	15.9	97.8	11.0 kg/m²
Total	**229.6**	**503.3**	

* Element thickness does not contribute to total thickness (i.e. in cavity)

ASTM E90 Test Results – Airborne Sound Transmission Loss

Client: CSSBI **Test ID:** TLA-14-066

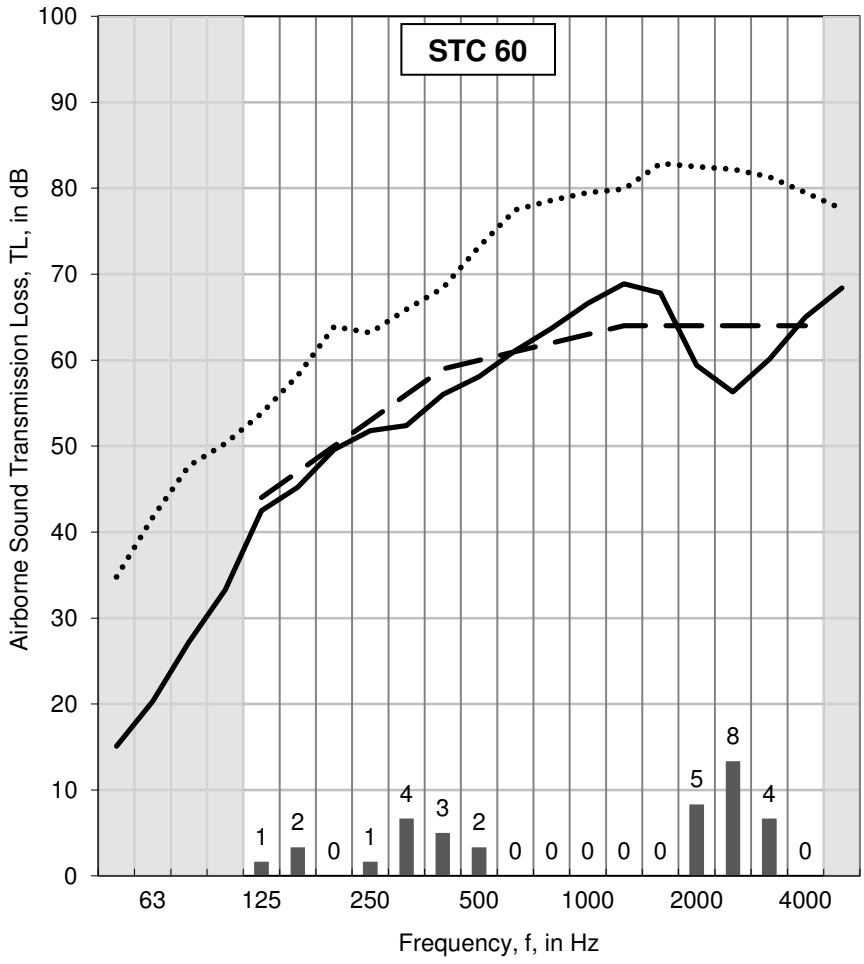
Specimen ID: A1-005007-23W **Date of Test:** 08 October 2014

Room	Volume (m³)	Air Temperature (°C)	Humidity (%)
Large	254.0	19.4 to 19.4	48.3 to 49.6
Small	140.4	19.4 to 19.4	53.7 to 53.9

Area of test specimen:	8.92 m^2
Mass of test specimen:	503.3 kg

f (Hz)	TL (dB)
50	15
63	20
80	27
100	33
125	43
160	45
200	50
250	52
315	52
400	56
500	58
630	61
800	64
1000	67
1250	69
1600	68
2000	59
2500	56
3150	60
4000	65
5000	68
Sound Transmission Class (STC)	**60**

Sum of Deficiencies (dB)
30
Max. Deficiency (dB)
8 dB at 2500 Hz



For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Airborne sound transmission loss measurements were conducted in accordance with the requirements of ASTM E90-09, "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements."**

In the graph:
The solid line is the measured sound transmission loss for this specimen. The dashed line is the STC contour fitted to the measured values according to ASTM E413-10. The dotted line (may be above the displayed range) is 10 dB below the flanking limit established for this facility. For any frequency band where the measured transmission loss is above the dotted line, the reported value is potentially limited by flanking transmission via laboratory surfaces, and the true value may be higher than that measured. Bars at the bottom of the graph show deficiencies where the measured data are less than the reference contour as described in the fitting procedure for the STC, defined in ASTM E413-10. The shaded cells in the table and areas in the graph are outside the STC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. The reported values have been corrected according to the procedure outlined in ASTM E90-09. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level, in which case, the corrected values provide an estimate of the lower limit of airborne sound transmission loss.

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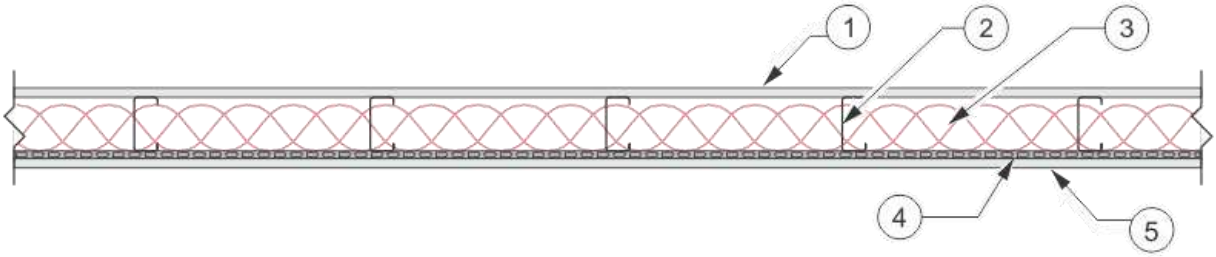
Wall assembly 24W: G16_SS92(406)_GFB92_RC13(406)_G16



Description	One layer of 15.9 mm (5/8”) gypsum board Type X, attached on each side of 92 mm (3-5/8”) deep steel studs spaced 406 mm (16”) o.c., with resilient channels on one side spaced 406 mm (16”) o.c. and 92 mm (3-5/8”) deep glass fibre insulation (R-12) in the cavity.
Side 1	• **(1)** One layer of 15.9 mm (5/8”) gypsum board Type X, installed vertically, directly attached to the studs using 32 mm (1-1/4”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • Joints of Side 1 gypsum boards staggered by at least one stud spacing from joints of Side 2 gypsum boards • Gaps along the joints and the perimeter of gypsum boards caulked and taped with aluminum tape
Framing & Cavity Insulation	• Base track and top track (steel thickness: 1.37 mm/0.054”) attached to test frame using four 19 mm (3/4”) screws (#10 wafer head) • **(2)** 92 mm (3-5/8”) deep steel C-studs (steel thickness: 1.37 mm/0.054”) spaced 406 mm (16”) o.c., attached to base track and top track using 19 mm (3/4”) screws (#10 pan head) • One through-the-knockout bridging channel, attached to each stud • Flat-strap steel cross-bracing, attached on Side 1 to each stud using 19 mm (3/4”) screws (#10 pan head) • **(3)** Cavities between studs filled with 406 mm (16”) wide by 92 mm (3-5/8”) thick glass fibre insulation (R-12), cut in half to accommodate bridging channel
Side 2	• **(4)** 13 mm resilient channels installed horizontally using 19 mm (3/4”) screws (#10 wafer head), spaced 406 mm (16”) o.c. and installed according to ASTM C754-11 • **(5)** One layer of 15.9 mm (5/8”) gypsum board Type X, installed vertically, attached to resilient channels using 32 mm (1-1/4”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • Joints of Side 1 gypsum boards staggered by at least one stud spacing from joints of Side 2 gypsum boards • Gaps along the joints and the perimeter of gypsum boards caulked and taped with aluminum tape

Specimen Properties

Element	Actual thickness (mm)	Mass (kg)	Mass/length, area or volume
Gypsum Board	15.9	97.8	11.0 kg/m²
Flat Strap	1	3.0	0.3 kg/m
Steel Studs	92	50.2	2.1 kg/m
Steel Tracks	92 *	12.6	1.7 kg/m
C Channel Bridging	1 *	1.9	0.5 kg/m
Angle Bracket	1 *	5.0	0.5 kg/piece
Glass Fibre Insulation	92 *	8.5	10.4 kg/m³
Resilient Channels	13	5.6	0.2 kg/m
Gypsum Board	15.9	97.8	11.0 kg/m²
Total	**137.8**	**282.4**	

* Element thickness does not contribute to total thickness (i.e. in cavity)

ASTM E90 Test Results – Airborne Sound Transmission Loss

Client: CSSBI **Test ID:** TLA-14-067

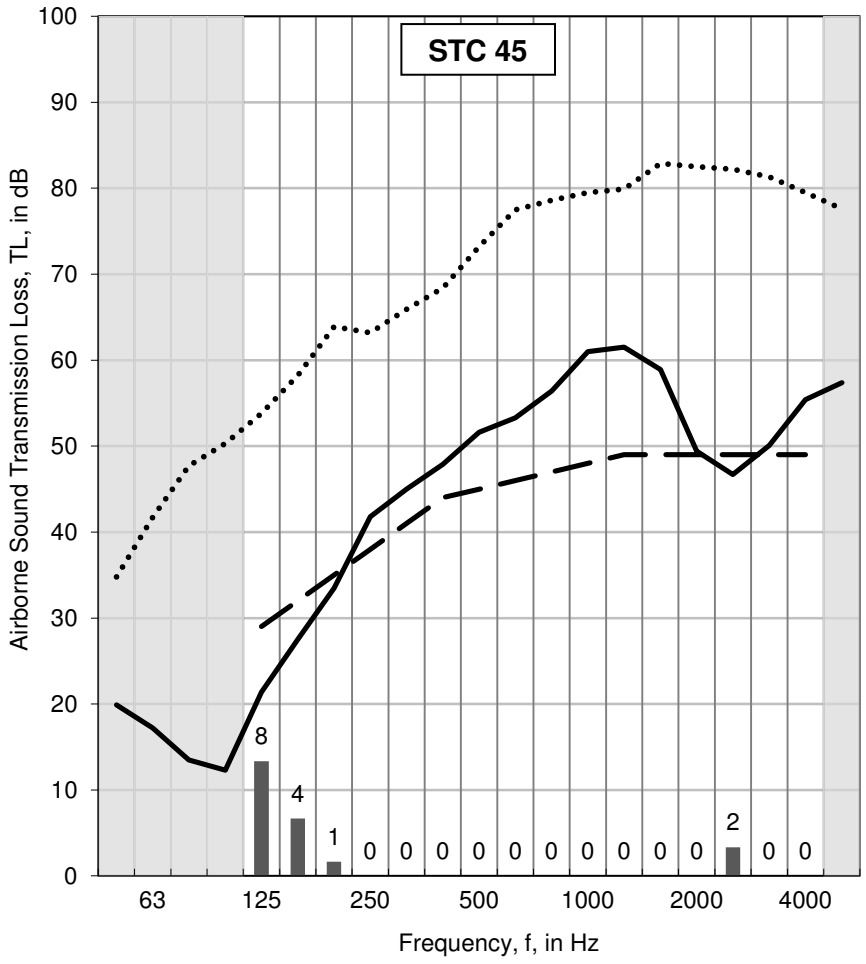
Specimen ID: A1-005007-24W **Date of Test:** 09 October 2014

Room	Volume (m³)	Air Temperature (°C)	Humidity (%)
Large	256.1	19.2 to 19.3	40.2 to 40.5
Small	141.1	19.3 to 19.4	44.0 to 44.6

Area of test specimen:	8.92 m^2
Mass of test specimen:	282.4 kg

f (Hz)	TL (dB)
50	20
63	17
80	14
100	12
125	21
160	28
200	34
250	42
315	45
400	48
500	52
630	53
800	56
1000	61
1250	62
1600	59
2000	49
2500	47
3150	50
4000	55
5000	57
Sound Transmission Class (STC)	**45**

Sum of Deficiencies (dB)
15
Max. Deficiency (dB)
8 dB at 125 Hz



For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Airborne sound transmission loss measurements were conducted in accordance with the requirements of ASTM E90-09, "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements."**

In the graph:
The solid line is the measured sound transmission loss for this specimen. The dashed line is the STC contour fitted to the measured values according to ASTM E413-10. The dotted line (may be above the displayed range) is 10 dB below the flanking limit established for this facility. For any frequency band where the measured transmission loss is above the dotted line, the reported value is potentially limited by flanking transmission via laboratory surfaces, and the true value may be higher than that measured. Bars at the bottom of the graph show deficiencies where the measured data are less than the reference contour as described in the fitting procedure for the STC, defined in ASTM E413-10. The shaded cells in the table and areas in the graph are outside the STC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. The reported values have been corrected according to the procedure outlined in ASTM E90-09. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level, in which case, the corrected values provide an estimate of the lower limit of airborne sound transmission loss.

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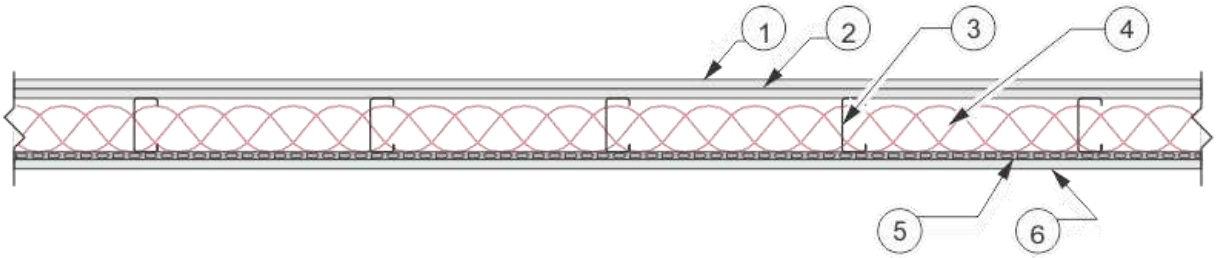
Wall assembly 25W: 2G16_SS92(406)_GFB92_RC13(406)_G16



Description	Two layers of 15.9 mm (5/8”) gypsum board Type X, directly attached to one side of 92 mm (3-5/8”) deep steel studs spaced 406 mm (16”) o.c., and one layer of 15.9 mm (5/8”) gypsum board Type X attached to resilient channels spaced 406 mm (16”) o.c. on the other side, with 92 mm (3-5/8”) deep glass fibre insulation (R-12) in the cavity.
Side 1	• Two layers of 15.9 mm (5/8”) gypsum board Type X, installed vertically • **(1)** Base layer attached to the studs using 32 mm (1-1/4”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • **(2)** Face layer attached to base layer and studs using 41 mm (1-5/8”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • Screws from base layer to face layer offset by 152 mm (6”) • Joints of base layer Side 1 gypsum boards staggered by at least one stud spacing from joints of base layer Side 2 gypsum boards • Joints of face layer staggered by at least one stud spacing from joints of base layer • Gaps along the joints and the perimeter of face layer gypsum boards caulked and taped with aluminum tape
Framing & Cavity Insulation	• Base track and top track (steel thickness: 1.37 mm/0.054”) attached to test frame using four 19 mm (3/4”) screws (#10 wafer head) • **(3)** 92 mm (3-5/8”) deep steel C-studs (steel thickness: 1.37 mm/0.054”) spaced 406 mm (16”) o.c., attached to base track and top track using 19 mm (3/4”) screws (#10 pan head) • One through-the-knockout bridging channel, attached to each stud • Flat-strap steel cross-bracing, attached on Side 1 to each stud using 19 mm (3/4”) screws (#10 pan head) • **(4)** Cavities between studs filled with 406 mm (16”) wide by 92 mm (3-5/8”) thick glass fibre insulation (R-12), cut in half to accommodate bridging channel
Side 2	• **(5)** 13 mm resilient channels installed horizontally using 19 mm (3/4”) screws (#10 wafer head), spaced 406 mm (16”) o.c. and installed according to ASTM C754-11 • **(6)** One layer of 15.9 mm (5/8”) gypsum board Type X, installed vertically and attached to resilient channels using 32 mm (1-1/4”) screws (#6

	scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • Joints of Side 1 gypsum boards staggered by at least one stud spacing from joints of Side 2 gypsum boards • Gaps along the joints and the perimeter of gypsum boards caulked and taped with aluminum tape

Specimen Properties

Element	Actual thickness (mm)	Mass (kg)	Mass/length, area or volume
Gypsum Board	15.9	97.8	11.0 kg/m²
Gypsum Board	15.9	97.8	11.0 kg/m²
Flat Strap	1	3.0	0.3 kg/m
Steel Studs	92	50.2	2.1 kg/m
Steel Tracks	92 *	12.6	1.7 kg/m
C Channel Bridging	1 *	1.9	0.5 kg/m
Angle Bracket	1 *	5.0	0.5 kg/piece
Glass Fibre Insulation	92 *	8.5	10.4 kg/m³
Resilient Channels	13	5.6	0.2 kg/m
Gypsum Board	15.9	97.8	11.0 kg/m²
Total	**153.7**	**380.2**	

* Element thickness does not contribute to total thickness (i.e. in cavity)

ASTM E90 Test Results – Airborne Sound Transmission Loss

Client: CSSBI **Test ID:** TLA-14-068

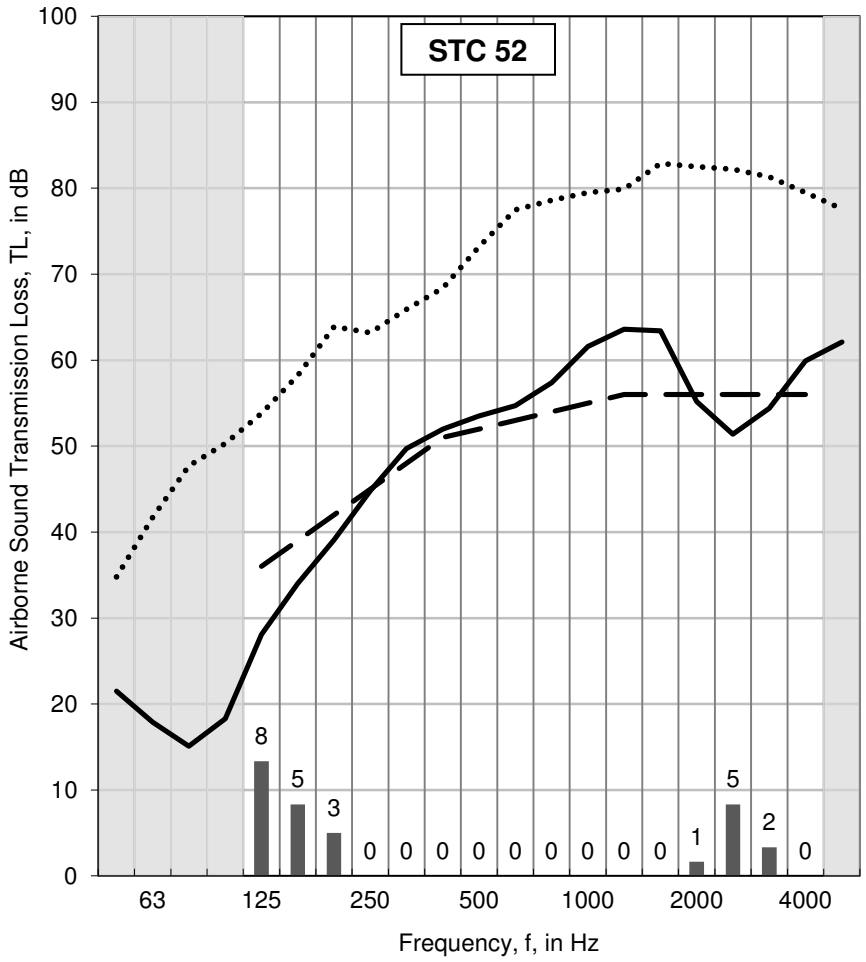
Specimen ID: A1-005007-25W **Date of Test:** 14 October 2014

Room	Volume (m³)	Air Temperature (°C)	Humidity (%)
Large	256.1	22.0 to 22.1	56.4 to 56.7
Small	141.1	19.2 to 19.4	64.5 to 65.9

Area of test specimen:	8.92 m^2
Mass of test specimen:	380.2 kg

f (Hz)	TL (dB)
50	22
63	18
80	15
100	18
125	28
160	34
200	39
250	45
315	50
400	52
500	54
630	55
800	57
1000	62
1250	64
1600	63
2000	55
2500	51
3150	54
4000	60
5000	62
Sound Transmission Class (STC)	**52**

Sum of Deficiencies (dB)
24
Max. Deficiency (dB)
8 dB at 125 Hz



For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Airborne sound transmission loss measurements were conducted in accordance with the requirements of ASTM E90-09, "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements."**

In the graph:
The solid line is the measured sound transmission loss for this specimen. The dashed line is the STC contour fitted to the measured values according to ASTM E413-10. The dotted line (may be above the displayed range) is 10 dB below the flanking limit established for this facility. For any frequency band where the measured transmission loss is above the dotted line, the reported value is potentially limited by flanking transmission via laboratory surfaces, and the true value may be higher than that measured. Bars at the bottom of the graph show deficiencies where the measured data are less than the reference contour as described in the fitting procedure for the STC, defined in ASTM E413-10. The shaded cells in the table and areas in the graph are outside the STC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. The reported values have been corrected according to the procedure outlined in ASTM E90-09. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level, in which case, the corrected values provide an estimate of the lower limit of airborne sound transmission loss.

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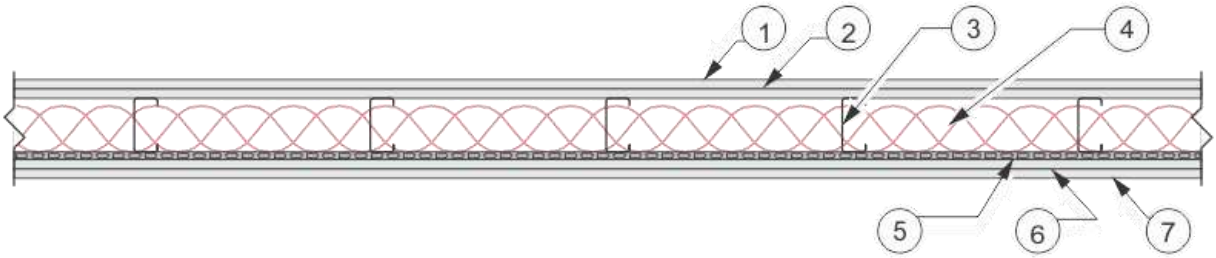
Wall assembly 26W: 2G16_SS92(406)_GFB92_RC13(406)_2G16



Description	Two layers of 15.9 mm (5/8”) gypsum board Type X, attached on each side of 92 mm (3-5/8”) deep steel studs spaced 406 mm (16”) o.c., with resilient channels on one side spaced 406 mm (16”) o.c. and 92 mm (3-5/8”) deep glass fibre insulation (R-12) in the cavity.
Side 1	• Two layers of 15.9 mm (5/8”) gypsum board Type X, installed vertically • **(2)** Base layer attached to the studs using 32 mm (1-1/4”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • **(1)** Face layer attached to base layer and studs using 41 mm (1-5/8”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • Screws from base layer to face layer offset by 152 mm (6”) • Joints of base layer Side 1 gypsum boards staggered by at least one stud spacing from joints of base layer Side 2 gypsum boards • Joints of face layer staggered by at least one stud spacing from joints of base layer • Gaps along the joints and the perimeter of face layer gypsum boards caulked and taped with aluminum tape
Framing & Cavity Insulation	• Base track and top track (steel thickness: 1.37 mm/0.054”) attached to test frame using four 19 mm (3/4”) screws (#10 wafer head) • **(3)** 92 mm (3-5/8”) deep steel C-studs (steel thickness: 1.37 mm/0.054”) spaced 406 mm (16”) o.c., attached to base track and top track using 19 mm (3/4”) screws (#10 pan head) • One through-the-knockout bridging channel, attached to each stud • Flat-strap steel cross-bracing, attached on Side 1 to each stud using 19 mm (3/4”) screws (#10 pan head) • **(4)** Cavities between studs filled with 406 mm (16”) wide by 92 mm (3-5/8”) thick glass fibre insulation (R-12), cut in half to accommodate bridging channel
Side 2	• **(5)** 13 mm resilient channels installed horizontally using 19 mm (3/4”) screws (#10 wafer head), spaced 406 mm (16”) o.c. and installed according to ASTM C754-11 • Two layers of 15.9 mm (5/8”) gypsum board Type X, installed vertically • **(6)** Base layer attached to resilient channels using 32 mm (1-1/4”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in

	the field • **(7)** Face layer attached to base layer and resilient channels using 41 mm (1-5/8") screws (#6 scavenger head) spaced 305 mm (12") o.c. at the perimeter and in the field • Screws from base layer to face layer offset by 152 mm (6") • Joints of base layer Side 1 gypsum boards staggered by at least one stud spacing from joints of base layer Side 2 gypsum boards • Joints of face layer staggered by at least one stud spacing from joints of base layer • Gaps along the joints and the perimeter of face layer gypsum boards caulked and taped with aluminum tape

Specimen Properties

Element	Actual thickness (mm)	Mass (kg)	Mass/length, area or volume
Gypsum Board	15.9	97.8	11.0 kg/m²
Gypsum Board	15.9	97.8	11.0 kg/m²
Flat Strap	1	3.0	0.3 kg/m
Steel Studs	92	50.2	2.1 kg/m
Steel Tracks	92 *	12.6	1.7 kg/m
C Channel Bridging	1 *	1.9	0.5 kg/m
Angle Bracket	1 *	5.0	0.5 kg/piece
Glass Fibre Insulation	92 *	8.5	10.4 kg/m³
Resilient Channels	13	5.6	0.2 kg/m
Gypsum Board	15.9	97.8	11.0 kg/m²
Gypsum Board	15.9	97.8	11.0 kg/m²
Total	**169.6**	**478.0**	

* Element thickness does not contribute to total thickness (i.e. in cavity)

ASTM E90 Test Results – Airborne Sound Transmission Loss

Client: CSSBI **Test ID:** TLA-14-069

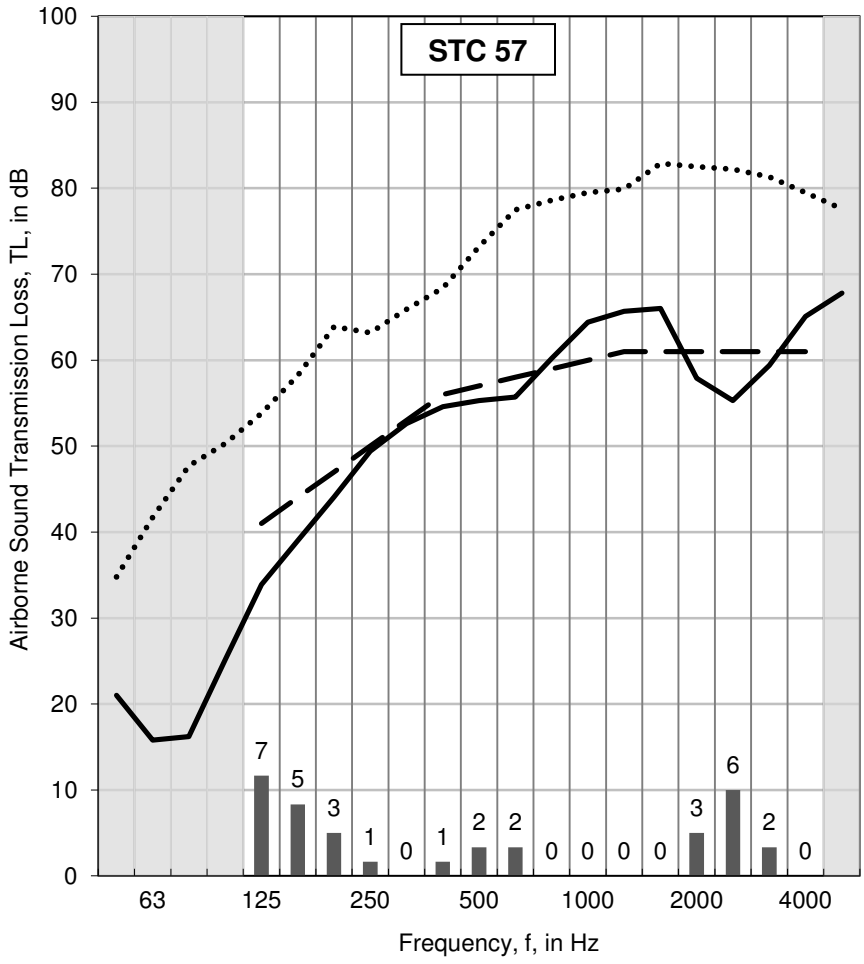
Specimen ID: A1-005007-26W **Date of Test:** 17 October 2014

Room	Volume (m³)	Air Temperature (°C)	Humidity (%)
Large	256.1	20.4 to 20.4	58.8 to 59.4
Small	141.1	19.9 to 19.9	57.7 to 57.9

Area of test specimen:	8.92 m^2
Mass of test specimen:	478.0 kg

f (Hz)	TL (dB)
50	21
63	16
80	16
100	25
125	34
160	39
200	44
250	49
315	53
400	55
500	55
630	56
800	60
1000	64
1250	66
1600	66
2000	58
2500	55
3150	59
4000	65
5000	68
Sound Transmission Class (STC)	**57**

Sum of Deficiencies (dB)
32
Max. Deficiency (dB)
7 dB at 125 Hz



For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Airborne sound transmission loss measurements were conducted in accordance with the requirements of ASTM E90-09, "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements."**

In the graph:
The solid line is the measured sound transmission loss for this specimen. The dashed line is the STC contour fitted to the measured values according to ASTM E413-10. The dotted line (may be above the displayed range) is 10 dB below the flanking limit established for this facility. For any frequency band where the measured transmission loss is above the dotted line, the reported value is potentially limited by flanking transmission via laboratory surfaces, and the true value may be higher than that measured. Bars at the bottom of the graph show deficiencies where the measured data are less than the reference contour as described in the fitting procedure for the STC, defined in ASTM E413-10. The shaded cells in the table and areas in the graph are outside the STC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. The reported values have been corrected according to the procedure outlined in ASTM E90-09. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level, in which case, the corrected values provide an estimate of the lower limit of airborne sound transmission loss.

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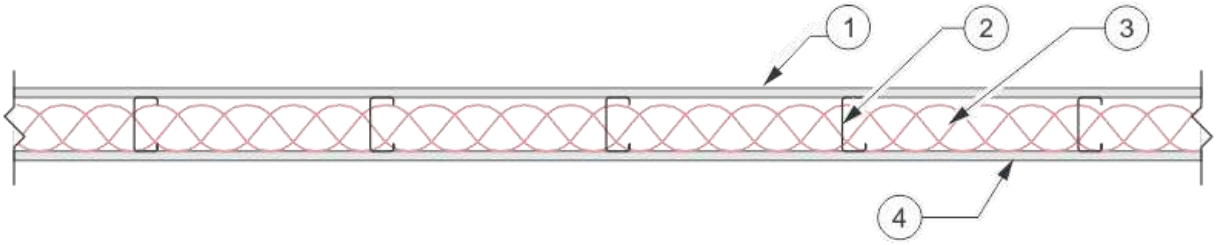
Wall assembly 27W: G16_SS92(406)_GFB92_G16



Description	One layer of 15.9 mm (5/8”) gypsum board Type X, attached on each side of 92 mm (3-5/8”) deep steel studs spaced 406 mm (16”) o.c., with 92 mm (3-5/8”) deep glass fibre insulation (R-12) in the cavity.
Side 1	• **(1)** One layer of 15.9 mm (5/8”) gypsum board Type X, installed vertically and directly attached to the studs using 32 mm (1-1/4”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • Joints of Side 1 gypsum boards staggered by at least one stud spacing from joints of Side 2 gypsum boards • Gaps along the joints and the perimeter of gypsum boards caulked and taped with aluminum tape
Framing & Cavity Insulation	• Base track and top track (steel thickness: 1.37 mm/0.054”) attached to test frame using four 19 mm (3/4”) screws (#10 wafer head) • **(2)** 92 mm (3-5/8”) deep steel C-studs (steel thickness: 1.37 mm/0.054”) spaced 406 mm (16”) o.c., attached to base track and top track using 19 mm (3/4”) screws (#10 pan head) • One through-the-knockout bridging channel, attached to each stud • Flat-strap steel cross-bracing, attached on Side 1 to each stud using 19 mm (3/4”) screws (#10 pan head) • **(3)** Cavities between studs filled with 406 mm (16”) wide by 92 mm (3-5/8”) thick glass fibre insulation (R-12), cut in half to accommodate bridging channel
Side 2	• **(4)** One layer of 15.9 mm (5/8”) gypsum board Type X, installed vertically and directly attached to the studs using 32 mm (1-1/4”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • Joints of Side 1 gypsum boards staggered by at least one stud spacing from joints of Side 2 gypsum boards • Gaps along the joints and the perimeter of gypsum boards caulked and taped with aluminum tape

Specimen Properties

Element	Actual thickness (mm)		Mass (kg)	Mass/length, area or volume
Gypsum Board	15.9		97.8	11.0 kg/m²
Flat Strap	1		3.0	0.3 kg/m
Steel Studs	92		50.2	2.1 kg/m
Steel Tracks	92	*	12.6	1.7 kg/m
C Channel Bridging	1	*	1.9	0.5 kg/m
Angle Bracket	1	*	5.0	0.5 kg/piece
Glass Fibre Insulation	92	*	8.5	10.4 kg/m³
Gypsum Board	15.9		97.8	11.0 kg/m²
Total	**124.8**		**276.8**	

* Element thickness does not contribute to total thickness (i.e. in cavity)

ASTM E90 Test Results – Airborne Sound Transmission Loss

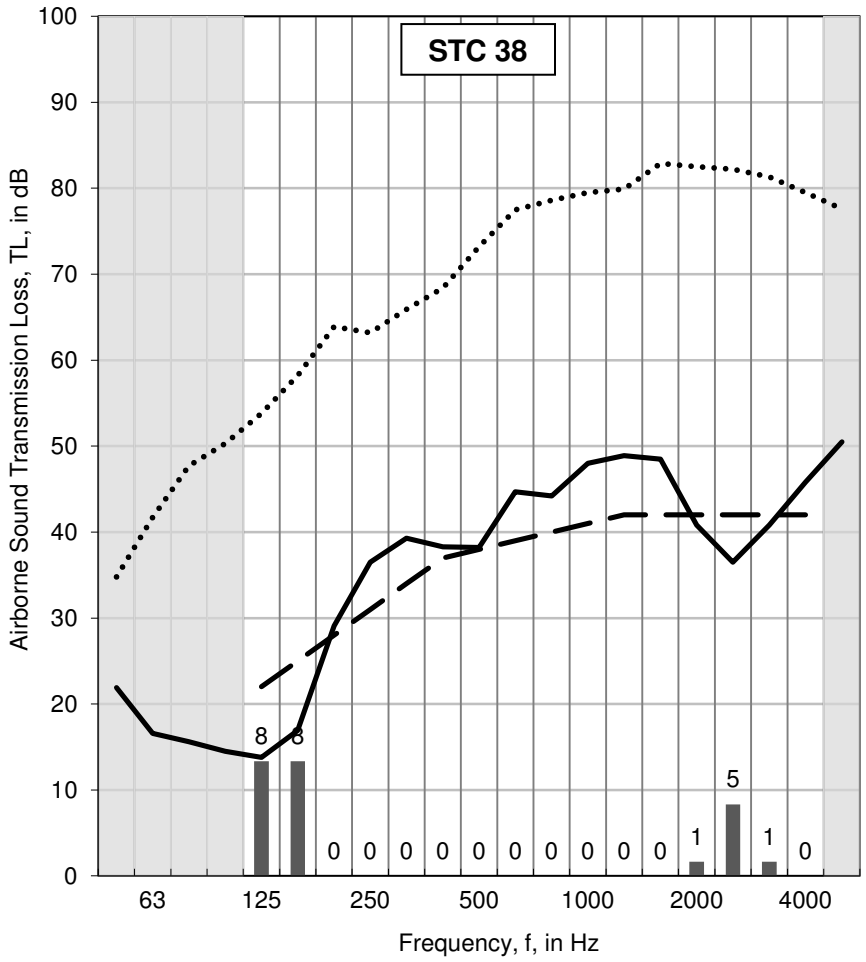
Client: CSSBI **Test ID:** TLA-14-073

Specimen ID: A1-005007-27W **Date of Test:** 23 October 2014

Room	Volume (m³)	Air Temperature (°C)	Humidity (%)
Large	256.1	19.3 to 19.4	38.6 to 38.8
Small	141.1	19.4 to 19.5	49.7 to 49.9

Area of test specimen:	8.92 m^2
Mass of test specimen:	276.8 kg

f (Hz)	TL (dB)
50	22
63	17
80	16
100	15
125	14
160	17
200	29
250	37
315	39
400	38
500	38
630	45
800	44
1000	48
1250	49
1600	49
2000	41
2500	37
3150	41
4000	46
5000	51
Sound Transmission Class (STC)	**38**



Sum of Deficiencies (dB)
23
Max. Deficiency (dB)
8 dB at 125 Hz and 160 Hz

For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Airborne sound transmission loss measurements were conducted in accordance with the requirements of ASTM E90-09, "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements."**

In the graph:
The solid line is the measured sound transmission loss for this specimen. The dashed line is the STC contour fitted to the measured values according to ASTM E413-10. The dotted line (may be above the displayed range) is 10 dB below the flanking limit established for this facility. For any frequency band where the measured transmission loss is above the dotted line, the reported value is potentially limited by flanking transmission via laboratory surfaces, and the true value may be higher than that measured. Bars at the bottom of the graph show deficiencies where the measured data are less than the reference contour as described in the fitting procedure for the STC, defined in ASTM E413-10. The shaded cells in the table and areas in the graph are outside the STC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. The reported values have been corrected according to the procedure outlined in ASTM E90-09. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level, in which case, the corrected values provide an estimate of the lower limit of airborne sound transmission loss.

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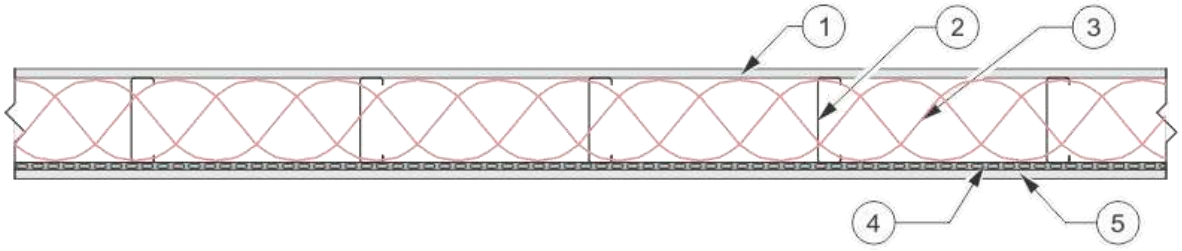
Wall assembly 28W: G16_SS152(406)_GFB152_RC13(406)_G16



Description	One layer of 15.9 mm (5/8”) gypsum board Type X, attached on each side of 152 mm (6”) deep steel studs spaced 406 mm (16”) o.c., with resilient channels on one side spaced 406 mm (16”) o.c. and 152 mm (6”) deep glass fibre insulation (R-20) in the cavity.
Side 1	• **(1)** One layer of 15.9 mm (5/8”) gypsum board Type X, installed vertically, directly attached to the studs using 32 mm (1-1/4”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • Joints of Side 1 gypsum boards staggered by at least one stud spacing from joints of Side 2 gypsum boards • Gaps along the joints and the perimeter of gypsum boards caulked and taped with aluminum tape
Framing & Cavity Insulation	• Base track and top track (steel thickness: 1.09 mm/0.043”) attached to test frame using four 19 mm (3/4”) screws (#10 wafer head) • **(2)** 152 mm (6”) deep steel C-studs (steel thickness: 1.09 mm/0.043”) spaced 406 mm (16”) o.c., attached to base track and top track using 19 mm (3/4”) screws (#10 pan head) • One through-the-knockout bridging channel, attached to each stud using 140 mm (5-1/2”) bridging clips • Flat-strap steel cross-bracing, attached on Side 1 to each stud using 19 mm (3/4”) screws (#10 pan head) • **(3)** Cavities between studs filled with 406 mm (16”) wide by 152 mm (6”) thick glass fibre insulation (R-20), cut in half to accommodate bridging channel
Side 2	• **(4)** 13 mm resilient channels installed horizontally using 19 mm (3/4”) screws (#10 wafer head), spaced 406 mm (16”) o.c. and installed according to ASTM C754-11 • **(5)** One layer of 15.9 mm (5/8”) gypsum board Type X, installed vertically, attached to resilient channels using 32 mm (1-1/4”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • Joints of Side 1 gypsum boards staggered by at least one stud spacing from joints of Side 2 gypsum boards • Gaps along the joints and the perimeter of gypsum boards caulked and taped with aluminum tape

Specimen Properties

Element	Actual thickness (mm)		Mass (kg)	Mass/length, area or volume
Gypsum Board	15.9		97.8	11.0 kg/m²
Flat Strap	1		3.0	0.3 kg/m
Steel Studs	152		50.3	2.1 kg/m
Steel Tracks	152	*	16.8	2.4 kg/m
C Channel Bridging	1	*	1.9	0.5 kg/m
Angle Bracket	1	*	10.8	1.1 kg/piece
Glass Fibre Insulation	152	*	12.4	9.2 kg/m³
Resilient Channels	13		5.6	0.2 kg/m
Gypsum Board	15.9		97.8	11.0 kg/m²
Total	**197.8**		**296.4**	

* Element thickness does not contribute to total thickness (i.e. in cavity)

ASTM E90 Test Results – Airborne Sound Transmission Loss

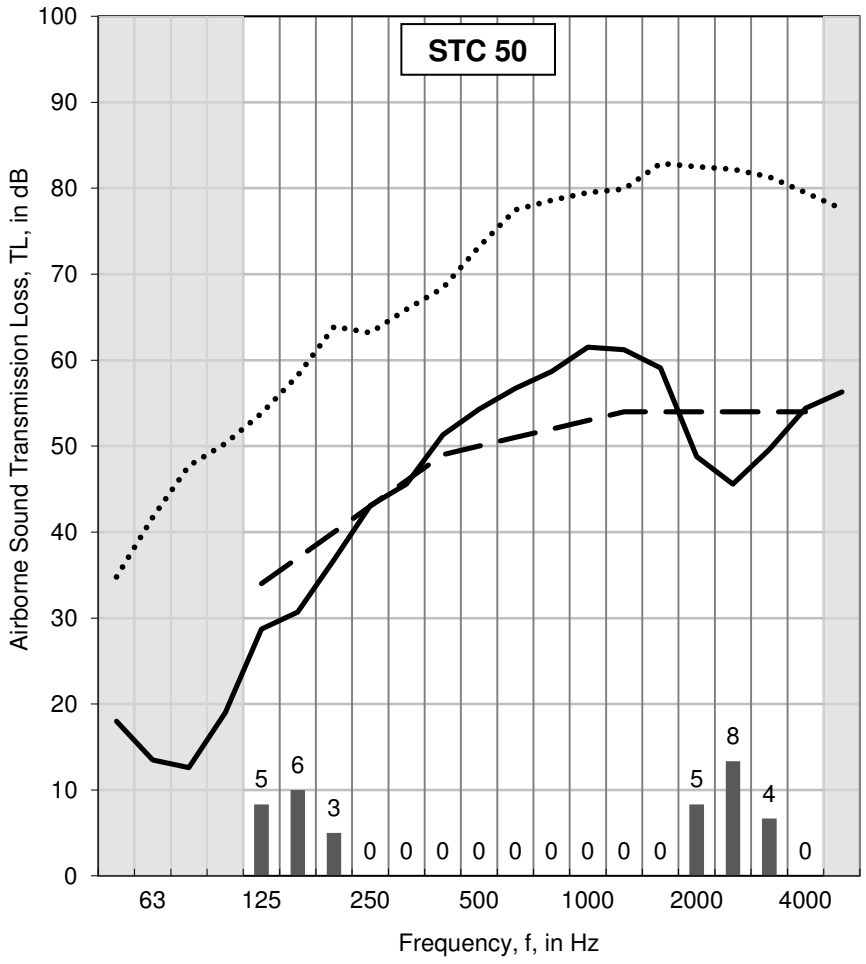
Client: CSSBI **Test ID:** TLA-14-074

Specimen ID: A1-005007-28W **Date of Test:** 28 October 2014

Room	Volume (m³)	Air Temperature (°C)	Humidity (%)
Large	255.9	19.1 to 19.1	44.0 to 44.5
Small	140.6	19.3 to 19.4	42.1 to 42.5

Area of test specimen:	8.92 m^2
Mass of test specimen:	296.4 kg

f (Hz)	TL (dB)
50	18
63	14
80	13
100	19
125	29
160	31
200	37
250	43
315	46
400	51
500	54
630	57
800	59
1000	62
1250	61
1600	59
2000	49
2500	46
3150	50
4000	54
5000	56
Sound Transmission Class (STC)	**50**



Sum of Deficiencies (dB)
31
Max. Deficiency (dB)
8 dB at 2500 Hz

For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Airborne sound transmission loss measurements were conducted in accordance with the requirements of ASTM E90-09, "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements."**

In the graph:
The solid line is the measured sound transmission loss for this specimen. The dashed line is the STC contour fitted to the measured values according to ASTM E413-10. The dotted line (may be above the displayed range) is 10 dB below the flanking limit established for this facility. For any frequency band where the measured transmission loss is above the dotted line, the reported value is potentially limited by flanking transmission via laboratory surfaces, and the true value may be higher than that measured. Bars at the bottom of the graph show deficiencies where the measured data are less than the reference contour as described in the fitting procedure for the STC, defined in ASTM E413-10. The shaded cells in the table and areas in the graph are outside the STC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. The reported values have been corrected according to the procedure outlined in ASTM E90-09. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level, in which case, the corrected values provide an estimate of the lower limit of airborne sound transmission loss.

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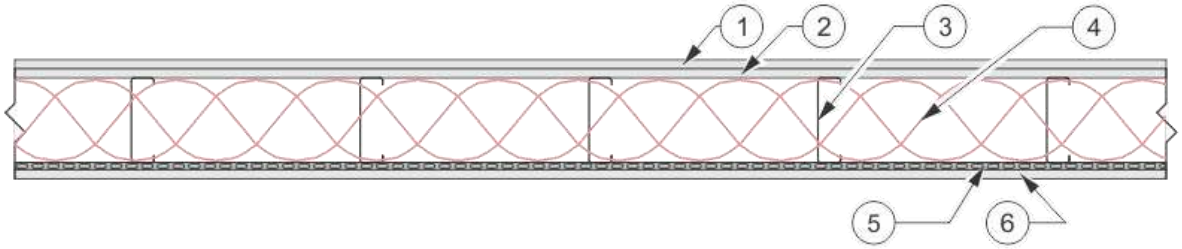
Wall assembly 29W: 2G16_SS152(406)_GFB152_RC13(406)_G16



Description	Two layers of 15.9 mm (5/8”) gypsum board Type X, directly attached to one side of 152 mm (6”) deep steel studs spaced 406 mm (16”) o.c., and one layer of 15.9 mm (5/8”) gypsum board Type X attached to resilient channels spaced 406 mm (16”) o.c. on the other side and 152 mm (6”) deep glass fibre insulation (R-20) in the cavity.
Side 1	• Two layers of 15.9 mm (5/8”) gypsum board Type X, installed vertically • **(2)** Base layer attached to the studs using 32 mm (1-1/4”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • **(1)** Face layer attached to base layer and studs using 41 mm (1-5/8”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • Screws from base layer to face layer offset by 152 mm (6”) • Joints of base layer Side 1 gypsum boards staggered by at least one stud spacing from joints of base layer Side 2 gypsum boards • Joints of face layer staggered by at least one stud spacing from joints of base layer • Gaps along the joints and the perimeter of face layer gypsum boards caulked and taped with aluminum tape
Framing & Cavity Insulation	• Base track and top track (steel thickness: 1.09 mm/0.043”) attached to test frame using four 19 mm (3/4”) screws (#10 wafer head) • **(3)** 152 mm (6”) deep steel C-studs (steel thickness: 1.09 mm/0.043”) spaced 406 mm (16”) o.c., attached to base track and top track using 19 mm (3/4”) screws (#10 pan head) • One through-the-knockout bridging channel, attached to each stud using 140 mm (5-1/2”) bridging clips • Flat-strap steel cross-bracing, attached on Side 1 to each stud using 19 mm (3/4”) screws (#10 pan head) • **(4)** Cavities between studs filled with 406 mm (16”) wide by 152 mm (6”) thick glass fibre insulation (R-20), cut in half to accommodate bridging channel
Side 2	• **(5)** 13 mm resilient channels installed horizontally using 19 mm (3/4”) screws (#10 wafer head), spaced 406 mm (16”) o.c. and installed according to ASTM C754-11 • **(6)** One layer of 15.9 mm (5/8”) gypsum board Type X, installed vertically

	and attached to resilient channels using 32 mm (1-1/4”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • Joints of Side 1 gypsum boards staggered by at least one stud spacing from joints of Side 2 gypsum boards • Gaps along the joints and the perimeter of gypsum boards caulked and taped with aluminum tape

Specimen Properties

Element	Actual thickness (mm)	Mass (kg)	Mass/length, area or volume
Gypsum Board	15.9	97.8	11.0 kg/m²
Gypsum Board	15.9	97.8	11.0 kg/m²
Flat Strap	1	3.0	0.3 kg/m
Steel Studs	152	50.3	2.1 kg/m
Steel Tracks	152 *	16.8	2.4 kg/m
C Channel Bridging	1 *	1.9	0.5 kg/m
Angle Bracket	1 *	10.8	1.1 kg/piece
Glass Fibre Insulation	152 *	12.4	9.2 kg/m³
Resilient Channels	13	5.6	0.2 kg/m
Gypsum Board	15.9	97.8	11.0 kg/m²
Total	**213.7**	**394.2**	

* Element thickness does not contribute to total thickness (i.e. in cavity)

ASTM E90 Test Results – Airborne Sound Transmission Loss

Client: CSSBI **Test ID:** TLA-14-075

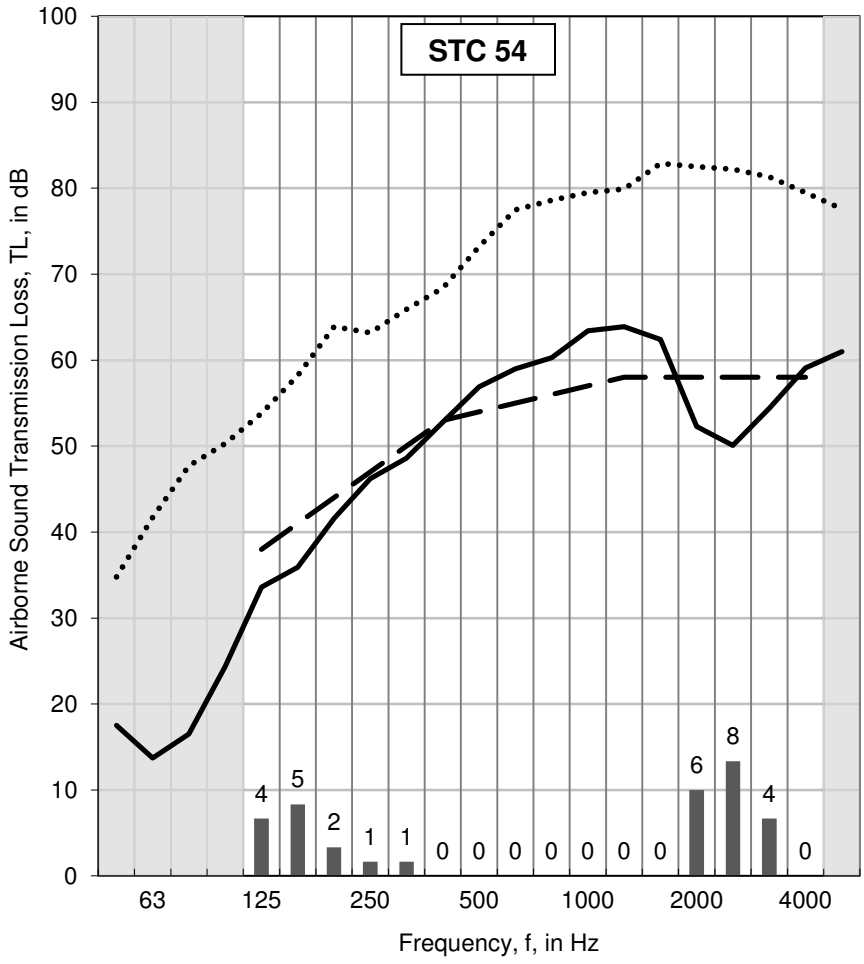
Specimen ID: A1-005007-29W **Date of Test:** 31 October 2014

Room	Volume (m³)	Air Temperature (°C)	Humidity (%)
Large	253.4	18.9 to 19.0	32.4 to 32.8
Small	139.0	19.2 to 19.2	38.6 to 40.4

Area of test specimen:	8.92 m^2
Mass of test specimen:	394.2 kg

f (Hz)	TL (dB)
50	18
63	14
80	17
100	24
125	34
160	36
200	42
250	46
315	49
400	53
500	57
630	59
800	60
1000	63
1250	64
1600	62
2000	52
2500	50
3150	54
4000	59
5000	61
Sound Transmission Class (STC)	**54**

Sum of Deficiencies (dB)
31
Max. Deficiency (dB)
8 dB at 2500 Hz



For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Airborne sound transmission loss measurements were conducted in accordance with the requirements of ASTM E90-09, "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements."**

In the graph:
The solid line is the measured sound transmission loss for this specimen. The dashed line is the STC contour fitted to the measured values according to ASTM E413-10. The dotted line (may be above the displayed range) is 10 dB below the flanking limit established for this facility. For any frequency band where the measured transmission loss is above the dotted line, the reported value is potentially limited by flanking transmission via laboratory surfaces, and the true value may be higher than that measured. Bars at the bottom of the graph show deficiencies where the measured data are less than the reference contour as described in the fitting procedure for the STC, defined in ASTM E413-10. The shaded cells in the table and areas in the graph are outside the STC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. The reported values have been corrected according to the procedure outlined in ASTM E90-09. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level, in which case, the corrected values provide an estimate of the lower limit of airborne sound transmission loss.

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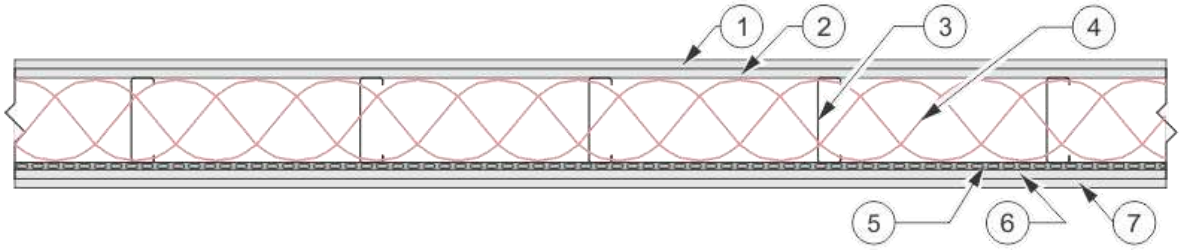
Wall assembly 30W: 2G16_SS152(406)_GFB152_RC13(406)_2G16



Description	Two layers of 15.9 mm (5/8”) gypsum board Type X, attached on each side of 152 mm (6”) deep steel studs spaced 406 mm (16”) o.c., with resilient channels on one side spaced 406 mm (16”) o.c. and 152 mm (6”) deep glass fibre insulation (R-20) in the cavity.
Side 1	• Two layers of 15.9 mm (5/8”) gypsum board Type X, installed vertically • **(2)** Base layer attached to the studs using 32 mm (1-1/4”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • **(1)** Face layer attached to base layer and studs using 41 mm (1-5/8”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • Screws from base layer to face layer offset by 152 mm (6”) • Joints of base layer Side 1 gypsum boards staggered by at least one stud spacing from joints of base layer Side 2 gypsum boards • Joints of face layer staggered by at least one stud spacing from joints of base layer • Gaps along the joints and the perimeter of face layer gypsum boards caulked and taped with aluminum tape
Framing & Cavity Insulation	• Base track and top track (steel thickness: 1.09 mm/0.043”) attached to test frame using four 19 mm (3/4”) screws (#10 wafer head) • **(3)** 152 mm (6”) deep steel C-studs (steel thickness: 1.09 mm/0.043”) spaced 406 mm (16”) o.c., attached to base track and top track using 19 mm (3/4”) screws (#10 pan head) • One through-the-knockout bridging channel, attached to each stud using 140 mm (5-1/2”) bridging clips • Flat-strap steel cross-bracing, attached on Side 1 to each stud using 19 mm (3/4”) screws (#10 pan head) • **(4)** Cavities between studs filled with 406 mm (16”) wide by 152 mm (6”) thick glass fibre insulation (R-20), cut in half to accommodate bridging channel
Side 2	• **(5)** 13 mm resilient channels installed horizontally using 19 mm (3/4”) screws (#10 wafer head), spaced 406 mm (16”) o.c. and installed according to ASTM C754-11 • Two layers of 15.9 mm (5/8”) gypsum board Type X, installed vertically • **(6)** Base layer attached to resilient channels using 32 mm (1-1/4”) screws

	(#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • **(7)** Face layer attached to base layer and resilient channels using 41 mm (1-5/8”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. at the perimeter and in the field • Screws from base layer to face layer offset by 152 mm (6”) • Joints of base layer Side 1 gypsum boards staggered by at least one stud spacing from joints of base layer Side 2 gypsum boards • Joints of face layer staggered by at least one stud spacing from joints of base layer • Gaps along the joints and the perimeter of face layer gypsum boards caulked and taped with aluminum tape

Specimen Properties

Element	Actual thickness (mm)		Mass (kg)	Mass/length, area or volume
Gypsum Board	15.9		97.8	11.0 kg/m²
Gypsum Board	15.9		97.8	11.0 kg/m²
Flat Strap	1		3.0	0.3 kg/m
Steel Studs	152		50.3	2.1 kg/m
Steel Tracks	152	*	16.8	2.4 kg/m
C Channel Bridging	1	*	1.9	0.5 kg/m
Angle Bracket	1	*	10.8	1.1 kg/piece
Glass Fibre Insulation	152	*	12.4	9.2 kg/m³
Resilient Channels	13		5.6	0.2 kg/m
Gypsum Board	15.9		97.8	11.0 kg/m²
Gypsum Board	15.9		97.8	11.0 kg/m²
Total	**229.6**		**492.0**	

* Element thickness does not contribute to total thickness (i.e. in cavity)

ASTM E90 Test Results – Airborne Sound Transmission Loss

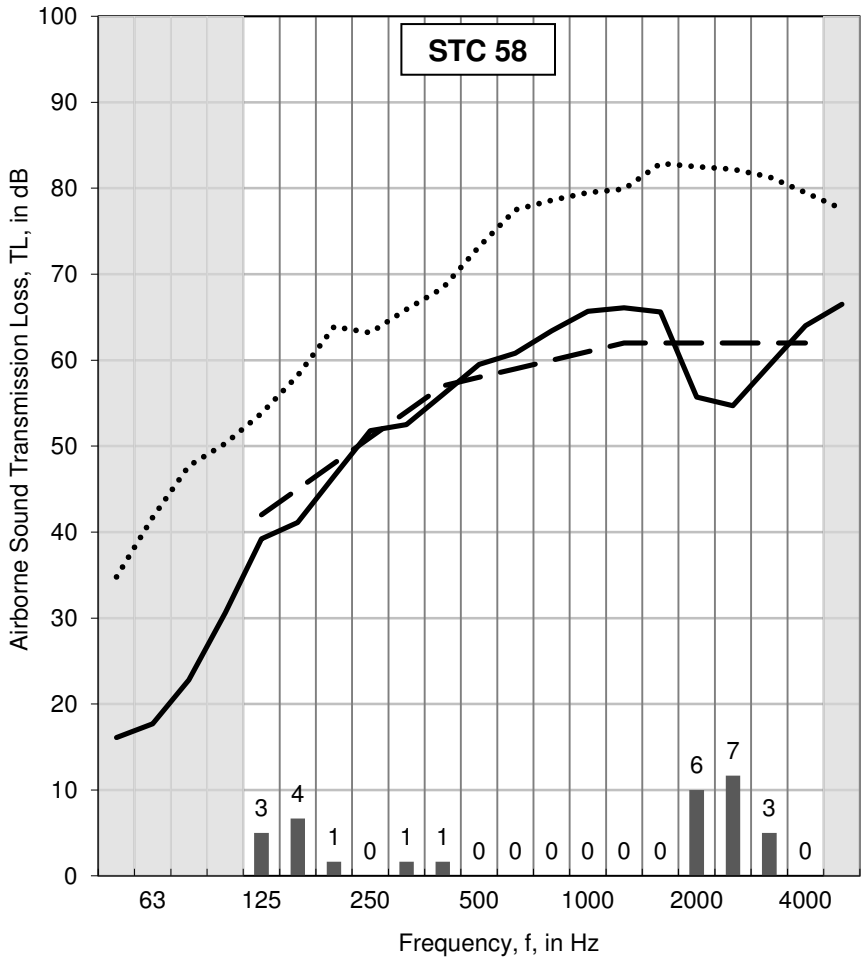
Client: CSSBI **Test ID:** TLA-14-076

Specimen ID: A1-005007-30W **Date of Test:** 31 October 2014

Room	Volume (m³)	Air Temperature (°C)	Humidity (%)
Large	253.4	18.9 to 19.1	32.6 to 32.8
Small	139.0	19.1 to 19.2	42.5 to 43.0

Area of test specimen:	8.92 m^2
Mass of test specimen:	492.0 kg

f (Hz)	TL (dB)
50	16
63	18
80	23
100	31
125	39
160	41
200	47
250	52
315	53
400	56
500	60
630	61
800	63
1000	66
1250	66
1600	66
2000	56
2500	55
3150	59
4000	64
5000	67
Sound Transmission Class (STC)	**58**



Sum of Deficiencies (dB)
26
Max. Deficiency (dB)
7 dB at 2500 Hz

For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Airborne sound transmission loss measurements were conducted in accordance with the requirements of ASTM E90-09, "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements."**

In the graph:
The solid line is the measured sound transmission loss for this specimen. The dashed line is the STC contour fitted to the measured values according to ASTM E413-10. The dotted line (may be above the displayed range) is 10 dB below the flanking limit established for this facility. For any frequency band where the measured transmission loss is above the dotted line, the reported value is potentially limited by flanking transmission via laboratory surfaces, and the true value may be higher than that measured. Bars at the bottom of the graph show deficiencies where the measured data are less than the reference contour as described in the fitting procedure for the STC, defined in ASTM E413-10. The shaded cells in the table and areas in the graph are outside the STC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. The reported values have been corrected according to the procedure outlined in ASTM E90-09. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level, in which case, the corrected values provide an estimate of the lower limit of airborne sound transmission loss.

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1.3 Analysis of Results for CFS-Framed Walls

The following sections present a brief analysis of some parameters affecting the sound insulation of wall assemblies with cold-formed steel-framed studs. A more detailed analysis can be found in [3].

1.3.1 Transmission Loss of Reference Assembly

Wall 01W is used as a reference. The assembly consisted of cold-formed steel studs (steel thickness: 1.37 mm/0.054”) spaced 406 mm (16”) on centres, with resilient channels on one side spaced 406 mm (16”) on centres and 152 mm (6”) deep glass fibre batts in the wall cavity. The sheathing consisted of one layer of 15.9 mm (5/8”) gypsum board type X on each side. The reference assembly achieved a sound transmission class (STC) rating of 49.

Figure 1 shows the measured transmission loss curve of the reference assembly 01W in the frequency range between 50 Hz and 5000 Hz. Only the frequency range between 125 Hz and 4000 Hz is used for the calculation of the STC rating, according to the procedure of ASTM E413 [4].

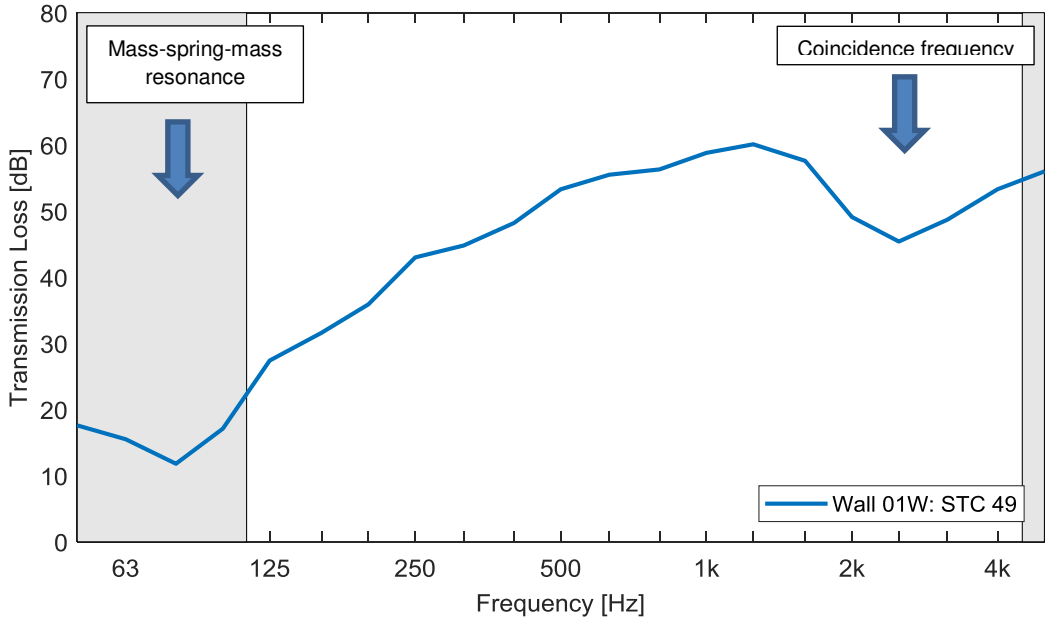


Figure 1: Transmission loss of reference wall assembly

The transmission loss curve in Figure 1 exhibits the characteristic pattern of double-panel walls. The mass-spring-mass (gypsum board – air/stud – gypsum board) resonance frequency lies in the 80 Hz band. The coincidence dip of the 15.9 mm thick gypsum board occurs in the 2500 Hz band. At the coincidence frequency, the bending wavelength on the gypsum board equals the wavelength in air, leading to very efficient sound radiation. The reference wall assembly falls just short of the minimum requirement for partition walls between dwelling units in the 2010 edition of the National Building Code of Canada, STC 50.

1.3.2 Influence of Sheathing

Adding layers of gypsum board to the reference wall assembly has two effects on the acoustical performance. Most importantly, increasing the mass per area of the gypsum board panels leads to a downward shift of the mass-spring-mass resonance frequency, which in turn leads to higher transmission loss values in the frequency region of interest (125 Hz to 4000 Hz). This is shown in Figure 2, where the transmission loss curves of three wall assemblies with different numbers of gypsum board layers are presented. The mass-spring-mass resonance frequency shifts from the 80 Hz band (Wall 04W with one layer of gypsum board on each side) into the 63 Hz band (Wall 05W with one layer of gypsum board on one side and two layers on the other side) and further into the 50 Hz band (Wall 06W with two layers of gypsum board on each side). Each additional layer of gypsum board increases the STC rating by 4 points. For wall assemblies without cavity insulation, the improvement in STC is slightly higher, with 5 points per additional layer (see Figure 4). For wall assemblies without resilient channels, the improvement in STC is only 3 points per additional layer (Figure 5). For walls with 92 mm studs, the improvement is 6 points per additional layer (Figure 6).

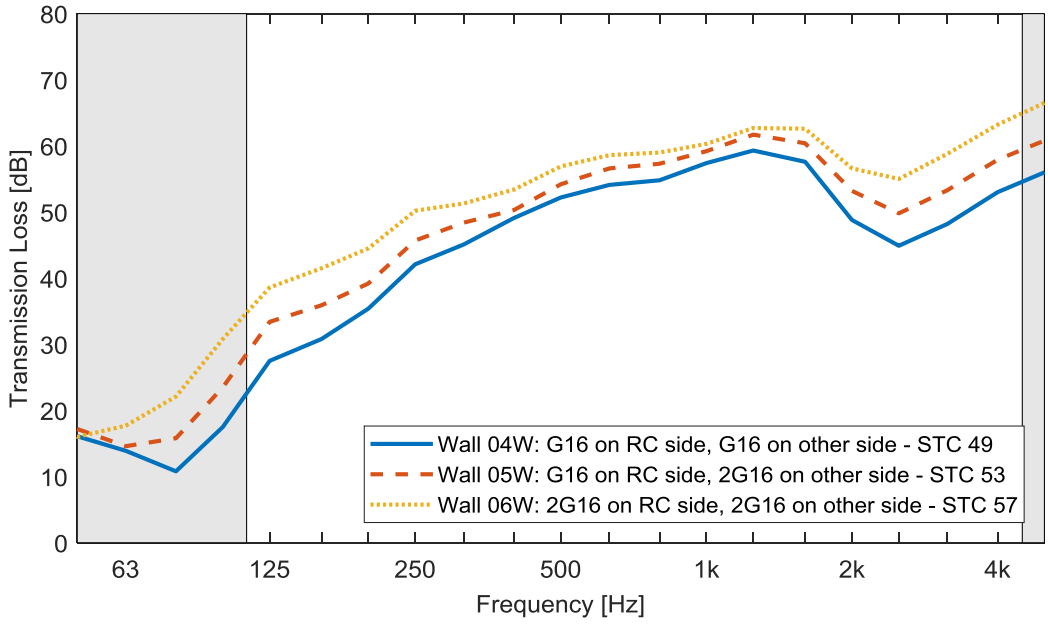


Figure 2: Influence of the layers of gypsum board on the transmission loss

The second effect of changing the sheathing affects the transmission loss curve in the region of the coincidence frequency. The coincidence frequency of a gypsum board wall assembly depends on the density of the gypsum board (i.e. on thickness and mass per area) and on its bending stiffness. This is illustrated in Figure 3, where the transmission loss for two walls with identical framing members (and with resilient channels and cavity insulation) but different types of gypsum board is shown: Wall 02W had 15.9 mm (5/8") thick gypsum board panels with a mass per area of 11.0 kg/m^2, and Wall 03W had 12.7 mm (1/2") thick gypsum board panels with a mass per area of 10.0 kg/m^2. The transmission loss of the two walls is very similar, except in the region of the coincidence frequency. Due to the slightly different mass of the boards, the mass-spring-mass resonance shifts down a little. Due to the thinner gypsum board, the coincidence frequency for Wall 03W is higher than the coincidence frequency of Wall 02W. In this case, the effect on the STC rating is small – Wall 02W has an STC rating of 58 and Wall 03W has an STC rating of 57. It should be noted that the coincidence frequency of a gypsum board wall does not depend on the number of layers of gypsum board. Adding a layer of gypsum board does not yield a coincidence frequency equal to that of a single board with double the thickness (31.8mm), as might be expected. This is because the two gypsum boards are only point-connected, and acoustical waves still propagate through them independently. On the other hand, additional layers of gypsum board may have an effect on the damping of the board, and therefore on the depth of the coincidence frequency dip. This can be observed in Figure 2, where the coincidence dip for Wall 04W is much deeper than the coincidence dip for Wall 06W. Since the STC value can sometimes be limited by this dip (especially due to the 8 dB rule in ASTM E413), changing the damping of the sheathing can be of benefit in these cases.

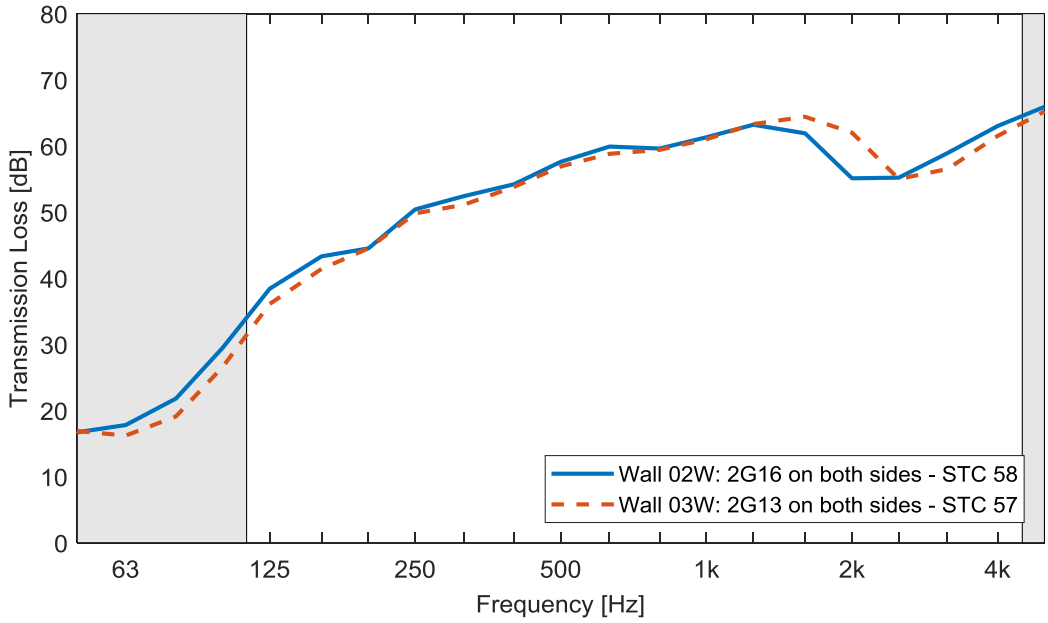


Figure 3: Influence of the type of gypsum board on the coincidence frequency

Figure 4 shows the effect of changing the sheathing for a wall assembly with resilient channels, but without cavity insulation. Once again, the mass-spring-mass resonance frequency shifts down for additional layers of gypsum board, as in Figure 2. However, this time the improvement in transmission loss is about 5 dB across the frequency range for one additional layer (Wall 08W and Wall 10W), and 10 dB on average for two additional layers (Wall 09W). The STC values change from STC 42 to STC 47/48 and STC 53. Adding additional layers of gypsum board is therefore even more beneficial for walls without insulation in the cavity. This is to be expected, as it is generally easier to improve an assembly with lower sound insulation than one that already performs well.

Figure 4 also shows that for the direct sound transmission through a partition wall it is of minor importance on which side of the assembly the additional layer of gypsum board is attached. The transmission loss curves for Wall 08W and Wall 10W are within 1 dB of each other for most of the frequency range of interest.

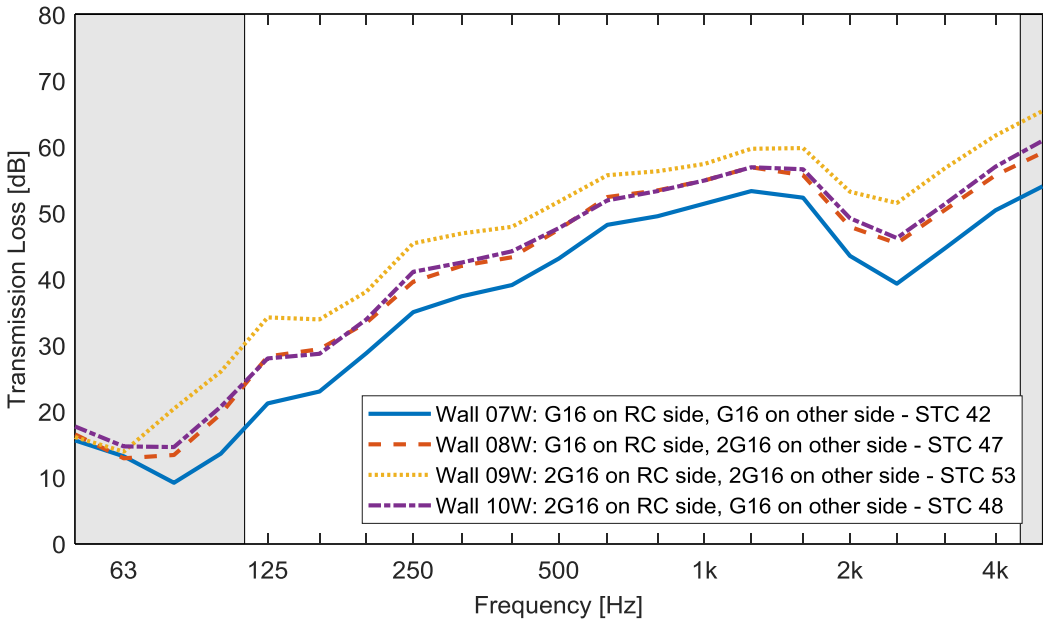


Figure 4: Influence of the layers of gypsum board for walls without cavity insulation

Figure 5 shows the effect of changing the sheathing for a wall assembly with cavity insulation but without resilient channels. In this case, the three transmission loss curves are merely shifted upwards. The mass-spring-mass frequency is not visibly affected by the change in sheathing. The STC rating improves by 3 points for each additional layer of gypsum board – from STC 42 to STC 45 to STC 48. None of the three wall assemblies meets the requirements of the 2010 edition of the National Building Code, STC 50. This shows that resilient channels are a required element when designing loadbearing steel stud walls between dwelling units in mid-rise constructions.

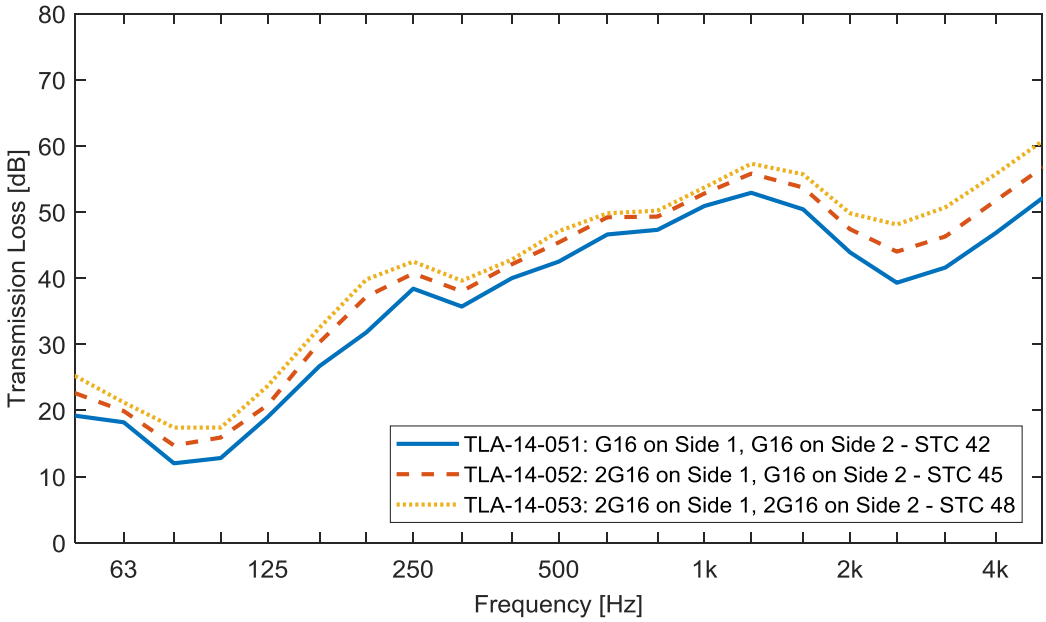


Figure 5: Influence of the layers of gypsum board for walls without resilient channels

Figure 6 shows the effect of changing the sheathing for a wall assembly with 92 mm deep cold-formed steel-framed studs (and with cavity insulation and resilient channels). The observed changes are very similar to the changes for the walls with 152 mm deep studs in Figure 2: The mass-spring-mass frequency shifts down with increasing layers of gypsum board, and the transmission loss curve above the mass-spring-mass frequency shifts up. In this case, the improvement in STC ratings is slightly higher than in Figure 2. The STC rating improves from 45 (for one layer of gypsum board on each side) to 52 (for one layer on one side and two layers on the other side) and 57 (for two layers on each side).

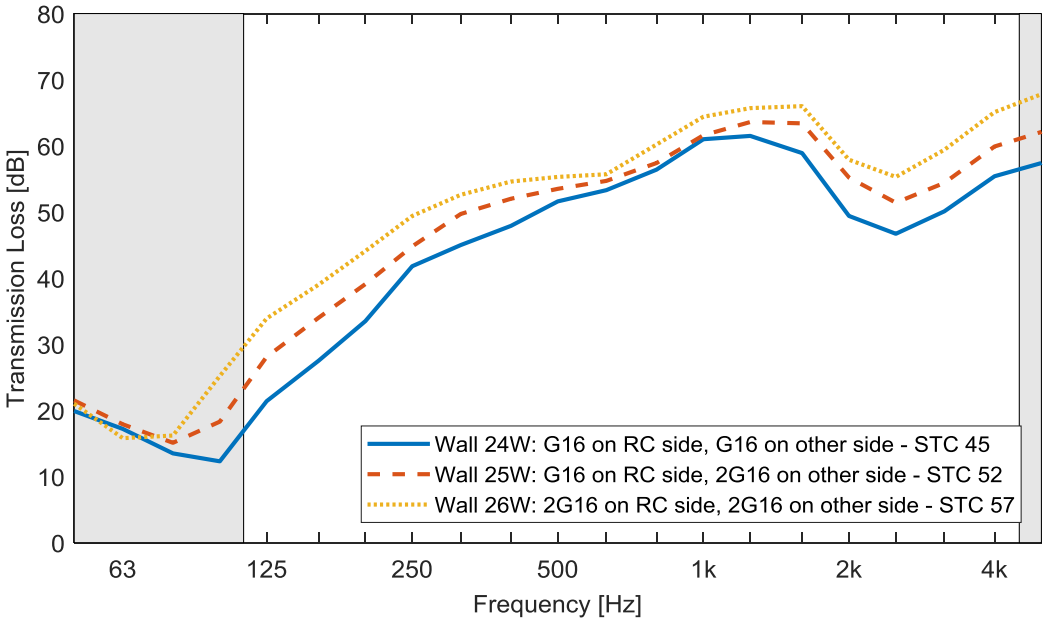


Figure 6: Influence of the layers of gypsum board for 92 mm deep walls

1.3.3 Influence of Cavity Insulation

Figure 7 shows the transmission loss curves for three wall assemblies with resilient channels, one layer of 15.9 mm (5/8”) gypsum board Type X on each side, and varying cavity insulation. The improvement from the wall without cavity insulation to the walls with cavity insulation is quite significant. The STC rating changes from STC 42 for Wall 07W to STC 49 for Wall 01W and Wall 04W. The transmission loss curves improve by about 7 dB on average between 125 Hz and 2500 Hz.

The thickness of the cavity insulation appears to be of minor significance. The STC values for Wall 01W (152 mm deep glass fibre batts) and Wall 07W (89 mm deep glass fibre batts) are the same, and the transmission loss values are within 1.5 dB for most of the frequency range of interest.

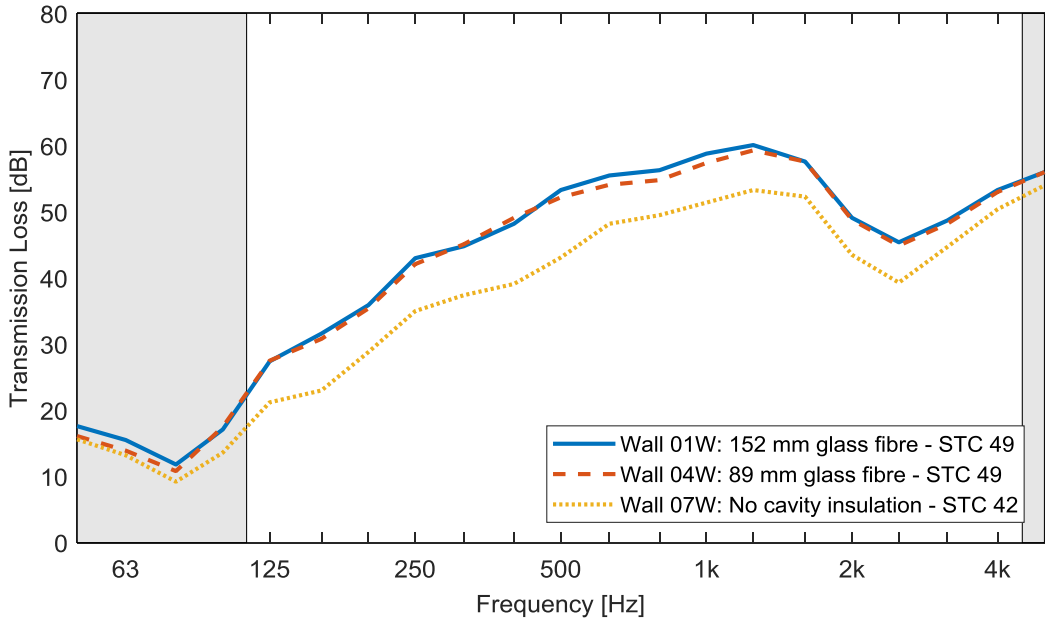


Figure 7: Influence of cavity insulation

1.3.4 Influence of Resilient Channels

Figure 8 shows the influence of resilient channels for a wall assembly with one layer of 15.9 mm (5/8”) gypsum board type X on each side, and 152 mm deep glass fibre insulation in the cavity. The STC value increases from STC 42 for Wall 11W to STC 49 for Wall 01W when adding resilient channels on one side. The resonance frequency is shifted from the 100 Hz one-third octave band into the 80 Hz one-third octave band, resulting in an improvement in transmission loss of about 5 dB on average between 100 Hz and 250 Hz. Above 250 Hz, a further effect is observed: if the resilient channels are removed, the two sides of the assembly are no longer decoupled from each other, and structural transmission via the studs becomes important.

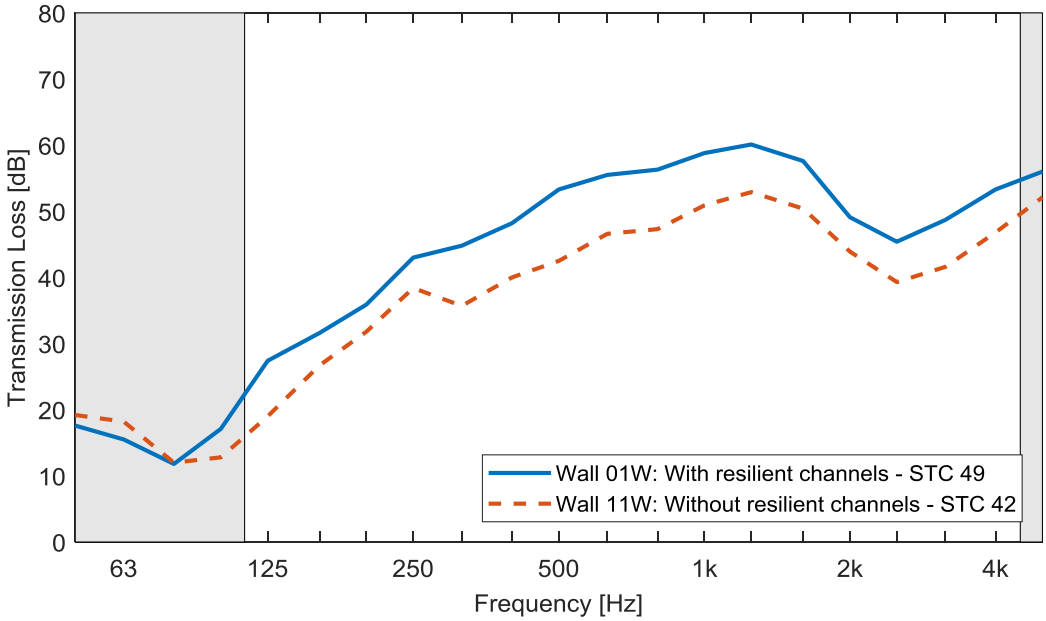


Figure 8: Influence of resilient channels

1.3.5 Influence of Stud Spacing

The stud spacing is often determined by structural and/or fire resistance considerations. The smaller the stud spacing, the stronger the wall will be structurally, and the higher will be the fire resistance. These considerations are particularly important for mid-rise buildings. For sound insulation performance, a larger stud spacing is desirable, to decrease the number of studs and thereby limit the structural transmission, and to decrease the stiffness of the entire wall assembly. Two different stud spacings were investigated in this study: 406 mm (16”) on centres and 610 mm (24”) on centres. The results are shown in Figure 9, for walls with two layers of gypsum board on each side (and resilient channels and cavity insulation). The change in stud spacing has a notable effect on the transmission loss curves. It increases over the entire frequency of interest. The STC increases by 1 point.

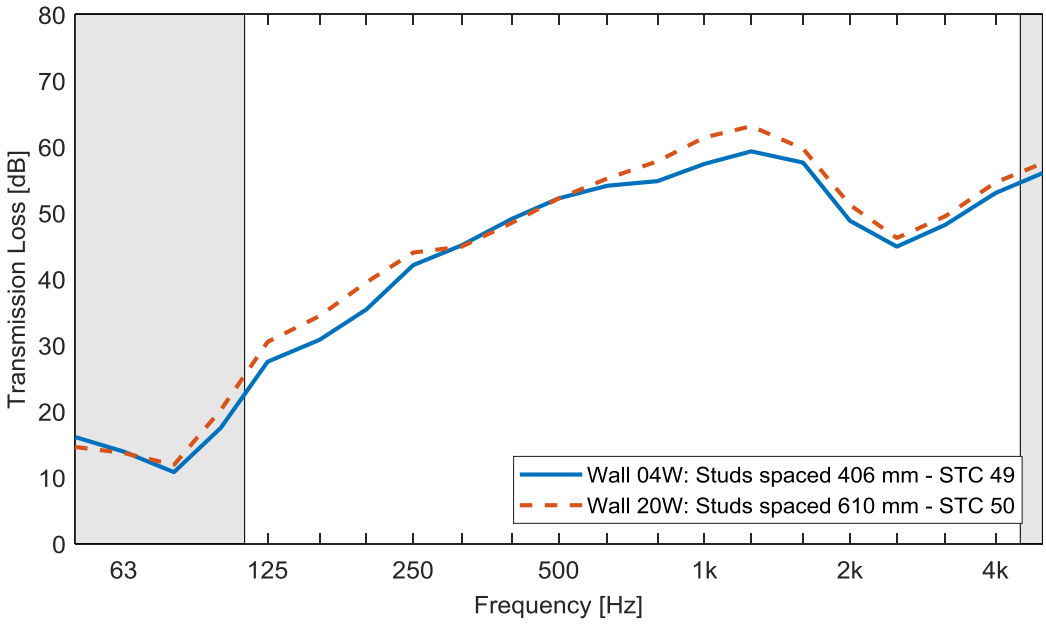


Figure 9: Influence of stud spacing

1.3.6 Influence of Stud Depth

Figure 10 shows the influence of the stud depth. Two stud depths were investigated: 152 mm (6”) and 92 mm (3-5/8”). For both types of stud, the stud spacing and the steel thickness was the same (406 mm on centres and 1.37 mm, respectively). As would be expected, decreasing the stud depth decreases the sound insulation performance. The smaller air gap between the two sides leads to an upward shift of the mass-spring-mass resonance frequency. The STC value drops from 49 for 152 mm studs to 45 for 92 mm studs. If more layers of gypsum board are used, the change between walls with different stud depth gets smaller (not shown). The influence of the stud depth was not investigated for wall assemblies without resilient channels.

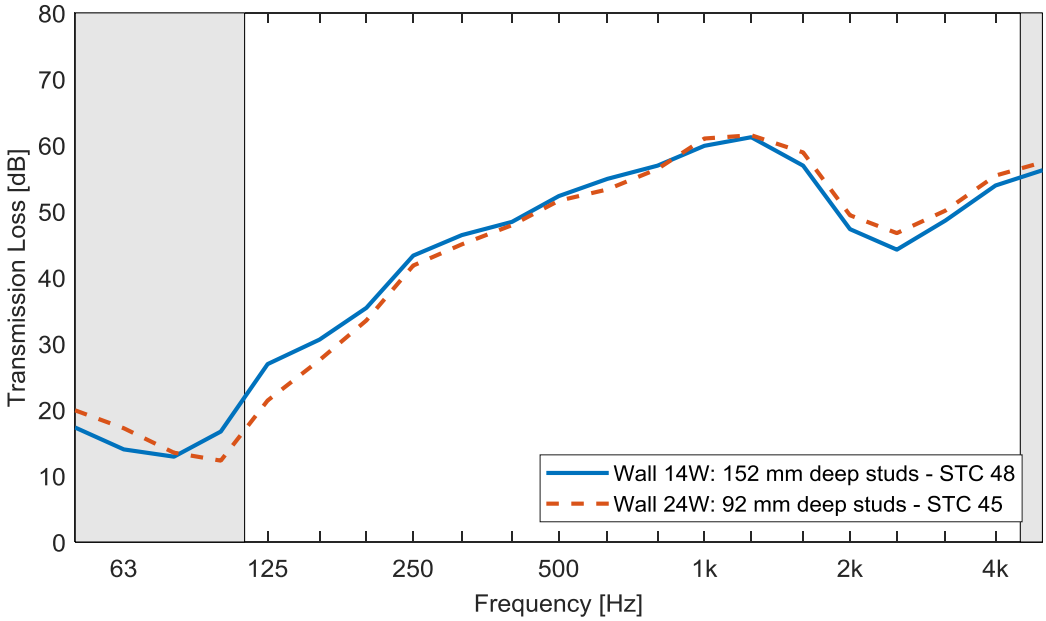


Figure 10: Influence of stud depth

1.3.7 Influence of Steel Thickness

The walls investigated in this study were steel stud walls, intended to be loadbearing walls in mid-rise constructions. The studs in the reference wall assembly and in all the walls presented so far had a steel thickness of 1.37 mm (0.054”). Several walls with slightly thinner steel thickness were tested as well, namely 1.09 mm (0.043”). Figure 11 shows the transmission loss of the reference assembly and of the same wall with studs with smaller steel thickness. There are some differences between the curves, but they are not very significant. The STC value improves by 1 point for the wall with thinner steel thickness. While the observed effects between walls with different stud steel thickness are not very significant for the cases studied, it is expected that using studs with thinner steel (e.g. typical non-loadbearing steel studs) would show more pronounced effects. Also, the differences between walls with studs of different steel thickness will likely be larger for walls without resilient channels, but this was not investigated as part of this study.

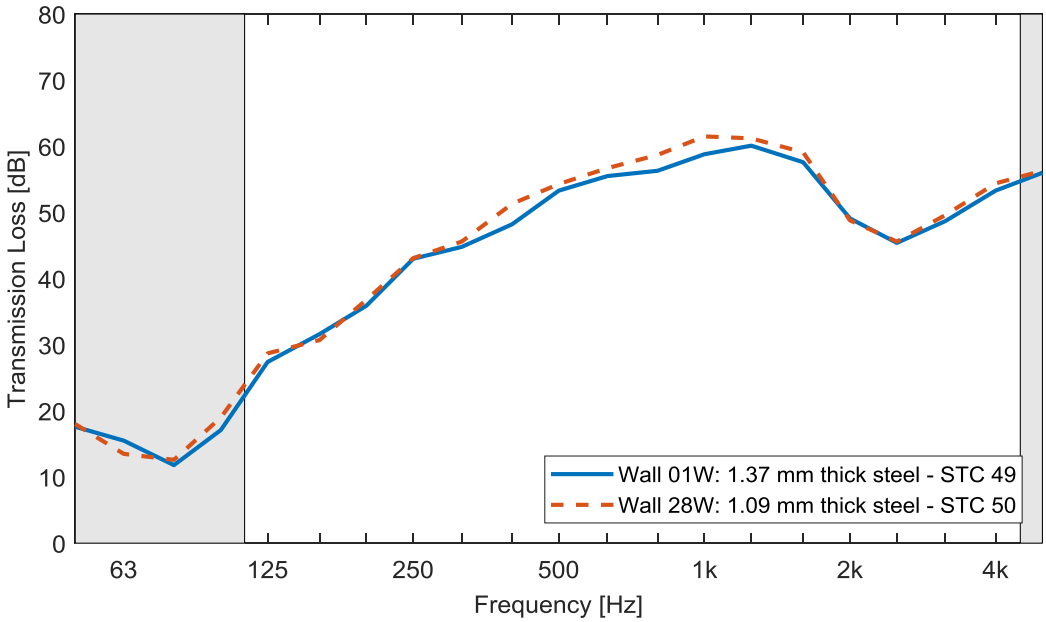


Figure 11: Influence of the steel thickness of the wall studs

1.3.8 Influence of Flat Straps and Bridging Channels

The influence of the flat straps and the bridging channels used for bracing against lateral and shear loads on the direct sound insulation performance was investigated using wall assemblies with 92 mm (3-5/8”) deep studs. The transmission loss was measured three times for the same wall: with flat straps and bridging channels, with bridging channels but with flat straps removed, and without flat straps and bridging channels. As shown in Figure 12, the measurements yielded the same results in each case. Since there is no observable effect for the wall with 92 mm deep studs, it is anticipated that there will also be no observable effect for walls with a deeper cavity. It can be concluded that flat strap bracing and bridging channels have no significant effect on the direct sound transmission of the cold-formed steel-framed walls under investigation.

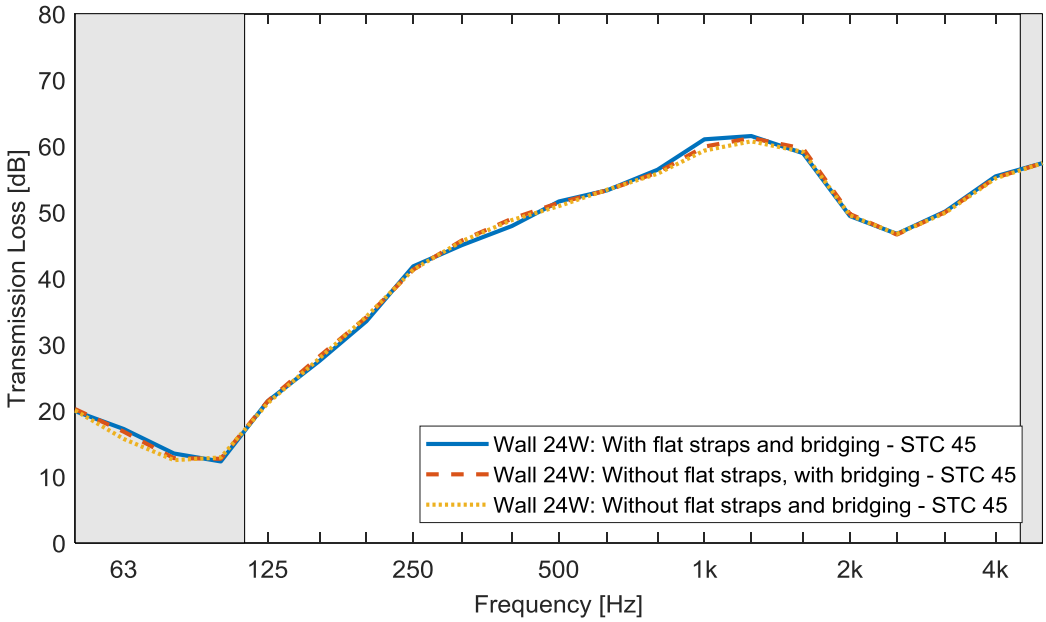


Figure 12: Influence of flat straps and bridging channels

2. Sound Insulation of CFS-Framed Floors

The sound insulation properties of 17 cold-formed steel-framed floor assemblies for mid-rise construction were measured in the NRC Construction Floor Sound Transmission Facility, in accordance with the requirements of ASTM E90-09 [2] and ASTM E492-09 [5]. The facility and the test methods are described in Appendix B and Appendix C.

The first floor that was tested was chosen as reference assembly. It was constructed from 254 mm (10”) deep cold-formed steel joists spaced 406 mm (16”) on centres, with a corrugated steel deck and 38 mm (1-1/2”) thick lightweight gypsum concrete on top. The ceiling consisted of one layer of 15.9 mm (5/8”) gypsum board type X attached to resilient channels spaced 305 mm (12”) on centres, with 92 mm (3-5/8”) thick glass fibre batts resting on the resilient channels in the joist cavities. The floor also included blocking strips, installed at the centre of the joists between the two last joists on each end and between the two joists in the floor centre, and a steel strap connecting the three blocking strips with each other and with the other joists. The reference assembly achieved a Sound Transmission Class (STC) rating of 57 and an Impact Insulation Class (IIC) rating of 21.

Based on the reference assembly described above, a parametric study was conducted to investigate the importance of various floor members. The following parameters were examined: the joist depth, the gypsum board ceiling, and various floor coverings.

This section is divided into three parts:

Section 2.1 provides a tabulated overview of the floor assemblies that were tested as part of this study. Table 4 contains short descriptions and drawings of all floor assemblies together with their measured STC and IIC ratings and a reference to the page where the detailed test reports can be found.

Section 2.2 provides the detailed test reports which list the construction details, material properties, test conditions, and test results for each specimen.

Section 2.4 provides brief analyses of parameters affecting the sound insulation of cold-formed steel-framed floor assemblies.

2.1 Overview of Tested Floor Assemblies

Table 4 provides an overview of all floor assemblies that were tested as part of this study. Each row contains the specimen identifier, a sketch and a short code describing the specimen, the measured Sound Transmission Class (STC) and Impact Insulation Class (IIC) ratings of the specimen, and the page number where the detailed test reports can be found.

A coding system is used in the table to avoid long descriptions of the floor constructions. Each surface layer in a floor is coded as follows:

- An integer representing the number of layers of material; if the number of layers is one, the leading 1 is omitted
- A sequence of letters to indicate the material in the layer (see Table 3 below)
- A number representing the thickness in mm of each sheet or element in the layer
- Underscores separating the codes for each layer

The coding system is also applied to elements that do not constitute surface layers such as joists, studs, and resilient metal channels. For such elements, the number following the letters is the depth of each element (the dimension along the axis perpendicular to the surface of the assembly) and the number in parentheses following the depth code is the separation between adjacent elements.

Table 3: Examples of the codes used to identify materials and describe constructions

Code	Material
LAMxx	Laminate flooring “xx” mm thick
CARxx	Carpet “xx” mm thick
VINxx	Vinyl flooring “xx” mm thick
STYxx	Styrofoam bead underlay “xx” mm thick
UDLYxx	Carpet pad “xx” mm thick
GCONxx	Lightweight gypsum concrete with nominal thickness of “xx” mm, measured from the bottom of the corrugated steel deck
CORSTExx	Corrugated steel deck with nominal depth of “xx” mm
SJxx(ss)	Cold-formed steel (CFS) joists with nominal depth of “xx” mm, spaced “ss” mm on centres
GFBxx	Glass fibre batts “xx” mm thick
RCxx(ss)	Resilient metal channels with nominal depth of “xx” mm, spaced “ss” mm on centres
Gxx	Gypsum board “xx” mm thick

Note that the coding system is a convenience and actual dimensions may not be exactly as coded. For example, the nominal 16 mm thick gypsum board would be labelled by the manufacturer as 5/8” or 15.9 mm thick.

For brevity, not all pertinent parameters are included in the short codes. For example, the thickness of the steel in the CFS joists is not indicated. This information is given separately in the specimen descriptions in Section 2.2.

Figure 13 shows a cross-section of the reference floor assembly, with a detailed cut-out showing the dimensions of the corrugated steel deck with gypsum concrete subfloor.

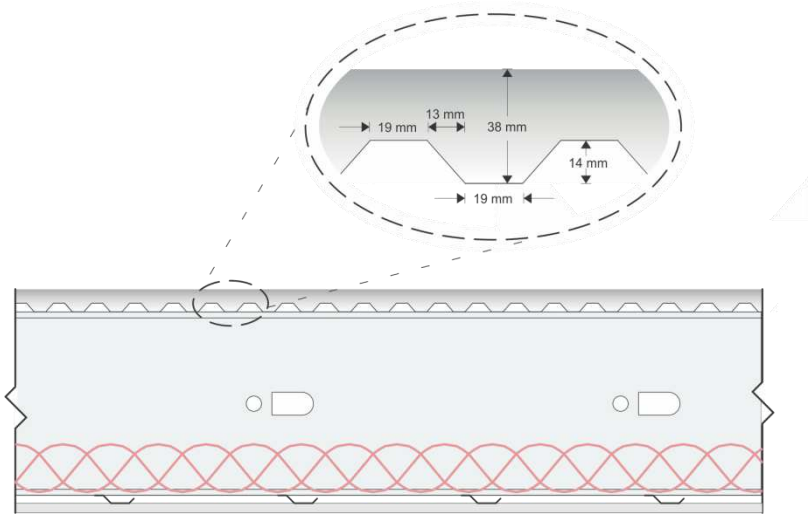
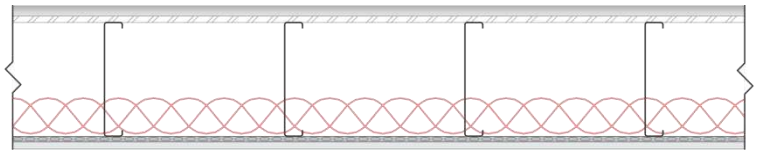
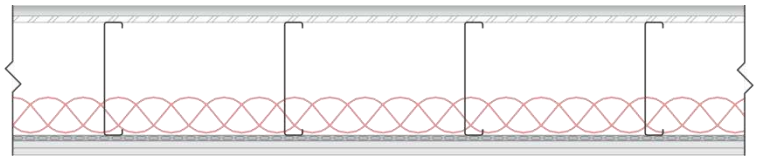
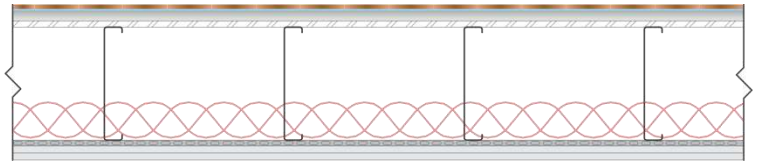
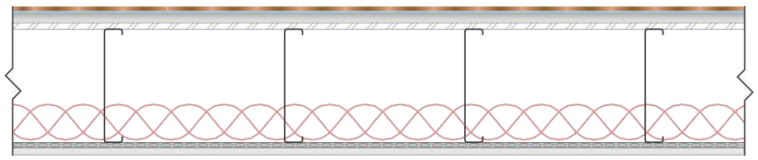
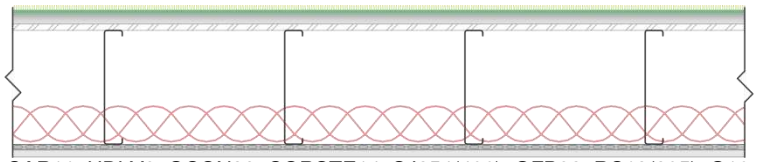
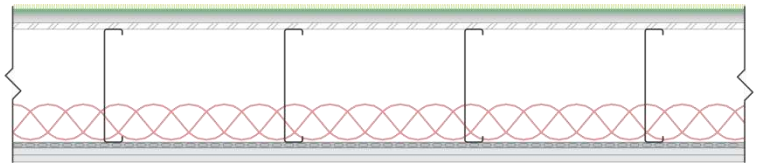
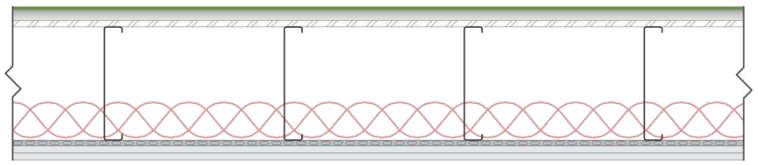
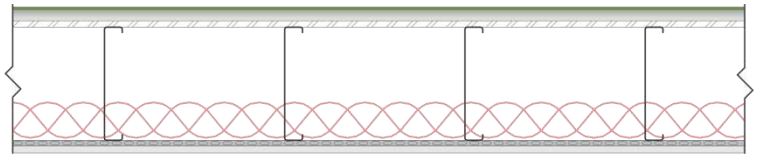
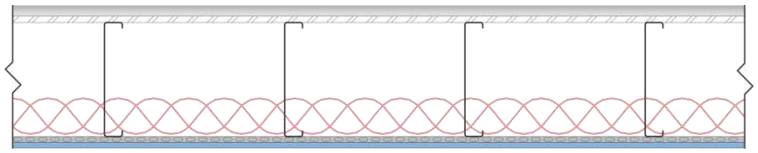
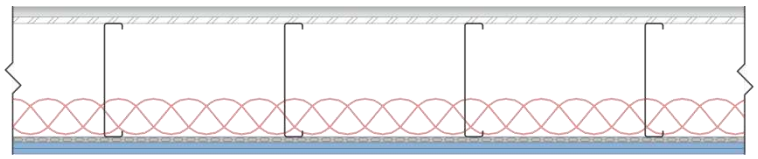
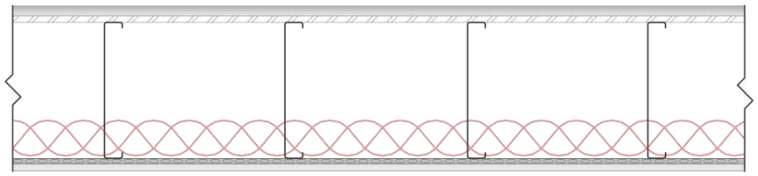
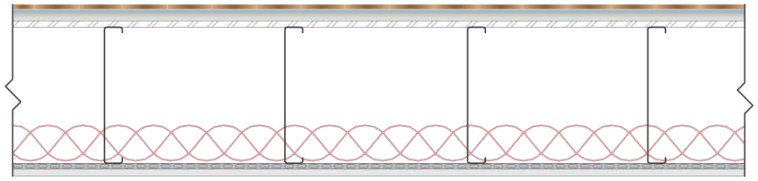
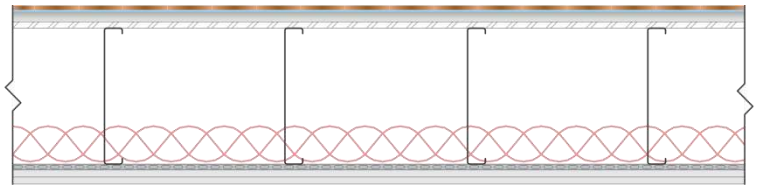
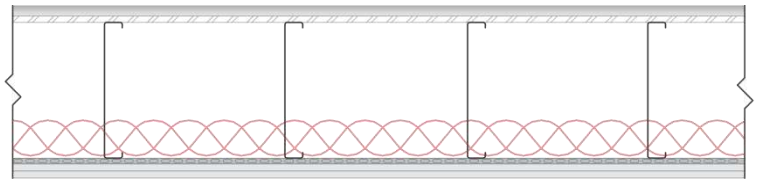
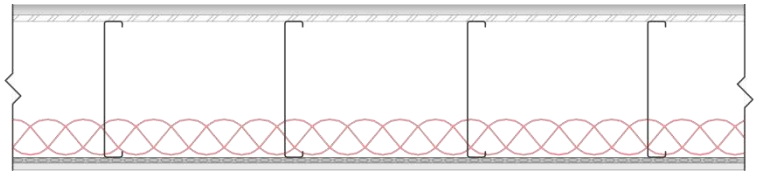
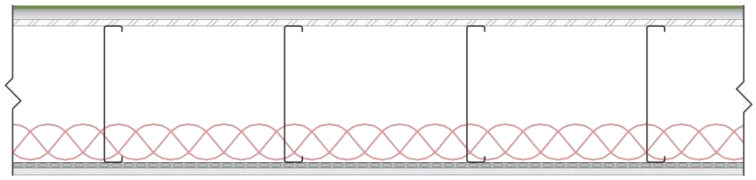
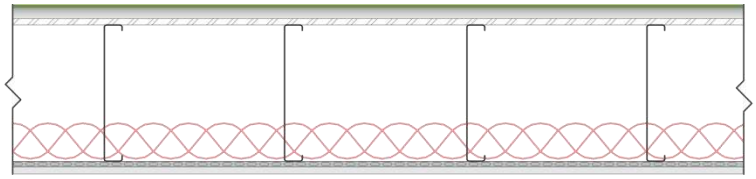


Figure 13: Cross-section of the reference floor assembly, with detailed cut-out of the corrugated steel deck with gypsum concrete subfloor

Table 4: List of Floor Assemblies

Specimen	Sketch and Short Code	STC	IIC	Page
A1-005007-01F	 GCON38_CORSTE14_SJ254(406)_GFB92_RC13(305)_G16	**57**	**21**	146
A1-005007-02F	 GCON38_CORSTE14_SJ254(406)_GFB92_RC13(305)_2G16	**60**	**26**	150
A1-005007-03F	 LAM10_STY3_GCON38_CORSTE14_SJ254(406)_GFB92_RC13(305)_2G16	**62**	**55**	154
A1-005007-04F	 LAM10_STY3_GCON38_CORSTE14_SJ254(406)_GFB92_RC13(305)_G16	**58**	**50**	158
A1-005007-05F	 CAR11_UDLY9_GCON38_CORSTE14_SJ254(406)_GFB92_RC13(305)_G16	**58**	**67**	162
A1-005007-06F	 CAR11_UDLY9_GCON38_CORSTE14_SJ254(406)_GFB92_RC13(305)_2G16	**61**	**70**	166
A1-005007-07F	 VIN2_GCON38_CORSTE14_SJ254(406)_GFB92_RC13(305)_2G16	**59**	**54**	170

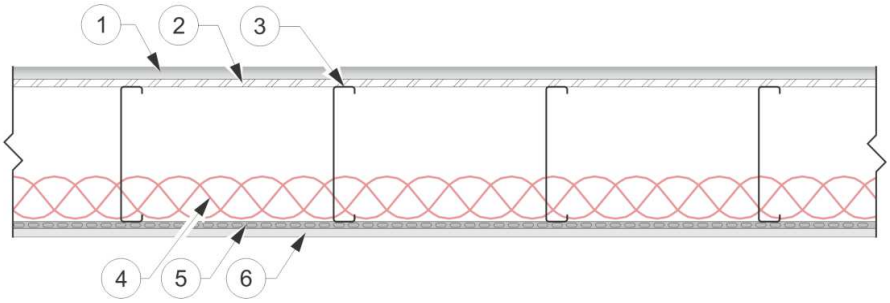
Specimen	Sketch and Short Code	STC	IIC	Page
A1-005007-08F	 VIN2_GCON38_CORSTE14_SJ254(406)_GFB92_RC13(305)_G16	**55**	**50**	174
A1-005007-09F	 GCON38_CORSTE14_SJ254(406)_GFB92_RC13(305)_G13	**56**	**18**	178
A1-005007-10F	 GCON38_CORSTE14_SJ254(406)_GFB92_RC13(305)_2G13	**60**	**24**	182
A1-005007-11F	 GCON38_CORSTE14_SJ317(406)_GFB92_RC13(305)_G16	**56**	**20**	186
A1-005007-12F	 LAM10_STY3_GCON38_CORSTE14_SJ317(406)_GFB92_RC13(305)_G16	**58**	**49**	190
A1-005007-13F	 LAM10_STY3_GCON38_CORSTE14_SJ317(406)_GFB92_RC13(305)_2G16	**62**	**54**	194
A1-005007-14F	 GCON38_CORSTE14_SJ317(406)_GFB92_RC13(305)_2G16	**60**	**26**	198

Specimen	Sketch and Short Code	STC	IIC	Page
A1-005007-15F	 GCON38_CORSTE14_SJ317(406)_GFB92_RC13(305)_G16	**57**	**N/A**	202
A1-005007-16F	 VIN2_GCON38_CORSTE14_SJ317(406)_GFB92_RC13(305)_G16	**55**	**47**	206
A1-005007-17F	 VIN2_GCON38_CORSTE14_SJ317(406)_GFB92_RC13(305)_G16	**57**	**48**	210

2.2 Detailed Test Reports

The following pages contain the detailed test reports for the 17 floor assemblies that were tested as part of this study. Each report presents the detailed specimen descriptions, material properties, test conditions, and test results.

Floor assembly 01F: GCON38_CORSTE14_SJ254(406)_GFB92_RC13(305)_G16



Description	38 mm poured lightweight gypsum concrete on corrugated steel deck, attached to 254 mm deep steel joists spaced 406 mm o.c., with two layers of 15.9 mm gypsum board Type X, attached to resilient channels spaced 305 mm o.c., and 92 mm deep glass fibre insulation (R-12) in the cavity.
Topping	• None
Subfloor	• **(1)** 38 mm (1-1/2”) nominal poured lightweight gypsum concrete, measured from the bottom of the flute, on corrugated steel deck (corrugation: 14 mm (9/16”), steel thickness: 0.76 mm (0.030”)) • **(2)** Steel deck attached to joists using 19 mm (3/4”) screws (#10 hex washer head) spaced 203 mm (8”) o.c.
Framing & Cavity Insulation	• Framing headers resting on test frame (steel thickness: 1.37 mm (0.054”)) • **(3)** 254 mm (10”) deep steel C-joists (steel thickness: 1.37 mm (0.054”)) spaced 406 mm (16”) o.c., attached to headers using bearing stiffeners and 19 mm (3/4”) screws (#10 wafer head) through top of header into joists • 203 mm (8”) blocking strips, installed at the centre of the joists between the two last joists on each end and between the two joists in the floor centre • Flat strap connecting blocking strips, attached to the bottom of each joist • **(4)** Cavities between joists filled with 406 mm (16”) wide by 92 mm (3-5/8”) thick glass fibre insulation (R-12), resting on resilient channels
Ceiling	• **(5)** 13 mm resilient channels, spaced 305 mm (12”) o.c., installed perpendicularly to the joists and attached to each joist using 19 mm (3/4”) screws (#10 wafer head) • **(6)** One layer of 15.9 mm (5/8”) gypsum board Type X, long side installed perpendicularly to resilient channels, attached using 32 mm (1-1/4”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. • Gaps along the joints and the perimeter of gypsum boards caulked and taped with aluminum tape

Specimen Properties

Element	Actual thickness (mm)	Mass (kg)	Mass/length, area or volume
Gypsum Concrete (24.3 MPa)	40	1260.0	1944.0 kg/m^3
Corrugated Steel Deck	14 *	147.4	6.9 kg/m^2
Steel Joists	254	224.6	3.9 kg/m
Web Stiffeners	254 **	12.0	1.9 kg/m
Glass Fibre Insulation	92 **	16.6	0.9 kg/m^2
Flat Strap	1 **	1.4	0.3 kg/m
Resilient Channels	13	14.4	0.2 kg/m
Gypsum Board	16	197.7	11.1 kg/m^2
Total	**323**	**1874**	

* Corrugated steel deck thickness already included in gypsum concrete thickness

** Element thickness does not contribute to total thickness (ie. in cavity)

Test Specimen Installation

- The exposed area of the floor specimen used for the calculations of the airborne sound transmission loss was 17.85 m^2 (4.71 m x 3.79 m).
- The total area of the floor assembly resting on top of the lip was 19.32 m^2 (4.88 m x 3.96 m).
- The mass per area of the elements above the lip was calculated using the total area (19.32 m^2).
- The mass per area of the ceiling elements was calculated using the exposed area (17.85 m^2).

ASTM E90 Test Results – Airborne Sound Transmission Loss

Client: CSSBI **Test ID:** TLF-14-050

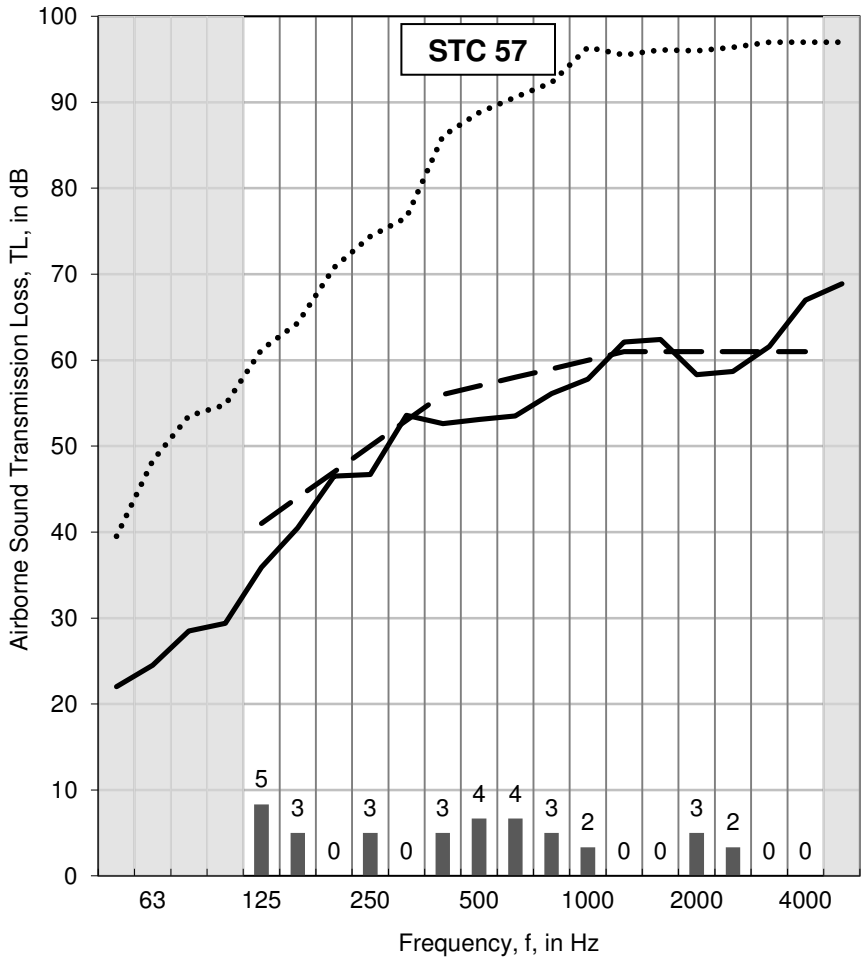
Specimen ID: A1-005007-01F **Date of Test:** 10 September 2014

Room	Volume (m³)	Air Temperature (°C)	Humidity (%)
Upper	174.0	19.3 to 19.3	54.1 to 57.9
Lower	176.6	18.5 to 18.6	50.2 to 50.8

Area of test specimen:	17.85 m^2
Mass of test specimen:	1874 kg

f (Hz)	TL (dB)
50	22
63	25
80	29
100	29
125	36
160	41
200	47
250	47
315	54
400	53
500	53
630	54
800	56
1000	58
1250	62
1600	62
2000	58
2500	59
3150	62
4000	67
5000	69
Sound Transmission Class (STC)	**57**

Sum of Deficiencies (dB)
32
Max. Deficiency (dB)
5 dB at 125 Hz



For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Airborne sound transmission loss measurements were conducted in accordance with the requirements of ASTM E90-09, "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements."**

In the graph:
The solid line is the measured sound transmission loss for this specimen. The dashed line is the STC contour fitted to the measured values according to ASTM E413-10. The dotted line (may be above the displayed range) is the flanking limit established for this facility. For any frequency band where the measured transmission loss is above the dotted line, the reported value is potentially limited by flanking transmission via laboratory surfaces, and the true value may be higher than that measured. Bars at the bottom of the graph show deficiencies where the measured data are less than the reference contour as described in the fitting procedure for the STC, defined in ASTM E413-10. The shaded cells in the table and areas in the graph are outside the STC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. The reported values have been corrected according to the procedure outlined in ASTM E90-09. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level, in which case, the corrected values provide an estimate of the lower limit of airborne sound transmission loss.

ASTM E492 Test Results – Normalized Impact Sound Pressure Levels

Client: CSSBI **Test ID:** IIF-14-022

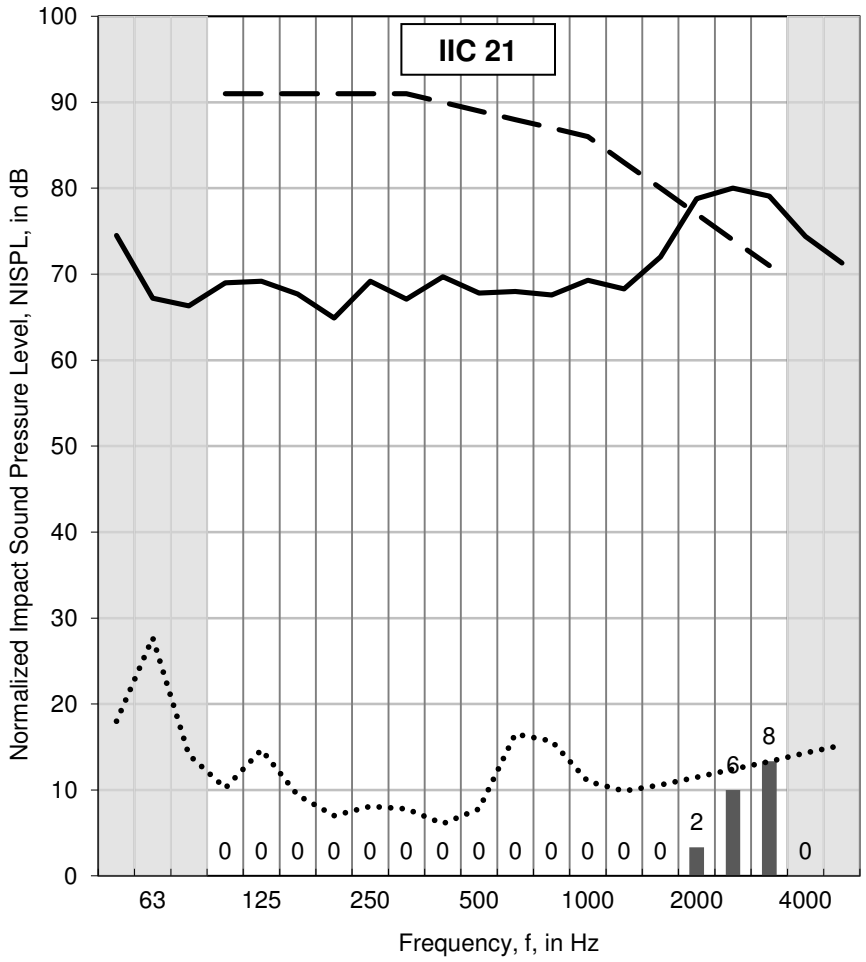
Specimen ID: A1-005007-01F **Date of Test:** 23 September 2014

Room	Volume (m^3)	Air Temperature (°C)	Humidity (%)
Upper	174.0	19.4 to 19.6	63.4 to 64.2
Lower	176.6	18.5 to 18.5	51.0 to 51.5

Area of test specimen:	17.85 m^2
Mass of test specimen:	1874 kg

f (Hz)	NISPL (dB)
50	75
63	67
80	66
100	69
125	69
160	68
200	65
250	69
315	67
400	70
500	68
630	68
800	68
1000	69
1250	68
1600	72
2000	79
2500	80
3150	79
4000	74
5000	71
Impact Insulation Class (IIC)	**21**

Sum of Positive Differences (dB)
16
Max. Positive Difference (dB)
8 dB at 3150 Hz

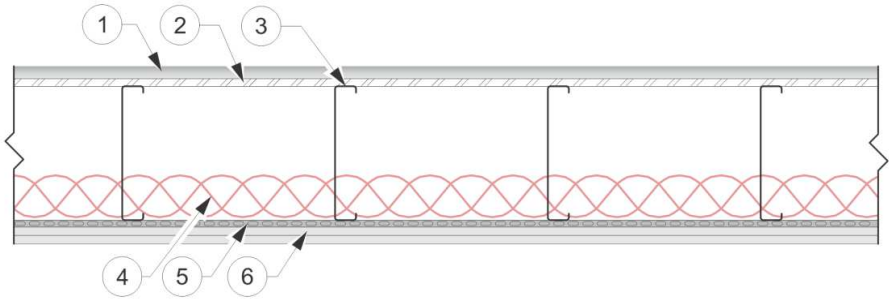


For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Measurements of normalized impact sound pressure level (NISPL) were conducted in accordance with the requirements of ASTM E492-09, "Standard Laboratory Measurement of Impact Sound Transmission through Floor-Ceiling Assemblies Using the Tapping Machine".**

In the graph:
The solid line is the measured normalized impact sound pressure level (NISPL) for this specimen. The dashed line is the IIC contour fitted to the measured values according to ASTM E989-06. The dotted line is the background sound level measured in the receiving room during this test (may be below the displayed range). For any frequency where the measured NISPL is less than 10 dB above the dotted line, the reported values were adjusted as noted below. Bars at the bottom of the graph show positive differences; where the measured data are greater than the reference contour as defined in ASTM E989-06. Shaded cells in the table and areas in the graph are outside the IIC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level and the reported values of NISPL provide an estimate of the upper limit of normalized impact sound pressure level, according to the procedure outlined in ASTM E492-09. The reported values of NISPL have been corrected according to the procedure outlined in ASTM E492-09.

Floor assembly 02F: GCON38_CORSTE14_SJ254(406)_GFB92_RC13(305)_2G16



Description	38 mm poured lightweight gypsum concrete on corrugated steel deck, attached to 254 mm deep steel joists spaced 406 mm o.c., with two layers of 15.9 mm gypsum board Type X, attached to resilient channels spaced 305 mm o.c., and 92 mm deep glass fibre insulation (R-12) in the cavity.
Topping	• None
Subfloor	• **(1)** 38 mm (1-1/2”) nominal poured lightweight gypsum concrete, measured from the bottom of the flute, on corrugated steel deck (corrugation: 14 mm (9/16”), steel thickness: 0.76 mm (0.030”)) • **(2)** Steel deck attached to joists using 19 mm (3/4”) screws (#10 hex washer head) spaced 203 mm (8”) o.c.
Framing & Cavity Insulation	• Framing headers resting on test frame (steel thickness: 1.37 mm (0.054”)) • **(3)** 254 mm (10”) deep steel C-joists (steel thickness: 1.37 mm (0.054”)) spaced 406 mm (16”) o.c., attached to headers using bearing stiffeners and 19 mm (3/4”) screws (#10 wafer head) through top of header into joists • 203 mm (8”) blocking strips, installed at the centre of the joists between the two last joists on each end and between the two joists in the floor centre • Flat strap connecting blocking strips, attached to the bottom of each joist • **(4)** Cavities between joists filled with 406 mm (16”) wide by 92 mm (3-5/8”) thick glass fibre insulation (R-12), resting on resilient channels
Ceiling	• **(5)** 13 mm resilient channels, spaced 305 mm (12”) o.c., installed perpendicularly to the joists and attached to each joist using 19 mm (3/4”) screws (#10 wafer head) • **(6)** Two layers of 15.9 mm (5/8”) gypsum board Type X installed with long side perpendicular to resilient channels • Face layer attached using 41 mm (1-5/8”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. along the perimeter and in the field • Base layer attached using 32 mm (1-1/4”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. along the perimeter and in the field • Screws from base layer to face layer offset by 152 mm (6”) • Gaps along the joints and the perimeter of gypsum boards caulked and taped with aluminum tape

Specimen Properties

Element	Actual thickness (mm)	Mass (kg)	Mass/length, area or volume
Gypsum Concrete (24.3 MPa)	40	1260.0	1944.0 kg/m^3
Corrugated Steel Deck	14 *	147.4	6.9 kg/m^2
Steel Joists	254	224.6	3.9 kg/m
Web Stiffeners	254 **	12.0	1.9 kg/m
Glass Fibre Insulation	92 **	16.6	0.9 kg/m^2
Flat Strap	1 **	1.4	0.3 kg/m
Resilient Channels	13	14.4	0.2 kg/m
Gypsum Board	16	197.7	11.1 kg/m^2
Gypsum Board	16	197.7	11.1 kg/m^2
Total	**339**	**2072**	

* Corrugated steel deck thickness already included in gypsum concrete thickness

** Element thickness does not contribute to total thickness (ie. in cavity)

Test Specimen Installation

- The exposed area of the floor specimen used for the calculations of the airborne sound transmission loss was 17.85 m^2 (4.71 m x 3.79 m).
- The total area of the floor assembly resting on top of the lip was 19.32 m^2 (4.88 m x 3.96 m).
- The mass per area of the elements above the lip was calculated using the total area (19.32 m^2).
- The mass per area of the ceiling elements was calculated using the exposed area (17.85 m^2).

ASTM E90 Test Results – Airborne Sound Transmission Loss

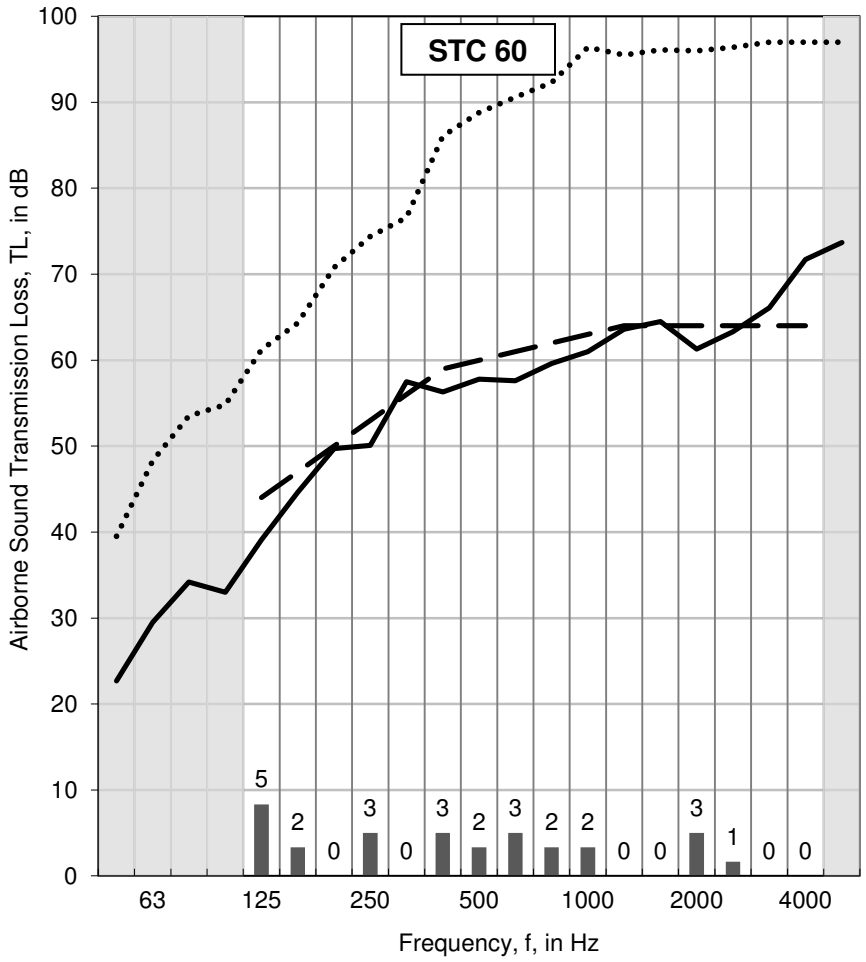
Client: CSSBI **Test ID:** TLF-14-046

Specimen ID: A1-005007-02F **Date of Test:** 15 September 2014

Room	Volume (m³)	Air Temperature (°C)	Humidity (%)
Upper	174.0	20.9 to 20.9	58.7 to 61.4
Lower	176.3	19.5 to 19.5	59.7 to 59.7

Area of test specimen:	17.85 m^2
Mass of test specimen:	2072 kg

f (Hz)	TL (dB)
50	23
63	30
80	34
100	33
125	39
160	45
200	50
250	50
315	58
400	56
500	58
630	58
800	60
1000	61
1250	64
1600	65
2000	61
2500	63
3150	66
4000	72
5000	74
Sound Transmission Class (STC)	**60**



Sum of Deficiencies (dB)
26
Max. Deficiency (dB)
5 dB at 125 Hz

For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Airborne sound transmission loss measurements were conducted in accordance with the requirements of ASTM E90-09, "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements."**

In the graph:
The solid line is the measured sound transmission loss for this specimen. The dashed line is the STC contour fitted to the measured values according to ASTM E413-10. The dotted line (may be above the displayed range) is the flanking limit established for this facility. For any frequency band where the measured transmission loss is above the dotted line, the reported value is potentially limited by flanking transmission via laboratory surfaces, and the true value may be higher than that measured. Bars at the bottom of the graph show deficiencies where the measured data are less than the reference contour as described in the fitting procedure for the STC, defined in ASTM E413-10. The shaded cells in the table and areas in the graph are outside the STC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. The reported values have been corrected according to the procedure outlined in ASTM E90-09. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level, in which case, the corrected values provide an estimate of the lower limit of airborne sound transmission loss.

ASTM E492 Test Results – Normalized Impact Sound Pressure Levels

Client: CSSBI **Test ID:** IIF-14-020

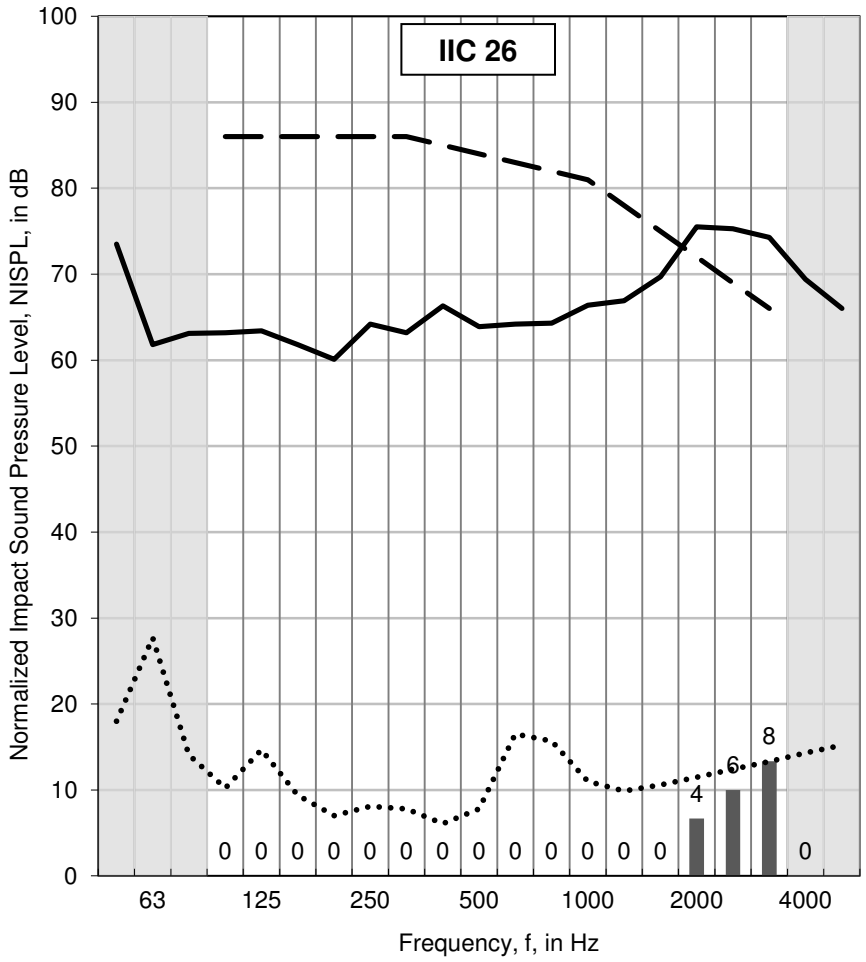
Specimen ID: A1-005007-02F **Date of Test:** 15 September 2014

Room	Volume (m^3)	Air Temperature (°C)	Humidity (%)
Upper	174.0	20.8 to 21.1	53.3 to 55.3
Lower	176.3	19.6 to 19.7	59.3 to 60.1

Area of test specimen:	17.85 m^2
Mass of test specimen:	2072 kg

f (Hz)	NISPL (dB)
50	74
63	62
80	63
100	63
125	63
160	62
200	60
250	64
315	63
400	66
500	64
630	64
800	64
1000	66
1250	67
1600	70
2000	76
2500	75
3150	74
4000	69
5000	66
Impact Insulation Class (IIC)	**26**

Sum of Positive Differences (dB)
18
Max. Positive Difference (dB)
8 dB at 3150 Hz

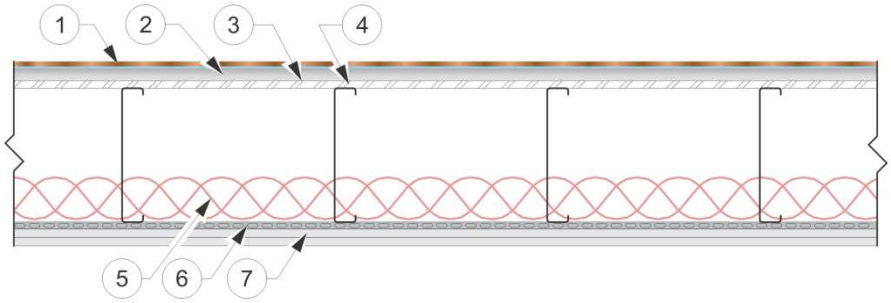


For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Measurements of normalized impact sound pressure level (NISPL) were conducted in accordance with the requirements of ASTM E492-09, "Standard Laboratory Measurement of Impact Sound Transmission through Floor-Ceiling Assemblies Using the Tapping Machine".**

In the graph:
The solid line is the measured normalized impact sound pressure level (NISPL) for this specimen. The dashed line is the IIC contour fitted to the measured values according to ASTM E989-06. The dotted line is the background sound level measured in the receiving room during this test (may be below the displayed range). For any frequency where the measured NISPL is less than 10 dB above the dotted line, the reported values were adjusted as noted below. Bars at the bottom of the graph show positive differences; where the measured data are greater than the reference contour as defined in ASTM E989-06. Shaded cells in the table and areas in the graph are outside the IIC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level and the reported values of NISPL provide an estimate of the upper limit of normalized impact sound pressure level, according to the procedure outlined in ASTM E492-09. The reported values of NISPL have been corrected according to the procedure outlined in ASTM E492-09.

Floor assembly 03F: LAM10_STY3_GCON38_CORSTE14_SJ254(406)_GFB92_RC13(305)_2G16



Description	10 mm laminate flooring on 3 mm styrofoam bead underlay on 38 mm poured lightweight gypsum concrete on corrugated steel deck, attached to 254 mm deep steel joists spaced 406 mm o.c., with two layers of 15.9 mm gypsum board Type X, attached to resilient channels spaced 305 mm o.c., and 92 mm deep glass fibre insulation (R-12) in the cavity.
Topping	• **(1)** 10 mm glueless laminate installed on 3 mm (1/8") styrofoam bead underlay
Subfloor	• **(2)** 38 mm (1-1/2”) nominal poured lightweight gypsum concrete, measured from the bottom of the flute, on corrugated steel deck (corrugation: 14 mm (9/16”), steel thickness: 0.76 mm (0.030”)) • **(3)** Steel deck attached to joists using 19 mm (3/4”) screws (#10 hex washer head) spaced 203 mm (8”) o.c.
Framing & Cavity Insulation	• Framing headers resting on test frame (steel thickness: 1.37 mm (0.054”)) • **(4)** 254 mm (10”) deep steel C-joists (steel thickness: 1.37 mm (0.054”)) spaced 406 mm (16”) o.c., attached to headers using bearing stiffeners and 19 mm (3/4”) screws (#10 wafer head) through top of header into joists • 203 mm (8”) blocking strips, installed at the centre of the joists between the two last joists on each end and between the two joists in the floor centre • Flat strap connecting blocking strips, attached to the bottom of each joist • **(5)** Cavities between joists filled with 406 mm (16”) wide by 92 mm (3-5/8”) thick glass fibre insulation (R-12), resting on resilient channels
Ceiling	• **(6)** 13 mm resilient channels, spaced 305 mm (12”) o.c., installed perpendicularly to the joists and attached to each joist using 19 mm (3/4”) screws (#10 wafer head) • **(7)** Two layers of 15.9 mm (5/8”) gypsum board Type X installed with long side perpendicular to resilient channels • Face layer attached using 41 mm (1-5/8”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. along the perimeter and in the field • Base layer attached using 32 mm (1-1/4”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. along the perimeter and in the field • Screws from base layer to face layer offset by 152 mm (6”) • Gaps along the joints and the perimeter of gypsum boards caulked and taped with aluminum tape

Specimen Properties

Element	Actual thickness (mm)	Mass (kg)	Mass/length, area or volume
Laminate Flooring	10	162.7	8.3 kg/m^2
Styrofoam Bead Underlay	3	2.9	0.2 kg/m^2
Gypsum Concrete (24.3 MPa)	40	1260.0	1944.0 kg/m^3
Corrugated Steel Deck	14 *	147.4	6.9 kg/m^2
Steel Joists	254	224.6	3.9 kg/m
Web Stiffeners	254 **	12.0	1.9 kg/m
Glass Fibre Insulation	92 **	16.6	0.9 kg/m^2
Flat Strap	1 **	1.4	0.3 kg/m
Resilient Channels	13	14.4	0.2 kg/m
Gypsum Board	16	197.7	11.1 kg/m^2
Gypsum Board	16	197.7	11.1 kg/m^2
Total	**352**	**2237**	

* Corrugated steel deck thickness already included in gypsum concrete thickness

** Element thickness does not contribute to total thickness (ie. in cavity)

Test Specimen Installation

- The exposed area of the floor specimen used for the calculations of the airborne sound transmission loss was 17.85 m^2 (4.71 m x 3.79 m).
- The total area of the floor assembly resting on top of the lip was 19.32 m^2 (4.88 m x 3.96 m).
- The mass per area of the elements above the lip was calculated using the total area (19.32 m^2).
- The mass per area of the ceiling elements was calculated using the exposed area (17.85 m^2).

ASTM E90 Test Results – Airborne Sound Transmission Loss

Client: CSSBI **Test ID:** TLF-14-047

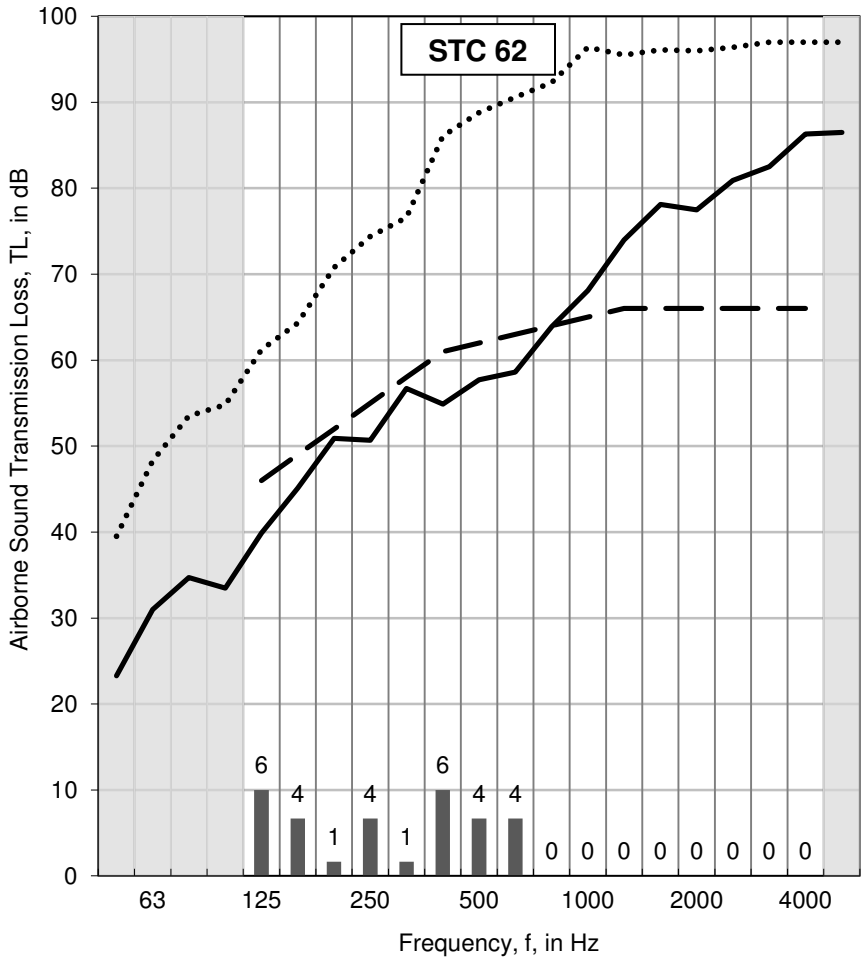
Specimen ID: A1-005007-03F **Date of Test:** 16 September 2014

Room	Volume (m³)	Air Temperature (°C)	Humidity (%)
Upper	173.7	20.6 to 21.0	53.6 to 54.6
Lower	176.3	19.2 to 19.3	59.5 to 59.6

Area of test specimen:	17.85 m^2
Mass of test specimen:	2237 kg

f (Hz)	TL (dB)
50	23
63	31
80	35
100	34
125	40
160	45
200	51
250	51
315	57
400	55
500	58
630	59
800	64
1000	68
1250	74
1600	78
2000	78
2500	81
3150	83
4000	86
5000	87
Sound Transmission Class (STC)	**62**

Sum of Deficiencies (dB)
30
Max. Deficiency (dB)
6 dB at 125 Hz and 400 Hz



For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Airborne sound transmission loss measurements were conducted in accordance with the requirements of ASTM E90-09, "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements."**

In the graph:
The solid line is the measured sound transmission loss for this specimen. The dashed line is the STC contour fitted to the measured values according to ASTM E413-10. The dotted line (may be above the displayed range) is the flanking limit established for this facility. For any frequency band where the measured transmission loss is above the dotted line, the reported value is potentially limited by flanking transmission via laboratory surfaces, and the true value may be higher than that measured. Bars at the bottom of the graph show deficiencies where the measured data are less than the reference contour as described in the fitting procedure for the STC, defined in ASTM E413-10. The shaded cells in the table and areas in the graph are outside the STC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. The reported values have been corrected according to the procedure outlined in ASTM E90-09. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level, in which case, the corrected values provide an estimate of the lower limit of airborne sound transmission loss.

ASTM E492 Test Results – Normalized Impact Sound Pressure Levels

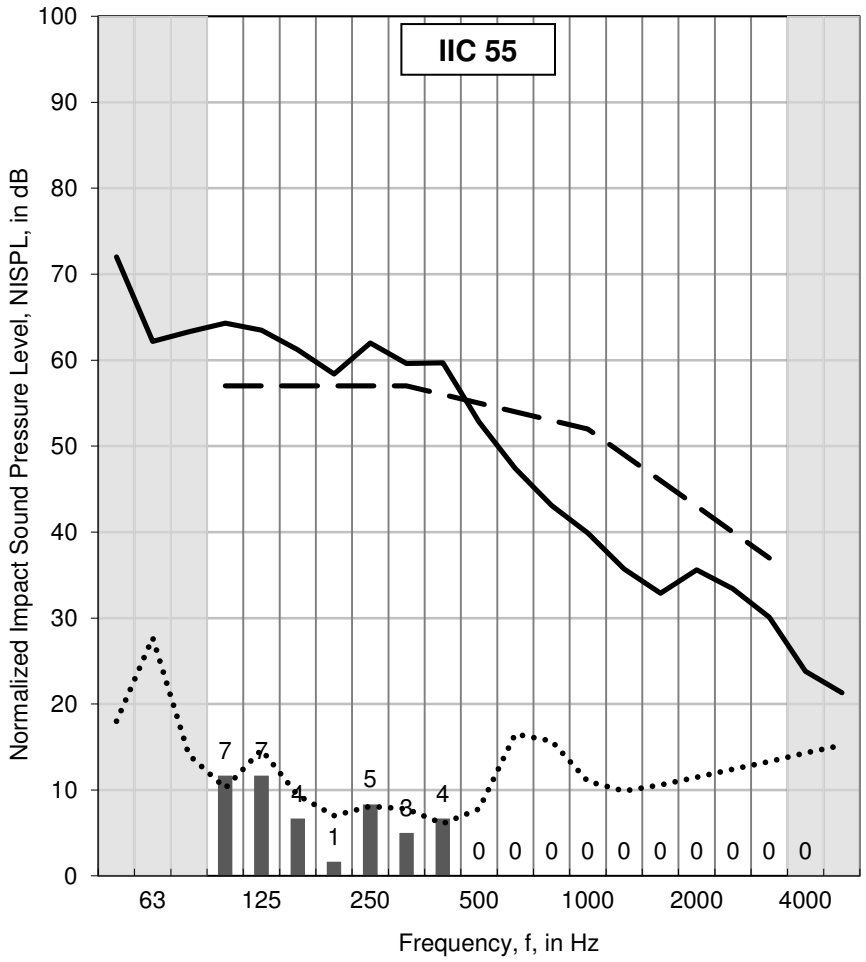
Client: CSSBI **Test ID:** IIF-14-021

Specimen ID: A1-005007-03F **Date of Test:** 17 September 2014

Room	Volume (m^3)	Air Temperature (°C)	Humidity (%)
Upper	173.7	20.1 to 20.5	48.6 to 50.3
Lower	176.3	19.1 to 19.3	59.1 to 59.2

Area of test specimen:	17.85 m^2
Mass of test specimen:	2237 kg

f (Hz)	NISPL (dB)	
50	72	
63	62	
80	63	
100	64	
125	64	
160	61	
200	58	
250	62	
315	60	
400	60	
500	53	
630	47	
800	43	
1000	40	
1250	36	
1600	33	
2000	36	
2500	33	
3150	30	
4000	24	*
5000	21	*
Impact Insulation Class (IIC)	**55**	



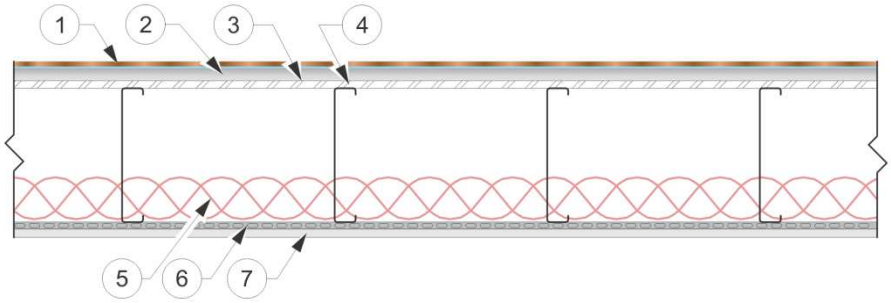
Sum of Positive Differences (dB)
31
Max. Positive Difference (dB)
7 dB at 100 Hz and 125 Hz

For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Measurements of normalized impact sound pressure level (NISPL) were conducted in accordance with the requirements of ASTM E492-09, "Standard Laboratory Measurement of Impact Sound Transmission through Floor-Ceiling Assemblies Using the Tapping Machine".**

In the graph:
The solid line is the measured normalized impact sound pressure level (NISPL) for this specimen. The dashed line is the IIC contour fitted to the measured values according to ASTM E989-06. The dotted line is the background sound level measured in the receiving room during this test (may be below the displayed range). For any frequency where the measured NISPL is less than 10 dB above the dotted line, the reported values were adjusted as noted below. Bars at the bottom of the graph show positive differences; where the measured data are greater than the reference contour as defined in ASTM E989-06. Shaded cells in the table and areas in the graph are outside the IIC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level and the reported values of NISPL provide an estimate of the upper limit of normalized impact sound pressure level, according to the procedure outlined in ASTM E492-09. The reported values of NISPL have been corrected according to the procedure outlined in ASTM E492-09.

Floor assembly 04F: LAM10_STY3_GCON38_CORSTE14_SJ254(406)_GFB92_RC13(305)_G16



Description	10 mm laminate flooring on 3 mm styrofoam bead underlay on 38 mm poured lightweight gypsum concrete on corrugated steel deck, attached to 254 mm deep steel joists spaced 406 mm o.c., with one layer of 15.9 mm gypsum board Type X, attached to resilient channels spaced 305 mm o.c., and 92 mm deep glass fibre insulation (R-12) in the cavity.
Topping	• **(1)** 10 mm glueless laminate floor installed on 3 mm (1/8") styrofoam bead underlay
Subfloor	• **(2)** 38 mm (1-1/2”) nominal poured lightweight gypsum concrete, measured from the bottom of the flute, on corrugated steel deck (corrugation: 14 mm (9/16”), steel thickness: 0.76 mm (0.030”)) • **(3)** Steel deck attached to joists using 19 mm (3/4”) screws (#10 hex washer head) spaced 203 mm (8”) o.c.
Framing & Cavity Insulation	• Framing headers resting on test frame (steel thickness: 1.37 mm (0.054”)) • **(4)** 254 mm (10”) deep steel C-joists (steel thickness: 1.37 mm (0.054”)) spaced 406 mm (16”) o.c., attached to headers using bearing stiffeners and 19 mm (3/4”) screws (#10 wafer head) through top of header into joists • 203 mm (8”) blocking strips, installed at the centre of the joists between the two last joists on each end and between the two joists in the floor centre • Flat strap connecting blocking strips, attached to the bottom of each joist • **(5)** Cavities between joists filled with 406 mm (16”) wide by 92 mm (3-5/8”) thick glass fibre insulation (R-12), resting on resilient channels
Ceiling	• **(6)** 13 mm resilient channels, spaced 305 mm (12”) o.c., installed perpendicularly to the joists and attached to each joist using 19 mm (3/4”) screws (#10 wafer head) • **(7)** One layer of 15.9 mm (5/8”) gypsum board Type X, long side installed perpendicularly to resilient channels, attached using 32 mm (1-1/4”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. • Gaps along the joints and the perimeter of gypsum boards caulked and taped with aluminum tape

Specimen Properties

Element	Actual thickness (mm)	Mass (kg)	Mass/length, area or volume
Laminate Flooring	10	162.7	8.3 kg/m^2
Styrofoam Bead Underlay	3	2.9	0.2 kg/m^2
Gypsum Concrete (24.3 MPa)	40	1260.0	1944.0 kg/m^3
Corrugated Steel Deck	14 *	147.4	6.9 kg/m^2
Steel Joists	254	224.6	3.9 kg/m
Web Stiffeners	254 **	12.0	1.9 kg/m
Glass Fibre Insulation	92 **	16.6	0.9 kg/m^2
Flat Strap	1 **	1.4	0.3 kg/m
Resilient Channels	13	14.4	0.2 kg/m
Gypsum Board	16	197.7	11.1 kg/m^2
Total	**336**	**2040**	

* Corrugated steel deck thickness already included in gypsum concrete thickness

** Element thickness does not contribute to total thickness (ie. in cavity)

Test Specimen Installation

- The exposed area of the floor specimen used for the calculations of the airborne sound transmission loss was 17.85 m^2 (4.71 m x 3.79 m).
- The total area of the floor assembly resting on top of the lip was 19.32 m^2 (4.88 m x 3.96 m).
- The mass per area of the elements above the lip was calculated using the total area (19.32 m^2).
- The mass per area of the ceiling elements was calculated using the exposed area (17.85 m^2).

ASTM E90 Test Results – Airborne Sound Transmission Loss

Client: CSSBI **Test ID:** TLF-14-052

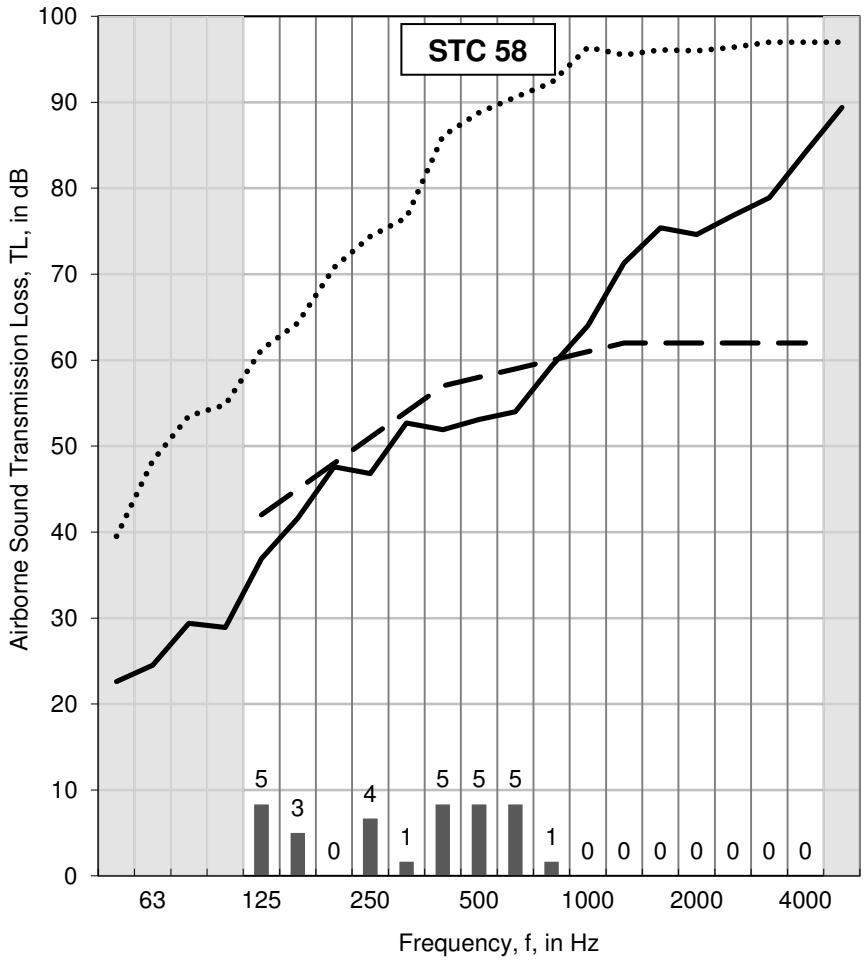
Specimen ID: A1-005007-04F **Date of Test:** 25 September 2014

Room	Volume (m³)	Air Temperature (°C)	Humidity (%)
Upper	173.7	21.5 to 21.6	57.3 to 57.6
Lower	176.6	19.5 to 19.6	54.3 to 54.4

Area of test specimen:	17.85 m^2
Mass of test specimen:	2040 kg

f (Hz)	TL (dB)
50	23
63	25
80	29
100	29
125	37
160	42
200	48
250	47
315	53
400	52
500	53
630	54
800	59
1000	64
1250	71
1600	75
2000	75
2500	77
3150	79
4000	84
5000	89
Sound Transmission Class (STC)	**58**

Sum of Deficiencies (dB)
29
Max. Deficiency (dB)
5 dB at 125 Hz, 400 Hz - 630 Hz



For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Airborne sound transmission loss measurements were conducted in accordance with the requirements of ASTM E90-09, "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements."**

In the graph:
The solid line is the measured sound transmission loss for this specimen. The dashed line is the STC contour fitted to the measured values according to ASTM E413-10. The dotted line (may be above the displayed range) is the flanking limit established for this facility. For any frequency band where the measured transmission loss is above the dotted line, the reported value is potentially limited by flanking transmission via laboratory surfaces, and the true value may be higher than that measured. Bars at the bottom of the graph show deficiencies where the measured data are less than the reference contour as described in the fitting procedure for the STC, defined in ASTM E413-10. The shaded cells in the table and areas in the graph are outside the STC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. The reported values have been corrected according to the procedure outlined in ASTM E90-09. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level, in which case, the corrected values provide an estimate of the lower limit of airborne sound transmission loss.

ASTM E492 Test Results – Normalized Impact Sound Pressure Levels

Client: CSSBI **Test ID:** IIF-14-023

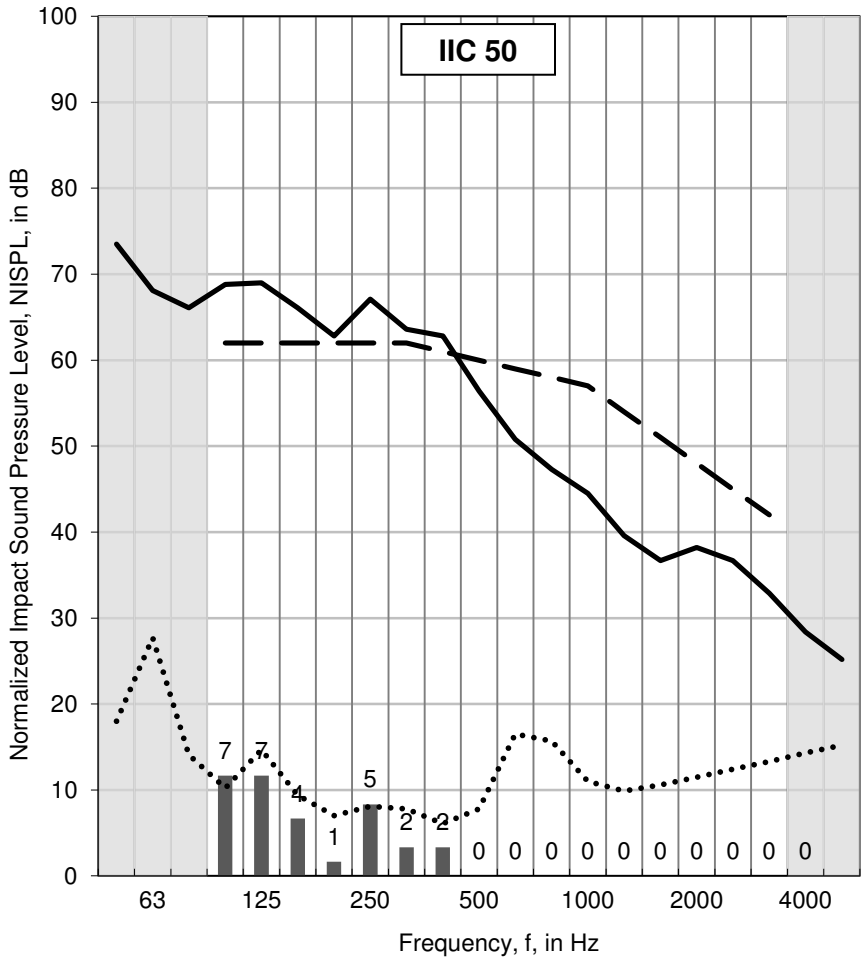
Specimen ID: A1-005007-04F **Date of Test:** 24 September 2014

Room	Volume (m³)	Air Temperature (°C)	Humidity (%)
Upper	173.7	20.1 to 20.3	61.1 to 61.5
Lower	176.6	18.7 to 18.8	53.7 to 54.1

Area of test specimen:	17.85 m^2
Mass of test specimen:	2040 kg

f (Hz)	NISPL (dB)	
50	74	
63	68	
80	66	
100	69	
125	69	
160	66	
200	63	
250	67	
315	64	
400	63	
500	56	
630	51	
800	47	
1000	45	
1250	40	
1600	37	
2000	38	
2500	37	
3150	33	
4000	28	
5000	25	c
Impact Insulation Class (IIC)	**50**	

Sum of Positive Differences (dB)
28
Max. Positive Difference (dB)
7 dB at 100 Hz and 125 Hz

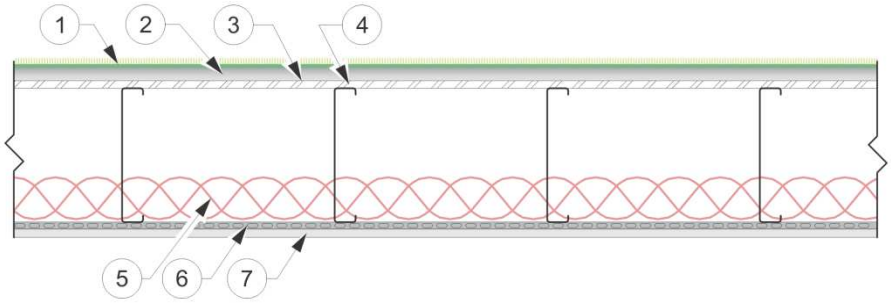


For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Measurements of normalized impact sound pressure level (NISPL) were conducted in accordance with the requirements of ASTM E492-09, "Standard Laboratory Measurement of Impact Sound Transmission through Floor-Ceiling Assemblies Using the Tapping Machine".**

In the graph:
The solid line is the measured normalized impact sound pressure level (NISPL) for this specimen. The dashed line is the IIC contour fitted to the measured values according to ASTM E989-06. The dotted line is the background sound level measured in the receiving room during this test (may be below the displayed range). For any frequency where the measured NISPL is less than 10 dB above the dotted line, the reported values were adjusted as noted below. Bars at the bottom of the graph show positive differences; where the measured data are greater than the reference contour as defined in ASTM E989-06. Shaded cells in the table and areas in the graph are outside the IIC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level and the reported values of NISPL provide an estimate of the upper limit of normalized impact sound pressure level, according to the procedure outlined in ASTM E492-09. The reported values of NISPL have been corrected according to the procedure outlined in ASTM E492-09.

Floor assembly 05F: CAR11_UDLY9_GCON38_CORSTE14_SJ254(406)_GFB92_RC13(305)_G16



Description	11 mm carpet with 8 mm carpet cushion on 38 mm poured lightweight gypsum concrete on corrugated steel deck, attached to 254 mm deep steel joists spaced 406 mm o.c., with one layer of 15.9 mm gypsum board Type X, attached to resilient channels spaced 305 mm o.c., and 92 mm deep glass fibre insulation (R-12) in the cavity.
Topping	• **(1)** 11 mm carpet with 8 mm carpet pad
Subfloor	• **(2)** 38 mm (1-1/2”) nominal poured lightweight gypsum concrete, measured from the bottom of the flute, on corrugated steel deck (corrugation: 14 mm (9/16”), steel thickness: 0.76 mm (0.030”)) • **(3)** Steel deck attached to joists using 19 mm (3/4”) screws (#10 hex washer head) spaced 203 mm (8”) o.c.
Framing & Cavity Insulation	• Framing headers resting on test frame (steel thickness: 1.37 mm (0.054”)) • **(4)** 254 mm (10”) deep steel C-joists (steel thickness: 1.37 mm (0.054”)) spaced 406 mm (16”) o.c., attached to headers using bearing stiffeners and 19 mm (3/4”) screws (#10 wafer head) through top of header into joists • 203 mm (8”) blocking strips, installed at the centre of the joists between the two last joists on each end and between the two joists in the floor centre • Flat strap connecting blocking strips, attached to the bottom of each joist • **(5)** Cavities between joists filled with 406 mm (16”) wide by 92 mm (3-5/8”) thick glass fibre insulation (R-12), resting on resilient channels
Ceiling	• **(6)** 13 mm resilient channels, spaced 305 mm (12”) o.c., installed perpendicularly to the joists and attached to each joist using 19 mm (3/4”) screws (#10 wafer head) • **(7)** One layer of 15.9 mm (5/8”) gypsum board Type X, long side installed perpendicularly to resilient channels, attached using 32 mm (1-1/4”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. • Gaps along the joints and the perimeter of gypsum boards caulked and taped with aluminum tape

Specimen Properties

Element	Actual thickness (mm)	Mass (kg)	Mass/length, area or volume
Carpet	11	37.0	1.9 kg/m^2
Carpet pad	8	21.0	1.1 kg/m^2
Gypsum Concrete (24.3 MPa)	40	1260.0	1944.0 kg/m^3
Corrugated Steel Deck	14 *	147.4	6.9 kg/m^2
Steel Joists	254	224.6	3.9 kg/m
Web Stiffeners	254 **	12.0	1.9 kg/m
Glass Fibre Insulation	92 **	16.6	0.9 kg/m^2
Flat Strap	1 **	1.4	0.3 kg/m
Resilient Channels	13	14.4	0.2 kg/m
Gypsum Board	16	197.7	11.1 kg/m^2
Total	**342**	**1932**	

* Corrugated steel deck thickness already included in gypsum concrete thickness

** Element thickness does not contribute to total thickness (ie. in cavity)

Test Specimen Installation

- The exposed area of the floor specimen used for the calculations of the airborne sound transmission loss was 17.85 m^2 (4.71 m x 3.79 m).
- The total area of the floor assembly resting on top of the lip was 19.32 m^2 (4.88 m x 3.96 m).
- The mass per area of the elements above the lip was calculated using the total area (19.32 m^2).
- The mass per area of the ceiling elements was calculated using the exposed area (17.85 m^2).

ASTM E90 Test Results – Airborne Sound Transmission Loss

Client: CSSBI **Test ID:** TLF-14-053

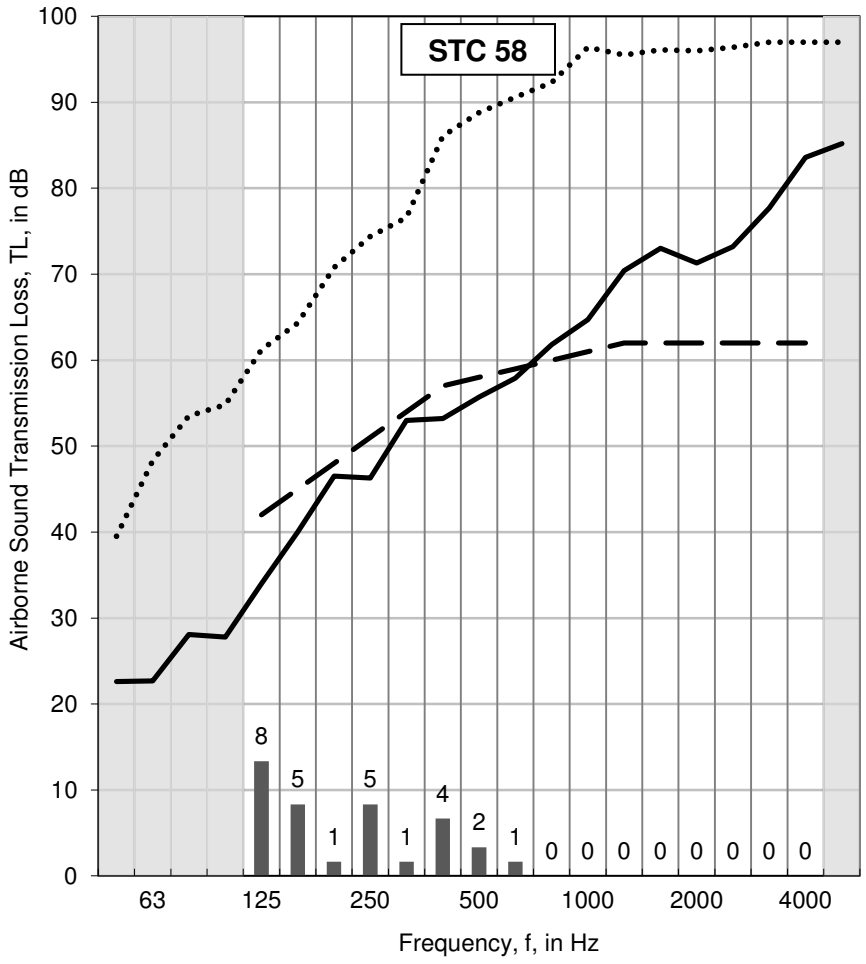
Specimen ID: A1-005007-05F **Date of Test:** 26 September 2014

Room	Volume (m³)	Air Temperature (°C)	Humidity (%)
Upper	173.5	22.3 to 22.9	53.6 to 54.5
Lower	176.6	20.5 to 20.6	54.4 to 54.5

Area of test specimen:	17.85 m^2
Mass of test specimen:	1932 kg

f (Hz)	TL (dB)
50	23
63	23
80	28
100	28
125	34
160	40
200	47
250	46
315	53
400	53
500	56
630	58
800	62
1000	65
1250	70
1600	73
2000	71
2500	73
3150	78
4000	84
5000	85
Sound Transmission Class (STC)	**58**

Sum of Deficiencies (dB)
27
Max. Deficiency (dB)
8 dB at 125 Hz



For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Airborne sound transmission loss measurements were conducted in accordance with the requirements of ASTM E90-09, "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements."**

In the graph:
The solid line is the measured sound transmission loss for this specimen. The dashed line is the STC contour fitted to the measured values according to ASTM E413-10. The dotted line (may be above the displayed range) is the flanking limit established for this facility. For any frequency band where the measured transmission loss is above the dotted line, the reported value is potentially limited by flanking transmission via laboratory surfaces, and the true value may be higher than that measured. Bars at the bottom of the graph show deficiencies where the measured data are less than the reference contour as described in the fitting procedure for the STC, defined in ASTM E413-10. The shaded cells in the table and areas in the graph are outside the STC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. The reported values have been corrected according to the procedure outlined in ASTM E90-09. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level, in which case, the corrected values provide an estimate of the lower limit of airborne sound transmission loss.

ASTM E492 Test Results – Normalized Impact Sound Pressure Levels

Client: CSSBI **Test ID:** IIF-14-024

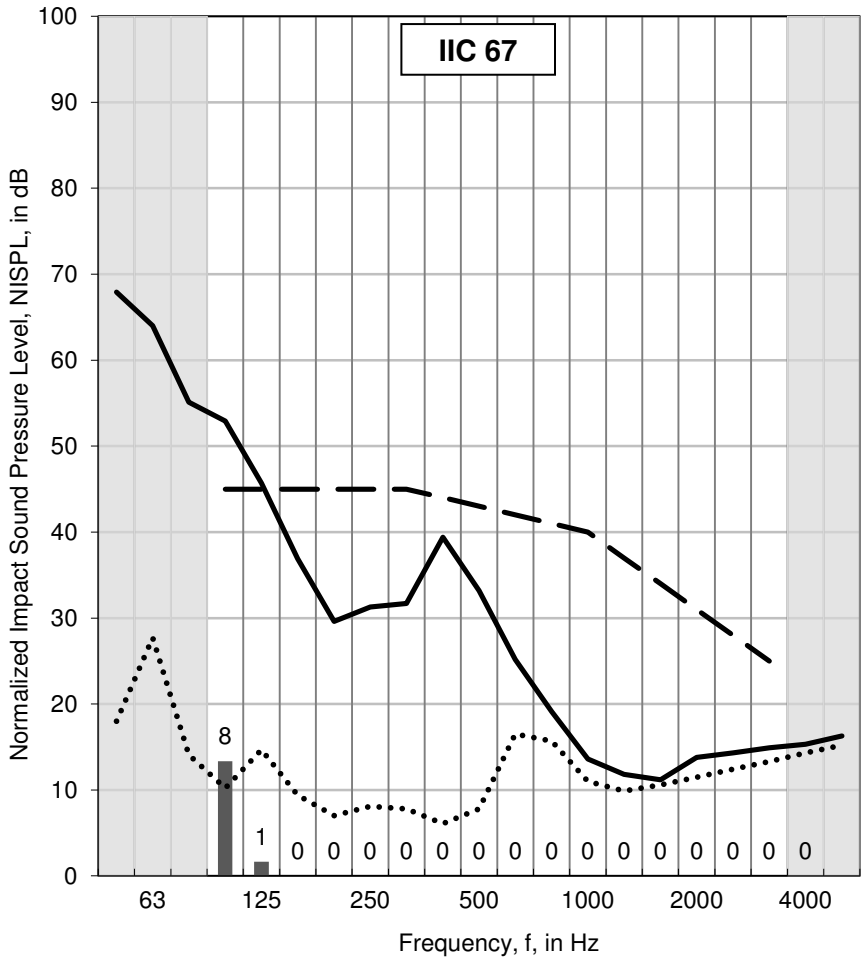
Specimen ID: A1-005007-05F **Date of Test:** 29 September 2014

Room	Volume (m³)	Air Temperature (°C)	Humidity (%)
Upper	173.5	25.2 to 26.0	47.1 to 50.0
Lower	176.6	22.8 to 22.8	54.3 to 54.5

Area of test specimen:	17.85 m^2
Mass of test specimen:	1932 kg

f (Hz)	NISPL (dB)	
50	68	
63	64	
80	55	
100	53	
125	46	
160	37	
200	30	
250	31	
315	32	
400	39	
500	33	
630	25	
800	19	c
1000	14	*
1250	12	*
1600	11	*
2000	14	*
2500	14	*
3150	15	*
4000	15	*
5000	16	*
Impact Insulation Class (IIC)		**67**

Sum of Positive Differences (dB)
9
Max. Positive Difference (dB)
8 dB at 100 Hz

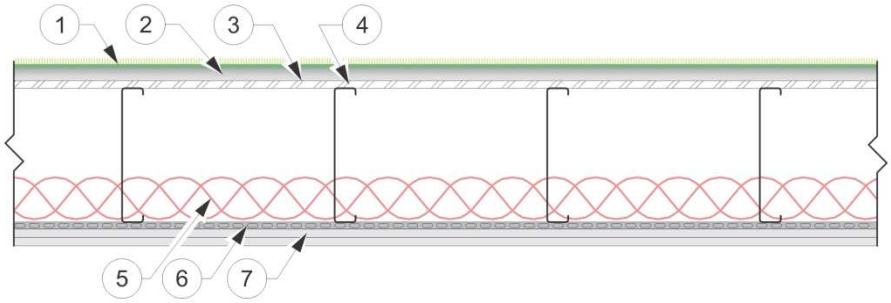


For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Measurements of normalized impact sound pressure level (NISPL) were conducted in accordance with the requirements of ASTM E492-09, "Standard Laboratory Measurement of Impact Sound Transmission through Floor-Ceiling Assemblies Using the Tapping Machine".**

In the graph:
The solid line is the measured normalized impact sound pressure level (NISPL) for this specimen. The dashed line is the IIC contour fitted to the measured values according to ASTM E989-06. The dotted line is the background sound level measured in the receiving room during this test (may be below the displayed range). For any frequency where the measured NISPL is less than 10 dB above the dotted line, the reported values were adjusted as noted below. Bars at the bottom of the graph show positive differences; where the measured data are greater than the reference contour as defined in ASTM E989-06. Shaded cells in the table and areas in the graph are outside the IIC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level and the reported values of NISPL provide an estimate of the upper limit of normalized impact sound pressure level, according to the procedure outlined in ASTM E492-09. The reported values of NISPL have been corrected according to the procedure outlined in ASTM E492-09.

Floor assembly 06F: CAR11_UDLY9_GCON38_CORSTE14_SJ254(406)_GFB92_RC13(305)_2G16



Description	11 mm carpet with 8 mm carpet cushion on 38 mm poured lightweight gypsum concrete on corrugated steel deck, attached to 254 mm deep steel joists spaced 406 mm o.c., with two layers of 15.9 mm gypsum board Type X, attached to resilient channels spaced 305 mm o.c., and 92 mm deep glass fibre insulation (R-12) in the cavity.
Topping	• **(1)** 11 mm carpet with 8 mm carpet pad
Subfloor	• **(2)** 38 mm (1-1/2”) nominal poured lightweight gypsum concrete, measured from the bottom of the flute, on corrugated steel deck (corrugation: 14 mm (9/16”), steel thickness: 0.76 mm (0.030”)) • **(3)** Steel deck attached to joists using 19 mm (3/4”) screws (#10 hex washer head) spaced 203 mm (8”) o.c.
Framing & Cavity Insulation	• Framing headers resting on test frame (steel thickness: 1.37 mm (0.054”)) • **(4)** 254 mm (10”) deep steel C-joists (steel thickness: 1.37 mm (0.054”)) spaced 406 mm (16”) o.c., attached to headers using bearing stiffeners and 19 mm (3/4”) screws (#10 wafer head) through top of header into joists • 203 mm (8”) blocking strips, installed at the centre of the joists between the two last joists on each end and between the two joists in the floor centre • Flat strap connecting blocking strips, attached to the bottom of each joist • **(5)** Cavities between joists filled with 406 mm (16”) wide by 92 mm (3-5/8”) thick glass fibre insulation (R-12), resting on resilient channels
Ceiling	• **(6)** 13 mm resilient channels, spaced 305 mm (12”) o.c., installed perpendicularly to the joists and attached to each joist using 19 mm (3/4”) screws (#10 wafer head) • **(7)** Two layers of 15.9 mm (5/8”) gypsum board Type X installed with long side perpendicular to resilient channels • Face layer attached using 41 mm (1-5/8”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. along the perimeter and in the field • Base layer attached using 32 mm (1-1/4”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. along the perimeter and in the field • Screws from base layer to face layer offset by 152 mm (6”) • Gaps along the joints and the perimeter of gypsum boards caulked and taped with aluminum tape

Specimen Properties

Element	Actual thickness (mm)	Mass (kg)	Mass/length, area or volume
Carpet	11	37.0	1.9 kg/m^2
Carpet pad	8	21.0	1.1 kg/m^2
Gypsum Concrete (24.3 MPa)	40	1260.0	1944.0 kg/m^3
Corrugated Steel Deck	14 *	147.4	6.9 kg/m^2
Steel Joists	254	224.6	3.9 kg/m
Web Stiffeners	254 **	12.0	1.9 kg/m
Glass Fibre Insulation	92 **	16.6	0.9 kg/m^2
Flat Strap	1 **	1.4	0.3 kg/m
Resilient Channels	13	14.4	0.2 kg/m
Gypsum Board	16	197.7	11.1 kg/m^2
Gypsum Board	16	197.7	11.1 kg/m^2
Total	**358**	**2130**	

* Corrugated steel deck thickness already included in gypsum concrete thickness

** Element thickness does not contribute to total thickness (ie. in cavity)

Test Specimen Installation

- The exposed area of the floor specimen used for the calculations of the airborne sound transmission loss was 17.85 m^2 (4.71 m x 3.79 m).
- The total area of the floor assembly resting on top of the lip was 19.32 m^2 (4.88 m x 3.96 m).
- The mass per area of the elements above the lip was calculated using the total area (19.32 m^2).
- The mass per area of the ceiling elements was calculated using the exposed area (17.85 m^2).

ASTM E90 Test Results – Airborne Sound Transmission Loss

Client: CSSBI **Test ID:** TLF-14-054

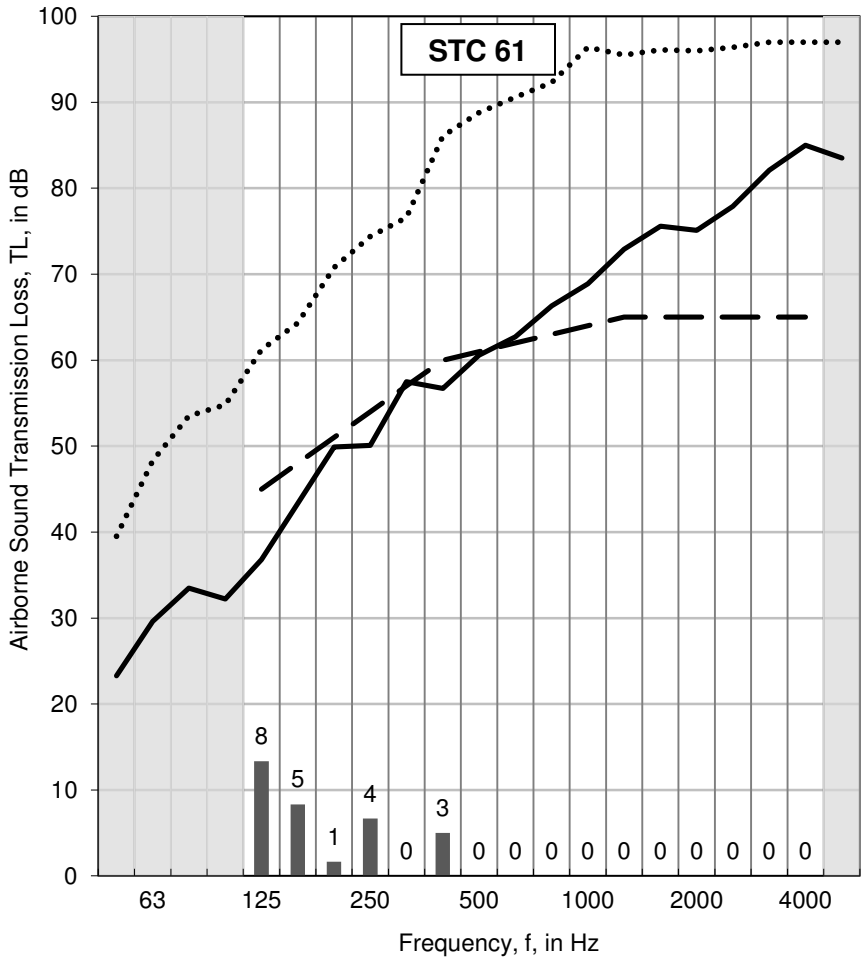
Specimen ID: A1-005007-06F **Date of Test:** 02 October 2014

Room	Volume (m³)	Air Temperature (°C)	Humidity (%)
Upper	173.5	24.2 to 24.2	50.7 to 51.7
Lower	176.2	21.7 to 21.7	51.3 to 51.7

Area of test specimen:	17.85 m^2
Mass of test specimen:	2130 kg

f (Hz)	TL (dB)
50	23
63	30
80	34
100	32
125	37
160	43
200	50
250	50
315	58
400	57
500	61
630	63
800	66
1000	69
1250	73
1600	76
2000	75
2500	78
3150	82
4000	85
5000	84
Sound Transmission Class (STC)	**61**

Sum of Deficiencies (dB)
21
Max. Deficiency (dB)
8 dB at 125 Hz



For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Airborne sound transmission loss measurements were conducted in accordance with the requirements of ASTM E90-09, "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements."**

In the graph:
The solid line is the measured sound transmission loss for this specimen. The dashed line is the STC contour fitted to the measured values according to ASTM E413-10. The dotted line (may be above the displayed range) is the flanking limit established for this facility. For any frequency band where the measured transmission loss is above the dotted line, the reported value is potentially limited by flanking transmission via laboratory surfaces, and the true value may be higher than that measured. Bars at the bottom of the graph show deficiencies where the measured data are less than the reference contour as described in the fitting procedure for the STC, defined in ASTM E413-10. The shaded cells in the table and areas in the graph are outside the STC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. The reported values have been corrected according to the procedure outlined in ASTM E90-09. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level, in which case, the corrected values provide an estimate of the lower limit of airborne sound transmission loss.

ASTM E492 Test Results – Normalized Impact Sound Pressure Levels

Client: CSSBI **Test ID:** IIF-14-025

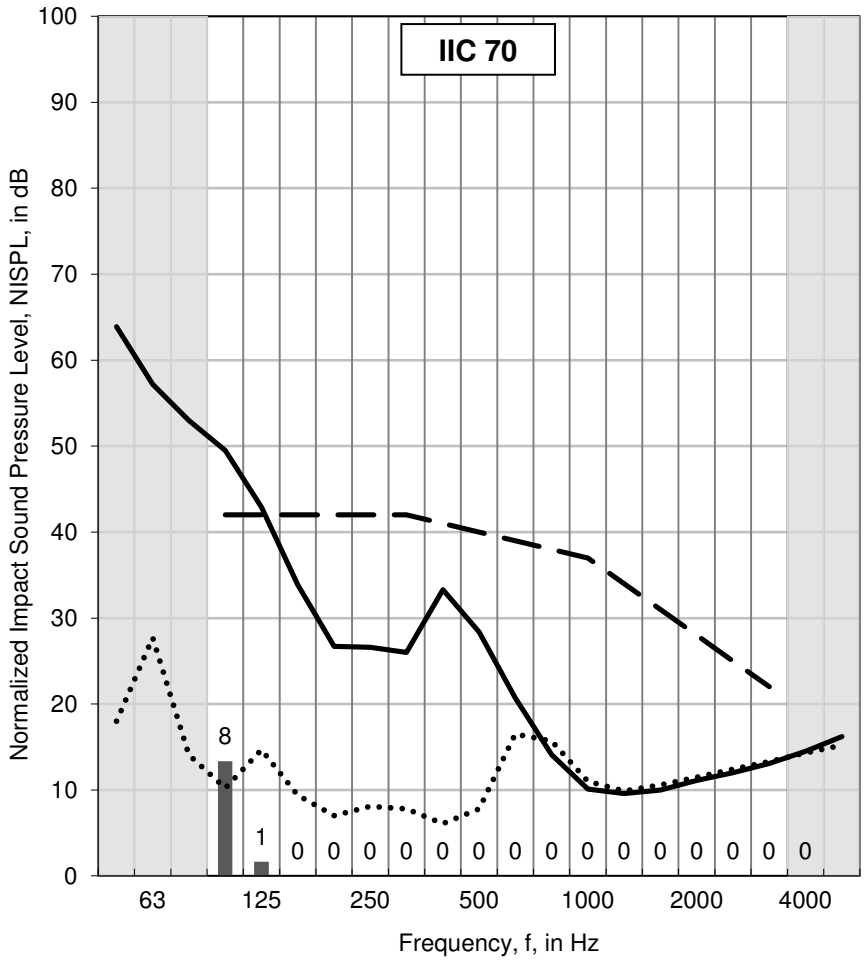
Specimen ID: A1-005007-06F **Date of Test:** 02 October 2014

Room	Volume (m³)	Air Temperature (°C)	Humidity (%)
Upper	173.5	24.1 to 24.3	48.7 to 49.0
Lower	176.2	21.7 to 21.7	50.1 to 50.8

Area of test specimen:	17.85 m^2
Mass of test specimen:	2130 kg

f (Hz)	NISPL (dB)	
50	64	
63	57	
80	53	
100	50	
125	43	
160	34	
200	27	c
250	27	c
315	26	
400	33	
500	28	
630	21	
800	14	c
1000	10	*
1250	10	*
1600	10	*
2000	11	*
2500	12	*
3150	13	*
4000	15	*
5000	16	*
Impact Insulation Class (IIC)	**70**	

Sum of Positive Differences (dB)
9
Max. Positive Difference (dB)
8 dB at 100 Hz

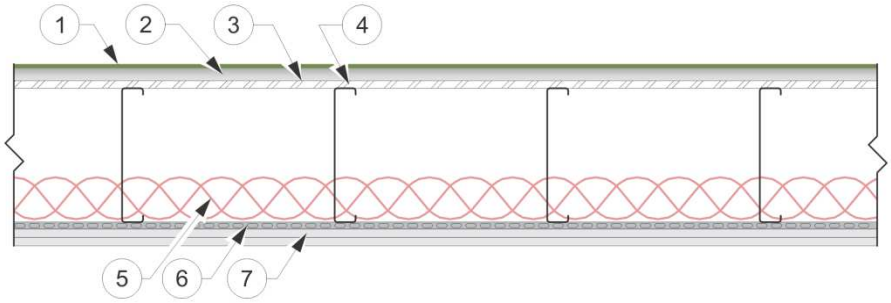


For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Measurements of normalized impact sound pressure level (NISPL) were conducted in accordance with the requirements of ASTM E492-09, "Standard Laboratory Measurement of Impact Sound Transmission through Floor-Ceiling Assemblies Using the Tapping Machine".**

In the graph:
The solid line is the measured normalized impact sound pressure level (NISPL) for this specimen. The dashed line is the IIC contour fitted to the measured values according to ASTM E989-06. The dotted line is the background sound level measured in the receiving room during this test (may be below the displayed range). For any frequency where the measured NISPL is less than 10 dB above the dotted line, the reported values were adjusted as noted below. Bars at the bottom of the graph show positive differences; where the measured data are greater than the reference contour as defined in ASTM E989-06. Shaded cells in the table and areas in the graph are outside the IIC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level and the reported values of NISPL provide an estimate of the upper limit of normalized impact sound pressure level, according to the procedure outlined in ASTM E492-09. The reported values of NISPL have been corrected according to the procedure outlined in ASTM E492-09.

Floor assembly 07F: VIN2_GCON38_CORSTE14_SJ254(406)_GFB92_RC13(305)_2G16



Description	2 mm vinyl sheet flooring on 38 mm poured lightweight gypsum concrete on corrugated steel deck, attached to 254 mm deep steel joists spaced 406 mm o.c., with two layers of 15.9 mm gypsum board Type X, attached to resilient channels spaced 305 mm o.c., and 92 mm deep glass fibre insulation (R-12) in the cavity.
Topping	• **(1)** 2 mm fibre floor sheet vinyl installed without glue on top of the gypsum concrete
Subfloor	• **(2)** 38 mm (1-1/2”) nominal poured lightweight gypsum concrete, measured from the bottom of the flute, on corrugated steel deck (corrugation: 14 mm (9/16”), steel thickness: 0.76 mm (0.030”)) • **(3)** Steel deck attached to joists using 19 mm (3/4”) screws (#10 hex washer head) spaced 203 mm (8”) o.c.
Framing & Cavity Insulation	• Framing headers resting on test frame (steel thickness: 1.37 mm (0.054”)) • **(4)** 254 mm (10”) deep steel C-joists (steel thickness: 1.37 mm (0.054”)) spaced 406 mm (16”) o.c., attached to headers using bearing stiffeners and 19 mm (3/4”) screws (#10 wafer head) through top of header into joists • 203 mm (8”) blocking strips, installed at the centre of the joists between the two last joists on each end and between the two joists in the floor centre • Flat strap connecting blocking strips, attached to the bottom of each joist • **(5)** Cavities between joists filled with 406 mm (16”) wide by 92 mm (3-5/8”) thick glass fibre insulation (R-12), resting on resilient channels
Ceiling	• **(6)** 13 mm resilient channels, spaced 305 mm (12”) o.c., installed perpendicularly to the joists and attached to each joist using 19 mm (3/4”) screws (#10 wafer head) • **(7)** Two layers of 15.9 mm (5/8”) gypsum board Type X installed with long side perpendicular to resilient channels • Face layer attached using 41 mm (1-5/8”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. along the perimeter and in the field • Base layer attached using 32 mm (1-1/4”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. along the perimeter and in the field • Screws from base layer to face layer offset by 152 mm (6”) • Gaps along the joints and the perimeter of gypsum boards caulked and taped with aluminum tape

Specimen Properties

Element	Actual thickness (mm)	Mass (kg)	Mass/length, area or volume
Vinyl Sheet Flooring	2	27.4	1.4 kg/m^2
Gypsum Concrete (24.3 MPa)	40	1260.0	1944.0 kg/m^3
Corrugated Steel Deck	14 *	147.4	6.9 kg/m^2
Steel Joists	254	224.6	3.9 kg/m
Web Stiffeners	254 **	12.0	1.9 kg/m
Glass Fibre Insulation	92 **	16.6	0.9 kg/m^2
Flat Strap	1 **	1.4	0.3 kg/m
Resilient Channels	13	14.4	0.2 kg/m
Gypsum Board	16	197.7	11.1 kg/m^2
Gypsum Board	16	197.7	11.1 kg/m^2
Total	**341**	**2099**	

* Corrugated steel deck thickness already included in gypsum concrete thickness

** Element thickness does not contribute to total thickness (ie. in cavity)

Test Specimen Installation

- The exposed area of the floor specimen used for the calculations of the airborne sound transmission loss was 17.85 m^2 (4.71 m x 3.79 m).
- The total area of the floor assembly resting on top of the lip was 19.32 m^2 (4.88 m x 3.96 m).
- The mass per area of the elements above the lip was calculated using the total area (19.32 m^2).
- The mass per area of the ceiling elements was calculated using the exposed area (17.85 m^2).

ASTM E90 Test Results – Airborne Sound Transmission Loss

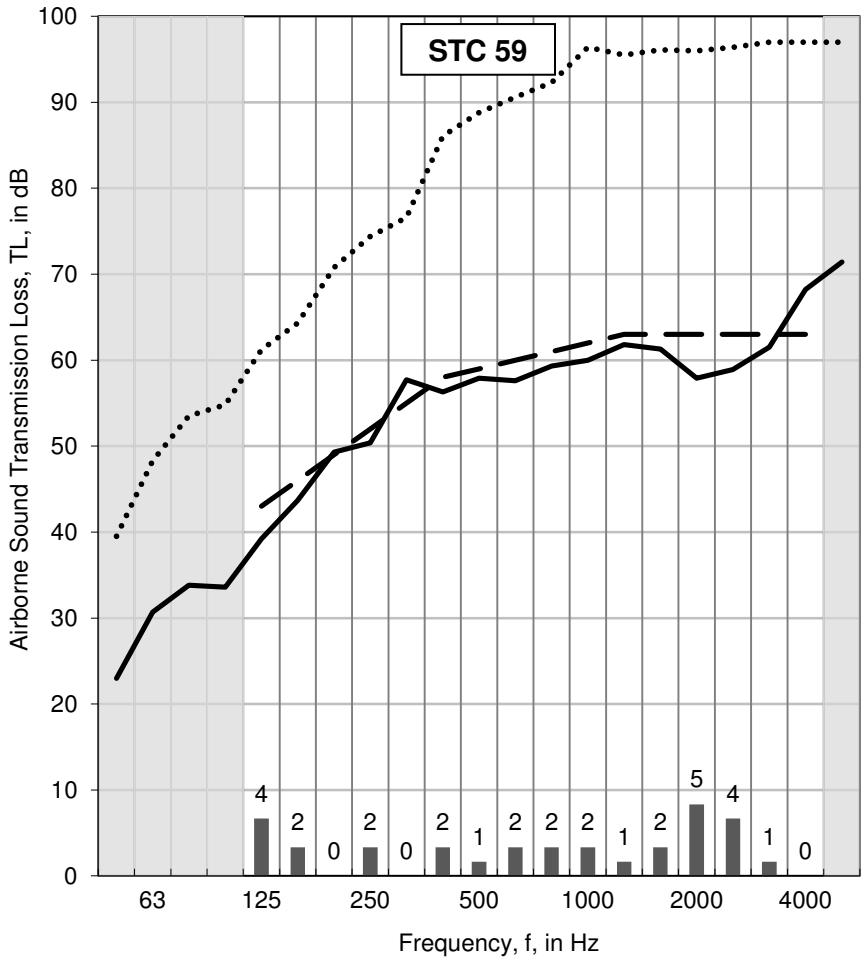
Client: CSSBI **Test ID:** TLF-14-056

Specimen ID: A1-005007-07F **Date of Test:** 07 October 2014

Room	Volume (m³)	Air Temperature (°C)	Humidity (%)
Upper	173.9	23.2 to 23.2	46.2 to 46.5
Lower	176.2	21.0 to 21.0	53.8 to 54.0

Area of test specimen:	17.85 m^2
Mass of test specimen:	2099 kg

f (Hz)	TL (dB)
50	23
63	31
80	34
100	34
125	39
160	44
200	49
250	50
315	58
400	56
500	58
630	58
800	59
1000	60
1250	62
1600	61
2000	58
2500	59
3150	62
4000	68
5000	71
Sound Transmission Class (STC)	**59**



Sum of Deficiencies (dB)
30
Max. Deficiency (dB)
5 dB at 2000 Hz

For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Airborne sound transmission loss measurements were conducted in accordance with the requirements of ASTM E90-09, "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements."**

In the graph:
The solid line is the measured sound transmission loss for this specimen. The dashed line is the STC contour fitted to the measured values according to ASTM E413-10. The dotted line (may be above the displayed range) is the flanking limit established for this facility. For any frequency band where the measured transmission loss is above the dotted line, the reported value is potentially limited by flanking transmission via laboratory surfaces, and the true value may be higher than that measured. Bars at the bottom of the graph show deficiencies where the measured data are less than the reference contour as described in the fitting procedure for the STC, defined in ASTM E413-10. The shaded cells in the table and areas in the graph are outside the STC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. The reported values have been corrected according to the procedure outlined in ASTM E90-09. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level, in which case, the corrected values provide an estimate of the lower limit of airborne sound transmission loss.

ASTM E492 Test Results – Normalized Impact Sound Pressure Levels

Client: CSSBI **Test ID:** IIF-14-026

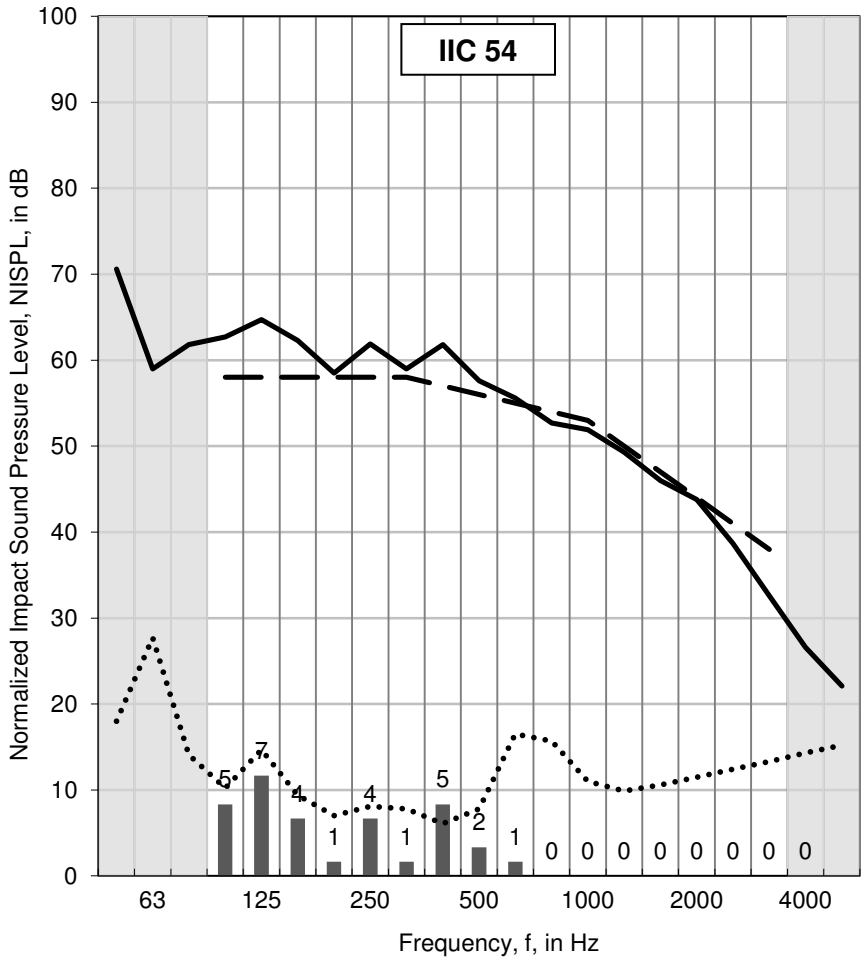
Specimen ID: A1-005007-07F **Date of Test:** 06 October 2014

Room	Volume (m³)	Air Temperature (°C)	Humidity (%)
Upper	173.9	22.8 to 23.0	37.8 to 39.5
Lower	176.2	21.3 to 21.4	53.7 to 54.0

Area of test specimen:	17.85 m^2
Mass of test specimen:	2099 kg

f (Hz)	NISPL (dB)	
50	71	
63	59	
80	62	
100	63	
125	65	
160	62	
200	59	
250	62	
315	59	
400	62	
500	58	
630	56	
800	53	
1000	52	
1250	49	
1600	46	
2000	44	
2500	39	
3150	33	
4000	27	c
5000	22	*
Impact Insulation Class (IIC)	**54**	

Sum of Positive Differences (dB)
30
Max. Positive Difference (dB)
7 dB at 125 Hz

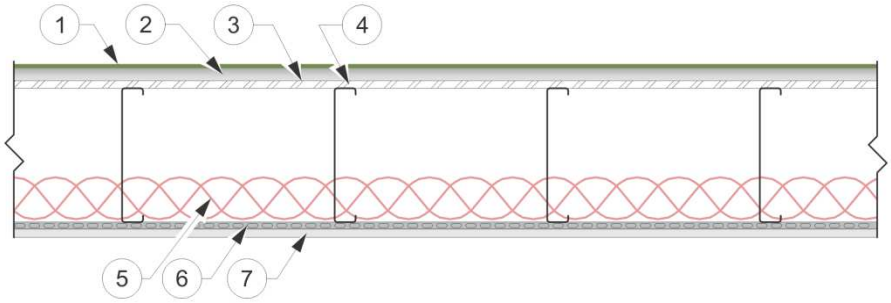


For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Measurements of normalized impact sound pressure level (NISPL) were conducted in accordance with the requirements of ASTM E492-09, "Standard Laboratory Measurement of Impact Sound Transmission through Floor-Ceiling Assemblies Using the Tapping Machine".**

In the graph:
The solid line is the measured normalized impact sound pressure level (NISPL) for this specimen. The dashed line is the IIC contour fitted to the measured values according to ASTM E989-06. The dotted line is the background sound level measured in the receiving room during this test (may be below the displayed range). For any frequency where the measured NISPL is less than 10 dB above the dotted line, the reported values were adjusted as noted below. Bars at the bottom of the graph show positive differences; where the measured data are greater than the reference contour as defined in ASTM E989-06. Shaded cells in the table and areas in the graph are outside the IIC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level and the reported values of NISPL provide an estimate of the upper limit of normalized impact sound pressure level, according to the procedure outlined in ASTM E492-09. The reported values of NISPL have been corrected according to the procedure outlined in ASTM E492-09.

Floor assembly 08F: VIN2_GCON38_CORSTE14_SJ254(406)_GFB92_RC13(305)_G16



Description	2 mm vinyl sheet flooring on 38 mm poured lightweight gypsum concrete on corrugated steel deck, attached to 254 mm deep steel joists spaced 406 mm o.c., with one layer of 15.9 mm gypsum board Type X, attached to resilient channels spaced 305 mm o.c., and 92 mm deep glass fibre insulation (R-12) in the cavity.
Topping	• **(1)** 2 mm vinyl sheet flooring installed without glue on top of the gypsum concrete
Subfloor	• **(2)** 38 mm (1-1/2”) nominal poured lightweight gypsum concrete, measured from the bottom of the flute, on corrugated steel deck (corrugation: 14 mm (9/16”), steel thickness: 0.76 mm (0.030”)) • **(3)** Steel deck attached to joists using 19 mm (3/4”) screws (#10 hex washer head) spaced 203 mm (8”) o.c.
Framing & Cavity Insulation	• Framing headers resting on test frame (steel thickness: 1.37 mm (0.054”)) • **(4)** 254 mm (10”) deep steel C-joists (steel thickness: 1.37 mm (0.054”)) spaced 406 mm (16”) o.c., attached to headers using bearing stiffeners and 19 mm (3/4”) screws (#10 wafer head) through top of header into joists • 203 mm (8”) blocking strips, installed at the centre of the joists between the two last joists on each end and between the two joists in the floor centre • Flat strap connecting blocking strips, attached to the bottom of each joist • **(5)** Cavities between joists filled with 406 mm (16”) wide by 92 mm (3-5/8”) thick glass fibre insulation (R-12), resting on resilient channels
Ceiling	• **(6)** 13 mm resilient channels, spaced 305 mm (12”) o.c., installed perpendicularly to the joists and attached to each joist using 19 mm (3/4”) screws (#10 wafer head) • **(7)** One layer of 15.9 mm (5/8”) gypsum board Type X, long side installed perpendicularly to resilient channels, attached using 32 mm (1-1/4”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. • Gaps along the joints and the perimeter of gypsum boards caulked and taped with aluminum tape

Specimen Properties

Element	Actual thickness (mm)	Mass (kg)	Mass/length, area or volume
Vinyl Sheet Flooring	2	27.4	1.4 kg/m^2
Gypsum Concrete (24.3 MPa)	40	1260.0	1944.0 kg/m^3
Corrugated Steel Deck	14 *	147.4	6.9 kg/m^2
Steel Joists	254	224.6	3.9 kg/m
Web Stiffeners	254 **	12.0	1.9 kg/m
Glass Fibre Insulation	92 **	16.6	0.9 kg/m^2
Flat Strap	1 **	1.4	0.3 kg/m
Resilient Channels	13	14.4	0.2 kg/m
Gypsum Board	16	197.7	11.1 kg/m^2
Total	**325**	**1901**	

* Corrugated steel deck thickness already included in gypsum concrete thickness

** Element thickness does not contribute to total thickness (ie. in cavity)

Test Specimen Installation

- The exposed area of the floor specimen used for the calculations of the airborne sound transmission loss was 17.85 m^2 (4.71 m x 3.79 m).
- The total area of the floor assembly resting on top of the lip was 19.32 m^2 (4.88 m x 3.96 m).
- The mass per area of the elements above the lip was calculated using the total area (19.32 m^2).
- The mass per area of the ceiling elements was calculated using the exposed area (17.85 m^2).

ASTM E90 Test Results – Airborne Sound Transmission Loss

Client: CSSBI **Test ID:** TLF-14-057

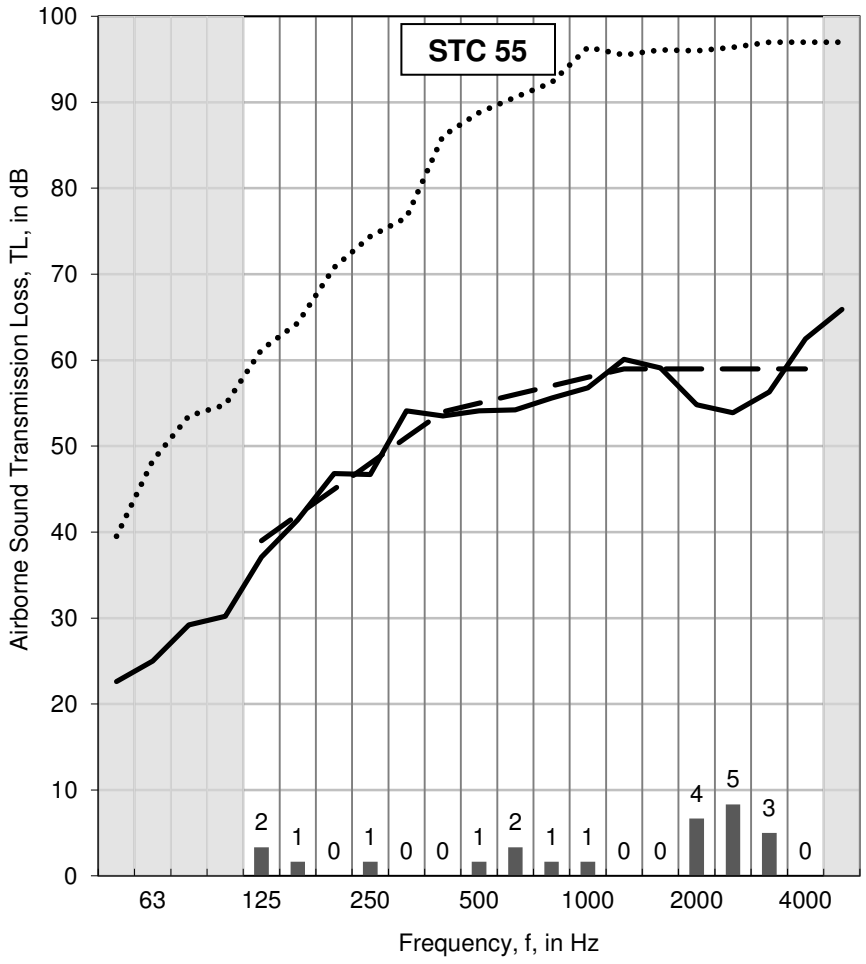
Specimen ID: A1-005007-08F **Date of Test:** 09 October 2014

Room	Volume (m³)	Air Temperature (°C)	Humidity (%)
Upper	173.7	22.9 to 23.1	38.1 to 38.8
Lower	176.9	20.9 to 20.9	54.3 to 54.5

Area of test specimen:	17.85 m^2
Mass of test specimen:	1901 kg

f (Hz)	TL (dB)
50	23
63	25
80	29
100	30
125	37
160	41
200	47
250	47
315	54
400	54
500	54
630	54
800	56
1000	57
1250	60
1600	59
2000	55
2500	54
3150	56
4000	63
5000	66
Sound Transmission Class (STC)	**55**

Sum of Deficiencies (dB)
21
Max. Deficiency (dB)
5 dB at 2500 Hz



For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Airborne sound transmission loss measurements were conducted in accordance with the requirements of ASTM E90-09, "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements."**

In the graph:
The solid line is the measured sound transmission loss for this specimen. The dashed line is the STC contour fitted to the measured values according to ASTM E413-10. The dotted line (may be above the displayed range) is the flanking limit established for this facility. For any frequency band where the measured transmission loss is above the dotted line, the reported value is potentially limited by flanking transmission via laboratory surfaces, and the true value may be higher than that measured. Bars at the bottom of the graph show deficiencies where the measured data are less than the reference contour as described in the fitting procedure for the STC, defined in ASTM E413-10. The shaded cells in the table and areas in the graph are outside the STC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. The reported values have been corrected according to the procedure outlined in ASTM E90-09. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level, in which case, the corrected values provide an estimate of the lower limit of airborne sound transmission loss.

ASTM E492 Test Results – Normalized Impact Sound Pressure Levels

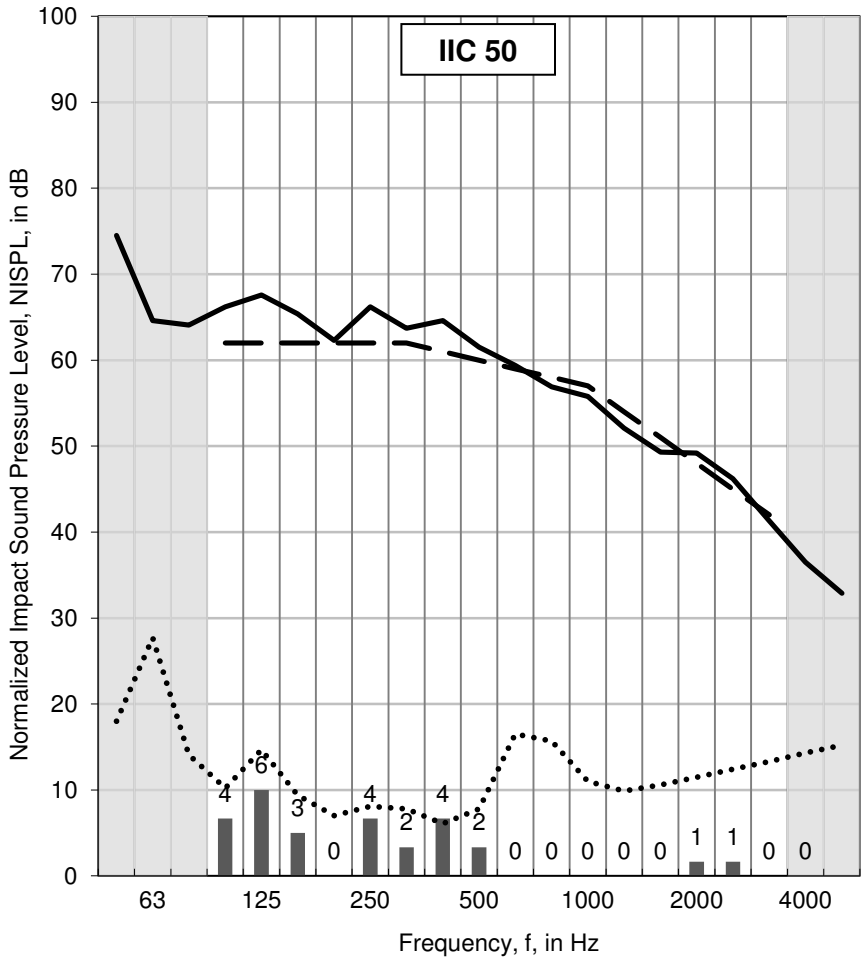
Client: CSSBI **Test ID:** IIF-14-027

Specimen ID: A1-005007-08F **Date of Test:** 10 October 2014

Room	Volume (m³)	Air Temperature (°C)	Humidity (%)
Upper	173.7	22.6 to 22.7	43.1 to 43.6
Lower	176.9	20.6 to 20.6	54.4 to 54.5

Area of test specimen:	17.85 m^2
Mass of test specimen:	1901 kg

f (Hz)	NISPL (dB)
50	75
63	65
80	64
100	66
125	68
160	65
200	62
250	66
315	64
400	65
500	62
630	59
800	57
1000	56
1250	52
1600	49
2000	49
2500	46
3150	41
4000	37
5000	33
Impact Insulation Class (IIC)	**50**



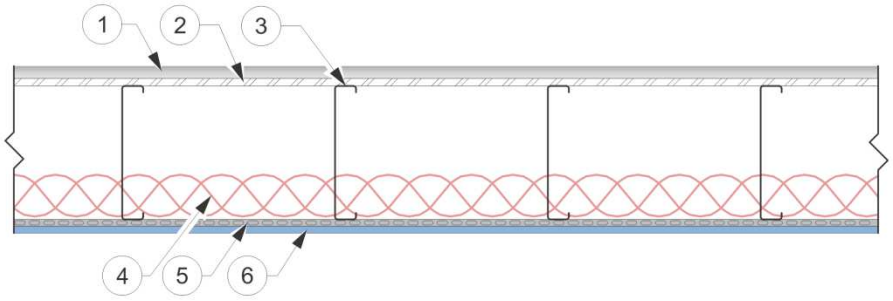
Sum of Positive Differences (dB)
27
Max. Positive Difference (dB)
6 dB at 125 Hz

For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Measurements of normalized impact sound pressure level (NISPL) were conducted in accordance with the requirements of ASTM E492-09, "Standard Laboratory Measurement of Impact Sound Transmission through Floor-Ceiling Assemblies Using the Tapping Machine".**

In the graph:
The solid line is the measured normalized impact sound pressure level (NISPL) for this specimen. The dashed line is the IIC contour fitted to the measured values according to ASTM E989-06. The dotted line is the background sound level measured in the receiving room during this test (may be below the displayed range). For any frequency where the measured NISPL is less than 10 dB above the dotted line, the reported values were adjusted as noted below. Bars at the bottom of the graph show positive differences; where the measured data are greater than the reference contour as defined in ASTM E989-06. Shaded cells in the table and areas in the graph are outside the IIC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level and the reported values of NISPL provide an estimate of the upper limit of normalized impact sound pressure level, according to the procedure outlined in ASTM E492-09. The reported values of NISPL have been corrected according to the procedure outlined in ASTM E492-09.

Floor assembly 09F: GCON38_CORSTE14_SJ254(406)_GFB92_RC13(305)_G13



Description	38 mm poured lightweight gypsum concrete on corrugated steel deck, attached to 254 mm deep steel joists spaced 406 mm o.c., with one layer of 15.9 mm gypsum board Type X, attached to resilient channels spaced 305 mm o.c., and 92 mm deep glass fibre insulation (R-12) in the cavity.
Topping	• None
Subfloor	• **(1)** 38 mm (1-1/2”) nominal poured lightweight gypsum concrete, measured from the bottom of the flute, on corrugated steel deck (corrugation: 14 mm (9/16”), steel thickness: 0.76 mm (0.030”)) • **(2)** Steel deck attached to joists using 19 mm (3/4”) screws (#10 hex washer head) spaced 203 mm (8”) o.c.
Framing & Cavity Insulation	• Framing headers resting on test frame (steel thickness: 1.37 mm (0.054”)) • **(3)** 254 mm (10”) deep steel C-joists (steel thickness: 1.37 mm (0.054”)) spaced 406 mm (16”) o.c., attached to headers using bearing stiffeners and 19 mm (3/4”) screws (#10 wafer head) through top of header into joists • 203 mm (8”) blocking strips, installed at the centre of the joists between the two last joists on each end and between the two joists in the floor centre • Flat strap connecting blocking strips, attached to the bottom of each joist • **(4)** Cavities between joists filled with 406 mm (16”) wide by 92 mm (3-5/8”) thick glass fibre insulation (R-12), resting on resilient channels
Ceiling	• **(5)** 13 mm resilient channels, spaced 305 mm (12”) o.c., installed perpendicularly to the joists and attached to each joist using 19 mm (3/4”) screws (#10 wafer head) • **(6)** One layer of 12.7 mm (1/2”) gypsum board Firecode C, long side installed perpendicularly to resilient channels, attached using 32 mm (1-1/4”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. • Gaps along the joints and the perimeter of gypsum boards caulked and taped with aluminum tape

Specimen Properties

Element	Actual thickness (mm)	Mass (kg)	Mass/length, area or volume
Gypsum Concrete (24.3 MPa)	40	1260.0	1944.0 kg/m^3
Corrugated Steel Deck	14 *	147.4	6.9 kg/m^2
Steel Joists	254	224.6	3.9 kg/m
Web Stiffeners	254 **	12.0	1.9 kg/m
Glass Fibre Insulation	92 **	16.6	0.9 kg/m^2
Flat Strap	1 **	1.4	0.3 kg/m
Resilient Channels	13	14.4	0.2 kg/m
Firecode C Gypsum Board	13	170.9	9.6 kg/m^2
Total	**320**	**1847**	

* Corrugated steel deck thickness already included in gypsum concrete thickness

** Element thickness does not contribute to total thickness (ie. in cavity)

Test Specimen Installation

- The exposed area of the floor specimen used for the calculations of the airborne sound transmission loss was 17.85 m^2 (4.71 m x 3.79 m).
- The total area of the floor assembly resting on top of the lip was 19.32 m^2 (4.88 m x 3.96 m).
- The mass per area of the elements above the lip was calculated using the total area (19.32 m^2).
- The mass per area of the ceiling elements was calculated using the exposed area (17.85 m^2).

ASTM E90 Test Results – Airborne Sound Transmission Loss

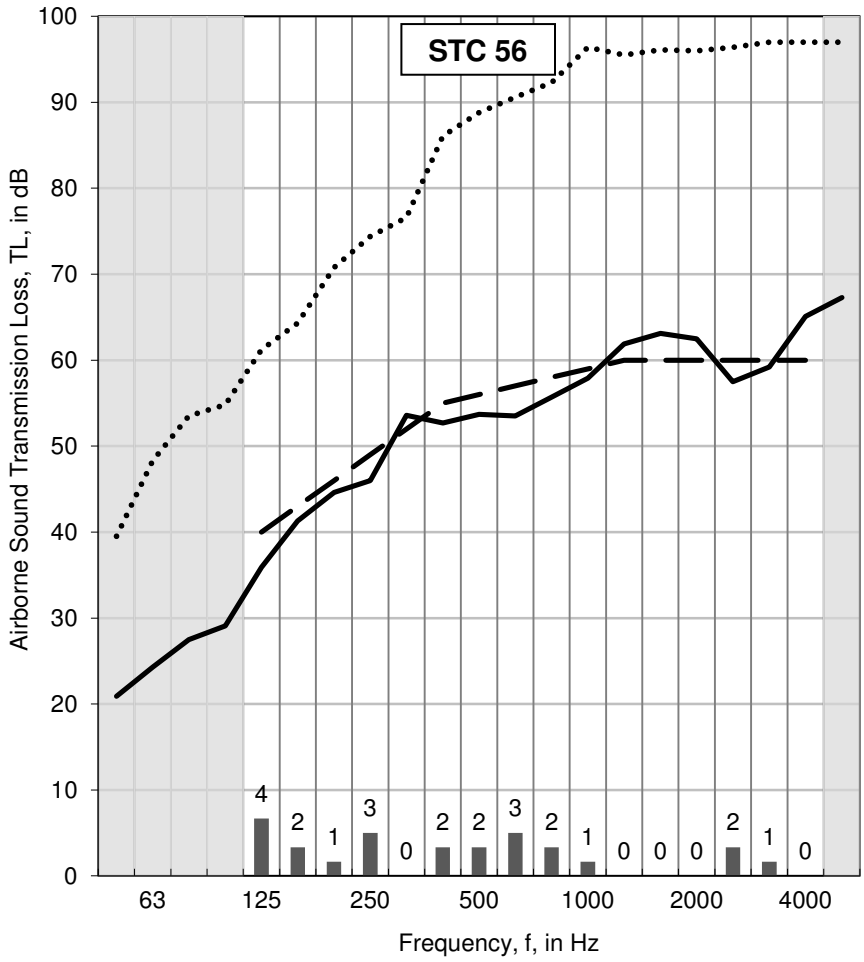
Client: CSSBI **Test ID:** TLF-14-061

Specimen ID: A1-005007-09F **Date of Test:** 20 October 2014

Room	Volume (m³)	Air Temperature (°C)	Humidity (%)
Upper	173.9	24.3 to 24.4	52.8 to 55.3
Lower	176.6	20.5 to 20.5	60.4 to 60.5

Area of test specimen:	17.85 m^2
Mass of test specimen:	1847 kg

f (Hz)	TL (dB)
50	21
63	24
80	28
100	29
125	36
160	41
200	45
250	46
315	54
400	53
500	54
630	54
800	56
1000	58
1250	62
1600	63
2000	63
2500	58
3150	59
4000	65
5000	67
Sound Transmission Class (STC)	**56**



Sum of Deficiencies (dB)
23
Max. Deficiency (dB)
4 dB at 125 Hz

For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Airborne sound transmission loss measurements were conducted in accordance with the requirements of ASTM E90-09, "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements."**

In the graph:
The solid line is the measured sound transmission loss for this specimen. The dashed line is the STC contour fitted to the measured values according to ASTM E413-10. The dotted line (may be above the displayed range) is the flanking limit established for this facility. For any frequency band where the measured transmission loss is above the dotted line, the reported value is potentially limited by flanking transmission via laboratory surfaces, and the true value may be higher than that measured. Bars at the bottom of the graph show deficiencies where the measured data are less than the reference contour as described in the fitting procedure for the STC, defined in ASTM E413-10. The shaded cells in the table and areas in the graph are outside the STC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. The reported values have been corrected according to the procedure outlined in ASTM E90-09. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level, in which case, the corrected values provide an estimate of the lower limit of airborne sound transmission loss.

ASTM E492 Test Results – Normalized Impact Sound Pressure Levels

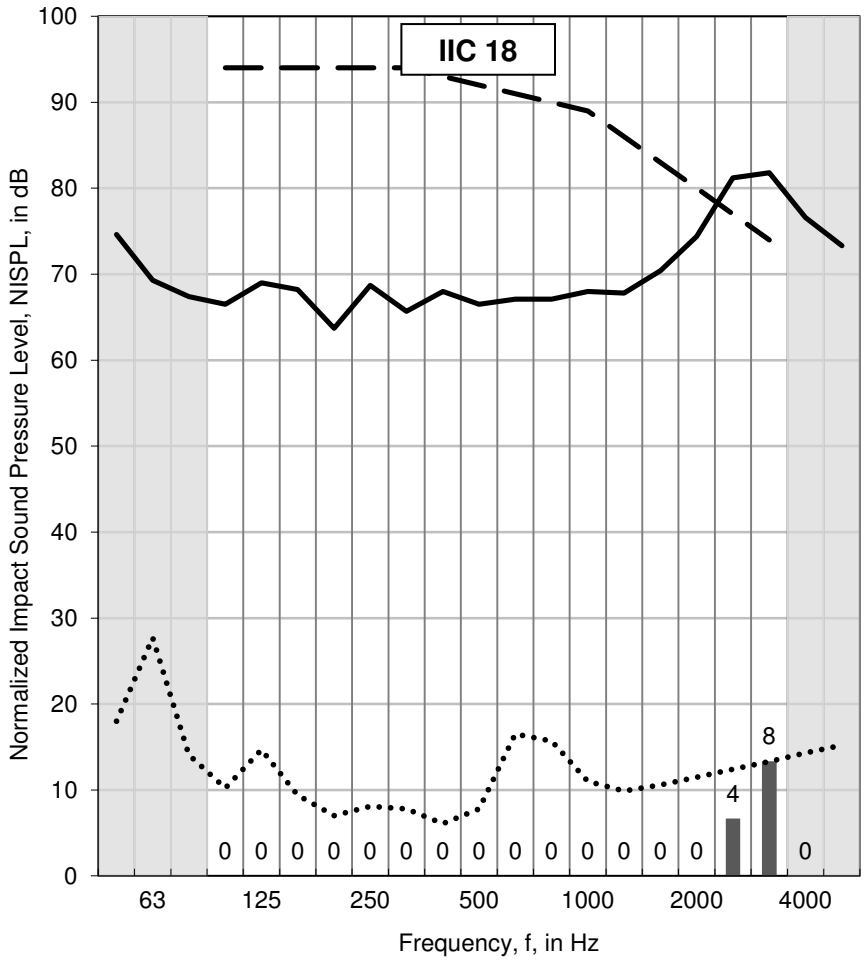
Client: CSSBI **Test ID:** IIF-14-028

Specimen ID: A1-005007-09F **Date of Test:** 17 October 2014

Room	Volume (m³)	Air Temperature (°C)	Humidity (%)
Upper	173.9	22.9 to 23.3	64.6 to 65.9
Lower	176.6	21.1 to 21.3	62.4 to 63.1

Area of test specimen:	17.85 m^2
Mass of test specimen:	1847 kg

f (Hz)	NISPL (dB)
50	75
63	69
80	67
100	67
125	69
160	68
200	64
250	69
315	66
400	68
500	67
630	67
800	67
1000	68
1250	68
1600	70
2000	74
2500	81
3150	82
4000	77
5000	73
Impact Insulation Class (IIC)	**18**



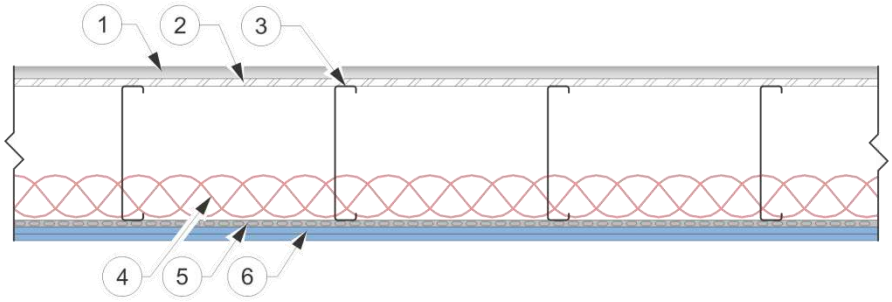
Sum of Positive Differences (dB)
12
Max. Positive Difference (dB)
8 dB at 3150 Hz

For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Measurements of normalized impact sound pressure level (NISPL) were conducted in accordance with the requirements of ASTM E492-09, "Standard Laboratory Measurement of Impact Sound Transmission through Floor-Ceiling Assemblies Using the Tapping Machine".**

In the graph:
The solid line is the measured normalized impact sound pressure level (NISPL) for this specimen. The dashed line is the IIC contour fitted to the measured values according to ASTM E989-06. The dotted line is the background sound level measured in the receiving room during this test (may be below the displayed range). For any frequency where the measured NISPL is less than 10 dB above the dotted line, the reported values were adjusted as noted below. Bars at the bottom of the graph show positive differences; where the measured data are greater than the reference contour as defined in ASTM E989-06. Shaded cells in the table and areas in the graph are outside the IIC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level and the reported values of NISPL provide an estimate of the upper limit of normalized impact sound pressure level, according to the procedure outlined in ASTM E492-09. The reported values of NISPL have been corrected according to the procedure outlined in ASTM E492-09.

Floor assembly 10F: GCON38_CORSTE14_SJ254(406)_GFB92_RC13(305)_2G13



Description	38 mm poured lightweight gypsum concrete on corrugated steel deck, attached to 254 mm deep steel joists spaced 406 mm o.c., with two layers of 12.7 mm gypsum board Firecode C, attached to resilient channels spaced 305 mm o.c., and 92 mm deep glass fibre insulation (R-12) in the cavity.
Topping	• None
Subfloor	• **(1)** 38 mm (1-1/2”) nominal poured lightweight gypsum concrete, measured from the bottom of the flute, on corrugated steel deck (corrugation: 14 mm (9/16”), steel thickness: 0.76 mm (0.030”)) • **(2)** Steel deck attached to joists using 19 mm (3/4”) screws (#10 hex washer head) spaced 203 mm (8”) o.c.
Framing & Cavity Insulation	• Framing headers resting on test frame (steel thickness: 1.37 mm (0.054”)) • **(3)** 254 mm (10”) deep steel C-joists (steel thickness: 1.37 mm (0.054”)) spaced 406 mm (16”) o.c., attached to headers using bearing stiffeners and 19 mm (3/4”) screws (#10 wafer head) through top of header into joists • 203 mm (8”) blocking strips, installed at the centre of the joists between the two last joists on each end and between the two joists in the floor centre • Flat strap connecting blocking strips, attached to the bottom of each joist • **(4)** Cavities between joists filled with 406 mm (16”) wide by 92 mm (3-5/8”) thick glass fibre insulation (R-12), resting on resilient channels
Ceiling	• **(5)** 13 mm resilient channels, spaced 305 mm (12”) o.c., installed perpendicularly to the joists and attached to each joist using 19 mm (3/4”) screws (#10 wafer head) • **(6)** Two layers of 12.7 mm (1/2”) gypsum board Firecode C, long side installed perpendicularly to resilient channels • Face layer attached using 41 mm (1-5/8”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. along the perimeter and in the field • Base layer attached using 32 mm (1-1/4”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. along the perimeter and in the field • Screws from base layer to face layer offset by 152 mm (6”) • Gaps along the joints and the perimeter of gypsum boards caulked and taped with aluminum tape

Specimen Properties

Element	Actual thickness (mm)	Mass (kg)	Mass/length, area or volume
Gypsum Concrete (24.3 MPa)	40	1260.0	1944.0 kg/m^3
Corrugated Steel Deck	14 *	147.4	6.9 kg/m^2
Steel Joists	254	224.6	3.9 kg/m
Web Stiffeners	254 **	12.0	1.9 kg/m
Glass Fibre Insulation	92 **	16.6	0.9 kg/m^2
Flat Strap	1 **	1.4	0.3 kg/m
Resilient Channels	13	14.4	0.2 kg/m
Firecode C Gypsum Board	13	170.9	9.6 kg/m^2
Firecode C Gypsum Board	13	170.9	9.6 kg/m^2
Total	**333**	**2018**	

* Corrugated steel deck thickness already included in gypsum concrete thickness

** Element thickness does not contribute to total thickness (ie. in cavity)

Test Specimen Installation

- The exposed area of the floor specimen used for the calculations of the airborne sound transmission loss was 17.85 m^2 (4.71 m x 3.79 m).
- The total area of the floor assembly resting on top of the lip was 19.32 m^2 (4.88 m x 3.96 m).
- The mass per area of the elements above the lip was calculated using the total area (19.32 m^2).
- The mass per area of the ceiling elements was calculated using the exposed area (17.85 m^2).

ASTM E90 Test Results – Airborne Sound Transmission Loss

Client: CSSBI **Test ID:** TLF-14-062

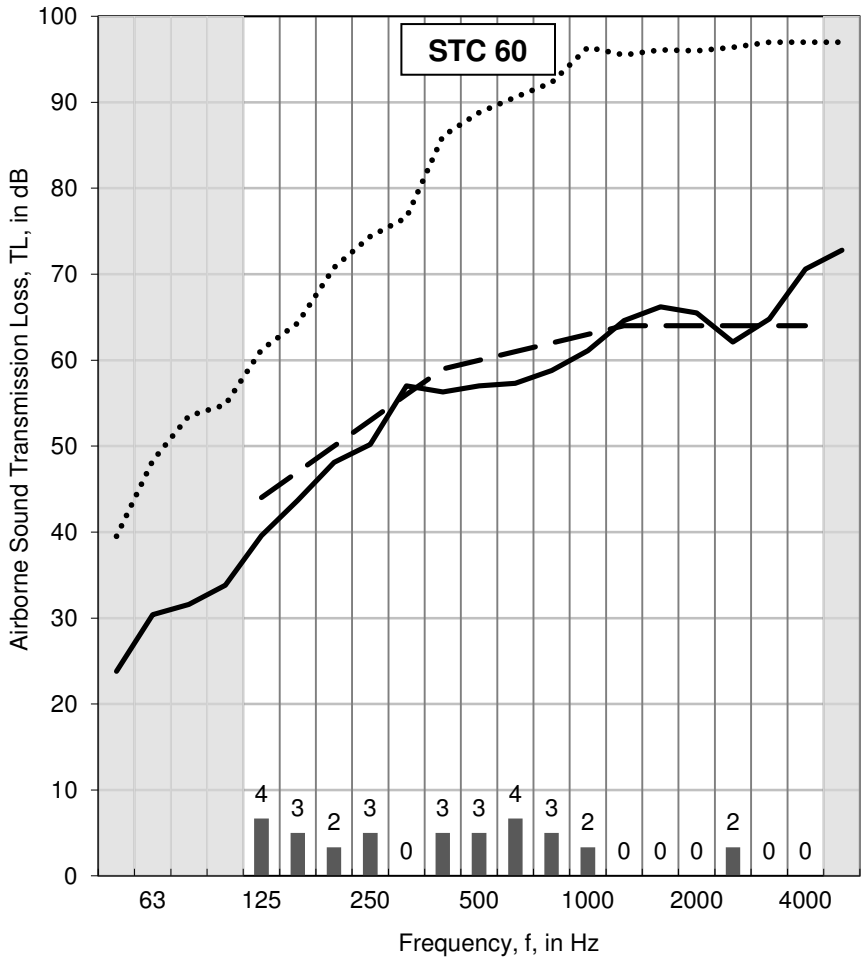
Specimen ID: A1-005007-10F **Date of Test:** 24 October 2014

Room	Volume (m³)	Air Temperature (°C)	Humidity (%)
Upper	174.6	23.7 to 23.8	56.4 to 56.8
Lower	176.3	19.4 to 19.5	47.1 to 47.2

Area of test specimen:	17.85 m^2
Mass of test specimen:	2018 kg

f (Hz)	TL (dB)
50	24
63	30
80	32
100	34
125	40
160	44
200	48
250	50
315	57
400	56
500	57
630	57
800	59
1000	61
1250	65
1600	66
2000	66
2500	62
3150	65
4000	71
5000	73
Sound Transmission Class (STC)	**60**

Sum of Deficiencies (dB)
29
Max. Deficiency (dB)
4 dB at 125 Hz and 630 Hz



For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Airborne sound transmission loss measurements were conducted in accordance with the requirements of ASTM E90-09, "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements."**

In the graph:
The solid line is the measured sound transmission loss for this specimen. The dashed line is the STC contour fitted to the measured values according to ASTM E413-10. The dotted line (may be above the displayed range) is the flanking limit established for this facility. For any frequency band where the measured transmission loss is above the dotted line, the reported value is potentially limited by flanking transmission via laboratory surfaces, and the true value may be higher than that measured. Bars at the bottom of the graph show deficiencies where the measured data are less than the reference contour as described in the fitting procedure for the STC, defined in ASTM E413-10. The shaded cells in the table and areas in the graph are outside the STC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. The reported values have been corrected according to the procedure outlined in ASTM E90-09. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level, in which case, the corrected values provide an estimate of the lower limit of airborne sound transmission loss.

ASTM E492 Test Results – Normalized Impact Sound Pressure Levels

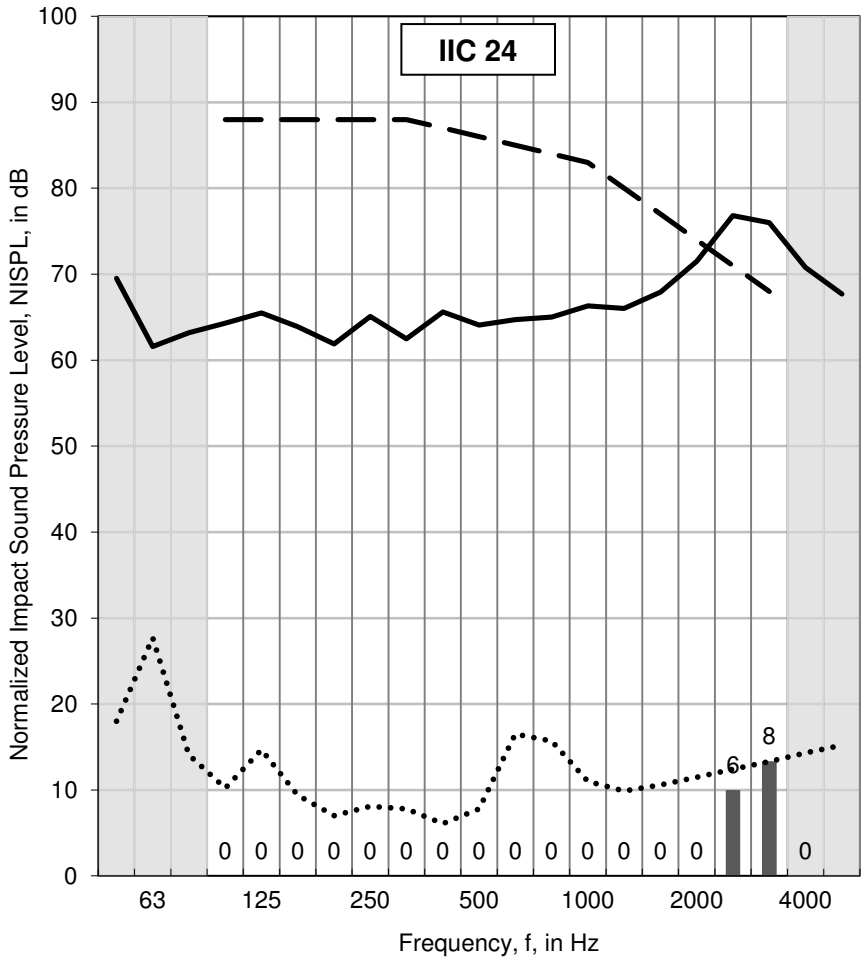
Client: CSSBI **Test ID:** IIF-14-029

Specimen ID: A1-005007-10F **Date of Test:** 24 October 2014

Room	Volume (m³)	Air Temperature (°C)	Humidity (%)
Upper	174.6	23.6 to 23.7	55.7 to 56.3
Lower	176.3	19.4 to 19.4	46.8 to 47.0

Area of test specimen:	17.85 m^2
Mass of test specimen:	2018 kg

f (Hz)	NISPL (dB)
50	70
63	62
80	63
100	64
125	66
160	64
200	62
250	65
315	63
400	66
500	64
630	65
800	65
1000	66
1250	66
1600	68
2000	72
2500	77
3150	76
4000	71
5000	68
Impact Insulation Class (IIC)	**24**



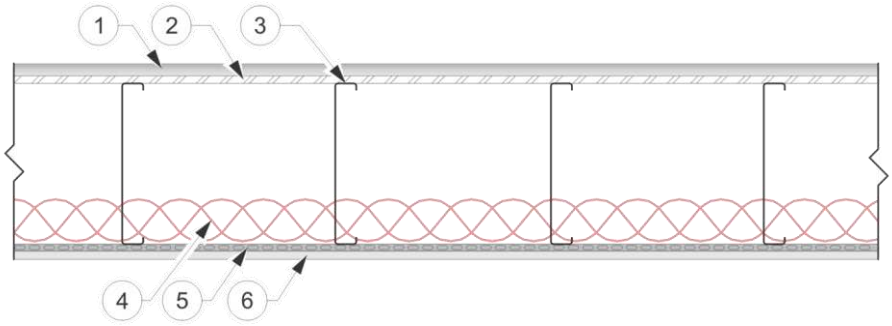
Sum of Positive Differences (dB)
14
Max. Positive Difference (dB)
8 dB at 3150 Hz

For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Measurements of normalized impact sound pressure level (NISPL) were conducted in accordance with the requirements of ASTM E492-09, "Standard Laboratory Measurement of Impact Sound Transmission through Floor-Ceiling Assemblies Using the Tapping Machine".**

In the graph:
The solid line is the measured normalized impact sound pressure level (NISPL) for this specimen. The dashed line is the IIC contour fitted to the measured values according to ASTM E989-06. The dotted line is the background sound level measured in the receiving room during this test (may be below the displayed range). For any frequency where the measured NISPL is less than 10 dB above the dotted line, the reported values were adjusted as noted below. Bars at the bottom of the graph show positive differences; where the measured data are greater than the reference contour as defined in ASTM E989-06. Shaded cells in the table and areas in the graph are outside the IIC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level and the reported values of NISPL provide an estimate of the upper limit of normalized impact sound pressure level, according to the procedure outlined in ASTM E492-09. The reported values of NISPL have been corrected according to the procedure outlined in ASTM E492-09.

Floor assembly 11F: GCON38_CORSTE14_SJ317(406)_GFB92_RC13(305)_G16



Description	38 mm poured lightweight gypsum concrete on corrugated steel deck, attached to 317 mm deep steel joists spaced 406 mm o.c., with two layers of 15.9 mm gypsum board Type X, attached to resilient channels spaced 305 mm o.c., and 92 mm deep glass fibre insulation (R-12) in the cavity.
Topping	• None
Subfloor	• **(1)** 38 mm (1-1/2”) nominal poured lightweight gypsum concrete, measured from the bottom of the flute, on corrugated steel deck (corrugation: 14 mm (9/16”), steel thickness: 0.76 mm (0.030”)) • **(2)** Steel deck attached to joists using 19 mm (3/4”) screws (#10 hex washer head) spaced 203 mm (8”) o.c.
Framing & Cavity Insulation	• Framing headers resting on test frame (steel thickness: 1.37 mm (0.054”)) • **(3)** 317 mm (12-1/4”) deep steel C-joists (steel thickness: 1.37 mm (0.054”)) spaced 406 mm (16”) o.c., attached to headers using bearing stiffeners and 19 mm (3/4”) screws (#10 wafer head) through top of header into joists • 203 mm (8”) blocking strips, installed at the centre of the joists between the two last joists on each end and between the two joists in the floor centre • Flat strap connecting blocking strips, attached to the bottom of each joist • **(4)** Cavities between joists filled with 406 mm (16”) wide by 92 mm (3-5/8”) thick glass fibre insulation (R-12), resting on resilient channels
Ceiling	• **(5)** 13 mm resilient channels, spaced 305 mm (12”) o.c., installed perpendicularly to the joists and attached to each joist using 19 mm (3/4”) screws (#10 wafer head) • **(6)** One layer of 15.9 mm (5/8”) gypsum board Type X, long side installed perpendicularly to resilient channels, attached using 32 mm (1-1/4”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. • Gaps along the joints and the perimeter of gypsum boards caulked and taped with aluminum tape

Specimen Properties

Element	Actual thickness (mm)	Mass (kg)	Mass/length, area or volume
Gypsum Concrete (24.3 MPa)	40	1260.0	1944.0 kg/m^3
Corrugated Steel Deck	14 *	147.4	6.9 kg/m^2
Steel Joists	317	236.4	4.4 kg/m
Web Stiffeners	317 **	14.4	1.9 kg/m
Glass Fibre Insulation	92 **	16.6	0.9 kg/m^2
Flat Strap	1 **	1.4	0.3 kg/m
Resilient Channels	13	14.4	0.2 kg/m
Gypsum Board	16	197.7	11.1 kg/m^2
Total	**386**	**1889**	

* Corrugated steel deck thickness already included in gypsum concrete thickness

** Element thickness does not contribute to total thickness (ie. in cavity)

Test Specimen Installation

- The exposed area of the floor specimen used for the calculations of the airborne sound transmission loss was 17.85 m^2 (4.71 m x 3.79 m).
- The total area of the floor assembly resting on top of the lip was 19.32 m^2 (4.88 m x 3.96 m).
- The mass per area of the elements above the lip was calculated using the total area (19.32 m^2).
- The mass per area of the ceiling elements was calculated using the exposed area (17.85 m^2).

ASTM E90 Test Results – Airborne Sound Transmission Loss

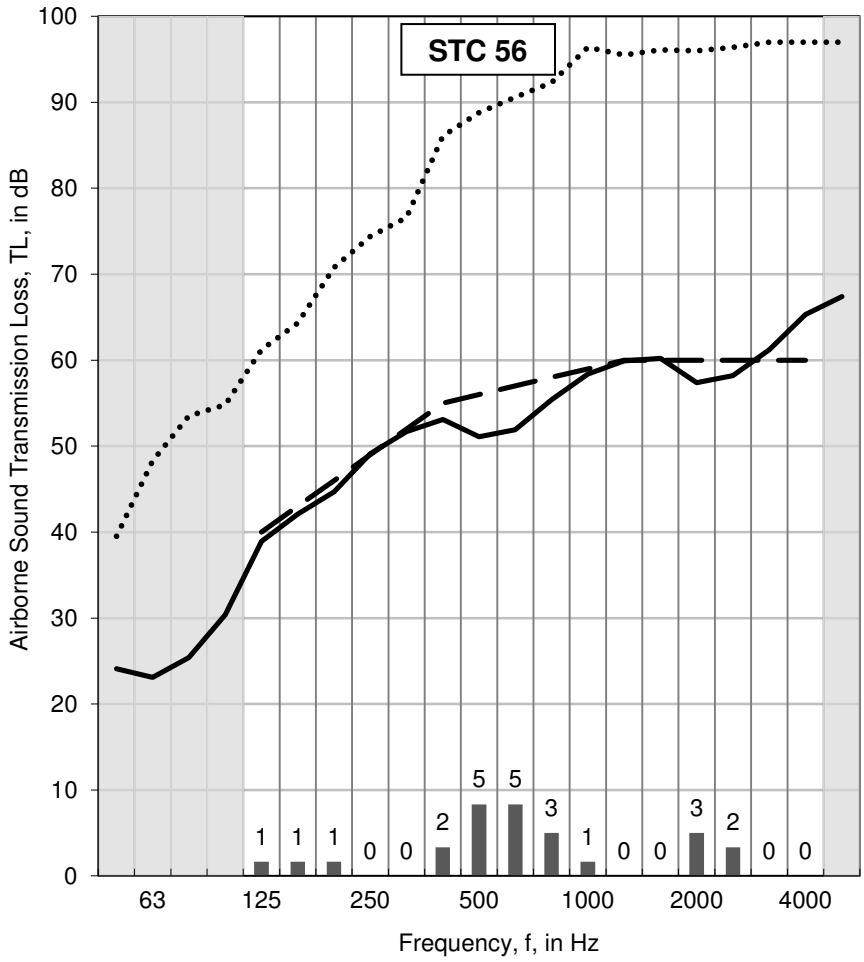
Client: CSSBI **Test ID:** TLF-14-063

Specimen ID: A1-005007-11F **Date of Test:** 30 October 2014

Room	Volume (m³)	Air Temperature (°C)	Humidity (%)
Upper	173.8	24.1 to 24.2	42.5 to 42.9
Lower	175.9	19.9 to 19.9	47.0 to 47.1

Area of test specimen:	17.85 m^2
Mass of test specimen:	1889 kg

f (Hz)	TL (dB)
50	24
63	23
80	25
100	30
125	39
160	42
200	45
250	49
315	52
400	53
500	51
630	52
800	55
1000	58
1250	60
1600	60
2000	57
2500	58
3150	61
4000	65
5000	67
Sound Transmission Class (STC)	**56**



Sum of Deficiencies (dB)
24
Max. Deficiency (dB)
5 dB at 500 Hz and 630 Hz

For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Airborne sound transmission loss measurements were conducted in accordance with the requirements of ASTM E90-09, "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements."**

In the graph:
The solid line is the measured sound transmission loss for this specimen. The dashed line is the STC contour fitted to the measured values according to ASTM E413-10. The dotted line (may be above the displayed range) is the flanking limit established for this facility. For any frequency band where the measured transmission loss is above the dotted line, the reported value is potentially limited by flanking transmission via laboratory surfaces, and the true value may be higher than that measured. Bars at the bottom of the graph show deficiencies where the measured data are less than the reference contour as described in the fitting procedure for the STC, defined in ASTM E413-10. The shaded cells in the table and areas in the graph are outside the STC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. The reported values have been corrected according to the procedure outlined in ASTM E90-09. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level, in which case, the corrected values provide an estimate of the lower limit of airborne sound transmission loss.

ASTM E492 Test Results – Normalized Impact Sound Pressure Levels

Client: CSSBI **Test ID:** IIF-14-030

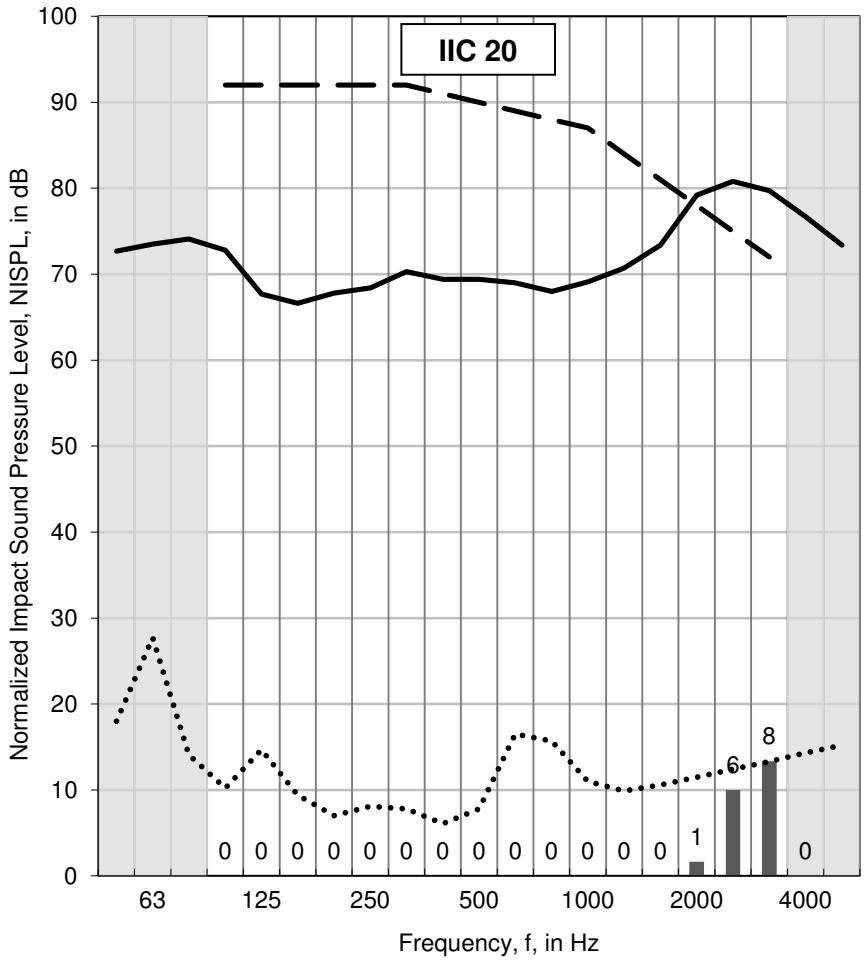
Specimen ID: A1-005007-11F **Date of Test:** 30 October 2014

Room	Volume (m^3)	Air Temperature (°C)	Humidity (%)
Upper	173.8	24.0 to 24.1	37.0 to 45.5
Lower	175.9	20.1 to 20.2	46.7 to 46.9

Area of test specimen:	17.85 m^2
Mass of test specimen:	1889 kg

f (Hz)	NISPL (dB)
50	73
63	74
80	74
100	73
125	68
160	67
200	68
250	68
315	70
400	69
500	69
630	69
800	68
1000	69
1250	71
1600	73
2000	79
2500	81
3150	80
4000	77
5000	73
Impact Insulation Class (IIC)	**20**

Sum of Positive Differences (dB)
20
Max. Positive Difference (dB)
8 dB at 3150 Hz

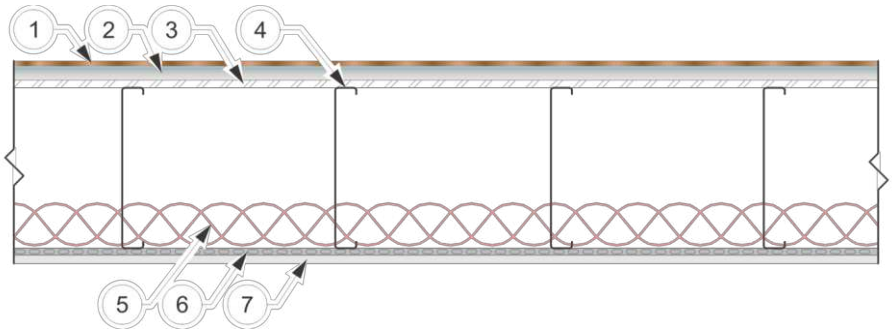


For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Measurements of normalized impact sound pressure level (NISPL) were conducted in accordance with the requirements of ASTM E492-09, "Standard Laboratory Measurement of Impact Sound Transmission through Floor-Ceiling Assemblies Using the Tapping Machine".**

In the graph:
The solid line is the measured normalized impact sound pressure level (NISPL) for this specimen. The dashed line is the IIC contour fitted to the measured values according to ASTM E989-06. The dotted line is the background sound level measured in the receiving room during this test (may be below the displayed range). For any frequency where the measured NISPL is less than 10 dB above the dotted line, the reported values were adjusted as noted below. Bars at the bottom of the graph show positive differences; where the measured data are greater than the reference contour as defined in ASTM E989-06. Shaded cells in the table and areas in the graph are outside the IIC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level and the reported values of NISPL provide an estimate of the upper limit of normalized impact sound pressure level, according to the procedure outlined in ASTM E492-09. The reported values of NISPL have been corrected according to the procedure outlined in ASTM E492-09.

Floor assembly 12F: LAM10_STY3_GCON38_CORSTE14_SJ317(406)_GFB92_RC13(305)_G16



Description	10 mm laminate flooring on 3 mm styrofoam bead underlay on 38 mm poured lightweight gypsum concrete on corrugated steel deck, attached to 317 mm deep steel joists spaced 406 mm o.c., with one layer of 15.9 mm gypsum board Type X, attached to resilient channels spaced 305 mm o.c., and 92 mm deep glass fibre insulation (R-12) in the cavity.
Topping	• **(1)** 10 mm glueless laminate floor installed on 3 mm (1/8") styrofoam bead underlay
Subfloor	• **(2)** 38 mm (1-1/2”) nominal poured lightweight gypsum concrete, measured from the bottom of the flute, on corrugated steel deck (corrugation: 14 mm (9/16”), steel thickness: 0.76 mm (0.030”)) • **(3)** Steel deck attached to joists using 19 mm (3/4”) screws (#10 hex washer head) spaced 203 mm (8”) o.c.
Framing & Cavity Insulation	• Framing headers resting on test frame (steel thickness: 1.37 mm (0.054”)) • **(4)** 317 mm (12-1/4”) deep steel C-joists (steel thickness: 1.37 mm (0.054”)) spaced 406 mm (16”) o.c., attached to headers using bearing stiffeners and 19 mm (3/4”) screws (#10 wafer head) through top of header into joists • 203 mm (8”) blocking strips, installed at the centre of the joists between the two last joists on each end and between the two joists in the floor centre • Flat strap connecting blocking strips, attached to the bottom of each joist • **(5)** Cavities between joists filled with 406 mm (16”) wide by 92 mm (3-5/8”) thick glass fibre insulation (R-12), resting on resilient channels
Ceiling	• **(6)** 13 mm resilient channels, spaced 305 mm (12”) o.c., installed perpendicularly to the joists and attached to each joist using 19 mm (3/4”) screws (#10 wafer head) • **(7)** One layer of 15.9 mm (5/8”) gypsum board Type X, long side installed perpendicularly to resilient channels, attached using 32 mm (1-1/4”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. • Gaps along the joints and the perimeter of gypsum boards caulked and taped with aluminum tape

Specimen Properties

Element	Actual thickness (mm)	Mass (kg)	Mass/length, area or volume
Laminate Flooring	10	162.7	8.3 kg/m^2
Styrofoam Bead Underlay	3	2.9	0.2 kg/m^2
Gypsum Concrete (24.3 MPa)	40	1260.0	1944.0 kg/m^3
Corrugated Steel Deck	14 *	147.4	6.9 kg/m^2
Steel Joists	317	236.4	4.4 kg/m
Web Stiffeners	317 **	14.4	1.9 kg/m
Glass Fibre Insulation	92 **	16.6	0.9 kg/m^2
Flat Strap	1 **	1.4	0.3 kg/m
Resilient Channels	13	14.4	0.2 kg/m
Gypsum Board	16	197.7	11.1 kg/m^2
Total	**399**	**2054**	

* Corrugated steel deck thickness already included in gypsum concrete thickness

** Element thickness does not contribute to total thickness (ie. in cavity)

Test Specimen Installation

- The exposed area of the floor specimen used for the calculations of the airborne sound transmission loss was 17.85 m^2 (4.71 m x 3.79 m).
- The total area of the floor assembly resting on top of the lip was 19.32 m^2 (4.88 m x 3.96 m).
- The mass per area of the elements above the lip was calculated using the total area (19.32 m^2).
- The mass per area of the ceiling elements was calculated using the exposed area (17.85 m^2).

ASTM E90 Test Results – Airborne Sound Transmission Loss

Client: CSSBI **Test ID:** TLF-14-064

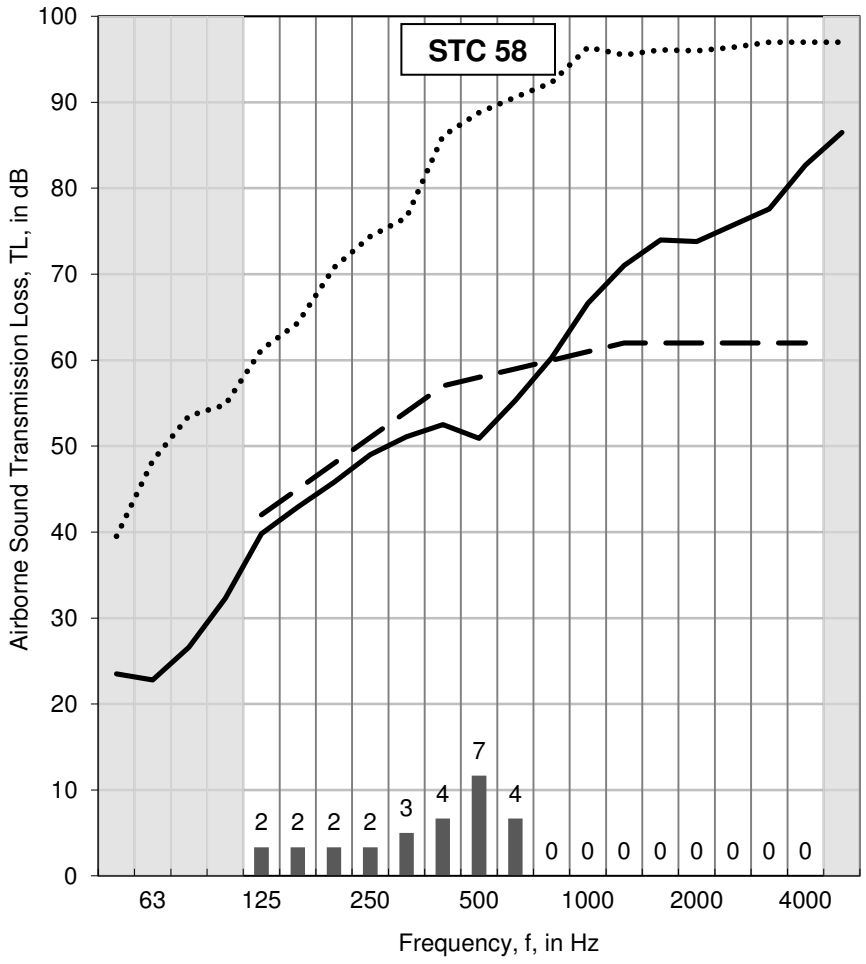
Specimen ID: A1-005007-12F **Date of Test:** 17 November 2014

Room	Volume (m³)	Air Temperature (°C)	Humidity (%)
Upper	172.7	21.3 to 21.3	39.4 to 39.5
Lower	176.8	18.1 to 18.1	49.6 to 49.6

Area of test specimen:	17.85 m^2
Mass of test specimen:	2054 kg

f (Hz)	TL (dB)
50	24
63	23
80	27
100	32
125	40
160	43
200	46
250	49
315	51
400	53
500	51
630	55
800	60
1000	67
1250	71
1600	74
2000	74
2500	76
3150	78
4000	83
5000	87
Sound Transmission Class (STC)	**58**

Sum of Deficiencies (dB)
26
Max. Deficiency (dB)
7 dB at 500 Hz



For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Airborne sound transmission loss measurements were conducted in accordance with the requirements of ASTM E90-09, "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements."**

In the graph:
The solid line is the measured sound transmission loss for this specimen. The dashed line is the STC contour fitted to the measured values according to ASTM E413-10. The dotted line (may be above the displayed range) is the flanking limit established for this facility. For any frequency band where the measured transmission loss is above the dotted line, the reported value is potentially limited by flanking transmission via laboratory surfaces, and the true value may be higher than that measured. Bars at the bottom of the graph show deficiencies where the measured data are less than the reference contour as described in the fitting procedure for the STC, defined in ASTM E413-10. The shaded cells in the table and areas in the graph are outside the STC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. The reported values have been corrected according to the procedure outlined in ASTM E90-09. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level, in which case, the corrected values provide an estimate of the lower limit of airborne sound transmission loss.

ASTM E492 Test Results – Normalized Impact Sound Pressure Levels

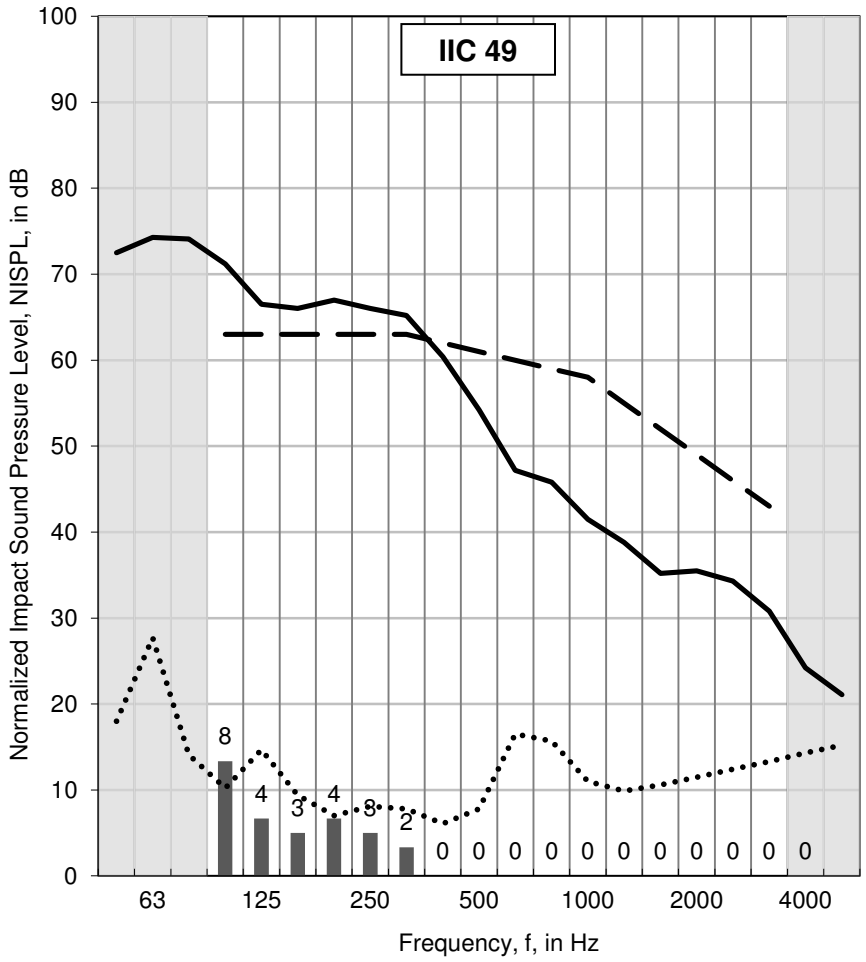
Client: CSSBI **Test ID:** IIF-14-032

Specimen ID: A1-005007-12F **Date of Test:** 18 November 2014

Room	Volume (m³)	Air Temperature (°C)	Humidity (%)
Upper	172.7	21.5 to 21.5	31.2 to 39.8
Lower	176.8	17.8 to 17.8	49.7 to 49.9

Area of test specimen:	17.85 m^2
Mass of test specimen:	2054 kg

f (Hz)	NISPL (dB)	
50	73	
63	74	
80	74	
100	71	
125	67	
160	66	
200	67	
250	66	
315	65	
400	60	
500	54	
630	47	
800	46	
1000	42	
1250	39	
1600	35	
2000	36	
2500	34	
3150	31	
4000	24	c
5000	21	*
Impact Insulation Class (IIC)	**49**	



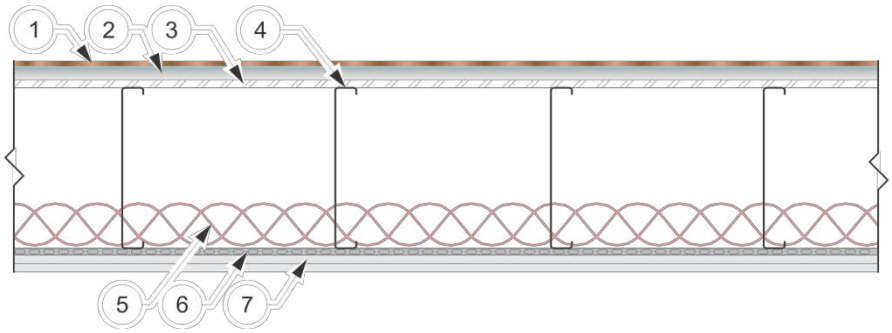
Sum of Positive Differences (dB)
24
Max. Positive Difference (dB)
8 dB at 100 Hz

For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Measurements of normalized impact sound pressure level (NISPL) were conducted in accordance with the requirements of ASTM E492-09, "Standard Laboratory Measurement of Impact Sound Transmission through Floor-Ceiling Assemblies Using the Tapping Machine".**

In the graph:
The solid line is the measured normalized impact sound pressure level (NISPL) for this specimen. The dashed line is the IIC contour fitted to the measured values according to ASTM E989-06. The dotted line is the background sound level measured in the receiving room during this test (may be below the displayed range). For any frequency where the measured NISPL is less than 10 dB above the dotted line, the reported values were adjusted as noted below. Bars at the bottom of the graph show positive differences; where the measured data are greater than the reference contour as defined in ASTM E989-06. Shaded cells in the table and areas in the graph are outside the IIC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level and the reported values of NISPL provide an estimate of the upper limit of normalized impact sound pressure level, according to the procedure outlined in ASTM E492-09. The reported values of NISPL have been corrected according to the procedure outlined in ASTM E492-09.

Floor assembly 13F: LAM10_STY3_GCON38_CORSTE14_SJ317(406)_GFB92_RC13(305)_2G16



Description	10 mm laminate flooring on 3 mm styrofoam bead underlay on 38 mm poured lightweight gypsum concrete on corrugated steel deck, attached to 317 mm deep steel joists spaced 406 mm o.c., with two layers of 15.9 mm gypsum board Type X, attached to resilient channels spaced 305 mm o.c., and 92 mm deep glass fibre insulation (R-12) in the cavity.
Topping	• **(1)** 10 mm glueless laminate installed on 3 mm (1/8") styrofoam bead underlay
Subfloor	• **(2)** 38 mm (1-1/2”) nominal poured lightweight gypsum concrete, measured from the bottom of the flute, on corrugated steel deck (corrugation: 14 mm (9/16”), steel thickness: 0.76 mm (0.030”)) • **(3)** Steel deck attached to joists using 19 mm (3/4”) screws (#10 hex washer head) spaced 203 mm (8”) o.c.
Framing & Cavity Insulation	• Framing headers resting on test frame (steel thickness: 1.37 mm (0.054”)) • **(4)** 317 mm (12-1/4”) deep steel C-joists (steel thickness: 1.37 mm (0.054”)) spaced 406 mm (16”) o.c., attached to headers using bearing stiffeners and 19 mm (3/4”) screws (#10 wafer head) through top of header into joists • 203 mm (8”) blocking strips, installed at the centre of the joists between the two last joists on each end and between the two joists in the floor centre • Flat strap connecting blocking strips, attached to the bottom of each joist • **(5)** Cavities between joists filled with 406 mm (16”) wide by 92 mm (3-5/8”) thick glass fibre insulation (R-12), resting on resilient channels
Ceiling	• **(6)** 13 mm resilient channels, spaced 305 mm (12”) o.c., installed perpendicularly to the joists and attached to each joist using 19 mm (3/4”) screws (#10 wafer head) • **(7)** Two layers of 15.9 mm (5/8”) gypsum board Type X installed with long side perpendicular to resilient channels • Face layer attached using 41 mm (1-5/8”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. along the perimeter and in the field • Base layer attached using 32 mm (1-1/4”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. along the perimeter and in the field • Screws from base layer to face layer offset by 152 mm (6”) • Gaps along the joints and the perimeter of gypsum boards caulked and taped with aluminum tape

Specimen Properties

Element	Actual thickness (mm)	Mass (kg)	Mass/length, area or volume
Laminate Flooring	10	162.7	8.3 kg/m^2
Styrofoam Bead Underlay	3	2.9	0.2 kg/m^2
Gypsum Concrete (24.3 MPa)	40	1260.0	1944.0 kg/m^3
Corrugated Steel Deck	14 *	147.4	6.9 kg/m^2
Steel Joists	317	236.4	4.4 kg/m
Web Stiffeners	317 **	14.4	1.9 kg/m
Glass Fibre Insulation	92 **	16.6	0.9 kg/m^2
Flat Strap	1 **	1.4	0.3 kg/m
Resilient Channels	13	14.4	0.2 kg/m
Gypsum Board	16	197.7	11.1 kg/m^2
Gypsum Board	16	197.7	11.1 kg/m^2
Total	**415**	**2252**	

* Corrugated steel deck thickness already included in gypsum concrete thickness

** Element thickness does not contribute to total thickness (ie. in cavity)

Test Specimen Installation

- The exposed area of the floor specimen used for the calculations of the airborne sound transmission loss was 17.85 m^2 (4.71 m x 3.79 m).
- The total area of the floor assembly resting on top of the lip was 19.32 m^2 (4.88 m x 3.96 m).
- The mass per area of the elements above the lip was calculated using the total area (19.32 m^2).
- The mass per area of the ceiling elements was calculated using the exposed area (17.85 m^2).

ASTM E90 Test Results – Airborne Sound Transmission Loss

Client: CSSBI **Test ID:** TLF-14-065

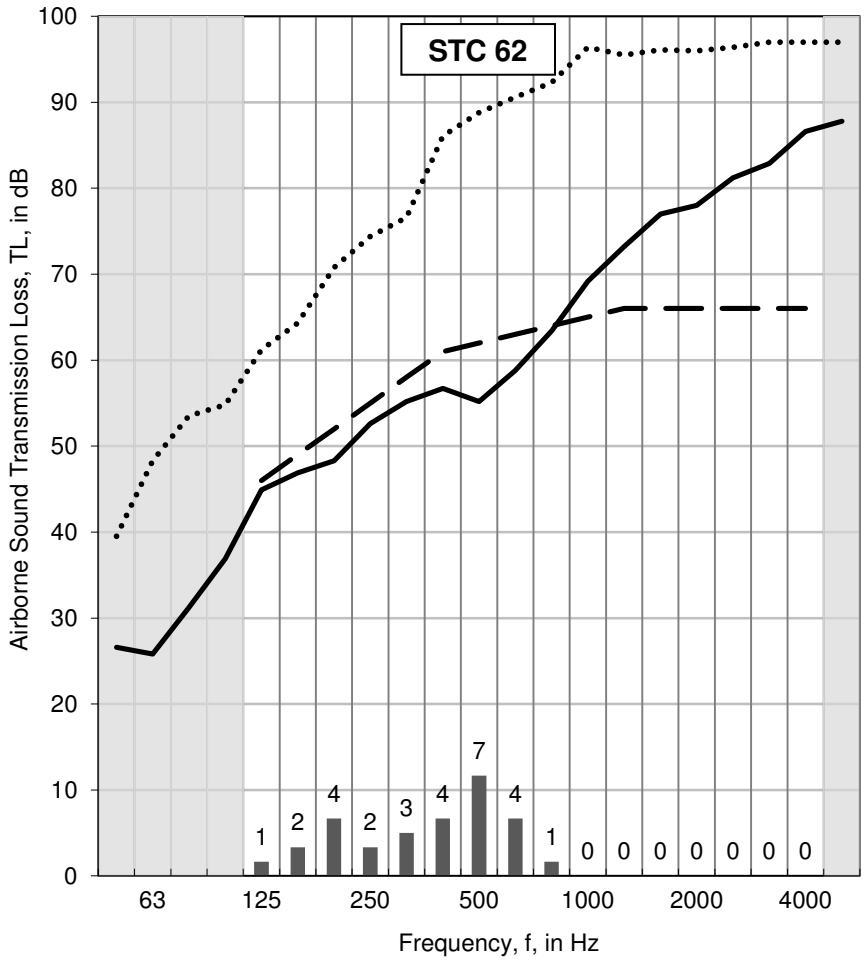
Specimen ID: A1-005007-13F **Date of Test:** 21 November 2014

Room	Volume (m³)	Air Temperature (°C)	Humidity (%)
Upper	172.7	22.3 to 22.3	36.3 to 36.7
Lower	176.5	17.7 to 17.8	44.7 to 45.0

Area of test specimen:	17.85 m^2
Mass of test specimen:	2252 kg

f (Hz)	TL (dB)	
50	27	
63	26	
80	31	
100	37	
125	45	
160	47	
200	48	
250	53	
315	55	
400	57	
500	55	
630	59	
800	63	
1000	69	
1250	73	
1600	77	
2000	78	
2500	81	*
3150	83	
4000	87	c
5000	88	
Sound Transmission Class (STC)	**62**	

Sum of Deficiencies (dB)
28
Max. Deficiency (dB)
7 dB at 500 Hz



For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Airborne sound transmission loss measurements were conducted in accordance with the requirements of ASTM E90-09, "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements."**

In the graph:
The solid line is the measured sound transmission loss for this specimen. The dashed line is the STC contour fitted to the measured values according to ASTM E413-10. The dotted line (may be above the displayed range) is the flanking limit established for this facility. For any frequency band where the measured transmission loss is above the dotted line, the reported value is potentially limited by flanking transmission via laboratory surfaces, and the true value may be higher than that measured. Bars at the bottom of the graph show deficiencies where the measured data are less than the reference contour as described in the fitting procedure for the STC, defined in ASTM E413-10. The shaded cells in the table and areas in the graph are outside the STC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. The reported values have been corrected according to the procedure outlined in ASTM E90-09. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level, in which case, the corrected values provide an estimate of the lower limit of airborne sound transmission loss.

ASTM E492 Test Results – Normalized Impact Sound Pressure Levels

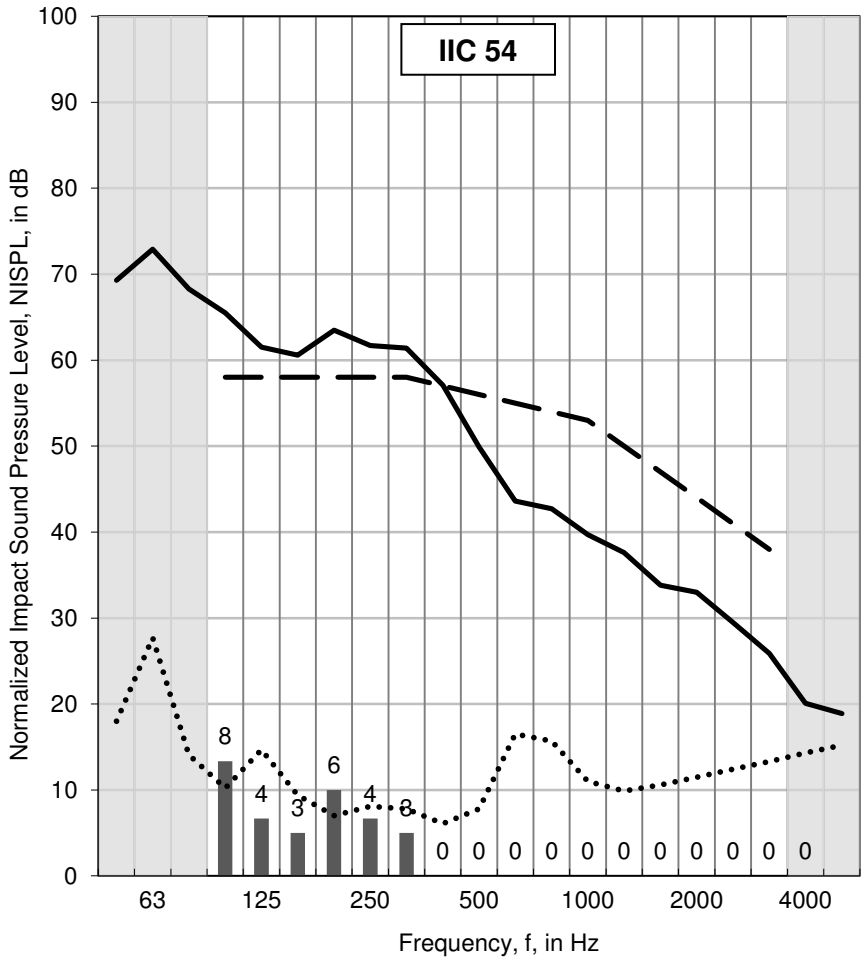
Client: CSSBI **Test ID:** IIF-14-034

Specimen ID: A1-005007-13F **Date of Test:** 21 November 2014

Room	Volume (m³)	Air Temperature (°C)	Humidity (%)
Upper	172.7	22.5 to 22.6	34.9 to 35.4
Lower	176.5	17.7 to 17.8	44.4 to 44.8

Area of test specimen:	17.85 m^2
Mass of test specimen:	2252 kg

f (Hz)	NISPL (dB)	
50	69	
63	73	
80	68	
100	66	
125	62	
160	61	
200	64	
250	62	
315	61	
400	57	
500	50	
630	44	
800	43	
1000	40	
1250	38	
1600	34	
2000	33	
2500	30	
3150	26	c
4000	20	*
5000	19	*
Impact Insulation Class (IIC)	**54**	



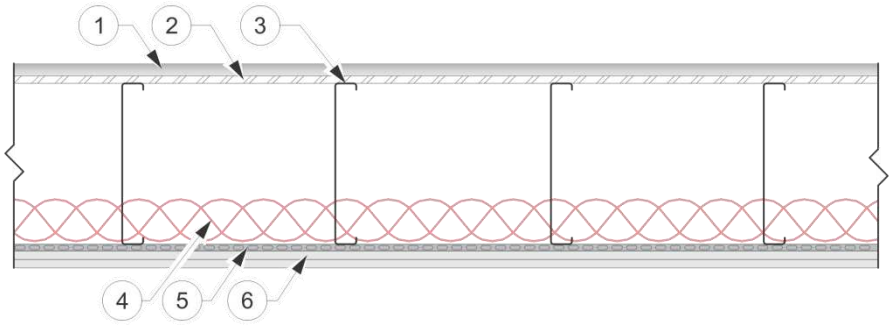
Sum of Positive Differences (dB)
28
Max. Positive Difference (dB)
8 dB at 100 Hz

For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Measurements of normalized impact sound pressure level (NISPL) were conducted in accordance with the requirements of ASTM E492-09, "Standard Laboratory Measurement of Impact Sound Transmission through Floor-Ceiling Assemblies Using the Tapping Machine".**

In the graph:
The solid line is the measured normalized impact sound pressure level (NISPL) for this specimen. The dashed line is the IIC contour fitted to the measured values according to ASTM E989-06. The dotted line is the background sound level measured in the receiving room during this test (may be below the displayed range). For any frequency where the measured NISPL is less than 10 dB above the dotted line, the reported values were adjusted as noted below. Bars at the bottom of the graph show positive differences; where the measured data are greater than the reference contour as defined in ASTM E989-06. Shaded cells in the table and areas in the graph are outside the IIC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level and the reported values of NISPL provide an estimate of the upper limit of normalized impact sound pressure level, according to the procedure outlined in ASTM E492-09. The reported values of NISPL have been corrected according to the procedure outlined in ASTM E492-09.

Floor assembly 14F: GCON38_CORSTE14_SJ317(406)_GFB92_RC13(305)_2G16



Description	38 mm poured lightweight gypsum concrete on corrugated steel deck, attached to 317 mm deep steel joists spaced 406 mm o.c., with two layers of 15.9 mm gypsum board Type X, attached to resilient channels spaced 305 mm o.c., and 92 mm deep glass fibre insulation (R-12) in the cavity.
Topping	• None
Subfloor	• **(1)** 38 mm (1-1/2”) nominal poured lightweight gypsum concrete, measured from the bottom of the flute, on corrugated steel deck (corrugation: 14 mm (9/16”), steel thickness: 0.76 mm (0.030”)) • **(2)** Steel deck attached to joists using 19 mm (3/4”) screws (#10 hex washer head) spaced 203 mm (8”) o.c.
Framing & Cavity Insulation	• Framing headers resting on test frame (steel thickness: 1.37 mm (0.054”)) • **(3)** 317 mm (12-1/4”) deep steel C-joists (steel thickness: 1.37 mm (0.054”)) spaced 406 mm (16”) o.c., attached to headers using bearing stiffeners and 19 mm (3/4”) screws (#10 wafer head) through top of header into joists • 203 mm (8”) blocking strips, installed at the centre of the joists between the two last joists on each end and between the two joists in the floor centre • Flat strap connecting blocking strips, attached to the bottom of each joist • **(4)** Cavities between joists filled with 406 mm (16”) wide by 92 mm (3-5/8”) thick glass fibre insulation (R-12), resting on resilient channels
Ceiling	• **(5)** 13 mm resilient channels, spaced 305 mm (12”) o.c., installed perpendicularly to the joists and attached to each joist using 19 mm (3/4”) screws (#10 wafer head) • **(6)** Two layers of 15.9 mm (5/8”) gypsum board Type X installed with long side perpendicular to resilient channels • Face layer attached using 41 mm (1-5/8”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. along the perimeter and in the field • Base layer attached using 32 mm (1-1/4”) screws (#6 scavenger head) spaced 305 mm (12”) o.c. along the perimeter and in the field • Screws from base layer to face layer offset by 152 mm (6”) • Gaps along the joints and the perimeter of gypsum boards caulked and taped with aluminum tape

Specimen Properties

Element	Actual thickness (mm)	Mass (kg)	Mass/length, area or volume
Gypsum Concrete (24.3 MPa)	40	1260.0	1944.0 kg/m^3
Corrugated Steel Deck	14 *	147.4	6.9 kg/m^2
Steel Joists	317	236.4	4.4 kg/m
Web Stiffeners	317 **	14.4	1.9 kg/m
Glass Fibre Insulation	92 **	16.6	0.9 kg/m^2
Flat Strap	1 **	1.4	0.3 kg/m
Resilient Channels	13	14.4	0.2 kg/m
Gypsum Board	16	197.7	11.1 kg/m^2
Gypsum Board	16	197.7	11.1 kg/m^2
Total	**402**	**2086**	

* Corrugated steel deck thickness already included in gypsum concrete thickness

** Element thickness does not contribute to total thickness (ie. in cavity)

Test Specimen Installation

- The exposed area of the floor specimen used for the calculations of the airborne sound transmission loss was 17.85 m^2 (4.71 m x 3.79 m).
- The total area of the floor assembly resting on top of the lip was 19.32 m^2 (4.88 m x 3.96 m).
- The mass per area of the elements above the lip was calculated using the total area (19.32 m^2).
- The mass per area of the ceiling elements was calculated using the exposed area (17.85 m^2).

ASTM E90 Test Results – Airborne Sound Transmission Loss

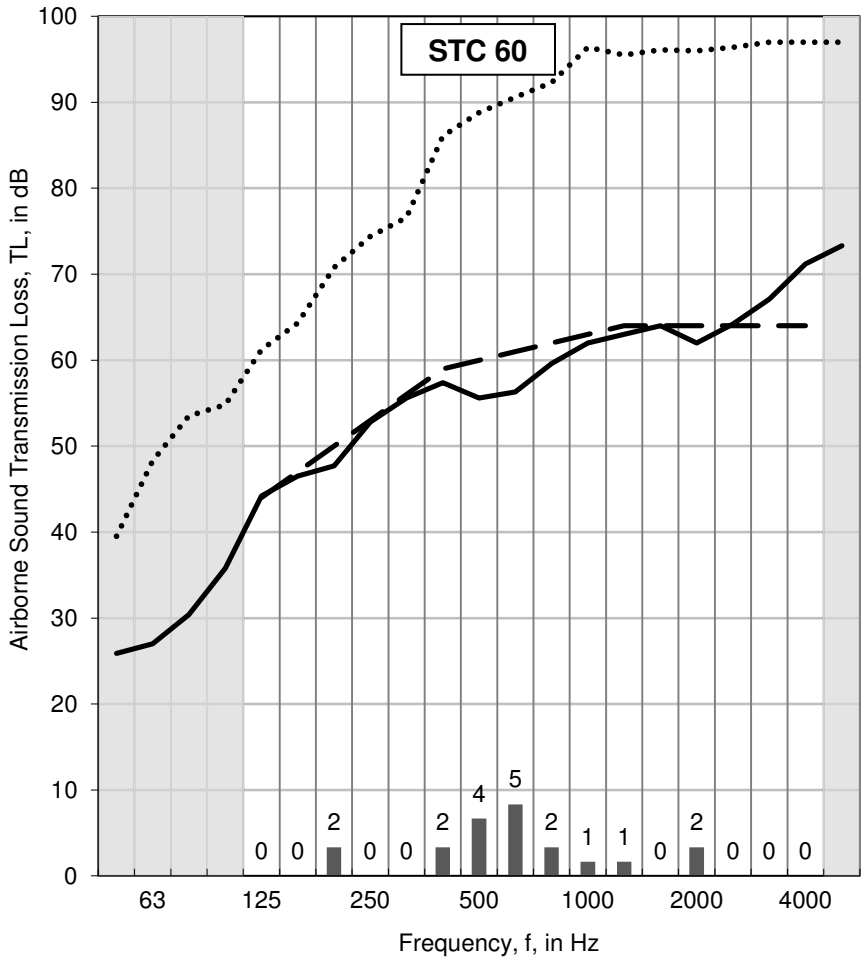
Client: CSSBI **Test ID:** TLF-14-066

Specimen ID: A1-005007-14F **Date of Test:** 26 November 2014

Room	Volume (m³)	Air Temperature (°C)	Humidity (%)
Upper	173.2	20.6 to 20.6	35.4 to 35.8
Lower	176.5	17.5 to 17.7	48.2 to 48.5

Area of test specimen:	17.85 m^2
Mass of test specimen:	2086 kg

f (Hz)	TL (dB)
50	26
63	27
80	30
100	36
125	44
160	47
200	48
250	53
315	56
400	57
500	56
630	56
800	60
1000	62
1250	63
1600	64
2000	62
2500	64
3150	67
4000	71
5000	73
Sound Transmission Class (STC)	**60**



Sum of Deficiencies (dB)
19
Max. Deficiency (dB)
5 dB at 630 Hz

For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Airborne sound transmission loss measurements were conducted in accordance with the requirements of ASTM E90-09, "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements."**

In the graph:
The solid line is the measured sound transmission loss for this specimen. The dashed line is the STC contour fitted to the measured values according to ASTM E413-10. The dotted line (may be above the displayed range) is the flanking limit established for this facility. For any frequency band where the measured transmission loss is above the dotted line, the reported value is potentially limited by flanking transmission via laboratory surfaces, and the true value may be higher than that measured. Bars at the bottom of the graph show deficiencies where the measured data are less than the reference contour as described in the fitting procedure for the STC, defined in ASTM E413-10. The shaded cells in the table and areas in the graph are outside the STC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. The reported values have been corrected according to the procedure outlined in ASTM E90-09. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level, in which case, the corrected values provide an estimate of the lower limit of airborne sound transmission loss.

ASTM E492 Test Results – Normalized Impact Sound Pressure Levels

Client: CSSBI **Test ID:** IIF-14-035

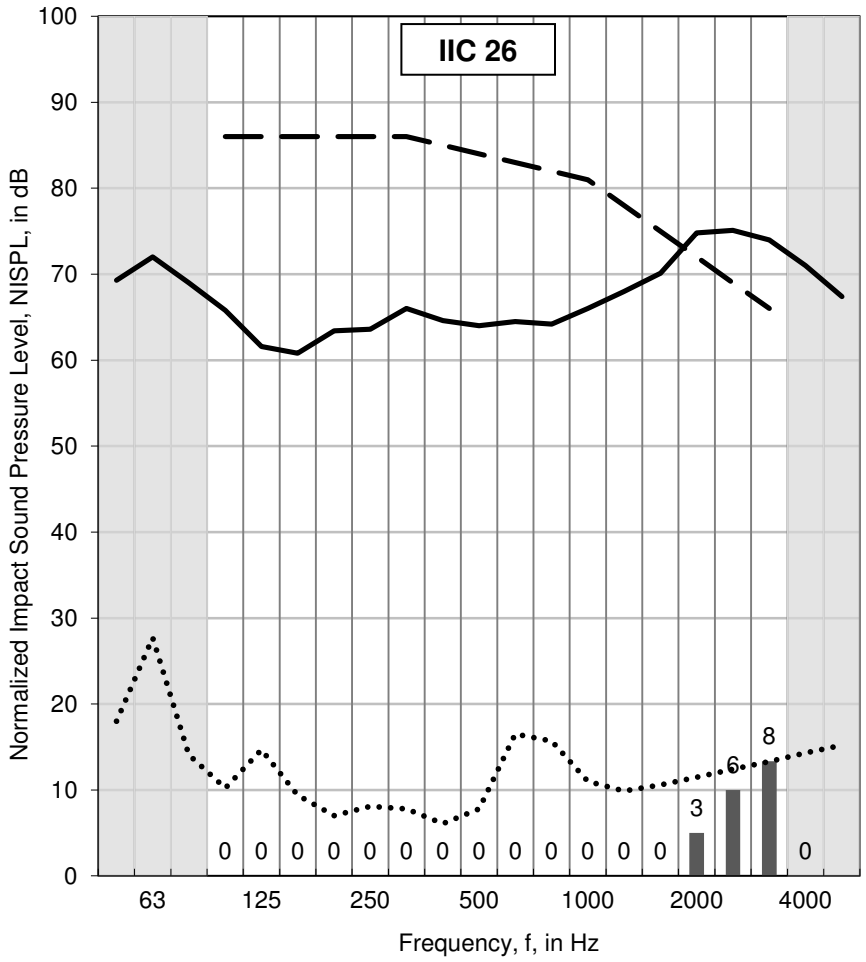
Specimen ID: A1-005007-14F **Date of Test:** 27 November 2014

Room	Volume (m^3)	Air Temperature (°C)	Humidity (%)
Upper	173.2	21.5 to 21.6	37.8 to 38.1
Lower	176.5	17.6 to 17.7	47.9 to 48.2

Area of test specimen:	17.85 m^2
Mass of test specimen:	2086 kg

f (Hz)	NISPL (dB)
50	69
63	72
80	69
100	66
125	62
160	61
200	63
250	64
315	66
400	65
500	64
630	65
800	64
1000	66
1250	68
1600	70
2000	75
2500	75
3150	74
4000	71
5000	67
Impact Insulation Class (IIC)	**26**

Sum of Positive Differences (dB)
17
Max. Positive Difference (dB)
8 dB at 3150 Hz

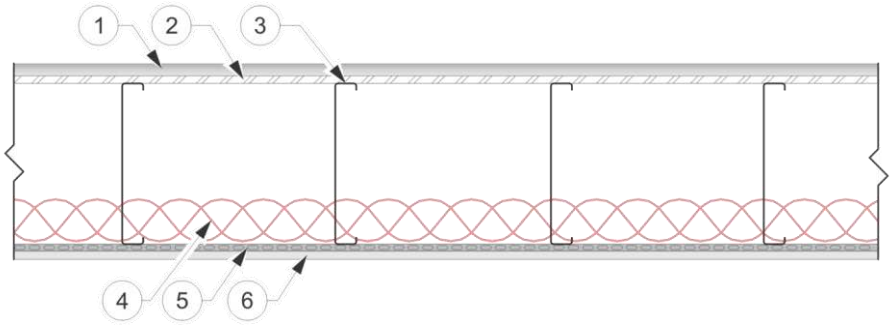


For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Measurements of normalized impact sound pressure level (NISPL) were conducted in accordance with the requirements of ASTM E492-09, "Standard Laboratory Measurement of Impact Sound Transmission through Floor-Ceiling Assemblies Using the Tapping Machine".**

In the graph:
The solid line is the measured normalized impact sound pressure level (NISPL) for this specimen. The dashed line is the IIC contour fitted to the measured values according to ASTM E989-06. The dotted line is the background sound level measured in the receiving room during this test (may be below the displayed range). For any frequency where the measured NISPL is less than 10 dB above the dotted line, the reported values were adjusted as noted below. Bars at the bottom of the graph show positive differences; where the measured data are greater than the reference contour as defined in ASTM E989-06. Shaded cells in the table and areas in the graph are outside the IIC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level and the reported values of NISPL provide an estimate of the upper limit of normalized impact sound pressure level, according to the procedure outlined in ASTM E492-09. The reported values of NISPL have been corrected according to the procedure outlined in ASTM E492-09.

Floor assembly 15F: GCON38_CORSTE14_SJ317(406)_GFB92_RC13(305)_G16



Description	38 mm poured lightweight gypsum concrete on corrugated steel deck, attached to 317 mm deep steel joists spaced 406 mm o.c., with one layer of 15.9 mm gypsum board Type X, attached to resilient channels spaced 305 mm o.c., and 92 mm deep glass fibre insulation (R-12) in the cavity. Ceiling gypsum board screwed at 203 mm o.c.
Topping	• None
Subfloor	• **(1)** 38 mm (1-1/2”) nominal poured lightweight gypsum concrete, measured from the bottom of the flute, on corrugated steel deck (corrugation: 14 mm (9/16”), steel thickness: 0.76 mm (0.030”)) • **(2)** Steel deck attached to joists using 19 mm (3/4”) screws (#10 hex washer head) spaced 203 mm (8”) o.c.
Framing & Cavity Insulation	• Framing headers resting on test frame (steel thickness: 1.37 mm (0.054”)) • **(3)** 317 mm (12-1/4”) deep steel C-joists (steel thickness: 1.37 mm (0.054”)) spaced 406 mm (16”) o.c., attached to headers using bearing stiffeners and 19 mm (3/4”) screws (#10 wafer head) through top of header into joists • 203 mm (8”) blocking strips, installed at the centre of the joists between the two last joists on each end and between the two joists in the floor centre • Flat strap connecting blocking strips, attached to the bottom of each joist • **(4)** Cavities between joists filled with 406 mm (16”) wide by 92 mm (3-5/8”) thick glass fibre insulation (R-12), resting on resilient channels
Ceiling	• **(5)** 13 mm resilient channels, spaced 305 mm (12”) o.c., installed perpendicularly to the joists and attached to each joist using 19 mm (3/4”) screws (#10 wafer head) • **(6)** One layer of 15.9 mm (5/8”) gypsum board Type X installed with long side perpendicular to resilient channels • Gypsum layer attached using 41 mm (1-5/8”) screws (#6 scavenger head) spaced 203 mm (8”) o.c. along the perimeter and in the field • Gaps along the joints and the perimeter of gypsum boards caulked and taped with aluminum tape

Specimen Properties

Element	Actual thickness (mm)	Mass (kg)	Mass/length, area or volume
Gypsum Concrete (24.3 MPa)	40	1260.0	1944.0 kg/m^3
Corrugated Steel Deck	14 *	147.4	6.9 kg/m^2
Steel Joists	317	236.4	4.4 kg/m
Web Stiffeners	317 **	14.4	1.9 kg/m
Glass Fibre Insulation	92 **	16.6	0.9 kg/m^2
Flat Strap	1 **	1.4	0.3 kg/m
Resilient Channels	13	14.4	0.2 kg/m
Gypsum Board	16	197.7	11.1 kg/m^2
Total	**386**	**1988**	

* Corrugated steel deck thickness already included in gypsum concrete thickness

** Element thickness does not contribute to total thickness (ie. in cavity)

Test Specimen Installation

- The exposed area of the floor specimen used for the calculations of the airborne sound transmission loss was 17.85 m^2 (4.71 m x 3.79 m).
- The total area of the floor assembly resting on top of the lip was 19.32 m^2 (4.88 m x 3.96 m).
- The mass per area of the elements above the lip was calculated using the total area (19.32 m^2).
- The mass per area of the ceiling elements was calculated using the exposed area (17.85 m^2).

ASTM E90 Test Results – Airborne Sound Transmission Loss

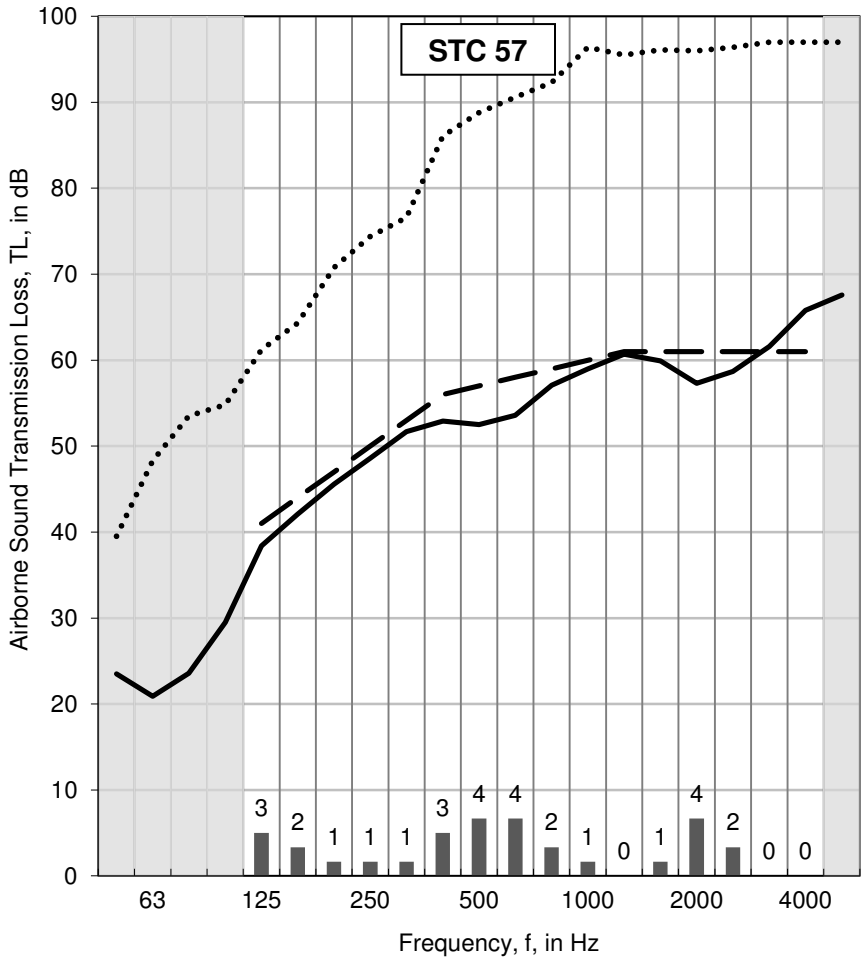
Client: CSSBI **Test ID:** TLF-14-067

Specimen ID: A1-005007-15F **Date of Test:** 28 November 2014

Room	Volume (m³)	Air Temperature (°C)	Humidity (%)
Upper	173.2	21.3 to 21.6	37.8 to 38.4
Lower	176.8	17.8 to 17.9	34.0 to 34.7

Area of test specimen:	17.85 m^2
Mass of test specimen:	1988 kg

f (Hz)	TL (dB)
50	24
63	21
80	24
100	30
125	38
160	42
200	46
250	49
315	52
400	53
500	53
630	54
800	57
1000	59
1250	61
1600	60
2000	57
2500	59
3150	62
4000	66
5000	68
Sound Transmission Class (STC)	**57**



Sum of Deficiencies (dB)
29
Max. Deficiency (dB)
4 dB at 500, 630, and 2000 Hz

For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Airborne sound transmission loss measurements were conducted in accordance with the requirements of ASTM E90-09, "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements."**

In the graph:
The solid line is the measured sound transmission loss for this specimen. The dashed line is the STC contour fitted to the measured values according to ASTM E413-10. The dotted line (may be above the displayed range) is the flanking limit established for this facility. For any frequency band where the measured transmission loss is above the dotted line, the reported value is potentially limited by flanking transmission via laboratory surfaces, and the true value may be higher than that measured. Bars at the bottom of the graph show deficiencies where the measured data are less than the reference contour as described in the fitting procedure for the STC, defined in ASTM E413-10. The shaded cells in the table and areas in the graph are outside the STC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. The reported values have been corrected according to the procedure outlined in ASTM E90-09. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level, in which case, the corrected values provide an estimate of the lower limit of airborne sound transmission loss.

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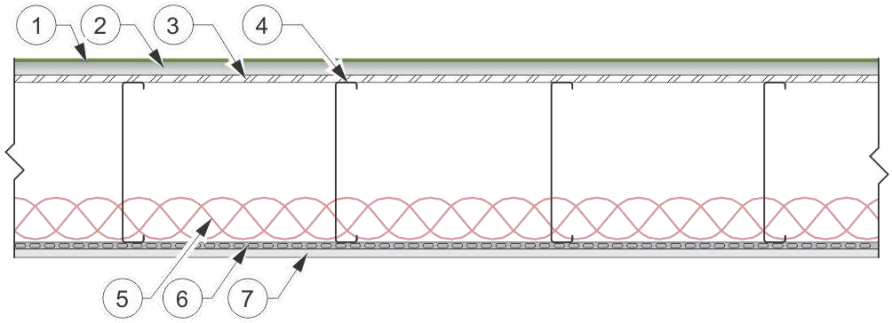
Floor assembly 16F: VIN2_GCON38_CORSTE14_SJ317(406)_GFB92_RC13(305)_G16



Description	2 mm vinyl sheet flooring on 38 mm poured lightweight gypsum concrete on corrugated steel deck, attached to 254 mm deep steel joists spaced 406 mm o.c., with one layers of 15.9 mm gypsum board Type X, attached to resilient channels spaced 305 mm o.c., and 92 mm deep glass fibre insulation (R-12) in the cavity.
Topping	• **(1)** 2 mm fibre floor sheet vinyl installed without glue on top of the gypsum concrete
Subfloor	• **(2)** 38 mm (1-1/2”) nominal poured lightweight gypsum concrete, measured from the bottom of the flute, on corrugated steel deck (corrugation: 14 mm (9/16”), steel thickness: 0.76 mm (0.030”)) • **(3)** Steel deck attached to joists using 19 mm (3/4”) screws (#10 hex washer head) spaced 203 mm (8”) o.c.
Framing & Cavity Insulation	• Framing headers resting on test frame (steel thickness: 1.37 mm (0.054”)) • **(4)** 317 mm (12-1/4”) deep steel C-joists (steel thickness: 1.37 mm (0.054”)) spaced 406 mm (16”) o.c., attached to headers using bearing stiffeners and 19 mm (3/4”) screws (#10 wafer head) through top of header into joists • 203 mm (8”) blocking strips, installed at the centre of the joists between the two last joists on each end and between the two joists in the floor centre • Flat strap connecting blocking strips, attached to the bottom of each joist • **(5)** Cavities between joists filled with 406 mm (16”) wide by 92 mm (3-5/8”) thick glass fibre insulation (R-12), resting on resilient channels
Ceiling	• **(6)** 13 mm resilient channels, spaced 305 mm (12”) o.c., installed perpendicularly to the joists and attached to each joist using 19 mm (3/4”) screws (#10 wafer head) • **(7)** One layer of 15.9 mm (5/8”) gypsum board Type X installed with long side perpendicular to resilient channels • Gypsum layer attached using 41 mm (1-5/8”) screws (#6 scavenger head) spaced 203 mm (8”) o.c. along the perimeter and in the field • Gaps along the joints and the perimeter of gypsum boards caulked and taped with aluminum tape

Specimen Properties

Element	Actual thickness (mm)	Mass (kg)	Mass/length, area or volume
Vinyl Sheet Flooring	2	27.4	1.4 kg/m^2
Gypsum Concrete (24.3 MPa)	40	1260.0	1944.0 kg/m^3
Corrugated Steel Deck	14 *	147.4	6.9 kg/m^2
Steel Joists	317	236.4	4.4 kg/m
Web Stiffeners	317 **	14.4	1.9 kg/m
Glass Fibre Insulation	92 **	16.6	0.9 kg/m^2
Flat Strap	1 **	1.4	0.3 kg/m
Resilient Channels	13	14.4	0.2 kg/m
Gypsum Board	16	197.7	11.1 kg/m^2
Total	**388**	**1915**	

* Corrugated steel deck thickness already included in gypsum concrete thickness

** Element thickness does not contribute to total thickness (ie. in cavity)

Test Specimen Installation

- The exposed area of the floor specimen used for the calculations of the airborne sound transmission loss was 17.85 m^2 (4.71 m x 3.79 m).
- The total area of the floor assembly resting on top of the lip was 19.32 m^2 (4.88 m x 3.96 m).
- The mass per area of the elements above the lip was calculated using the total area (19.32 m^2).
- The mass per area of the ceiling elements was calculated using the exposed area (17.85 m^2).

ASTM E90 Test Results – Airborne Sound Transmission Loss

Client: CSSBI **Test ID:** TLF-14-068

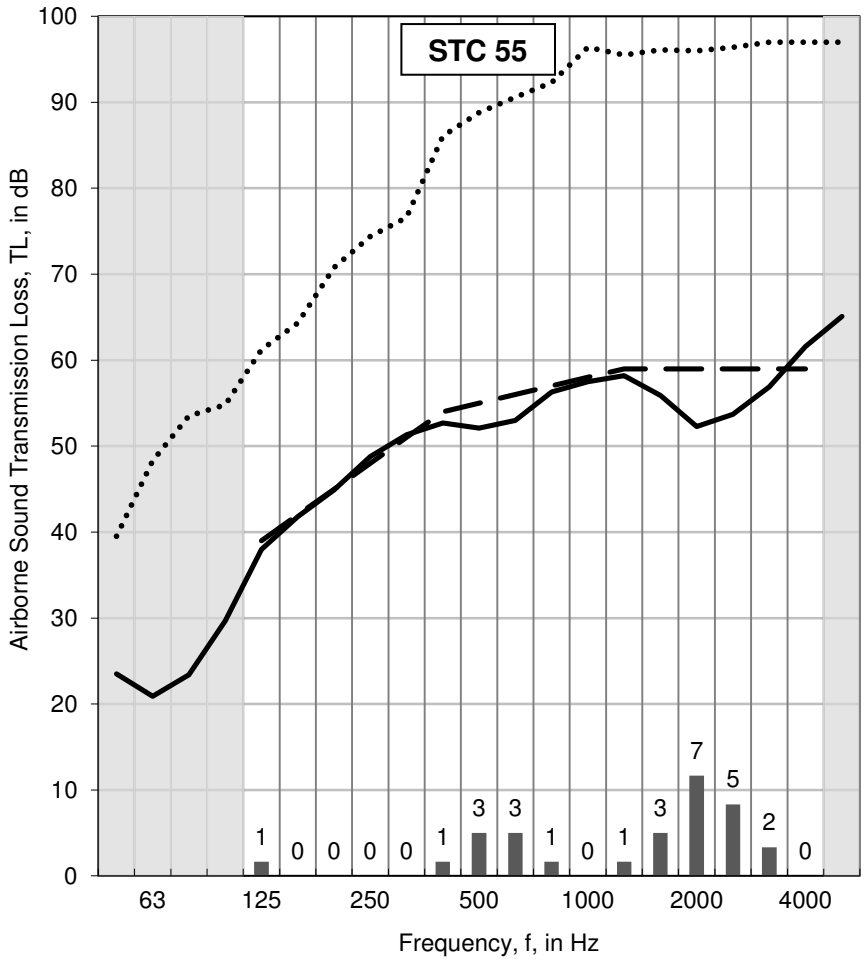
Specimen ID: A1-005007-16F **Date of Test:** 02 December 2014

Room	Volume (m³)	Air Temperature (°C)	Humidity (%)
Upper	173.2	21.2 to 21.4	32.7 to 32.9
Lower	176.5	17.7 to 17.8	42.3 to 42.5

Area of test specimen:	17.85 m^2
Mass of test specimen:	1915 kg

f (Hz)	TL (dB)
50	24
63	21
80	23
100	30
125	38
160	42
200	45
250	49
315	51
400	53
500	52
630	53
800	56
1000	58
1250	58
1600	56
2000	52
2500	54
3150	57
4000	62
5000	65
Sound Transmission Class (STC)	**55**

Sum of Deficiencies (dB)
27
Max. Deficiency (dB)
7 dB at 2000 Hz



For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Airborne sound transmission loss measurements were conducted in accordance with the requirements of ASTM E90-09, "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements."**

In the graph:
The solid line is the measured sound transmission loss for this specimen. The dashed line is the STC contour fitted to the measured values according to ASTM E413-10. The dotted line (may be above the displayed range) is the flanking limit established for this facility. For any frequency band where the measured transmission loss is above the dotted line, the reported value is potentially limited by flanking transmission via laboratory surfaces, and the true value may be higher than that measured. Bars at the bottom of the graph show deficiencies where the measured data are less than the reference contour as described in the fitting procedure for the STC, defined in ASTM E413-10. The shaded cells in the table and areas in the graph are outside the STC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. The reported values have been corrected according to the procedure outlined in ASTM E90-09. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level, in which case, the corrected values provide an estimate of the lower limit of airborne sound transmission loss.

ASTM E492 Test Results – Normalized Impact Sound Pressure Levels

Client: CSSBI **Test ID:** IIF-14-036

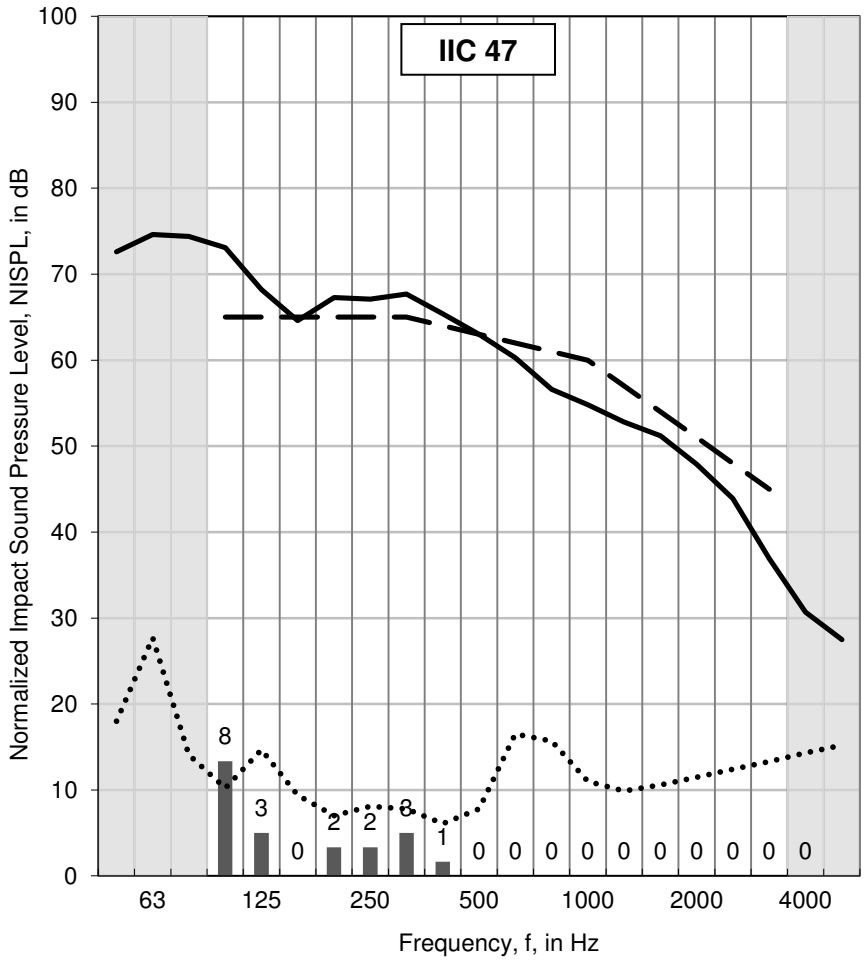
Specimen ID: A1-005007-16F **Date of Test:** 02 December 2014

Room	Volume (m³)	Air Temperature (°C)	Humidity (%)
Upper	173.2	21.5 to 21.8	33.4 to 35.0
Lower	176.5	17.8 to 17.8	42.3 to 42.4

Area of test specimen:	17.85 m^2
Mass of test specimen:	1915 kg

f (Hz)	NISPL (dB)	
50	73	
63	75	
80	74	
100	73	
125	68	
160	65	
200	67	
250	67	
315	68	
400	65	
500	63	
630	60	
800	57	
1000	55	
1250	53	
1600	51	
2000	48	
2500	44	
3150	37	
4000	31	
5000	28	c
Impact Insulation Class (IIC)	**47**	

Sum of Positive Differences (dB)
19
Max. Positive Difference (dB)
8 dB at 100 Hz

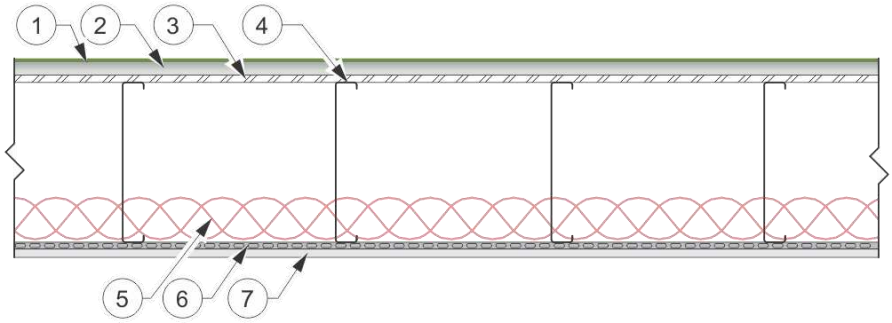


For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Measurements of normalized impact sound pressure level (NISPL) were conducted in accordance with the requirements of ASTM E492-09, "Standard Laboratory Measurement of Impact Sound Transmission through Floor-Ceiling Assemblies Using the Tapping Machine".**

In the graph:
The solid line is the measured normalized impact sound pressure level (NISPL) for this specimen. The dashed line is the IIC contour fitted to the measured values according to ASTM E989-06. The dotted line is the background sound level measured in the receiving room during this test (may be below the displayed range). For any frequency where the measured NISPL is less than 10 dB above the dotted line, the reported values were adjusted as noted below. Bars at the bottom of the graph show positive differences; where the measured data are greater than the reference contour as defined in ASTM E989-06. Shaded cells in the table and areas in the graph are outside the IIC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level and the reported values of NISPL provide an estimate of the upper limit of normalized impact sound pressure level, according to the procedure outlined in ASTM E492-09. The reported values of NISPL have been corrected according to the procedure outlined in ASTM E492-09.

Floor assembly 17F: VIN2_GCON38_CORSTE14_SJ317(406)_GFB92_RC13(305)_G16



Description	2 mm vinyl sheet flooring glued on 38 mm poured lightweight gypsum concrete on corrugated steel deck, attached to 254 mm deep steel joists spaced 406 mm o.c., with one layers of 15.9 mm gypsum board Type X, attached to resilient channels spaced 305 mm o.c., and 92 mm deep glass fibre insulation (R-12) in the cavity.
Topping	• **(1)** 2 mm fibre floor sheet vinyl glued on top of the gypsum concrete. Vinyl adhesive troweled on the gypsum concrete surface.
Subfloor	• **(2)** 38 mm (1-1/2”) nominal poured lightweight gypsum concrete, measured from the bottom of the flute, on corrugated steel deck (corrugation: 14 mm (9/16”), steel thickness: 0.76 mm (0.030”)) • **(3)** Steel deck attached to joists using 19 mm (3/4”) screws (#10 hex washer head) spaced 203 mm (8”) o.c.
Framing & Cavity Insulation	• Framing headers resting on test frame (steel thickness: 1.37 mm (0.054”)) • **(4)** 317 mm (12-1/4”) deep steel C-joists (steel thickness: 1.37 mm (0.054”)) spaced 406 mm (16”) o.c., attached to headers using bearing stiffeners and 19 mm (3/4”) screws (#10 wafer head) through top of header into joists • 203 mm (8”) blocking strips, installed at the centre of the joists between the two last joists on each end and between the two joists in the floor centre • Flat strap connecting blocking strips, attached to the bottom of each joist • **(5)** Cavities between joists filled with 406 mm (16”) wide by 92 mm (3-5/8”) thick glass fibre insulation (R-12), resting on resilient channels
Ceiling	• **(6)** 13 mm resilient channels, spaced 305 mm (12”) o.c., installed perpendicularly to the joists and attached to each joist using 19 mm (3/4”) screws (#10 wafer head) • **(7)** One layer of 15.9 mm (5/8”) gypsum board Type X installed with long side perpendicular to resilient channels • Gypsum layer attached using 41 mm (1-5/8”) screws (#6 scavenger head) spaced 203 mm (8”) o.c. along the perimeter and in the field • Gaps along the joints and the perimeter of gypsum boards caulked and taped with aluminum tape

Specimen Properties

Element	Actual thickness (mm)	Mass (kg)	Mass/length, area or volume
Vinyl Sheet Flooring	2	27.4	1.4 kg/m^2
Polyurethane Adhesive	0	15.0	0.8 kg/m^2
Gypsum Concrete (24.3 MPa)	40	1260.0	1944.0 kg/m^3
Corrugated Steel Deck	14 *	147.4	6.9 kg/m^2
Steel Joists	317	236.4	4.4 kg/m
Web Stiffeners	317 **	14.4	1.9 kg/m
Glass Fibre Insulation	92 **	16.6	0.9 kg/m^2
Flat Strap	1 **	1.4	0.3 kg/m
Resilient Channels	13	14.4	0.2 kg/m
Gypsum Board	16	197.7	11.1 kg/m^2
Total	**388**	**1930**	

* Corrugated steel deck thickness already included in gypsum concrete thickness

** Element thickness does not contribute to total thickness (ie. in cavity)

Test Specimen Installation

- The exposed area of the floor specimen used for the calculations of the airborne sound transmission loss was 17.85 m^2 (4.71 m x 3.79 m).
- The total area of the floor assembly resting on top of the lip was 19.32 m^2 (4.88 m x 3.96 m).
- The mass per area of the elements above the lip was calculated using the total area (19.32 m^2).
- The mass per area of the ceiling elements was calculated using the exposed area (17.85 m^2).

ASTM E90 Test Results – Airborne Sound Transmission Loss

Client: CSSBI **Test ID:** TLF-14-070

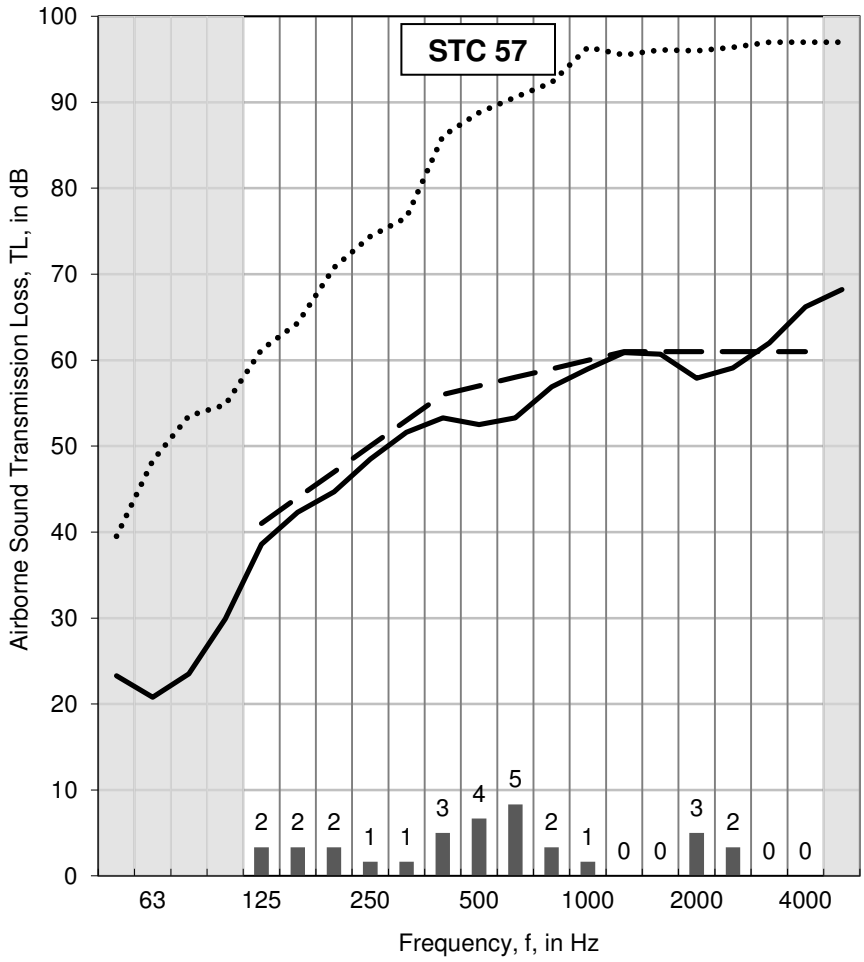
Specimen ID: A1-005007-17F **Date of Test:** 04 December 2014

Room	Volume (m³)	Air Temperature (°C)	Humidity (%)
Upper	173.2	21.2 to 21.3	35.7 to 35.9
Lower	176.5	17.4 to 17.4	43.4 to 43.6

Area of test specimen:	17.85 m^2
Mass of test specimen:	1930 kg

f (Hz)	TL (dB)
50	23
63	21
80	24
100	30
125	39
160	42
200	45
250	49
315	52
400	53
500	53
630	53
800	57
1000	59
1250	61
1600	61
2000	58
2500	59
3150	62
4000	66
5000	68
Sound Transmission Class (STC)	**57**

Sum of Deficiencies (dB)
28
Max. Deficiency (dB)
5 dB at 630 Hz



For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Airborne sound transmission loss measurements were conducted in accordance with the requirements of ASTM E90-09, "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements."**

In the graph:
The solid line is the measured sound transmission loss for this specimen. The dashed line is the STC contour fitted to the measured values according to ASTM E413-10. The dotted line (may be above the displayed range) is the flanking limit established for this facility. For any frequency band where the measured transmission loss is above the dotted line, the reported value is potentially limited by flanking transmission via laboratory surfaces, and the true value may be higher than that measured. Bars at the bottom of the graph show deficiencies where the measured data are less than the reference contour as described in the fitting procedure for the STC, defined in ASTM E413-10. The shaded cells in the table and areas in the graph are outside the STC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. The reported values have been corrected according to the procedure outlined in ASTM E90-09. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level, in which case, the corrected values provide an estimate of the lower limit of airborne sound transmission loss.

ASTM E492 Test Results – Normalized Impact Sound Pressure Levels

Client: CSSBI **Test ID:** IIF-14-037

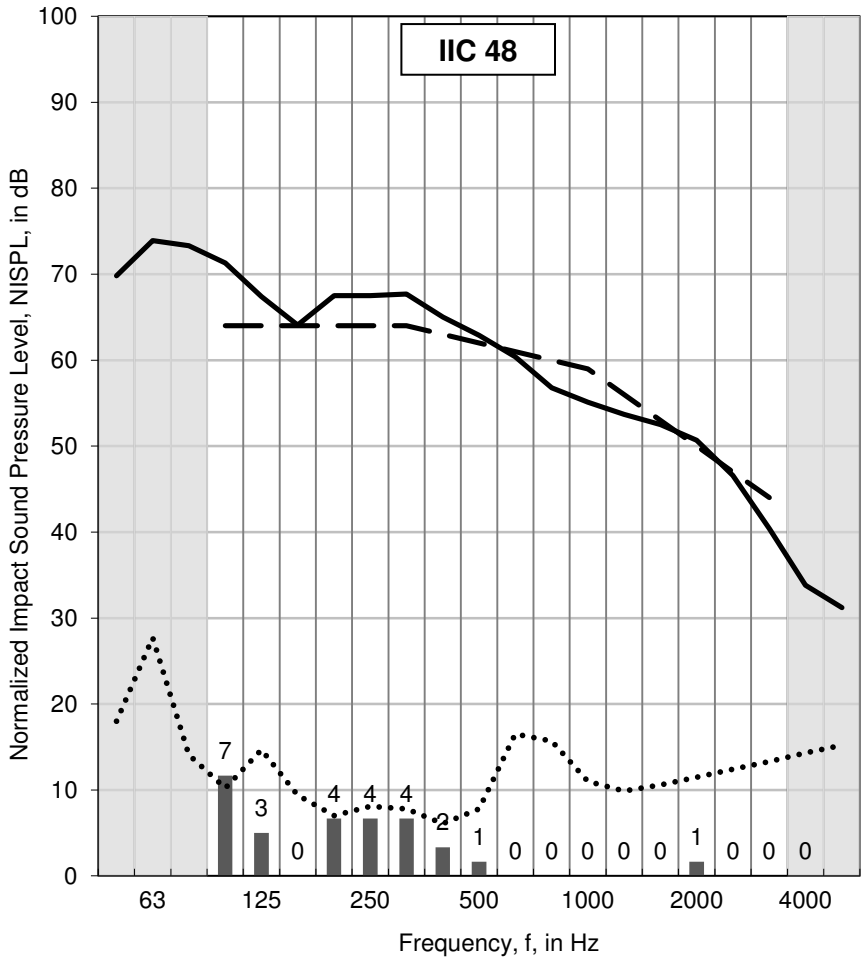
Specimen ID: A1-005007-17F **Date of Test:** 04 December 2014

Room	Volume (m³)	Air Temperature (°C)	Humidity (%)
Upper	173.2	21.2 to 21.4	35.2 to 36.2
Lower	176.5	17.5 to 17.5	43.7 to 43.9

Area of test specimen:	17.85 m^2
Mass of test specimen:	1930 kg

f (Hz)	NISPL (dB)
50	70
63	74
80	73
100	71
125	67
160	64
200	68
250	68
315	68
400	65
500	63
630	60
800	57
1000	55
1250	54
1600	53
2000	51
2500	47
3150	40
4000	34
5000	31
Impact Insulation Class (IIC)	**48**

Sum of Positive Differences (dB)
26
Max. Positive Difference (dB)
7 dB at 100 Hz



For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. **Measurements of normalized impact sound pressure level (NISPL) were conducted in accordance with the requirements of ASTM E492-09, "Standard Laboratory Measurement of Impact Sound Transmission through Floor-Ceiling Assemblies Using the Tapping Machine".**

In the graph:
The solid line is the measured normalized impact sound pressure level (NISPL) for this specimen. The dashed line is the IIC contour fitted to the measured values according to ASTM E989-06. The dotted line is the background sound level measured in the receiving room during this test (may be below the displayed range). For any frequency where the measured NISPL is less than 10 dB above the dotted line, the reported values were adjusted as noted below. Bars at the bottom of the graph show positive differences; where the measured data are greater than the reference contour as defined in ASTM E989-06. Shaded cells in the table and areas in the graph are outside the IIC contour range.

In the table:
Values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level and the reported values of NISPL provide an estimate of the upper limit of normalized impact sound pressure level, according to the procedure outlined in ASTM E492-09. The reported values of NISPL have been corrected according to the procedure outlined in ASTM E492-09.

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2.3 Analysis of Results for CFS-Framed Floors – Airborne Sound Transmission

The following sections present a brief analysis of some parameters affecting the airborne sound insulation of floor assemblies with cold-formed steel-framed joists. A more detailed analysis can be found in [6].

2.3.1 Transmission Loss of Reference Assembly

Floor assembly A1-005007-01F is used as a reference. The assembly consisted of 254 mm (10”) deep cold-formed steel joists spaced 406 mm (16”) on centres, with a corrugated steel deck and 38 mm (1-1/2”) thick lightweight gypsum concrete on top. The ceiling consisted of one layer of 15.9 mm (5/8”) gypsum board type X attached to resilient channels spaced 305 mm (12”) on centres, with 92 mm (3-5/8”) thick glass fibre batts resting on the resilient channels in the joist cavities. The floor also included blocking strips, installed at the centre of the joists between the two last joists on each end and between the two joists in the floor centre, and a steel strap connecting the three blocking strips with each other and with the other joists. The reference assembly achieved a Sound Transmission Class (STC) rating of 57 and an Impact Insulation Class (IIC) rating of 21.

Figure 14 shows the measured transmission loss curve of the reference assembly 01F in the frequency range between 50 Hz and 5000 Hz. Only the frequency range between 125 Hz and 4000 Hz is used for the calculation of the STC rating, according to the procedure of ASTM E413 [4].

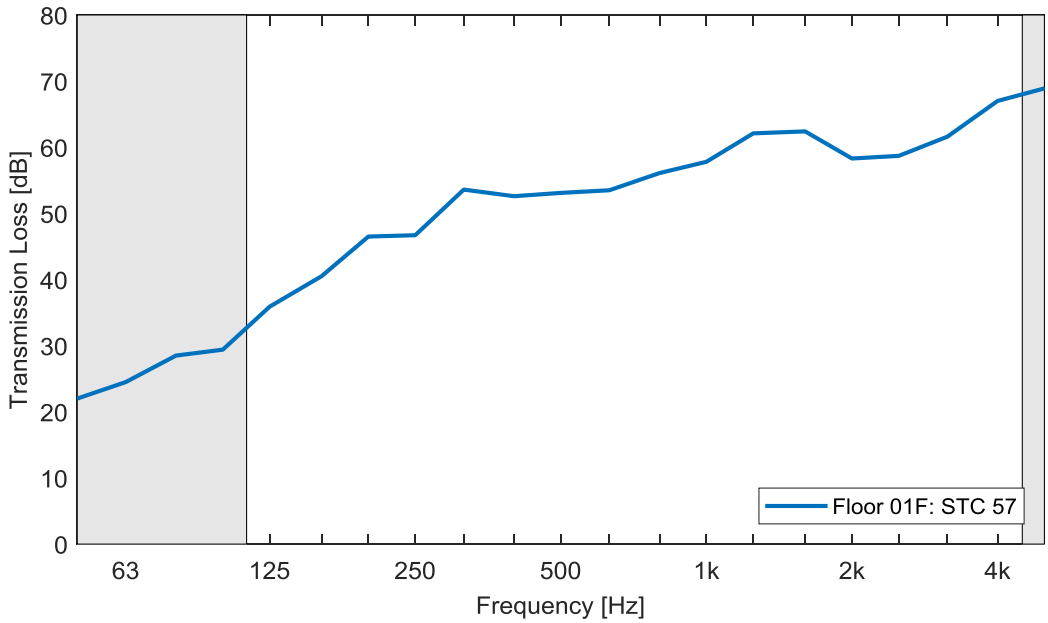

Figure 14: Transmission loss of reference floor assembly

2.3.2 Influence of Joist Depth

Figure 15 shows the transmission loss of four floors: two floors with 254 mm deep joists and one or two layers of gypsum board on the ceiling (Floor 01F and Floor 02F), and the same two floors but with 317 mm deep joists (Floor 11F and Floor 14F).

While the change from one layer to two layers of gypsum board on the ceiling clearly has a significant influence on the transmission loss (compare Floor 01F vs Floor 02F and Floor 11F vs Floor 14F, also see Section 2.3.3), the difference between floors with the same ceiling but different joist depth is smaller. The STC ratings between floors with different joist depths and same ceilings are within 1 point of each other.

The differences in transmission loss are larger – they are shown in Figure 16. For the floors with one layer of gypsum board, the differences between the floor with 254 mm joists and the floor with 317 mm joists are within ±3 dB below 200 Hz, and within ±2 dB above 200 Hz. For the floors with two layers of gypsum board, the differences are within ±5 dB below 200 Hz, and within ±3 dB above 200 Hz. In both cases, the differences decrease with increasing frequency. From the data presented in Figure 15 and Figure 16, it is difficult to precisely describe the influence of the joist depth on the sound insulation performance. The joist depth appears to be more important at lower frequencies, while generally being of minor importance compared with e.g. additional layers of gypsum board. Even though the two floors are nominally the same (except for the different joist depth), some variability due to workmanship and the mounting of the floors in the chamber does play a role. It is believed that at least some of the differences shown in Figure 16 can be attributed to these uncertainties.

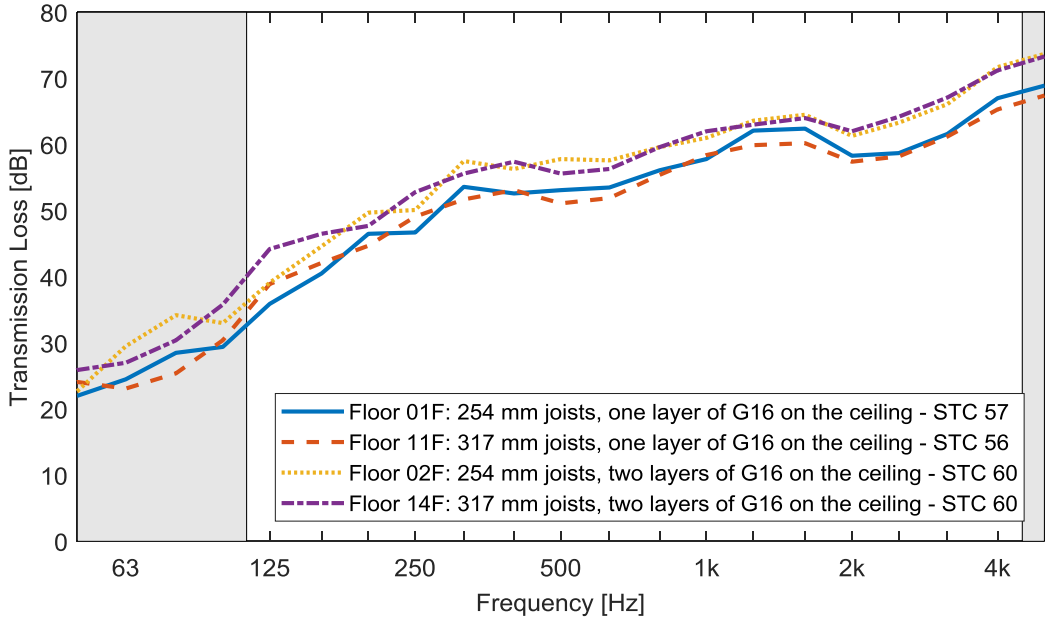

Figure 15: Influence of joist depth

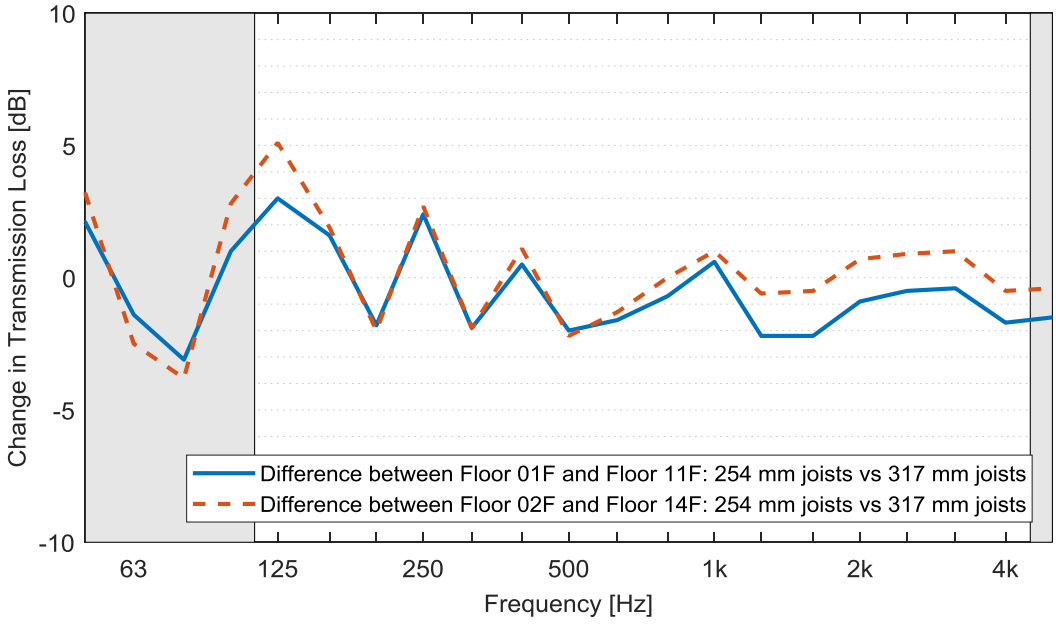

Figure 16: Influence of joist depth – Change in transmission loss

2.3.3 Influence of Gypsum Board Ceiling

Figure 17 shows the transmission loss of one floor with four different ceiling configurations. The reference ceiling consists of one layer of 15.9 mm gypsum board mounted on resilient metal channels. The other transmission loss curves are for a ceiling with two layers of 15.9 mm gypsum mounted in the same way, and for ceilings with one or two layers of 12.7 mm gypsum board mounted on resilient metal channels. Figure 18 shows the differences between ceilings with one layer or two layers of gypsum board.

Adding one layer of gypsum board yields an improvement in the transmission loss of about 4 dB across the frequency range of interest. Consequently, the STC ratings improve by 3-4 points when adding a layer of gypsum board.

The type of gypsum board used (15.9 mm vs. 12.7 mm) is less important. One important factor for the sound insulation performance is the mass of the assembly. The difference in mass per area between the two types of gypsum board is relatively small (11.0 kg/m^2 vs. 10.0 kg/m^2). This is reflected in the fact that at low and mid-frequencies, the transmission loss curves between ceilings with the same number of gypsum board layers are very similar. In this frequency region, both types of gypsum board perform equally well for sound insulation.

In the region of the coincidence frequency, however, the transmission loss curves for the 15.9 mm gypsum boards and the 12.7 mm gypsum boards show distinct differences. This is due to their different bending stiffness *B*, which is cubically proportional to their thickness:

$$B = \frac{E h^3}{12(1-\nu^2)}$$

Here, *E* is Young's modulus, *h* is the board thickness, and *v* is Poisson's ratio. A thinner board leads to a lower bending stiffness, which in turn leads to a higher coincidence frequency:

$$f_c = \frac{c_0^2}{2\pi}\sqrt{\frac{m''}{B}}$$

Here, c_0 is the speed of sound in air, and *m"* is the mass per area of the board.

In terms of STC rating, the differences in the region of the coincidence frequency only lead to a small shift. The STC ratings are within 1 point of each other for one layer of gypsum board, and are the same for two layers of gypsum board.

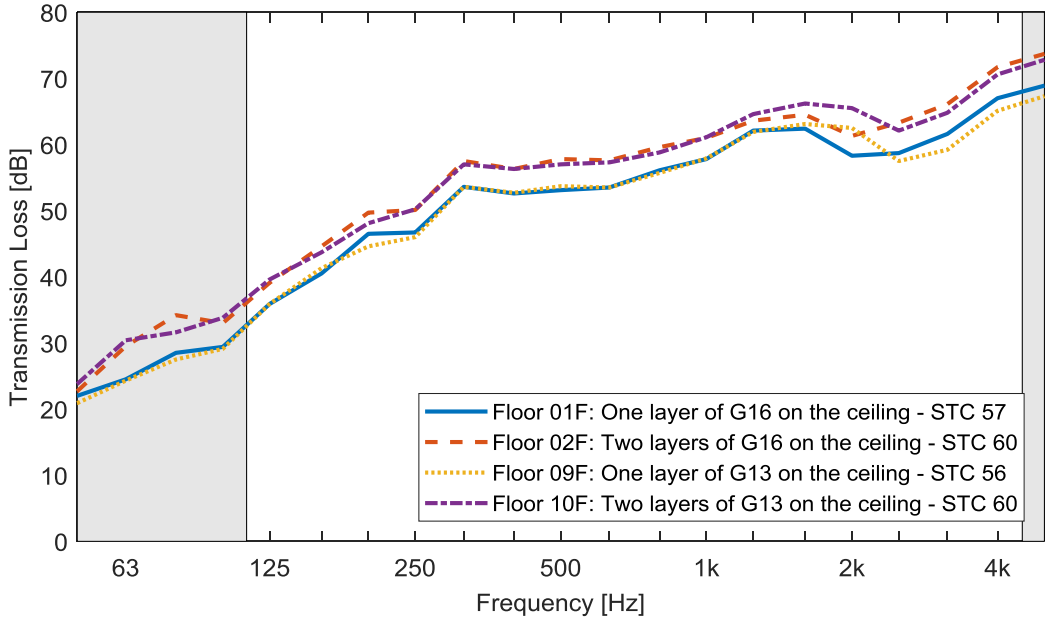

Figure 17: Influence of gypsum board ceiling

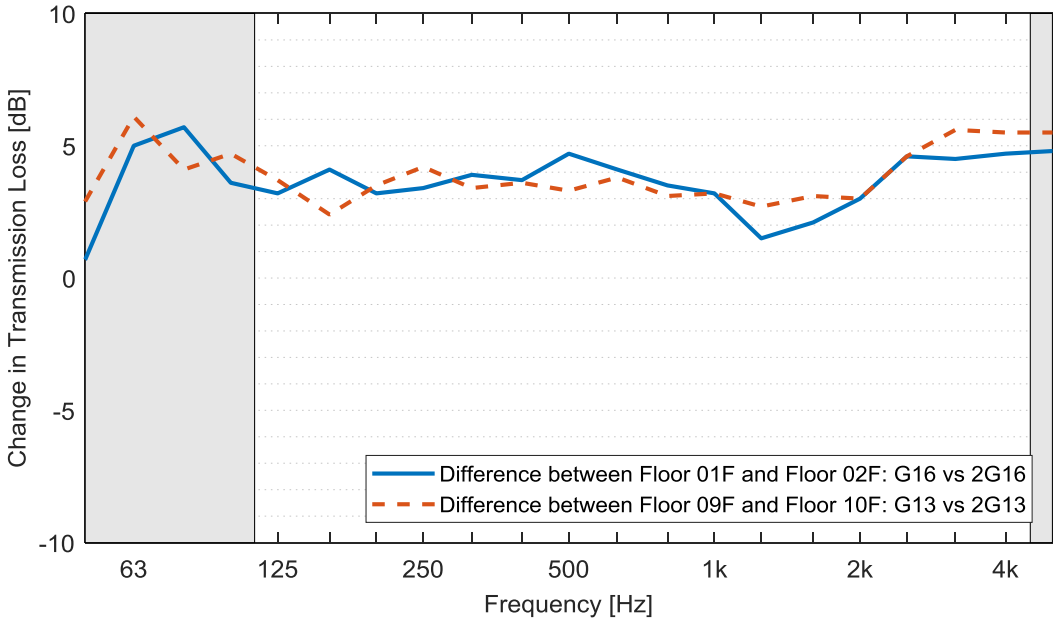

Figure 18: Influence of gypsum board ceiling – Change in transmission loss

2.3.4 Influence of Floor Coverings

Floor coverings are known to significantly improve the impact sound insulation of floors. This is investigated in Section 2.4.4. However, floor coverings can also affect the airborne sound insulation of floors.

Figure 19 shows the transmission loss curves of the reference assembly without any floor covering and with three different types of floor covering: laminate, carpet, and vinyl.

There is very little change between the bare floor and the other three assemblies at low frequencies. The differences are within ±1 dB below 500 Hz. Above the coincidence frequencies of the floor (500 Hz and 630 Hz) however, the differences between the bare configuration and the floors with coverings are significant. With carpet or laminate, the transmission loss increases by up to 18 dB. The STC ratings are not affected significantly by this improvement, though. They increase by 1 point each, except for the vinyl covering.

The results for the vinyl covering in Figure 19 were contrary to the expectations. It seemed that by adding the vinyl to the floor, the sound insulation performance decreased. This was investigated further. It was found that due to the glueless installation of the vinyl, small air gaps between the gypsum concrete and the vinyl were created, which acted as a spring, introducing additional mass-spring resonances. In order to verify this assessment, additional tests were conducted at the very end of the testing series. The vinyl was again placed on the concrete floor as before, but this time was area-glued to the floor surface. The glue was supposed to eliminate the air pockets and provide a good bond between the two elements.

The results of the additional tests are shown in Figure 20. The floor with glued-down vinyl performed as expected, slightly better than the bare floor at high frequencies, but similarly otherwise. The results from Floor 08F (or the repeated test 16F) should therefore be treated with caution. When installing glueless vinyl it should be ensured that there are no air gaps between the vinyl and the subfloor.

The differences in transmission loss shown in Figure 21 again demonstrate the significant improvement at high frequencies for laminate and carpet, the limited effect of vinyl on the airborne sound insulation, and the very limited effect of any floor covering for low-frequency airborne sound insulation.

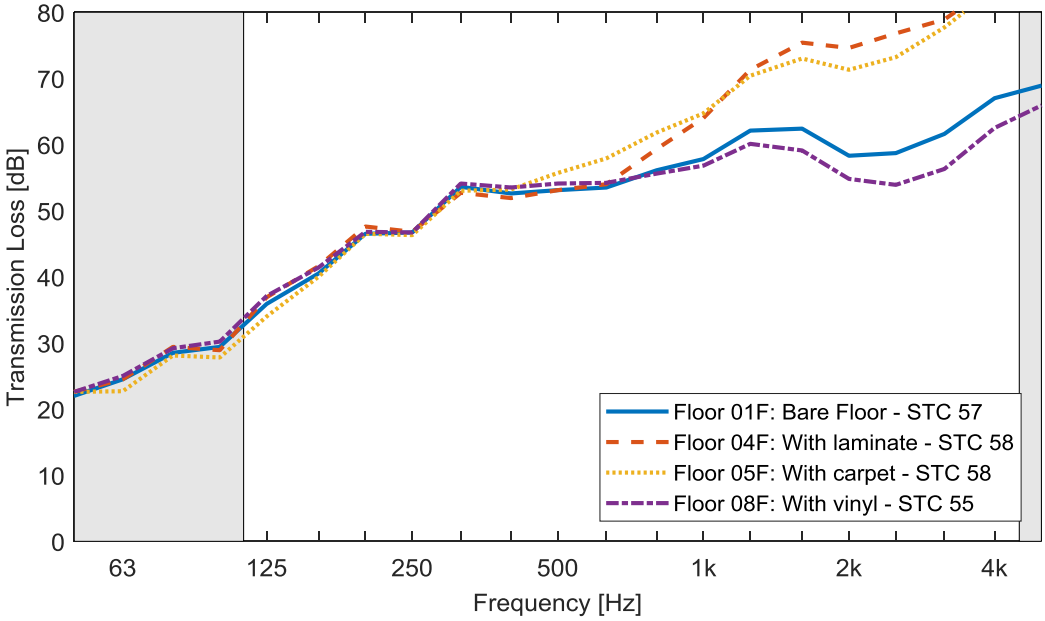

Figure 19: Influence of floor coverings

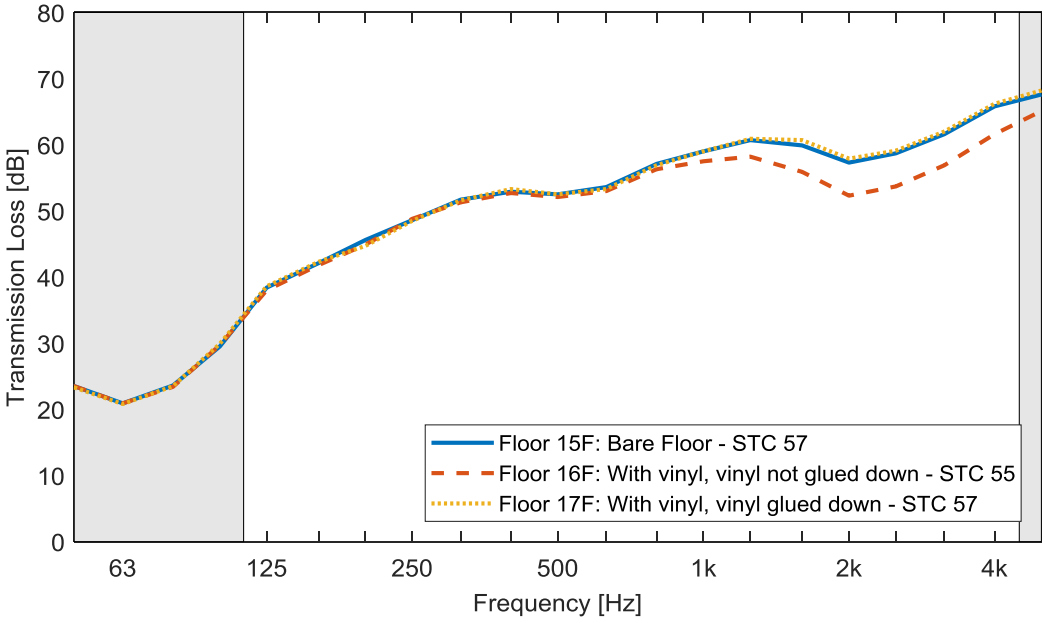

Figure 20: Influence of bonding method for vinyl covering

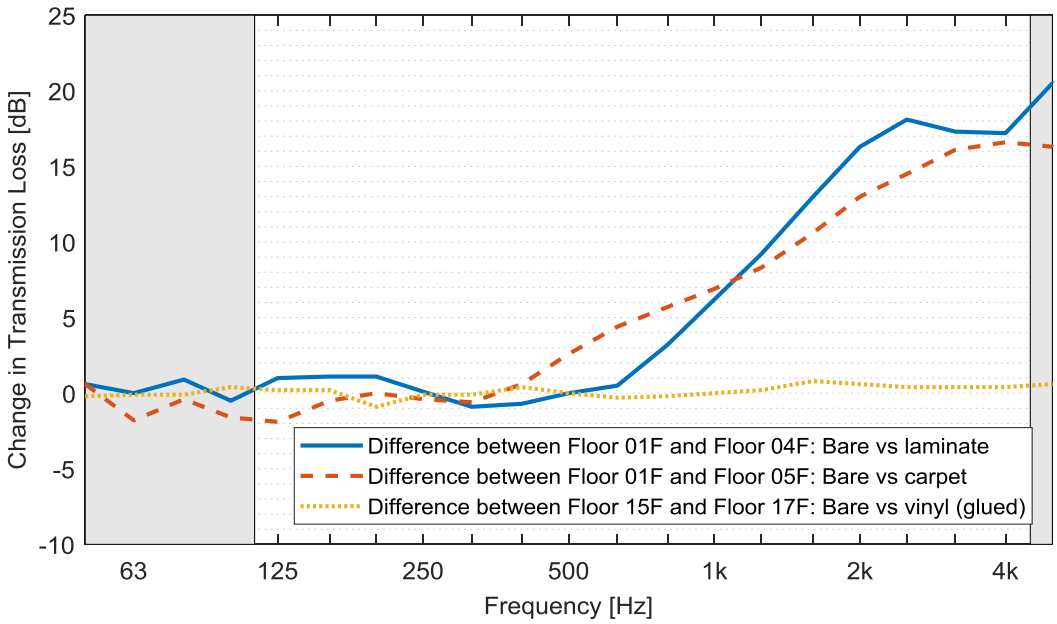

Figure 21: Influence of floor coverings – Change in transmission loss

2.4 Analysis of Results for CFS-Framed Floors – Impact Sound Transmission

The following sections present a brief analysis of some parameters affecting the impact sound insulation of floor assemblies with cold-formed steel-framed joists. Parts of the analysis were also presented in [6].

2.4.1 Normalized Impact Sound Pressure Level of Reference Assembly

Floor assembly A1-005007-01F is used as a reference. The assembly consisted of 254 mm (10”) deep cold-formed steel joists spaced 406 mm (16”) on centres, with a corrugated steel deck and 38 mm (1-1/2”) thick lightweight gypsum concrete on top. The ceiling consisted of one layer of 15.9 mm (5/8”) gypsum board type X attached to resilient channels spaced 305 mm (12”) on centres, with 92 mm (3-5/8”) thick glass fibre batts resting on the resilient channels in the joist cavities. The floor also included blocking strips, installed at the centre of the joists between the two last joists on each end and between the two joists in the floor centre, and a steel strap connecting the three blocking strips with each other and with the other joists. The reference assembly achieved a Sound Transmission Class (STC) rating of 57 and an Impact Insulation Class (IIC) rating of 21.

Figure 22 shows the measured normalized impact sound pressure level for the reference assembly 01F in the frequency range between 50 Hz and 5000 Hz. Only the frequency range between 100 Hz and 3150 Hz is used for the calculation of the IIC rating, according to the procedure of ASTM E989 [7].

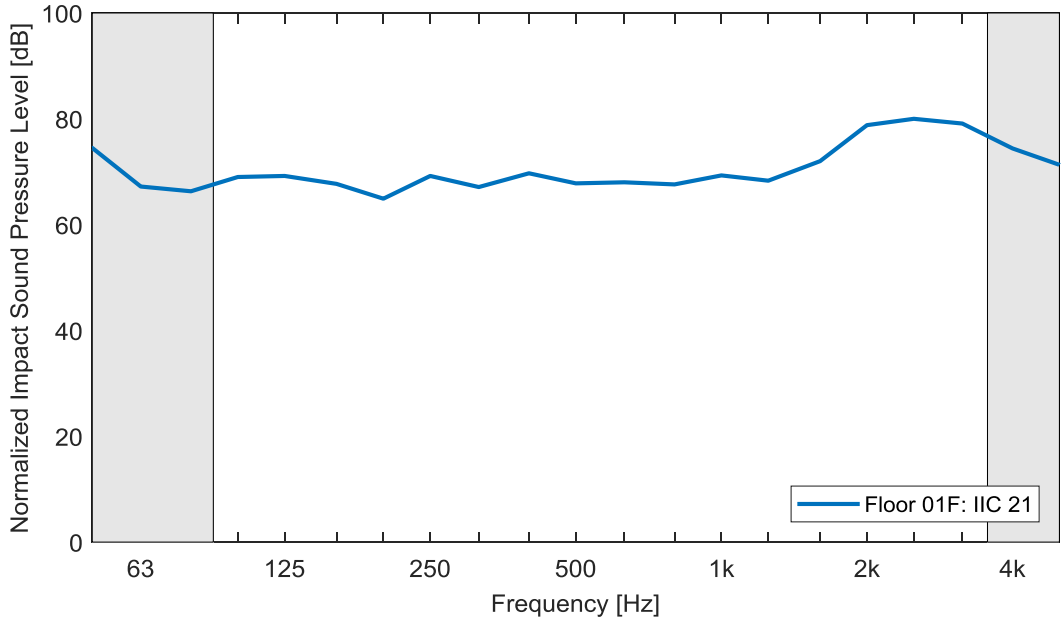

Figure 22: Normalized impact sound pressure level of reference floor assembly

2.4.2 Influence of Joist Depth

Figure 23 shows the normalized impact sound pressure levels for four floors: two floors with 254 mm deep joists and one or two layers of gypsum board on the ceiling (Floor 01F and Floor 02F), and the same two floors but with 317 mm deep joists (Floor 11F and Floor 14F).

As was observed for the airborne sound insulation in Section 2.3.2, the influence of the different joist depths on the impact sound insulation is relatively small. The IIC ratings for the floors with same ceiling but different joist depth are within 1 point, and the main discrepancies occur at the low frequencies.

Considering the difference in normalized impact sound pressure levels in Figure 24, similarities to the same plot for airborne sound insulation (Figure 16) can be observed. Again, the joist depth seems to have the most influence at low frequencies, and less influence with increasing frequency.

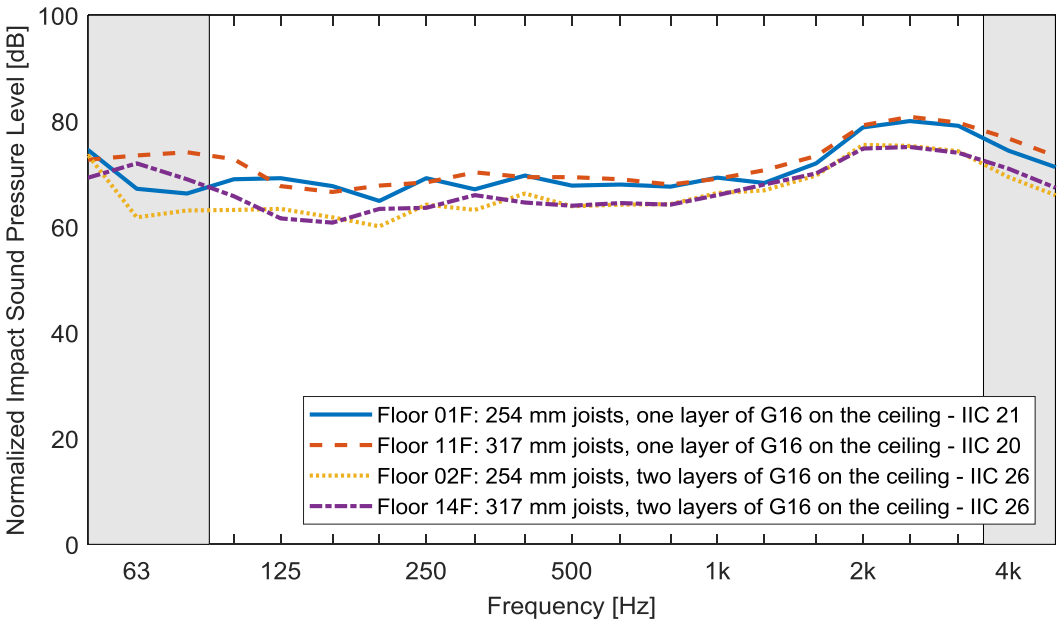

Figure 23: Influence of joist depth

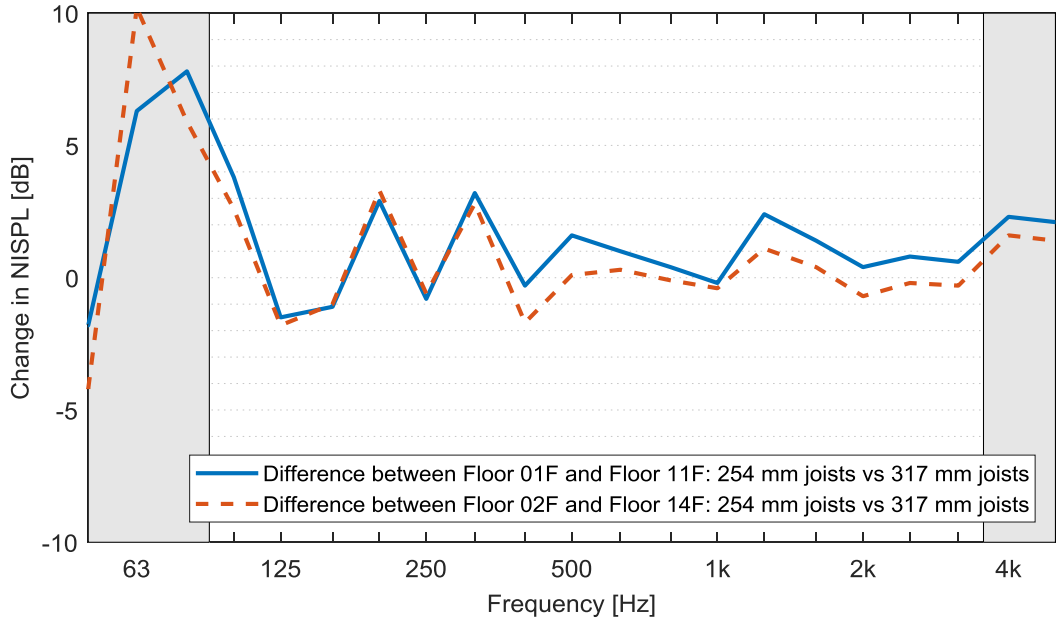

Figure 24: Influence of joist depth – Change in normalized impact sound pressure level

2.4.3 Influence of Gypsum Board Ceiling

Figure 25 shows the normalized impact sound pressure level for one floor with four different ceiling configurations. The reference ceiling consists of one layer of 15.9 mm gypsum board mounted on resilient metal channels. The other curves are for a ceiling with two layers of 15.9 mm gypsum mounted in the same way, and for ceilings with one or two layers of 12.7 mm gypsum board mounted on resilient metal channels. Figure 26 shows the differences between ceilings with one layer or two layers of gypsum board.

The difference in normalized impact sound pressure level between floors with one layer of gypsum board and with two layers of gypsum board is about 4 dB on average. The IIC ratings improve between 5 and 6 points, for either type of gypsum board.

As in Figure 18, the differences between 15.9 mm thick gypsum board and 12.7 mm thick gypsum board are small at low and mid frequencies. And as in Figure 18, there is a systematic difference in the normalized impact sound pressure levels in the region of the coincidence frequency. Due to the differences at the coincidence frequency, the IIC rating drops by 2-3 points when using 12.7 mm board instead of 15.9 mm board. However, it should be noted that this change in IIC ratings only occurs for bare floors, because in that case the single-number rating is driven by the high frequencies. For floors with coverings such as laminate or carpet (see Section 2.4.4), a shift in the coincidence frequency will usually not lead to a change in the IIC rating.

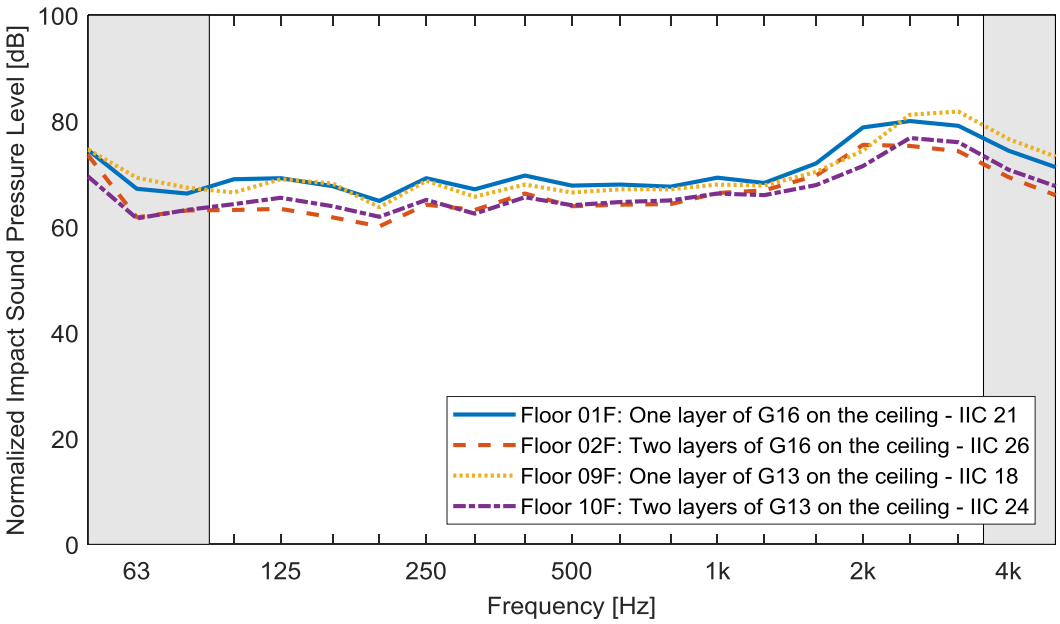

Figure 25: Influence of gypsum board ceiling

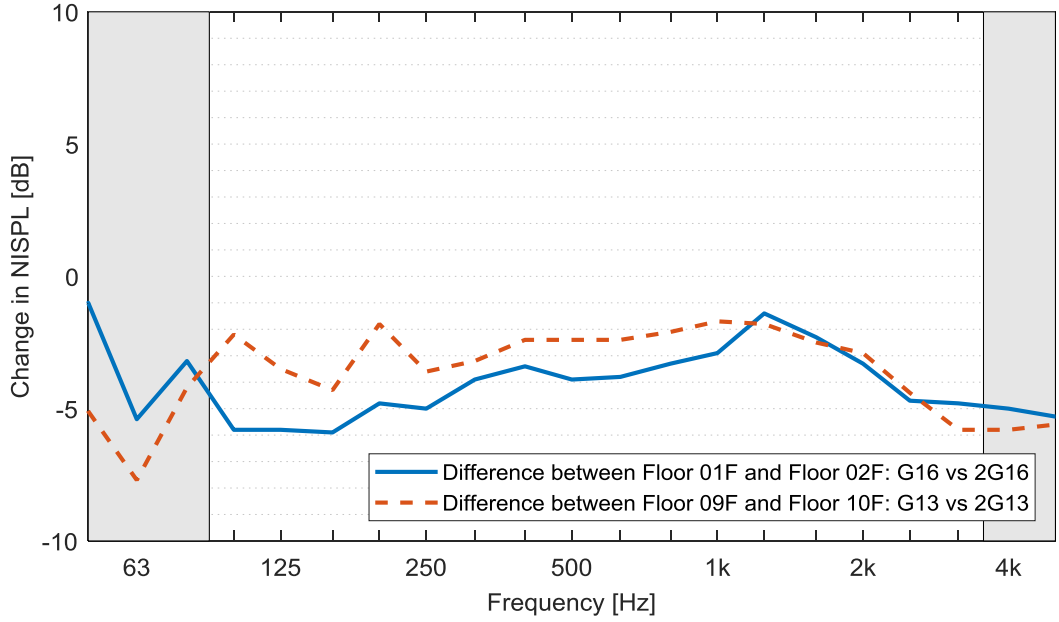

Figure 26: Influence of gypsum board ceiling – Change in normalized impact sound pressure level

2.4.4 Influence of Floor Coverings

Figure 27 illustrates the significant improvement that floor coverings produce when installed on the bare reference floor assembly. The normalized impact sound pressure level drops significantly for all three coverings, in particular at high frequencies. In consequence, the IIC ratings increase by 29, 46, and 29 points for laminate, carpet, and vinyl, respectively. The improvement for carpet at high frequencies exceeds the dynamic range of the measurement system – above 1 kHz, the normalized impact sound pressure level runs into background noise. However, the IIC ratings are not affected by this limitation, as they are dominated by the lowest frequency bands for this floor assembly.

Figure 28 shows the difference between the floors with vinyl covering installed without and with glue. As for airborne sound insulation (see Figure 20), it is advantageous to glue down the vinyl so as to eliminate any remaining air pockets.

Figure 29 shows the differences in normalized impact sound pressure levels between the bare floor assembly and the floor assemblies with coverings. Once again the significant improvement due to floor coverings at mid and high frequencies can be observed.

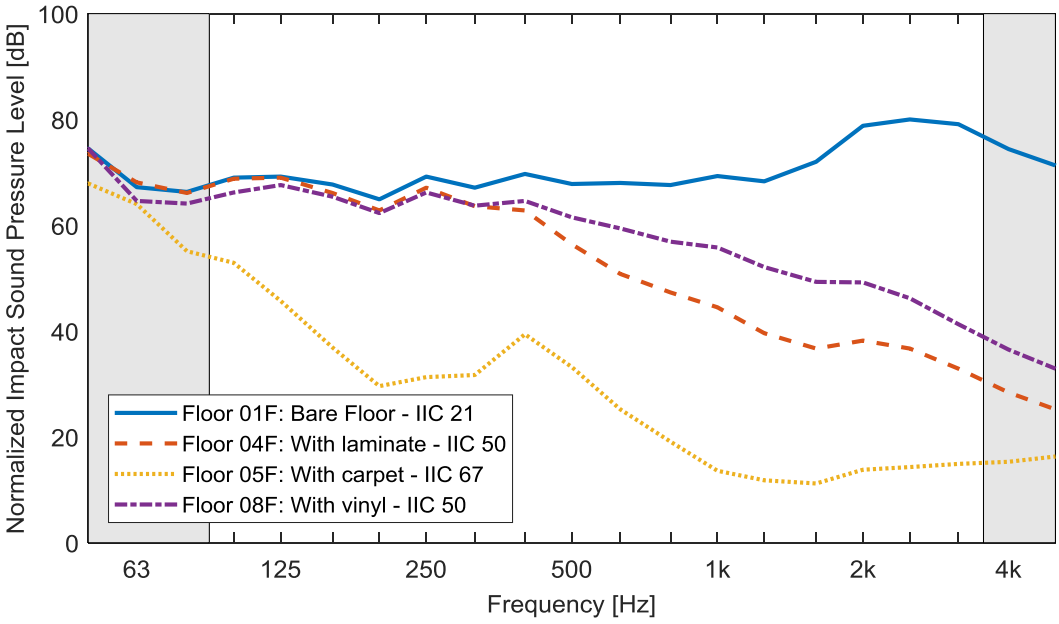

Figure 27: Influence of floor coverings

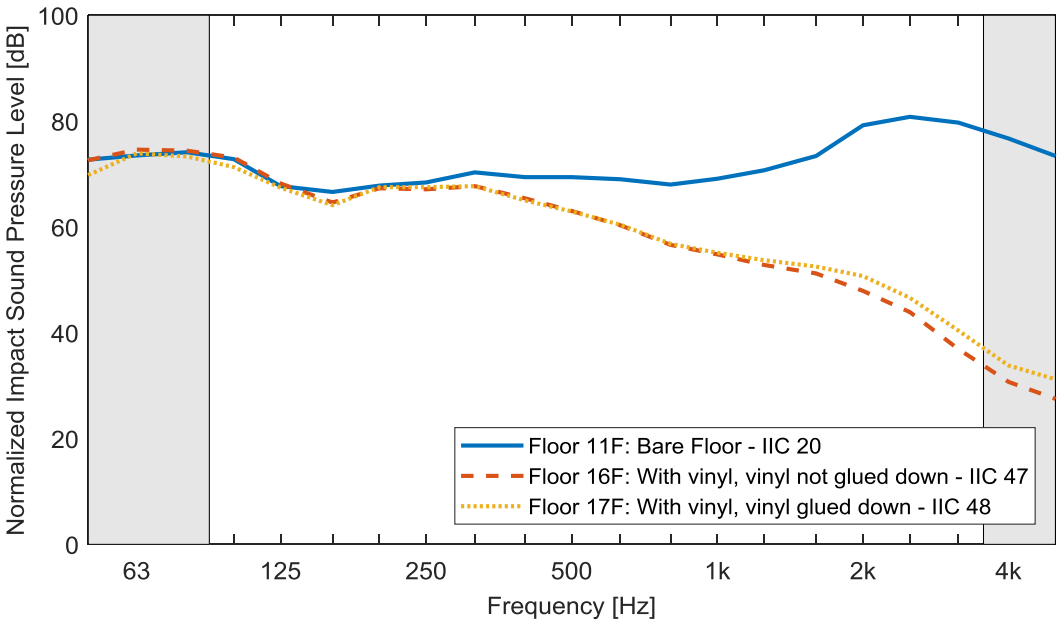

Figure 28: Influence of bonding method for vinyl covering

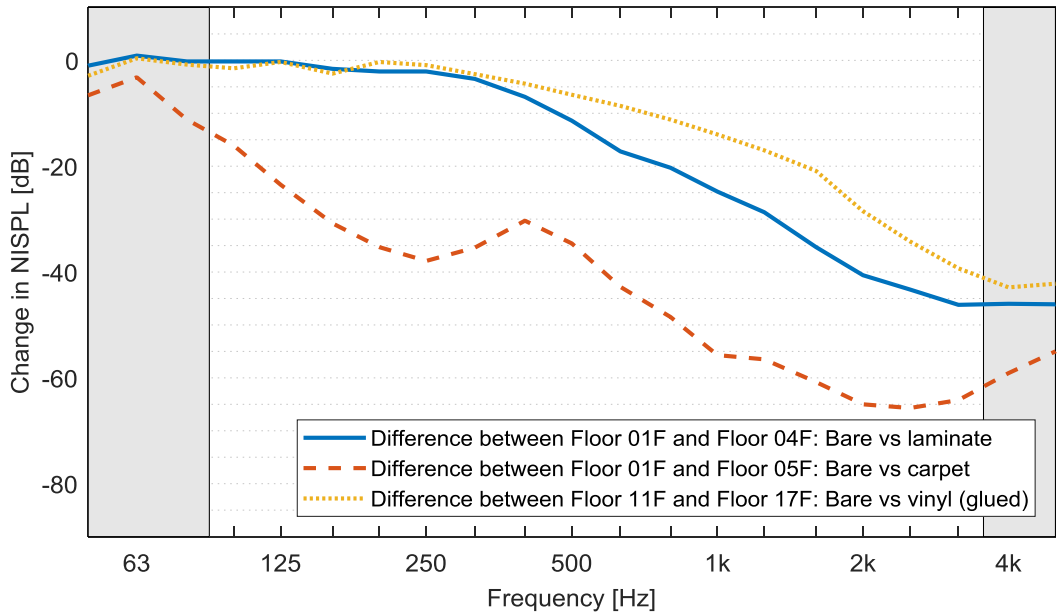

Figure 29: Influence of floor coverings – Change in normalized impact sound pressure level

References

[1] C. Höller, D. Quirt, B. Zeitler and I. Sabourin, "NRC Research Report RR-337: Apparent Sound Insulation in Cold-Formed Steel-Framed Buildings," National Research Council Canada, Ottawa, Ontario, 2017.

[2] *ASTM E90: Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements,* ASTM International, 2009.

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[7] *ASTM E989: Standard Classification for Determination of Impact Insulation Class (IIC),* ASTM International, 2006.

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Appendix A - ASTM E90-09 – Airborne Sound Transmission – Wall Facility

Facility and Equipment: The NRC Construction Wall Sound Transmission Facility comprises two reverberation rooms (referred to in this report as the large and the small room) with a moveable test frame between the rooms. The rooms have approximate volumes of 255 m^3 and 140 m^3, respectively. In each room, a calibrated Bruel & Kjaer condenser microphone (type 4166 or 4165) with preamp is moved under computer control to nine positions, and measurements are made in both rooms using an 8-channel National Instrument NI-4472 system installed in a computer. Each room has four bi-amped loudspeakers driven by separate amplifiers and noise sources. To increase randomness of the sound field, there are fixed diffusing panels in each room.

Test Procedure: Airborne sound transmission measurements were conducted in accordance with the requirements of ASTM E90-09, "Standard Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions". Airborne sound transmission loss tests were performed in the forward (receiving room is the large room) and reverse (receiving room is the small room) directions. Results presented in this report are the average of the tests in these two directions. In each case, sound transmission loss values were calculated from the average sound pressure levels of both the source and receiving rooms and the average reverberation times of the receiving room. One-third octave band sound pressure levels were measured for 32 seconds at nine microphone positions in each room and then averaged to get the average sound pressure level in each room. Five sound decays were averaged to get the reverberation time at each microphone position in the receiving room; these reverberation times were averaged to get the average reverberation times for each room. Information on the flanking limit of the facility and reference specimen test results are available on request.

Significance of Test Results: ASTM E90-09 requires measurements in one-third octave bands in the frequency range 100 Hz to 5000 Hz. The standards recommend making measurements and reporting results over a larger frequency range, and this report presents such results, which may be useful for expert evaluation of the specimen performance. The precision of results outside the 100 Hz to 5000 Hz range has not been established, but is expected to depend on laboratory-specific factors.

Sound Transmission Class (STC): The Sound Transmission Class (STC) was determined in accordance with ASTM E413-10, "Classification for Rating Sound Insulation". It is a single-number rating scheme intended to rate the acoustical performance of a partition element separating offices or dwellings. The higher the value of the rating, the better the performance. The rating is intended to correlate with subjective impressions of the sound insulation provided against the sounds of speech, radio, television, music, and similar sources of noise characteristic of offices and dwellings. The STC is of limited use in applications involving noise spectra that differ markedly from those referred to above (for example, heavy machinery, power transformers, aircraft noise, motor vehicle noise). Generally, in such applications it is preferable to consider the source levels and insulation requirements for each frequency band.

In Situ Performance: Ratings obtained by this standard method tend to represent an upper limit to what might be measured in a field test, due to structure-borne transmission ("flanking") and construction deficiencies in actual buildings.

Appendix B - ASTM E90-09 – Airborne Sound Transmission – Floor Facility

Facility and Equipment: The NRC Construction Floor Sound Transmission Facility comprises two reverberation rooms (referred to in this report as the upper and lower rooms) with a moveable test frame between the rooms. Both rooms have an approximate volume of 175 m^3. In each room, a calibrated Bruel & Kjaer condenser microphone (type 4166 or 4165) with preamp is moved under computer control to nine positions, and measurements are made in both rooms using an 8-channel National Instrument NI-4472 system installed in a computer. Each room has four bi-amped loudspeakers driven by separate amplifiers and noise sources. To increase randomness of the sound field, there are fixed diffusing panels in each room.

Test Procedure: Airborne sound transmission measurements were conducted in accordance with the requirements of ASTM E90-09, "Standard Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions". Airborne sound transmission loss tests were performed in the forward (receiving room is the lower room) and reverse (receiving room is the upper room) directions. Results presented in this report are the average of the tests in these two directions. In each case, sound transmission loss values were calculated from the average sound pressure levels of both the source and receiving rooms and the average reverberation times of the receiving room. One-third octave band sound pressure levels were measured for 32 seconds at nine microphone positions in each room and then averaged to get the average sound pressure level in each room. Five sound decays were averaged to get the reverberation time at each microphone position in the receiving room; these reverberation times were averaged to get the average reverberation times for each room. Information on the flanking limit of the facility and reference specimen test results are available on request.

Significance of Test Results: ASTM E90-09 requires measurements in one-third octave bands in the frequency range 100 Hz to 5000 Hz. The standards recommend making measurements and reporting results over a larger frequency range, and this report presents such results, which may be useful for expert evaluation of the specimen performance. The precision of results outside the 100 Hz to 5000 Hz range has not been established, but is expected to depend on laboratory-specific factors.

Sound Transmission Class (STC): The Sound Transmission Class (STC) was determined in accordance with ASTM E413-10, "Classification for Rating Sound Insulation". It is a single-number rating scheme intended to rate the acoustical performance of a partition element separating offices or dwellings. The higher the value of the rating, the better the performance. The rating is intended to correlate with subjective impressions of the sound insulation provided against the sounds of speech, radio, television, music, and similar sources of noise characteristic of offices and dwellings. The STC is of limited use in applications involving noise spectra that differ markedly from those referred to above (for example, heavy machinery, power transformers, aircraft noise, motor vehicle noise). Generally, in such applications it is preferable to consider the source levels and insulation requirements for each frequency band.

In Situ Performance: Ratings obtained by this standard method tend to represent an upper limit to what might be measured in a field test, due to structure-borne transmission ("flanking") and construction deficiencies in actual buildings.

Appendix C - ASTM E492-09 – Light Impact Sound Transmission – Floor Facility

Facility and Equipment: The NRC Construction Floor Sound Transmission Facility comprises two reverberation rooms (referred to in this report as the upper and lower rooms) with a moveable test frame between the two rooms. Both rooms have an approximate volume of 175 m^3. For impact sound transmission, only the lower room is used. A calibrated Bruel & Kjaer condenser microphone (type 4166 or 4165) with preamp is moved under computer control to nine positions, and measurements are made using an 8-channel National Instrument NI 4472 system installed in a computer. The room has 4 bi-amped loudspeakers driven by separate amplifiers and incoherent noise sources. To increase randomness of the sound field, there are fixed diffusing panels in the room.

Test Procedure: Impact sound transmission measurements were conducted in accordance with ASTM E492-09, "Standard Test Method for Laboratory Measurement of Impact Sound Transmission through Floor-Ceiling Assemblies Using the Tapping Machine". This method uses a standard tapping machine placed at four prescribed positions on the floor. One-third octave band sound pressure levels were measured for 32 seconds at each microphone position in the receiving room and then averaged to get the average sound pressure level in the room. Five sound decays were averaged to get the reverberation time at each of the nine microphone positions in the receiving room; these nine reverberation times were averaged to get the spatial average reverberation times for the room. The spatial average sound pressure levels and reverberation times of the receiving room were used to calculate the Normalized Impact Sound Pressure Levels.

Significance of Test Results: ASTM E492-09 requires measurements in one-third octave bands in the frequency range 100 Hz to 3150 Hz. The standard recommends making measurements and reporting results over a larger frequency range, and this report presents such results, which may be useful for expert evaluation of the specimen performance. The precision of results outside the standard ranges has not been established, and is expected to depend on laboratory-specific factors such as room size and specimen dimensions.

Impact Insulation Class (IIC): The Impact Insulation Class (IIC) was determined in accordance with ASTM E989-06, "Standard Classification for Determination of Impact Insulation Class (IIC)". It is a single-number rating scheme intended to rate the effectiveness of floor-ceiling assemblies at preventing the transmission of impact sound from the standard tapping machine. A higher IIC value indicates a better floor performance.

In Situ Performance: Ratings obtained by this standard method tend to represent an upper limit to what might be measured in a field test, due to structure-borne transmission ("flanking") and construction deficiencies in actual buildings.