



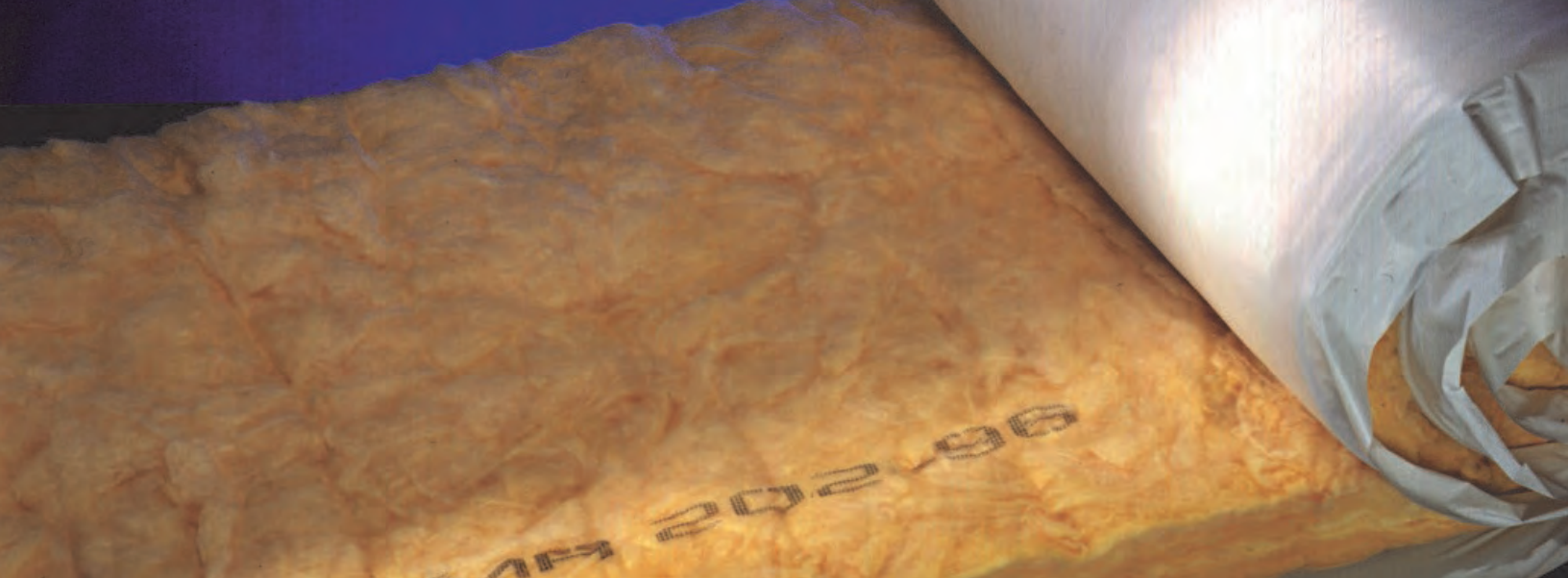
Acoustical Performance of Insulated Metal Building Roof and Wall Assemblies

NAIMA
NORTH AMERICAN INSULATION
MANUFACTURERS ASSOCIATION

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METAL BUILDING MANUFACTURERS ASSOCIATION®
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Introduction and Background

The Metal Building Manufacturers Association (MBMA) and the North American Insulation Manufacturers Association (NAIMA) performed acoustical testing on a range of standard metal building ceiling and wall insulation assemblies. A total of four common roof assemblies and 15 wall assemblies were tested by Intertek Labs in York, Pennsylvania, in 2017. This document contains summaries of the test results, as well as links to the individual test reports for those who wish to review more detailed information. This document discusses the fundamentals of acoustical performance and shows how to improve sound control in typical wall and roof assemblies through the use of fiberglass insulation. The construction details of each of the assemblies and their results are displayed in the subsequent sections below. This project was funded by MBMA and NAIMA, with the support of the American Iron and Steel Institute (AISI).

Need for These Test Results

Metal buildings are often used for a variety of building types including schools, retail and office occupancies. With the development of new codes and standards, more stringent Sound Transmission Class (STC) (or sometimes Outside-Inside Transmission Class (OITC)) ratings are coming into play. This is particularly an issue in educational and office occupancies where, until now, modern wall and roof assemblies did not have acoustical testing data available.

Noise transmission from outdoors is becoming an indoor environmental pollution issue as it can affect the health and performance of the building

occupants. Construction techniques to reduce sound transmission are becoming increasingly important and many builders and architects are looking for cost-effective options to further reduce sound transmission in metal buildings.

Metal Building Insulation— What Is It?

Metal building insulation has been used for many years to thermally insulate the walls and roofs of metal buildings. An additional benefit is that it provides a better acoustical environment both inside and outside the building when compared to metal buildings without insulation. Metal building insulation can absorb interior noise to provide a quieter work environment.

Because of the porous nature of metal building insulation, it is an excellent absorber of sound. It can reduce noise levels in a building up to 5 to 6 decibels (dB). This same sound-absorbing property is used to reduce the amount of sound that is transmitted through a wall or roof. Thus, it can reduce equipment noise transmitted to neighbors. It can also reduce outside noise so that building occupants are not disturbed by exterior noise sources such as traffic.

Summary of Strategies to Improve Acoustic Performance

The addition of faced metal building insulation to the wall or ceiling assembly alone can reduce noise levels in a metal building by 5 to 6 dB. However, additional construction techniques can further reduce the sound transmission.

This document outlines several assemblies that the testing demonstrated will achieve improved acoustical performance with the addition of acoustical ceiling tiles, gypsum board and additional fiberglass insulation.

To maximize a metal building's acoustical performance, the wall and/or roof panels should include at least one layer of faced metal building insulation and one layer of unfaced metal building insulation. Additionally, the construction should be tight, with attention to detail such as filling gaps with flexible sealants to assure that sound does not transmit via air leaks from one space to another.

The target STC values of 45 to 50 and OITC values 35 to 40 were easily met by the majority of the assemblies tested. STC and OITC were calculated by taking the Transmission Loss (TL) values tested at 16 standard frequencies over the range of 125 Hz to 4000 Hz.

Key Definitions

Sound Absorption Coefficients

The sound absorption properties of a material are expressed in terms of sound absorption coefficients. The higher the coefficient the better the material absorbs sound. Sound absorption coefficients are measured at several frequencies since the ability of a material to absorb sound varies with frequency. A material with an absorption coefficient of 0.66 at a single

frequency means that approximately 66 percent of the sound that strikes that material is absorbed, or conversely about 34 percent of the sound is reflected back into the room. Single-number ratings from sound absorption coefficients include both the newer sound absorption averages (SAA) and noise reduction coefficients (NRC).

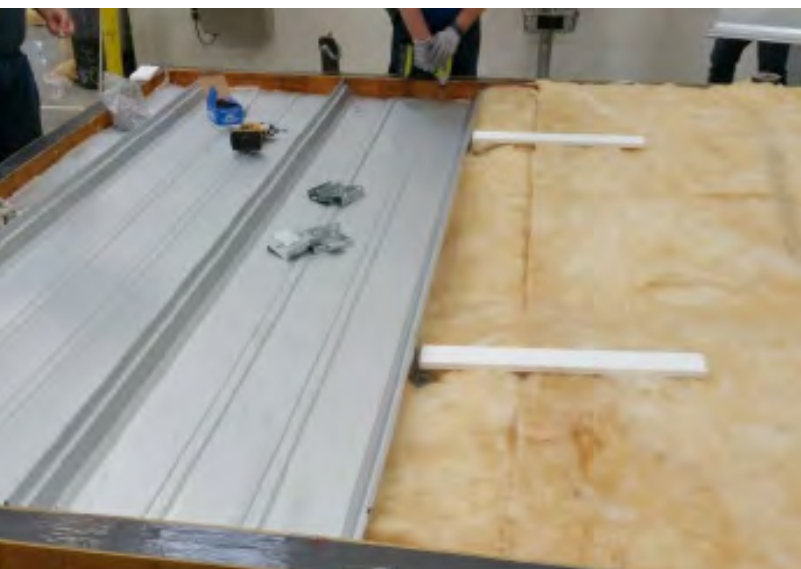
Sound Absorption Average (SAA) The sound absorption average for a material is the newer and preferred single-number rating that is generated using the ASTM C423 test method. The SAA is based on the average of sound absorption over 12 frequencies (200 Hz to 2500 Hz). The higher the SAA rating, the better a material absorbs sound. The SAA for faced fiberglass metal building insulation typically ranges between 0.75 and 1.15*.

Noise Reduction Coefficient (NRC) The noise reduction coefficient is a single-number rating that has been established to express the ability of a material to absorb sound at four frequencies (250 Hz to 2000 Hz). Again, the higher the NRC value, the better a material absorbs sound. NRC values for faced fiberglass metal building insulation range from about 0.75 to 1.15*.

Sound Transmission Loss

The ability of a wall or roof to reduce the amount of sound transmitted through it is called sound transmission loss. Sound transmission loss is expressed in decibels (dB) and it also varies with frequency. Most materials and constructions reduce the transmission of high-frequency sounds

**It is important to note that, because fiberglass metal building insulation is thick, and due to aspects of the ASTM C423 test method, it is possible to have an SAA or NRC value of greater than 1.0.*



more than low-frequency sounds. When building a wall or roof it is imperative that there are no air (sound) leaks in the construction. Sound leaks can drastically reduce the effectiveness of a wall to reduce the transmission of sound from one space to another. The construction should be as tight as possible. Where gaps exist, they should be filled with an acoustic caulk, typically a flexible sealant such as a non-curing Butyl, siliconized acrylic latex or an acrylic latex that does not dry out and become brittle over time.

Sound Transmission Class (STC)

A single-number rating system used to express the sound transmission loss properties of a wall or roof is the sound transmission class (STC). The higher the STC value, the better a construction reduces

the transmission of sound. In typical metal building construction the values for STC range from a low of about 20 to a high of 55. The STC rating has been in existence for many years and is based on speech sounds.

Outdoor-Indoor Transmission Class (OITC)

Recently, a new single-number rating has been introduced. It is called the outdoor-indoor transmission class (OITC). It is used to specify the sound transmission loss properties of exterior building elements such as walls and windows. The OITC uses outside noise sources such as traffic, aircraft and trains to calculate a single-number rating. The OITC is the preferred rating for exterior walls and roofs of metal buildings.

TABLE 1 - Tested Roof Assemblies

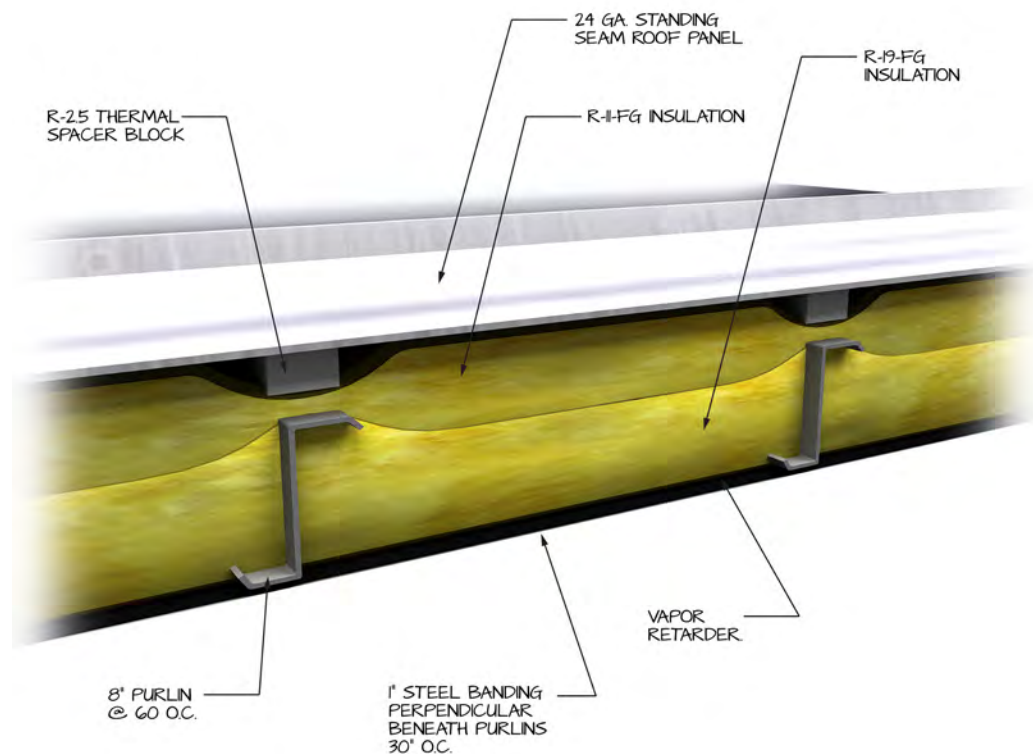
Test Specimen	24 Gauge Standing Seam Roof	8" Purlins @ 60" o.c.	Thermal Spacer Blocks	Fiberglass Insulation	2x2 Acoustical Ceiling Tile	Layers of 5/8" Gypsum Board Type X	STC	OITC	Fire Rating - 1 hr (UL P516)
R-1	X	X	R-2.5	R-19+R-11	-	0	37	26	-
R-2	X	X	R-2.5	R-19+R-11	X	0	45	30	-
R-3	X	X	R-2.5	R-19+R-11	-	1	56	43	-
R-4	X	X	R-2.5	R-19+R-11	-	2	58	46	1 hr

Test A, Specimen R-1, Test Date 05/31/17

Data File No. G9721.01

STC: 37

OITC: 26



Roof Assembly R-1

Materials (Source Room to Receive Room)

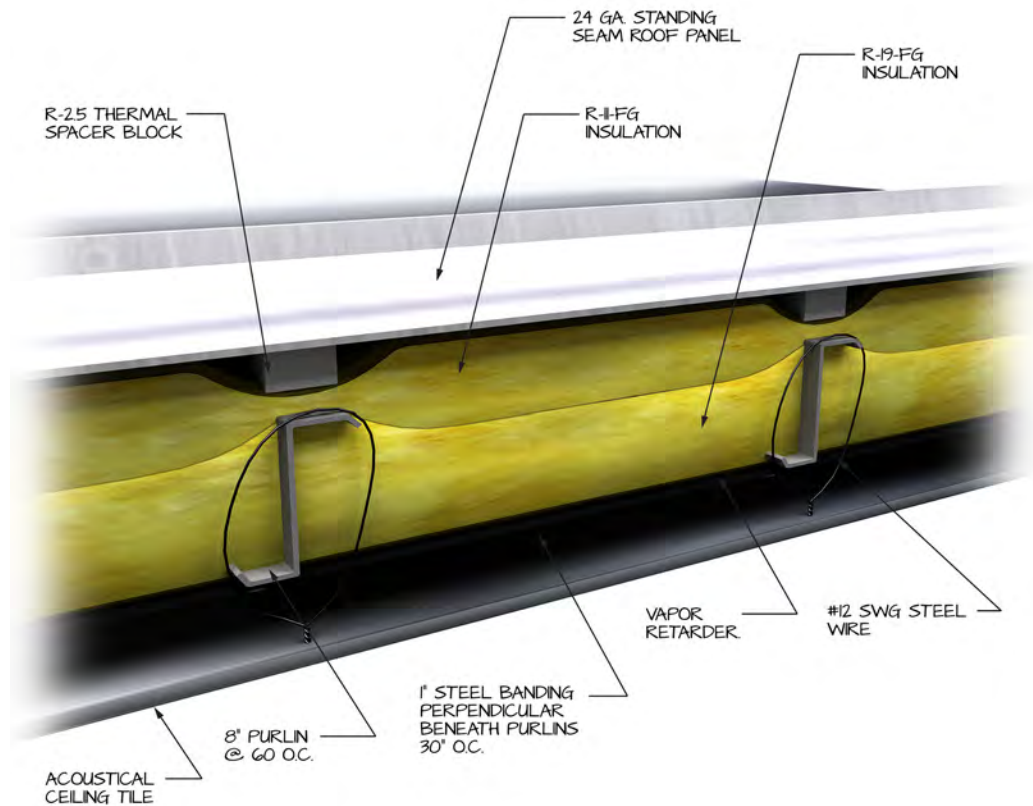
Steel Roof Panel	24 Gauge Standing Seam Roof Panel, 2.5" rib height
Spacer Block	R-2.5 Thermal Spacer Block
Steel Purlin	8" x 16 Gauge Steel Purlin
Insulation (Top Layer)	R-11 Fiberglass Insulation
Insulation (Bottom Layer)	R-19 Fiberglass Insulation
Vapor Retarder	Polypropylene with tri-directional fiberglass reinforcement
Steel Banding	0.02" thick, spaced 30" o.c.

Test B, Specimen R-2, Test Date 05/31/17

Data File No. G9721.02

STC: 45

OITC: 30



Roof Assembly R-2

Materials (Source Room to Receive Room)

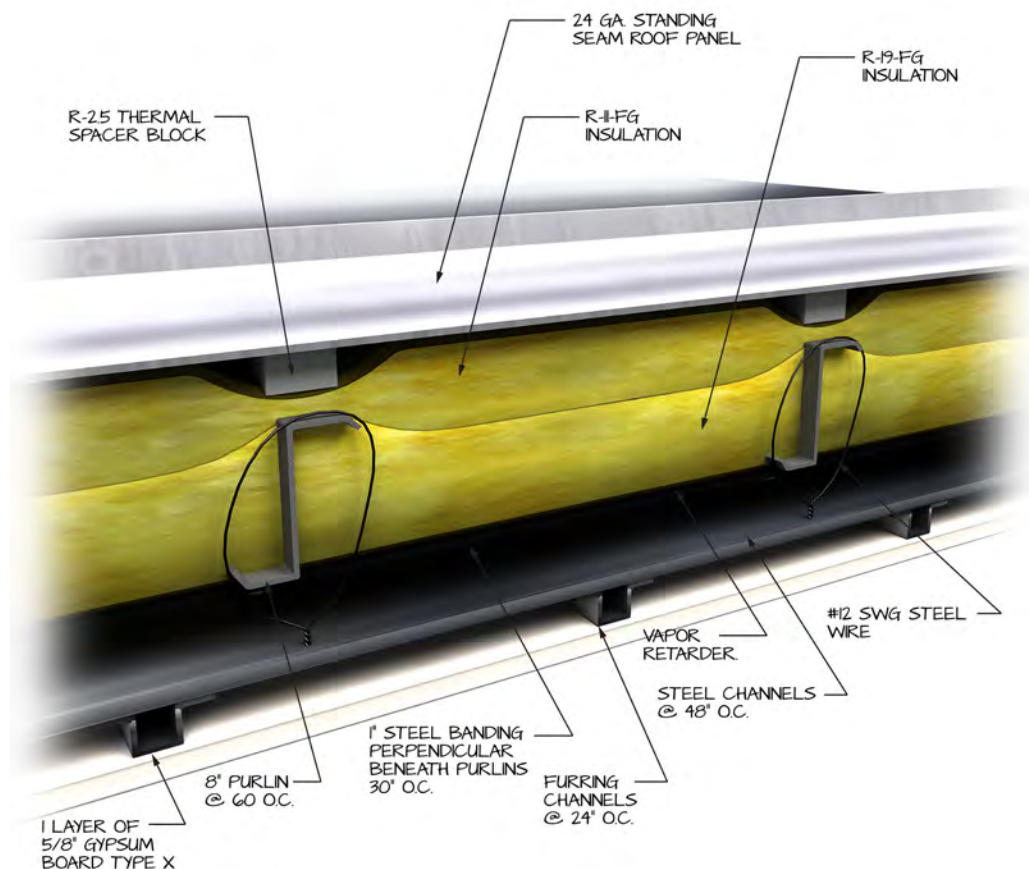
Steel Roof Panel	24 Gauge Standing Seam Roof Panel, 2.5" rib height
Spacer Block	R-2.5 Thermal Spacer Block
Steel Purlin	8" x 16 Gauge Steel Purlin
Insulation (Top Layer)	R-11 Fiberglass Insulation
Insulation (Bottom Layer)	R-19 Fiberglass Insulation
Vapor Retarder	Polypropylene with tri-directional fiberglass reinforcement
Steel Banding	0.02" thick, spaced 30" o.c.
Main Beams	Main Beams
Cross Tees	4' Cross Tees
Cross Tees	2' Cross Tees
Ceiling Tiles	Textured Square Edge Ceiling Tiles

Test C, Specimen R-3, Test Date 05/31/17

Data File No. G9721.03

STC: 56

OITC: 43



Roof Assembly R-3

Materials (Source Room to Receive Room)

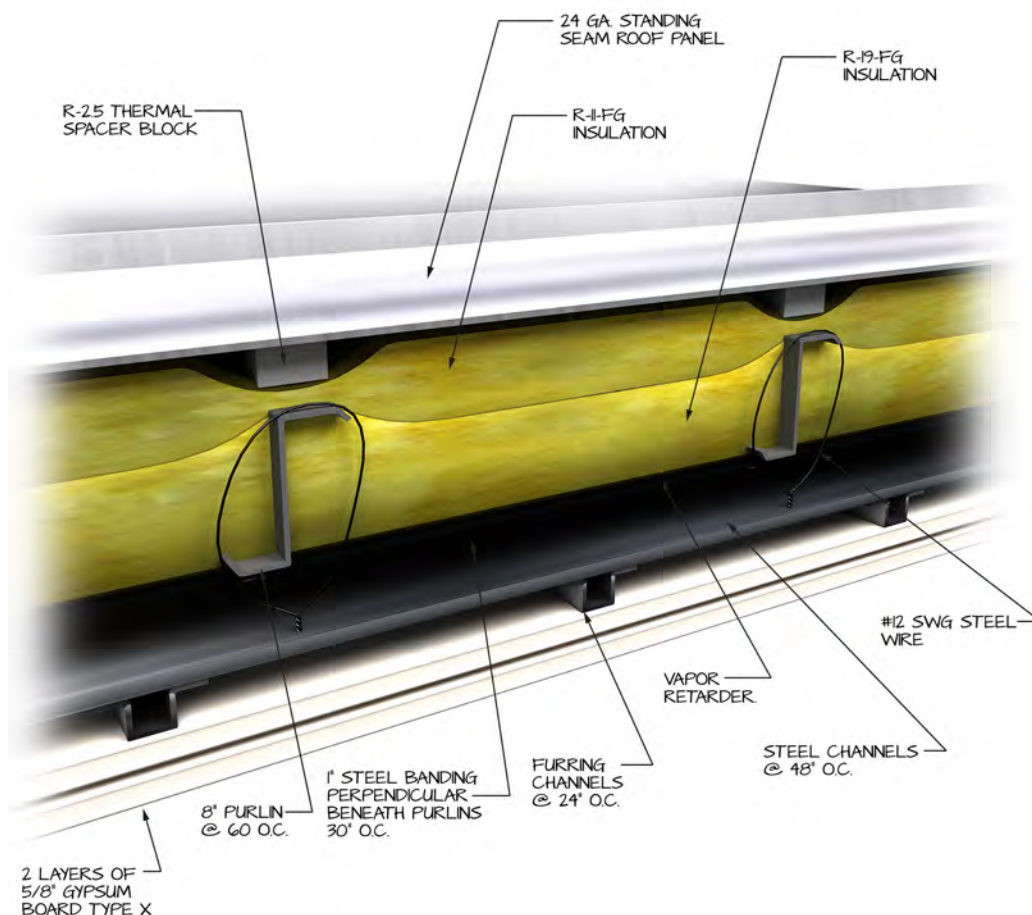
Steel Roof Panel	24 Gauge Standing Seam Roof Panel, 2.5" rib height
Spacer Block	R-2.5 Thermal Spacer Block
Steel Purlin	8" x 16 Gauge Steel Purlin
Insulation (Top Layer)	R-11 Fiberglass Insulation
Insulation (Bottom Layer)	R-19 Fiberglass Insulation
Vapor Retarder	Polypropylene with tri-directional fiberglass reinforcement
Steel Banding	0.02" thick, spaced 30" o.c.
Main Beams	C-Channel Cold Rolled Steel Channel, spaced 48" o.c.
Cross Beams	Steel Furring Channel, spaced 24" o.c.
Ceiling	5/8" Type X Gypsum Board

Test D, Specimen R-4, Test Date 05/31/17

Data File No. G9721.04

STC: 58

OITC: 46



Roof Assembly R-4

Materials (Source Room to Receive Room)

Steel Roof Panel	24 Gauge Standing Seam Roof Panel, 2.5" rib height
Spacer Block	R-2.5 Thermal Spacer Block
Steel Purlin	8" x 16 Gauge Steel Purlin
Insulation (Top Layer)	R-11 Fiberglass Insulation
Insulation (Bottom Layer)	R-19 Fiberglass Insulation
Vapor Retarder	Polypropylene with tri-directional fiberglass reinforcement
Steel Banding	0.02" thick, spaced 30" o.c.
Main Beams	C-Channel Cold Rolled Steel Channel, spaced 48" o.c.
Cross Beams	Steel Furring Channel, spaced 24" o.c.
Ceiling First Layer	5/8" Type X Gypsum Board
Ceiling Second Layer	5/8" Type X Gypsum Board

TABLE 2 - Tested Wall Assemblies

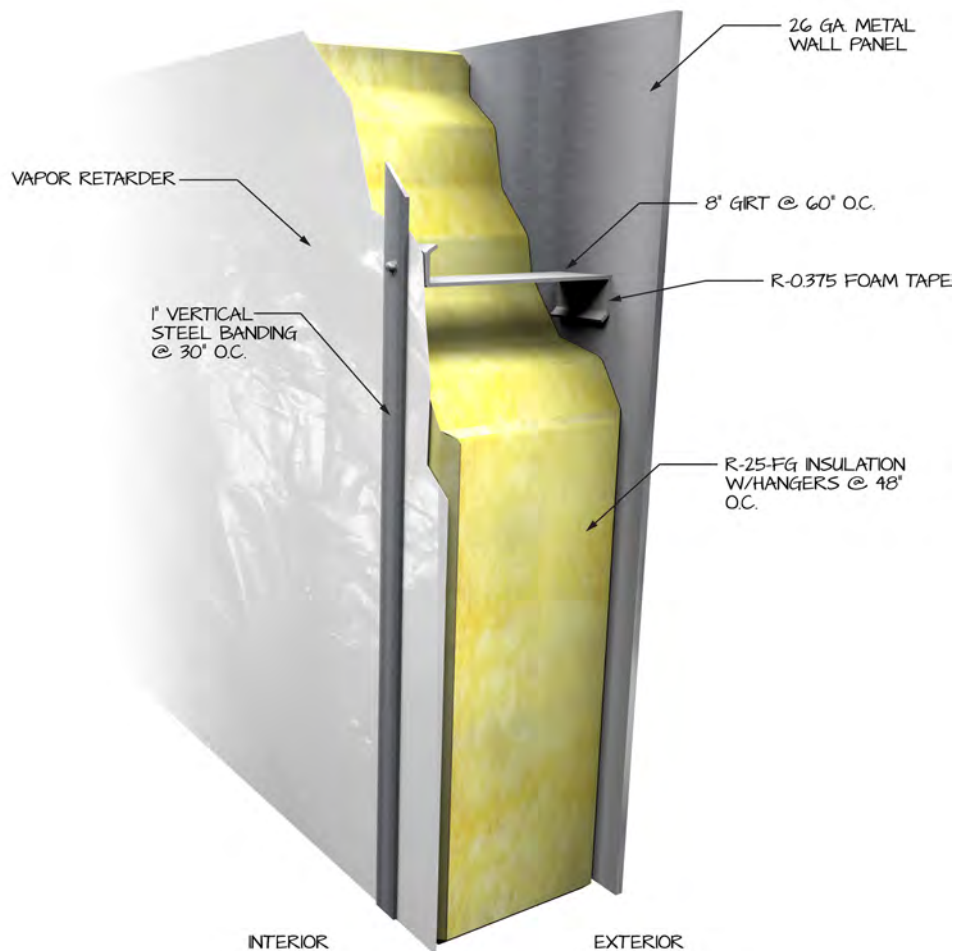
Test Specimen	24 Gauge Standing Seam Roof	8" Purlins @ 60" o.c.	Thermal Spacer Foam Tape on Exterior Girt Flange	Fiberglass Insulation	Insulation Hangers w/ R-0.375 tape	Hat Channels @ 24" o.c. (vert)	Resilient Chambers @ 24" o.c. (horiz)	Layers of Gypsum Board	STC	OITC	Fire Rating - 1 hr (UL W404), 2 hr (W413)	U-Factor (per 90.1-2016) (not accounting for gypsum board)
W-1	X	X	R-0.375	R-25	x	-	-	0	34	23	-	0.059
W-2	X	X	R-0.375	R-25	x	x	-	1	52	33	-	0.059
W-3	X	X	R-0.375	R-25	x	x	-	2	53	37	1 hr	0.059
W-4A	X	X	R-0.375	R-25	x	x	x	1	54	35	-	0.059
W-4B	X	X	R-0.375	R-25	x	x	x	2	57	39	-	0.059
W-6	X	X	R-0.75	R-30	x	-	-	0	34	23	-	0.052
W-7	X	X	R-0.75	R-30	x	x	-	1	49	33	-	0.052
W-8	X	X	R-0.75	R-30	x	x	-	2	54	37	1 hr	0.052
W-9	X	X	R-0.75	R-30	x	x	x	2	54	36	-	0.052
W-10	X	X	R-0.75	R-30	x	x	-	2	53	39	1 hr	0.052
W-11	X	X	-	R-25+R-10	x	-	-	0	35	24	-	0.047
W-12	X	X	-	R-25+R-10	x	x	-	1	51	34	-	0.047
W-13	X	X	-	R-25+R-10	x	x	-	2	53	38	1 hr	0.047
W-17	X	X	-	R-25+R-10	x	x	-	4	57	42	2 hr	0.047
W-18	X	X	-	6" Mineral Wool + R-10	-	x	-	3	55	41	2 hr	-

Test A, Specimen W-1, Test Date 05/1/17

Data File No. G9722.01A

STC: 34

OITC: 23



Wall Assembly W-1

Materials (Source Room to Receive Room)

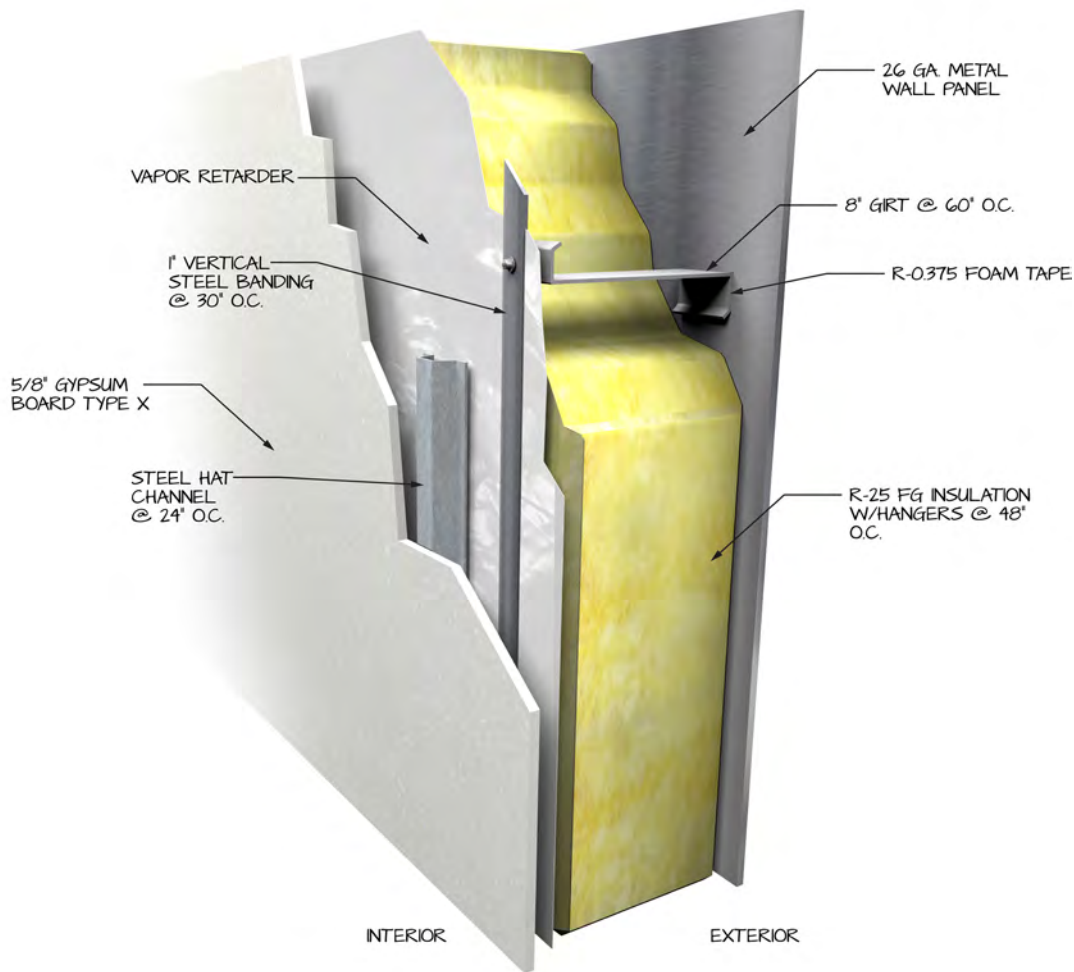
Steel Wall Panel	26 Gauge R-Panel
Foam Isolator	R-0.375 Foam Tape
Steel Girt	8" x 16 Gauge Steel Girt, spaced 60" o.c.
Insulation	R-25 Fiberglass Insulation
Vapor Retarder	Polypropylene with tri-directional fiberglass reinforcement
Steel Banding	0.02" thick, spaced 30" o.c.

Test B, Specimen W-2, Test Date 05/1/17

Data File No. G9722.01B

STC: 52

OITC: 33



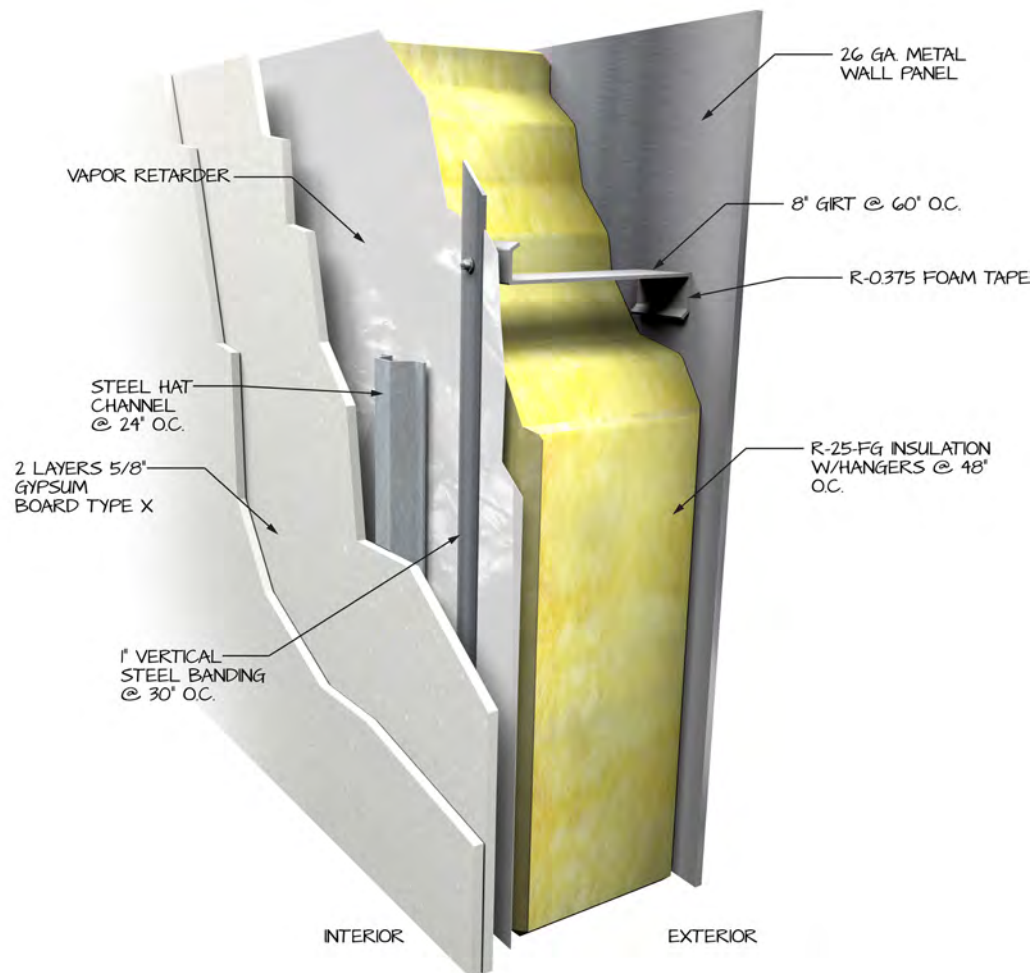
Wall Assembly W-2	
Materials (Source Room to Receive Room)	
Steel Wall Panel	26 Gauge R-Panel
Foam Isolator	R-0.375 Foam Tape
Steel Girt	8" x 16 Gauge Steel Girt, spaced 60" o.c.
Insulation	R-25 Fiberglass Insulation
Vapor Retarder	Polypropylene with tri-directional fiberglass reinforcement
Steel Banding	0.02" thick, spaced 30" o.c.
Steel Hat Channel	20 MSG Galvanized, spaced 24" o.c.
Gypsum Board	5/8" Type X Gypsum Board

Test C, Specimen W-3, Test Date 05/1/17

Data File No. G9722.01C

STC: 53

OITC: 37



Wall Assembly W-3

Materials (Source Room to Receive Room)

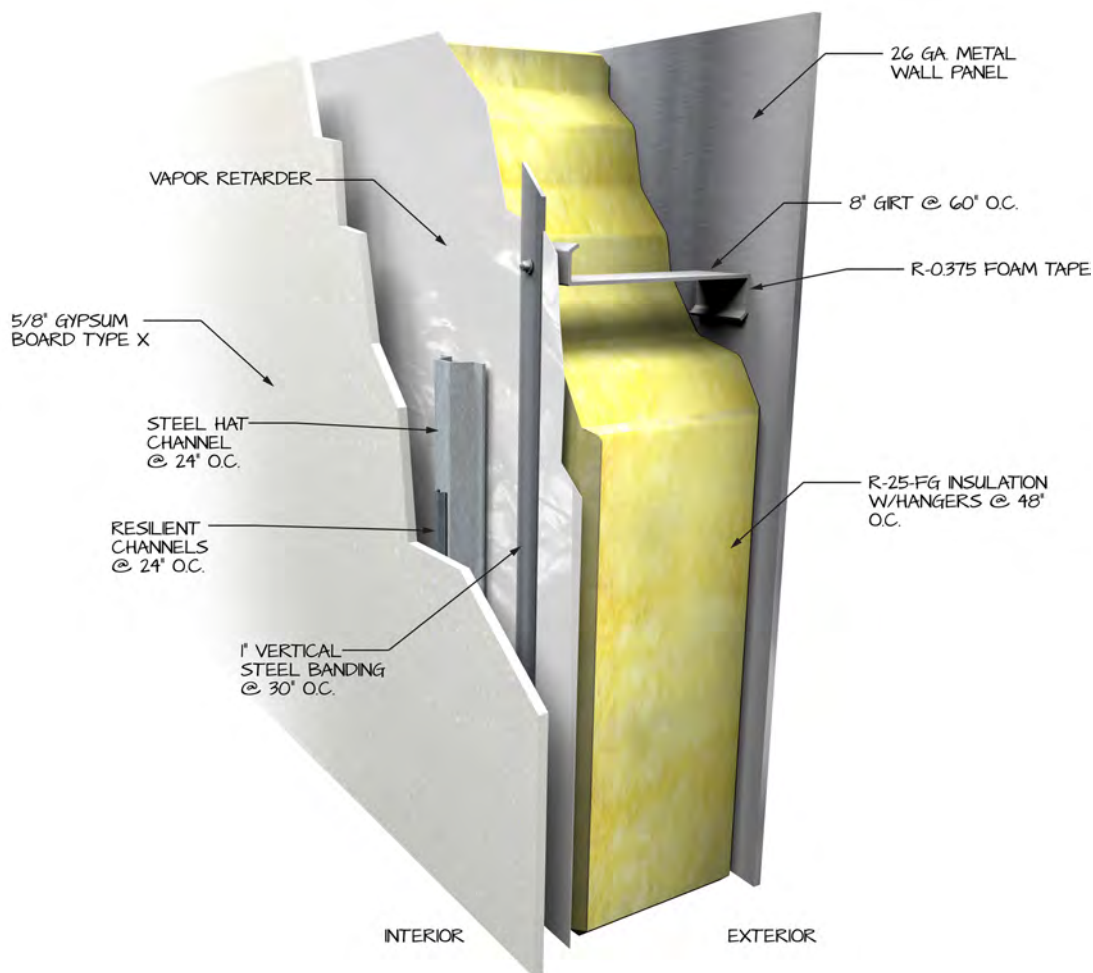
Steel Wall Panel	26 Gauge R-Panel
Foam Isolator	R-0.375 Foam Tape
Steel Girt	8" x 16 Gauge Steel Girt, spaced 60" o.c.
Insulation	R-25 Fiberglass Insulation
Vapor Retarder	Polypropylene with tri-directional fiberglass reinforcement
Steel Banding	0.02" thick, spaced 30" o.c.
Steel Hat Channel	20 MSG Galvanized, spaced 24" o.c.
Gypsum Board First Layer	5/8" Type X Gypsum Board
Gypsum Board Second Layer	5/8" Type X Gypsum Board

Test D1, Specimen W-4A, Test Date 05/2/17

Data File No. G9722.01D1

STC: 54

OITC: 35



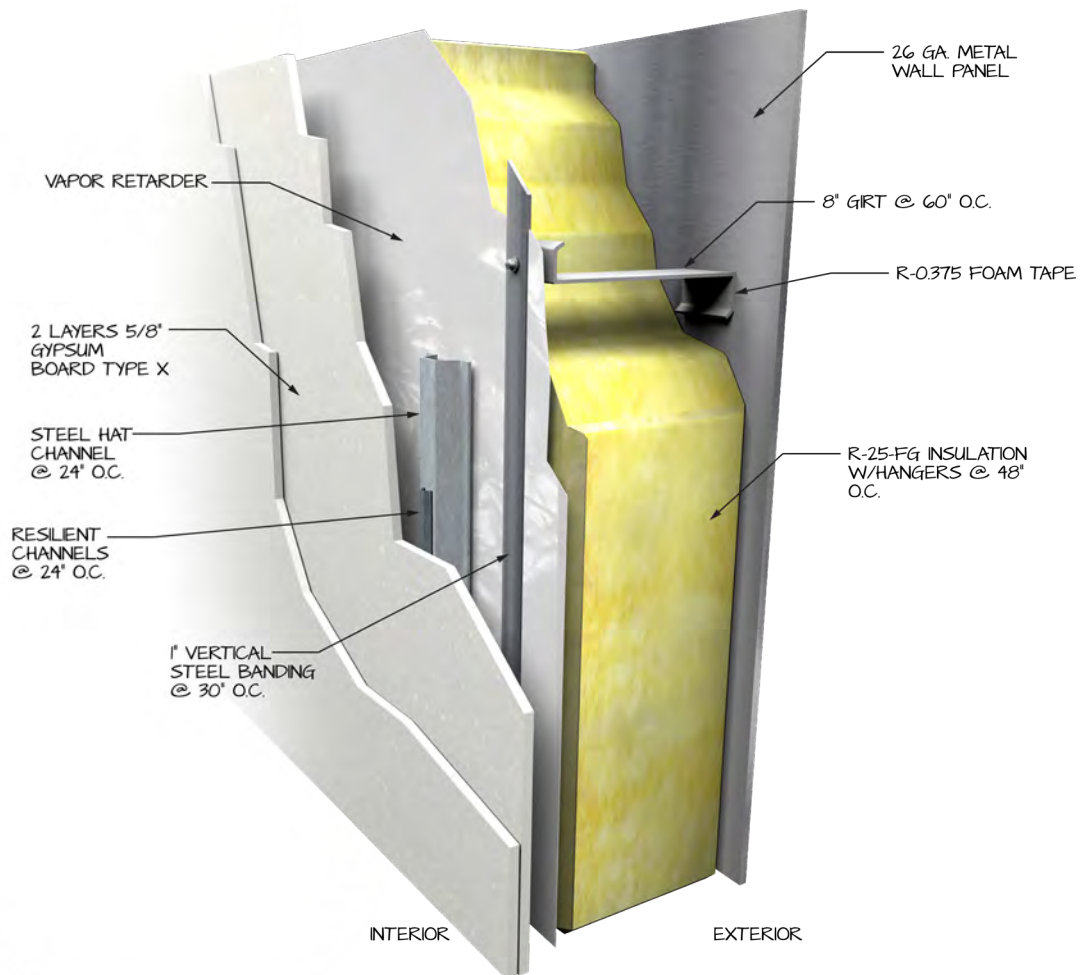
Wall Assembly W-4A	
Materials (Source Room to Receive Room)	
Steel Wall Panel	26 Gauge R-Panel
Foam Isolator	R-0.375 Foam Tape
Steel Girt	8" x 16 Gauge Steel Girt, spaced 60" o.c.
Insulation	R-25 Fiberglass Insulation
Vapor Retarder	Polypropylene with tri-directional fiberglass reinforcement
Steel Banding	0.02" thick, spaced 30" o.c.
Steel Hat Channel	20 MSG Galvanized, spaced 24" o.c., vertical
Resilient Channel	0.025" thick, spaced 24" o.c., horizontal
Gypsum Board	5/8" Type X Gypsum Board

Test D2, Specimen W-4B, Test Date 05/2/17

Data File No. G9722.01D2

STC: 57

OITC: 39



Wall Assembly W-4B

Materials (Source Room to Receive Room)

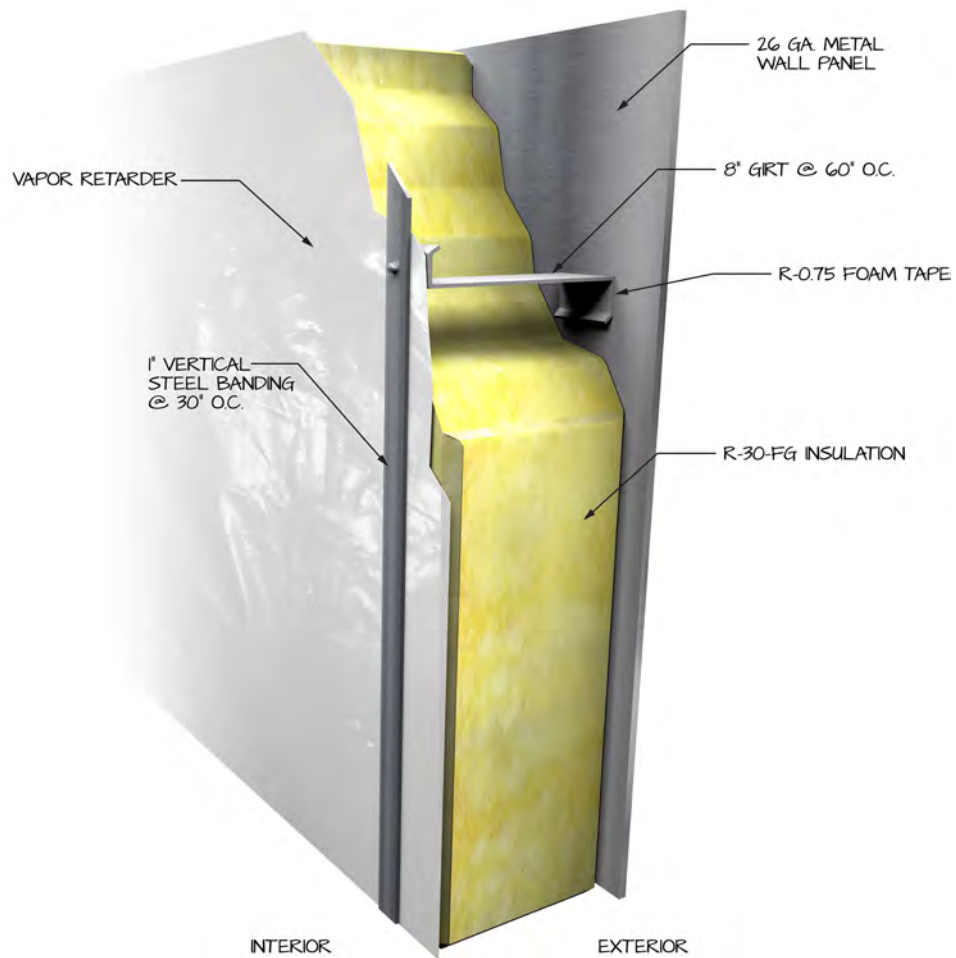
Steel Wall Panel	26 Gauge R-Panel
Foam Isolator	R-0.375 Foam Tape
Steel Girt	8" x 16 Gauge Steel Girt, spaced 60" o.c.
Insulation	R-25 Fiberglass Insulation
Vapor Retarder	Polypropylene with tri-directional fiberglass reinforcement
Steel Banding	0.02" thick, spaced 30" o.c.
Steel Hat Channel	20 MSG Galvanized, spaced 24" o.c., vertical
Resilient Channel	0.025" thick, spaced 24" o.c., horizontal
Gypsum Board First Layer	5/8" Type X Gypsum Board
Gypsum Board Second Layer	5/8" Type X Gypsum Board

Test I, Specimen W-6, Test Date 05/3/17

Data File No. G9722.011

STC: 34

OITC: 23



Wall Assembly W-6

Materials (Source Room to Receive Room)

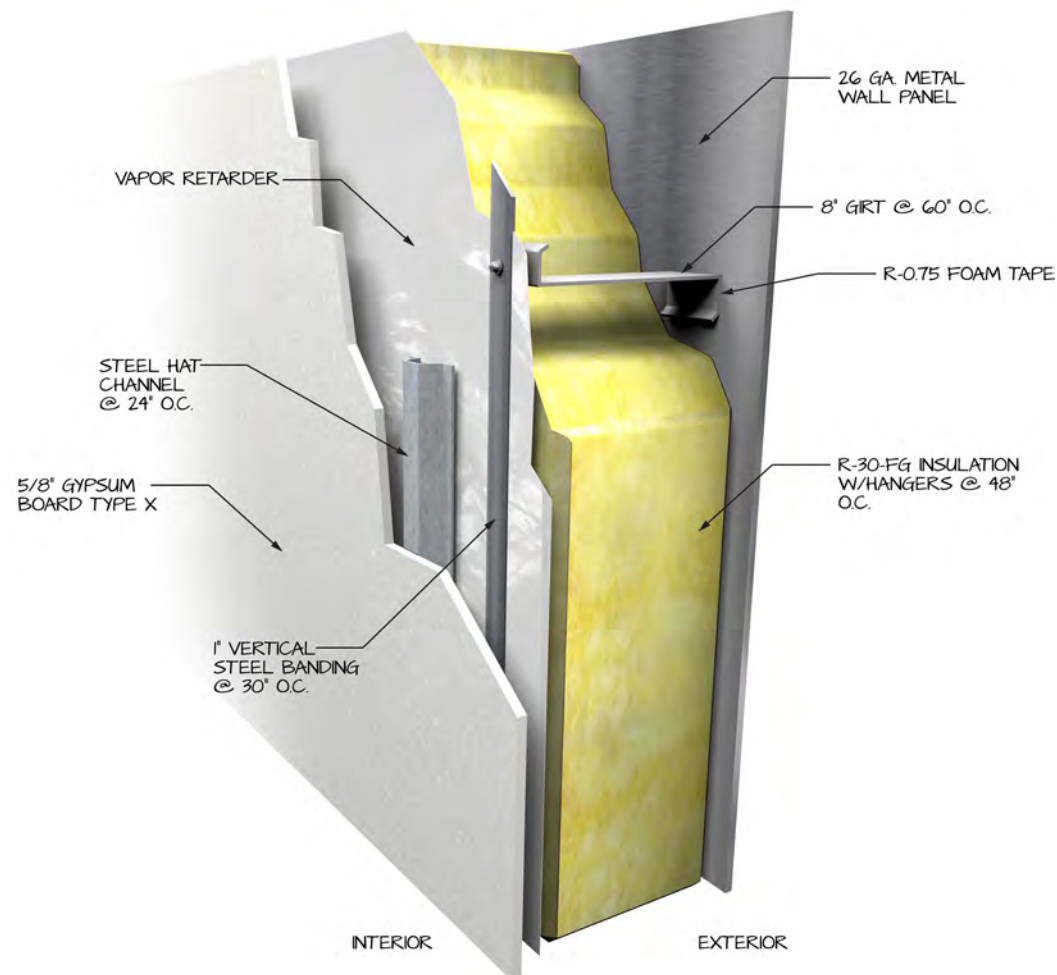
Steel Wall Panel	26 Gauge R-Panel
Foam Isolator	R-0.75 Foam Tape
Steel Girt	8" x 16 Gauge Steel Girt, spaced 60" o.c.
Insulation	R-30 Fiberglass Insulation
Vapor Retarder	Polypropylene with tri-directional fiberglass reinforcement
Steel Banding	0.02" thick, spaced 30" o.c.

Test H, Specimen W-7, Test Date 05/3/17

Data File No. G9722.01H

STC: 49

OITC: 33



Wall Assembly W-7

Materials (Source Room to Receive Room)

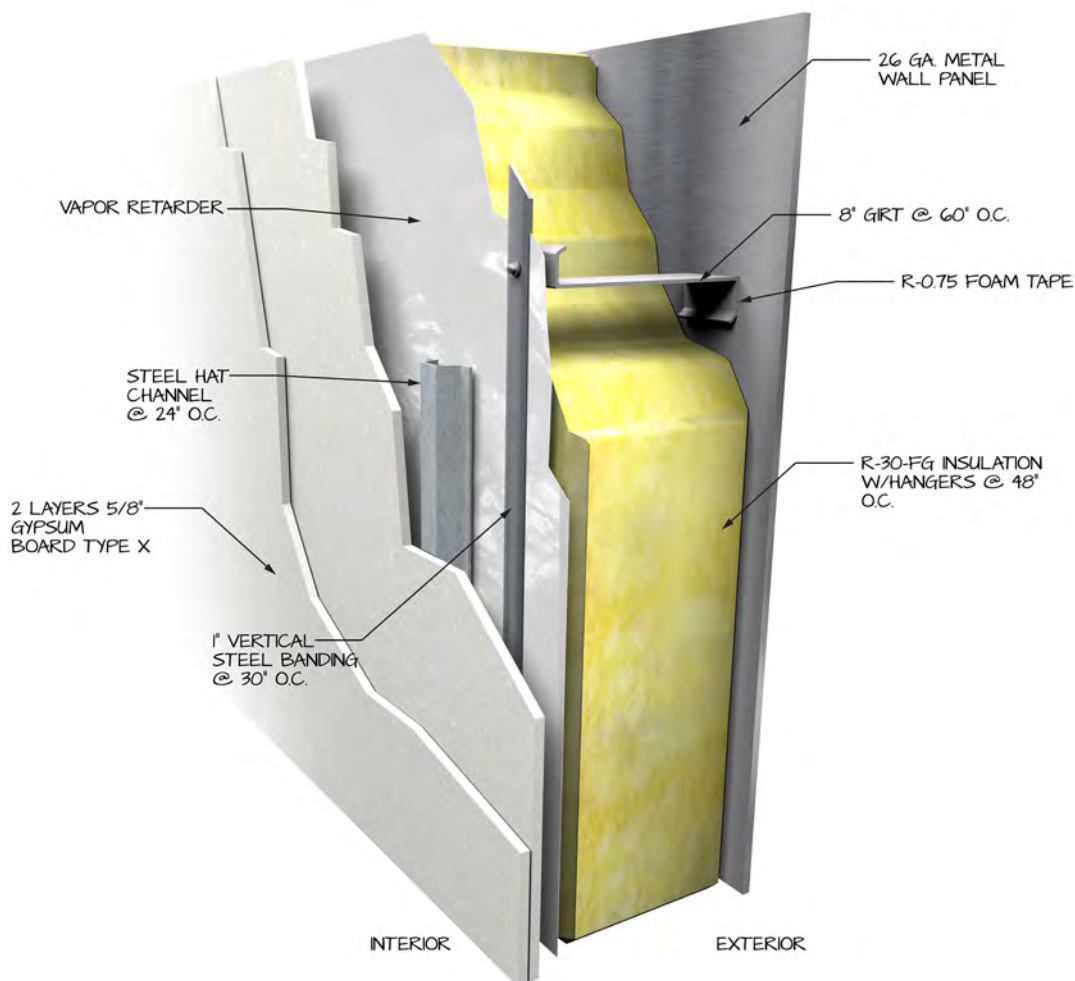
Steel Wall Panel	26 Gauge R-Panel
Foam Isolator	R-0.75 Foam Tape
Steel Girt	8" x 16 Gauge Steel Girt, spaced 60" o.c.
Insulation	R-30 Fiberglass Insulation
Vapor Retarder	Polypropylene with tri-directional fiberglass reinforcement
Steel Banding	0.02" thick, spaced 30" o.c.
Steel Hat Channel	20 MSG Galvanized, 24" o.c.
Gypsum Board	5/8" Type X Gypsum Board

Test F, Specimen W-8, Test Date 05/2/17

Data File No. G9722.01F

STC: 54

OITC: 37



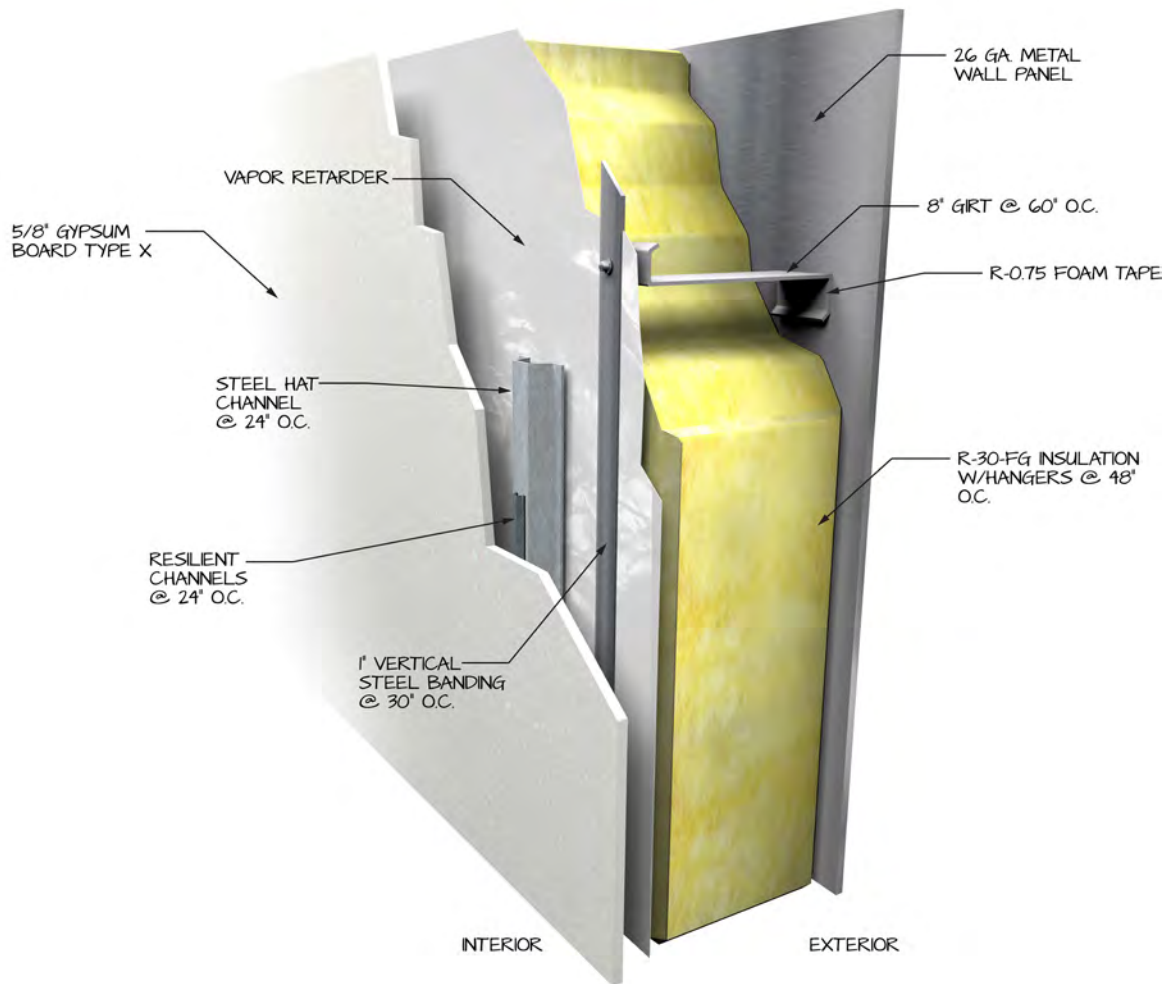
Wall Assembly W-8	
Materials (Source Room to Receive Room)	
Steel Wall Panel	26 Gauge R-Panel
Foam Isolator	R-0.75 Foam Tape
Steel Girt	8" x 16 Gauge Steel Girt, spaced 60" o.c.
Insulation	R-30 Fiberglass Insulation
Vapor Retarder	Polypropylene with tri-directional fiberglass reinforcement
Steel Banding	0.02" thick, spaced 30" o.c.
Steel Hat Channel	20 MSG Galvanized, 24" o.c.
Gypsum Board First Layer	5/8" Type X Gypsum Board
Gypsum Board Second Layer	5/8" Type X Gypsum Board

Test E, Specimen W-9, Test Date 05/2/17

Data File No. G9722.01E

STC: 54

OITC: 36



Wall Assembly W-9

Materials (Source Room to Receive Room)

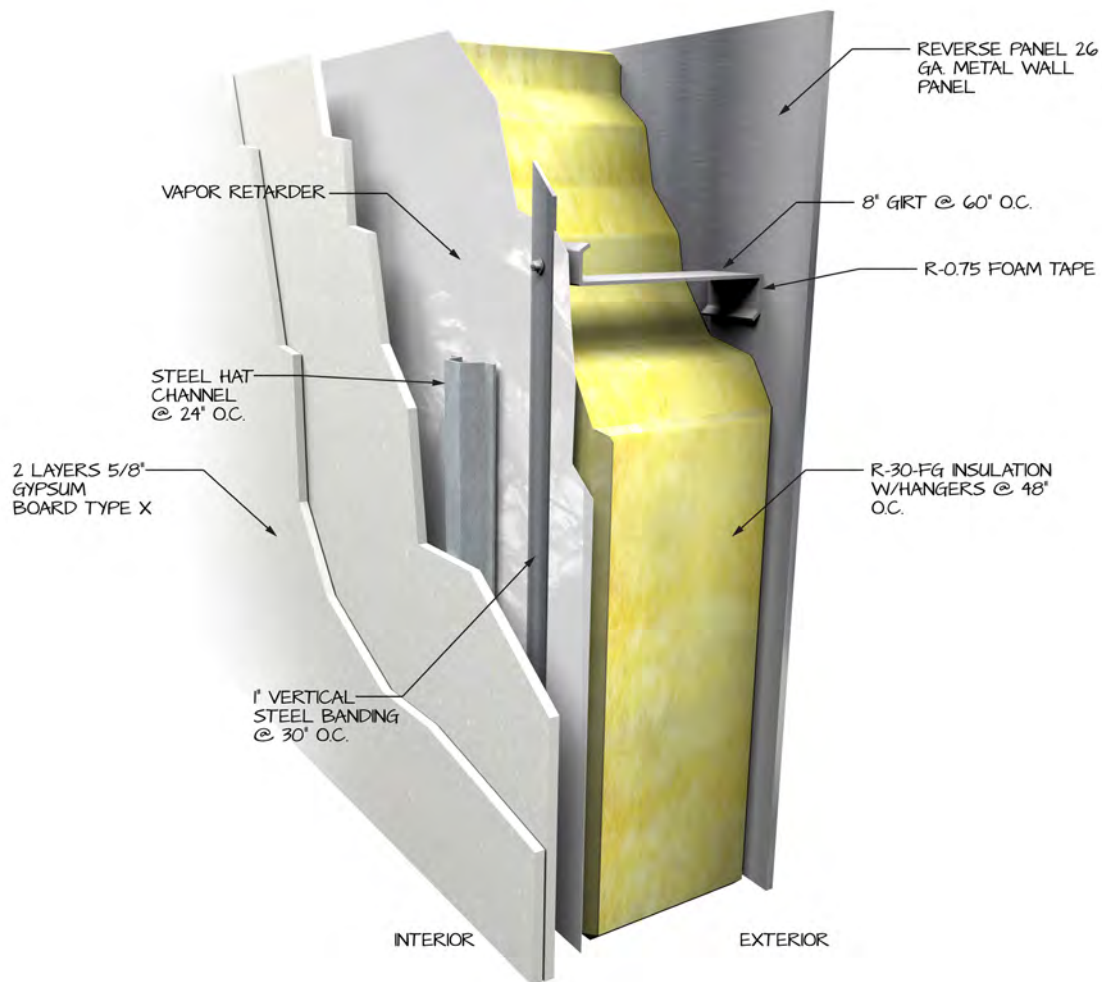
Steel Wall Panel	26 Gauge R-Panel
Foam Isolator	R-0.75 Foam Tape
Steel Girt	8" x 16 Gauge Steel Girt, spaced 60" o.c.
Insulation	R-30 Fiberglass Insulation
Vapor Retarder	Polypropylene with tri-directional fiberglass reinforcement
Steel Banding	0.02" thick, spaced 30" o.c.
Steel Hat Channel	20 MSG Galvanized, 24" o.c., vertical
Resilient Channel	0.025" thick, spaced 24" o.c., horizontal
Gypsum Board	5/8" Type X Gypsum Board

Test G, Specimen W-10, Test Date 05/2/17

Data File No. G9722.01G

STC: 53

OITC: 39



Wall Assembly W-10

Materials (Source Room to Receive Room)

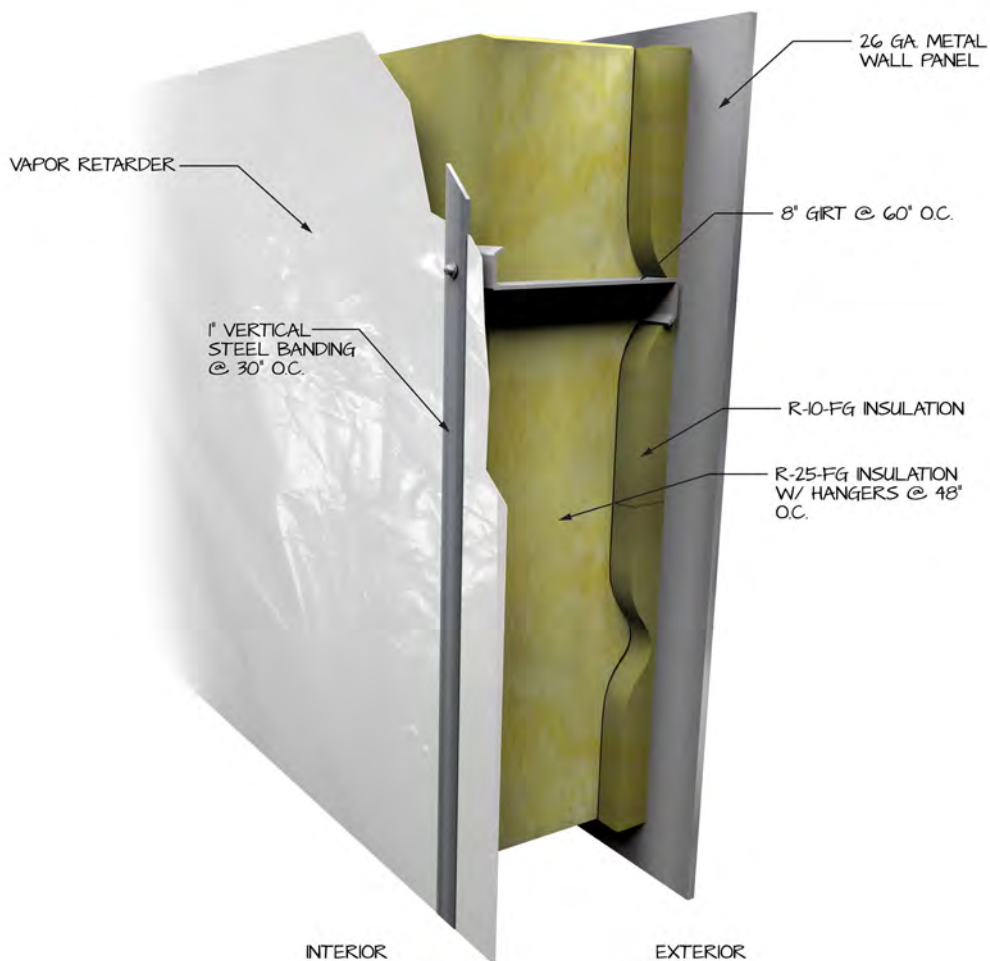
Steel Wall Panel	26 Gauge R-Panel
Foam Isolator	R-0.75 Foam Tape
Steel Girt	8" x 16 Gauge Steel Girt, spaced 60" o.c.
Insulation	R-30 Fiberglass Insulation
Vapor Retarder	Polypropylene with tri-directional fiberglass reinforcement
Steel Banding	0.02" thick, spaced 30" o.c.
Steel Hat Channel	20 MSG Galvanized, 24" o.c.
Gypsum Board First Layer	5/8" Type X Gypsum Board
Gypsum Board Second Layer	5/8" Type X Gypsum Board

Test J, Specimen W-11, Test Date 05/3/17

Data File No. G9722.01J

STC: 35

OITC: 24



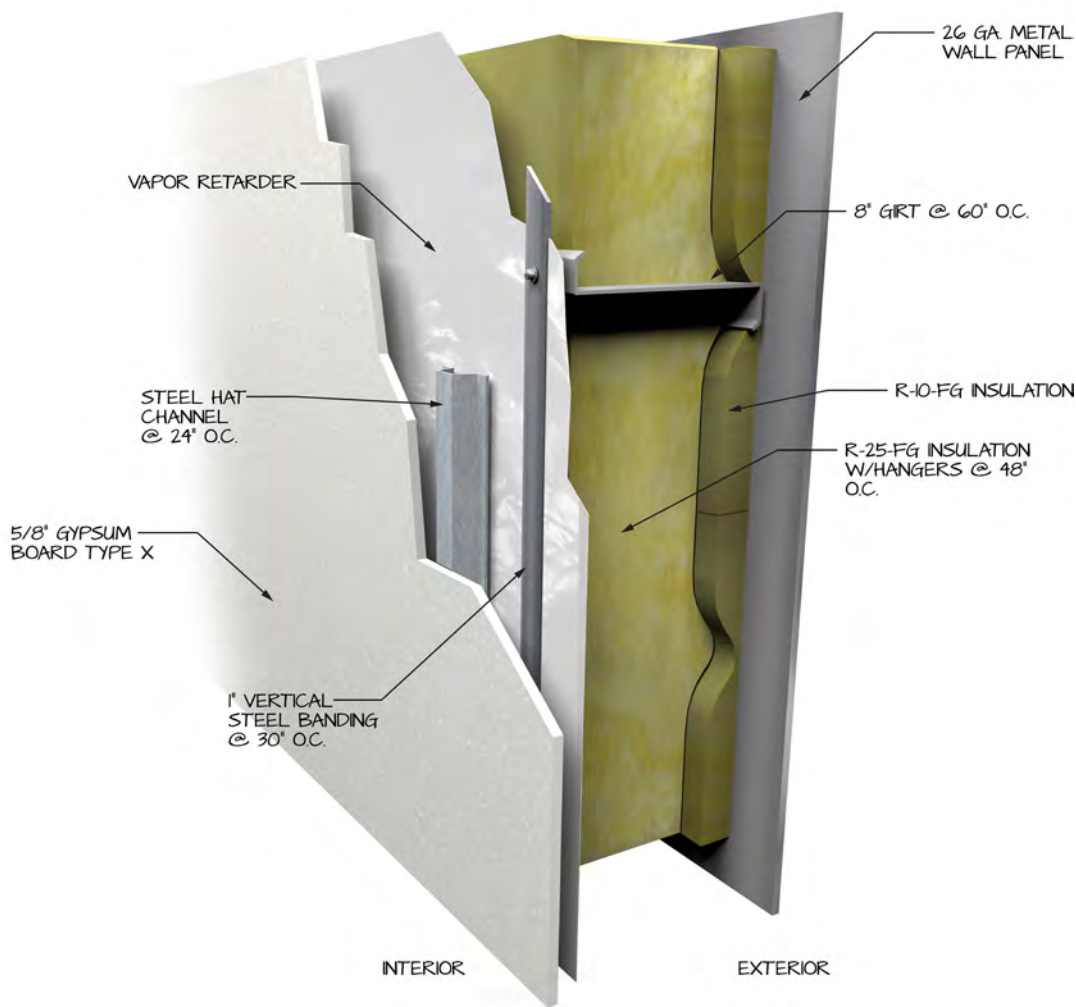
Wall Assembly W-11	
Materials (Source Room to Receive Room)	
Steel Wall Panel	26 Gauge R-Panel
Insulation	R-10 Fiberglass Insulation
Steel Girt	8" x 16 Gauge Steel Girt, spaced 60" o.c.
Insulation	R-25 Fiberglass Insulation
Vapor Retarder	Polypropylene with tri-directional fiberglass reinforcement
Steel Banding	0.02" thick, spaced 30" o.c.

Test K, Specimen W-12, Test Date 05/3/17

Data File No. G9722.01K

STC: 51

OITC: 34



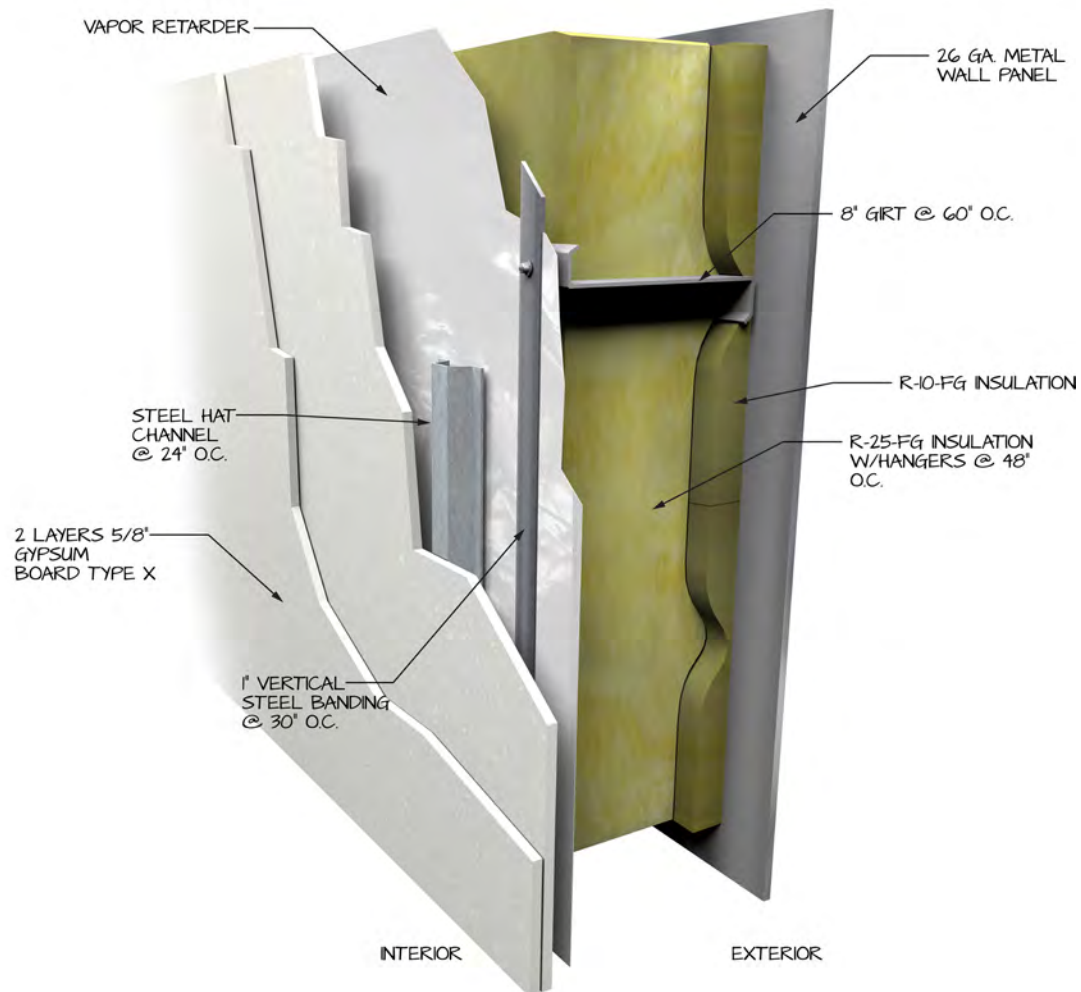
Wall Assembly W-12	
Materials (Source Room to Receive Room)	
Steel Wall Panel	26 Gauge R-Panel
Insulation	R-10 Fiberglass Insulation
Steel Girt	8" x 16 Gauge Steel Girt, spaced 60" o.c.
Insulation	R-25 Fiberglass Insulation
Vapor Retarder	Polypropylene with tri-directional fiberglass reinforcement
Steel Banding	0.02" thick, spaced 30" o.c.
Steel Hat Channel	20 MSG Galvanized, 24" o.c.
Gypsum Board	5/8" Type X Gypsum Board

Test L, Specimen W-13, Test Date 05/3/17

Data File No. G9722.01L

STC: 53

OITC: 38



Wall Assembly W-13

Materials (Source Room to Receive Room)

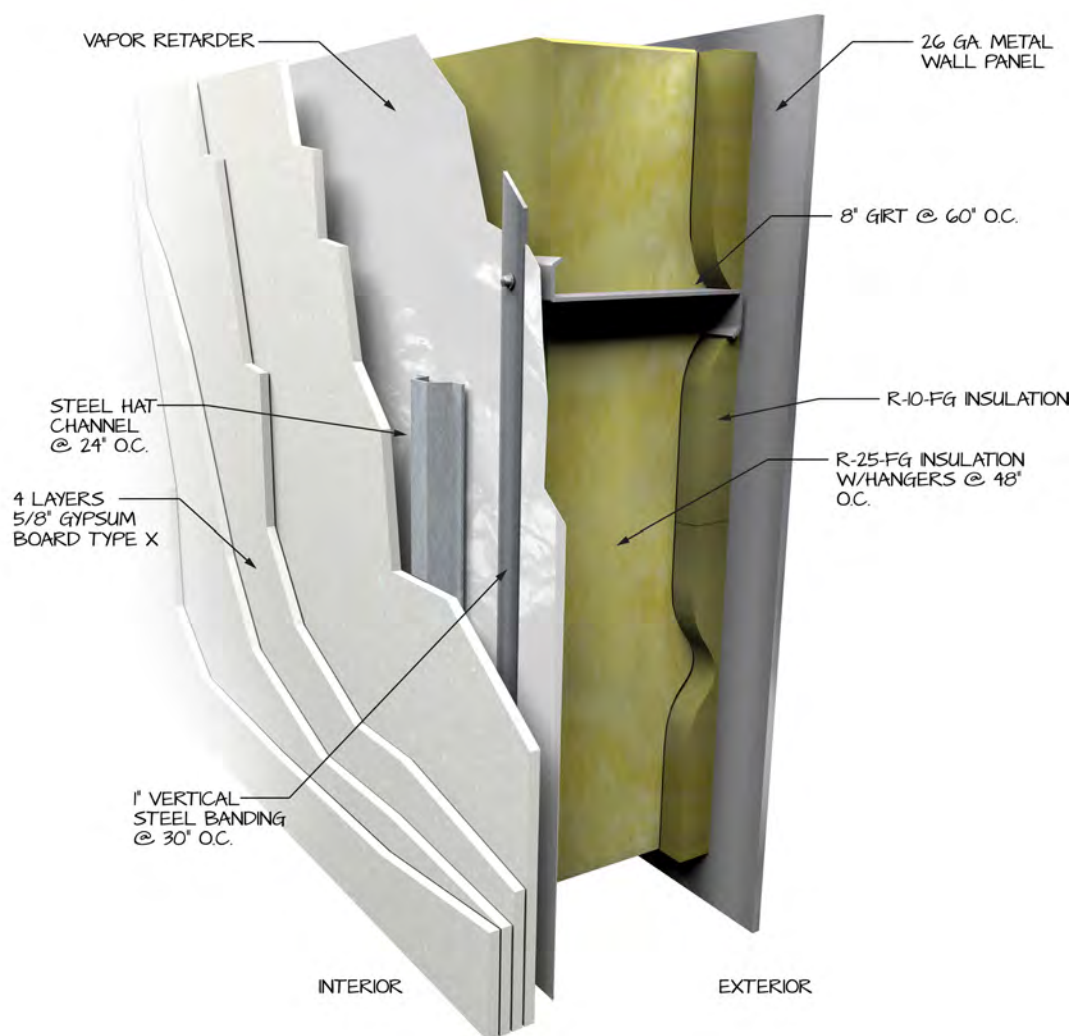
Steel Wall Panel	26 Gauge R-Panel
Insulation	R-10 Fiberglass Insulation
Steel Girt	8" x 16 Gauge Steel Girt, spaced 60" o.c.
Insulation	R-25 Fiberglass Insulation
Vapor Retarder	Polypropylene with tri-directional fiberglass reinforcement
Steel Banding	0.02" thick, spaced 30" o.c.
Steel Hat Channel	20 MSG Galvanized, 24" o.c.
Gypsum Board First Layer	5/8" Type X Gypsum Board
Gypsum Board Second Layer	5/8" Type X Gypsum Board

Test M, Specimen W-17, Test Date 05/3/17

Data File No. G9722.01M

STC: 57

OITC: 42



Wall Assembly W-17

Materials (Source Room to Receive Room)

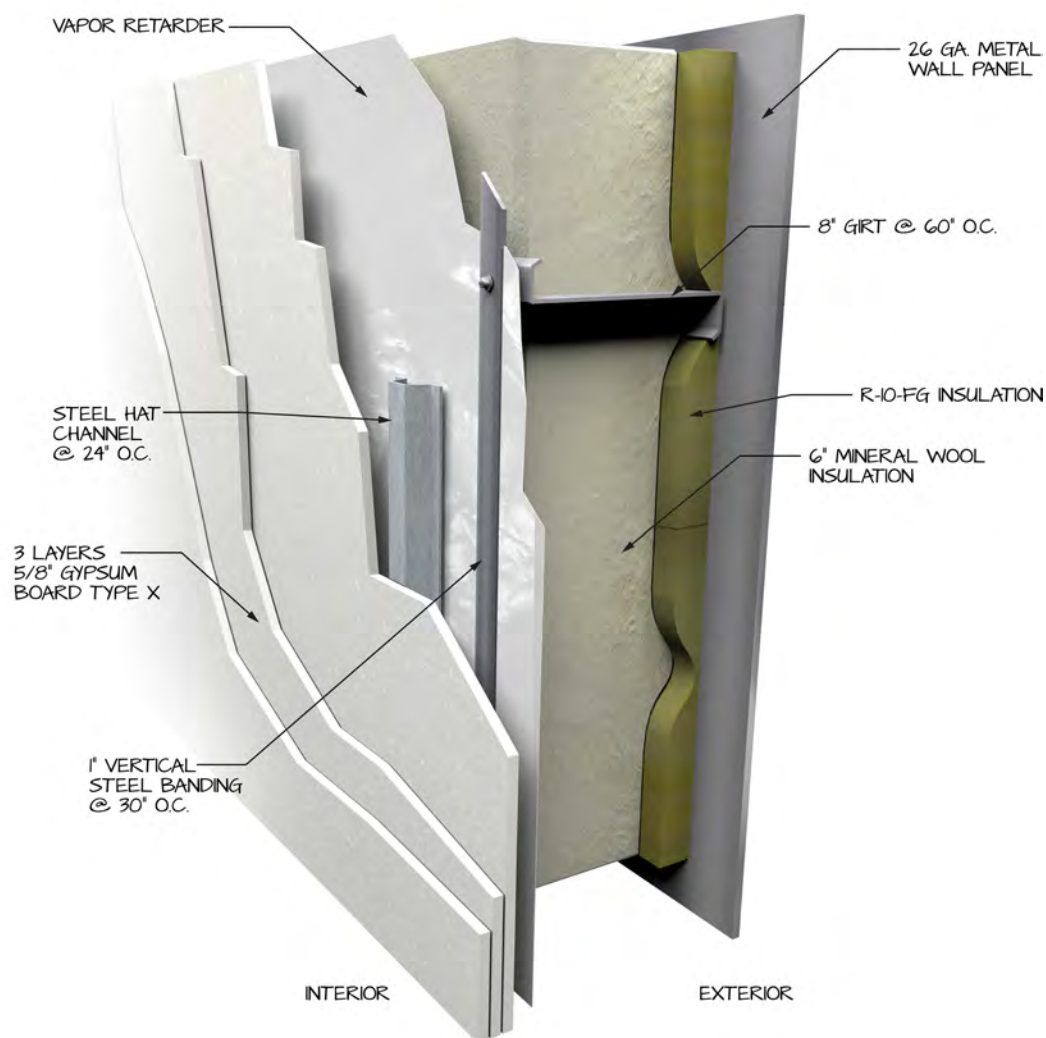
Steel Wall Panel	26 Gauge R-Panel
Insulation	R-10 Fiberglass Insulation
Steel Girt	8" x 16 Gauge Steel Girt, spaced 60" o.c.
Insulation	R-25 Fiberglass Insulation
Vapor Retarder	Polypropylene with tri-directional fiberglass reinforcement
Steel Banding	0.02" thick, spaced 30" o.c.
Steel Hat Channel	20 MSG Galvanized, 24" o.c.
Gypsum Board First Layer	5/8" Type X Gypsum Board
Gypsum Board Second Layer	5/8" Type X Gypsum Board
Gypsum Board Third Layer	5/8" Type X Gypsum Board
Gypsum Board Fourth Layer	5/8" Type X Gypsum Board

Test N, Specimen W-18, Test Date 05/3/17

Data File No. G9722.01N

STC: 55

OITC: 41



Wall Assembly W-18

Materials (Source Room to Receive Room)

Steel Wall Panel	26 Gauge R-Panel
Insulation	R-10 Fiberglass Insulation
Steel Girt	8" x 16 Gauge Steel Girt, spaced 60" o.c.
Insulation	6" Mineral Wool Insulation
Vapor Retarder	Polypropylene with tri-directional fiberglass reinforcement
Steel Banding	0.02" thick, spaced 30" o.c.
Steel Hat Channel	20 MSG Galvanized, 24" o.c.
Gypsum Board First Layer	5/8" Type X Gypsum Board
Gypsum Board Second Layer	5/8" Type X Gypsum Board
Gypsum Board Third Layer	5/8" Type X Gypsum Board



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