



MORRISON HERSHFIELD

SOPREMA / ACS Composite Systems Exterior Insulated Steel Stud Wall Thermal Analysis



Presented to:

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Report Number: 203501500
February 25, 2021

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1. INTRODUCTION

Morrison Hershfield (MH) was retained by Soprema Inc. (Soprema) to evaluate the thermal performance of the ACS-S Thermal Clip system for a variety of clip spacings, insulation types, insulation thicknesses, and a variety of backup wall configurations. This report is a summary of the analysis performed for the exterior insulated steel stud wall assemblies.

The ACS-S Thermal Clip is made of stainless steel with a 1/2 inch Extreme Pad rigid urethane foam thermal isolator. The girt is attached to the ACS-S Thermal Clip such that the girt is outboard of the exterior insulation, resulting in no girt penetration of the exterior insulation. The ACS-S Thermal Clips were evaluated to determine the clear field U-values and effective R-values for a variety of clip spacings and exterior insulation types.

For all configurations, the smallest ACS-S Thermal Clip was selected for the exterior insulation thickness as shown below in Table 1.1.

Table 1.1: Exterior Insulation Thickness for the ACS-S Thermal Clip System

ACS-S Thermal Clip Size (in)	Exterior Insulation Thickness in (mm)
2	1 (25)
2	2 (50)
3	3 (76)
4	4 (102)
5	5 (127)
6	6 (152)
7	7 (178)
8	8 (203)

Table 1.2 below summarizes the evaluated wall configurations, and Figure 1.1 illustrates a representative wall assembly using SOPRA-XPS 20 exterior insulation. The geometry of the ACS-S Thermal Clips were based on the drawings provided by ACS Composite Systems Inc. and Soprema, and are provided in Appendix A.

Table 1.2: Evaluated ACS-S Thermal Clip Assemblies: Exterior Insulated Steel Stud Wall

Exterior Insulation Type	Nominal R-Value/in	Exterior Insulation Thickness (inches)	Stud Spacing (in)	Horizontal Clip Spacing (in)	Vertical Clip Spacing (in)
SOPRA-XPS 20	R-5/in	3, 4, 5, 6, 7	16, 24	16, 24	24, 36, 48
SOPRA-SPF 202	R-6.2/in	1, 2* , 3, 4, 5, 6	16, 24	16, 24	24, 36, 48
SOPRA-ISO V ALU	R-6.5/in	1, 2* , 2.5* , 3, 3.5* , 4, 4.5* , 5, 5.5* , 6	16, 24	16, 24	24, 36, 48
Mineral Wool	R-4.3/in	3, 4* , 5, 6, 7, 8	16, 24	16, 24	24, 36, 48

*Indicates interpolated value

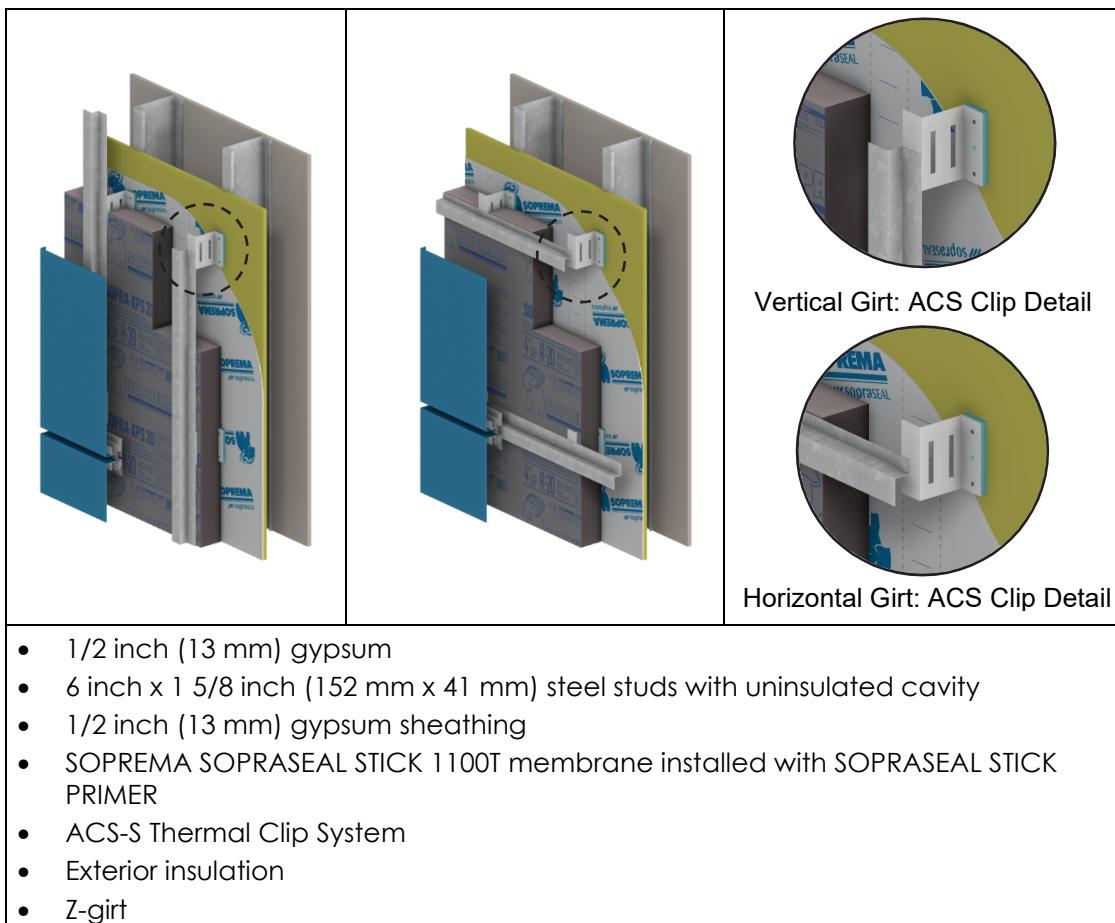


Figure 1.1: Schematic of Evaluated ACS-S Thermal Clip with Exterior Insulated Steel Stud Wall Assemblies

2. MODELLING PROCEDURES

The thermal performance of the different assembly scenarios was evaluated by 3D thermal modelling using the Nx software package from Siemens, which is a general purpose computer aided design (CAD) and finite element analysis (FEA) package. The thermal solver and modelling procedures utilized for this study were extensively calibrated and validated to within +/- 5% of hotbox testing for *ASHRAE Research Project 1365-RP Thermal Performance of Building Envelope Details for Mid- and High-Rise Construction and for the Building Envelope Thermal Bridging Guide*¹. The thermal analysis utilized steady-state conditions, published thermal properties of materials and information provided by Soprema and ACS Composite Systems Inc. Additional assumptions for the thermal analysis are listed in Appendix B. Further assembly information, including dimensions and materials are shown in the BETB Data Sheets provided in Appendix C.

¹ <https://www.bchydro.com/thermalguide>

3. THERMAL RESULTS

The clear field U- Values and effective R-values for all ACS-S Thermal Clip assembly configurations are shown below in Table 3.1 to Table 3.4. Example temperature profiles for each configuration are shown in the BETB Result Sheets provided in Appendix D.

Table 3.1: U-Value and Effective R-Value for ACS-S Thermal Clip with **SOPRA-XPS 20**
Exterior Insulation: Exterior Insulated Steel Stud Wall Assemblies

Horizontal Clip Spacing	Exterior Insulation Thickness in (mm)	Exterior Insulation 1D R-value ² (RSI)	24" Vertical Spacing		36" Vertical Spacing		48" Vertical Spacing	
			R _o ft ² ·hr·°F / Btu (m ² K / W)	U _o Btu/ft ² · hr · °F (W/m ² K)	R _o ft ² ·hr·°F / Btu (m ² K / W)	U _o Btu/ft ² · hr · °F (W/m ² K)	R _o ft ² ·hr·°F / Btu (m ² K / W)	U _o Btu/ft ² · hr · °F (W/m ² K)
16	3.0 (76)	R-15.0 (2.64)	R-17.2 (3.03)	0.058 (0.33)	R-17.5 (3.09)	0.057 (0.32)	R-17.7 (3.11)	0.057 (0.32)
	4.0 (102)	R-20.0 (3.52)	R-21.6 (3.81)	0.046 (0.26)	R-22.1 (3.89)	0.045 (0.26)	R-22.4 (3.94)	0.045 (0.25)
	5.0 (127)	R-25.0 (4.40)	R-25.9 (4.56)	0.039 (0.22)	R-26.6 (4.68)	0.038 (0.21)	R-27.0 (4.75)	0.037 (0.21)
	6.0 (152)	R-30.0 (5.28)	R-30.2 (5.32)	0.033 (0.19)	R-31.1 (5.48)	0.032 (0.18)	R-31.6 (5.57)	0.032 (0.18)
	7.0 (178)	R-35.0 (6.16)	R-34.3 (6.04)	0.029 (0.17)	R-35.5 (6.25)	0.028 (0.16)	R-36.1 (6.36)	0.028 (0.16)
24	3.0 (76)	R-15.0 (2.64)	R-17.5 (3.09)	0.057 (0.32)	R-17.7 (3.12)	0.056 (0.32)	R-17.8 (3.14)	0.056 (0.32)
	4.0 (102)	R-20.0 (3.52)	R-22.1 (3.90)	0.045 (0.26)	R-22.5 (3.96)	0.045 (0.25)	R-22.6 (3.99)	0.044 (0.25)
	5.0 (127)	R-25.0 (4.40)	R-26.6 (4.69)	0.038 (0.21)	R-27.1 (4.78)	0.037 (0.21)	R-27.4 (4.82)	0.037 (0.21)
	6.0 (152)	R-30.0 (5.28)	R-31.1 (5.48)	0.032 (0.18)	R-31.8 (5.60)	0.031 (0.18)	R-32.1 (5.65)	0.031 (0.18)
	7.0 (178)	R-35.0 (6.16)	R-35.5 (6.26)	0.028 (0.16)	R-36.3 (6.40)	0.028 (0.16)	R-36.8 (6.48)	0.027 (0.15)

Table 3.2: U-Value and Effective R-Value for ACS-S Thermal Clip with **SOPRA-SPF 202**
Exterior Insulation: Exterior Insulated Steel Stud Wall Assemblies

Horizontal Clip Spacing	Exterior Insulation Thickness in (mm)	Exterior Insulation 1D R-value ² (RSI)	24" Vertical Spacing		36" Vertical Spacing		48" Vertical Spacing	
			R _o ft ² ·hr·°F / Btu (m ² K / W)	U _o Btu/ft ² · hr · °F (W/m ² K)	R _o ft ² ·hr·°F / Btu (m ² K / W)	U _o Btu/ft ² · hr · °F (W/m ² K)	R _o ft ² ·hr·°F / Btu (m ² K / W)	U _o Btu/ft ² · hr · °F (W/m ² K)
16	1.0 (25)	R-6.2 (1.09)	R-9.2 (1.62)	0.109 (0.62)	R-9.2 (1.63)	0.108 (0.61)	R-9.2 (1.63)	0.108 (0.61)
	2.0 (51)	R-12.4 (2.18)	R-14.8 (2.61)*	0.067 (0.38)*	R-15.0 (2.65)*	0.066 (0.38)*	R-15.2 (2.67)*	0.066 (0.37)*
	3.0 (76)	R-18.6 (3.28)	R-20.3 (3.58)	0.049 (0.28)	R-20.8 (3.66)	0.048 (0.27)	R-21.0 (3.70)	0.048 (0.27)
	4.0 (102)	R-24.8 (4.37)	R-25.7 (4.52)	0.039 (0.22)	R-26.4 (4.64)	0.038 (0.22)	R-26.7 (4.71)	0.037 (0.21)
	5.0 (127)	R-31.0 (5.46)	R-30.8 (5.42)	0.033 (0.18)	R-31.8 (5.60)	0.031 (0.18)	R-32.3 (5.70)	0.031 (0.18)
	6.0 (152)	R-37.2 (6.55)	R-36.0 (6.33)	0.028 (0.16)	R-37.3 (6.57)	0.027 (0.15)	R-38.0 (6.69)	0.026 (0.15)
24	1.0 (25)	R-6.2 (1.09)	R-9.3 (1.63)	0.108 (0.61)	R-9.3 (1.63)	0.108 (0.61)	R-9.3 (1.64)	0.108 (0.61)
	2.0 (51)	R-12.4 (2.18)	R-15.1 (2.65)*	0.066 (0.38)*	R-15.2 (2.68)*	0.066 (0.37)*	R-15.3 (2.69)*	0.065 (0.37)*
	3.0 (76)	R-18.6 (3.28)	R-20.8 (3.66)	0.048 (0.27)	R-21.1 (3.71)	0.047 (0.27)	R-21.2 (3.74)	0.047 (0.27)
	4.0 (102)	R-24.8 (4.37)	R-26.4 (4.65)	0.038 (0.22)	R-26.9 (4.73)	0.037 (0.21)	R-27.1 (4.78)	0.037 (0.21)
	5.0 (127)	R-31.0 (5.46)	R-31.8 (5.60)	0.031 (0.18)	R-32.6 (5.73)	0.031 (0.17)	R-32.9 (5.80)	0.030 (0.17)
	6.0 (152)	R-37.2 (6.55)	R-37.3 (6.57)	0.027 (0.15)	R-38.2 (6.73)	0.026 (0.15)	R-38.7 (6.82)	0.026 (0.15)

*Indicates interpolated value

² This value is the nominal R-value of the exterior insulation ONLY. Additional components, such as the sheathing, air cavity, and air films all contribute an additional R-3.2 towards the nominal R-value of the entire assembly.

Table 3.3: U-Value and Effective R-Value for ACS-S Thermal Clip with **SOPRA-ISO V ALU** Exterior Insulation: Exterior Insulated Steel Stud Wall Assemblies

Horizontal Clip Spacing	Exterior Insulation Thickness in (mm)	Exterior Insulation 1D R-value ³ (RSI)	24" Vertical Spacing		36" Vertical Spacing		48" Vertical Spacing	
			R _o ft ² ·hr·°F / Btu (m ² K / W)	U _o Btu/ft ² · hr · °F (W/m ² K)	R _o ft ² ·hr·°F / Btu (m ² K / W)	U _o Btu/ft ² · hr · °F (W/m ² K)	R _o ft ² ·hr·°F / Btu (m ² K / W)	U _o Btu/ft ² · hr · °F (W/m ² K)
16	1.0 (25)	R-6.5 (1.14)	R-9.5 (1.68)	0.105 (0.60)	R-9.6 (1.69)	0.104 (0.59)	R-9.6 (1.69)	0.104 (0.59)
	2.0 (51)	R-13.0 (2.29)	R-15.4 (2.71)*	0.065 (0.37)*	R-15.7 (2.76)*	0.064 (0.36)*	R-15.8 (2.78)*	0.063 (0.36)*
	2.5 (64)	R-16.3 (2.86)	R-18.3 (3.22)*	0.055 (0.31)*	R-18.6 (3.28)*	0.054 (0.30)*	R-18.8 (3.32)*	0.053 (0.30)*
	3.0 (76)	R-19.5 (3.43)	R-21.2 (3.73)	0.047 (0.27)	R-21.6 (3.81)	0.046 (0.26)	R-21.9 (3.85)	0.046 (0.26)
	3.5 (89)	R-22.8 (4.01)	R-23.9 (4.22)*	0.042 (0.24)*	R-24.6 (4.33)*	0.041 (0.23)*	R-24.9 (4.38)*	0.040 (0.23)*
	4.0 (102)	R-26.0 (4.58)	R-26.7 (4.71)	0.037 (0.21)	R-27.5 (4.84)	0.036 (0.21)	R-27.9 (4.91)	0.036 (0.20)
	4.5 (114)	R-29.3 (5.15)	R-29.5 (5.19)*	0.034 (0.19)*	R-30.4 (5.35)*	0.033 (0.19)*	R-30.9 (5.43)*	0.032 (0.18)*
	5.0 (127)	R-32.5 (5.72)	R-32.1 (5.65)	0.031 (0.18)	R-33.2 (5.84)	0.030 (0.17)	R-33.8 (5.95)	0.030 (0.17)
	5.5 (140)	R-35.8 (6.30)	R-34.8 (6.13)*	0.029 (0.16)*	R-36.1 (6.35)*	0.028 (0.16)*	R-36.7 (6.47)*	0.027 (0.15)*
	6.0 (152)	R-39.0 (6.87)	R-37.5 (6.60)	0.027 (0.15)	R-38.9 (6.86)	0.026 (0.15)	R-39.7 (6.99)	0.025 (0.14)
24	1.0 (25)	R-6.5 (1.14)	R-9.6 (1.69)	0.104 (0.59)	R-9.6 (1.69)	0.104 (0.59)	R-9.6 (1.70)	0.104 (0.59)
	2.0 (51)	R-13.0 (2.29)	R-15.7 (2.76)*	0.064 (0.36)*	R-15.8 (2.79)*	0.063 (0.36)*	R-15.9 (2.80)*	0.063 (0.36)*
	2.5 (64)	R-16.3 (2.86)	R-18.7 (3.29)*	0.054 (0.30)*	R-18.9 (3.33)*	0.053 (0.30)*	R-19.0 (3.35)*	0.053 (0.30)*
	3.0 (76)	R-19.5 (3.43)	R-21.7 (3.81)	0.046 (0.26)	R-22.0 (3.87)	0.045 (0.26)	R-22.1 (3.90)	0.045 (0.26)
	3.5 (89)	R-22.8 (4.01)	R-24.6 (4.33)*	0.041 (0.23)*	R-25.0 (4.41)*	0.040 (0.23)*	R-25.2 (4.44)*	0.040 (0.23)*
	4.0 (102)	R-26.0 (4.58)	R-27.5 (4.85)	0.036 (0.21)	R-28.0 (4.94)	0.036 (0.20)	R-28.3 (4.99)	0.035 (0.20)
	4.5 (114)	R-29.3 (5.15)	R-30.4 (5.35)*	0.033 (0.19)*	R-31.0 (5.47)*	0.032 (0.18)*	R-31.4 (5.52)*	0.032 (0.18)*
	5.0 (127)	R-32.5 (5.72)	R-33.2 (5.85)	0.030 (0.17)	R-34.0 (5.99)	0.029 (0.17)	R-34.4 (6.06)	0.029 (0.17)
	5.5 (140)	R-35.8 (6.30)	R-36.1 (6.36)*	0.028 (0.16)*	R-37.0 (6.51)*	0.027 (0.15)*	R-37.4 (6.59)*	0.027 (0.15)*
	6.0 (152)	R-39.0 (6.87)	R-38.9 (6.86)	0.026 (0.15)	R-39.9 (7.03)	0.025 (0.14)	R-40.5 (7.13)	0.025 (0.14)

*Indicates interpolated value

³ This value is the nominal R-value of the exterior insulation ONLY. Additional components, such as the sheathing, air cavity, and air films all contribute an additional R-3.2 towards the nominal R-value of the entire assembly.

Table 3.4: U-Value and Effective R-Value for ACS-S Thermal Clip with **Mineral Wool**
Exterior Insulation: Exterior Insulated Steel Stud Wall Assemblies

Horizontal Clip Spacing	Exterior Insulation Thickness in (mm)	Exterior Insulation 1D R-value ⁴ (RSI)	24" Vertical Spacing		36" Vertical Spacing		48" Vertical Spacing	
			R _o ft ² ·hr·°F / Btu (m ² K / W)	U _o Btu/ft ² · hr · °F (W/m ² K)	R _o ft ² ·hr·°F / Btu (m ² K / W)	U _o Btu/ft ² · hr · °F (W/m ² K)	R _o ft ² ·hr·°F / Btu (m ² K / W)	U _o Btu/ft ² · hr · °F (W/m ² K)
16	3.0 (76)	R-12.9 (2.27)	R-15.3 (2.70)	0.065 (0.37)	R-15.6 (2.74)	0.064 (0.36)	R-15.7 (2.76)	0.064 (0.36)
	4.0 (102)	R-17.2 (3.03)	R-19.1 (3.37)*	0.052 (0.30)*	R-19.5 (3.44)*	0.051 (0.29)*	R-19.7 (3.47)*	0.051 (0.29)*
	5.0 (127)	R-21.5 (3.79)	R-22.9 (4.03)	0.044 (0.25)	R-23.5 (4.13)	0.043 (0.24)	R-23.7 (4.18)	0.042 (0.24)
	6.0 (152)	R-25.8 (4.54)	R-26.7 (4.70)	0.037 (0.21)	R-27.4 (4.82)	0.037 (0.21)	R-27.8 (4.89)	0.036 (0.20)
	7.0 (178)	R-30.1 (5.30)	R-30.3 (5.34)	0.033 (0.19)	R-31.2 (5.50)	0.032 (0.18)	R-31.7 (5.58)	0.032 (0.18)
	8.0 (203)	R-34.4 (6.06)	R-34.1 (6.00)	0.029 (0.17)	R-35.1 (6.19)	0.028 (0.16)	R-35.7 (6.29)	0.028 (0.16)
24	3.0 (76)	R-12.9 (2.27)	R-15.6 (2.75)	0.064 (0.36)	R-15.7 (2.77)	0.063 (0.36)	R-15.8 (2.79)	0.063 (0.36)
	4.0 (102)	R-17.2 (3.03)	R-19.5 (3.44)*	0.051 (0.29)*	R-19.8 (3.49)*	0.050 (0.29)*	R-19.9 (3.51)*	0.050 (0.28)*
	5.0 (127)	R-21.5 (3.79)	R-23.5 (4.13)	0.043 (0.24)	R-23.9 (4.21)	0.042 (0.24)	R-24.1 (4.24)	0.042 (0.24)
	6.0 (152)	R-25.8 (4.54)	R-27.4 (4.83)	0.036 (0.21)	R-27.9 (4.91)	0.036 (0.20)	R-28.2 (4.96)	0.036 (0.20)
	7.0 (178)	R-30.1 (5.30)	R-31.2 (5.50)	0.032 (0.18)	R-31.9 (5.61)	0.031 (0.18)	R-32.2 (5.67)	0.031 (0.18)
	8.0 (203)	R-34.4 (6.06)	R-35.2 (6.19)	0.028 (0.16)	R-35.9 (6.33)	0.028 (0.16)	R-36.3 (6.40)	0.028 (0.16)

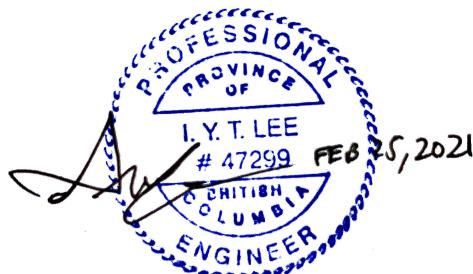
*Indicates interpolated value

We believe that this report meets your objectives for evaluating the thermal performance for the ACS-S Thermal Clip system with exterior insulated steel stud wall assemblies. If you have any questions or comments related to the above, please do not hesitate to contact the undersigned.

Morrison Hershfield Limited



Katie Hay, P.Eng.
Building Science Consultant

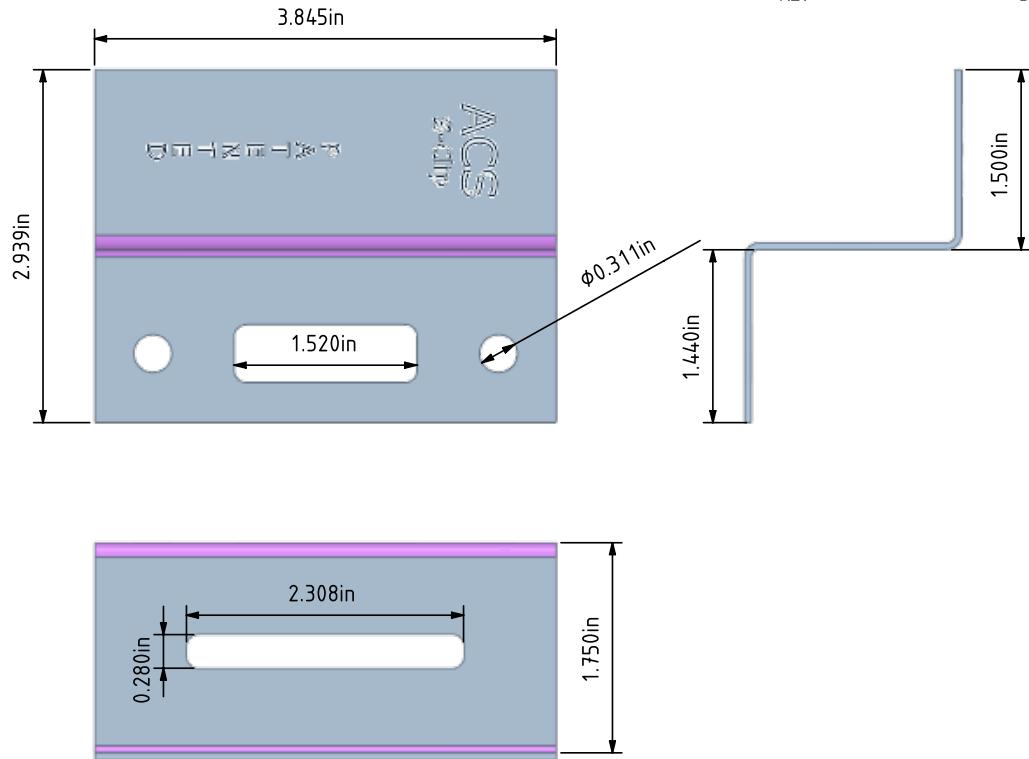


Ivan Lee, P.Eng.
Building Science Consultant

⁴ This value is the nominal R-value of the exterior insulation ONLY. Additional components, such as the sheathing, air cavity, and air films all contribute an additional R-3.2 towards the nominal R-value of the entire assembly.

APPENDIX A: DETAIL DRAWINGS

NOTES:



REVISION HISTORY

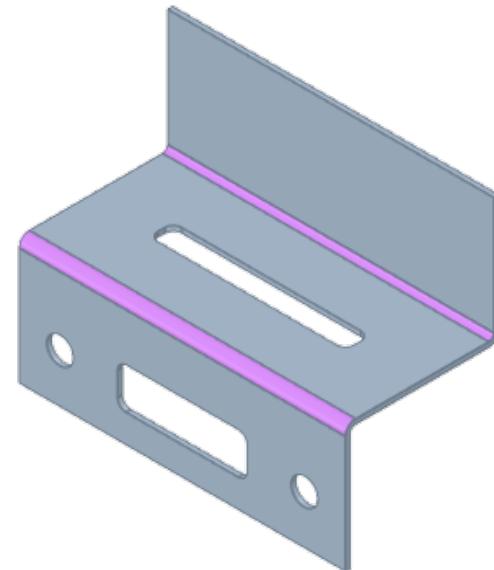
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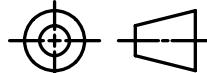
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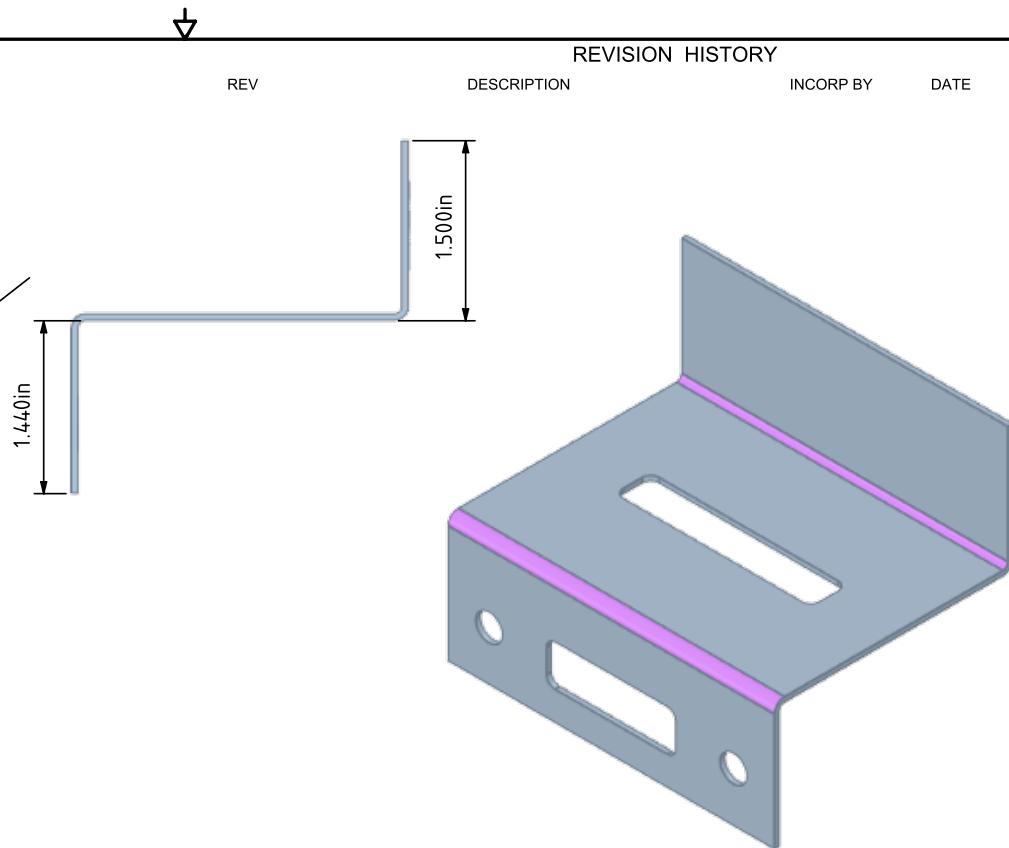
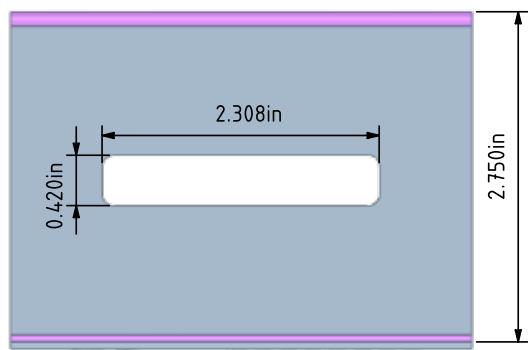
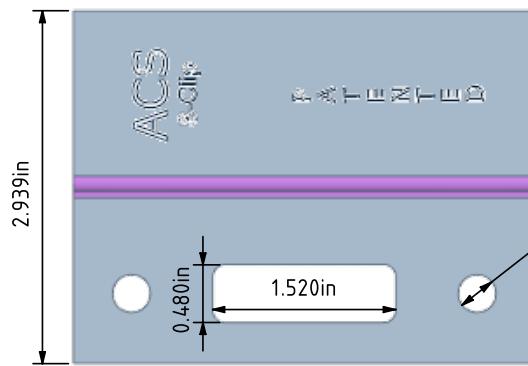
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						B					
						SCALE		SHEET			

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NOTES:



REVISION HISTORY

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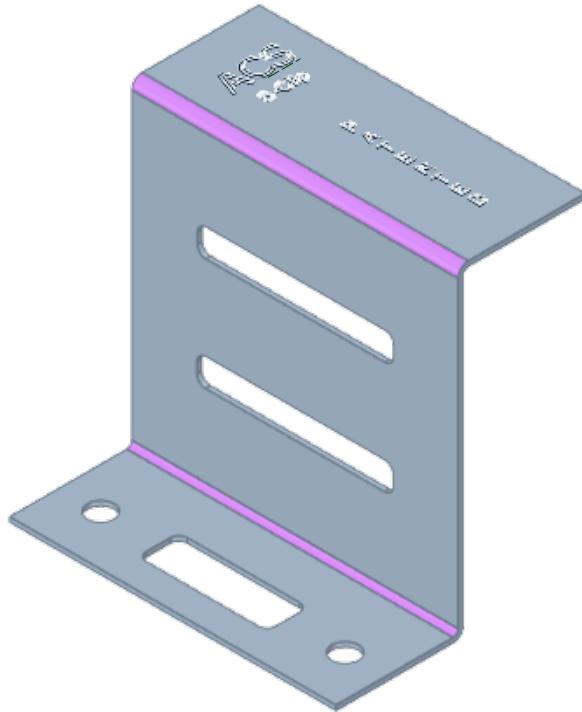
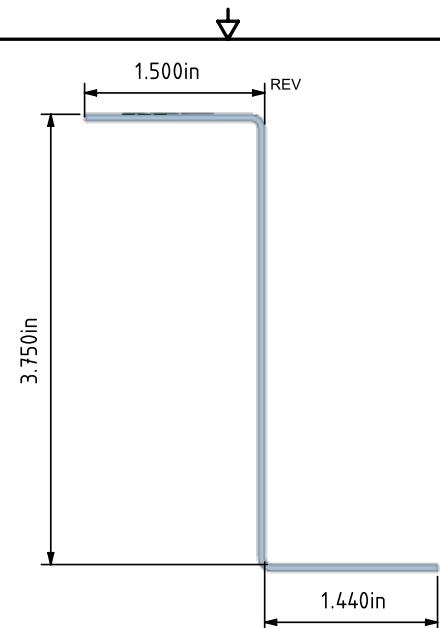
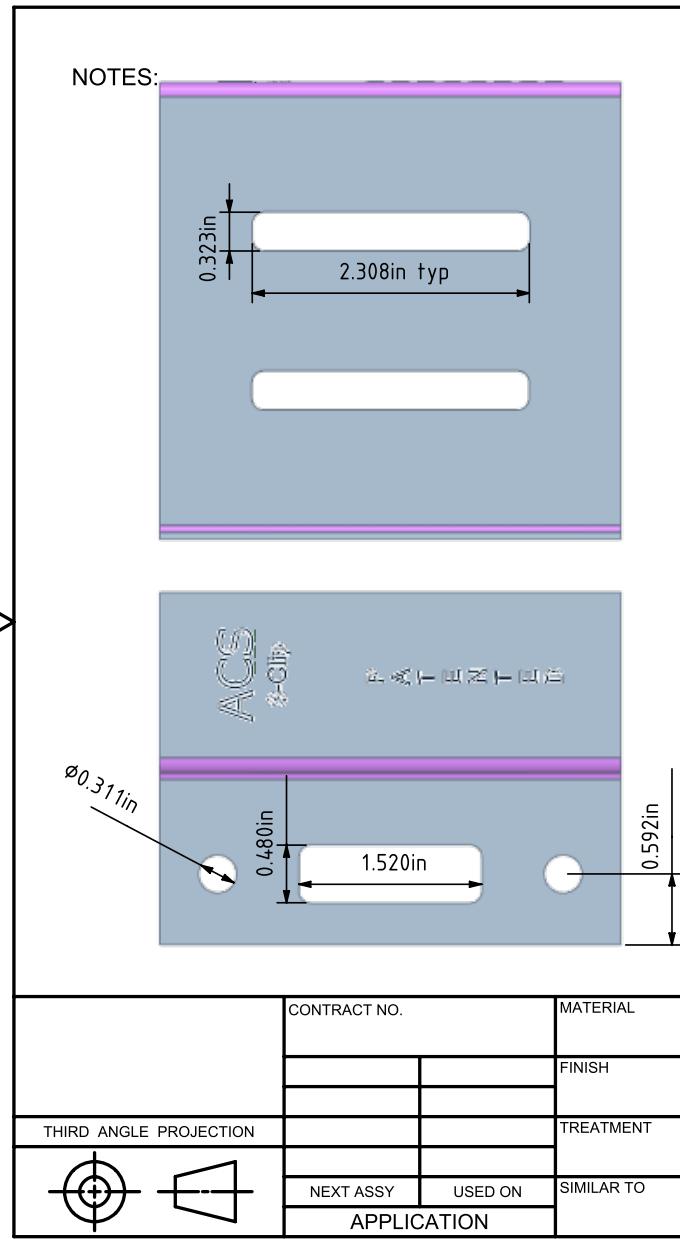
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REVISION HISTORY

DESCRIPTION

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DATE

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INIT	APPROVALS	DATE	INIT	APPROVALS	DATE	ACS Composite Systems			
						TITLE 4in Solid Clip			
						SIZE	CAGE CODE	DWG NO.	REV
						B			2
						SCALE		SHEET	

REVISION HISTORY

REV

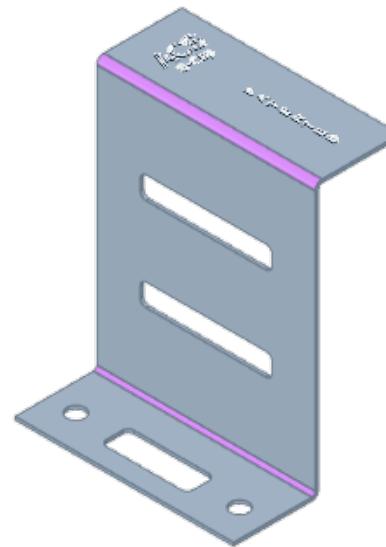
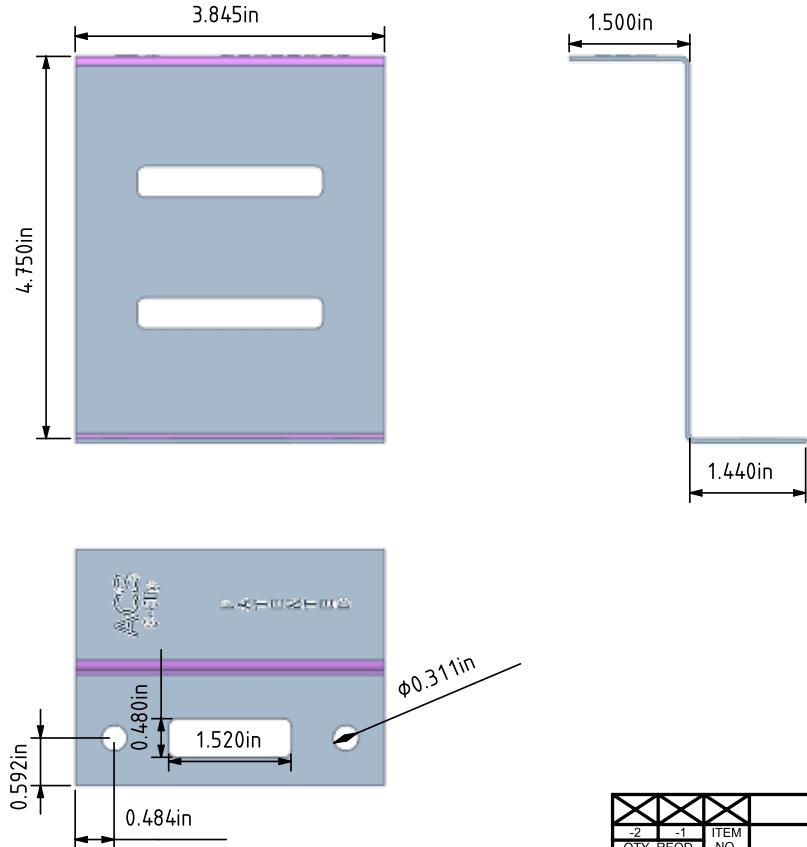
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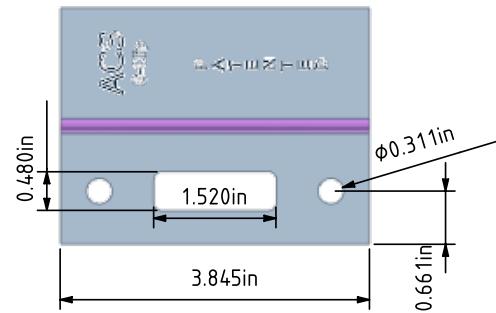
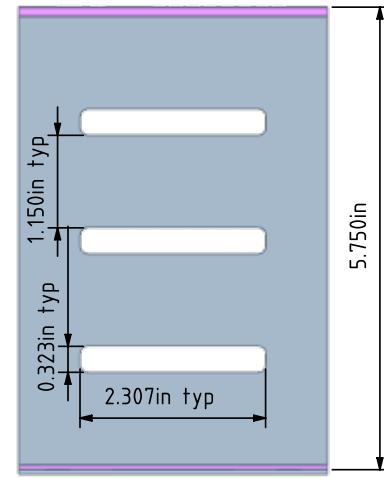
DATE

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NOTES:



NOTES:



1.500in REV

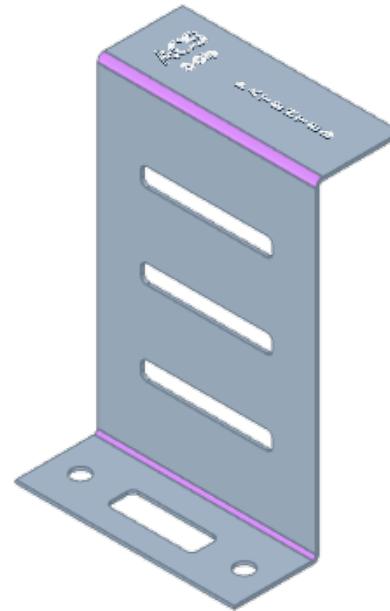
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DATE

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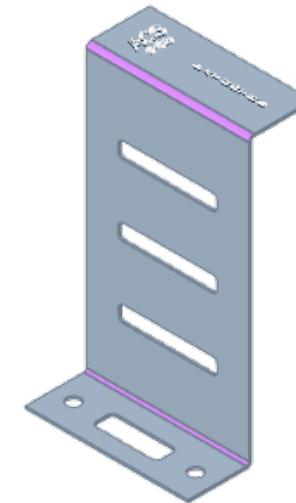
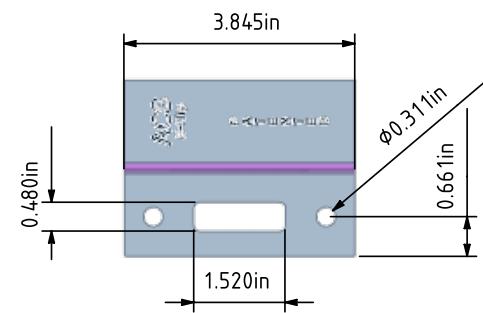
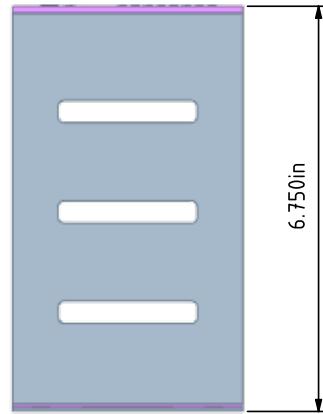
PART OR IDENTIFYING NO.

NOMENCLATURE OR DESCRIPTION

PARTS LIST

CONTRACT NO.	MATERIAL	INIT	APPROVALS	DATE	INIT	APPROVALS	DATE	ACS Composite Systems		
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	TREATMENT									
THIRD ANGLE PROJECTION	SIMILAR TO									
	APPLICATION							SIZE	CAGE CODE	DWG NO.
		B								REV 2
		SCALE						SHEET		

NOTES:



REV

REVISION HISTORY

DESCRIPTION

INCORP BY

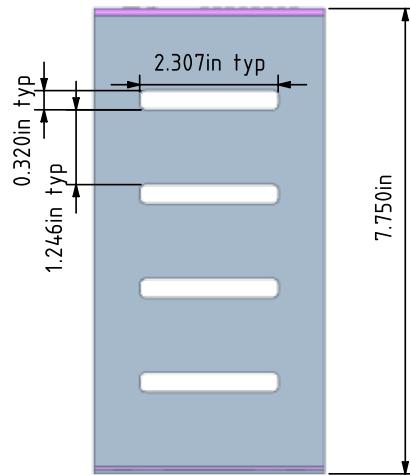
DATE

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-2	-1	ITEM NO.	PART OR IDENTIFYING NO.		NOMENCLATURE OR DESCRIPTION	
INIT	APPROVALS	DATE	INIT	APPROVALS	DATE	ACS Composite Systems
TITLE						
7in Solid Clip						
						SIZE CAGE CODE DWG NO.
						B REV 2
						SCALE SHEET

	CONTRACT NO.		MATERIAL
			FINISH
THIRD ANGLE PROJECTION			TREATMENT
	NEXT ASSY	USED ON	SIMILAR TO
	APPLICATION		

NOTES:

REV
1.500in

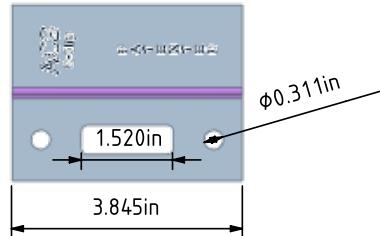
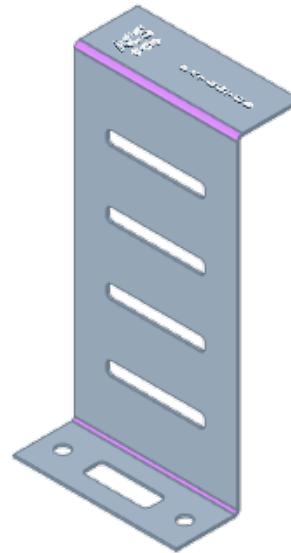
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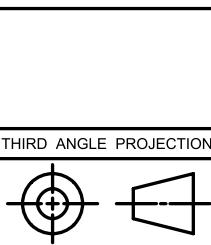
INCORP BY

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CONTRACT NO.	MATERIAL	PART OR IDENTIFYING NO.		NOMENCLATURE OR DESCRIPTION		
		INIT	APPROVALS	DATE	INIT	
ACS Composite Systems						
8in Solid Clip						
THIRD ANGLE PROJECTION	FINISH					
NEXT ASSY	USED ON	TREATMENT				
APPLICATION		SIMILAR TO				
			SIZE	CAGE CODE	DWG NO.	
		B				
			SCALE		SHEET	
					REV 2	



APPENDIX B: MODELLING PARAMETERS AND ASSUMPTIONS

1. GENERAL MODELLING APPROACH

For this report, a steady-state conduction model was used. The following parameters were also assumed:

- Material properties were taken from information provided by Soprema Inc., ACS Composite Systems Inc., and ASHRAE Handbook – Fundamentals for common materials.
- Enclosed air spaces were modelled with an equivalent thermal conductivity of the air that includes the impacts of convection and radiation within the enclosure. Calculations for this equivalent conductivity were based on ISO 10077.
- Interior/exterior air films were taken from Table 10, p. 26.21 of 2017 ASHRAE Handbook – Fundamentals depending on surface orientation. The exterior air films were based on an exterior wind speed of 15 mph.
- In ASHRAE 1365-RP, for rain screen cavity systems, most lightweight claddings have an insignificant impact on the thermal performance other than shielding the insulation from direct wind exposure. The cladding and secondary structure outboard of the clip system were not explicitly modelled, but were incorporated into the exterior film coefficient.
- From the calibration in 1365-RP, contact resistances between materials were modelled and varied between R-0.01 and R-0.2 depending on the materials and interfaces.
- Insulation and other components were considered tight to adjacent interfaces.
- The clear field transmittances included in this analysis include uniform thermal bridges such as studs, clips, and girts.

2. TEMPERATURE INDEX

The temperature index is the ratio of the surface temperature relative to the interior and exterior temperatures. The temperature index has a value between 0 and 1, where 0 is the exterior temperature and 1 is the interior temperature. If T_i is known, Equation 1 can be rearranged for $T_{surface}$. This arrangement allows the modelled surface temperatures to be applicable to any climate.

$$T_i = \frac{T_{surface} - T_{outside}}{T_{inside} - T_{outside}} \quad \text{EQ 1}$$

Note, these indices shown in the temperature profiles for this analysis are for general information only and are not intended to predict in-service surface temperatures subject to transient conditions, variable heating systems, and/ or interior obstructions that restrict heating of the assembly. For full limitations of this modeling approach, see ASHRAE 1365-RP.

3. BOUNDARY CONDITIONS

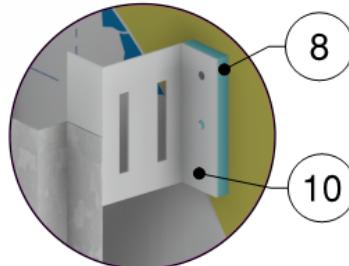
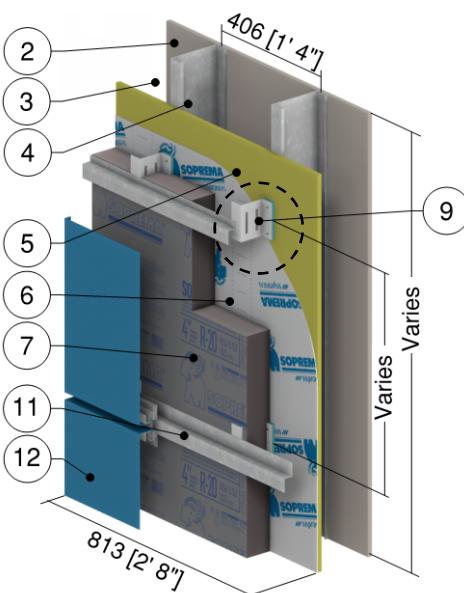
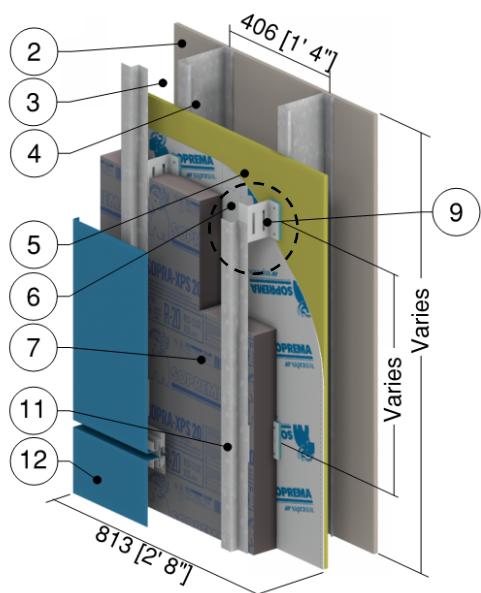
Table B3.1: Boundary Conditions

Boundary Location	Combined Convective and Radiation Heat Transfer Coefficient BTU/h ft ² °F (W/m ² K)
Exterior Wall Surfaces with Generic Cladding	1.5 (8.3)
Interior Walls	1.5 (8.3)

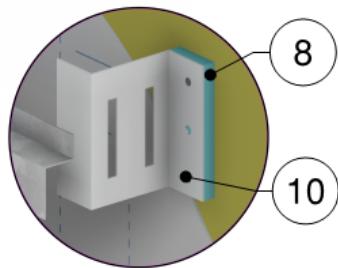
**APPENDIX C:
BUILDING ENVELOPE THERMAL
BRIDGING GUIDE DATA SHEETS**

Detail 1.1

Exterior Insulated 6" x 1 5/8" Steel Stud (16" o.c.) Wall Assembly with SOPREMA SOPRA-XPS 20 and ACS-S Thermal Clip Supporting Metal Cladding - Clear Wall



Vertical Girt: ACS Clip Detail



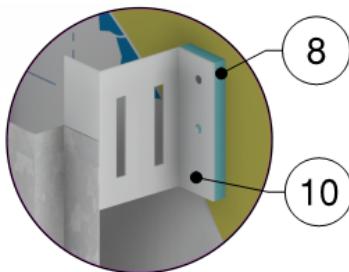
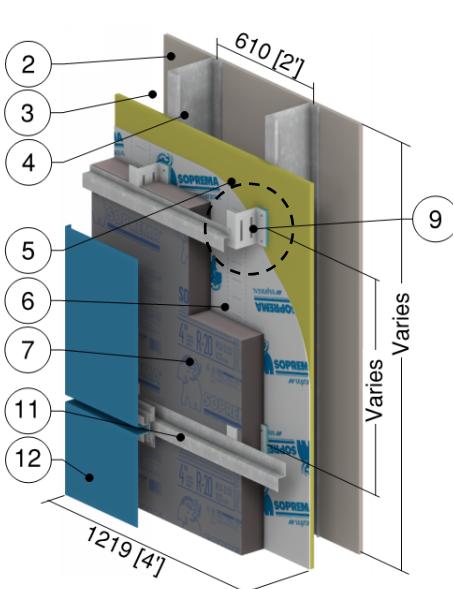
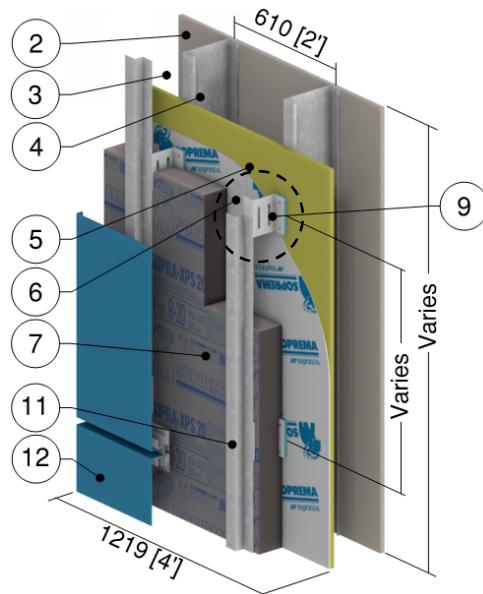
Horizontal Girt: ACS Clip Detail

ID	Component	Thickness Inches (mm)	Conductivity Btu·in / ft ² ·hr·°F (W/m K)	Nominal Resistance hr·ft ² ·°F/Btu (m ² K/W)	Density lb/ft ³ (kg/m ³)	Specific Heat Btu/lb·°F (J/kg K)
1	Interior Film ¹	-	-	R-0.7 (0.12 RSI)	-	-
2	Gypsum Board	1/2" (13)	1.1 (0.16)	R-0.5 (0.09 RSI)	50 (800)	0.26 (1090)
3	Air in Stud Cavity	6" (152)	-	R-0.9 (0.16 RSI)	0.075 (1.2)	0.24 (1000)
4	6" x 1 5/8" Steel Studs	18 Gauge	430 (62)	-	489 (7830)	0.12 (500)
5	Exterior Sheathing	1/2" (13)	1.1 (0.16)	R-0.5 (0.09 RSI)	50 (800)	0.26 (1090)
6	SOPREMA SOPRASEAL STICK 1100T membrane installed with SOPRASEAL STICK PRIMER	-	-	-	-	-
7	SOPRA-XPS 20 Exterior Insulation	Varies	0.20 (0.029)	R-15.0 to R-35.0 (2.64 RSI to 6.16 RSI)	2.5 (40)	0.29 (1220)
8	Thermal Break	1/2" (13)	0.13 (0.019)	-	2.1 (33)	0.50 (2100)
9	ACS-S Thermal Clip	16 Gauge	118 (17)	-	500 (8000)	0.13 (530)
10	Fastener	1/4" (6.4) Ø	347 (50)	-	489 (7830)	0.12 (500)
11	Girt	18 Gauge	430 (62)	-	489 (7830)	0.12 (500)
12	Cladding with 1/2" vented airspace incorporated into exterior heat transfer coefficient					
13	Exterior Film ¹	-	-	R-0.7 (0.12 RSI)	-	-

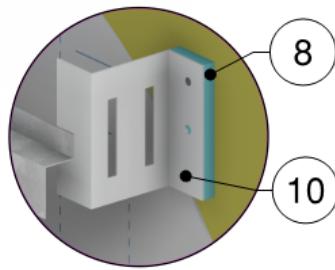
¹ Value selected from table 1, p. 26.1 of 2009 ASHRAE Handbook – Fundamentals depending on surface orientation

Detail 1.2

Exterior Insulated 6" x 1 5/8" Steel Stud (24" o.c.) Wall Assembly with SOPREMA SOPRA-XPS 20 and ACS-S Thermal Clip Supporting Metal Cladding - Clear Wall



Vertical Girt: ACS Clip Detail



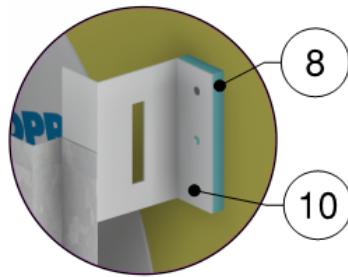
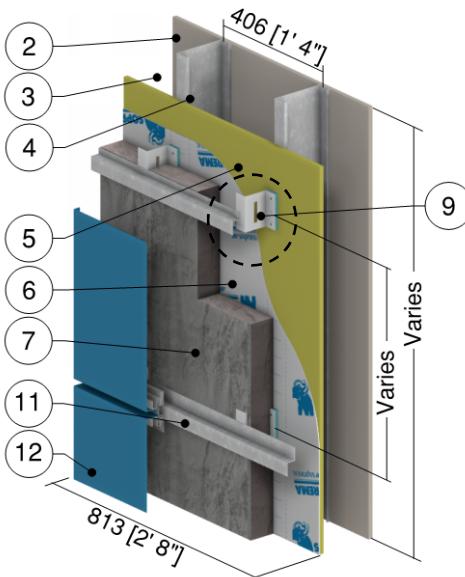
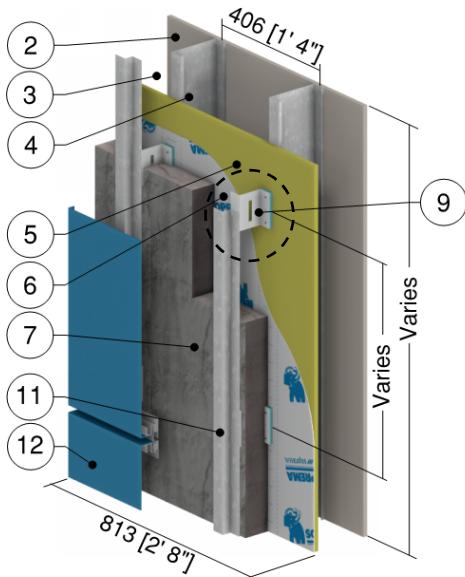
Horizontal Girt: ACS Clip Detail

ID	Component	Thickness Inches (mm)	Conductivity Btu·in / ft ² ·hr·°F (W/m K)	Nominal Resistance hr·ft ² ·°F/Btu (m ² K/W)	Density lb/ft ³ (kg/m ³)	Specific Heat Btu/lb·°F (J/kg K)
1	Interior Film ¹	-	-	R-0.7 (0.12 RSI)	-	-
2	Gypsum Board	1/2" (13)	1.1 (0.16)	R-0.5 (0.09 RSI)	50 (800)	0.26 (1090)
3	Air in Stud Cavity	6" (152)	-	R-0.9 (0.16 RSI)	0.075 (1.2)	0.24 (1000)
4	6" x 1 5/8" Steel Studs	18 Gauge	430 (62)	-	489 (7830)	0.12 (500)
5	Exterior Sheathing	1/2" (13)	1.1 (0.16)	R-0.5 (0.09 RSI)	50 (800)	0.26 (1090)
6	SOPREMA SOPRASEAL STICK 1100T membrane installed with SOPRASEAL STICK PRIMER	-	-	-	-	-
7	SOPRA-XPS 20 Exterior Insulation	Varies	0.20 (0.029)	R-15.0 to R-35.0 (2.64 RSI to 6.16 RSI)	2.5 (40)	0.29 (1220)
8	Thermal Break	1/2" (13)	0.13 (0.019)	-	2.1 (33)	0.50 (2100)
9	ACS-S Thermal Clip	16 Gauge	118 (17)	-	500 (8000)	0.13 (530)
10	Fastener	1/4" (6.4) Ø	347 (50)	-	489 (7830)	0.12 (500)
11	Girt	18 Gauge	430 (62)	-	489 (7830)	0.12 (500)
12	Cladding with 1/2" vented airspace incorporated into exterior heat transfer coefficient					
13	Exterior Film ¹	-	-	R-0.7 (0.12 RSI)	-	-

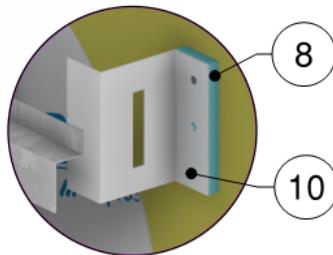
¹ Value selected from table 1, p. 26.1 of 2009 ASHRAE Handbook – Fundamentals depending on surface orientation

Detail 1.3

Exterior Insulated 6" x 1 5/8" Steel Stud (16" o.c.) Wall Assembly with SOPREMA SOPRA-SPF 202 and ACS-S Thermal Clip Supporting Metal Cladding - Clear Wall



Vertical Girt: ACS Clip Detail



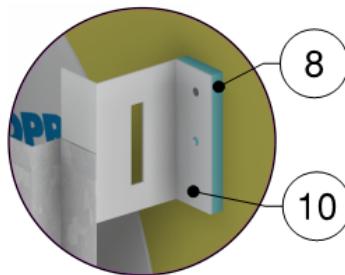
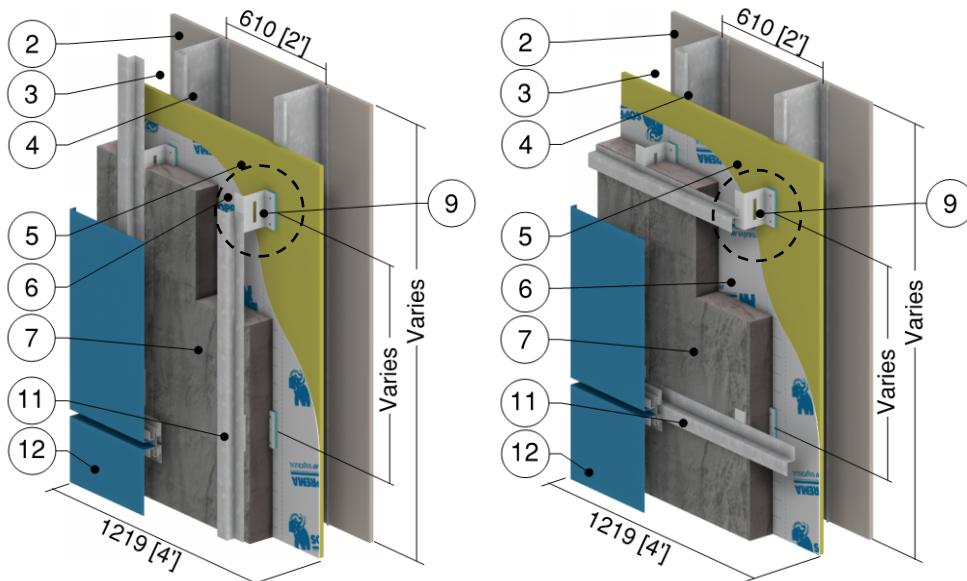
Horizontal Girt: ACS Clip Detail

ID	Component	Thickness Inches (mm)	Conductivity Btu·in / ft ² ·hr·°F (W/m K)	Nominal Resistance hr·ft ² ·°F/Btu (m ² K/W)	Density lb/ft ³ (kg/m ³)	Specific Heat Btu/lb·°F (J/kg K)
1	Interior Film ¹	-	-	R-0.7 (0.12 RSI)	-	-
2	Gypsum Board	1/2" (13)	1.1 (0.16)	R-0.5 (0.09 RSI)	50 (800)	0.26 (1090)
3	Air in Stud Cavity	6" (152)	-	R-0.9 (0.16 RSI)	0.075 (1.2)	0.24 (1000)
4	6" x 1 5/8" Steel Studs	18 Gauge	430 (62)	-	489 (7830)	0.12 (500)
5	Exterior Sheathing	1/2" (13)	1.1 (0.16)	R-0.5 (0.09 RSI)	50 (800)	0.26 (1090)
6	SOPREMA SOPRASEAL STICK 1100T membrane installed with SOPRASEAL STICK PRIMER	-	-	-	-	-
7	SOPRA-SPF 202 Exterior Insulation	Varies	0.16 (0.023)	R-6.2 to R-37.2 (1.09 RSI to 6.55 RSI)	1.8 (28)	0.29 (1220)
8	Thermal Break	1/2" (13)	0.13 (0.019)	-	2.1 (33)	0.50 (2100)
9	ACS-S Thermal Clip	16 Gauge	118 (17)	-	500 (8000)	0.13 (530)
10	Fastener	1/4" (6.4) Ø	347 (50)	-	489 (7830)	0.12 (500)
11	Girt	18 Gauge	430 (62)	-	489 (7830)	0.12 (500)
12	Cladding with 1/2" vented airspace incorporated into exterior heat transfer coefficient					
13	Exterior Film ¹	-	-	R-0.7 (0.12 RSI)	-	-

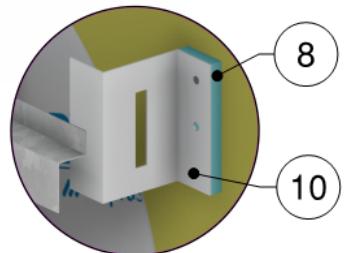
¹ Value selected from table 1, p. 26.1 of 2009 ASHRAE Handbook – Fundamentals depending on surface orientation

Detail 1.4

Exterior Insulated 6" x 1 5/8" Steel Stud (24" o.c.) Wall Assembly with SOPREMA SOPRA-SPF 202 and ACS-S Thermal Clip Supporting Metal Cladding - Clear Wall



Vertical Girt: ACS Clip Detail



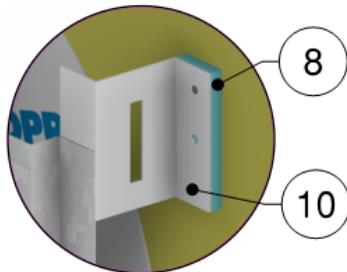
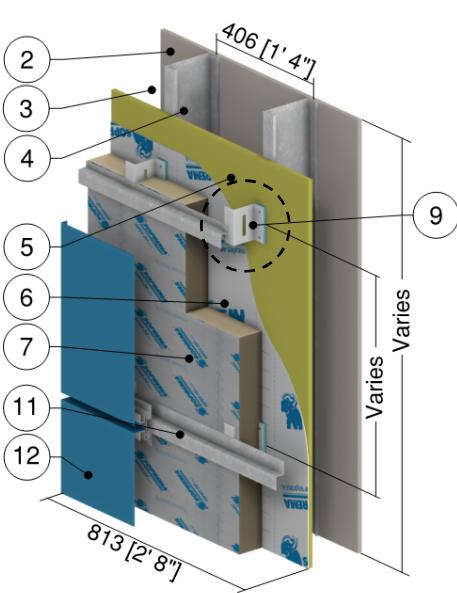
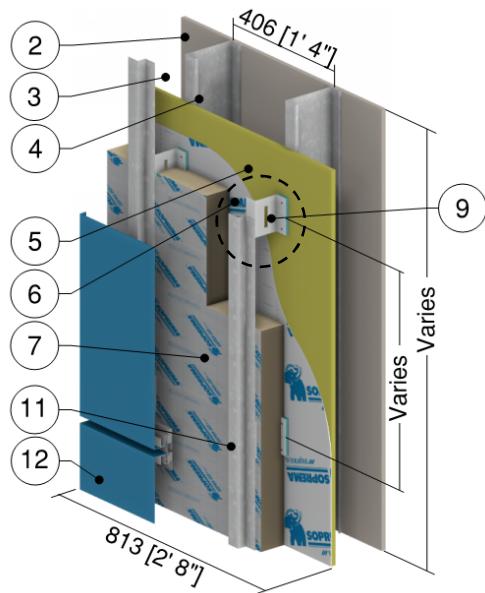
Horizontal Girt: ACS Clip Detail

ID	Component	Thickness Inches (mm)	Conductivity Btu·in / ft ² ·hr·°F (W/m K)	Nominal Resistance hr·ft ² ·°F/Btu (m ² K/W)	Density lb/ft ³ (kg/m ³)	Specific Heat Btu/lb·°F (J/kg K)
1	Interior Film ¹	-	-	R-0.7 (0.12 RSI)	-	-
2	Gypsum Board	1/2" (13)	1.1 (0.16)	R-0.5 (0.09 RSI)	50 (800)	0.26 (1090)
3	Air in Stud Cavity	6" (152)	-	R-0.9 (0.16 RSI)	0.075 (1.2)	0.24 (1000)
4	6" x 1 5/8" Steel Studs	18 Gauge	430 (62)	-	489 (7830)	0.12 (500)
5	Exterior Sheathing	1/2" (13)	1.1 (0.16)	R-0.5 (0.09 RSI)	50 (800)	0.26 (1090)
6	SOPREMA SOPRASEAL STICK 1100T membrane installed with SOPRASEAL STICK PRIMER	-	-	-	-	-
7	SOPRA-SPF 202 Exterior Insulation	Varies	0.16 (0.023)	R-6.2 to R-37.2 (1.09 RSI to 6.55 RSI)	1.8 (28)	0.29 (1220)
8	Thermal Break	1/2" (13)	0.13 (0.019)	-	2.1 (33)	0.50 (2100)
9	ACS-S Thermal Clip	16 Gauge	118 (17)	-	500 (8000)	0.13 (530)
10	Fastener	1/4" (6.4) Ø	347 (50)	-	489 (7830)	0.12 (500)
11	Girt	18 Gauge	430 (62)	-	489 (7830)	0.12 (500)
12	Cladding with 1/2" vented airspace incorporated into exterior heat transfer coefficient					
13	Exterior Film ¹	-	-	R-0.7 (0.12 RSI)	-	-

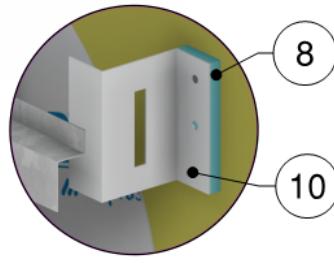
¹ Value selected from table 1, p. 26.1 of 2009 ASHRAE Handbook – Fundamentals depending on surface orientation

Detail 1.5

Exterior Insulated 6" x 1 5/8" Steel Stud (16" o.c.) Wall Assembly with SOPREMA SOPRA-ISO V ALU and ACS-S Thermal Clip Supporting Metal Cladding - Clear Wall



Vertical Girt: ACS Clip Detail



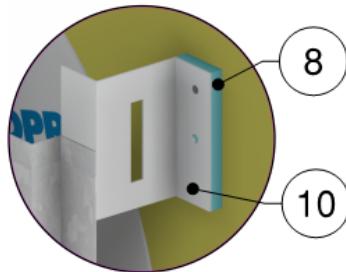
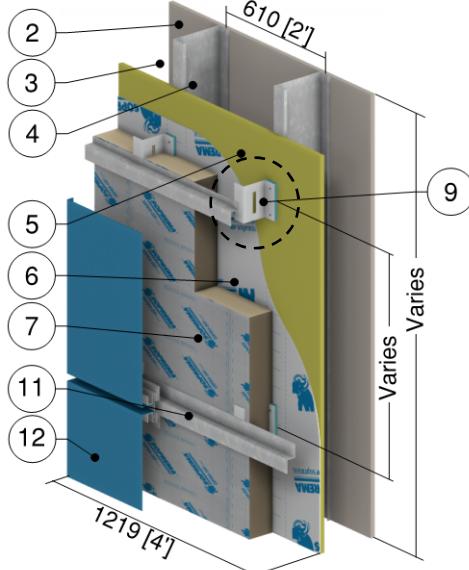
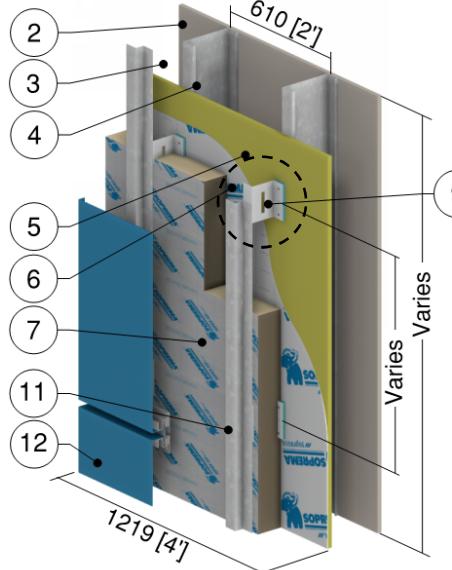
Horizontal Girt: ACS Clip Detail

ID	Component	Thickness Inches (mm)	Conductivity Btu·in / ft ² ·hr·°F (W/m K)	Nominal Resistance hr·ft ² ·°F/Btu (m ² K/W)	Density lb/ft ³ (kg/m ³)	Specific Heat Btu/lb·°F (J/kg K)
1	Interior Film ¹	-	-	R-0.7 (0.12 RSI)	-	-
2	Gypsum Board	1/2" (13)	1.1 (0.16)	R-0.5 (0.09 RSI)	50 (800)	0.26 (1090)
3	Air in Stud Cavity	6" (152)	-	R-0.9 (0.16 RSI)	0.075 (1.2)	0.24 (1000)
4	6" x 1 5/8" Steel Studs	18 Gauge	430 (62)	-	489 (7830)	0.12 (500)
5	Exterior Sheathing	1/2" (13)	1.1 (0.16)	R-0.5 (0.09 RSI)	50 (800)	0.26 (1090)
6	SOPREMA SOPRASEAL STICK 1100T membrane installed with SOPRASEAL STICK PRIMER	-	-	-	-	-
7	SOPRA-ISO V ALU Exterior Insulation	Varies	0.15 (0.022)	R-6.5 to R-39.0 (1.14 RSI to 6.87 RSI)	1.9 (30)	0.36 (1500)
8	Thermal Break	1/2" (13)	0.13 (0.019)	-	2.1 (33)	0.50 (2100)
9	ACS-S Thermal Clip	16 Gauge	118 (17)	-	500 (8000)	0.13 (530)
10	Fastener	1/4" (6.4) Ø	347 (50)	-	489 (7830)	0.12 (500)
11	Girt	18 Gauge	430 (62)	-	489 (7830)	0.12 (500)
12	Cladding with 1/2" vented airspace incorporated into exterior heat transfer coefficient					
13	Exterior Film ¹	-	-	R-0.7 (0.12 RSI)	-	-

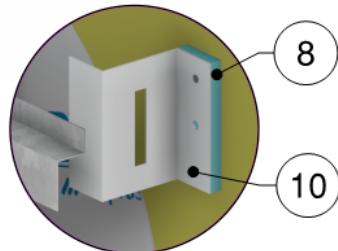
¹ Value selected from table 1, p. 26.1 of 2009 ASHRAE Handbook – Fundamentals depending on surface orientation

Detail 1.6

Exterior Insulated 6" x 1 5/8" Steel Stud (24" o.c.) Wall Assembly with SOPREMA SOPRA-ISO V ALU and ACS-S Thermal Clip Supporting Metal Cladding - Clear Wall



Vertical Girt: ACS Clip Detail



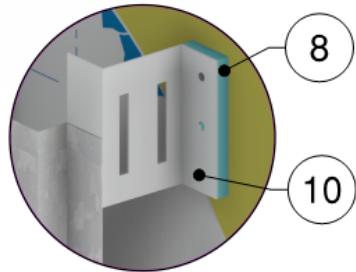
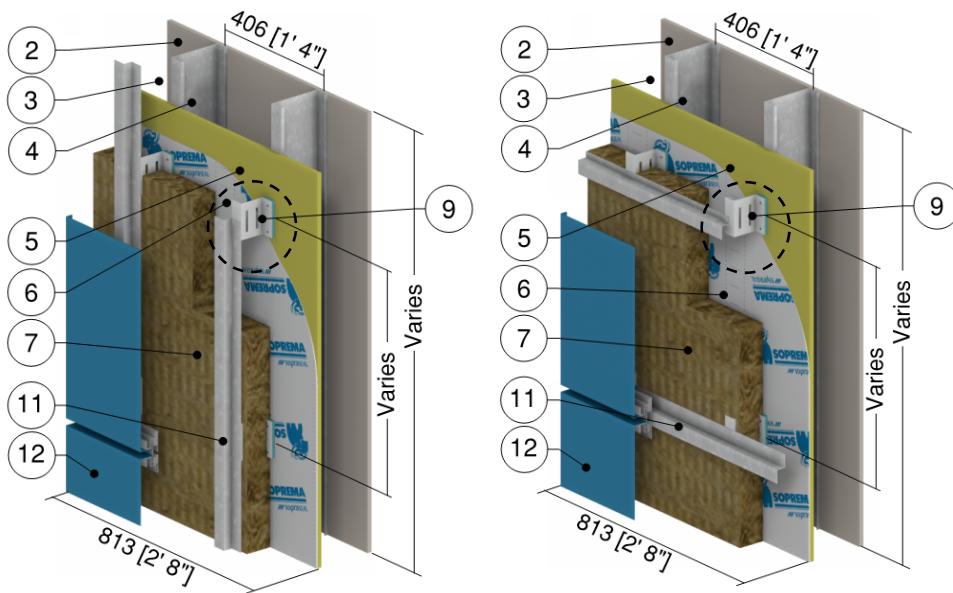
Horizontal Girt: ACS Clip Detail

ID	Component	Thickness Inches (mm)	Conductivity Btu·in / ft ² ·hr·°F (W/m K)	Nominal Resistance hr·ft ² ·°F/Btu (m ² K/W)	Density lb/ft ³ (kg/m ³)	Specific Heat Btu/lb·°F (J/kg K)
1	Interior Film ¹	-	-	R-0.7 (0.12 RSI)	-	-
2	Gypsum Board	1/2" (13)	1.1 (0.16)	R-0.5 (0.09 RSI)	50 (800)	0.26 (1090)
3	Air in Stud Cavity	6" (152)	-	R-0.9 (0.16 RSI)	0.075 (1.2)	0.24 (1000)
4	6" x 1 5/8" Steel Studs	18 Gauge	430 (62)	-	489 (7830)	0.12 (500)
5	Exterior Sheathing	1/2" (13)	1.1 (0.16)	R-0.5 (0.09 RSI)	50 (800)	0.26 (1090)
6	SOPREMA SOPRASEAL STICK 1100T membrane installed with SOPRASEAL STICK PRIMER	-	-	-	-	-
7	SOPRA-ISO V ALU Exterior Insulation	Varies	0.15 (0.022)	R-6.5 to R-39.0 (1.14 RSI to 6.87 RSI)	1.9 (30)	0.36 (1500)
8	Thermal Break	1/2" (13)	0.13 (0.019)	-	2.1 (33)	0.50 (2100)
9	ACS-S Thermal Clip	16 Gauge	118 (17)	-	500 (8000)	0.13 (530)
10	Fastener	1/4" (6.4) Ø	347 (50)	-	489 (7830)	0.12 (500)
11	Girt	18 Gauge	430 (62)	-	489 (7830)	0.12 (500)
12	Cladding with 1/2" vented airspace incorporated into exterior heat transfer coefficient					
13	Exterior Film ¹	-	-	R-0.7 (0.12 RSI)	-	-

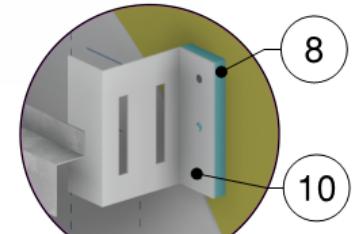
¹ Value selected from table 1, p. 26.1 of 2009 ASHRAE Handbook – Fundamentals depending on surface orientation

Detail 1.7

Exterior Insulated 6" x 1 5/8" Steel Stud (16" o.c.) Wall Assembly with Mineral Wool and ACS-S Thermal Clip Supporting Metal Cladding - Clear Wall



Vertical Girt: ACS Clip Detail



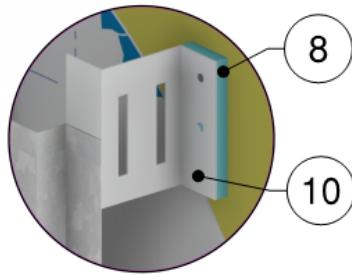
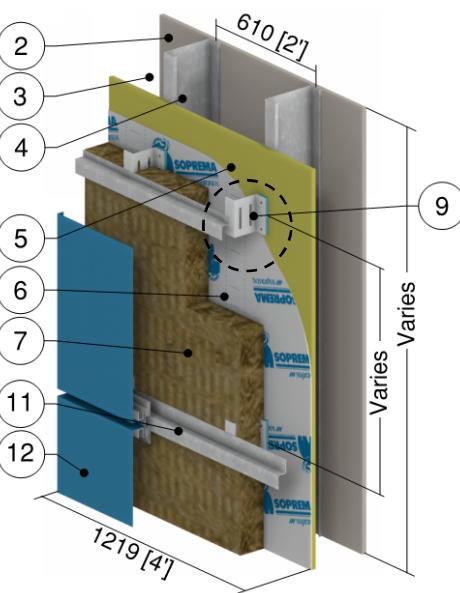
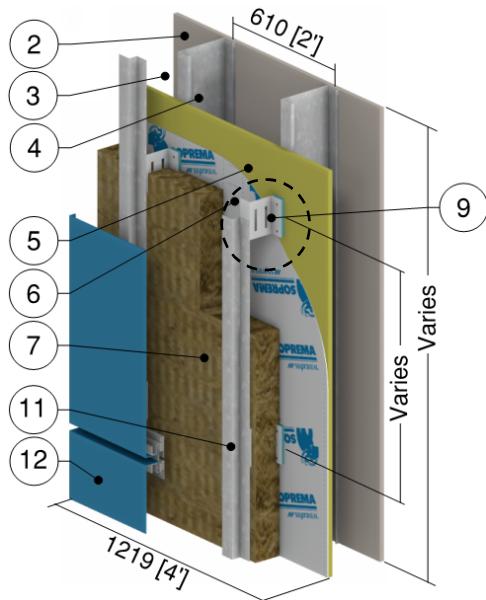
Horizontal Girt: ACS Clip Detail

ID	Component	Thickness Inches (mm)	Conductivity Btu-in / ft ² ·hr·°F (W/m K)	Nominal Resistance hr·ft ² ·°F/Btu (m ² K/W)	Density lb/ft ³ (kg/m ³)	Specific Heat Btu/lb·°F (J/kg K)
1	Interior Film ¹	-	-	R-0.7 (0.12 RSI)	-	-
2	Gypsum Board	1/2" (13)	1.1 (0.16)	R-0.5 (0.09 RSI)	50 (800)	0.26 (1090)
3	Air in Stud Cavity	6" (152)	-	R-0.9 (0.16 RSI)	0.075 (1.2)	0.24 (1000)
4	6" x 1 5/8" Steel Studs	18 Gauge	430 (62)	-	489 (7830)	0.12 (500)
5	Exterior Sheathing	1/2" (13)	1.1 (0.16)	R-0.5 (0.09 RSI)	50 (800)	0.26 (1090)
6	SOPREMA SOPRASEAL STICK 1100T membrane installed with SOPRASEAL STICK PRIMER	-	-	-	-	-
7	Exterior Mineral Wool Insulation	Varies	0.23 (0.034)	R-12.9 to R-34.4 (2.27 RSI to 6.06 RSI)	1.8 (28)	0.29 (1220)
8	Thermal Break	1/2" (13)	0.13 (0.019)	-	2.1 (33)	0.50 (2100)
9	ACS-S Thermal Clip	16 Gauge	118 (17)	-	500 (8000)	0.13 (530)
10	Fastener	1/4" (6.4) Ø	347 (50)	-	489 (7830)	0.12 (500)
11	Girt	18 Gauge	430 (62)	-	489 (7830)	0.12 (500)
12	Cladding with 1/2" vented airspace incorporated into exterior heat transfer coefficient					
13	Exterior Film ¹	-	-	R-0.7 (0.12 RSI)	-	-

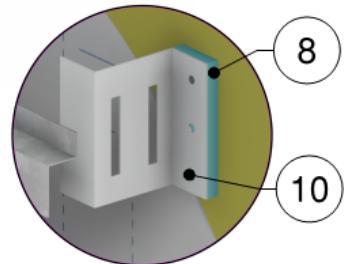
¹ Value selected from table 1, p. 26.1 of 2009 ASHRAE Handbook – Fundamentals depending on surface orientation

Detail 1.8

Exterior Insulated 6" x 1 5/8" Steel Stud (24" o.c.) Wall Assembly with Mineral Wool and ACS-S Thermal Clip Supporting Metal Cladding - Clear Wall



Vertical Girt: ACS Clip Detail



Horizontal Girt: ACS Clip Detail

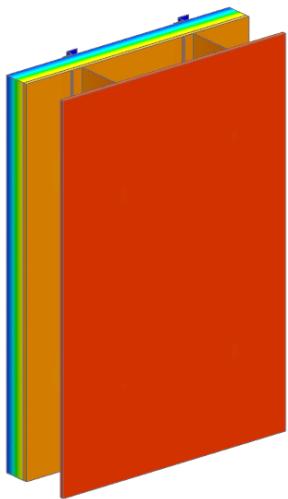
ID	Component	Thickness Inches (mm)	Conductivity Btu-in / ft ² ·hr·°F (W/m K)	Nominal Resistance hr·ft ² ·°F/Btu (m ² K/W)	Density lb/ft ³ (kg/m ³)	Specific Heat Btu/lb·°F (J/kg K)
1	Interior Film ¹	-	-	R-0.7 (0.12 RSI)	-	-
2	Gypsum Board	1/2" (13)	1.1 (0.16)	R-0.5 (0.09 RSI)	50 (800)	0.26 (1090)
3	Air in Stud Cavity	6" (152)	-	R-0.9 (0.16 RSI)	0.075 (1.2)	0.24 (1000)
4	6" x 1 5/8" Steel Studs	18 Gauge	430 (62)	-	489 (7830)	0.12 (500)
5	Exterior Sheathing	1/2" (13)	1.1 (0.16)	R-0.5 (0.09 RSI)	50 (800)	0.26 (1090)
6	SOPREMA SOPRASEAL STICK 1100T membrane installed with SOPRASEAL STICK PRIMER	-	-	-	-	-
7	Exterior Mineral Wool Insulation	Varies	0.23 (0.034)	R-12.9 to R-34.4 (2.27 RSI to 6.06 RSI)	1.8 (28)	0.29 (1220)
8	Thermal Break	1/2" (13)	0.13 (0.019)	-	2.1 (33)	0.50 (2100)
9	ACS-S Thermal Clip	16 Gauge	118 (17)	-	500 (8000)	0.13 (530)
10	Fastener	1/4" (6.4) Ø	347 (50)	-	489 (7830)	0.12 (500)
11	Girt	18 Gauge	430 (62)	-	489 (7830)	0.12 (500)
12	Cladding with 1/2" vented airspace incorporated into exterior heat transfer coefficient					
13	Exterior Film ¹	-	-	R-0.7 (0.12 RSI)	-	-

¹ Value selected from table 1, p. 26.1 of 2009 ASHRAE Handbook – Fundamentals depending on surface orientation

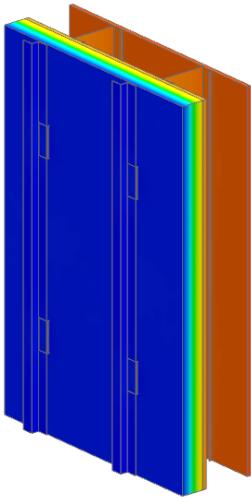
**APPENDIX D:
BUILDING ENVELOPE THERMAL
BRIDGING GUIDE RESULT SHEETS**

Detail 1.1

Exterior Insulated 6" x 1 5/8" Steel Stud (16" o.c.) Wall Assembly with SOPREMA SOPRA-XPS 20 and ACS-S Thermal Clip Supporting Metal Cladding - Clear Wall



View from Interior



View from Exterior



Thermal Performance Indicators

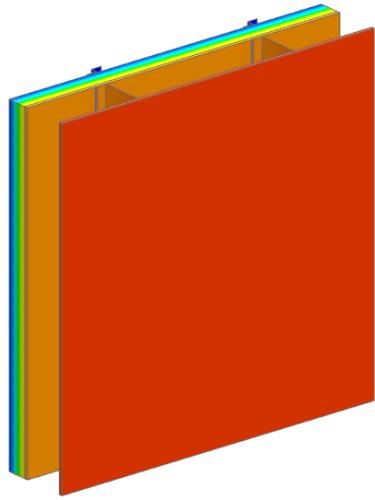
Assembly 1D (Nominal) R-Value	R_{1D}	R-3.17 (0.56 RSI) + exterior insulation
Transmittance / Resistance	U_o, R_o	"Clear wall" U- and R-value

Nominal (1D) vs. Assembly Performance Indicators

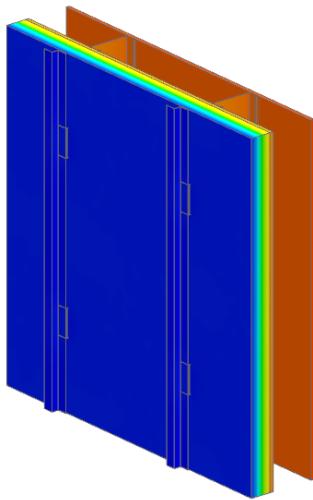
Exterior Insulation 1D R-value (RSI)	R_{1D} $\text{ft}^2 \cdot \text{hr} \cdot {}^\circ\text{F} / \text{Btu}$ ($\text{m}^2 \text{K} / \text{W}$)	24" Vertical Spacing		36" Vertical Spacing		48" Vertical Spacing	
		R_o $\text{ft}^2 \cdot \text{hr} \cdot {}^\circ\text{F} / \text{Btu}$ ($\text{m}^2 \text{K} / \text{W}$)	U_o $\text{Btu}/\text{ft}^2 \cdot \text{hr} \cdot {}^\circ\text{F}$ ($\text{W}/\text{m}^2 \text{K}$)	R_o $\text{ft}^2 \cdot \text{hr} \cdot {}^\circ\text{F} / \text{Btu}$ ($\text{m}^2 \text{K} / \text{W}$)	U_o $\text{Btu}/\text{ft}^2 \cdot \text{hr} \cdot {}^\circ\text{F}$ ($\text{W}/\text{m}^2 \text{K}$)	R_o $\text{ft}^2 \cdot \text{hr} \cdot {}^\circ\text{F} / \text{Btu}$ ($\text{m}^2 \text{K} / \text{W}$)	U_o $\text{Btu}/\text{ft}^2 \cdot \text{hr} \cdot {}^\circ\text{F}$ ($\text{W}/\text{m}^2 \text{K}$)
R-15.0 (2.64)	R-18.2 (3.20)	R-17.2 (3.03)	0.058 (0.33)	R-17.5 (3.09)	0.057 (0.32)	R-17.7 (3.11)	0.057 (0.32)
R-20.0 (3.52)	R-23.2 (4.08)	R-21.6 (3.81)	0.046 (0.26)	R-22.1 (3.89)	0.045 (0.26)	R-22.4 (3.94)	0.045 (0.25)
R-25.0 (4.40)	R-28.2 (4.96)	R-25.9 (4.56)	0.039 (0.22)	R-26.6 (4.68)	0.038 (0.21)	R-27.0 (4.75)	0.037 (0.21)
R-30.0 (5.28)	R-33.2 (5.84)	R-30.2 (5.32)	0.033 (0.19)	R-31.1 (5.48)	0.032 (0.18)	R-31.6 (5.57)	0.032 (0.18)
R-35.0 (6.16)	R-38.2 (6.72)	R-34.3 (6.04)	0.029 (0.17)	R-35.5 (6.25)	0.028 (0.16)	R-36.1 (6.36)	0.028 (0.16)

Detail 1.2

Exterior Insulated 6" x 1 5/8" Steel Stud (24" o.c.) Wall Assembly with SOPREMA SOPRA-XPS 20 and ACS-S Thermal Clip Supporting Metal Cladding - Clear Wall



View from Interior



View from Exterior



Thermal Performance Indicators

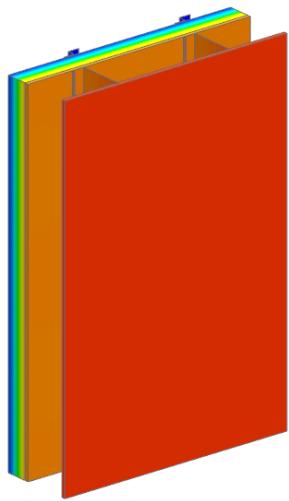
Assembly 1D (Nominal) R-Value	R_{1D}	R-3.17 (0.56 RSI) + exterior insulation
Transmittance / Resistance	U_o, R_o	"Clear wall" U- and R-value

Nominal (1D) vs. Assembly Performance Indicators

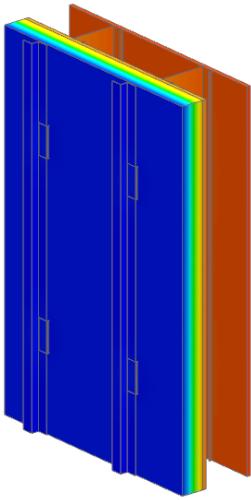
Exterior Insulation 1D R-value (RSI)	R_{1D} $\text{ft}^2 \cdot \text{hr} \cdot {}^\circ\text{F} / \text{Btu}$ ($\text{m}^2 \text{K} / \text{W}$)	24" Vertical Spacing		36" Vertical Spacing		48" Vertical Spacing	
		R_o $\text{ft}^2 \cdot \text{hr} \cdot {}^\circ\text{F} / \text{Btu}$ ($\text{m}^2 \text{K} / \text{W}$)	U_o $\text{Btu}/\text{ft}^2 \cdot \text{hr} \cdot {}^\circ\text{F}$ ($\text{W}/\text{m}^2 \text{K}$)	R_o $\text{ft}^2 \cdot \text{hr} \cdot {}^\circ\text{F} / \text{Btu}$ ($\text{m}^2 \text{K} / \text{W}$)	U_o $\text{Btu}/\text{ft}^2 \cdot \text{hr} \cdot {}^\circ\text{F}$ ($\text{W}/\text{m}^2 \text{K}$)	R_o $\text{ft}^2 \cdot \text{hr} \cdot {}^\circ\text{F} / \text{Btu}$ ($\text{m}^2 \text{K} / \text{W}$)	U_o $\text{Btu}/\text{ft}^2 \cdot \text{hr} \cdot {}^\circ\text{F}$ ($\text{W}/\text{m}^2 \text{K}$)
R-15.0 (2.64)	R-18.2 (3.20)	R-17.5 (3.09)	0.057 (0.32)	R-17.7 (3.12)	0.056 (0.32)	R-17.8 (3.14)	0.056 (0.32)
R-20.0 (3.52)	R-23.2 (4.08)	R-22.1 (3.90)	0.045 (0.26)	R-22.5 (3.96)	0.045 (0.25)	R-22.6 (3.99)	0.044 (0.25)
R-25.0 (4.40)	R-28.2 (4.96)	R-26.6 (4.69)	0.038 (0.21)	R-27.1 (4.78)	0.037 (0.21)	R-27.4 (4.82)	0.037 (0.21)
R-30.0 (5.28)	R-33.2 (5.84)	R-31.1 (5.48)	0.032 (0.18)	R-31.8 (5.60)	0.031 (0.18)	R-32.1 (5.65)	0.031 (0.18)
R-35.0 (6.16)	R-38.2 (6.72)	R-35.5 (6.26)	0.028 (0.16)	R-36.3 (6.40)	0.028 (0.16)	R-36.8 (6.48)	0.027 (0.15)

Detail 1.3

Exterior Insulated 6" x 1 5/8" Steel Stud (16" o.c.) Wall Assembly with SOPREMA SOPRA-SPF 202 and ACS-S Thermal Clip Supporting Metal Cladding - Clear Wall



View from Interior



View from Exterior



Thermal Performance Indicators

Assembly 1D (Nominal) R-Value	R_{1D}	R-3.17 (0.56 RSI) + exterior insulation
Transmittance / Resistance	U_o , R_o	"Clear wall" U- and R-value

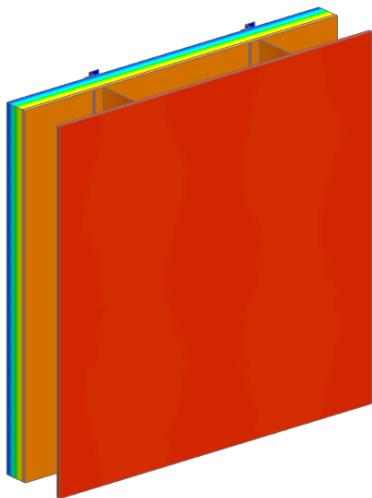
Nominal (1D) vs. Assembly Performance Indicators

Exterior Insulation 1D R-value (RSI)	R_{1D} $\text{ft}^2 \cdot \text{hr} \cdot {}^\circ\text{F} / \text{Btu}$ ($\text{m}^2 \text{K} / \text{W}$)	24" Vertical Spacing		36" Vertical Spacing		48" Vertical Spacing	
		R_o $\text{ft}^2 \cdot \text{hr} \cdot {}^\circ\text{F} / \text{Btu}$ ($\text{m}^2 \text{K} / \text{W}$)	U_o $\text{Btu}/\text{ft}^2 \cdot \text{hr} \cdot {}^\circ\text{F}$ ($\text{W}/\text{m}^2 \text{K}$)	R_o $\text{ft}^2 \cdot \text{hr} \cdot {}^\circ\text{F} / \text{Btu}$ ($\text{m}^2 \text{K} / \text{W}$)	U_o $\text{Btu}/\text{ft}^2 \cdot \text{hr} \cdot {}^\circ\text{F}$ ($\text{W}/\text{m}^2 \text{K}$)	R_o $\text{ft}^2 \cdot \text{hr} \cdot {}^\circ\text{F} / \text{Btu}$ ($\text{m}^2 \text{K} / \text{W}$)	U_o $\text{Btu}/\text{ft}^2 \cdot \text{hr} \cdot {}^\circ\text{F}$ ($\text{W}/\text{m}^2 \text{K}$)
R-6.2 (1.09)	R-9.4 (1.65)	R-9.2 (1.62)	0.109 (0.62)	R-9.2 (1.63)	0.108 (0.61)	R-9.2 (1.63)	0.108 (0.61)
R-12.4 (2.18)	R-15.6 (2.74)	R-14.8 (2.61)*	0.067 (0.38)*	R-15.0 (2.65)*	0.066 (0.38)*	R-15.2 (2.67)*	0.066 (0.37)*
R-18.6 (3.28)	R-21.8 (3.83)	R-20.3 (3.58)	0.049 (0.28)	R-20.8 (3.66)	0.048 (0.27)	R-21.0 (3.70)	0.048 (0.27)
R-24.8 (4.37)	R-28.0 (4.93)	R-25.7 (4.52)	0.039 (0.22)	R-26.4 (4.64)	0.038 (0.22)	R-26.7 (4.71)	0.037 (0.21)
R-31.0 (5.46)	R-34.2 (6.02)	R-30.8 (5.42)	0.033 (0.18)	R-31.8 (5.60)	0.031 (0.18)	R-32.3 (5.70)	0.031 (0.18)
R-37.2 (6.55)	R-40.4 (7.11)	R-36.0 (6.33)	0.028 (0.16)	R-37.3 (6.57)	0.027 (0.15)	R-38.0 (6.69)	0.026 (0.15)

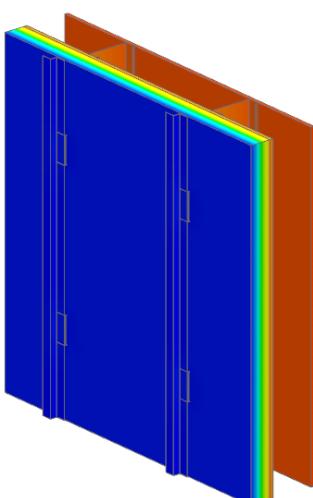
*Indicates interpolated value

Detail 1.4

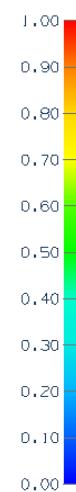
Exterior Insulated 6" x 1 5/8" Steel Stud (24" o.c.) Wall Assembly with SOPREMA SOPRA-SPF 202 and ACS-S Thermal Clip Supporting Metal Cladding - Clear Wall



View from Interior



View from Exterior



Thermal Performance Indicators

Assembly 1D (Nominal) R-Value	R_{1D}	R-3.17 (0.56 RSI) + exterior insulation
Transmittance / Resistance	U_o , R_o	"Clear wall" U- and R-value

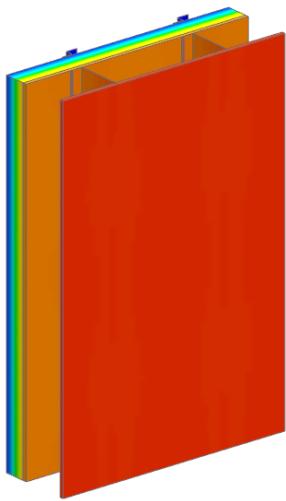
Nominal (1D) vs. Assembly Performance Indicators

Exterior Insulation 1D R-value (RSI)	R_{1D} $\text{ft}^2 \cdot \text{hr} \cdot {}^\circ\text{F} / \text{Btu}$ ($\text{m}^2 \text{K} / \text{W}$)	24" Vertical Spacing		36" Vertical Spacing		48" Vertical Spacing	
		R_o $\text{ft}^2 \cdot \text{hr} \cdot {}^\circ\text{F} / \text{Btu}$ ($\text{m}^2 \text{K} / \text{W}$)	U_o $\text{Btu}/\text{ft}^2 \cdot \text{hr} \cdot {}^\circ\text{F}$ ($\text{W}/\text{m}^2 \text{K}$)	R_o $\text{ft}^2 \cdot \text{hr} \cdot {}^\circ\text{F} / \text{Btu}$ ($\text{m}^2 \text{K} / \text{W}$)	U_o $\text{Btu}/\text{ft}^2 \cdot \text{hr} \cdot {}^\circ\text{F}$ ($\text{W}/\text{m}^2 \text{K}$)	R_o $\text{ft}^2 \cdot \text{hr} \cdot {}^\circ\text{F} / \text{Btu}$ ($\text{m}^2 \text{K} / \text{W}$)	U_o $\text{Btu}/\text{ft}^2 \cdot \text{hr} \cdot {}^\circ\text{F}$ ($\text{W}/\text{m}^2 \text{K}$)
R-6.2 (1.09)	R-9.4 (1.65)	R-9.3 (1.63)	0.108 (0.61)	R-9.3 (1.63)	0.108 (0.61)	R-9.3 (1.64)	0.108 (0.61)
R-12.4 (2.18)	R-15.6 (2.74)	R-15.1 (2.65)*	0.066 (0.38)*	R-15.2 (2.68)*	0.066 (0.37)*	R-15.3 (2.69)*	0.065 (0.37)*
R-18.6 (3.28)	R-21.8 (3.83)	R-20.8 (3.66)	0.048 (0.27)	R-21.1 (3.71)	0.047 (0.27)	R-21.2 (3.74)	0.047 (0.27)
R-24.8 (4.37)	R-28.0 (4.93)	R-26.4 (4.65)	0.038 (0.22)	R-26.9 (4.73)	0.037 (0.21)	R-27.1 (4.78)	0.037 (0.21)
R-31.0 (5.46)	R-34.2 (6.02)	R-31.8 (5.60)	0.031 (0.18)	R-32.6 (5.73)	0.031 (0.17)	R-32.9 (5.80)	0.030 (0.17)
R-37.2 (6.55)	R-40.4 (7.11)	R-37.3 (6.57)	0.027 (0.15)	R-38.2 (6.73)	0.026 (0.15)	R-38.7 (6.82)	0.026 (0.15)

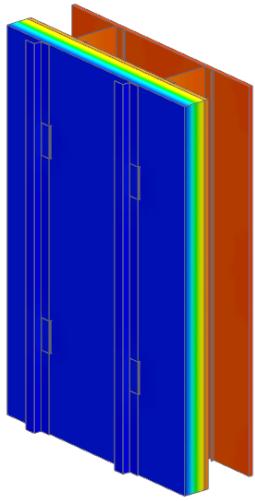
*Indicates interpolated value

Detail 1.5

Exterior Insulated 6" x 1 5/8" Steel Stud (16" o.c.) Wall Assembly with SOPREMA SOPRA-ISO V ALU and ACS-S Thermal Clip Supporting Metal Cladding - Clear Wall



View from Interior



View from Exterior



Thermal Performance Indicators

Assembly 1D (Nominal) R-Value	R_{1D}	R-3.17 (0.56 RSI) + exterior insulation
Transmittance / Resistance	U_o , R_o	"Clear wall" U- and R-value

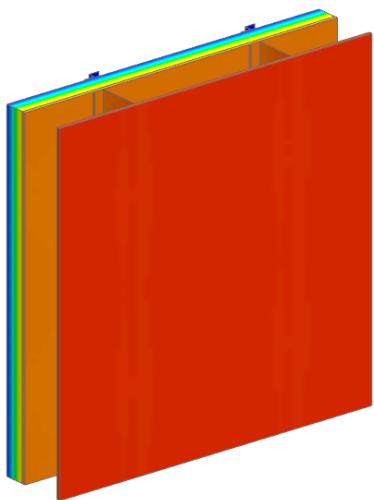
Nominal (1D) vs. Assembly Performance Indicators

Exterior Insulation 1D R-value (RSI)	R_{1D} $\text{ft}^2 \cdot \text{hr} \cdot {}^\circ\text{F} / \text{Btu}$ ($\text{m}^2 \text{K} / \text{W}$)	24" Vertical Spacing		36" Vertical Spacing		48" Vertical Spacing	
		R_o $\text{ft}^2 \cdot \text{hr} \cdot {}^\circ\text{F} / \text{Btu}$ ($\text{m}^2 \text{K} / \text{W}$)	U_o $\text{Btu}/\text{ft}^2 \cdot \text{hr} \cdot {}^\circ\text{F}$ ($\text{W}/\text{m}^2 \text{K}$)	R_o $\text{ft}^2 \cdot \text{hr} \cdot {}^\circ\text{F} / \text{Btu}$ ($\text{m}^2 \text{K} / \text{W}$)	U_o $\text{Btu}/\text{ft}^2 \cdot \text{hr} \cdot {}^\circ\text{F}$ ($\text{W}/\text{m}^2 \text{K}$)	R_o $\text{ft}^2 \cdot \text{hr} \cdot {}^\circ\text{F} / \text{Btu}$ ($\text{m}^2 \text{K} / \text{W}$)	U_o $\text{Btu}/\text{ft}^2 \cdot \text{hr} \cdot {}^\circ\text{F}$ ($\text{W}/\text{m}^2 \text{K}$)
R-6.5 (1.14)	R-9.7 (1.70)	R-9.5 (1.68)	0.105 (0.60)	R-9.6 (1.69)	0.104 (0.59)	R-9.6 (1.69)	0.104 (0.59)
R-13.0 (2.29)	R-16.2 (2.85)	R-15.4 (2.71)*	0.065 (0.37)*	R-15.7 (2.76)*	0.064 (0.36)*	R-15.8 (2.78)*	0.063 (0.36)*
R-16.3 (2.86)	R-19.4 (3.42)	R-18.3 (3.22)*	0.055 (0.31)*	R-18.6 (3.28)*	0.054 (0.30)*	R-18.8 (3.32)*	0.053 (0.30)*
R-19.5 (3.43)	R-22.7 (3.99)	R-21.2 (3.73)	0.047 (0.27)	R-21.6 (3.81)	0.046 (0.26)	R-21.9 (3.85)	0.046 (0.26)
R-22.8 (4.01)	R-25.9 (4.56)	R-23.9 (4.22)*	0.042 (0.24)*	R-24.6 (4.33)*	0.041 (0.23)*	R-24.9 (4.38)*	0.040 (0.23)*
R-26.0 (4.58)	R-29.2 (5.14)	R-26.7 (4.71)	0.037 (0.21)	R-27.5 (4.84)	0.036 (0.21)	R-27.9 (4.91)	0.036 (0.20)
R-29.3 (5.15)	R-32.4 (5.71)	R-29.5 (5.19)*	0.034 (0.19)*	R-30.4 (5.35)*	0.033 (0.19)*	R-30.9 (5.43)*	0.032 (0.18)*
R-32.5 (5.72)	R-35.7 (6.28)	R-32.1 (5.65)	0.031 (0.18)	R-33.2 (5.84)	0.030 (0.17)	R-33.8 (5.95)	0.030 (0.17)
R-35.8 (6.30)	R-38.9 (6.85)	R-34.8 (6.13)*	0.029 (0.16)*	R-36.1 (6.35)*	0.028 (0.16)*	R-36.7 (6.47)*	0.027 (0.15)*
R-39.0 (6.87)	R-42.2 (7.43)	R-37.5 (6.60)	0.027 (0.15)	R-38.9 (6.86)	0.026 (0.15)	R-39.7 (6.99)	0.025 (0.14)

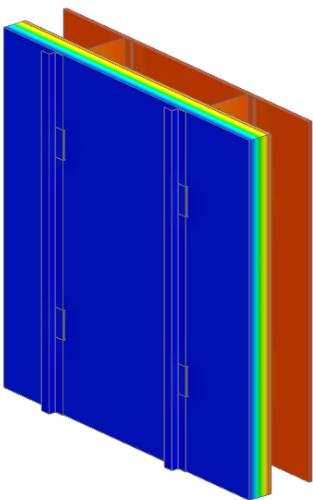
*Indicates interpolated value

Detail 1.6

Exterior Insulated 6" x 1 5/8" Steel Stud (24" o.c.) Wall Assembly with SOPREMA SOPRA-ISO V ALU and ACS-S Thermal Clip Supporting Metal Cladding - Clear Wall



View from Interior



View from Exterior



Thermal Performance Indicators

Assembly 1D (Nominal) R-Value	R_{1D}	R-3.17 (0.56 RSI) + exterior insulation
Transmittance / Resistance	U_o , R_o	"Clear wall" U- and R-value

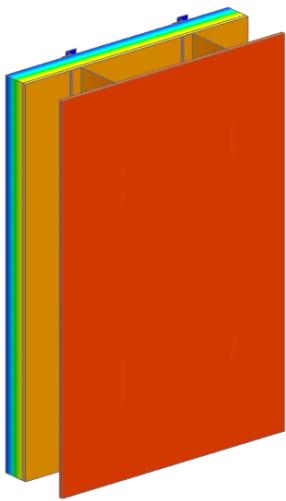
Nominal (1D) vs. Assembly Performance Indicators

Exterior Insulation 1D R-value (RSI)	R_{1D} $\text{ft}^2 \cdot \text{hr} \cdot {}^\circ\text{F} / \text{Btu}$ ($\text{m}^2 \text{K} / \text{W}$)	24" Vertical Spacing		36" Vertical Spacing		48" Vertical Spacing	
		R_o $\text{ft}^2 \cdot \text{hr} \cdot {}^\circ\text{F} / \text{Btu}$ ($\text{m}^2 \text{K} / \text{W}$)	U_o $\text{Btu}/\text{ft}^2 \cdot \text{hr} \cdot {}^\circ\text{F}$ ($\text{W}/\text{m}^2 \text{K}$)	R_o $\text{ft}^2 \cdot \text{hr} \cdot {}^\circ\text{F} / \text{Btu}$ ($\text{m}^2 \text{K} / \text{W}$)	U_o $\text{Btu}/\text{ft}^2 \cdot \text{hr} \cdot {}^\circ\text{F}$ ($\text{W}/\text{m}^2 \text{K}$)	R_o $\text{ft}^2 \cdot \text{hr} \cdot {}^\circ\text{F} / \text{Btu}$ ($\text{m}^2 \text{K} / \text{W}$)	U_o $\text{Btu}/\text{ft}^2 \cdot \text{hr} \cdot {}^\circ\text{F}$ ($\text{W}/\text{m}^2 \text{K}$)
R-6.5 (1.14)	R-9.7 (1.70)	R-9.6 (1.69)	0.104 (0.59)	R-9.6 (1.69)	0.104 (0.59)	R-9.6 (1.70)	0.104 (0.59)
R-13.0 (2.29)	R-16.2 (2.85)	R-15.7 (2.76)*	0.064 (0.36)*	R-15.8 (2.79)*	0.063 (0.36)*	R-15.9 (2.80)*	0.063 (0.36)*
R-16.3 (2.86)	R-19.4 (3.42)	R-18.7 (3.29)*	0.054 (0.30)*	R-18.9 (3.33)*	0.053 (0.30)*	R-19.0 (3.35)*	0.053 (0.30)*
R-19.5 (3.43)	R-22.7 (3.99)	R-21.7 (3.81)	0.046 (0.26)	R-22.0 (3.87)	0.045 (0.26)	R-22.1 (3.90)	0.045 (0.26)
R-22.8 (4.01)	R-25.9 (4.56)	R-24.6 (4.33)*	0.041 (0.23)*	R-25.0 (4.41)*	0.040 (0.23)*	R-25.2 (4.44)*	0.040 (0.23)*
R-26.0 (4.58)	R-29.2 (5.14)	R-27.5 (4.85)	0.036 (0.21)	R-28.0 (4.94)	0.036 (0.20)	R-28.3 (4.99)	0.035 (0.20)
R-29.3 (5.15)	R-32.4 (5.71)	R-30.4 (5.35)*	0.033 (0.19)*	R-31.0 (5.47)*	0.032 (0.18)*	R-31.4 (5.52)*	0.032 (0.18)*
R-32.5 (5.72)	R-35.7 (6.28)	R-33.2 (5.85)	0.030 (0.17)	R-34.0 (5.99)	0.029 (0.17)	R-34.4 (6.06)	0.029 (0.17)
R-35.8 (6.30)	R-38.9 (6.85)	R-36.1 (6.36)*	0.028 (0.16)*	R-37.0 (6.51)*	0.027 (0.15)*	R-37.4 (6.59)*	0.027 (0.15)*
R-39.0 (6.87)	R-42.2 (7.43)	R-38.9 (6.86)	0.026 (0.15)	R-39.9 (7.03)	0.025 (0.14)	R-40.5 (7.13)	0.025 (0.14)

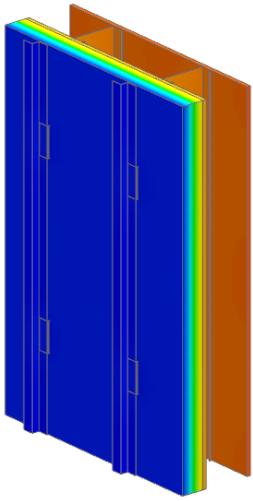
*Indicates interpolated value

Detail 1.7

Exterior Insulated 6" x 1 5/8" Steel Stud (16" o.c.) Wall Assembly with Mineral Wool and ACS-S Thermal Clip Supporting Metal Cladding - Clear Wall



View from Interior



View from Exterior



Thermal Performance Indicators

Assembly 1D (Nominal) R-Value	R_{1D}	R-3.17 (0.56 RSI) + exterior insulation
Transmittance / Resistance	U_o , R_o	"Clear wall" U- and R-value

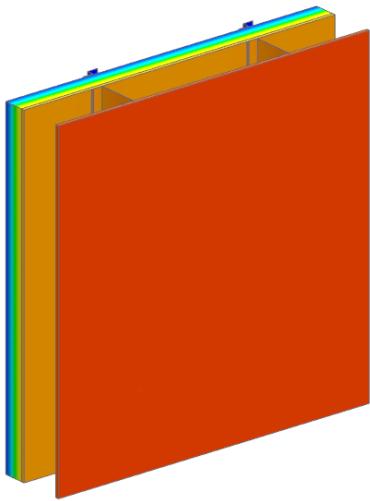
Nominal (1D) vs. Assembly Performance Indicators

Exterior Insulation 1D R-value (RSI)	R_{1D} ft ² ·hr·°F / Btu (m ² K / W)	24" Vertical Spacing		36" Vertical Spacing		48" Vertical Spacing	
		R_o ft ² ·hr·°F / Btu (m ² K / W)	U_o Btu/ft ² · hr · °F (W/m ² K)	R_o ft ² ·hr·°F / Btu (m ² K / W)	U_o Btu/ft ² · hr · °F (W/m ² K)	R_o ft ² ·hr·°F / Btu (m ² K / W)	U_o Btu/ft ² · hr · °F (W/m ² K)
R-12.9 (2.27)	R-16.1 (2.83)	R-15.3 (2.70)	0.065 (0.37)	R-15.6 (2.74)	0.064 (0.36)	R-15.7 (2.76)	0.064 (0.36)
R-17.2 (3.03)	R-20.4 (3.59)	R-19.1 (3.37)*	0.052 (0.30)*	R-19.5 (3.44)*	0.051 (0.29)*	R-19.7 (3.47)*	0.051 (0.29)*
R-21.5 (3.79)	R-24.7 (4.34)	R-22.9 (4.03)	0.044 (0.25)	R-23.5 (4.13)	0.043 (0.24)	R-23.7 (4.18)	0.042 (0.24)
R-25.8 (4.54)	R-29.0 (5.10)	R-26.7 (4.70)	0.037 (0.21)	R-27.4 (4.82)	0.037 (0.21)	R-27.8 (4.89)	0.036 (0.20)
R-30.1 (5.30)	R-33.3 (5.86)	R-30.3 (5.34)	0.033 (0.19)	R-31.2 (5.50)	0.032 (0.18)	R-31.7 (5.58)	0.032 (0.18)
R-34.4 (6.06)	R-37.6 (6.62)	R-34.1 (6.00)	0.029 (0.17)	R-35.1 (6.19)	0.028 (0.16)	R-35.7 (6.29)	0.028 (0.16)

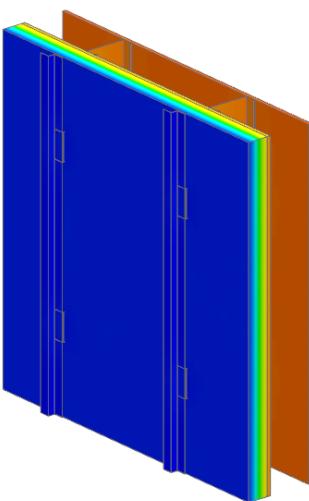
*Indicates interpolated value

Detail 1.8

Exterior Insulated 6" x 1 5/8" Steel Stud (24" o.c.) Wall Assembly with Mineral Wool and ACS-S Thermal Clip Supporting Metal Cladding - Clear Wall



View from Interior



View from Exterior



Thermal Performance Indicators

Assembly 1D (Nominal) R-Value	R_{1D}	R-3.17 (0.56 RSI) + exterior insulation
Transmittance / Resistance	U_o , R_o	"Clear wall" U- and R-value

Nominal (1D) vs. Assembly Performance Indicators

Exterior Insulation 1D R-value (RSI)	R_{1D} ft ² ·hr·°F / Btu (m ² K / W)	24" Vertical Spacing		36" Vertical Spacing		48" Vertical Spacing	
		R_o ft ² ·hr·°F / Btu (m ² K / W)	U_o Btu/ft ² · hr · °F (W/m ² K)	R_o ft ² ·hr·°F / Btu (m ² K / W)	U_o Btu/ft ² · hr · °F (W/m ² K)	R_o ft ² ·hr·°F / Btu (m ² K / W)	U_o Btu/ft ² · hr · °F (W/m ² K)
R-12.9 (2.27)	R-16.1 (2.83)	R-15.6 (2.75)	0.064 (0.36)	R-15.7 (2.77)	0.063 (0.36)	R-15.8 (2.79)	0.063 (0.36)
R-17.2 (3.03)	R-20.4 (3.59)	R-19.5 (3.44)*	0.051 (0.29)*	R-19.8 (3.49)*	0.050 (0.29)*	R-19.9 (3.51)*	0.050 (0.28)*
R-21.5 (3.79)	R-24.7 (4.34)	R-23.5 (4.13)	0.043 (0.24)	R-23.9 (4.21)	0.042 (0.24)	R-24.1 (4.24)	0.042 (0.24)
R-25.8 (4.54)	R-29.0 (5.10)	R-27.4 (4.83)	0.036 (0.21)	R-27.9 (4.91)	0.036 (0.20)	R-28.2 (4.96)	0.036 (0.20)
R-30.1 (5.30)	R-33.3 (5.86)	R-31.2 (5.50)	0.032 (0.18)	R-31.9 (5.61)	0.031 (0.18)	R-32.2 (5.67)	0.031 (0.18)
R-34.4 (6.06)	R-37.6 (6.62)	R-35.2 (6.19)	0.028 (0.16)	R-35.9 (6.33)	0.028 (0.16)	R-36.3 (6.40)	0.028 (0.16)

*Indicates interpolated value