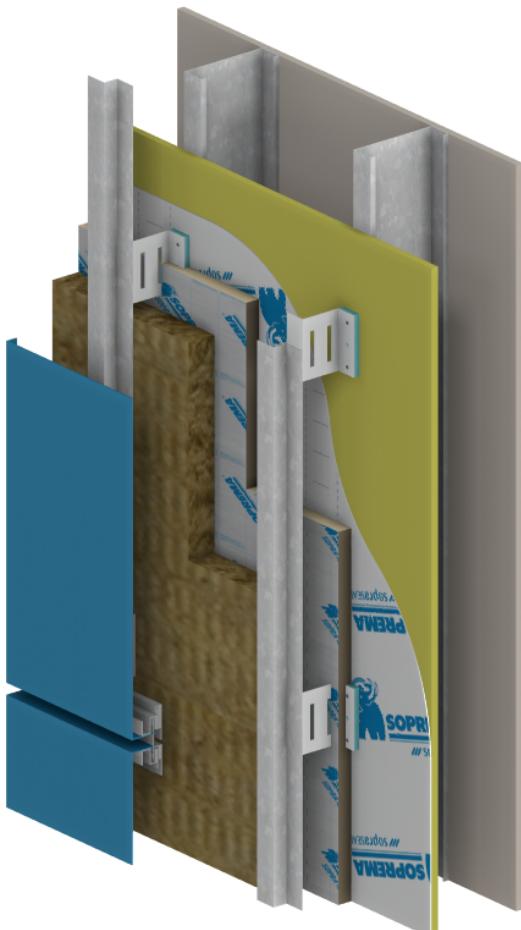




MORRISON HERSHFIELD

# SOPREMA / ACS Composite Systems Protected Exterior Insulation Wall Thermal Analysis



Presented to:

**Jean-Francois Cote**  
Director, Standards & Scientific Affairs

**Soprema Inc.**  
1688 Jean-Brechmans-Michaud  
Drummondville, QC J2C 8E9

and

**Danny White**

**ACS Composite Systems Inc.**  
35-7450 Butler Road  
Sooke, BC V9Z 1N1

Report Number: 203501500  
May 5, 2021

# TABLE OF CONTENTS

	Page
1. INTRODUCTION	1
2. MODELLING PROCEDURES	4
3. THERMAL RESULTS	5
APPENDIX A: DETAIL DRAWINGS	
APPENDIX B: MODELLING PARAMETERS AND ASSUMPTIONS	
APPENDIX C: MATERIAL PROPERTIES	
APPENDIX D: SIMULATED TEMPERATURE PROFILES	

## 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 protected exterior insulation assemblies.

The ACS-S 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 backup wall configurations using protected polyisocyanurate exterior insulation.

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)	Total Exterior Insulation Thickness in (mm)
3	3 (76)
4	4 (102)
5	5 (127)
6	6 (152)
7	7 (178)

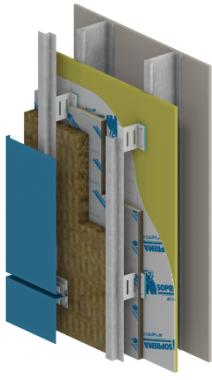
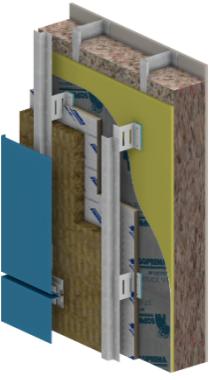
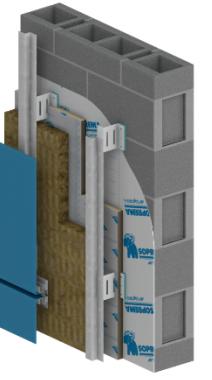
Table 1.2 below summarizes the evaluated wall configurations, and Figure 1.1 illustrates representative wall assemblies for all backup wall configurations. The geometry of the ACS-S Thermal Clips were based on the drawings provided by ACS Composite Systems Inc. and Soprema, and are provided in Appendix A.

**Table 1.2:** Evaluated ACS-S Thermal Clip Assemblies: Protected Exterior Insulation Wall Assemblies

Backup Wall	Exterior Insulation Type	Nominal R-Value/in	Total Exterior Insulation Thickness (inches)	Stud Spacing (in)	Horizontal Clip Spacing (in)	Vertical Clip Spacing (in)
6" Steel Stud, Uninsulated Cavity	SOPRA ISO V ALU + 2" Mineral Wool	R-6.5/in + R-4.3/in	3, 3.5*, 4, 4.5*, 5, 5.5*, 6, 6.5*, 7, 8**	16, 24	16, 24	24, 36, 48
6" Steel Stud, R-20 Cellulose Insulation in Cavity	SOPRA ISO V PLUS + 2" Mineral Wool	R-6/in + R-4.3/in	3, 3.5*, 4, 4.5*, 5, 5.5*, 6*, 6.5*, 7	16, 24	16, 24	24, 36, 48
2" x 6" Wood Frame, R-19 Cellulose Insulation in Cavity	SOPRA ISO V PLUS + 2" Mineral Wool	R-6/in + R-4.3/in	3, 3.5*, 4, 4.5*, 5, 5.5*, 6*, 6.5*, 7	16, 24	16, 24	24, 36, 48
CMU	SOPRA ISO V ALU + 2" Mineral Wool	R-6.5/in + R-4.3/in	3, 3.5*, 4, 4.5*, 5, 5.5*, 6, 6.5", 7	16, 24	16, 24	24, 36, 48
2" x 4" Wood Frame, R-13 Cellulose Insulation in Cavity	SOPRA ISO V PLUS + 2" Mineral Wool	R-6/in + R-4.3/in	3, 3.5*, 4, 4.5*, 5, 5.5*, 6*, 6.5*, 7	16, 24	16, 24	24, 36, 48

\*Indicates interpolated value

\*\* Indicates extrapolated value

				
<b>Exterior Insulated Steel Stud Assembly</b> <ul style="list-style-type: none"> <li>• 1/2 inch (13 mm) gypsum</li> <li>• 6 inch x 1 5/8 inch (152 mm x 41 mm) steel studs with uninsulated cavity</li> <li>• 1/2 inch (13 mm) gypsum sheathing</li> <li>• SOPREMA SOPRASEAL STICK 1100T membrane installed with SOPRASEAL STICK PRIMER</li> <li>• ACS-S Thermal Clip System</li> <li>• SOPRA-ISO V ALU insulation</li> <li>• 2" (51 mm) mineral wool insulation</li> <li>• Z-girt</li> </ul>	<b>Split Insulated Steel Stud Assembly</b> <ul style="list-style-type: none"> <li>• 1/2 inch (13 mm) gypsum</li> <li>• 6 inch x 1 5/8 inch (152 mm x 41 mm) steel studs with R-20 cellulose insulation in stud cavity</li> <li>• 1/2 inch (13 mm) gypsum sheathing</li> <li>• SOPREMA SOPRASEAL STICK VP membrane</li> <li>• ACS-S Thermal Clip System</li> <li>• SOPRA-ISO V PLUS insulation</li> <li>• 2" (51 mm) mineral wool insulation</li> <li>• Z-girt</li> </ul>	<b>Split Insulated 2x6 Wood Frame Assembly</b> <ul style="list-style-type: none"> <li>• 1/2 inch (13 mm) gypsum</li> <li>• 2x6 (37 mm x 140 mm) wood studs with R-19 cellulose insulation in stud cavity</li> <li>• 1/2 inch (13 mm) plywood sheathing</li> <li>• SOPREMA SOPRASEAL STICK VP membrane</li> <li>• ACS-S Thermal Clip System</li> <li>• SOPRA-ISO V PLUS insulation</li> <li>• 2" (51 mm) mineral wool insulation</li> <li>• Z-girt</li> </ul>	<b>Concrete Block Wall</b> <ul style="list-style-type: none"> <li>• 8 inch (203 mm) CMU Wall</li> <li>• SOPREMA SOPRASEAL STICK 1100T membrane installed with SOPRASEAL STICK PRIMER</li> <li>• ACS-S Thermal Clip System</li> <li>• SOPRA-ISO V ALU insulation</li> <li>• 2" (51 mm) mineral wool insulation</li> <li>• Z-girt</li> </ul>	<b>Split Insulated 2x4 Wood Frame Assembly</b> <ul style="list-style-type: none"> <li>• 1/2 inch (13 mm) gypsum</li> <li>• 2x4 (38 mm x 89 mm) wood studs with R-13 cellulose insulation in stud cavity</li> <li>• 1/2 inch (13 mm) plywood sheathing</li> <li>• SOPREMA SOPRASEAL STICK VP membrane</li> <li>• ACS-S Thermal Clip System</li> <li>• SOPRA-ISO V PLUS insulation</li> <li>• 2" (51 mm) mineral wool insulation</li> <li>• Z-girt</li> </ul>

**Figure 1.1:** Schematic of Evaluated ACS-S Thermal Clip with Protected Exterior Insulation 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*<sup>1</sup>. 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, is provided in Appendix C.

---

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

### 3. THERMAL RESULTS

The clear field U- Values and effective R-values for all ACS-S Thermal Clip wall assembly configurations are shown below in Table 3.1 to Table 3.5. Example temperature profiles for each configuration are shown in Appendix D.

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

Horizontal Clip Spacing	Total Exterior Insulation Thickness in (mm)	Total Exterior Insulation 1D R-value <sup>2</sup> (RSI)	24" Vertical Spacing		36" Vertical Spacing		48" Vertical Spacing	
			R <sub>o</sub> ft <sup>2</sup> ·hr·°F / Btu (m <sup>2</sup> K / W)	U <sub>o</sub> Btu/ft <sup>2</sup> · hr · °F (W/m <sup>2</sup> K)	R <sub>o</sub> ft <sup>2</sup> ·hr·°F / Btu (m <sup>2</sup> K / W)	U <sub>o</sub> Btu/ft <sup>2</sup> · hr · °F (W/m <sup>2</sup> K)	R <sub>o</sub> ft <sup>2</sup> ·hr·°F / Btu (m <sup>2</sup> K / W)	U <sub>o</sub> Btu/ft <sup>2</sup> · hr · °F (W/m <sup>2</sup> K)
16	3.0 (76)	R-15.1 (2.66)	R-17.5 (3.08)	0.057 (0.32)	R-17.8 (3.13)	0.056 (0.32)	R-17.9 (3.15)	0.056 (0.32)
	3.5 (89)	R-18.4 (3.23)	R-20.3 (3.58)*	0.049 (0.28)*	R-20.7 (3.65)*	0.048 (0.27)*	R-20.9 (3.69)*	0.048 (0.27)*
	4.0 (102)	R-21.6 (3.80)	R-23.2 (4.08)	0.043 (0.24)	R-23.7 (4.17)	0.042 (0.24)	R-24.0 (4.22)	0.042 (0.24)
	4.5 (114)	R-24.9 (4.38)	R-26.0 (4.57)*	0.039 (0.22)*	R-26.6 (4.69)*	0.038 (0.21)*	R-27.0 (4.75)*	0.037 (0.21)*
	5.0 (127)	R-28.1 (4.95)	R-28.7 (5.05)	0.035 (0.20)	R-29.5 (5.19)	0.034 (0.19)	R-29.9 (5.27)	0.033 (0.19)
	5.5 (140)	R-31.4 (5.52)	R-31.4 (5.54)*	0.032 (0.18)*	R-32.4 (5.71)*	0.031 (0.18)*	R-32.9 (5.79)*	0.030 (0.17)*
	6.0 (152)	R-34.6 (6.09)	R-34.2 (6.02)	0.029 (0.17)	R-35.3 (6.22)	0.028 (0.16)	R-35.9 (6.32)	0.028 (0.16)
	6.5 (165)	R-37.9 (6.67)	R-36.8 (6.48)*	0.027 (0.15)*	R-38.1 (6.71)*	0.026 (0.15)*	R-38.8 (6.83)*	0.026 (0.15)*
	7.0 (178)	R-41.1 (7.24)	R-39.4 (6.94)	0.025 (0.14)	R-40.9 (7.20)	0.024 (0.14)	R-41.7 (7.34)	0.024 (0.14)
	8.0 (203)	R-47.6 (8.38)	R-44.6 (7.85)**	0.022 (0.13)**	R-46.5 (8.18)**	0.022 (0.12)**	R-47.5 (8.36)**	0.021 (0.12)**
24	3.0 (76)	R-15.1 (2.66)	R-17.8 (3.13)	0.056 (0.32)	R-18.0 (3.17)	0.056 (0.32)	R-18.1 (3.18)	0.055 (0.31)
	3.5 (89)	R-18.4 (3.23)	R-20.8 (3.65)*	0.048 (0.27)*	R-21.0 (3.70)*	0.048 (0.27)*	R-21.2 (3.73)*	0.047 (0.27)*
	4.0 (102)	R-21.6 (3.80)	R-23.7 (4.18)	0.042 (0.24)	R-24.1 (4.24)	0.042 (0.24)	R-24.2 (4.27)	0.041 (0.23)
	4.5 (114)	R-24.9 (4.38)	R-26.6 (4.69)*	0.038 (0.21)*	R-27.1 (4.77)*	0.037 (0.21)*	R-27.3 (4.81)*	0.037 (0.21)*
	5.0 (127)	R-28.1 (4.95)	R-29.5 (5.20)	0.034 (0.19)	R-30.1 (5.30)	0.033 (0.19)	R-30.4 (5.35)	0.033 (0.19)
	5.5 (140)	R-31.4 (5.52)	R-32.4 (5.71)*	0.031 (0.18)*	R-33.1 (5.83)*	0.030 (0.17)*	R-33.4 (5.89)*	0.030 (0.17)*
	6.0 (152)	R-34.6 (6.09)	R-35.3 (6.22)	0.028 (0.16)	R-36.1 (6.36)	0.028 (0.16)	R-36.5 (6.43)	0.027 (0.16)
	6.5 (165)	R-37.9 (6.67)	R-38.1 (6.71)*	0.026 (0.15)*	R-39.0 (6.87)*	0.026 (0.15)*	R-39.5 (6.96)*	0.025 (0.14)*
	7.0 (178)	R-41.1 (7.24)	R-40.9 (7.21)	0.024 (0.14)	R-42.0 (7.39)	0.024 (0.14)	R-42.5 (7.49)	0.024 (0.13)
	8.0 (203)	R-47.6 (8.38)	R-46.5 (8.19)**	0.022 (0.12)**	R-47.8 (8.43)**	0.021 (0.12)**	R-48.6 (8.56)**	0.021 (0.12)**

\*Indicates interpolated value

\*\* Indicates extrapolated value

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

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

Horizontal Clip Spacing	Total Exterior Insulation Thickness in (mm)	Total Exterior Insulation 1D R-value <sup>3</sup> (RSI)	24" Vertical Spacing		36" Vertical Spacing		48" Vertical Spacing	
			R <sub>o</sub> ft <sup>2</sup> ·hr·°F / Btu (m <sup>2</sup> K / W)	U <sub>o</sub> Btu/ft <sup>2</sup> · hr ·°F (W/m <sup>2</sup> K)	R <sub>o</sub> ft <sup>2</sup> ·hr·°F / Btu (m <sup>2</sup> K / W)	U <sub>o</sub> Btu/ft <sup>2</sup> · hr ·°F (W/m <sup>2</sup> K)	R <sub>o</sub> ft <sup>2</sup> ·hr·°F / Btu (m <sup>2</sup> K / W)	U <sub>o</sub> Btu/ft <sup>2</sup> · hr ·°F (W/m <sup>2</sup> K)
16	3.0 (76)	R-14.6 (2.57)	R-26.5 (4.66)	0.038 (0.21)	R-26.8 (4.72)	0.037 (0.21)	R-27.0 (4.75)	0.037 (0.21)
	3.5 (89)	R-17.6 (3.10)	R-29.1 (5.12)*	0.034 (0.20)*	R-29.5 (5.20)*	0.034 (0.19)*	R-29.8 (5.25)*	0.034 (0.19)*
	4.0 (102)	R-20.6 (3.63)	R-31.7 (5.58)	0.032 (0.18)	R-32.3 (5.68)	0.031 (0.18)	R-32.6 (5.74)	0.031 (0.17)
	4.5 (114)	R-23.6 (4.16)	R-34.2 (6.02)*	0.029 (0.17)*	R-34.9 (6.15)*	0.029 (0.16)*	R-35.3 (6.22)*	0.028 (0.16)*
	5.0 (127)	R-26.6 (4.68)	R-36.7 (6.46)	0.027 (0.15)	R-37.6 (6.62)	0.027 (0.15)	R-38.1 (6.70)	0.026 (0.15)
	5.5 (140)	R-29.6 (5.21)	R-39.2 (6.91)*	0.026 (0.14)*	R-40.3 (7.09)*	0.025 (0.14)*	R-40.8 (7.19)*	0.024 (0.14)*
	6.0 (152)	R-32.6 (5.74)	R-41.7 (7.34)*	0.024 (0.14)*	R-42.9 (7.56)*	0.023 (0.13)*	R-43.6 (7.67)*	0.023 (0.13)*
	6.5 (165)	R-35.6 (6.27)	R-44.2 (7.78)*	0.023 (0.13)*	R-45.5 (8.02)*	0.022 (0.12)*	R-46.3 (8.15)*	0.022 (0.12)*
	7.0 (178)	R-38.6 (6.80)	R-46.6 (8.21)	0.021 (0.12)	R-48.1 (8.48)	0.021 (0.12)	R-49.0 (8.62)	0.020 (0.12)
24	3.0 (76)	R-14.6 (2.57)	R-29.2 (5.14)	0.034 (0.19)	R-29.5 (5.19)	0.034 (0.19)	R-29.6 (5.22)	0.034 (0.19)
	3.5 (89)	R-17.6 (3.10)	R-31.9 (5.62)*	0.031 (0.18)*	R-32.3 (5.69)*	0.031 (0.18)*	R-32.5 (5.72)*	0.031 (0.17)*
	4.0 (102)	R-20.6 (3.63)	R-34.6 (6.10)	0.029 (0.16)	R-35.1 (6.18)	0.028 (0.16)	R-35.4 (6.23)	0.028 (0.16)
	4.5 (114)	R-23.6 (4.16)	R-37.3 (6.57)*	0.027 (0.15)*	R-37.9 (6.67)*	0.026 (0.15)*	R-38.2 (6.72)*	0.026 (0.15)*
	5.0 (127)	R-26.6 (4.68)	R-39.9 (7.03)	0.025 (0.14)	R-40.6 (7.16)	0.025 (0.14)	R-41.0 (7.22)	0.024 (0.14)
	5.5 (140)	R-29.6 (5.21)	R-42.6 (7.51)*	0.023 (0.13)*	R-43.4 (7.65)*	0.023 (0.13)*	R-43.8 (7.72)*	0.023 (0.13)*
	6.0 (152)	R-32.6 (5.74)	R-45.3 (7.97)*	0.022 (0.13)*	R-46.2 (8.13)*	0.022 (0.12)*	R-46.7 (8.22)*	0.021 (0.12)*
	6.5 (165)	R-35.6 (6.27)	R-47.9 (8.43)*	0.021 (0.12)*	R-48.9 (8.61)*	0.020 (0.12)*	R-49.5 (8.71)*	0.020 (0.11)*
	7.0 (178)	R-38.6 (6.80)	R-50.5 (8.89)	0.020 (0.11)	R-51.6 (9.09)	0.019 (0.11)	R-52.3 (9.20)	0.019 (0.11)

\*Indicates interpolated value

<sup>3</sup> This value is the nominal R-value of the exterior insulation ONLY. Additional components, such as the sheathing, cellulose insulation, and air films all contribute an additional R-22.3 towards the nominal R-value of the entire assembly.

**Table 3.3:** U-Value and Effective R-Value for ACS-S Thermal Clip with Protected Exterior Insulation: Split Insulated 2x6 Wood Frame Wall Assemblies

Horizontal Clip Spacing	Total Exterior Insulation Thickness in (mm)	Exterior Insulation 1D R-value <sup>4</sup> (RSI)	24" Vertical Spacing		36" Vertical Spacing		48" Vertical Spacing	
			R <sub>o</sub> ft <sup>2</sup> ·hr·°F / Btu (m <sup>2</sup> K / W)	U <sub>o</sub> Btu/ft <sup>2</sup> · hr ·°F (W/m <sup>2</sup> K)	R <sub>o</sub> ft <sup>2</sup> ·hr·°F / Btu (m <sup>2</sup> K / W)	U <sub>o</sub> Btu/ft <sup>2</sup> · hr ·°F (W/m <sup>2</sup> K)	R <sub>o</sub> ft <sup>2</sup> ·hr·°F / Btu (m <sup>2</sup> K / W)	U <sub>o</sub> Btu/ft <sup>2</sup> · hr ·°F (W/m <sup>2</sup> K)
16	3.0 (76)	R-14.6 (2.57)	R-33.4 (5.88)	0.030 (0.17)	R-33.7 (5.93)	0.030 (0.17)	R-33.8 (5.96)	0.030 (0.17)
	3.5 (89)	R-17.6 (3.10)	R-36.1 (6.35)*	0.028 (0.16)*	R-36.4 (6.42)*	0.027 (0.16)*	R-36.6 (6.45)*	0.027 (0.16)*
	4.0 (102)	R-20.6 (3.63)	R-38.7 (6.82)	0.026 (0.15)	R-39.2 (6.90)	0.026 (0.14)	R-39.4 (6.94)	0.025 (0.14)
	4.5 (114)	R-23.6 (4.16)	R-41.3 (7.27)*	0.024 (0.14)*	R-41.9 (7.38)*	0.024 (0.14)*	R-42.2 (7.43)*	0.024 (0.13)*
	5.0 (127)	R-26.6 (4.68)	R-43.8 (7.72)	0.023 (0.13)	R-44.6 (7.85)	0.022 (0.13)	R-45.0 (7.92)	0.022 (0.13)
	5.5 (140)	R-29.6 (5.21)	R-46.4 (8.17)*	0.022 (0.12)*	R-47.3 (8.33)*	0.021 (0.12)*	R-47.7 (8.41)*	0.021 (0.12)*
	6.0 (152)	R-32.6 (5.74)	R-48.9 (8.61)*	0.020 (0.12)*	R-49.9 (8.80)*	0.020 (0.11)*	R-50.5 (8.89)*	0.020 (0.11)*
	6.5 (165)	R-35.6 (6.27)	R-51.4 (9.05)*	0.019 (0.11)*	R-52.6 (9.26)*	0.019 (0.11)*	R-53.2 (9.37)*	0.019 (0.11)*
	7.0 (178)	R-38.6 (6.80)	R-53.9 (9.49)	0.019 (0.11)	R-55.2 (9.73)	0.018 (0.10)	R-55.9 (9.85)	0.018 (0.10)
24	3.0 (76)	R-14.6 (2.57)	R-34.1 (6.01)	0.029 (0.17)	R-34.5 (6.08)	0.029 (0.16)	R-34.7 (6.12)	0.029 (0.16)
	3.5 (89)	R-17.6 (3.10)	R-37.0 (6.51)*	0.027 (0.15)*	R-37.3 (6.58)*	0.027 (0.15)*	R-37.6 (6.62)*	0.027 (0.15)*
	4.0 (102)	R-20.6 (3.63)	R-39.8 (7.01)	0.025 (0.14)	R-40.2 (7.07)	0.025 (0.14)	R-40.5 (7.13)	0.025 (0.14)
	4.5 (114)	R-23.6 (4.16)	R-42.5 (7.49)*	0.024 (0.13)*	R-43.0 (7.57)*	0.023 (0.13)*	R-43.3 (7.63)*	0.023 (0.13)*
	5.0 (127)	R-26.6 (4.68)	R-45.2 (7.97)	0.022 (0.13)	R-45.8 (8.06)	0.022 (0.12)	R-46.1 (8.13)	0.022 (0.12)
	5.5 (140)	R-29.6 (5.21)	R-48.0 (8.45)*	0.021 (0.12)*	R-48.5 (8.55)*	0.021 (0.12)*	R-49.0 (8.63)*	0.020 (0.12)*
	6.0 (152)	R-32.6 (5.74)	R-50.6 (8.92)*	0.020 (0.11)*	R-51.3 (9.04)*	0.019 (0.11)*	R-51.8 (9.13)*	0.019 (0.11)*
	6.5 (165)	R-35.6 (6.27)	R-53.3 (9.38)*	0.019 (0.11)*	R-54.1 (9.52)*	0.018 (0.11)*	R-54.6 (9.62)*	0.018 (0.10)*
	7.0 (178)	R-38.6 (6.80)	R-55.9 (9.84)	0.018 (0.10)	R-56.8 (10.01)	0.018 (0.10)	R-57.5 (10.12)	0.017 (0.10)

\*Indicates interpolated value

<sup>4</sup> This value is the nominal R-value of the exterior insulation ONLY. Additional components, such as the sheathing, cellulose insulation, and air films all contribute an additional R-21.5 towards the nominal R-value of the entire assembly.

**Table 3.4:** U-Value and Effective R-Value for ACS-S Thermal Clip with Protected Exterior Insulation: CMU Wall Assemblies

Horizontal Clip Spacing	Total Exterior Insulation Thickness in (mm)	Exterior Insulation 1D R-value <sup>5</sup> (RSI)	24" Vertical Spacing		36" Vertical Spacing		48" Vertical Spacing	
			R <sub>o</sub> ft <sup>2</sup> ·hr·°F / Btu (m <sup>2</sup> K / W)	U <sub>o</sub> Btu/ft <sup>2</sup> ·hr ·°F (W/m <sup>2</sup> K)	R <sub>o</sub> ft <sup>2</sup> ·hr·°F / Btu (m <sup>2</sup> K / W)	U <sub>o</sub> Btu/ft <sup>2</sup> ·hr ·°F (W/m <sup>2</sup> K)	R <sub>o</sub> ft <sup>2</sup> ·hr·°F / Btu (m <sup>2</sup> K / W)	U <sub>o</sub> Btu/ft <sup>2</sup> ·hr ·°F (W/m <sup>2</sup> K)
16	3.0 (76)	R-15.1 (2.66)	R-17.0 (2.99)	0.059 (0.33)	R-17.2 (3.04)	0.058 (0.33)	R-17.4 (3.06)	0.058 (0.33)
	3.5 (89)	R-18.4 (3.23)	R-19.8 (3.49)*	0.050 (0.29)*	R-20.2 (3.56)*	0.050 (0.28)*	R-20.4 (3.59)*	0.049 (0.28)*
	4.0 (102)	R-21.6 (3.80)	R-22.6 (3.99)	0.044 (0.25)	R-23.2 (4.08)	0.043 (0.25)	R-23.4 (4.12)	0.043 (0.24)
	4.5 (114)	R-24.9 (4.38)	R-25.4 (4.47)*	0.039 (0.22)*	R-26.1 (4.59)*	0.038 (0.22)*	R-26.4 (4.65)*	0.038 (0.22)*
	5.0 (127)	R-28.1 (4.95)	R-28.1 (4.95)	0.036 (0.20)	R-28.9 (5.10)	0.035 (0.20)	R-29.4 (5.17)	0.034 (0.19)
	5.5 (140)	R-31.4 (5.52)	R-30.9 (5.44)*	0.032 (0.18)*	R-31.9 (5.61)*	0.031 (0.18)*	R-32.4 (5.70)*	0.031 (0.18)*
	6.0 (152)	R-34.6 (6.09)	R-33.6 (5.92)	0.030 (0.17)	R-34.7 (6.12)	0.029 (0.16)	R-35.3 (6.22)	0.028 (0.16)
	6.5 (165)	R-37.9 (6.67)	R-36.3 (6.38)*	0.028 (0.16)*	R-37.6 (6.62)*	0.027 (0.15)*	R-38.3 (6.74)*	0.026 (0.15)*
	7.0 (178)	R-41.1 (7.24)	R-38.9 (6.85)	0.026 (0.15)	R-40.4 (7.12)	0.025 (0.14)	R-41.2 (7.26)	0.024 (0.14)
24	3.0 (76)	R-15.1 (2.66)	R-17.2 (3.04)	0.058 (0.33)	R-17.4 (3.07)	0.057 (0.33)	R-17.5 (3.09)	0.057 (0.32)
	3.5 (89)	R-18.4 (3.23)	R-20.2 (3.56)*	0.050 (0.28)*	R-20.5 (3.61)*	0.049 (0.28)*	R-20.6 (3.63)*	0.049 (0.28)*
	4.0 (102)	R-21.6 (3.80)	R-23.2 (4.08)	0.043 (0.25)	R-23.5 (4.14)	0.043 (0.24)	R-23.7 (4.17)	0.042 (0.24)
	4.5 (114)	R-24.9 (4.38)	R-26.1 (4.59)*	0.038 (0.22)*	R-26.5 (4.67)*	0.038 (0.21)*	R-26.8 (4.72)*	0.037 (0.21)*
	5.0 (127)	R-28.1 (4.95)	R-28.9 (5.10)	0.035 (0.20)	R-29.5 (5.20)	0.034 (0.19)	R-29.8 (5.25)	0.034 (0.19)
	5.5 (140)	R-31.4 (5.52)	R-31.9 (5.61)*	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-34.6 (6.09)	R-34.7 (6.12)	0.029 (0.16)	R-35.6 (6.27)	0.028 (0.16)	R-36.0 (6.34)	0.028 (0.16)
	6.5 (165)	R-37.9 (6.67)	R-37.6 (6.62)*	0.027 (0.15)*	R-38.5 (6.79)*	0.026 (0.15)*	R-39.0 (6.87)*	0.026 (0.15)*
	7.0 (178)	R-41.1 (7.24)	R-40.4 (7.12)	0.025 (0.14)	R-41.5 (7.31)	0.024 (0.14)	R-42.0 (7.40)	0.024 (0.14)

\*Indicates interpolated value

<sup>5</sup> This value is the nominal R-value of the exterior insulation ONLY. Additional components, such as the CMU wall and air films all contribute an additional R-2.9 towards the nominal R-value of the entire assembly.

**Table 3.5:** U-Value and Effective R-Value for ACS-S Thermal Clip with Protected Exterior Insulation: Split Insulated 2x4 Wood Frame Wall Assemblies

Horizontal Clip Spacing	Total Exterior Insulation Thickness in (mm)	Exterior Insulation 1D R-value <sup>6</sup> (RSI)	24" Vertical Spacing		36" Vertical Spacing		48" Vertical Spacing	
			R <sub>o</sub> ft <sup>2</sup> ·hr·°F / Btu (m <sup>2</sup> K / W)	U <sub>o</sub> Btu/ft <sup>2</sup> · hr ·°F (W/m <sup>2</sup> K)	R <sub>o</sub> ft <sup>2</sup> ·hr·°F / Btu (m <sup>2</sup> K / W)	U <sub>o</sub> Btu/ft <sup>2</sup> · hr ·°F (W/m <sup>2</sup> K)	R <sub>o</sub> ft <sup>2</sup> ·hr·°F / Btu (m <sup>2</sup> K / W)	U <sub>o</sub> Btu/ft <sup>2</sup> · hr ·°F (W/m <sup>2</sup> K)
16	3.0 (76)	R-14.6 (2.57)	R-28.0 (4.94)	0.036 (0.20)	R-28.3 (4.99)	0.035 (0.20)	R-28.5 (5.01)	0.035 (0.20)
	3.5 (89)	R-17.6 (3.10)	R-30.7 (5.41)*	0.033 (0.18)*	R-31.1 (5.47)*	0.032 (0.18)*	R-31.3 (5.51)*	0.032 (0.18)*
	4.0 (102)	R-20.6 (3.63)	R-33.3 (5.87)	0.030 (0.17)	R-33.8 (5.96)	0.030 (0.17)	R-34.1 (6.00)	0.029 (0.17)
	4.5 (114)	R-23.6 (4.16)	R-35.9 (6.32)*	0.028 (0.16)*	R-36.5 (6.43)*	0.027 (0.16)*	R-36.8 (6.49)*	0.027 (0.15)*
	5.0 (127)	R-26.6 (4.68)	R-38.5 (6.77)	0.026 (0.15)	R-39.2 (6.91)	0.025 (0.14)	R-39.6 (6.98)	0.025 (0.14)
	5.5 (140)	R-29.6 (5.21)	R-41.0 (7.22)*	0.024 (0.14)*	R-41.9 (7.38)*	0.024 (0.14)*	R-42.4 (7.46)*	0.024 (0.13)*
	6.0 (152)	R-32.6 (5.74)	R-43.5 (7.67)*	0.023 (0.13)*	R-44.6 (7.85)*	0.022 (0.13)*	R-45.1 (7.95)*	0.022 (0.13)*
	6.5 (165)	R-35.6 (6.27)	R-46.0 (8.11)*	0.022 (0.12)*	R-47.2 (8.32)*	0.021 (0.12)*	R-47.9 (8.43)*	0.021 (0.12)*
	7.0 (178)	R-38.6 (6.80)	R-48.5 (8.54)	0.021 (0.12)	R-49.9 (8.79)	0.020 (0.11)	R-50.6 (8.91)	0.020 (0.11)
24	3.0 (76)	R-14.6 (2.57)	R-28.6 (5.03)	0.035 (0.20)	R-29.0 (5.10)	0.035 (0.20)	R-29.1 (5.13)	0.034 (0.19)
	3.5 (89)	R-17.6 (3.10)	R-31.4 (5.54)*	0.032 (0.18)*	R-31.8 (5.60)*	0.031 (0.18)*	R-32.0 (5.63)*	0.031 (0.18)*
	4.0 (102)	R-20.6 (3.63)	R-34.3 (6.04)	0.029 (0.17)	R-34.6 (6.10)	0.029 (0.16)	R-34.8 (6.14)	0.029 (0.16)
	4.5 (114)	R-23.6 (4.16)	R-37.0 (6.51)*	0.027 (0.15)*	R-37.4 (6.59)*	0.027 (0.15)*	R-37.7 (6.64)*	0.027 (0.15)*
	5.0 (127)	R-26.6 (4.68)	R-39.7 (6.99)	0.025 (0.14)	R-40.2 (7.08)	0.025 (0.14)	R-40.5 (7.14)	0.025 (0.14)
	5.5 (140)	R-29.6 (5.21)	R-42.4 (7.47)*	0.024 (0.13)*	R-43.0 (7.57)*	0.023 (0.13)*	R-43.4 (7.64)*	0.023 (0.13)*
	6.0 (152)	R-32.6 (5.74)	R-45.1 (7.94)*	0.022 (0.13)*	R-45.8 (8.06)*	0.022 (0.12)*	R-46.2 (8.14)*	0.022 (0.12)*
	6.5 (165)	R-35.6 (6.27)	R-47.7 (8.40)*	0.021 (0.12)*	R-48.5 (8.55)*	0.021 (0.12)*	R-49.0 (8.63)*	0.020 (0.12)*
	7.0 (178)	R-38.6 (6.80)	R-50.3 (8.86)	0.020 (0.11)	R-51.3 (9.03)	0.020 (0.11)	R-51.8 (9.13)	0.019 (0.11)

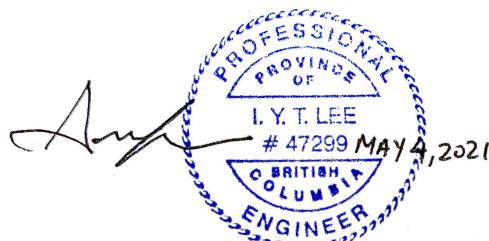
\*Indicates interpolated value

We believe that this report meets your objectives for evaluating the thermal performance for the ACS Thermal Clip system with protected exterior insulation 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

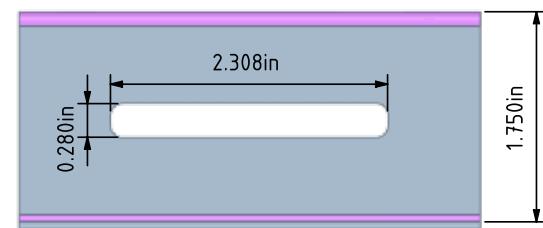
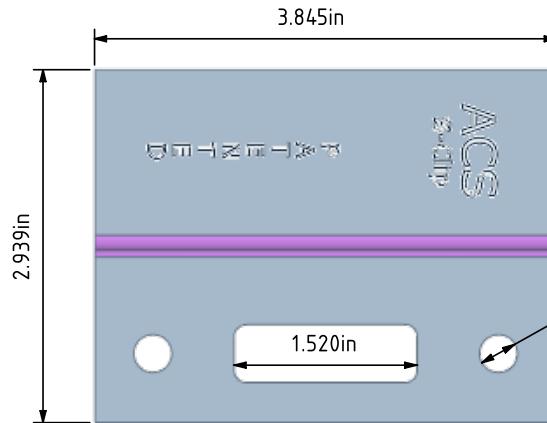


Ivan Lee, P.Eng.  
Principal, Building Science Consultant

<sup>6</sup> This value is the nominal R-value of the exterior insulation ONLY. Additional components, such as the sheathing, cellulose insulation, and air films all contribute an additional R-15.5 towards the nominal R-value of the entire assembly.

## **APPENDIX A: DETAIL DRAWINGS**

## NOTES:



↓

REV

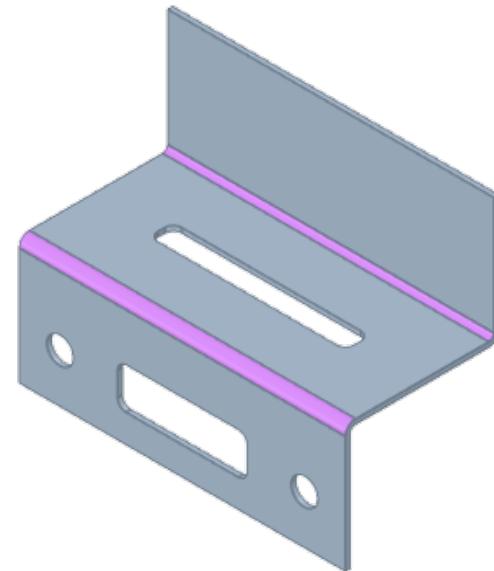
## REVISION HISTORY

## DESCRIPTION

## INCORP BY

## DATE

## CHECKED



↑

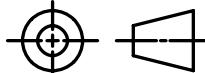
-2	-1	ITEM NO.
QTY REQD		IDENTIFYING NO.

NOMENCLATURE OR DESCRIPTION

## PARTS LIST

INIT	APPROVALS	DATE	INIT	APPROVALS	DATE	ACS Composite Systems					
<b>TITLE</b>											
<b>2in Solid Clip</b>											
						SIZE	CAGE CODE	DWG NO.			
						B					
						SCALE		SHEET			

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

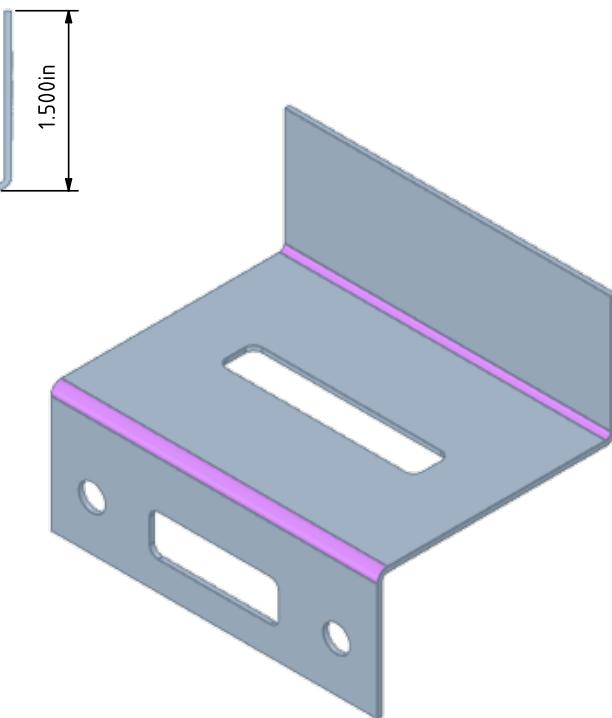
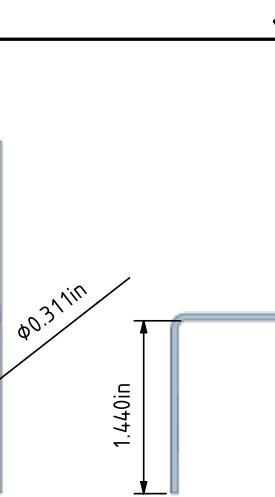
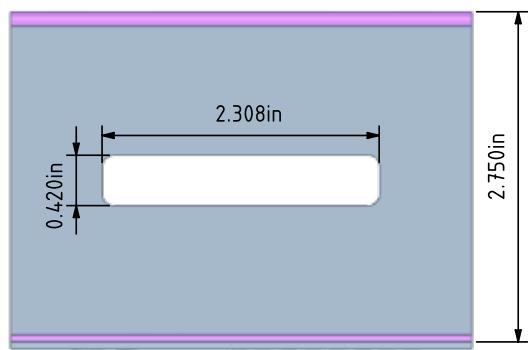
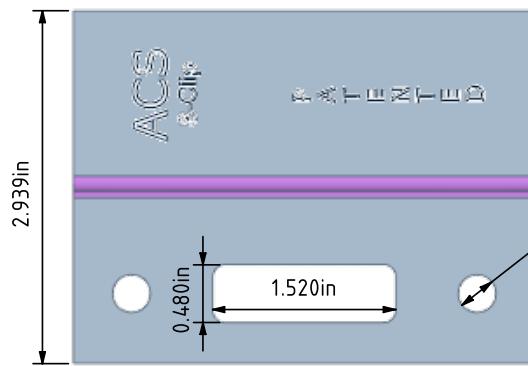


4

↑

4

## NOTES:



## REVISION HISTORY

REV

DESCRIPTION

INCORP BY

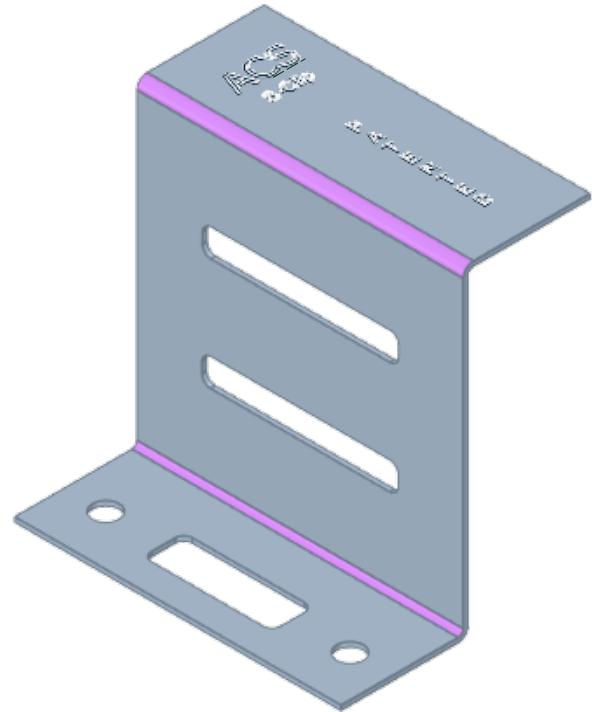
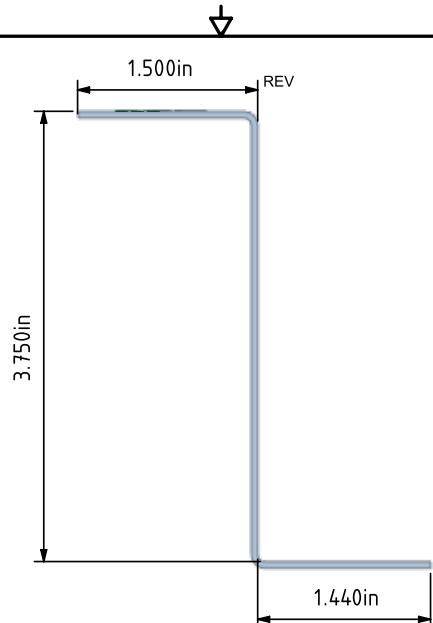
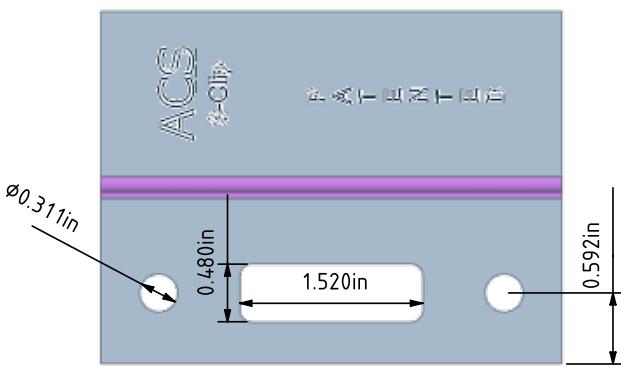
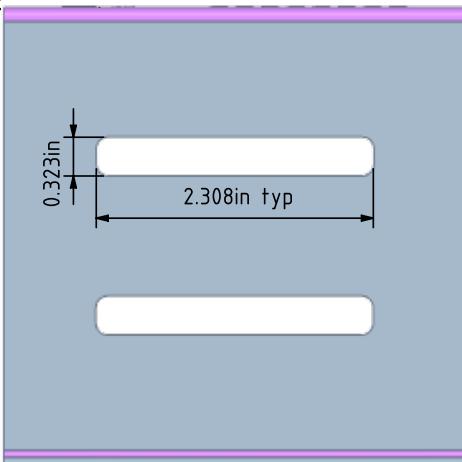
DATE

CHECKED

-2	-1	ITEM NO.	PART OR IDENTIFYING NO.		NOMENCLATURE OR DESCRIPTION				
QTY REQD			INIT	APPROVALS	DATE	INIT	APPROVALS	DATE	ACS Composite Systems
TITLE									
3in Solid Clip									
									SIZE CAGE CODE DWG NO.
									B REV 2
									SCALE SHEET

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

## NOTES:



## REVISION HISTORY

DESCRIPTION

INCORP BY

DATE

CHECKED

	CONTRACT NO.		MATERIAL	INIT	APPROVALS	DATE	INIT	APPROVALS	DATE	NOMENCLATURE OR DESCRIPTION		
	QTY REQD	ITEM NO.								PART OR IDENTIFYING NO.		
			FINISH							4in Solid Clip		
THIRD ANGLE PROJECTION			TREATMENT							TITLE		
			SIMILAR TO							SIZE	CAGE CODE	DWG NO.
			APPLICATION							B		
										SCALE		SHEET

## REVISION HISTORY

REV

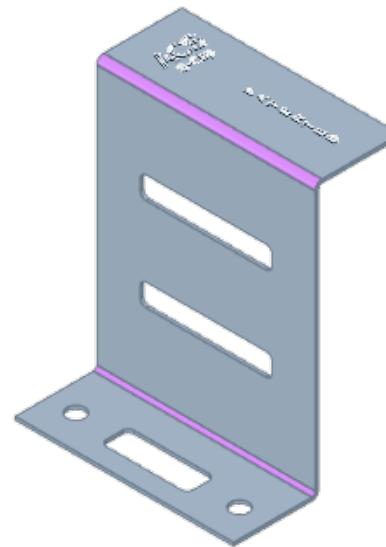
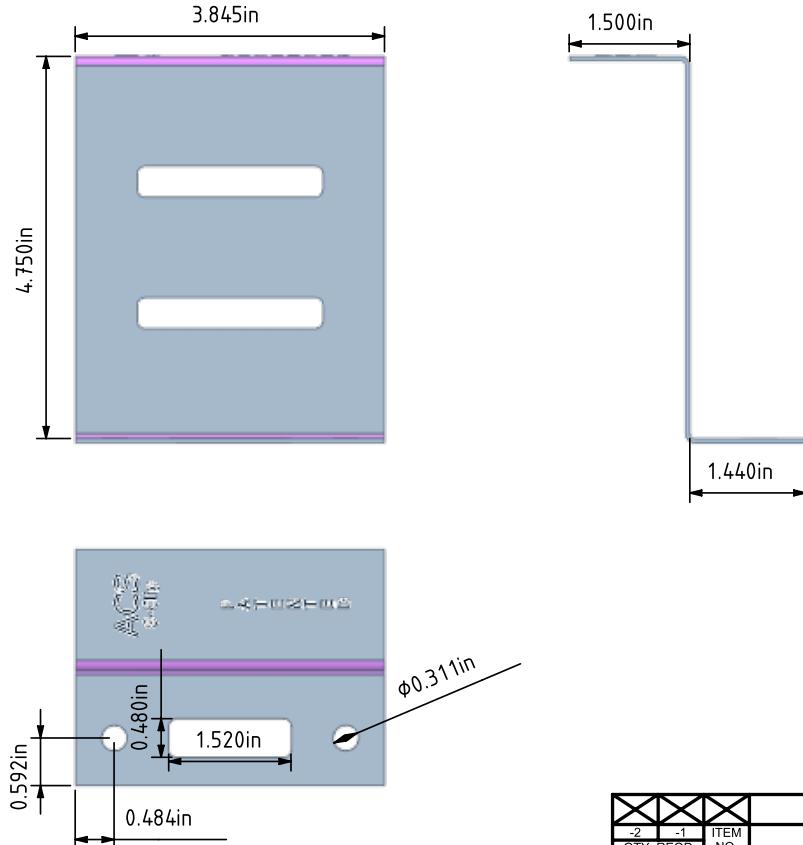
## DESCRIPTION

INCORP BY

DATE

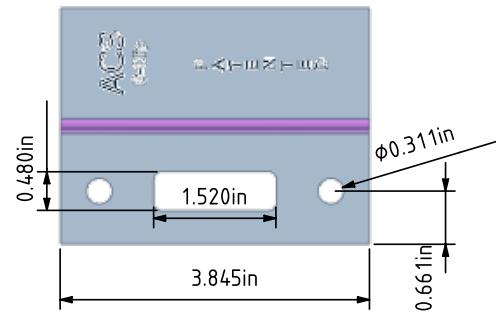
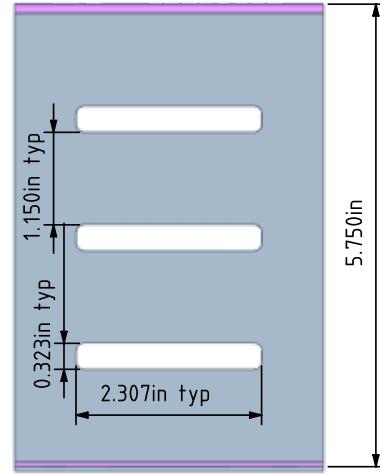
CHECKED

## NOTES:



 		ITEM NO.	PART OR IDENTIFYING NO.		NOMENCLATURE OR DESCRIPTION	
QTY REQD						
PARTS LIST						
INIT	APPROVALS	DATE	INIT	APPROVALS	DATE	<b>ACS Composite Systems</b>  <b>TITLE</b> <b>5in Solid Clip</b>
						<b>REV</b> <b>2</b>
						<b>SHEET</b> <b>1</b>

## NOTES:



1.500in REV

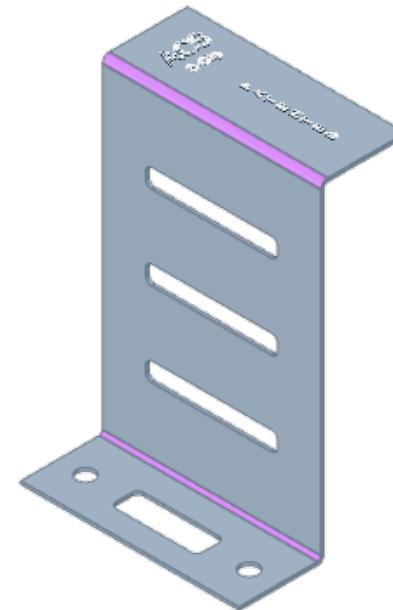
## REVISION HISTORY

## DESCRIPTION

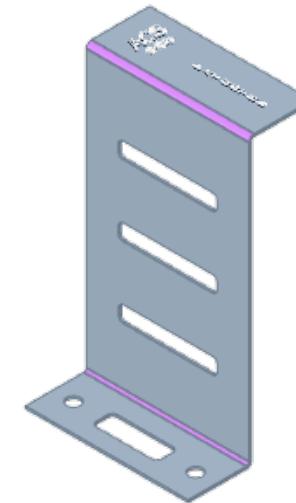
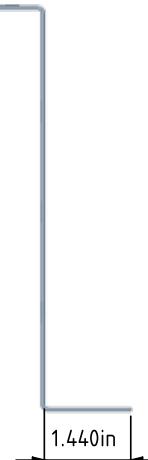
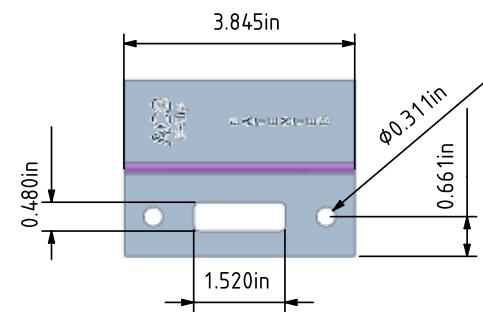
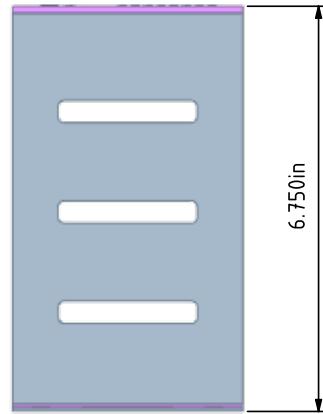
INCORP BY

DATE

CHECKED



NOTES:



REVISION HISTORY

REV

DESCRIPTION

INCORP BY

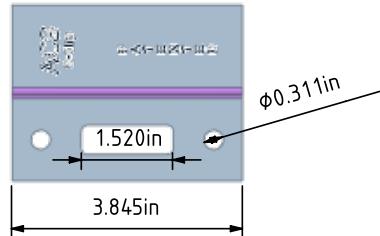
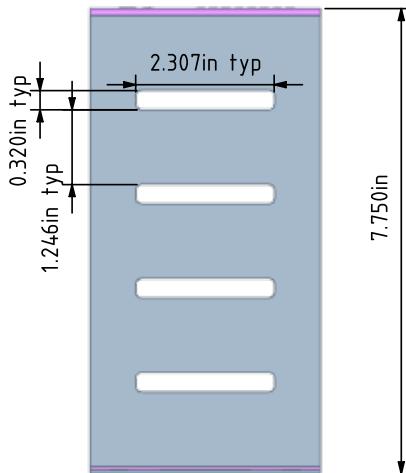
DATE

CHECKED

-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.
						REV
						2
SCALE						
SHEET						

	CONTRACT NO.			
	FINISH			
	TREATMENT			
	NEXT ASSY	USED ON		
APPLICATION		SIMILAR TO		

## NOTES:



REV  
1.500in

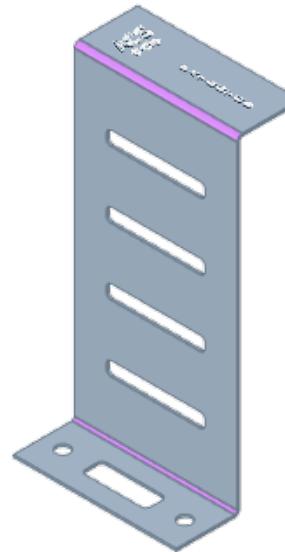
## REVISION HISTORY

## DESCRIPTION

INCORP BY

DATE

CHECKED



## **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.

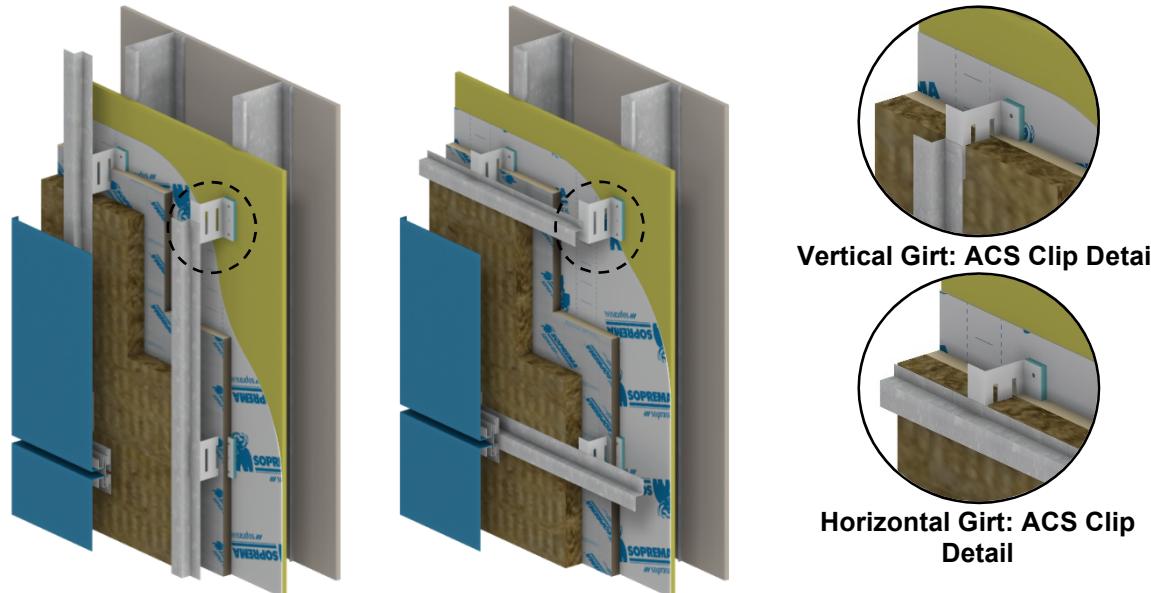
### 3. BOUNDARY CONDITIONS

**Table B3.1:** Boundary Conditions

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

## **APPENDIX C: MATERIAL PROPERTIES**

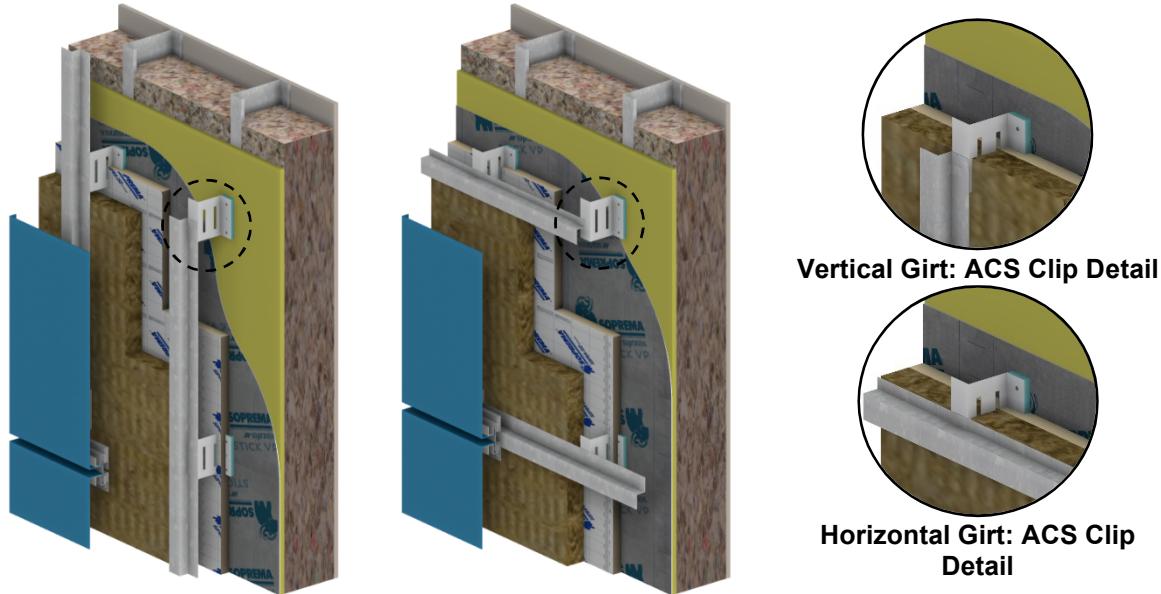
## 1. ACS-S THERMAL CLIP WITH PROTECTED EXTERIOR INSULATION: EXTERIOR INSULATED STEEL STUD WALL ASSEMBLIES



Component	Material	Thickness in (mm)	Thermal Conductivity Btu in / ft <sup>2</sup> hr °F (W/m K)	Nominal Resistance ft <sup>2</sup> hr °F / Btu (m <sup>2</sup> K/W)
Interior Film	-	-	-	R-0.7 (0.12 RSI)
Gypsum	Gypsum	1/2 (13)	1.1 (0.16)	R-0.5 (0.08 RSI)
Stud Cavity	Airspace	6 (152)	6.7 (0.96)	R-0.9 (0.16 RSI)
Steel Stud	Galvanized Steel	18 ga.	430 (62)	-
Sheathing	Gypsum	1/2 (13)	1.1 (0.16)	R-0.5 (0.08 RSI)
SOPREMA SOPRASEAL STICK 1100T membrane installed with SOPRASEAL STICK PRIMER	-	-	-	-
SOPRA-ISO V ALU	SOPRA-ISO V ALU	Varies	0.15 (0.022)	R-6.5 to R-39.0 (1.14 to 6.87 RSI)
Mineral Wool	Mineral Wool	2 (50)	0.23 (0.034)	R-8.6 (1.51 RSI)
ACS-S Thermal Clip	Stainless Steel	16 ga.	118 (17)	-
Extreme Pad	Rigid Urethane Foam	1/2 (13)	0.13 (0.019)	-
ACS Clip-Fasteners	Steel	1/4" (6.4) Ø	347 (50)	-
Vertical Girt	Galvanized Steel	18 ga.	430 (62)	-
Air Spaces <sup>1</sup>	Air	Varies	Varies	-
Exterior Film	-	-	-	R-0.7 (0.12 RSI)
Overall Wall Assembly 1D	-	-	-	R-18.3 to R-50.8 (3.22 to 8.94 RSI)

<sup>1</sup> The thermal conductivities of the air spaces were determined according to ISO 10077-2

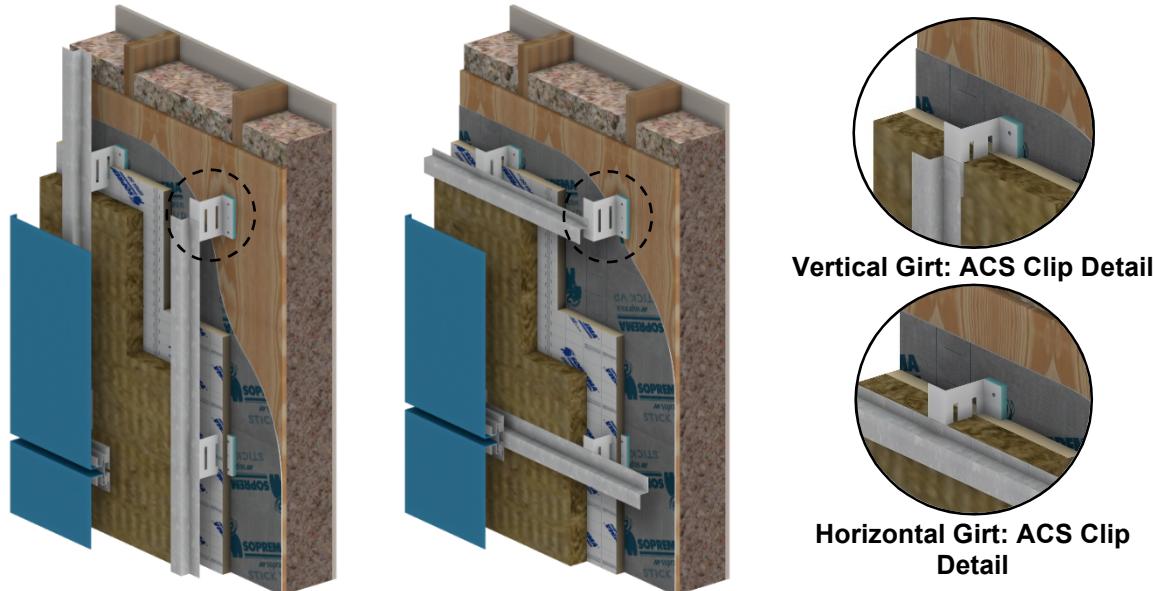
## 2. ACS-S THERMAL CLIP WITH PROTECTED EXTERIOR INSULATION: SPLIT INSULATED STEEL STUD WALL ASSEMBLIES



Component	Material	Thickness in (mm)	Thermal Conductivity Btu in / ft <sup>2</sup> hr °F (W/m K)	Nominal Resistance ft <sup>2</sup> hr °F / Btu (m <sup>2</sup> K/W)
Interior Film	-	-	-	R-0.7 (0.12 RSI)
Gypsum	Gypsum	1/2 (13)	1.1 (0.16)	R-0.5 (0.08 RSI)
Stud Cavity	R-20 Cellulose	6 (152)	0.30 (0.043)	R-20.0 (3.52 RSI)
Steel Stud	Galvanized Steel	18 ga.	430 (62)	-
Sheathing	Gypsum	1/2 (13)	1.1 (0.16)	R-0.5 (0.08 RSI)
SOPREMA SOPRASEAL STICK VP membrane	-	-	-	-
SOPRA-ISO V PLUS	SOPRA-ISO V PLUS	Varies	0.17 (0.024)	R-6.0 to R-30.0 (1.06 to 5.28 RSI)
Mineral Wool	Mineral Wool	2 (50)	0.23 (0.034)	R-8.6 (1.51 RSI)
ACS-S Thermal Clip	Stainless Steel	16 ga.	118 (17)	-
Extreme Pad	Rigid Urethane Foam	1/2 (13)	0.13 (0.019)	-
ACS Clip-Fasteners	Steel	1/4" (6.4) Ø	347 (50)	-
Vertical Girt	Galvanized Steel	18 ga.	430 (62)	-
Air Spaces <sup>1</sup>	Air	Varies	Varies	-
Exterior Film	-	-	-	R-0.7 (0.12 RSI)
Overall Wall Assembly 1D	-	-	-	R-36.9 to R-60.9 (6.49 to 10.72 RSI)

<sup>1</sup> The thermal conductivities of the air spaces were determined according to ISO 10077-2

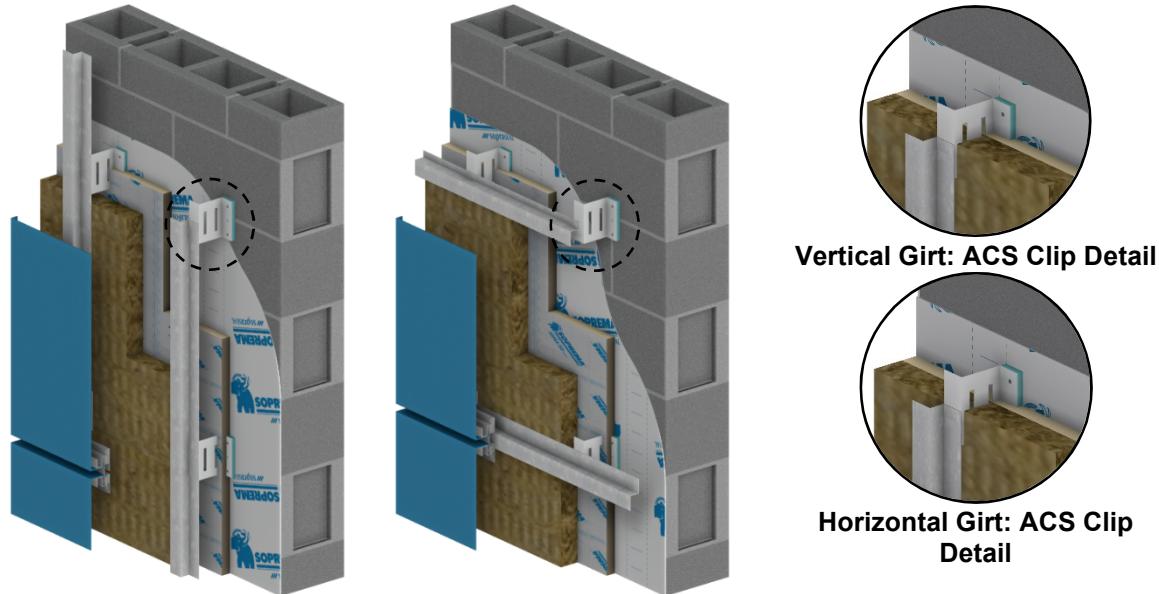
### 3. ACS-S THERMAL CLIP WITH PROTECTED EXTERIOR INSULATION: SPLIT INSULATED 2X6 WOOD FRAME WALL ASSEMBLIES



Component	Material	Thickness in (mm)	Thermal Conductivity Btu in / ft <sup>2</sup> hr °F (W/m K)	Nominal Resistance ft <sup>2</sup> hr °F / Btu (m <sup>2</sup> K/W)
Interior Film	-	-	-	R-0.7 (0.12 RSI)
Gypsum	Gypsum	1/2 (13)	1.1 (0.16)	R-0.5 (0.08 RSI)
Stud Cavity	R-19 Cellulose Insulation	5-1/2 (140)	0.3 (0.04)	R-19.0 (3.35 RSI)
2x6 Wood Stud	Wood	5-1/2 (140)	0.69 (0.10)	-
Sheathing	Plywood	1/2 (13)	0.7 (0.10)	R-0.7 (0.13 RSI)
SOPREMA SOPRASEAL STICK VP membrane	-	-	-	-
SOPRA-ISO V PLUS	SOPRA-ISO V PLUS	Varies	0.17 (0.024)	R-6.0 to R-30.0 (1.06 to 5.28 RSI)
Mineral Wool	Mineral Wool	2 (50)	0.23 (0.034)	R-8.6 (1.51 RSI)
ACS-S Thermal Clip	Stainless Steel	16 ga.	118 (17)	-
Extreme Pad	Rigid Urethane Foam	1/2 (13)	0.13 (0.019)	-
ACS Clip-Fasteners	Steel	1/4" (6.4) Ø	347 (50)	-
Vertical Girt	Galvanized Steel	18 ga.	430 (62)	-
Air Spaces <sup>1</sup>	Air	Varies	Varies	-
Exterior Film	-	-	-	R-0.7 (0.12 RSI)
Overall Wall Assembly 1D	-	-	-	R-36.1 to R-60.1 (6.36 to 10.59 RSI)

<sup>1</sup> The thermal conductivities of the air spaces were determined according to ISO 10077-2

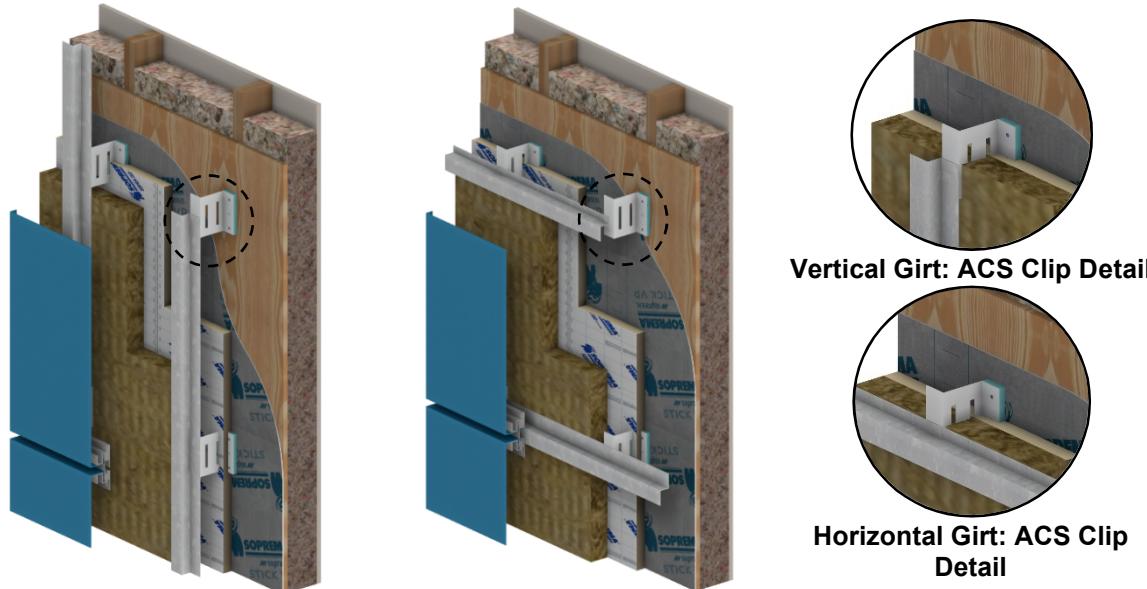
## 4. ACS-S THERMAL CLIP WITH PROTECTED EXTERIOR INSULATION: CMU WALL ASSEMBLIES



Component	Material	Thickness in (mm)	Thermal Conductivity Btu in / ft <sup>2</sup> hr °F (W/m K)	Nominal Resistance ft <sup>2</sup> hr °F / Btu (m <sup>2</sup> K/W)
Interior Film	-	-	-	R-0.7 (0.12 RSI)
Standard Concrete Blocks	Concrete	8 (203)	10.4 (1.50)	-
SOPREMA SOPRASEAL STICK 1100T membrane installed with SOPRASEAL STICK PRIMER	-	-	-	-
SOPRA-ISO V ALU	SOPRA-ISO V ALU	Varies	0.15 (0.022)	R-6.5 to R-32.5 (1.14 to 5.72 RSI)
Mineral Wool	Mineral Wool	2 (50)	0.23 (0.034)	R-8.6 (1.51 RSI)
ACS-S Thermal Clip	Stainless Steel	16 ga.	118 (17)	-
Extreme Pad	Rigid Urethane Foam	1/2 (13)	0.13 (0.019)	-
ACS Clip-Fasteners	Steel	1/4" (6.4) Ø	347 (50)	-
Vertical Girt	Galvanized Steel	18 ga.	430 (62)	-
Air Spaces <sup>1</sup>	Air	Varies	Varies	-
Exterior Film	-	-	-	R-0.7 (0.12 RSI)
Overall Wall Assembly 1D	-	-	-	R-18.0 to R-44.0 (3.16 to 7.74 RSI)

<sup>1</sup> The thermal conductivities of the air spaces were determined according to ISO 10077-2

## 5. ACS-S THERMAL CLIP WITH PROTECTED EXTERIOR INSULATION: SPLIT INSULATED 2X4 WOOD FRAME WALL ASSEMBLIES

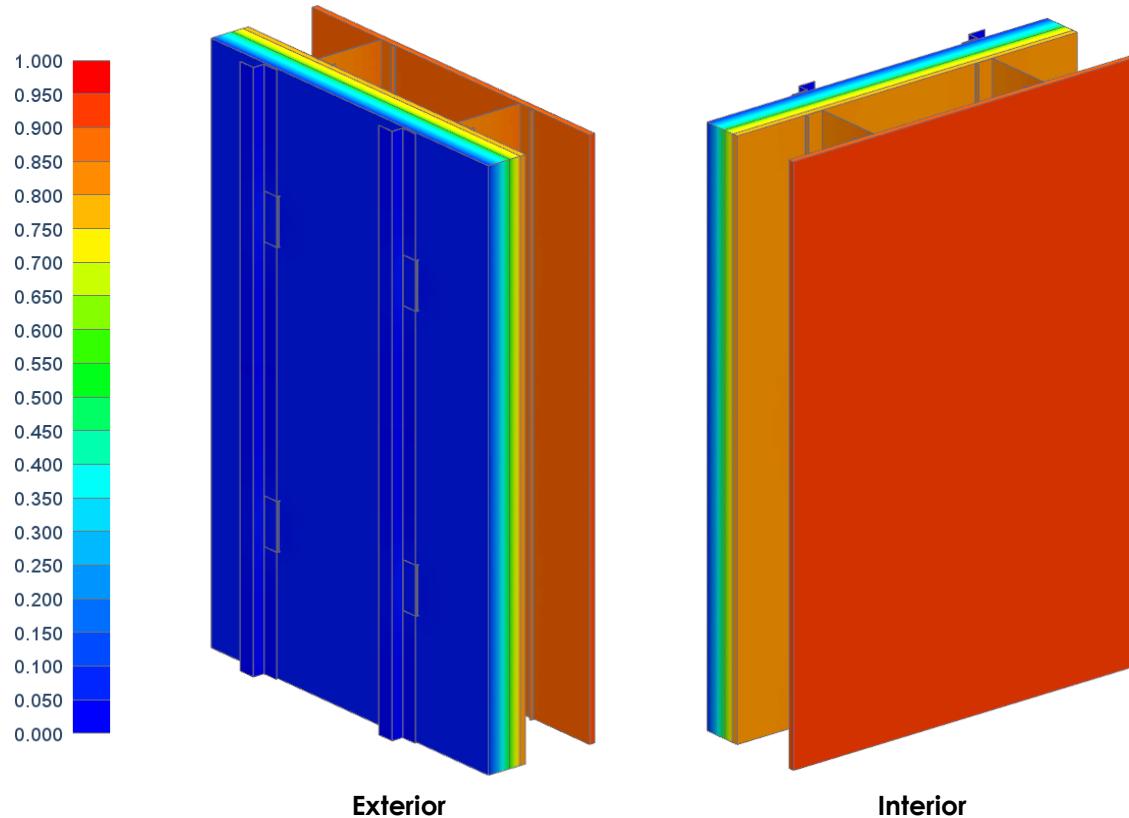


Component	Material	Thickness in (mm)	Thermal Conductivity Btu in / ft <sup>2</sup> hr °F (W/m K)	Nominal Resistance ft <sup>2</sup> hr °F / Btu (m <sup>2</sup> K/W)
Interior Film	-	-	-	R-0.7 (0.12 RSI)
Gypsum	Gypsum	1/2 (13)	1.1 (0.16)	R-0.5 (0.08 RSI)
Stud Cavity	R-13 Cellulose Insulation	3-1/2 (89)	0.3 (0.04)	R-13.0 (2.29 RSI)
2x4 Wood Stud	Wood	3-1/2 (89)	0.69 (0.10)	-
Sheathing	Plywood	1/2 (13)	0.7 (0.10)	R-0.7 (0.13 RSI)
SOPREMA SOPRASEAL STICK VP membrane	-	-	-	-
SOPRA-ISO V PLUS	SOPRA-ISO V PLUS	Varies	0.17 (0.024)	R-6.0 to R-30.0 (1.06 to 5.28 RSI)
Mineral Wool	Mineral Wool	2 (50)	0.23 (0.034)	R-8.6 (1.51 RSI)
ACS-S Thermal Clip	Stainless Steel	16 ga.	118 (17)	-
Extreme Pad	Rigid Urethane Foam	1/2 (13)	0.13 (0.019)	-
ACS Clip-Fasteners	Steel	1/4" (6.4) Ø	347 (50)	-
Vertical Girt	Galvanized Steel	18 ga.	430 (62)	-
Air Spaces <sup>1</sup>	Air	Varies	Varies	-
Exterior Film	-	-	-	R-0.7 (0.12 RSI)
Overall Wall Assembly 1D	-	-	-	R-30.1 to R-54.1 (5.31 to 9.54 RSI)

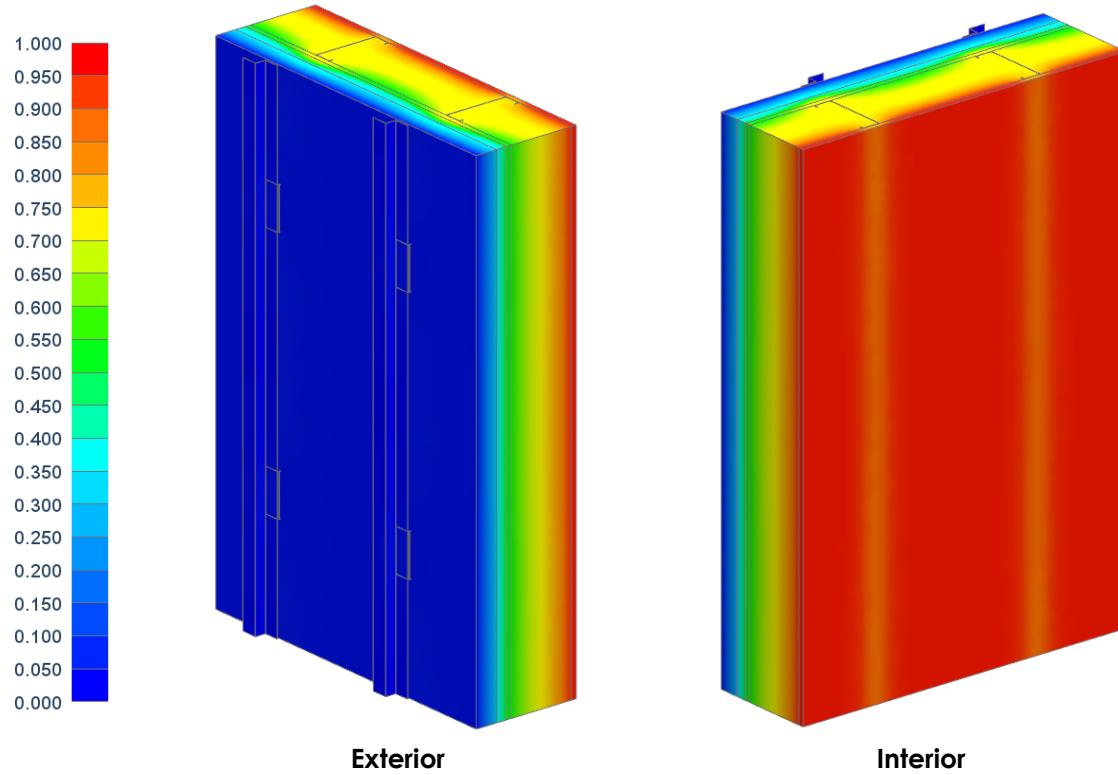
<sup>1</sup> The thermal conductivities of the air spaces were determined according to ISO 10077-2

## **APPENDIX D: SIMULATED TEMPERATURE PROFILES**

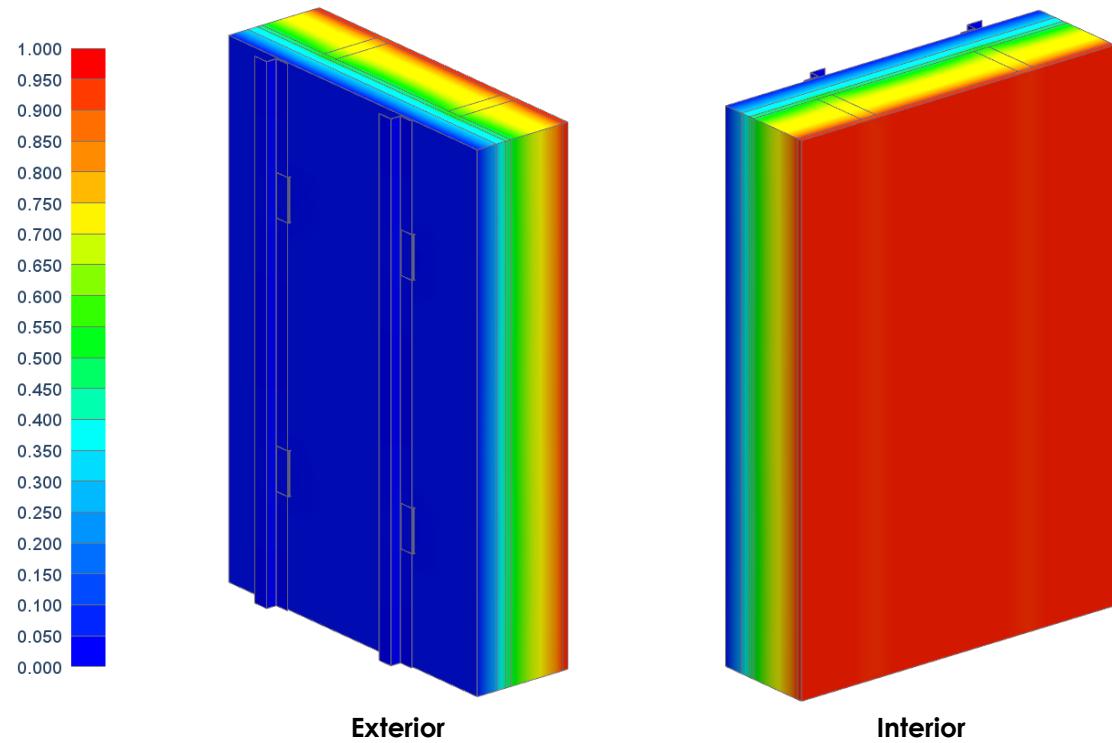
As an example of the thermal profiles of the ACS-S Thermal Clip system with the protected exterior insulation wall assembly, the following figures illustrate a typical temperature distribution for the 3 inch ACS-S Thermal Clip with 3 inches total of exterior insulation (1 inch SPORA-ISO V and 2 inches mineral wool) and 16 inches o.c. horizontal and 24 inches o.c. vertical clip spacing. The profiles are presented as a temperature index (between 0 and 1). See Appendix B.2 for more information.



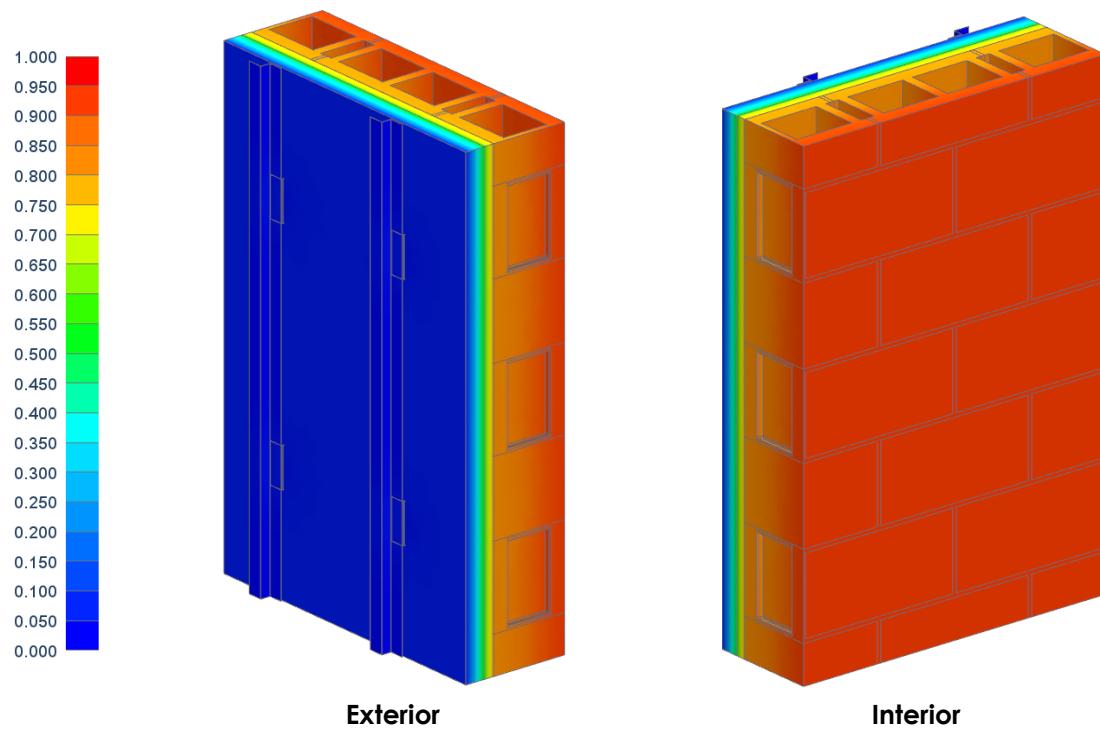
**Figure D1:** Temperature Profile of ACS-S Thermal Clip with Protected Exterior Insulation: Exterior Insulated Steel Stud Wall Assemblies



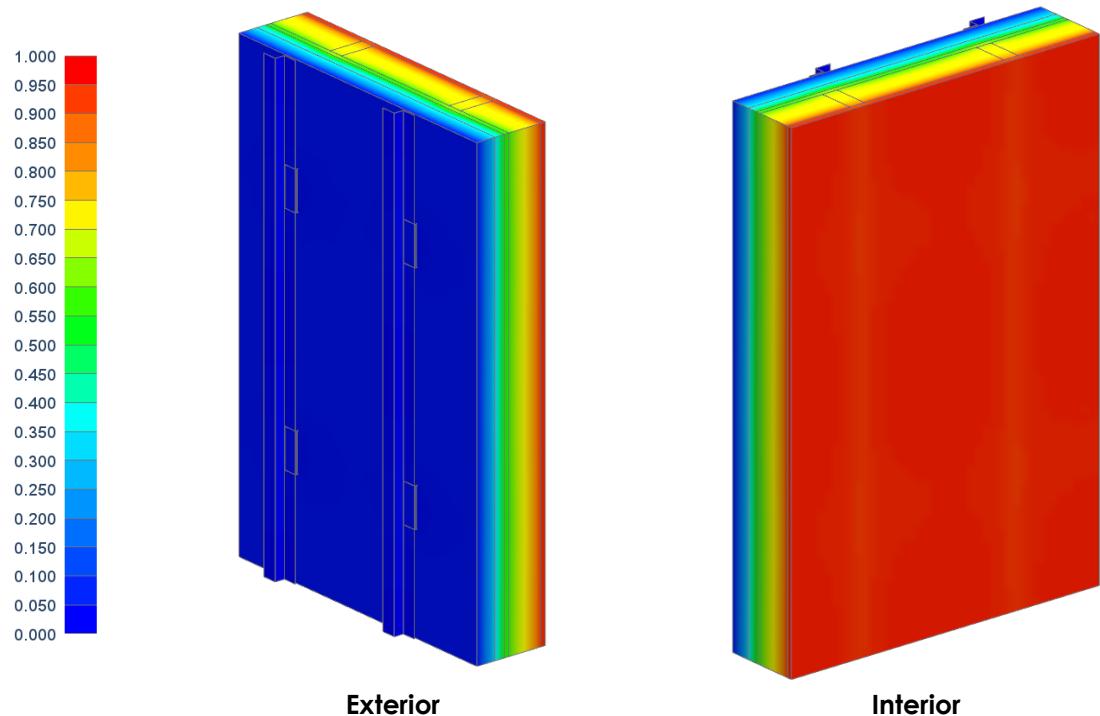
**Figure D2:** Temperature Profile of ACS-S Thermal Clip with Protected Exterior Insulation: Split Insulated Steel Stud Wall Assemblies



**Figure D3:** Temperature Profile of ACS-S Thermal Clip with Protected Exterior Insulation: Split Insulated 2x6 Wood Frame Wall Assemblies



**Figure D4:** Temperature Profile of ACS-S Thermal Clip with Protected Exterior Insulation: CMU Wall Assemblies



**Figure D5:** Temperature Profile of ACS-S Thermal Clip with Protected Exterior Insulation: Split Insulated 2x4 Wood Frame Wall Assemblies

