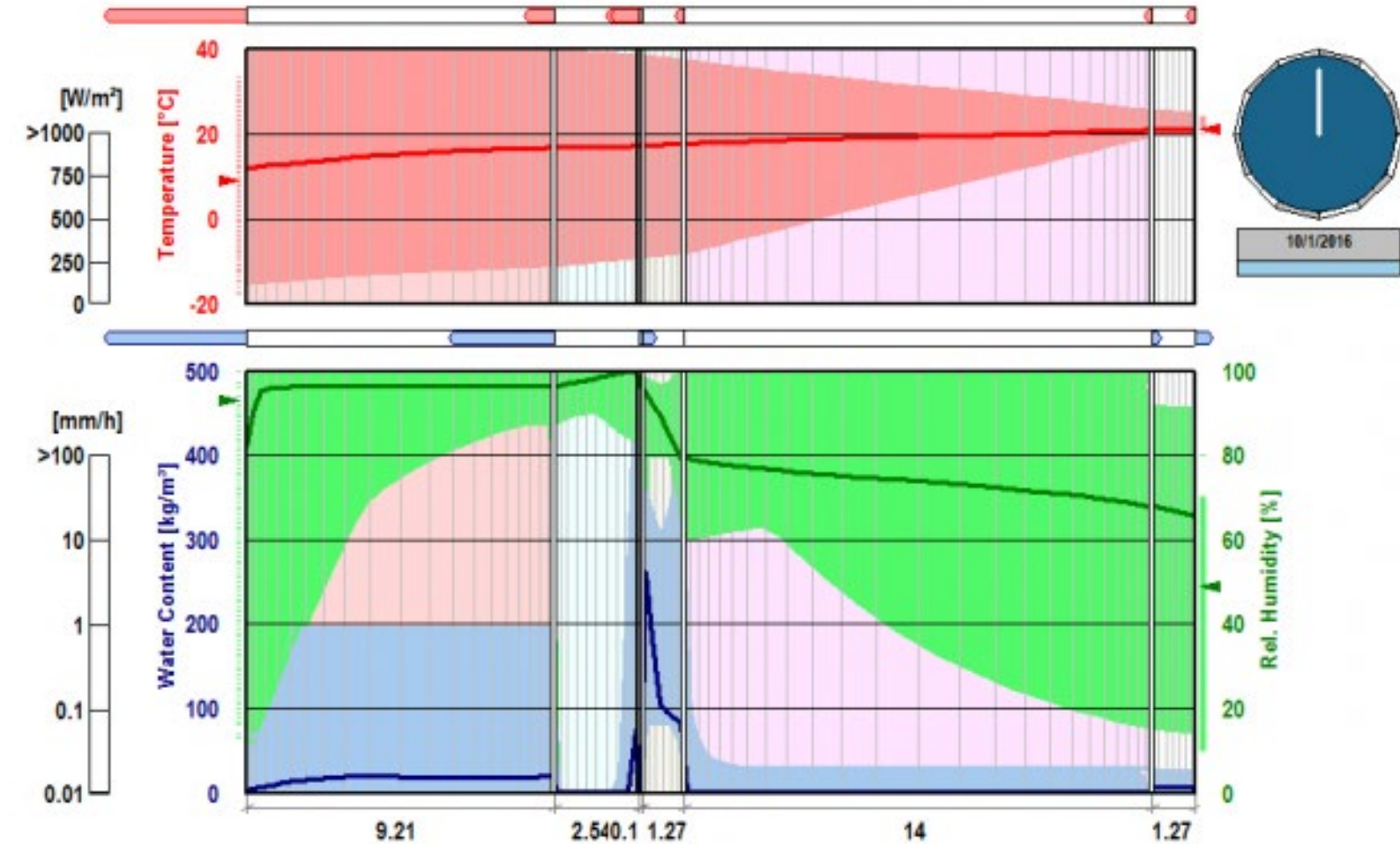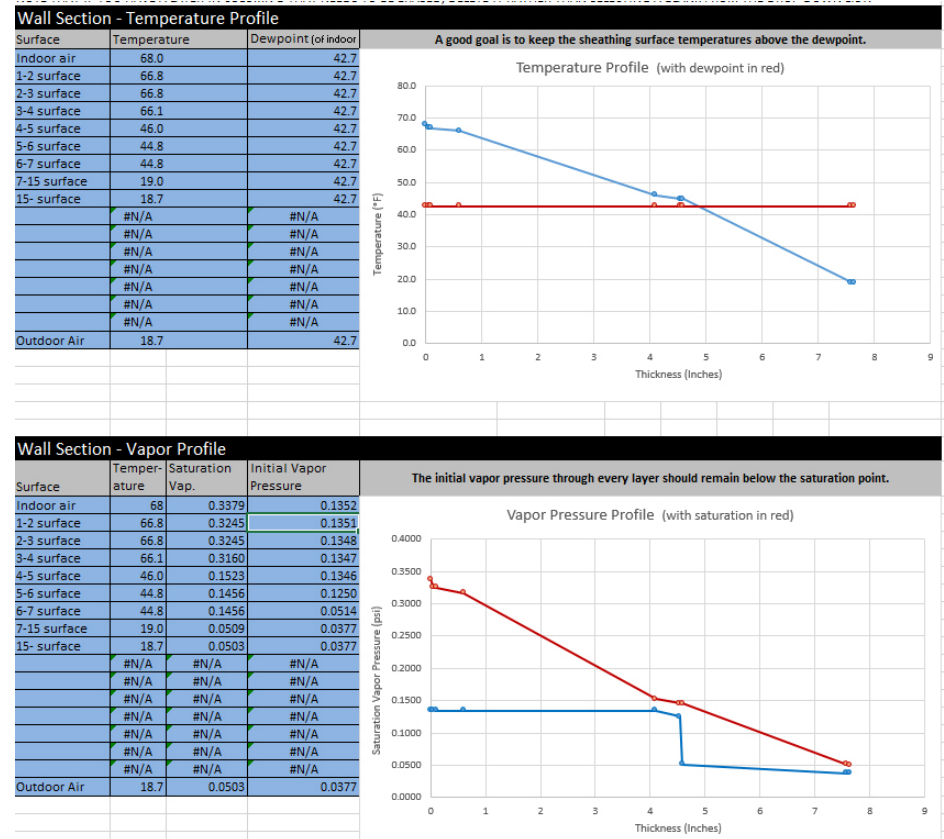# Moisture Risk and Heat Loss Analysis

For Wall Assemblies and Junctions

Glaser Walk-through and Exercises

Glaser Analysis (static
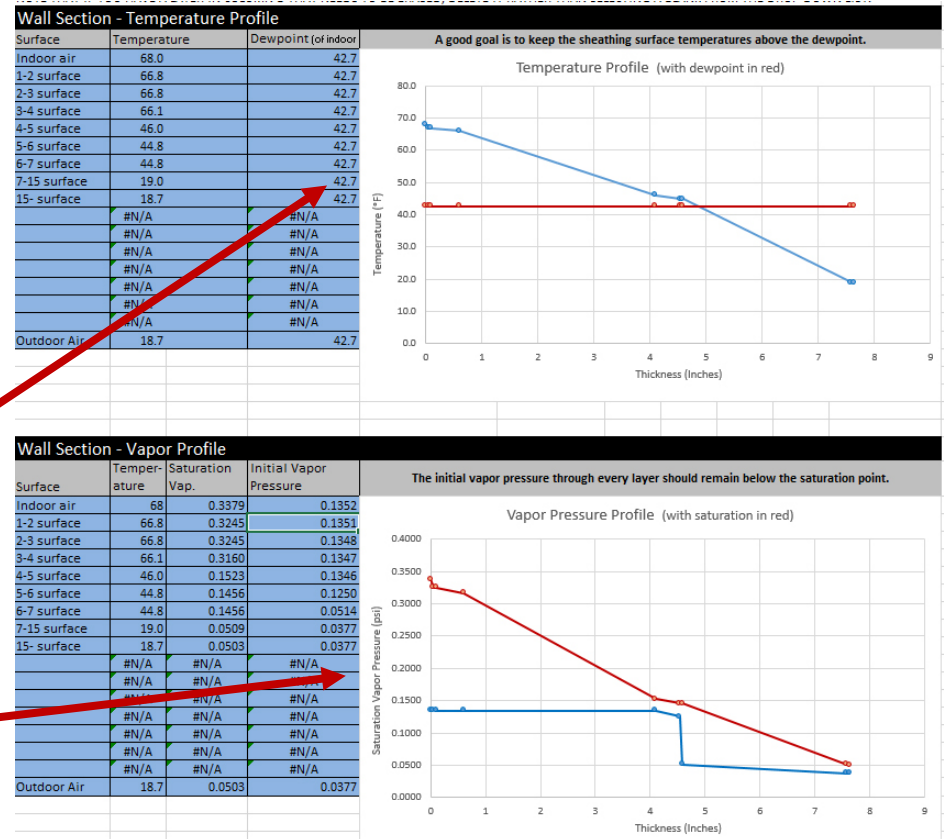analysis) using the
B3 Glaser Calculator Tool

Glaser Walk-through and Exercises

Glaser Analysis (static analysis) using the B3 Glaser Calculator Tool

2 different analyses are provided:

1) Condensation risk (dewpoint temperature)

2) Diffusion risk (vapor drive)

(In cold climates, these are typically winter issues.)

Wall Section - Temperature Profile

Surface	Temperature	Dewpoint (of indoor
Indoor air	68.0	42.7
1-2 surface	66.8	42.7
2-3 surface	66.8	42.7
3-4 surface	66.1	42.7
4-5 surface	46.0	42.7
5-6 surface	44.8	42.7
6-7 surface	44.8	42.7
7-15 surface	19.0	42.7
15- surface	18.7	42.7
	#N/A	#N/A
	#N/A	#N/A
	#N/A	#N/A
	#N/A	#N/A
	#N/A	#N/A
	#N/A	#N/A
	#N/A	#N/A
Outdoor Air	18.7	42.7

A good goal is to keep the sheathing surface temperatures above the dewpoint.

Temperature Profile (with dewpoint in red)

Wall Section - Vapor Profile

Surface	Temperature	Saturation Vap.	Initial Vapor Pressure
Indoor air	68	0.3379	0.1352
1-2 surface	66.8	0.3245	0.1351
2-3 surface	66.8	0.3245	0.1348
3-4 surface	66.1	0.3160	0.1347
4-5 surface	46.0	0.1523	0.1346
5-6 surface	44.8	0.1456	0.1250
6-7 surface	44.8	0.1456	0.0514
7-15 surface	19.0	0.0509	0.0377
15- surface	18.7	0.0503	0.0377
	#N/A	#N/A	#N/A
	#N/A	#N/A	#N/A
	#N/A	#N/A	#N/A
	#N/A	#N/A	#N/A
	#N/A	#N/A	#N/A
	#N/A	#N/A	#N/A
	#N/A	#N/A	#N/A
Outdoor Air	18.7	0.0503	0.0377

The initial vapor pressure through every layer should remain below the saturation point.

Vapor Pressure Profile (with saturation in red)

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Glaser Walk-through and Exercises

B3 Glaser Calculator Tool Test Conditions

Recall that it only calculates one condition at a time.
For the B3 program, this condition shall be:

"…the average winter temperature and humidity conditions (average of the coldest three months) both inside and outside the building."

Appendix I-2: Glaser Calculator
B3 Guidelines - Version 3.0

KEY:		
		Blue highlighted areas show constants or outputs calculated by the spreadsheet
		Yellow highlighted areas show required inputs

Climate Information
Exterior

Winter temp (°F)	18.7	*(average temperature of 3 coldest months)*
Winter RH	75%	*(average RH of 3 coldest months)*

Interior

Winter temp (°F)	68	*(average interior temperature during 3 coldest months)*
Winter RH	40%	*(average interior RH during 3 coldest months)*

Material Properties

Materials	R-value/inch	Permeability (perm inches)	
OSB sheathing	1.57	0.158	
EPS	4	3.5	Permeance to Permeability Converter
DOW Thermax	6.6	0.015	0.03 Permeance at tested thickness (perms)
gypsum board	0.89	18.25	0.5 Tested Thickness (inches)
Portland stucco	0.4	0.36	

Glaser Walk-through and Exercises

B3 Glaser Calculator Tool Test Conditions

Recall that it only calculates one condition at a time.
For the B3 program, this condition shall be:

In MSP, the outdoor averages are: 18.7°F, 75% RH

It's up to you to determine the likely indoor conditions…

Appendix I-2: Glaser Calculator
B3 Guidelines - Version 3.0

KEY:		Blue highlighted areas show constants or outputs calculated by the spreadsheet
		Yellow highlighted areas show required inputs

Climate Information

Exterior
Winter temp (°F)	18.7	(average temperature of 3 coldest months)
Winter RH	75%	(average RH of 3 coldest months)

Interior
Winter temp (°F)	68	(average interior temperature during 3 coldest months)
Winter RH	40%	(average interior RH during 3 coldest months)

Material Properties

Materials	R-value/inch	Permeability (perm inches)		
OSB sheathing	1.57	0.158		
EPS	4	3.5	Permeance to Permeability Converter	
DOW Thermax	6.6	0.015	0.03	Permeance at tested thickness (perms)
gypsum board	0.89	18.25	0.5	Tested Thickness (inches)
Portland stucco	0.4	0.36		

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Glaser Walk-through and Exercises

B3 Glaser Calculator Tool Test Conditions

Recall that it only calculates one condition at a time.
For the B3 program, this condition shall be:

In MSP, the outdoor averages are: 18.7°F, 75% RH

Remember that warmer and wetter interior conditions will increase the vapor pressure through the wall and lead to a more challenging test scenario. As will a colder exterior temperature.

Appendix I-2: Glaser Calculator
B3 Guidelines - Version 3.0

KEY:		Blue highlighted areas show constants or outputs calculated by the spreadsheet
		Yellow highlighted areas show required inputs

Climate Information

Exterior

Winter temp (°F)	18.7	*(average temperature of 3 coldest months)*
Winter RH	75%	*(average RH of 3 coldest months)*

Interior

Winter temp (°F)	68	*(average interior temperature during 3 coldest months)*
Winter RH	40%	*(average interior RH during 3 coldest months)*

Material Properties

Materials	R-value/inch	Permeability (perm inches)		
OSB sheathing	1.57	0.158		
EPS	4	3.5	Permeance to Permeability Converter	
DOW Thermax	6.6	0.015	0.03	Permeance at tested thickness (perms)
gypsum board	0.89	18.25	0.5	Tested Thickness (inches)
Portland stucco	0.4	0.36		

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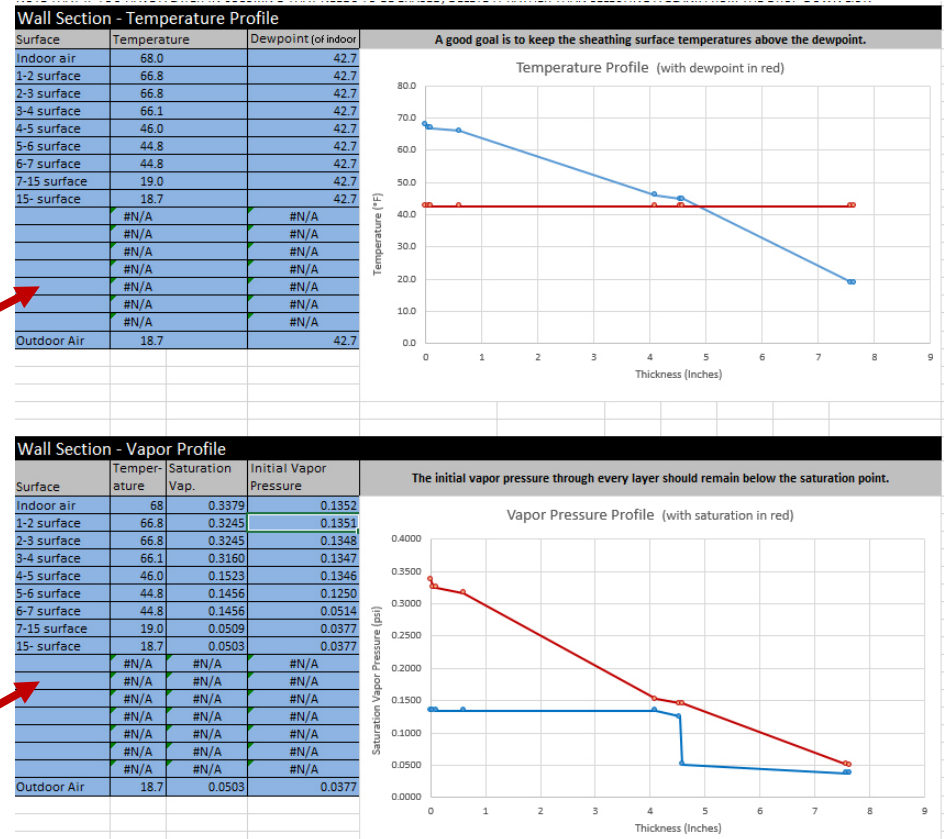
Glaser Walk-through and Exercises

B3 Glaser Calculator Tool Functions

This tool is generally useful for:
1) Determining exterior insulation thickness necessary to keep sheathing above dewpoint
2) Optimizing diffusion-drying in cold climates (by tracking vapor pressures through the assembly)

Wall Section - Temperature Profile

Surface	Temperature	Dewpoint (of indoor)
Indoor air	68.0	42.7
1-2 surface	66.8	42.7
2-3 surface	66.8	42.7
3-4 surface	66.1	42.7
4-5 surface	46.0	42.7
5-6 surface	44.8	42.7
6-7 surface	44.8	42.7
7-15 surface	19.0	42.7
15- surface	18.7	42.7
	#N/A	#N/A
	#N/A	#N/A
	#N/A	#N/A
	#N/A	#N/A
	#N/A	#N/A
	#N/A	#N/A
Outdoor Air	18.7	42.7

A good goal is to keep the sheathing surface temperatures above the dewpoint.

Temperature Profile (with dewpoint in red)

Wall Section - Vapor Profile

Surface	Temperature	Saturation Vap.	Initial Vapor Pressure
Indoor air	68	0.3379	0.1352
1-2 surface	66.8	0.3245	0.1351
2-3 surface	66.8	0.3245	0.1348
3-4 surface	66.1	0.3160	0.1347
4-5 surface	46.0	0.1523	0.1346
5-6 surface	44.8	0.1456	0.1250
6-7 surface	44.8	0.1456	0.0514
7-15 surface	19.0	0.0509	0.0377
15- surface	18.7	0.0503	0.0377
	#N/A	#N/A	#N/A
	#N/A	#N/A	#N/A
	#N/A	#N/A	#N/A
	#N/A	#N/A	#N/A
	#N/A	#N/A	#N/A
	#N/A	#N/A	#N/A
Outdoor Air	18.7	0.0503	0.0377

The initial vapor pressure through every layer should remain below the saturation point.

Vapor Pressure Profile (with saturation in red)

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Glaser Walk-through and Exercises

B3 Glaser Calculator Tool Data Import

Import material and wall section tables directly from the B3 Qualitative Moisture Assessment Worksheet (copy yellow sections only).

The temperature & vapor pressure profile charts should automatically update below.

Material Properties

Materials	R-value/inch	Permeability (perm inches)
gypsum board	0.89	18.25
fiberglass insulation	3.33	106
OSB sheathing	1.57	0.5
XPS	5	0.755

Permeance to Permeability Converter

1	Permeance at tested thickness (perms)
0.5	Tested Thickness (inches)
0.5	Permeability (perm inches)

Membranes & Still Air Layers

Membranes & Still Air Layers	R-value*	Permeance** (perms)
latex paint (2 coats)	0	10
4 mil poly	0	0.1
tyvek	0	49
inside air film	0.68	167
outside air film	0.17	1000

Permeability to Permeance Converter

21.5	Permeability (perm inches)
0.5	Desired Thickness (inches)
43	Permeance at desired thickness (perms)

Enter R-0 unless specific value is available
** This value is listed for specific, tested thickness

Wall Section*

Layer #	Layer (inside to outside)	Installed thickness**	Thermal resistance	Fraction of total	Vapor resistance	Fraction of total
1	inside air film	0	0.68	0.030	0.01	0.001
2	latex paint (2 coats)	0	0.00	0.030	0.10	0.009
3	gypsum board	0.5	0.45	0.049	0.03	0.011
4	4 mil poly	0	0.00	0.049	10.00	0.863
5	fiberglass insulation	5.5	18.32	0.853	0.05	0.867
6	OSB sheathing	0.4375	0.69	0.883	0.88	0.942
7	tyvek	0	0.00	0.883	0.02	0.944
8	XPS	0.5	2.50	0.993	0.66	1.000
9			#N/A	0.993	#N/A	1.000
10			#N/A	0.993	#N/A	1.000
11			#N/A	0.993	#N/A	1.000
12			#N/A	0.993	#N/A	1.000
13			#N/A	0.993	#N/A	1.000
14			#N/A	0.993	#N/A	1.000
15	outside air film	0	0.17	1.000	0.001	1.000
			22.80 total		11.74 total	

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Glaser Walk-through and Exercises

B3 Glaser Calculator Tool Data Import

When importing wall sections (or creating them from scratch) remember that all layers to the exterior of a vented or ventilated air gap should be removed from the section.

Therefore, brick cladding for a cavity wall, vinyl siding, or fiber cement in a rainscreen would not be included – for example.

Material Properties

Materials	R-value/inch	Permeability (perm inches)			
gypsum board	0.89	18.25			
fiberglass insulation	3.33	106		Permeance to Permeability Converter	
OSB sheathing	1.57	0.5		1	Permeance at tested thickness (perms)
XPS	5	0.755		0.5	Tested Thickness (inches)
				0.5	Permeability (perm inches)

Membranes & Still Air Layers	R-value*	Permeance** (perms)			
latex paint (2 coats)	0	10			
4 mil poly	0	0.1		Permeability to Permeance Converter	
tyvek	0	49		21.5	Permeability (perm inches)
				0.5	Desired Thickness (inches)
				43	Permeance at desired thickness (perms)
inside air film	0.68	167			
outside air film	0.17	1000			

* Enter R-0 unless specific value is available
** This value is listed for specific, tested thickness

Wall Section*

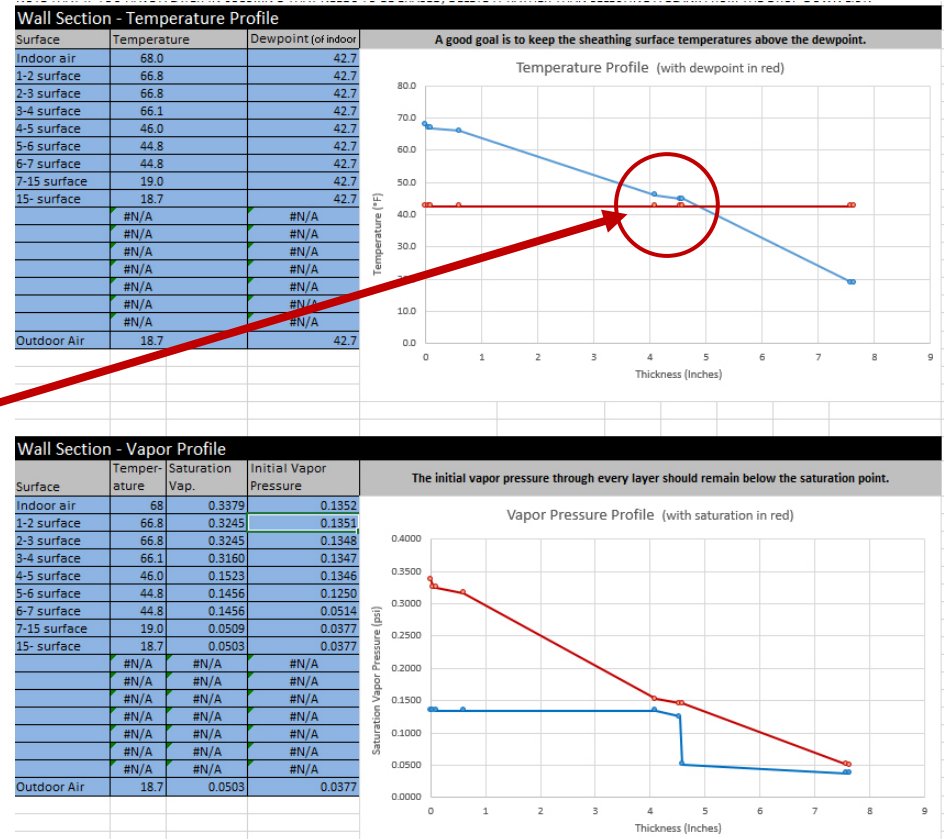| Layer #	Layer (inside to outside)	Installed thickness**	Thermal resistance	Fraction of total	Vapor resistance	Fraction of total
1	inside air film	0	0.68	0.030	0.01	0.001
2	latex paint (2 coats)	0	0.00	0.030	0.10	0.009
3	gypsum board	0.5	0.45	0.049	0.03	0.011
4	4 mil poly	0	0.00	0.049	10.00	0.863
5	fiberglass insulation	5.5	18.32	0.853	0.05	0.867
6	OSB sheathing	0.4375	0.69	0.883	0.88	0.942
7	tyvek	0	0.00	0.883	0.02	0.944
8	XPS	0.5	2.50	0.993	0.66	1.000
9			#N/A	0.993	#N/A	1.000
10			#N/A	0.993	#N/A	1.000
11			#N/A	0.993	#N/A	1.000
12			#N/A	0.993	#N/A	1.000
13			#N/A	0.993	#N/A	1.000
14			#N/A	0.993	#N/A	1.000
15	outside air film	0	0.17	1.000	0.001	1.000
			22.80 total		11.74 total	

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Glaser Walk-through and Exercises

B3 Glaser Calculator Tool
Analyze Results (condensation)

1) Keep the blue line (surface temperature) above the red line (dewpoint temperature) at the sheathing.

   (Note that this is not technically a requirement of the B3 program.)
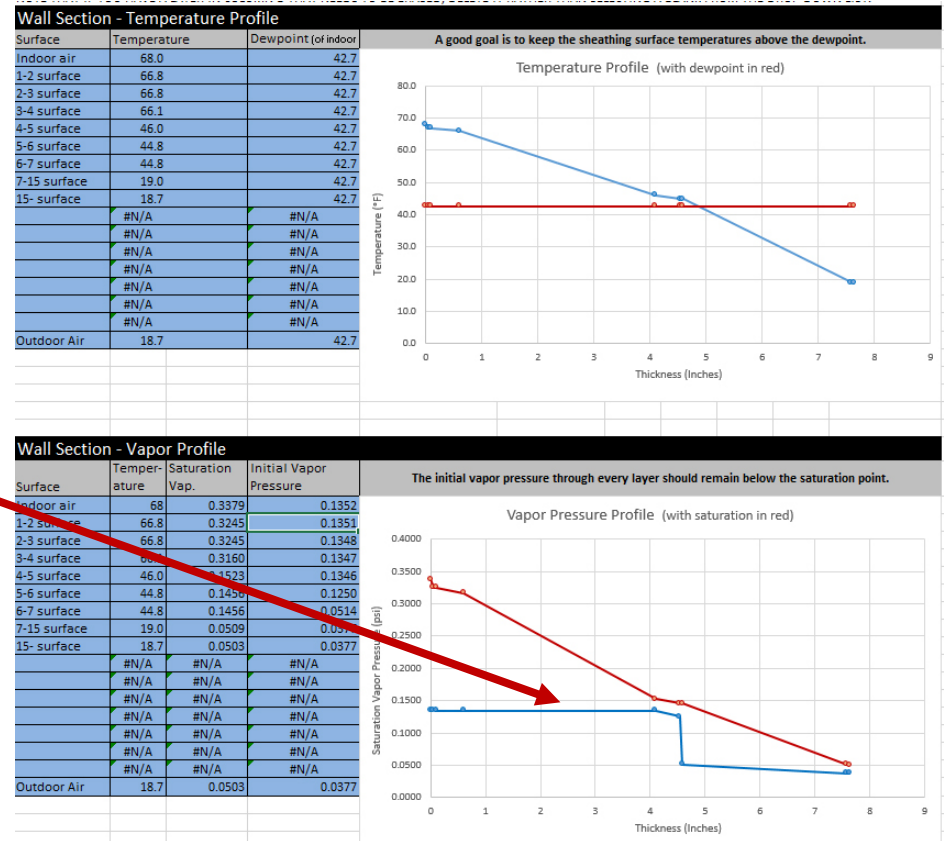
Wall Section - Temperature Profile

Surface	Temperature	Dewpoint (of indoor
Indoor air	68.0	42.7
1-2 surface	66.8	42.7
2-3 surface	66.8	42.7
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6-7 surface	44.8	42.7
7-15 surface	19.0	42.7
15- surface	18.7	42.7
	#N/A	#N/A
	#N/A	#N/A
	#N/A	#N/A
	#N/A	#N/A
	#N/A	#N/A
	#N/A	#N/A
Outdoor Air	18.7	42.7

A good goal is to keep the sheathing surface temperatures above the dewpoint.

Temperature Profile (with dewpoint in red)

Wall Section - Vapor Profile

Surface	Temperature	Saturation Vap.	Initial Vapor Pressure
Indoor air	68	0.3379	0.1352
1-2 surface	66.8	0.3245	0.1351
2-3 surface	66.8	0.3245	0.1348
3-4 surface	66.1	0.3160	0.1347
4-5 surface	46.0	0.1523	0.1346
5-6 surface	44.8	0.1456	0.1250
6-7 surface	44.8	0.1456	0.0514
7-15 surface	19.0	0.0509	0.0377
15- surface	18.7	0.0503	0.0377
	#N/A	#N/A	#N/A
	#N/A	#N/A	#N/A
	#N/A	#N/A	#N/A
	#N/A	#N/A	#N/A
	#N/A	#N/A	#N/A
	#N/A	#N/A	#N/A
Outdoor Air	18.7	0.0503	0.0377

The initial vapor pressure through every layer should remain below the saturation point.

Vapor Pressure Profile (with saturation in red)

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Glaser Walk-through and Exercises

B3 Glaser Calculator Tool
Analyze Results (diffusion)

2) Keep the initial vapor pressure (blue line) below the saturation vapor pressure (red line) at every surface of the assembly.

(This is a B3 requirement if using the Glaser approach for quantitative analysis.)

Wall Section - Temperature Profile

Surface	Temperature	Dewpoint (of indoor
Indoor air	68.0	42.7
1-2 surface	66.8	42.7
2-3 surface	66.8	42.7
3-4 surface	66.1	42.7
4-5 surface	46.0	42.7
5-6 surface	44.8	42.7
6-7 surface	44.8	42.7
7-15 surface	19.0	42.7
15- surface	18.7	42.7
	#N/A	#N/A
	#N/A	#N/A
	#N/A	#N/A
	#N/A	#N/A
	#N/A	#N/A
	#N/A	#N/A
	#N/A	#N/A
Outdoor Air	18.7	42.7

A good goal is to keep the sheathing surface temperatures above the dewpoint.

Temperature Profile (with dewpoint in red)

Wall Section - Vapor Profile

Surface	Temperature	Saturation Vap.	Initial Vapor Pressure
Indoor air	68	0.3379	0.1352
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2-3 surface	66.8	0.3245	0.1348
3-4 surface	66	0.3160	0.1347
4-5 surface	46.0	0.1523	0.1346
5-6 surface	44.8	0.1456	0.1250
6-7 surface	44.8	0.1456	0.0514
7-15 surface	19.0	0.0509	0.0
15- surface	18.7	0.0503	0.0377
	#N/A	#N/A	#N/A
	#N/A	#N/A	#N/A
	#N/A	#N/A	#N/A
	#N/A	#N/A	#N/A
	#N/A	#N/A	#N/A
	#N/A	#N/A	#N/A
	#N/A	#N/A	#N/A
Outdoor Air	18.7	0.0503	0.0377

The initial vapor pressure through every layer should remain below the saturation point.

Vapor Pressure Profile (with saturation in red)

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Glaser Walk-through and Exercises

Remember - Glaser analysis is limited:

👍 Offers simple comparisons between wall assemblies that can be used quickly during design phase to identify and reduce condensation and diffusion risks. It is a quick design tool.

👎 Only considers behavior at one set of conditions (a given temp and RH)

👎 Does not incorporate many important elements related to moisture behavior – water leakage, air leakage, and capillary drive

👎 Cannot model impacts of vented/ventilated cladding systems

👎 Does not predict ultimate moisture levels, safety, or failure

Glaser Walk-through and Exercises

Select one of three enclosures to evaluate, then make and test an improvement.

1. Steel Stud with hybrid insulation & metal panel
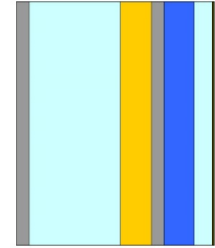
2. Steel Stud with exterior insulation & brick

3. Concrete tilt-up panel

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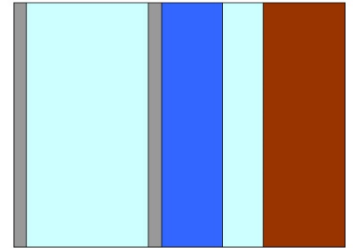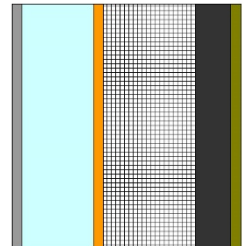
Option 1 - Steel Stud with hybrid insulation & metal panel

Layers from inside to outside:

1.	2-coats latex paint	10 perms	R-0
2.	5/8" gypsum board	29.2 perms @ 5/8"	R-0.9/inch
3.	4 ½" still air space	120 perm in	R-1.0
4.	1 ½" closed cell SPF	1.39 perm in	R-6.7/inch
5.	Fiberglass facer	60 perms	R-0
6.	5/8" gypsum board	29.2 perms @ 5/8"	R-0.9/inch
7.	Fiberglass facer	60 perms	R-0
8.	Tyvek	60 perms	R-0
9.	1 ½" XPS (extruded polystyrene)	1 perm @ 1 ½"	R-5.0/inch
10.	7/8" ventilated air gap	120 perm in	R-1.0
11.	0.03" Metal panel	0.05 perms	R-0

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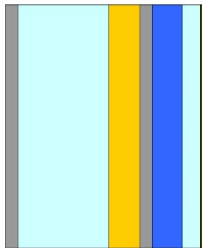
Option 2 - Steel Stud with exterior insulation & brick

Layers from inside to outside:

1.	2-coats latex paint	10 perms	R-0
2.	5/8" gypsum board	29.2 perms @ 5/8"	R-0.9/inch
3.	6" still air space	120 perm in	R-1.0
4.	Fiberglass facer	60 perms	R-0
5.	5/8" gypsum board	29.2 perms @ 5/8"	R-0.9/inch
6.	Fiberglass facer	60 perms	R-0
7.	Perm-a-Barrier	0.047 perms	R-0
8.	3" XPS (extruded polystyrene)	0.5 perms @ 3"	R-5.0/inch
9.	2" vented air gap	120 perm in	R-1.0
10.	4" brick cladding	3.2 perm in	R-0.11/inch

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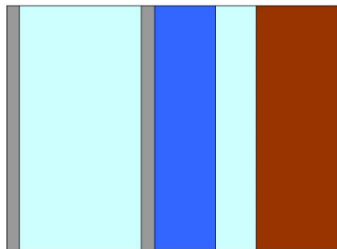
Option 3 – Concrete tilt-up panel

Layers from inside to outside:

1.	2-coats latex paint	10 perms	R-0
2.	1/2" gypsum board	36.5 perms @ 1/2"	R-0.9/inch
3.	3 1/2" air space	120 perm in	R-1.0
4.	Foil facer	0.05 perms	R-0
5.	1/2" DOW Thermax	3 perm in	R-6.6/inch
6.	Foil facer	0.05 perms	R-0
7.	4 1/2" EPS	3.5 perm in	R-4.0/inch
8.	1 3/4" concrete shell (5000 psi)	0.1 perm in	R-0.1/inch
9.	1/2" portland stucco	0.36 perm in	R-0.4/inch

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