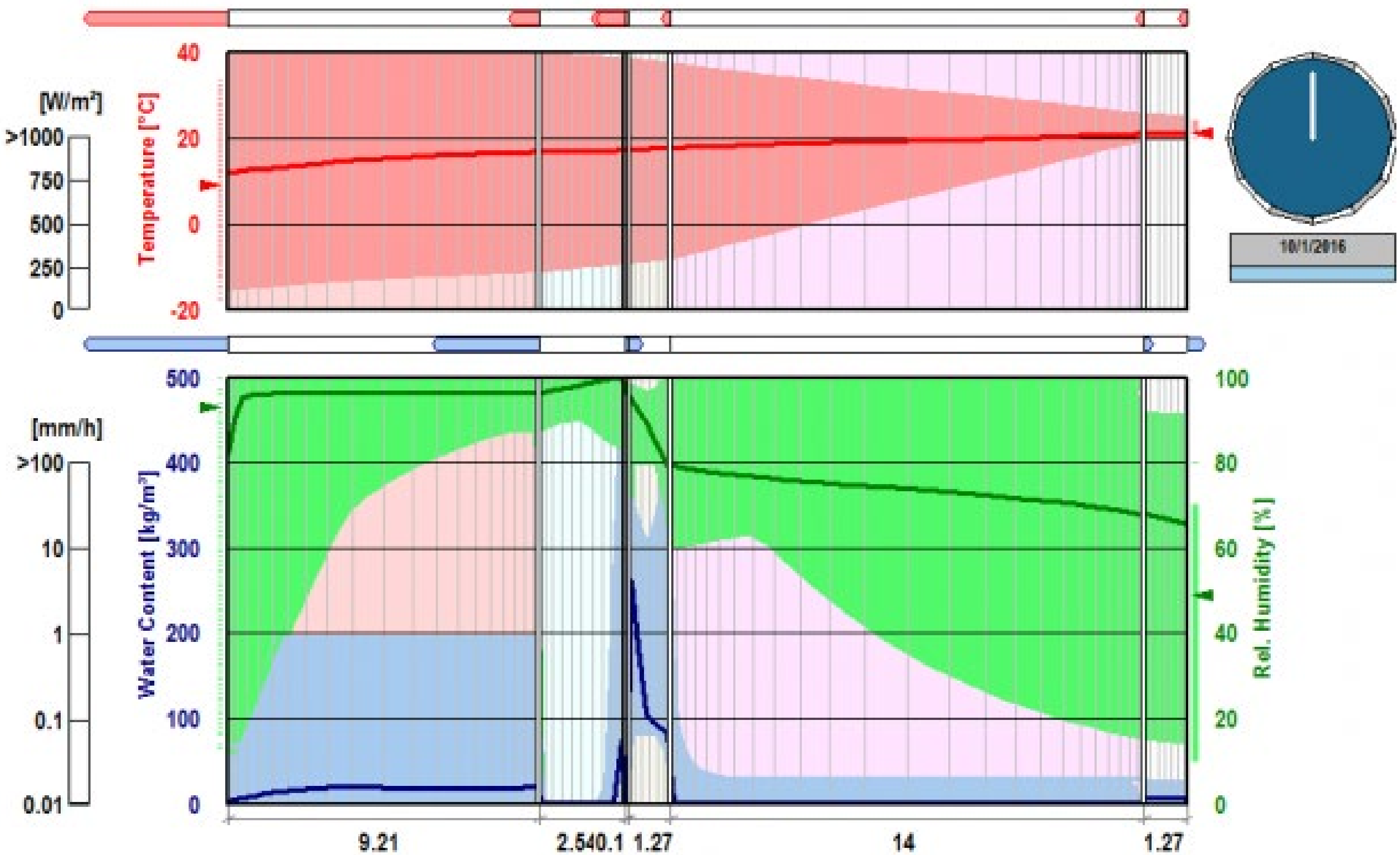
Moisture Risk and Heat Loss Analysis

For Wall Assemblies and Junctions



CSBR
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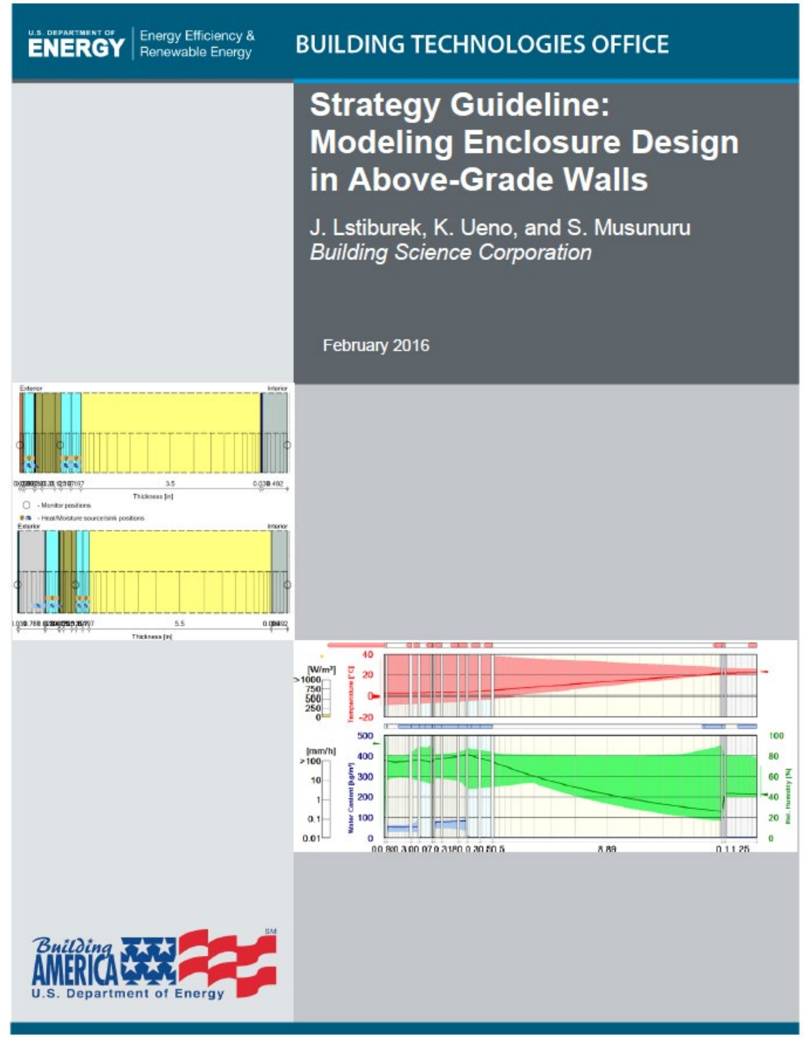
WUFI Pro Walk-through and Exercises

Dynamic hourly analysis using WUFI

…Following the Building America Strategy Guideline (2016) produced by Building Science Corp. This is an excellent, easy to use resource.

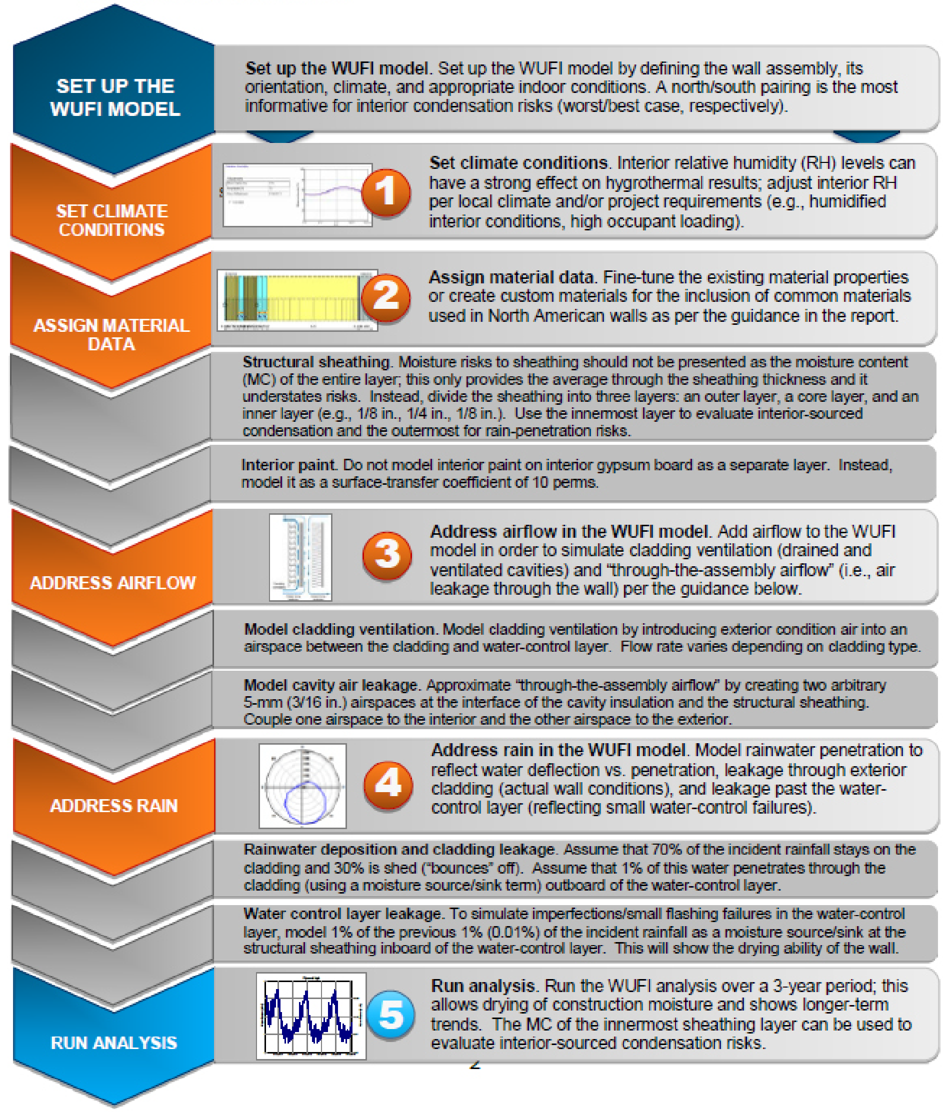
(Also assuming that the modeling should be in compliance with ASHRAE 160)



WUFI Pro Walk-through and Exercises

See page 9 of the strategy guideline.

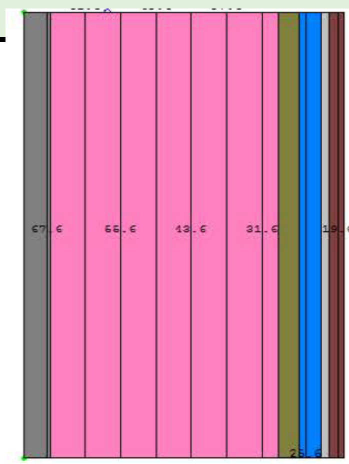
Progression Summary



WUFI Pro Walk-through and Exercises

Walkthrough– simulate 2x6 Energy Star wall, then test an improvement

2x6 Energy Star	Specified Material/Product	Thickness	R-value/inch	Vapor flow	Density (lbs/ft3)
paint	2-coats latex	-	-	10 perms (BSC guideline)	
drywall	gypsum board	1/2"	0.9	36.5 perms @ 1/2 inch	
vapor retarder	4 mil polyethylene	4 mil	-	0.08 perms	
cavity insulation	fiberglass batt	5.5"	3.7	106 perms @ 1 inch	0.7 (approx.)
sheathing	OSB	7/16"	1.5	1 perm at 1/2 inch	
weather barrier	Grace Perm-a-Barrier	3/64"	-	0.05 perms	
exterior insulation	Dow XPS 'Square Edge'	1/2"	5	1.5 perms @ 1 inch	
cladding	LP Smartside (no back ventilation)	5/16"	1.5	0.6 - 1.4 perms @ 1 inch	40.0
paint	3-coats latex	-	-	5 perms	



WUFI Pro Walk-through and Exercises

Step 0 – Set Units!   (find under “Options” on top menu bar)

WUFI Pro Walk-through and Exercises

Step 1 – Set Climate Conditions

- Exterior Climate
- Interior Climate

WUFI Pro Walk-through and Exercises

Step 1 – Set Climate Conditions

- Exterior Climate: Minneapolis, MN

To stay on the conservative side, select a challenging weather file. For a cold climate, like Minneapolis, we'd select "cold year"

Side note:

ASHRAE Year 1

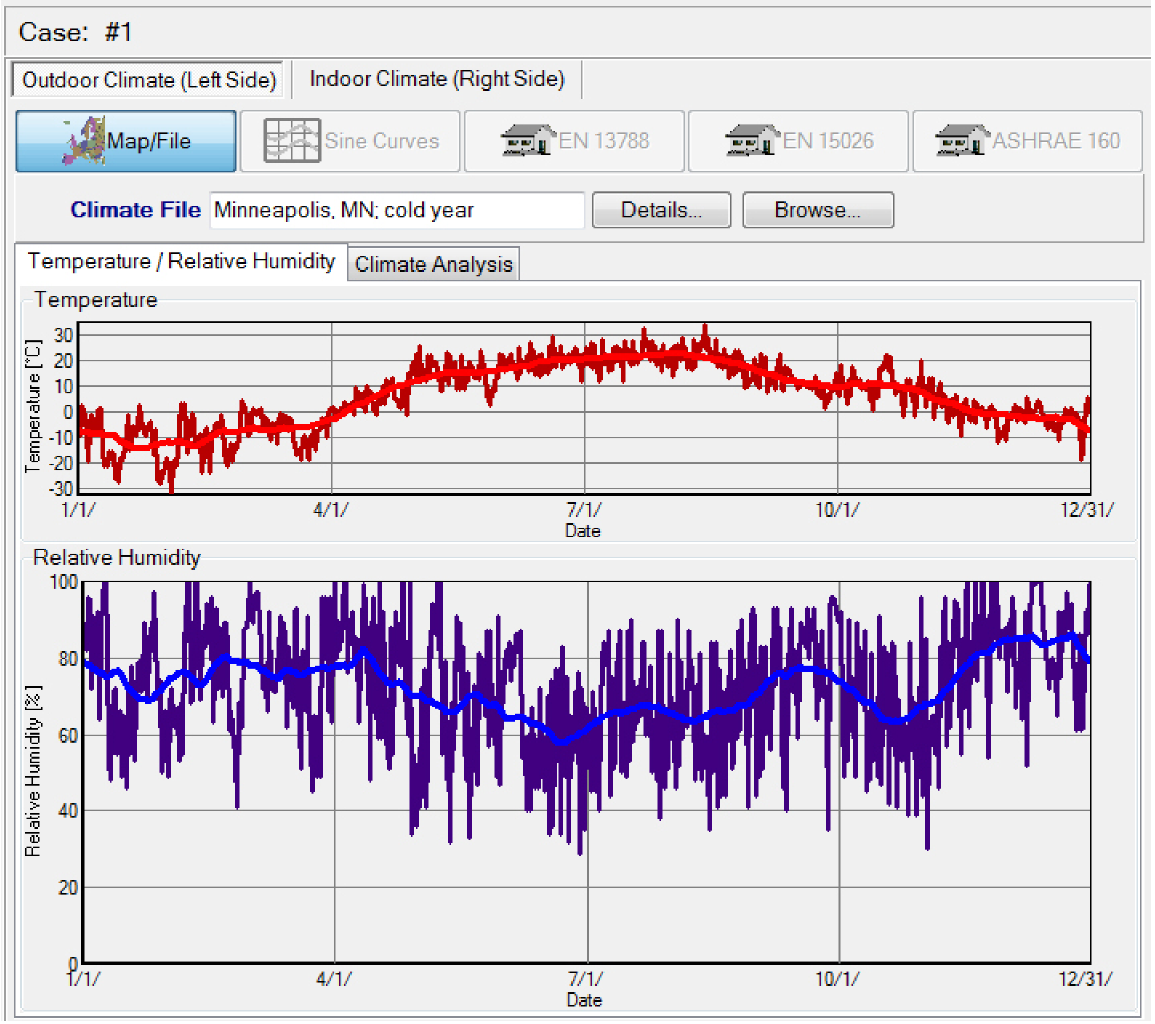
ASHRAE Year 2

ASHRAE Year 3

- These are the top 3 most challenging years in an average 10 year stretch from a moisture standpoint, but it's unrealistic to string these together for multiple years in a row.

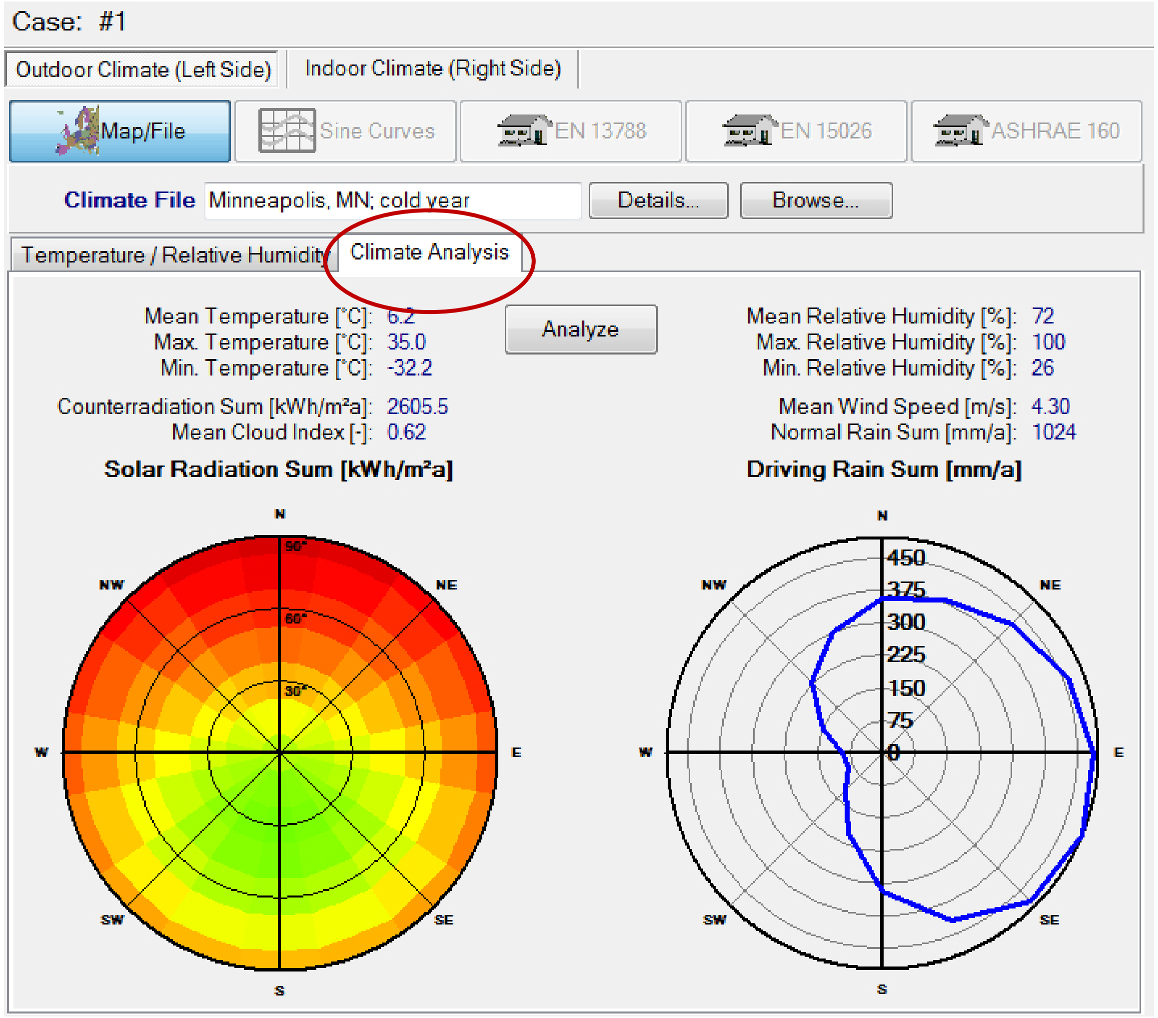
WUFI Pro Walk-through and Exercises

Check the graphs to make sure they look plausible.



WUFI Pro Walk-through and Exercises

Select “Climate Analysis” to see direction of driving rain.



Center for Sustainable Building Research

WUFI Pro Walk-through and Exercises

Step 1 – Set Climate Conditions

- Interior Climate: determined by building design and occupancy
    - Select ASHRAE 160 (this determines the inputs)
    - Building volume 19,220 cf (single family house, 2400 sf)
    - 4 bedrooms (5 occupants)
        - Higher occupants = greater moisture load
    - Air Exchange Rate
        - Select “user defined”, enter 0.3 ACH for typical code ventilation, less if under-ventilated
        - More air exchange will generally help reduce interior RH (in cold climates)
        - WUFI Pro and WUFI Passive allow more advanced settings such as air leakage and ventilation with energy recovery

WUFI Pro Walk-through and Exercises

Step 1 – Set Climate Conditions

- Interior Climate: determined by building design and occupancy
  - Mechanical systems
    - Select “air conditioning” (this includes heating)
    - Air conditioning will help control interior summer RH
    - The goal is not to create an actual mechanical system, just achieve appropriate interior boundary conditions.
  - Track the interior RH. Ensure that the graph is realistic for your given building. We are not really creating a house or full energy model, we are just determining the interior RH for your building.

WUFI Pro Walk-through and Exercises

Step 2 – Assign Material Data

- Wall assembly is built from left (exterior) to right (interior)
- Assign material from Database
  - Materials in database may not always match your building materials. Pay close attention!
    - Insulation materials: match conductivity and permeability (perm in)
    - Membranes: match permeance (perms) and <u>do not change thickness</u>
    - Structural materials (e.g. OSB, drywall): match permeability, or density if nothing else.
    - Air layers: find closest matching thickness and <u>do not change</u>. Always select “without additional moisture capacity”

WUFI Pro Walk-through and Exercises

Step 2 – Assign Material Data, helps to create a chart!

Material Data Set

2x6 Energy Star	Specified Material/Product	Thickness	R-value/inch	Vapor flow	Density (lbs/ft3)	Selected WUFI Material	R-value/inch	Vapor flow	Density (lbs/ft3)
paint	2-coats latex	-	-	10 perms (BSC guideline)		surface transfer coefficient	-	10 perms	-
drywall	gypsum board	1/2"	0.9	36.5 perms @ 1/2 inch		Gypsum Board (USA)	0.89	21.5 perm in	53.1
vapor retarder	6 mil polyethylene	4 mil	-	0.08 perms		vapor retarder	-	0.1 perms	-
cavity insulation	fiberglass batt	5.5"	3.7	106 perms @ 1 inch	0.7 (approx.)	Low Density Glass Fibre Batt Insulati	3.33	106.45 perm in	0.55
sheathing	OSB	7/16"	1.5	1 perm at 1/2 inch		Oriented strand board	1.57	0.158 perm in	40.6
weather barrier	Grace Perm-a-Barrier	3/64"	-	0.05 perms		PE-Membrane (Poly; 0.07 perm)	-	0.066 perms	-
exterior insulation	Dow XPS 'Square Edge'	1/2"	5	1.5 perms @ 1 inch		Extruded Polystyrene Insulation	5.95	0.755 perm in	1.8
cladding	LP Smartside (no back ventilation)	5/16"	1.5	0.6 - 1.4 perms @ 1 inch	40.0	Composite Wood Siding	1.54	2.43 perm in	46.2
paint	3-coats latex	-	-	5 perms		surface transfer coefficient	-	5 perms	-
2x4 Opti-MN									
paint	2-coats latex	-	-	10 perms (BSC guideline)		surface transfer coefficient	-	10 perms	-
drywall	gypsum board	1/2"	0.9	36.5 perms @ 1/2 inch		Gypsum Board (USA)	0.89	21.46 perm in	53.1
cavity insulation	fiberglass batt	3.5"	3.7	106 perms @ 1 inch	0.7 (approx.)	Low Density Glass Fibre Batt Insulati	3.33	106.45 perm in	0.55
sheathing	OSB	7/16"	1.5	1 perm at 1/2 inch		Oriented strand board	1.57	0.158 perm in	40.6
weather barrier	Grace Perm-a-Barrier	3/64"	-	0.05 perms		PE-Membrane (Poly; 0.07 perm)	-	0.066 perms	-
exterior insulation	Dow XPS 'Square Edge'	3"	5	1.5 perms @ 1 inch		Extruded Polystyrene Insulation	5.95	0.755 perm in	1.8
air gap	air	3/4"	-	120 perm in		Air layer 20mm: w/out additional m	1.11	230 perm in	
cladding	LP Smartside (backventilated on 1x	5/16"	-	0.6 - 1.4 perms @ 1 inch	40.0	Composite Wood Siding	1.54	2.43 perm in	46.2
paint	3-coats latex	-	-	5 perms		surface transfer coefficient	-	5 perms	-
SEP ETMMS									
paint	2-coats latex	-	-	10 perms (BSC guideline)		surface transfer coefficient	-	10 perms	-
SEP panel	Huber Advantech Flooring	2.25"	1.4 - 1.5	0.86 perms @ 23/32" (equiv to 0.618 perm in)	40.1	Oriented strand board	1.57	0.158 perm in	40.6
weather barrier	Grace Perm-a-Barrier	3/64"	-	0.05 perms		PE-Membrane (Poly; 0.07 perm)	-	0.066 perms	-
exterior insulation	Dow XPS 'Square Edge'	4"	5	1.5 perms @ 1 inch		Extruded Polystyrene Insulation	5.95	0.755 perm in	1.8
air gap	air	3/4"	-	120 perm in		Air layer 20mm: w/out additional m	1.11	230 perm in	
cladding	LP Smartside (backventilated on 1x	5/16"	-	0.6 - 1.4 perms @ 1 inch	40.0	Composite Wood Siding	1.54	2.43 perm in	46.2
paint	3-coats latex	-	-	5 perms		surface transfer coefficient	-	5 perms	-

WUFI Pro Walk-through and Exercises

Step 2 – Assign Material Data

- Some suggestions:
  - Fiber cement siding = “Composite Wood Siding”
  - Peel & stick membrane (vapor closed, i.e. Perm-a-Barrier) = “PE Membrane 0,15mm” (0.047 perms)
  - OSB = “Oriented Strand Board” (0.158 perm in)
  - Gypsum board = “Gypsum Board USA” (21.5 perm in)
  - Fiberglass batt = “Low Density Glass Fiber Batt Insulation” (R-3.35/inch)
  - Tyvek = “Spun Bonded Polyolefin” (66 perms)
  - “Smart” vapor retarder (e.g. MemBrain) = “PA Membrane”

(don’t modify thickness of any membranes)

  - Be careful using metal from the WUFI database
  - Products with facers need to be broken down into layers

WUFI Pro Walk-through and Exercises

Step 2 – Assign Material Data

- Some suggestions:
  - Fiberglass-faced gypsum sheathing:
    - Model as three separate layers
      - two layers of SBP membrane (Tyvek) (66 perms)
      - sandwiching a layer of Gypsum Board USA (43 perms @ ½”)
      - total product = 1/(1/66 + 1/43 + 1/66) = 18.7 perms

WUFI Pro Walk-through and Exercises

Step 2 – Assign Material Data

- Some suggestions:
    - Polyiso with foil facers:
        - Model as three separate layers
            - two layers of PE-membrane (Poly, 0.07 perms) for the foil (try to avoid using metal materials in database)
            - sandwiching a layer of polyiso at design thickness (2.5 perm in)
            - total product = 1/(1/0.07 + 1/0.07) = 0.035 perms

WUFI Pro Walk-through and Exercises

Step 2 – Assign Material Data

- Some suggestions:
  - Metal panels/cladding:
    - Metal materials in WUFI database have been known to cause simulation issues. Try an alternative material:
      - find material in database with the highest density (“Concrete brick” at 144lbs/cf is best match)
      - adjust its thickness to match metal panel thickness
      - turn off rain water absorption (in surface coefficient settings, set adhering fraction of rain to 0)
      - set exterior surface permeance to something close to 0 perms (in surface coefficient settings, use “metal foil”)
      - set exterior surface to match color of metal panel (to match radiation absorptivity)

WUFI Pro Walk-through and Exercises

Step 2 – Assign Material Data

- Useful Conversions:
  - Permeability (perm in) to Permeance (perms)

    perm in / thickness (in) = perms

  - Conductivity (BTU/hr ft °F) to R/inch

    (1 / conductivity) / 12 = R/inch

(Or use the conversion tool in the B3 Glaser Calculator)

WUFI Pro Walk-through and Exercises

Step 2 – Assign Material Data

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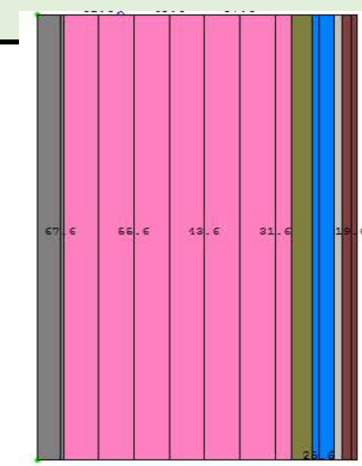
paint	2-coats latex	-	-	10 perms (BSC guideline)	
drywall	gypsum board	1/2"	0.9	36.5 perms @ 1/2 inch	
vapor retarder	4 mil polyethylene	4 mil	-	0.08 perms	
cavity insulation	fiberglass batt	5.5"	3.7	106 perms @ 1 inch	0.7 (approx.)
sheathing	OSB	7/16"	1.5	1 perm at 1/2 inch	
weather barrier	Grace Perm-a-Barrier	3/64"	-	0.05 perms	
exterior insulation	Dow XPS 'Square Edge'	1/2"	5	1.5 perms @ 1 inch	
cladding	LP Smartside (no back ventilation)	5/16"	1.5	0.6 - 1.4 perms @ 1 inch	40.0
paint	3-coats latex	-	-	5 perms	



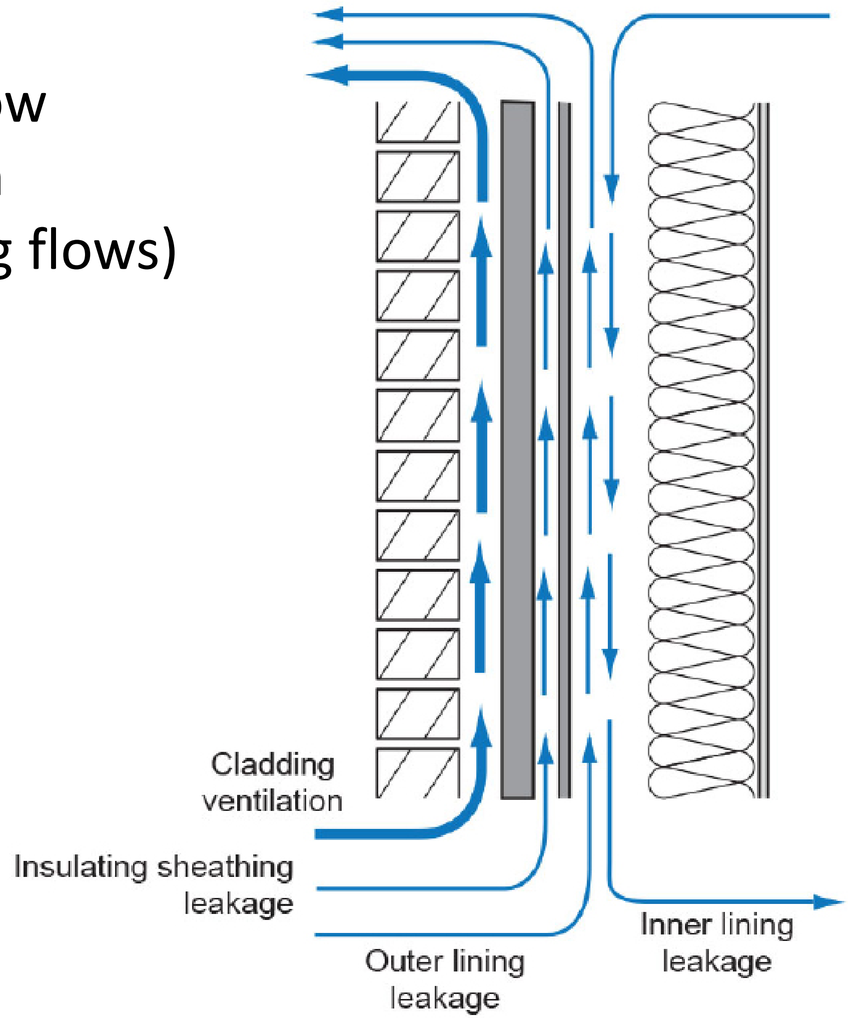
WUFI Pro Walk-through and Exercises

Step 3 – Address Airflow

- Cladding ventilation (purposeful or not)
- Air leakage (flanking flows)

WUFI Pro Walk-through and Exercises

Step 3 – Address Airflow
- Cladding ventilation
- Air leakage (flanking flows)



From BA Strategy Guideline 2016, BSC

Figure 12: Air-space coupling to address through-the-assembly airflow in WUFI

WUFI Pro Walk-through and Exercises

Step 3 – Address Airflow

- Cladding ventilation
- Air leakage (flanking flows)

Table 3. Cladding ventilation/ sheathing ventilation

	Flow Rate (CFM/ft^2)	Gap (in.)	ACH (1/h)
Wood Siding	0.1	3/16	20
Vinyl Siding	0.5	3/16	200
Brick Veneer	0.15	1	10
Stucco (Vented)	0.1	3/8	10
Stucco (Directly Applied)	none	none	0
Sheathing Flanking Flow*	0.05	3/16	10

* Flanking flow refers to outer-lining leakage, inner-lining leakage, and insulating-sheathing leakage.

From BA Strategy Guideline 2016, BSC

WUFI Pro Walk-through and Exercises

Step 3 – Address Airflow

- Cladding ventilation
- Air leakage (flanking flows)

Table 3. Cladding ventilation/ sheathing ventilation

	Flow Rate (CFM/ft^2)	Gap (in.)	ACH (1/h)
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Stucco (Vented)	0.1	3/8	10
Stucco (Directly Applied)	none	none	0
Sheathing Flanking Flow*	0.05	3/16	10

* Flanking flow refers to outer-lining leakage, inner-lining leakage, and insulating-sheathing leakage.

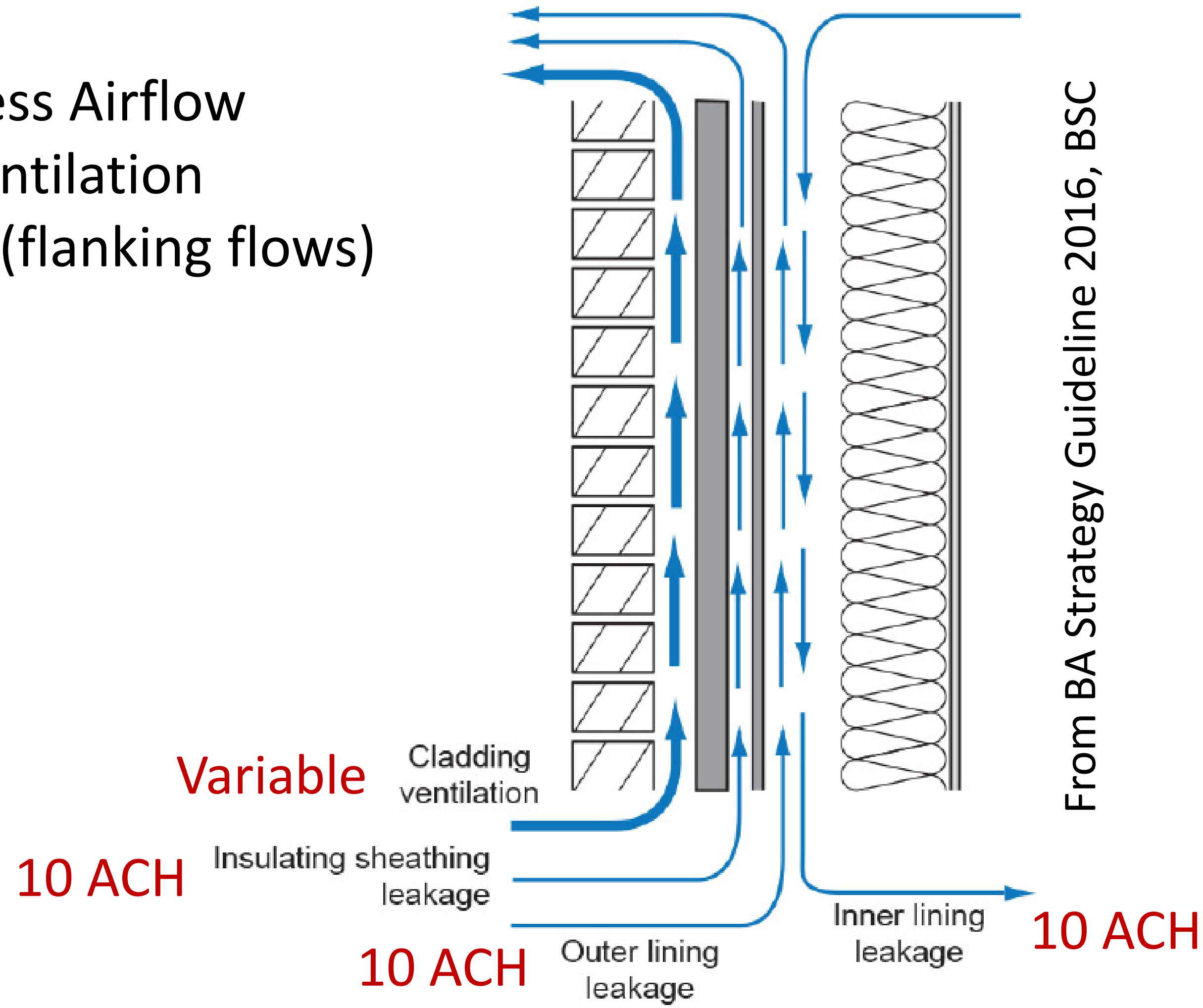
From BA Strategy Guideline 2016, BSC

- Think carefully about which flanking flows to include!

WUFI Pro Walk-through and Exercises

Step 3 – Address Airflow

- Cladding ventilation
- Air leakage (flanking flows)



From BA Strategy Guideline 2016, BSC

Figure 12: Air-space coupling to address through-the-assembly airflow in WUFI

WUFI Pro Walk-through and Exercises

Step 4 – Address Rain
- Orientation
- Height and exposure
- Adhering Fraction
- Rain penetration

WUFI Pro Walk-through and Exercises

Step 4 – Address Rain

- Orientation
  - Test two scenarios to find out which is most wet:
    1) North orientation (little solar gain, limited drying potential)
    2) Whichever side had the highest wind-driven rain load

WUFI Pro Walk-through and Exercises

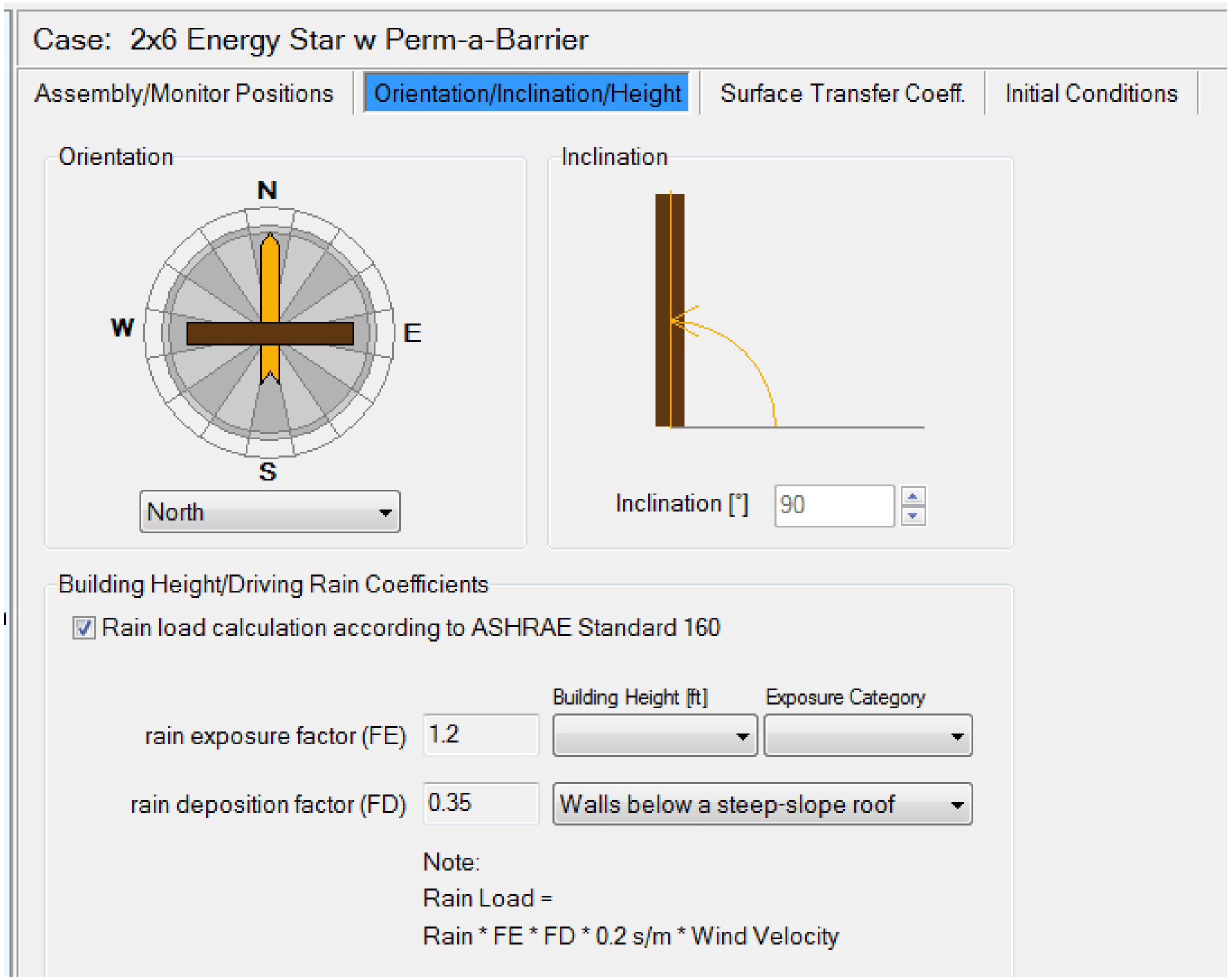
Step 4 – Address Rain

- Height and exposure
  - Walls that are higher up and capped by flat roofs are subject to the most wind-driven rain
  - To be on the conservative side, select the most challenging condition for your particular building
  - These determine the rain exposure and deposition factors
  - Set under "Orientation/Inclination/Height" tab
  - Select "Rain load calculation according to ASHRAE Standard 160

  - For this case, use : Building height >33 and <66, "Medium Exposure", and "Walls below a low-slope roof". This is a fairly challenging condition.

WUFI Pro Walk-through and Exercises

Step 4 – Address Rain, height and exposure



WUFI Pro Walk-through and Exercises

Step 4 – Address Rain

- Adhering Fraction
  - This is done on Surface Transfer Coefficients tab
  - Typically, adhering fraction of rain should be set to 0.7 for walls. (0.7 is set automatically for vertical walls if "depending on inclination" is selected.)
    - This means that 30% of rain that the wall is exposed to bounces off (is shed) while 70% stays on the cladding
    - Set under "Surface Transfer Coefficients" tab

If you are using a metal cladding substitute, set adhering fraction to 0, which is "no absorption".

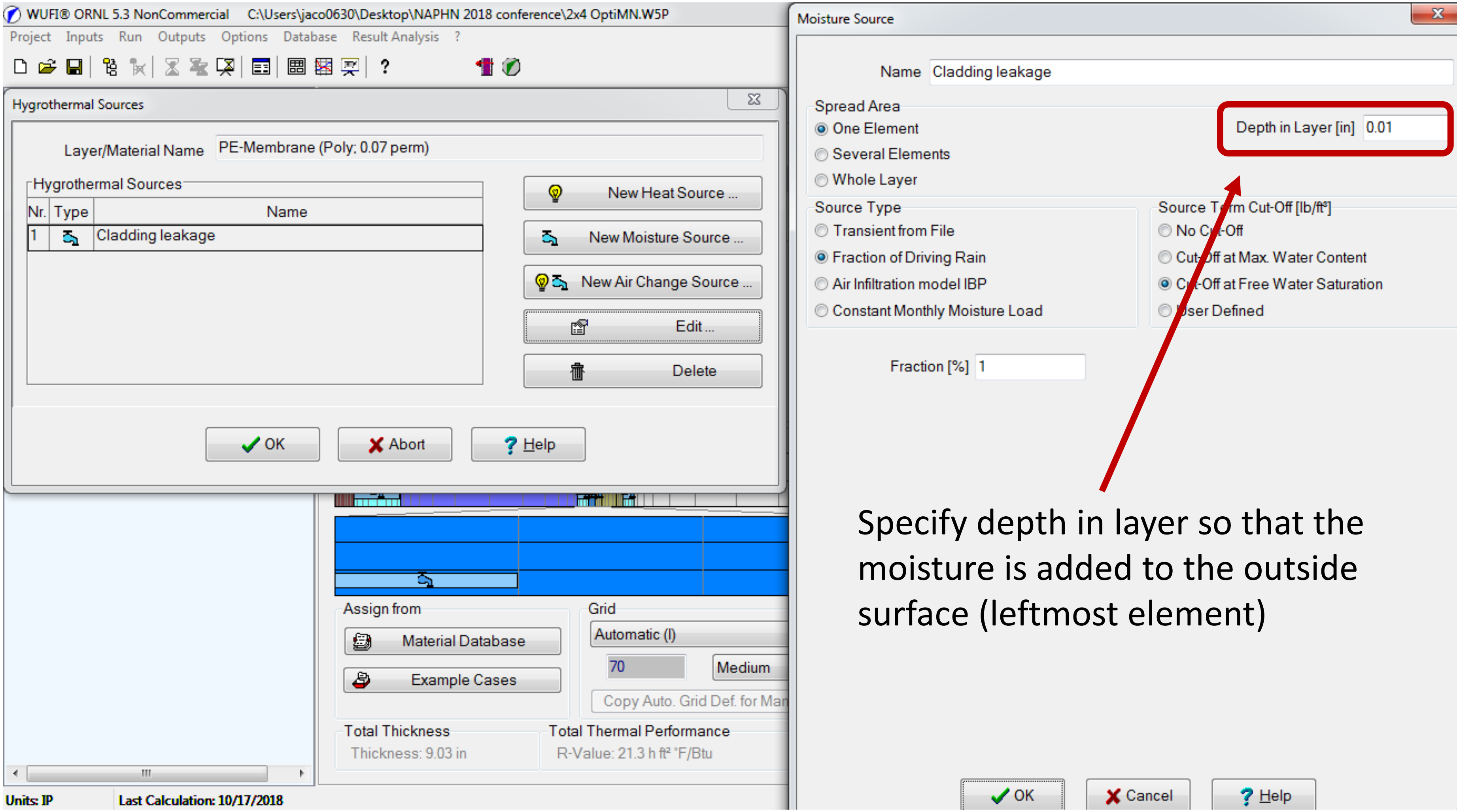
WUFI Pro Walk-through and Exercises

Step 4 – Address Rain

- Rain penetration
    - ASHRAE 160 requires that the simulation assumes 1% of wind driven rain leaks past the exterior surface.
      This water is added to the exterior surface of the WRB as a "moisture source". "If a WRB is not provided, the deposit site shall be described and a rationale for its selection shall be provided."
    - In addition, the Building America strategy guideline suggests 1% of the 1% (0.01%) leaks past the WRB. This water is added to the exterior surface layer of the sheathing. (Cannot be modeled with WUFI Light 6.3)

WUFI Pro Walk-through and Exercises

Step 4 – Address Rain, Rain penetration



Specify depth in layer so that the moisture is added to the outside surface (leftmost element)

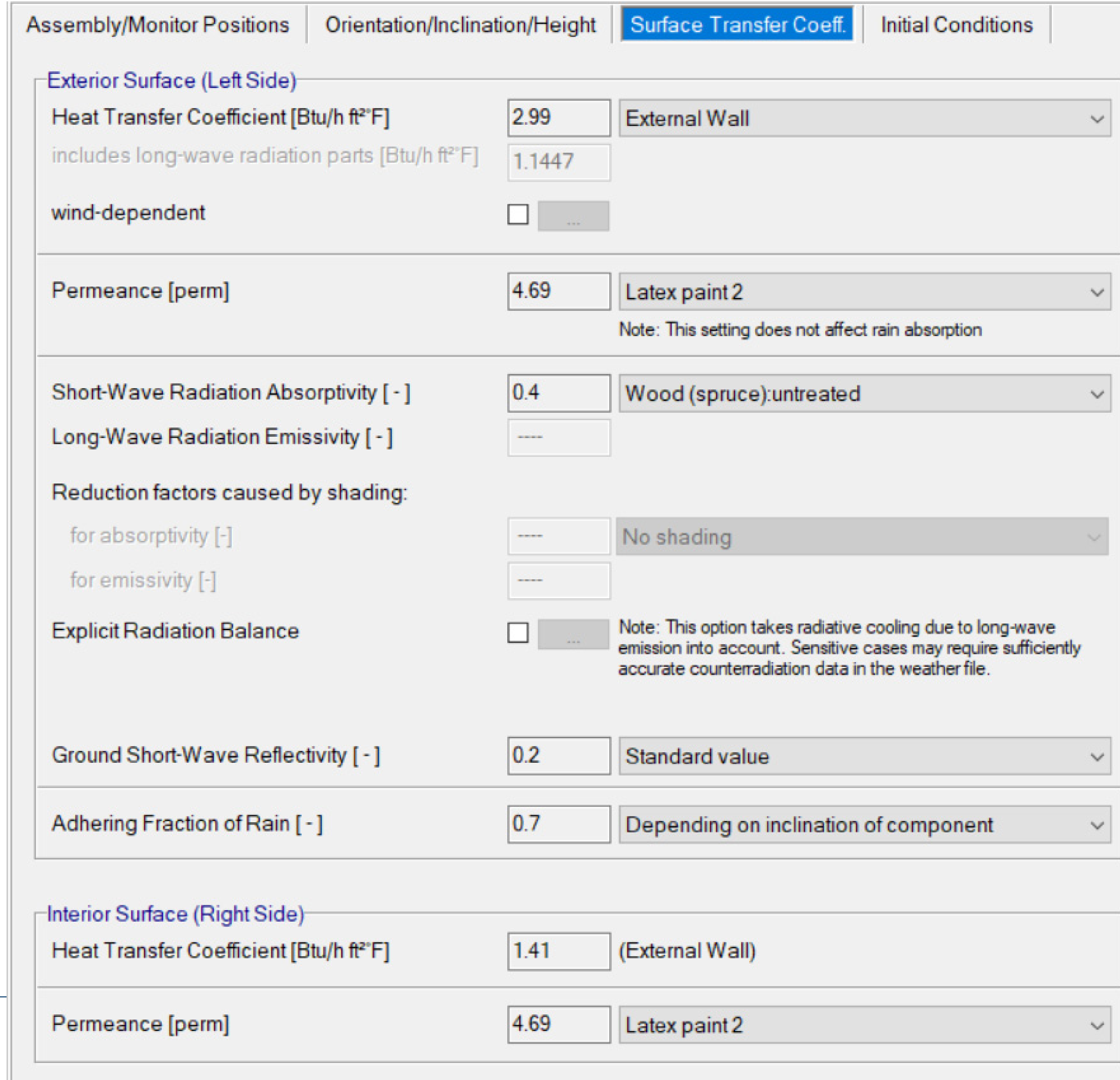
WUFI Pro Walk-through and Exercises

Step 5 – Surface Transfer Coefficients

- Heat transfer
  - For walls, select “External Wall”
  - This automatically sets interior/exterior surface film resistance
- Radiation exchange
  - Determined by cladding type and color
  - Absorptivity: Select “untreated wood” for this example
  - No need to model Explicit Radiation Balance (this is most applicable to flat roofs exposed directly to night sky)
  - Reflectivity: Select “standard value” for this example
- Vapor transfer
  - For interior, select “Latex paint2” = 4.7 perm coating (2 coats of latex paint, do not model as a separate layer)
  - For exterior, select the same

WUFI Pro Walk-through and Exercises

Step 5 – Surface Transfer Coefficients



WUFI Pro Walk-through and Exercises

Step 6 – Initial Conditions

- ASHRAE 160 calls for all layers to start wet, at 80%RH. This tests the drying potential of the assembly

- Concrete is an exception. It should start at 90% RH (However, WUFI Light 6.3 does not allow us to individually adjust the initial moisture levels of different layers.)

WUFI Pro Walk-through and Exercises

Step 7 – Simulation Controls

- Calculation period
- Numerics

WUFI Pro Walk-through and Exercises

Step 7 – Simulation Controls

- Calculation period
    - In general, simulations should run for at least 3 years.
    - We want to see the assembly dry out the first year, then achieve a stable, repeating moisture pattern for the next couple years.
    - If a stable pattern is not achieved, a longer simulation may be necessary (and consider a redesign!) This is an indication that the assembly has a very low drying potential.

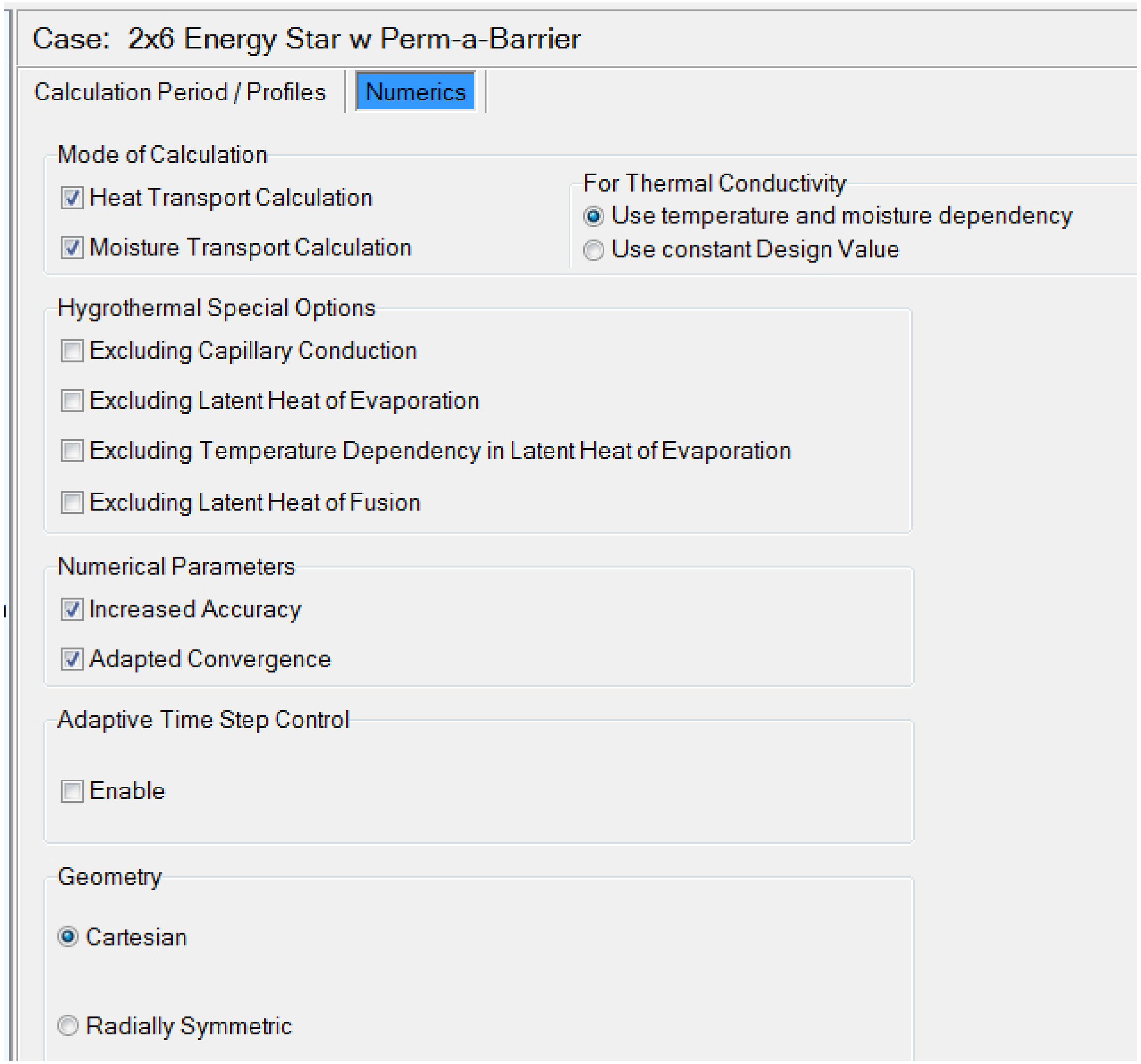
WUFI Pro Walk-through and Exercises

Step 7 – Simulation Controls

- Numerics
    - In general, leave the default settings as they are.

WUFI Pro Walk-through and Exercises

Numerics



WUFI Pro Walk-through and Exercises

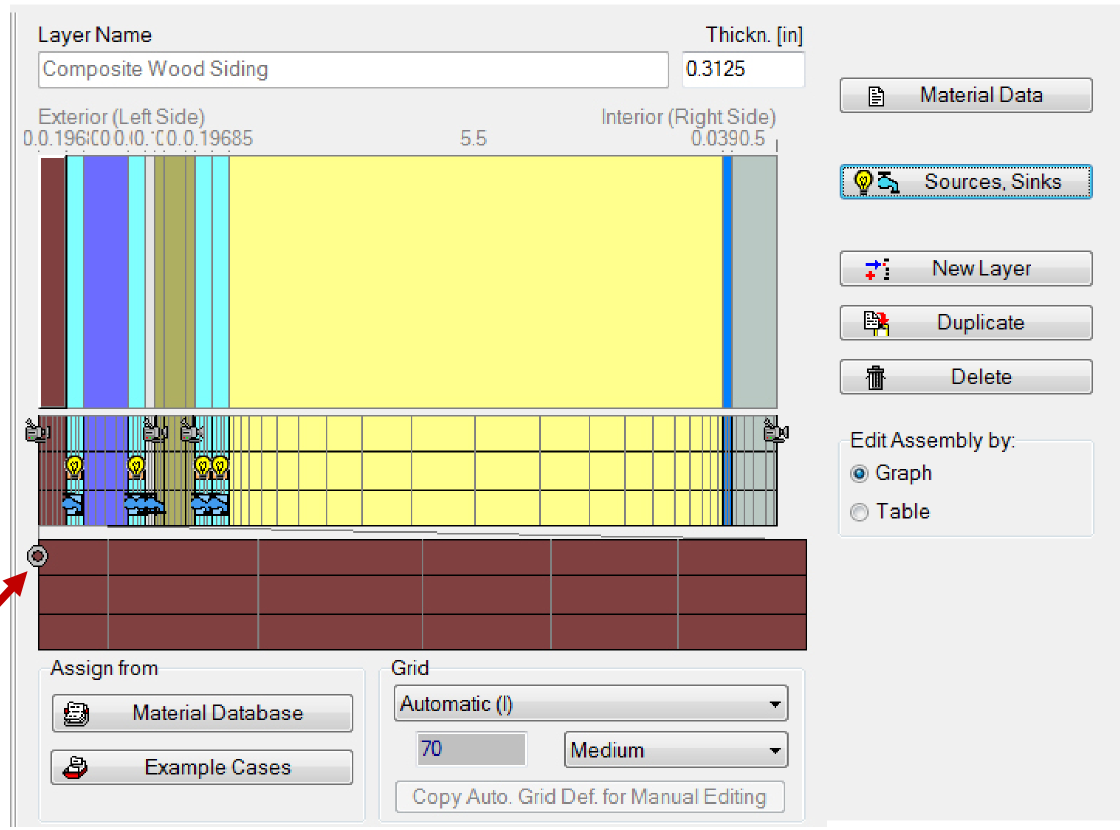
Step 8 – Run Simulation

- Position RH/temp monitors
- Divide sheathing into layers
- Run simulation
- Check for simulation quality

WUFI Pro Walk-through and Exercises

Step 8 – Run Simulation
- Position RH/temp monitors

Monitors are created with a click in the desired element of the blow-up view of the desired layer of the assembly cross section, here.



WUFI Pro Walk-through and Exercises

Step 8 – Run Simulation

- Position RH/temp monitors
  - Monitors should be placed in both the inner and outermost elements of the “critical layer”. This is the material that is most at risk for mold growth or moisture damage – usually the sheathing.

WUFI Pro Walk-through and Exercises

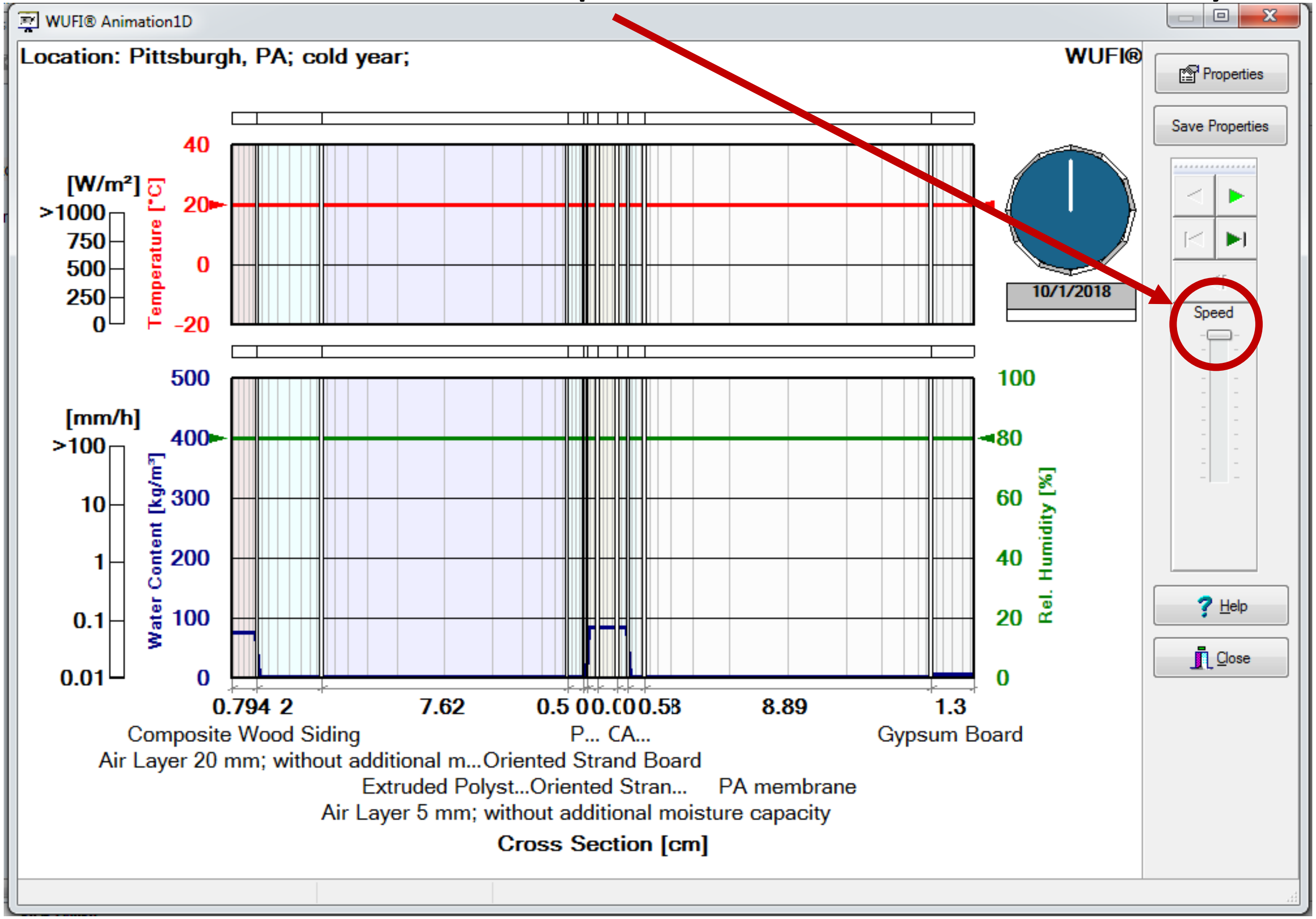
Step 8 – Run Simulation

- Divide sheathing into layers
    - In addition to placing monitors there, the sheathing itself should be divided into three layers.
        - Inner layer 1/8” thick => site of condensation
        - Outer layer 1/8” thick => site of rain leak deposition
        - Middle layer approx. 1/4“ thick

      This will enable the moisture content of the inner and outer sheathing surface layers to be tracked separately and directly in the results.

WUFI Pro Walk-through and Exercises

Step 8 – Run Simulation, set speed to maximum, click Play button



WUFI Pro Walk-through and Exercises

Step 8 – Run Simulation

- Check for simulation quality
  - Convergence failures = 0 (or < 100 at the very most)
  - Moisture balance = Start water content - End water content

Status of Last Calculation

Status of Calculation

Calculation: Time and Date	10/17/2018 2:46:30 PM
Computing Time	6 min,19 sec.
Begin / End of calculation	10/1/2018 / 10/1/2020
No. of Convergence Failures	0

Check for numerical quality

Integral of fluxes, left side (kl,dl)	[lb/ft²]	0.08 0.54
Integral of fluxes, right side (kr,dr)	[lb/ft²]	1E-8 0.01
Balance 1	[lb/ft²]	-0.14
Balance 2	[lb/ft²]	-0.14

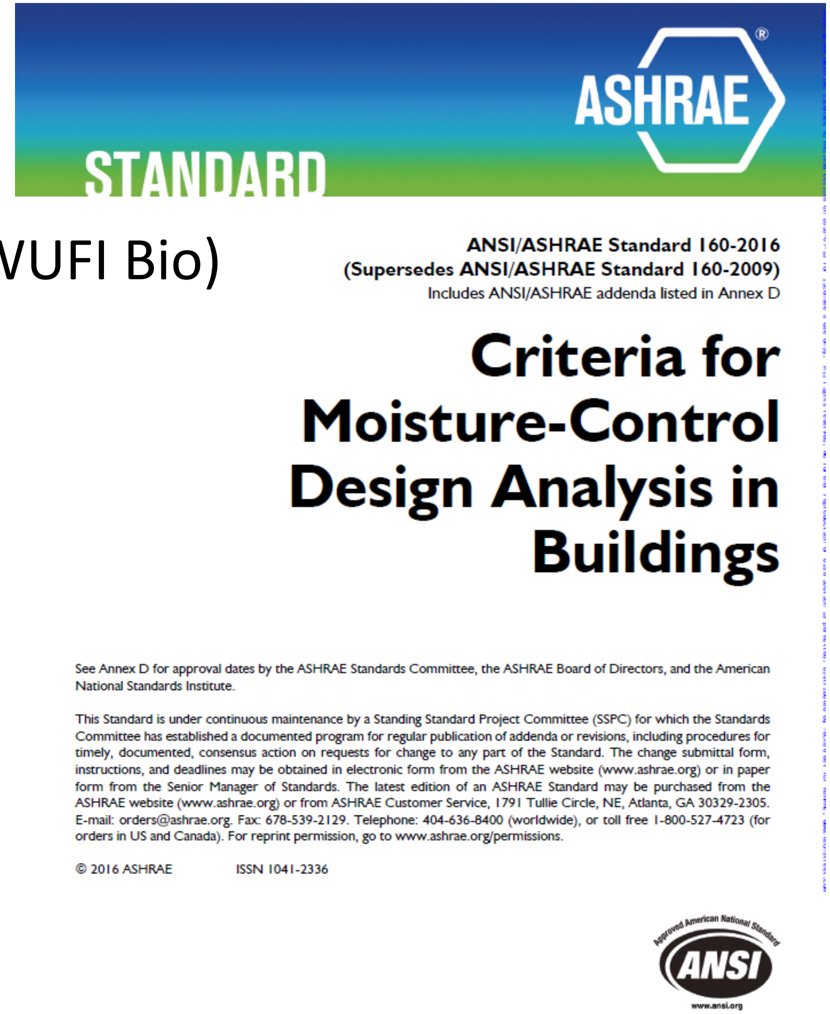
Water Content [lb/ft²]

	Start	End	Min.	Max.
Total Water Content	0.37	0.22	0.2	0.37

WUFI Pro Walk-through and Exercises

Step 9 – Analysis

- ASHRAE 160 2009 (former)
- ASHRAE 160 2016 (current – WUFI Bio)



ASHRAE®

STANDARD

ANSI/ASHRAE Standard 160-2016
(Supersedes ANSI/ASHRAE Standard 160-2009)
Includes ANSI/ASHRAE addenda listed in Annex D

Criteria for Moisture-Control Design Analysis in Buildings

See Annex D for approval dates by the ASHRAE Standards Committee, the ASHRAE Board of Directors, and the American National Standards Institute.

This Standard is under continuous maintenance by a Standing Standard Project Committee (SSPC) for which the Standards Committee has established a documented program for regular publication of addenda or revisions, including procedures for timely, documented, consensus action on requests for change to any part of the Standard. The change submittal form, instructions, and deadlines may be obtained in electronic form from the ASHRAE website (www.ashrae.org) or in paper form from the Senior Manager of Standards. The latest edition of an ASHRAE Standard may be purchased from the ASHRAE website (www.ashrae.org) or from ASHRAE Customer Service, 1791 Tullie Circle, NE, Atlanta, GA 30329-2305. E-mail: orders@ashrae.org. Fax: 678-539-2129. Telephone: 404-636-8400 (worldwide), or toll free 1-800-527-4723 (for orders in US and Canada). For reprint permission, go to www.ashrae.org/permissions.

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WUFI Pro Walk-through and Exercises

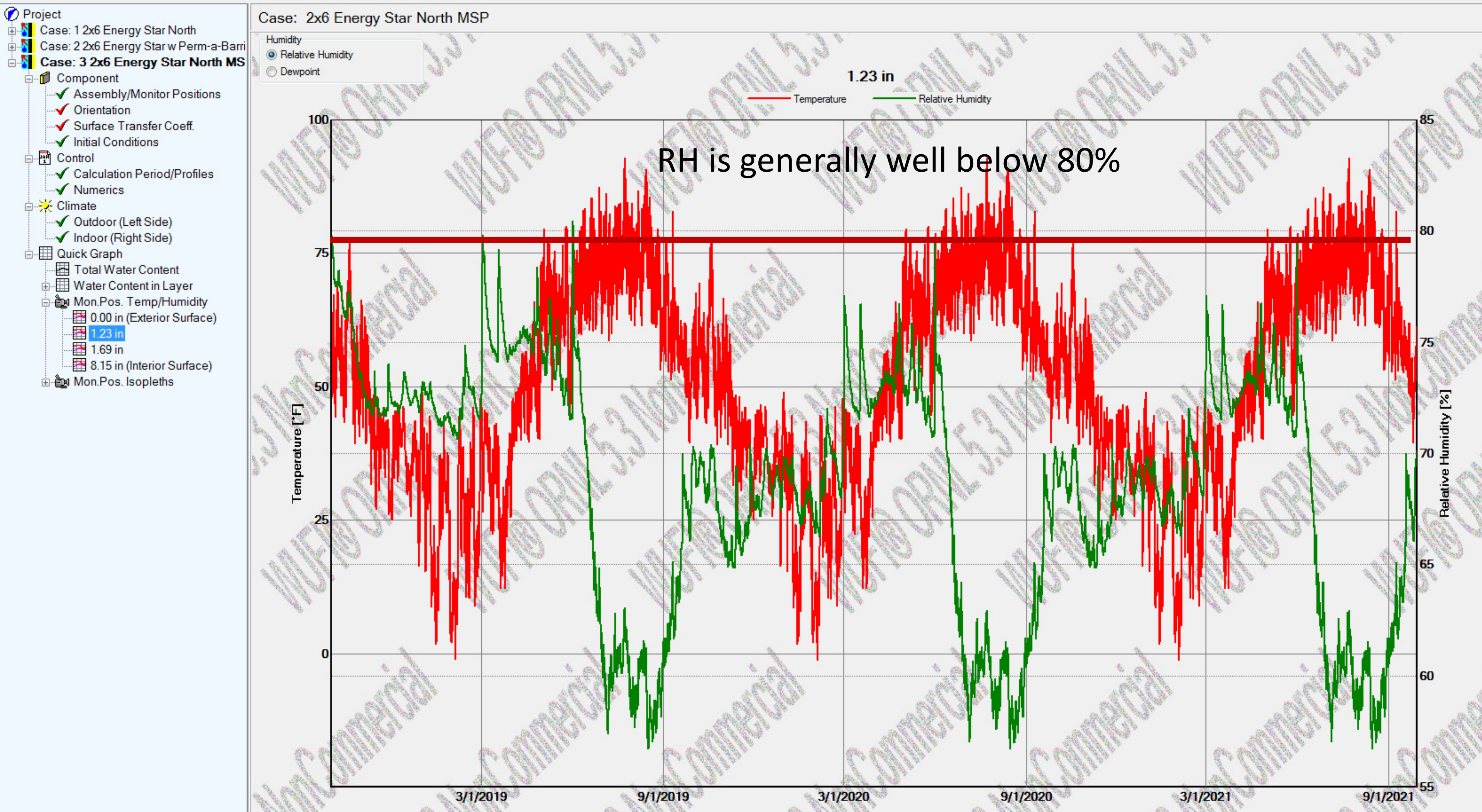
Step 9 – Analysis

ASHRAE Standard 160 (2009) provides guidance on moisture analysis for building-envelope design, including the moisture performance evaluation criteria. The failure criteria (defined as the risk of mold growth) were redefined in addendum (a) (ASHRAE 2011) as follows:

6.1 Conditions Necessary to Minimize Mold Growth. *In order to minimize problems associated with mold growth on the surfaces of components of building envelope assemblies, condition shall be met: a 30-day running average surface RH < 80% when the 30-day running average surface temperature is between 5°C (41°F) and 40°C (104°F).*

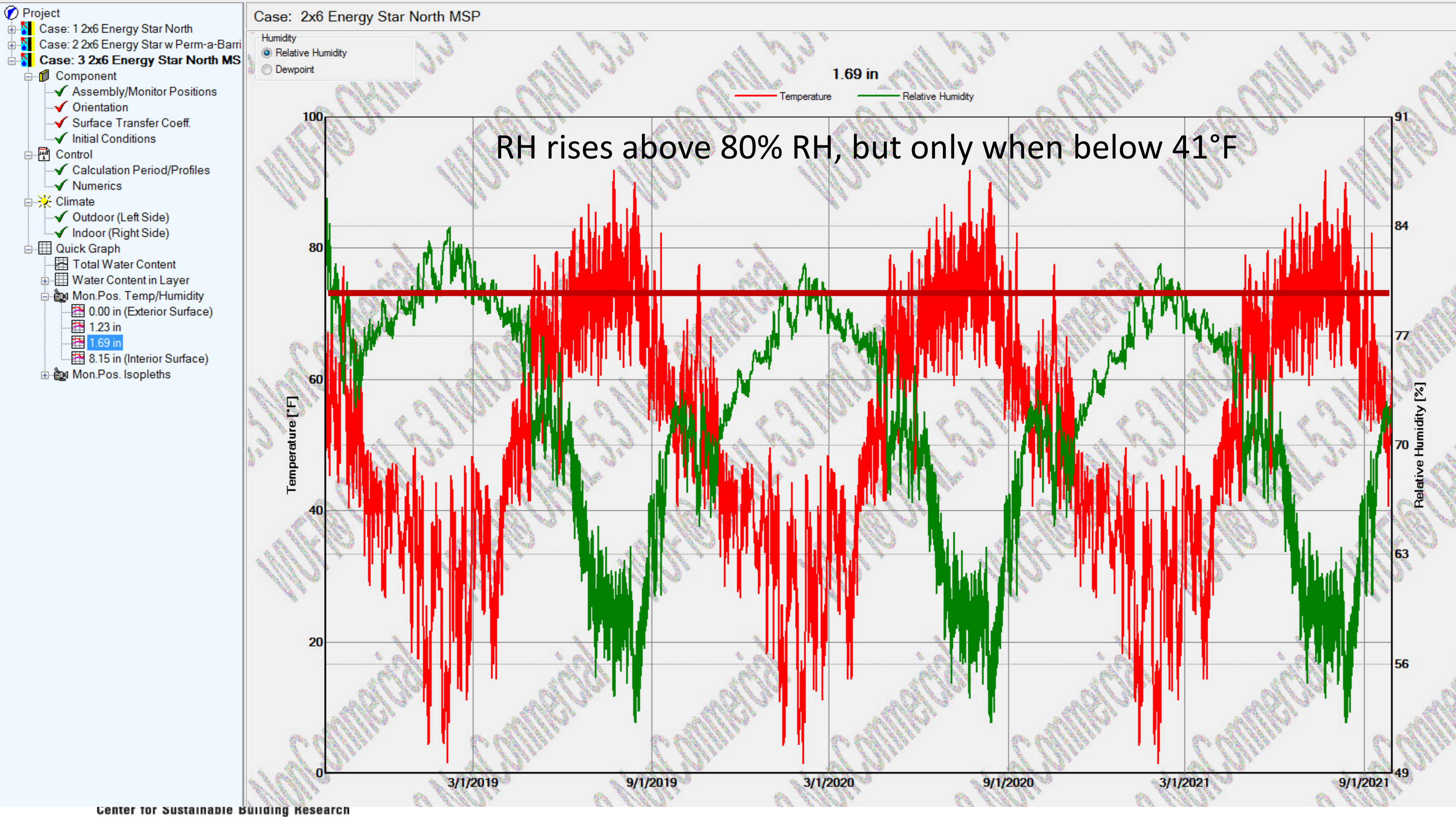
WUFI Pro Walk-through and Exercises

Step 9 – Analysis, ASHRAE Standard 160 (2009) – outer layer of sheathing



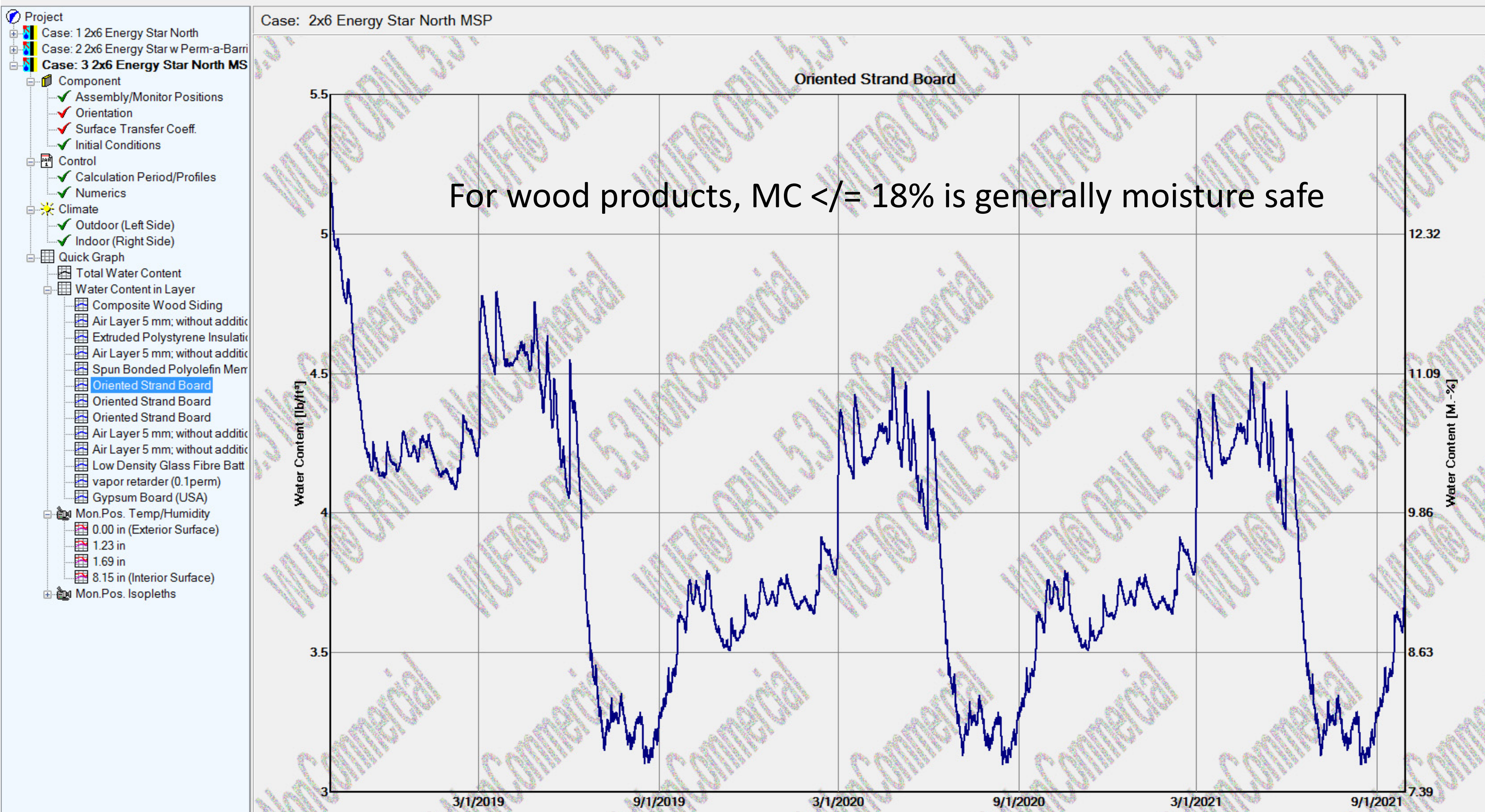
WUFI Pro Walk-through and Exercises

Step 9 – Analysis, ASHRAE Standard 160 (2009) – inner layer of sheathing



WUFI Pro Walk-through and Exercises

Step 9 – Analysis, ASHRAE Standard 160 (2009) – outer layer of sheathing



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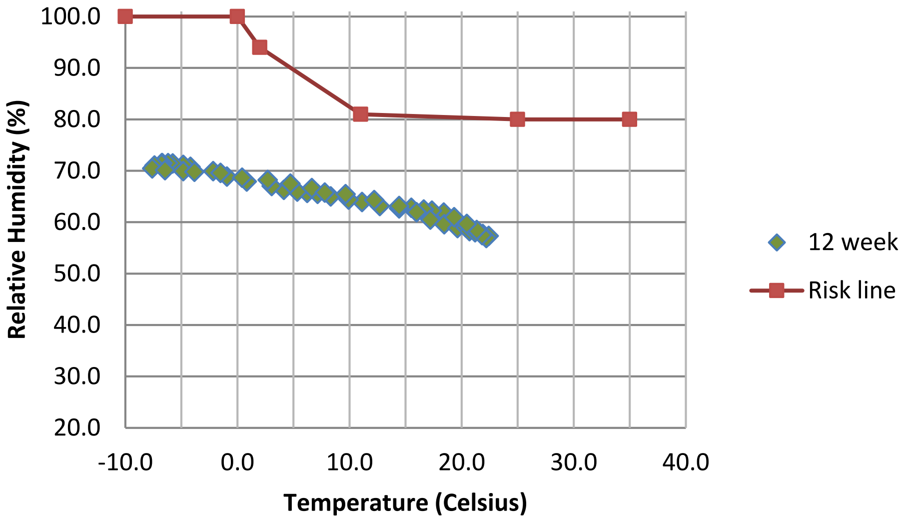
WUFI Pro Walk-through and Exercises

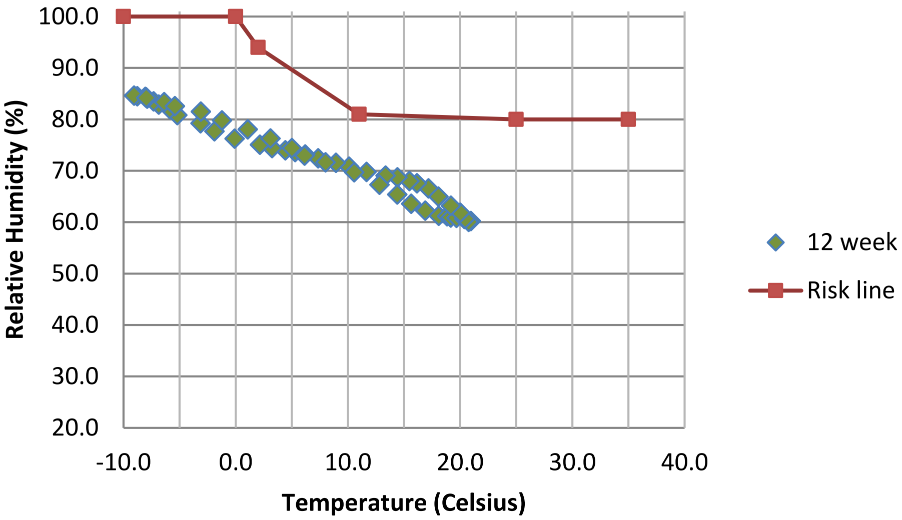
Step 9 – Analysis, ASHRAE Standard 160 (2009)

- WUFI Pro allows data exports, from all layers and monitor positions. This hourly data (RH and temp) can be imported into an excel processor which calculates the rolling 30 day averages and plots the results.

Standard 2x6 framing



Norwegian cross batten



WUFI Pro Walk-through and Exercises

Step 9 – Analysis

ASHRAE Standard 160 (2016) The failure criteria (defined as the mold index) were redefined as follows:

6.1 Conditions Necessary to Minimize Mold Growth. In order to minimize problems associated with mold growth on the surfaces of components of building envelope assemblies, the mold index, calculated in accordance with Equations 6-1 through 6-7, shall not exceed a value of three (3.00)

(A mold index of three (M = 3) is described as visual findings of mold on the surface with <10% coverage, or <50% coverage of mold under microscope. Mold index values less than three correspond with growth visible only under microscope.)

WUFI Pro Walk-through and Exercises

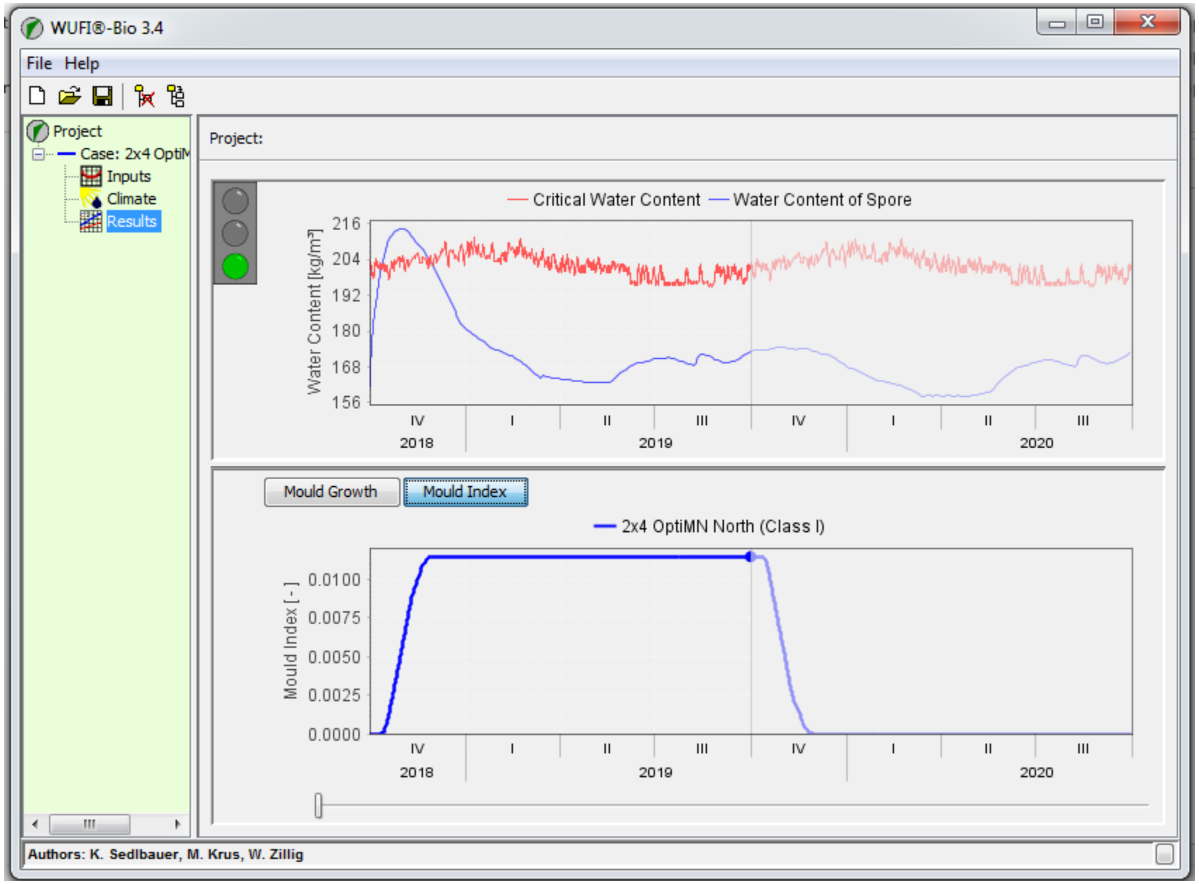
Step 9 – Analysis
ASHRAE Standard 160 (2016)

- In practice, this analysis of the failure criteria is performed with an add-on program, WUFI-Bio

WUFI Pro Walk-through and Exercises

Step 9 – Analysis, *ASHRAE Standard 160* (2016)

It imports the simulation results for a selected layer and analyzes them for potential mold growth

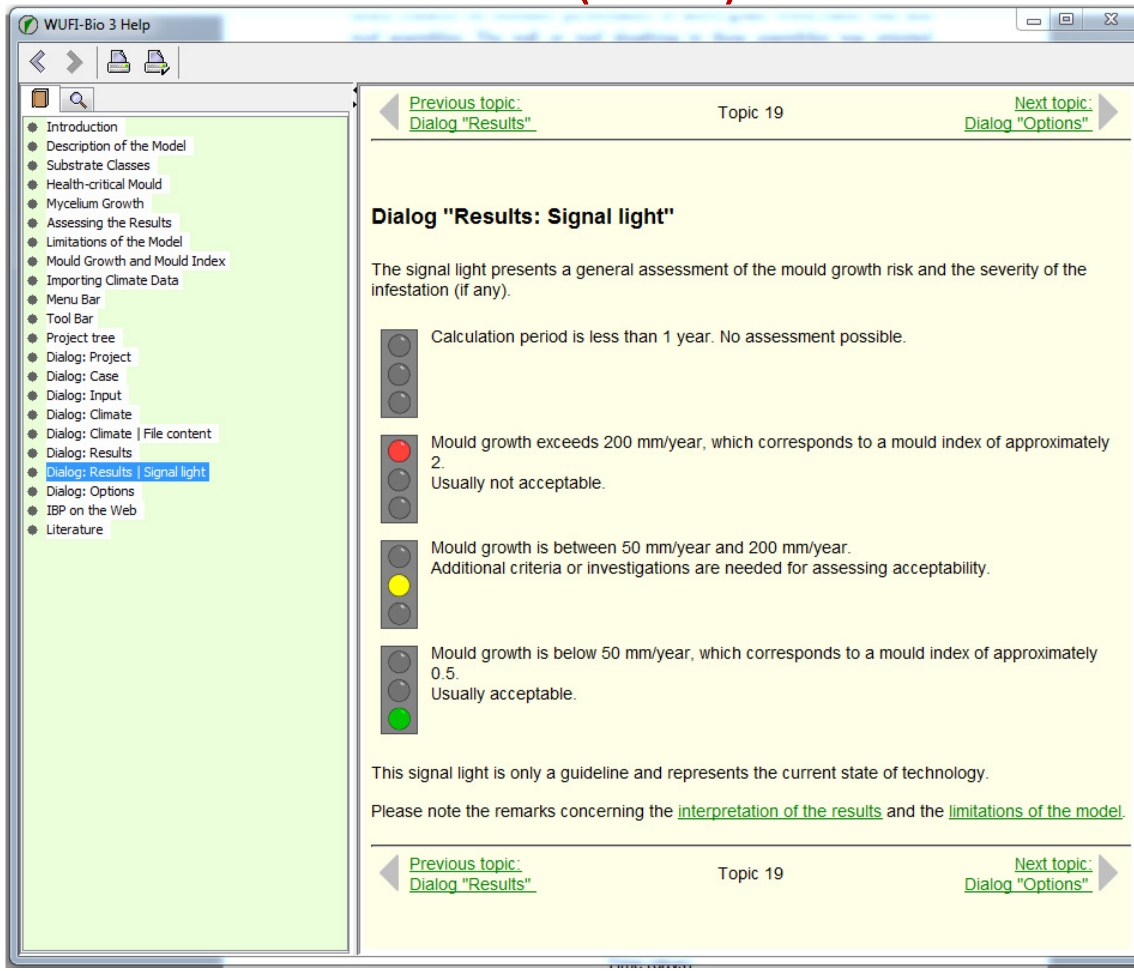


WUFI Pro Walk-through and Exercises

Step 9 – Analysis, *ASHRAE Standard 160* (2016)

WUFI-Bio provides a "stoplight" analysis of the layer under analysis.

Green = safe
Yellow = undetermined
Red = not safe



WUFI Pro Walk-through and Exercises

Step 9 – Analysis, *ASHRAE Standard 160* (2016)

- The failure criteria also depend on the type of substrate being analyzed (i.e., how sensitive is it to mold growth)

TABLE 6.1.1 Recommended Mold Sensitivity Classes for Various Materials

Sensitivity Class	Materials	
Very sensitive	Untreated wood; includes lots of nutrients for biological growth	Class 0
Sensitive	Planed wood, paper-coated products, wood-based boards	Class I
Medium resistant	Cement or plastic based materials, mineral fibers	Class II
Resistant	Glass and metal products, materials with efficient protective compound treatments	Class K

- Wood sheathing products generally fall in Class I
- Paper-faced gypsum generally falls in Class I
- Fiberglass-faced gypsum generally falls in Class II

WUFI Pro Walk-through and Exercises

Step 9 – Analysis, a spectrum of choices…

Least conservative
(assembly most likely to
be labelled moisture safe)

Most conservative
(assembly least likely to
be labelled moisture safe)

<--->

Flanking flows from BA Strategy Guideline
+
WUFI Bio (ASHRAE 160 2016)

Flanking flows from BA Strategy Guideline
+
80% RH avg. (ASHRAE 160 2009)

No flanking flows
+
80% RH avg. (ASHRAE 160 2009)

WUFI Pro Walk-through and Exercises

Step 9 – Currently, B3 requirements follow ASHRAE 160 2009

Least conservative
(assembly most likely to
be labelled moisture safe)

Most conservative
(assembly least likely to
be labelled moisture safe)

<-->

~~Flanking flows from BA Strategy Guideline~~
~~+~~
~~WUFI Bio (ASHRAE 160 2016)~~

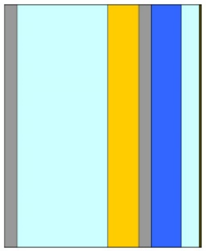
Flanking flows from BA Strategy Guideline
+
80% RH avg. (ASHRAE 160 2009)

No flanking flows
+
80% RH avg. (ASHRAE 160 2009)

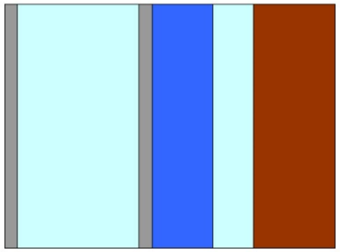
Glaser Walk-through and Exercises

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

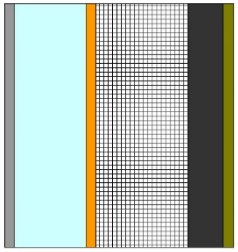
1. Steel Stud with hybrid insulation & metal panel



2. Steel Stud with exterior insulation & brick



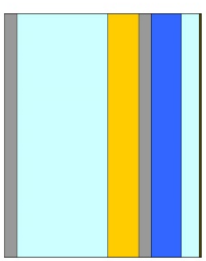
3. Concrete tilt-up panel



Option 1 - Steel Stud with hybrid insulation & metal panel

Layers from inside to outside:

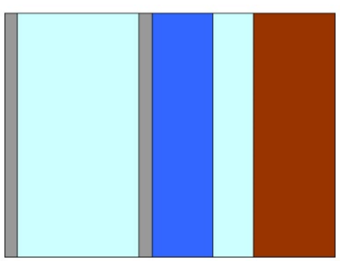
1. 2-coats latex paint	10 perms	R-0
2. 5/8” gypsum board	29.2 perms @ 5/8”	R-0.9/inch
3. 4 ½” still air space	120 perm in	R-1.0
4. 1 ½” closed cell SPF	1.39 perm in	R-6.7/inch
5. Fiberglass facer	60 perms	R-0
6. 5/8” gypsum board	29.2 perms @ 5/8”	R-0.9/inch
7. Fiberglass facer	60 perms	R-0
8. Tyvek	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



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



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