DAY 1

8:00 – 8:45 **Welcome, introductions**, load software onto each student's laptop. Review contents of CD, overview of course.

8:45 – 9:15 **Presentation 1: Development of WUFI-ORNL software**, Philosophy of Software, International status of WUFI-ORNL, Structure of Software Collaboration (ORNL-IBP), DOE Future Directive in Moisture Control Research

9:15 - 10:00 **Presentation 2: Hygrothermal Phenomena in Building Practice** –

1. Moisture Effects
2. Examples Cases, Efflorescence, Algae, Mold
3. Assessment Methods

10:00 – 10:10 COFFEE BREAK

10:10 - 12:00 Run WUFI Pro 4.1 – Instructor demonstrates how to run while students follow along on own computers. Set up project, case studies, and parameters. Demonstrate databases of materials and properties, assigning layers of materials in a wall, re-ordering and changing thicknesses of layers, set temperature and RH monitoring positions. Set orientation, inclination, building height/driving rain coefficients or values per ASHRAE 160P. F1 Help menu is input-specific and gives explanations of how derived. Set interior and exterior climates – heat and vapor resistance, wind dependency. Select coatings, vapor permeance, liquid uptakes. Short Wave Radiation Absorptivity, Long-Wave Radiation Emissivity, Rain Water Absorption Factor, Interior Surface Heat Resistance, Permeance. Set Initial conditions for moisture content, RH. Set simulation time controls. Input interior and exterior climate. View graph outputs for temperature and humidity. Climate analysis. Simulation Outputs.

12:00 – 1:00 LUNCH

1:00 - 2:00 Continue on simulation outputs and analysis. View and modify graph outputs for output results. Open saved project, "Quick graph". Review outputs by layers. Look at mold growth predictions by layers. Export file. Create Movie files. Compare two cases using the movie viewer.

2:00 - 3:00 **Presentation 3: Fundamentals and Prerequisites –**

1. Models
    a. Glaser / Dew Point Method – out of date, limitations.
    b. Real (Transient) Conditions – transport mechanisms
    c. Storage capacities, wetting & drying capabilities, drainage, air convection, evaporation.
    d. History of models
    e. Inputs, Outputs
2. Heat Storage and Transport
    a. Heat capacity of the dry material

b. Heat capacity of water
c. Energy balance
d. Moisture retention, sorption and suction isotherms
e. Vapor transport mechanisms
f. Liquid transport mechanisms
g. Moisture transport – diffusion, capillary flow, water absorption, redistribution
h. Coupling of heat and moisture transfer

3. Calculation of the coupled Transport:
   a. Discretisation, programming
   b. Interpretation of results
   c. Models being developed to optimize building products.
   d. Validation of models through experiments, measured field data

3:00-3:15 BREAK

3:15 – 5:00 Class exercise, class forms teams of 4 – 5 persons to solve a real hygrothermal project and make a presentation next day on solutions and conclusions.

DAY 2

8:00 - 8:45 Class presentations (Each group presents their solution). Q & A by other teams and instructors.

8:45 - 9:30 **Presentation 4: Hygrothermal Material Properties**

1. What Data are Necessary for WUFI?
2. Basic Properties – Macro- and Micro-structure, density, porosity, vapor diffusion resistance, liquid transport coefficient
3. Optional Parameters

9:30 - 10:45 Instructor-led WUFI project with class following on own computers – Advanced WUFI features – graphs, new charts and curves in reports, default graphics pages, add graph pages, delete and insert curves on graphs, change parameters of curves. Animation 1D – export film in separate file, launch Explorer to bring up film, show two films at same time, options to average the curves shown, select time frame, adjust properties of visual (animation), save as ASCII file and open, save AVI film. Import file into PowerPoint and create batch file to launch the .fid animation file.

10:45 – 11:00 BREAK

11:00 – 12:30 Instructor-led new exercise, students following on own laptops - Example of how to enter a new material in WUFI Pro. Example: Analyze a coating that penetrates through brick. Demonstrate how to create a new construction (system) / catalog and save. Copy data into own database and change it there. Create 2 .fid film files, export films, save, open WUFI 1D animations, run side-by-side simulations. Q & A 5 minutes. Info on source and sinks in F1 or Help. Real constructions – cracks, leaky, wind-driven rain goes through mortar and cracks in brick is absorbed on the back side. "Sources and sinks" gives ability to inject water into any layer. Can add realistic loads. Handout, demo of web sites where WUFI users can register and post questions and answers (www.WUFI-Forum.com).

12:30 – 1:30 Lunch

1:30 - 2:00 **Presentation 5**: **ASHRAE Standard 160P (Provisional) Design Criteria for Moisture Control in Buildings** –Purpose is to create a performance-based Design Criteria to calculate whether a component would be susceptible to moisture damage. Provides a link between the design of the envelope and the expected environmental conditions in the building. Provides transparency by requiring reporting of assumptions and input data (is reproducible).

2:00 – 2:30 WUFI 4.1-ORNL: Sinks and Sources Option - Hands-on exercise including source and sink button or grid. Heat, moisture, and air change rates input. Heat source options include "Transient Heat Source from File" or "Fraction of Incident Solar Radiation"; can specify a transparent layer. Moisture sources are "Transient Moisture Source from File" or "Fraction of Driving Rain" – this is to create a leak – can use ASHRAE 160 for values. Air change input file created.

2:30 – 3:30 Weather File Analyzer and creating a weather file. Instructor-led hands-on running cases. Additional Tools: Energy, Determine U-value, effect of moisture on heat flows.

3:30 – 3:45 BREAK

3:45 – 4:30 **Presentation 6: Limitations** – What Can WUFI Do? What Can WUFI *Not* Do? WUFI 5 will have durability included (UV, freeze-thaw exposure, temperature).

4:30 – 5:00 Q & A, certificates of completion.