Appendix A: Detailed Content Outline

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Building Energy Modeling Professional *Certification Examination Content Outline 2017* Course Title	*Complexity Level and Number of Items*			
	Recall	*Application*	*Analysis*	*TOTALS*
I. ESTABLISHING THE MODELING SCOPE	***3***	***7***	***7***	***17***
A. Modeling Objectives	***0***	***1***	***2***	***3***
1. Define the purpose of the modeling study.				
2. Interpret the design intent of the building project.				
3. Evaluate the suitability of available design and operational information.				
4. Link required project deliverables to goals of the modeling study.				
B. Analysis Methodologies	***2***	***3***	***3***	***8***
1. Differentiate among calculation methods within available software and tools (e.g.):				
a. time-neutral (e.g.): ▪ bin method. ▪ degree day.				
b. time-sequencing (e.g.): ▪ heat balance. ▪ weighting factor. ▪ thermal network. ▪ parametric.				
2. Evaluate mathematical modeling methods for building components (e.g.): ▪ empirical. ▪ first-principle.				
3. Translate a building project into an energy model:				
a. simplify building physics to a mathematical model.				
b. anticipate the impact of simplification and model deficiencies.				
c. translate BIM data into an energy model				
C. Software and Tool Selection	***1***	***2***	***1***	***4***
1. Evaluate the appropriateness of the methodology by characteristics of the project (e.g.): ▪ project phase. ▪ building type. ▪ climate				
2. Select the optimal software and tools to meet output data needs of the project (e.g.): ▪ life-cycle cost analysis. ▪ energy use and demand. individual component performance.				
D. Project Scheduling and Budget Considerations	***0***	***1***	***1***	***2***
1. Tailor the modeling strategy to the design phase (e.g.): ▪ conceptual. ▪ mid-design. ▪ design benchmarking.				

2. Recognize budget implications of and on modeling methodology.				
3. Make approximations targeted toward specific model limitations.				
II. COMPONENTS OF BUILDING AND ENERGY SYSTEMS	***11***	***14***	***13***	***38***
A. Location and Climate Definition	***1***	***1***	***1***	***3***
1. Use commonly available data about the local climate (e.g.): ▪ temperature. ▪ solar. ▪ humidity. ▪ elevation. ▪ precipitation. ▪ wind.				
2. Choose the best source of weather data for a project (e.g.): ▪ long-term representative. ▪ geographically equivalent. ▪ constructed. ▪ historical for a time period.				
3. Identify site characteristics (e.g.): ▪ microclimates. ▪ adjacent buildings. ▪ orientation. ▪ shading. IN our exceed course we teach how to use 90.1 appendix G to model a baseline building and compare it to a proposed building that exceeds the 90.1 requirements.				
B. Building Envelope and Partitions	***1***	***2***	***2***	***5***
1. Model exterior and interior opaque surface performance (e.g.): ▪ geometry. thermal transmission and ▪ boundary conditions. capacitance. We teach the 90.1 envelope tables and how to use the information.				
2. Model ground-coupled surface performance				
3. Model fenestrations (e.g.): ▪ solar heat gain. ▪ glazing. ▪ shading. ▪ framing. ▪ reflectance. ▪ spectral. We teach the 90.1 envelope tables and how to use the information.				
4. Model building airflow (e.g.): ▪ psychrometrics. ▪ driving forces of infiltration. ▪ air-tightness. We teach the 90.1 air barrier				
C. Building HVAC Systems	***3***	***3***	***2***	***8***
1. Model terminal equipment in each zone (e.g.): ▪ perimeter heating. ▪ heated / chilled radiant slabs. ▪ fan coil units. ▪ VAV / CAV boxes. We teach zoning, perimeter and core zones, requirements for boxes.				
2. Model secondary distribution systems (e.g.): ▪ air. ▪ refrigerant. ▪ water. We teach the efficiency tables and requirements for use of the HVAC equipment				
3. Model primary energy systems (e.g.): ▪ chillers. ▪ thermal storage. ▪ boilers. ▪ combined heat and power. ▪ heat rejection.				
4. Model packaged systems (e.g.): ▪ split. ▪ packaged terminal air- ▪ roof-top. conditioner.				
5. Model ventilation (e.g.): ▪ mechanical ▪ natural We teach the 90.1 requirements for ventilation and how they work with 62.1				
D. Lighting Systems	***1***	***1***	***1***	***3***
1. Model artificial lighting power. We teach the 90.1 power density and controls				
2. Model daylighting (e.g.): ▪ glare ▪ illuminance				
3. Distribute lighting heat gain among room, return, and plenum.				

E. Other Internal and Process Loads	***2***	***1***	***2***	***5***
1. Differentiate between space loads and building loads.				
2. Model loads as sensible, latent, or radiant fractions and thermal distribution (e.g.): ▪ occupants. ▪ water heating. ▪ plug loads. ▪ appliances. ▪ vertical transportation. ▪ commercial refrigeration. ▪ external lighting. ▪ special processes.				
F. District Energy Systems	***0***	***1***	***1***	***2***
1. Model purchased energy.				
2. Model shared energy systems.				
G. Renewable Energy Systems	***1***	***1***	***1***	***3***
1. Model solar thermal systems.				
2. Model onsite power generation (e.g.): • photovoltaic. • wind.				
3. Evaluate financing options for renewable energy (e.g., power purchase agreements, solar leases).				
H. Controls	***2***	***4***	***3***	***9***
1. Model HVAC controls:				
a. temperature.				
b. humidification and de-humidification.				
c. supply air variation e.g., ▪ supply pressure variation. ▪ supply temperature variation. ▪ supply pressure and temperature coordination.				
d. outside air ventilation e.g., ▪ quantity. ▪ quality. ▪ humidity. ▪ temperature. ▪ demand-control.				
e. supply and return flow (e.g.): ▪ economizers. ▪ exhaust. ▪ maximum and minimum. ▪ capacity control.				
2. Model lighting controls (e.g.): ▪ illuminance. ▪ occupancy. ▪ time-based. ▪ glare considerations. ▪ dimming.				
3. Model controls for miscellaneous equipment (e.g.): ▪ service hot water. ▪ process equipment. ▪ vertical transportation.				
4. Describe basic control sequences (e.g.): ▪ 2-position. ▪ scheduled. ▪ proportional integral derivative.				
5. Sequence equipment to manage loads (e.g.): ▪ pumps. ▪ fans. ▪ large plant equipment.				

We teach the 90.1 limits on water heating and external lighting and require commercial refrigeration to be energy star. We have some requirements on vertical transportation

Appendix has some of these requirements only taught in the exceeds course.

We have limits on both

We have fan power limits and require fan tracking for pressurization

We teach demand control

We teach economizers

We teach 90.1 lighting controls

III. APPLICATIONS OF ENERGY MODELS FOR BUILDINGS	**6**	**10**	**6**	**22**
A. Simulation Comparisons	*2*	*3*	*2*	*7*
1. Compare alternative simulation results (e.g.): ▪ code compliance ▪ parametric studies ▪ performance relative to standards ▪ equipment and component selection	Only in exceeds not in comply			
2. Compare a simulation to measured data.				
a. statistical models.				
b. calibrated building-specific data (e.g.): ▪ forensics ▪ measurement and verification ▪ utility bills				
B. Modeling Energy Performance	*3*	*5*	*2*	*10*
1. Choose whole-building metrics (e.g.): ▪ cost ▪ source energy consumption ▪ emissions ▪ site energy consumption ▪ demand ▪ PCI, EUI				
2. Choose component metrics (e.g.): ▪ equipment usage ▪ component performance ▪ equipment sizes				
3. Choose metrics for indoor environmental performance (e.g.): ▪ temperature ▪ ventilation rate ▪ humidity ▪ daylighting				
C. Evolution of Simulation Techniques to Meet Project Methods and Objectives	*0*	*1*	*1*	*2*
1. Adapt simulations to the project phase.				
2. Customize simulations for changes in building use.				
D. Baseline Building Models	*1*	*1*	*1*	*3*
1. Distinguish between regulated and non-regulated energy use.				
2. Define model inputs that are the same for both the baseline and proposed design models (neutral independent and neutral dependent) and those that can be different.				
IV. INTERPRETATIONS OF ENERGY MODEL RESULTS	**5**	**10**	**8**	**23**
A. Verification and Troubleshooting of Simulation Results	*1*	*3*	*3*	*7*
1. Perform reality check (e.g.): ▪ hand calculations ▪ conformance with expected ▪ mass and energy balance values				
2. Perform software check (e.g.): ▪ metering ▪ hourly reports ▪ input files				
3. Perform parametric bracketing to verify model sensitivity.				
4. Review data for anomalies.				
5. Reconcile anomalies using single time-step reports.				
6. Resolve loads not met and hours outside of control range.				

B. Analyzing and Comparing Modeling Results	***2***	***4***	***2***	***8***
1. Analyze simulation outputs (e.g.): ▪ component metrics ▪ energy use intensity ▪ whole building metric				
2. Compare outputs to targets (e.g.): ▪ rating programs ▪ codes ▪ building labelling programs				
C. Economic Analyses	***1***	***1***	***1***	***3***
1. Determine effects of utility rate structures and regulations on costs.				
2. Calculate financial metrics (e.g.): ▪ life-cycle costing ▪ effects of incentives ▪ investment performance				
D. Sensitivity Analyses	***0***	***1***	***1***	***2***
1. Perform a sensitivity analysis on modeling assumptions.				
2. Identify critical synergistic interactions of building components.				
E. Project Deliverable	***1***	***1***	***1***	***3***
1. Communicate results.				
2. Communicate methodology and assumptions on which results are based.				
3. Submit documentation that affirms the accuracy and completeness of results.				
4. Recommend actions.				
TOTALS	***25***	***41***	***34***	***100***

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Appendix B

Acceptable Professional Development Activities and PDHs Earned

Activity	PDHs
Completion of short courses, workshops and seminars in a related field	1 PDH for each hour of documented attendance
Attendance at meetings and conferences (e.g. National, Annual, Regional) or special conferences in a related field	1 PDH for each hour of documented attendance
Successful completion of a course in a related field from an accredited institution of higher learning **Note:** *To qualify for this credit, a course must be offered regularly and must conclude with a test that sets a passing grade.*	15 PDHs per credit hour (semester system) OR 10 PDHs (quarter system)
Patent in a related field **Note:** *PDHs can be claimed after a patent is issued and the inventor submits details to the board. The invention must be related to engineering.*	10 PDHs per patent
Publication of article/paper/book in a recognized, peer reviewed journal in a related field (max. 3 per year). **Note:** *A "news" article in a technical or professional bulletin is not considered a published paper.*	10 PDHs per published item
Active participation in a professional or technical society in a related field **Note:** *The certificant must serve as an officer and/or must actively participate in a committee of the organization. PDHs are earned at the end of each year of service.*	2 PDHs per year per organization
Write ASHRAE certification exam items in a related field	5 PDHs per 10 acceptable exam questions, annually
Pass ASHRAE certification exam (E.g. BEMP should pass BEMP exam)	45 PDHs
Accreditation Visit Evaluator	3 PDHs, annually
Professional awards	2 PDHs per award
Teach courses and workshops in a related field. Faculty performing regular duties may earn PDHs.	2 PDHs per hour taught for the first presentation, then 1 per hour for subsequent equivalent presentations.

Certificants are not required to submit a report of Professional Development activities as part of the recertification application; however, a percentage of Certificants are randomly chosen for audit each year. If audited, a report of continuing professional development with documentation must be submitted to the Certification Coordinator for review.

For questions about any of the information about ASHRAE certification renewal requirements, including clarification of acceptable and reportable qualifying activities, please contact ASHRAE at certification@ASHRAE.org.