2012 IECC Commercial Proposal
Technical Support Document:
Energy Simulation Methodology

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The New Buildings Institute Advanced Codes Team has developed a proposal to the ICC for modifications to the 2012 International Energy Conservation Code for Commercial Buildings. These modifications are based on NBI’s Core Performance Program, a voluntary prescriptive program intended to provide predictable energy savings for new commercial buildings in the range of 10,000 to 70,000 square feet\(^1\). In an effort to quantify the energy savings associated with these code additions, Madison Engineering PS, working with NBI, has performed a large set of energy simulations on a series of three prototypical building models. Simulations were performed for selected locations representing all 16 US ASHRAE climate zones for each of four building code versions: ASHRAE 90.1 2004, 2009 IECC, NBI’s IECC Proposal, and NBI’s Advanced Proposal. Results of these simulations will be transferred to NBI for weighting and analysis. The building prototypes and the energy simulation methodology are described in this document.

**Building Prototypes:**

The configurations of the prototypical building models are the cumulative result of a joint effort between Madison Engineering and NBI throughout the development of NBI’s Advanced Buildings Program. The models include a small two story office, a small “box type” retail establishment, and a small school. Detailed descriptions of the building prototypes follow.

**OFFICE:**

- 2 Story
- 21600 ft\(^2\)
- 30% Window/Wall Ratio
- Metal Frame Construction
- Brick Exterior Finish
- Built-Up Flat Roof, absorbtivity: 0.70
- Floor to Floor Height: 12 ft
- 3 foot dropped ceiling w/ ducted returns
- Package Single Zone HVAC with Furnace Heat and DX cooling

**RETAIL:**

- 1 Story
- 10000 ft\(^2\)
- Storefront Window/Wall ratio: 60%
- Skylight/Roof Ratio 2%
- Metal Frame Construction
- Stucco/Gunite Exterior Finish
- Built-Up Flat Roof, absorbtivity: 0.60
- Floor to Floor Height: 15 ft
- 4 foot dropped ceiling w/ ducted returns
- Package Single Zone HVAC with Furnace Heat and DX cooling

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\(^1\) New Buildings Institute, *Core Performance Guide*, (Washington: NBI, 2007), 11
SCHOOL:

1 Story
49996 ft²
3 distinct building area types: Office, Gymnasium/Multipurpose, Classroom Wings
CMU Wall Construction
Built-Up Flat Roof, absorbtivity: 0.60

Office/Classroom Area:
30% WWR
Floor to Roof Height 15 ft
3 foot dropped ceiling w/ ducted returns
Package VAV HVAC with Hot Water Reheat and DX Cooling

Multipurpose Area:
5 foot full length windows at top of wall
2% Skylight/Roof Ratio
Floor to Roof Height 20ft
Exposed rafters
Package Single Zone HVAC with Furnace Heat and DX Cooling
Simulation Software:

The energy simulations were performed in eQUEST version 3.63. The functionality of the eQUEST Wizard coupled with a batch style pre-processor was used to automate the simulation process, modifying model parameters and initiating the simulation, as well as writing the simulation output parameters. Though documentation is sparse, this capability is freely available with the eQUEST software package.

Specific Code Measures:

The modifications in NBI’s proposal can be distilled down to a set of discrete energy efficiency measures for which the required component performance meets or exceeds that of current relevant building codes. The savings associated with this package of measures is determined by comparing the simulated performance of a building prototype conforming to the proposal to that of a building conforming to the baseline code. In this case there are two baselines codes: 90.1-2004 and IECC 2009. A complete list of prescriptive values simulated for each measure for each code package can be obtained from NBI. The following is a list of the energy efficiency measures that were simulated:

- Roof Insulation
- Wall Insulation
- Slab Perimeter Insulation
- Infiltration Rate (Perim/Core)
- Shell Glazing Properties (Ufactor, SHGC)
- Lighting Power Density by Activity Area
- Misc Equip Power Density by Activity Area
- Static Fan Pressure
- Cooling Efficiency
- Heating Efficiency
- Boiler Efficiency (HW systems only)
- Economizer Control
- Primary and Secondary Loop Pump Controls
- Supply Air Temperature Reset (VAV systems only)
- VAV Fan Control (VAV systems only)
- Demand Controlled Ventilation
- Daylighting Controls
- Occupancy Sensors
- DHW System Efficiency

Each of the above measures is simulated via modification of one or more eQUEST Wizard Properties. For instance – the Roof Insulation measure is associated with modifications to the property ShellWiz:RoofOverallRVal. The Vertical Glazing Properties measure, on the other hand, is associated with modifications to the following properties: ShellWiz:GTCCategory, ShellWiz:GP_Ufactor, and ShellWiz:GP_SHGC. Though an exhaustive list of properties associated with each measure is outside the scope of this document, an archive of simulation files is available from NBI.

Simulation Assumptions:

Where prescriptive code measures are unavailable, unclear, incomplete, or not representative of the current building population, assumptions must be made regarding the input to and intent of the simulations. Guidance in this area was provided by NBI. Two aspects of the simulation set in particular stand out as worthy of discussion:
Economizer Simulation: 90.1 2004 and IECC require OA Economizers under certain equipment size and climate conditions. However NBI’s research shows that, due to the lack of required functional performance testing and lack of maintenance these economizers often operate in a less than optimal mode. Thus, in the 90.1 and IECC baseline simulations the economizer is set up to operate with a fixed dry bulb high limit of 55 degrees and the compressor locked out during economizer operation – even though this does not meet code requirements for 90.1 2004. Since the 2012 Proposal includes language requiring functional performance testing of economizer performance, simulations representing the proposed code include economizers operating as the code dictates.

DCV Simulation: Demand Controlled Ventilation has the potential to engender large savings in spaces with significant variability in occupancy. The simulated savings associated with DCV, however, are largely dependent on assumptions made about minimum OA requirements, fan schedules and occupancy schedules. The minimum OA requirements simulated for this project are based on ASHRAE 62.1 2004 requirements for the selected occupancy types. The fan and occupancy schedules are eQUEST defaults, which are widely accepted and used in the building simulation industry. Though the inputs are based on widely accepted industry assumptions, the large savings associated with DCV may warrant further investigation.

Summary:

This document describes the methodology and assumptions behind the simulations for the 2012 IECC Commercial Proposal. It contains links to the full set of simulated values for each measure and code version as well as an archive of the actual simulation models. The actual code proposal language, as well as full results of the simulations, are available from NBI.