ASHRAE Standard 209P
“Energy Simulation-Aided Design for Buildings”

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IBPSA-USA SUMMER MEETING ST LOUIS

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• Marcus Sheffer, Energy Opportunities
• Aaron Smith, M&R Engineering
• First public review
  – March 25 to May 9, 2016
  – 84 Comments received from 14 commenters
Purpose and Scope

• Purpose:
  – Define minimum requirements for providing energy design assistance using building energy simulation and analysis.

• Scope:
  – This standard applies to new buildings or major renovations of, or additions to, existing buildings utilizing energy simulation during the design process. This standard does not apply to single-family houses, multi-family structures of three stories or fewer above grade, manufactured houses (mobile homes) and modular homes.
Who Complies

• *NOT* required for all buildings
• “utilizing energy simulation during the design process”
• Would be adopted by:
  – Organizations that certify high performance buildings
  – Utilities and agencies that provide incentives for low energy buildings
  – Building owners and architects seeking a uniform way to specify a scope of work for building energy modeling.
Brief History

- Spring 2011 - discussion on the BLDG-SIM list
- Community drafted the title, purpose and scope
- June 2011 endorsed by ASHRAE committees
  - TC 4.7 Energy Calculations
  - TC 2.8 Building Environmental Impacts and Sustainability
  - TC 7.6 Building Energy Performance
- October 2011 Approved soon after by ASHRAE Standards Committee
- First meeting in June 2012
- 26 voting members
- Full roster of 51 people
Why do we need this standard?

- Appendix G helped to spur building energy simulation modeling industry of today
- Often simulation applied only at the end of the design process to determine savings
- Simulation not used often enough in the process of making design decisions
When is energy modeling typically used?

- Typical energy modeling timeframe
- High level of effort / performance
- Low level of effort / performance

- Performance Impact
- Level of Effort

Time

Project Start

Project Finish
By end of SDs, use “simple box” energy model to explore how to reduce energy loads, analyzing the following:

- Site conditions
- Massing and Orientation
- Building envelope
- Lighting Levels
- Thermal Comfort ranges
- Plug and process loads
- Operational parameters
• Establish Source EUI energy target
• Analyze efficiency measures, focusing on load reduction and HVAC-related strategies
• Project potential energy savings and total project cost implications
• Account for results in decision making
ASHRAE Standard 209 Structure

1. Purpose
2. Scope
3. Definitions
4. Utilization
5. General Requirements
6. Design Modeling Cycles
7. Construction and Operations Modeling
8. Post-Occupancy Energy Performance Comparison

General Requirements
- Software Requirements
- Modeler Credentials
- Climate and Site Analysis
- Benchmarking
- Energy Charrette
- Establish Energy Performance Goals
- General Modeling Cycle Requirements

Design Modeling Cycles
1. Simple Box Model
2. Conceptual Design
3. Load Reduction
4. HVAC System Selection
5. Design Refinement
6. Design Integration & Optimization
7. Energy Simulation-Aided Value Engineering

Construction/Operations Modeling Cycles
8. As-Designed Performance
9. Change Orders
10. As-Built Performance
   - Comparison of Design to Actual
Compliance

Required: all of these activities

- 5.3 Climate and Site Analysis
- 5.4 Benchmarking
- 5.5 Energy Charrette
- 5.6 Energy Performance Goals in OPR
- 5.7 General Modeling Cycle Requirements

+ 6.3 Modeling Cycle #3
  Load Reduction Modeling
**Compliance**

Required: **one of the following**

<table>
<thead>
<tr>
<th>5.7 +</th>
<th>6.1 Modeling Cycle #1 – Simple Box Modeling</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.7 +</td>
<td>6.2 Modeling Cycle #2 – Conceptual Design Modeling</td>
</tr>
<tr>
<td>5.7 +</td>
<td>6.4 Modeling Cycle #4 – HVAC System Selection Modeling</td>
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<tr>
<td>5.7 +</td>
<td>6.5 Modeling Cycle #5 – Design Refinement</td>
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<tr>
<td>5.7 +</td>
<td>6.6 Modeling Cycle #6 – Design Integration and Optimization</td>
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<tr>
<td>5.7 +</td>
<td>6.7 Modeling Cycle #7 – Energy Simulation Aided Value Engineering</td>
</tr>
</tbody>
</table>
Compliance

Optional (if required by adopting authority)

- 5.7 + 7.1 Modeling Cycle #8 – As-Design Energy Performance
- 5.7 + 7.2 Modeling Cycle #9 – Contemplated Change Orders
- 5.7 + 7.3 Modeling Cycle #10 – As-Built Energy Performance
- 5.7 + 8. Post-Occupancy Energy Performance Comparison
5.3 Climate and Site Analysis

- Review local climate data
- Assess site characteristics
- Create list of climate- and site-specific design strategies
5.4 – 5.6 Benchmarking, Charrette, Performance Goals

Benchmarking / Overall Goals
- CBECs database
- Energy Star Target Finder
- AIA 2030 Challenge
- DOE Building Performance Database

Charrette Topics
- Purpose of energy modeling in project
- Project performance metrics and goals
- Results of any previous modeling
- Financial criteria for decision making
- Project schedule and follow-up items

The 2030 Challenge
Source: ©2015 2030, Inc. / Architecture 2030 All Rights Reserved.
*Using no fossil fuel GHG-emitting energy to operate.
5.6 Energy Performance Goals in OPR

- **Overall Building Energy Goals**
- **Discipline- or System-specific energy goals**
  - Envelope
  - Lighting/Daylighting
  - Plugs/Process Loads
  - Service Water Heating
  - HVAC

<table>
<thead>
<tr>
<th>Item</th>
<th>Component</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Form/space planning</strong></td>
<td>Proper zoning</td>
<td>Group similar space types within the building footprint.</td>
</tr>
<tr>
<td><strong>Roofs</strong></td>
<td>Insulation thickness</td>
<td>R-38.9 c.f.i.</td>
</tr>
<tr>
<td></td>
<td>Solar reflectance index (SR)</td>
<td>0.75-1.1%</td>
</tr>
<tr>
<td><strong>Walls</strong></td>
<td>Value (10% - 75% of wall)</td>
<td>R-13.3 c.f.i.</td>
</tr>
<tr>
<td></td>
<td>Stacked framed wall</td>
<td>R-13.0 - R-7.5 c.f.i.</td>
</tr>
<tr>
<td><strong>Floors</strong></td>
<td>Value</td>
<td>R-14.6 c.f.i.</td>
</tr>
<tr>
<td></td>
<td>Stacked framed</td>
<td>R-8.0</td>
</tr>
<tr>
<td><strong>Slabs</strong></td>
<td>Unheated</td>
<td>Comply with Standard 90.1%</td>
</tr>
<tr>
<td></td>
<td>Heated</td>
<td>R-20 for 24 in.</td>
</tr>
<tr>
<td><strong>Doors</strong></td>
<td>Swinging</td>
<td>U-0.50</td>
</tr>
<tr>
<td></td>
<td>Nonswinging</td>
<td>U-0.50</td>
</tr>
<tr>
<td><strong>Wet areas</strong></td>
<td>As primary visitor building entrance</td>
<td>Comply with Standard 90.1%</td>
</tr>
<tr>
<td><strong>Continuous air barriers</strong></td>
<td>Continuous air barriers</td>
<td>Entire building envelope</td>
</tr>
<tr>
<td><strong>Vertical concentration</strong></td>
<td>Window-to-wall ratio</td>
<td>40% of net wall (floor-ceiling)</td>
</tr>
<tr>
<td><strong>(full assembly-NFRC rating)</strong></td>
<td>Thermal transmittance</td>
<td>Nonmetal framing windows = 0.66</td>
</tr>
<tr>
<td></td>
<td>Solar heat gain coefficient (SHGC)</td>
<td>Nonmetal framing windows = 0.62</td>
</tr>
<tr>
<td></td>
<td>Light-to-squat ratio (LSR)</td>
<td>All orientations ≥ 1.5</td>
</tr>
<tr>
<td><strong>Form-driven daylighting option</strong></td>
<td>South orientation only</td>
<td>Only PF = 0.5</td>
</tr>
<tr>
<td><strong>Diagnostic and treatment block</strong></td>
<td>Comply with LEED for healthcare credits</td>
<td>EQ 6.1 (daylighting) and EQ 6.2 (view)</td>
</tr>
<tr>
<td><strong>Inpatient units</strong></td>
<td>Shape the building footprint and form such that the area within 15 ft of the perimeter exceeds 40% of the floorplate.</td>
<td></td>
</tr>
<tr>
<td><strong>Staff areas (exam rooms, nurse stations, offices, corridors): public spaces (waiting, reception); and other regularly occupied spaces as applicable</strong></td>
<td>Ensure that 75% of the occupied space not including patient rooms lies within 20 ft of the perimeter.</td>
<td></td>
</tr>
<tr>
<td><strong>Nonterminally driven daylighting option</strong></td>
<td>Design the building form to maximize access to natural light, through side lighting and top lighting.</td>
<td></td>
</tr>
<tr>
<td><strong>Interior finishes</strong></td>
<td>Room interior surface reflectance</td>
<td>Ceiling ≥ 60%</td>
</tr>
<tr>
<td></td>
<td>Walls ≥ 70%</td>
<td></td>
</tr>
<tr>
<td><strong>Lighting power density (LPD)</strong></td>
<td>Whole building = 0.9 W/ft²</td>
<td>Space-by-space per Table 5.4</td>
</tr>
<tr>
<td><strong>Light source efficacy (lumen per watt)</strong></td>
<td>T6 &amp; T6 ≥ 2.8 l/ft²</td>
<td>All other ≥ 50</td>
</tr>
<tr>
<td><strong>Ballasts—T8 Lamps</strong></td>
<td>Non-dimming = NEMA Premium Dimming</td>
<td>NEMA Premium Program Start</td>
</tr>
<tr>
<td><strong>Ballasts—Fluorescent and HID</strong></td>
<td>Electronic</td>
<td></td>
</tr>
<tr>
<td><strong>Dimming controls daylight harvesting</strong></td>
<td>Dim all fixtures in daylighted zones.</td>
<td></td>
</tr>
<tr>
<td><strong>Lighting controls—General</strong></td>
<td>Manual ON, auto-off in all areas as possible.</td>
<td></td>
</tr>
<tr>
<td><strong>Surgery task lights</strong></td>
<td>Use LED lights exclusively.</td>
<td></td>
</tr>
<tr>
<td><strong>Exit signage</strong></td>
<td>0.1-0.2 W Light Emitting Capacitor (LEC)</td>
<td>Exit signs exclusively.</td>
</tr>
</tbody>
</table>
Typical Energy Modeling “Cycle”

1. Update Baselines and Goals
2. Gather Input Data
3. QA Input Data
4. Conduct Analysis
5. Report Results
6. QA Output Data

- Reflect latest design
- Refine OPR goals

- Narrative
- Inputs
- Outputs relative to goals

- Refer to specific Modeling Cycle for purpose, applicability, and analysis

- Project-specific data
- Incremental costs
Design-Phase Modeling Cycles

- **Conceptual Design**
  - #1 Simple Box Modeling
  - #2 Conceptual Design Modeling

- **Schematic Design**
  - #3 Load Reduction Modeling
  - #4 HVAC System Selection

- **Design Development**
  - #5 Design Refinement
  - #6 Integration & Optimization

- **Construction Documents**
  - #7 Energy-Simulation-Aided Value Engineering
Modeling Cycle #3: Load Reduction Modeling

- Determine which design strategies have biggest impact on HVAC system sizing and energy consumption.
- Prior to the end of schematic design.
- Develop a list of load reduction strategies and use energy model to evaluate their effect on performance.
Construction/Operations Phase Modeling Cycles

Construction

#8 As-Designed Performance
#9 Contemplated Change Orders

Operations

#10 As-Built Performance
• Compare Design and Actual Performance