

# Defining the Standard of Care for Energy Modelers: An Overview of ASHRAE Standard 209

Building Energy Simulation Forum

4/12/2017

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360 Analytics

## Introduction

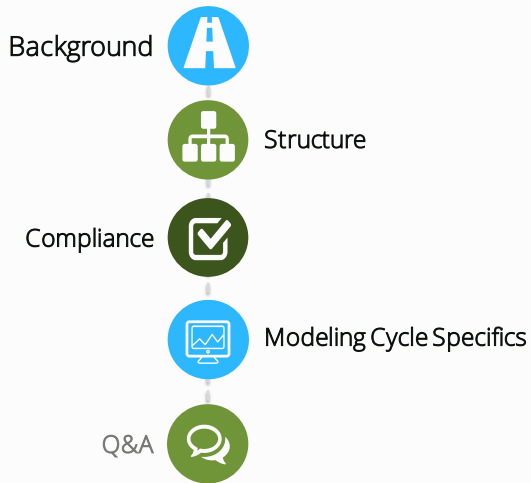


### David Reddy, PE

- Principal, 360 Analytics, Seattle, WA
- Spc209 Construction/Operations Sub-committee Chair
- Consultant and contributor to CBECC, and open-source energy code compliance software
- **Acknowledgements**
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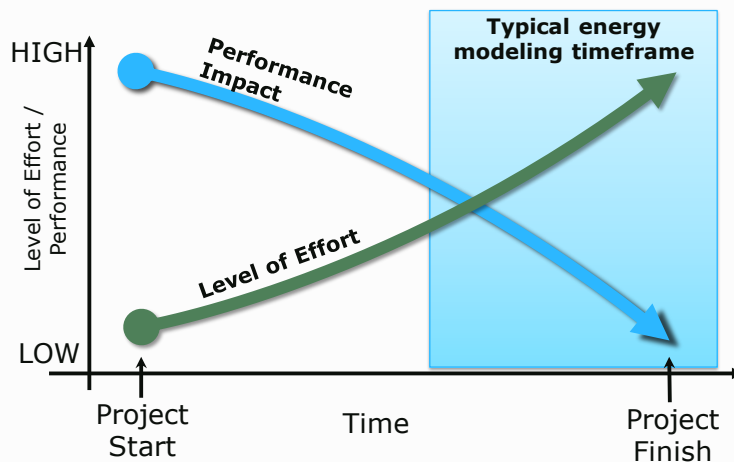


# Our Agenda for Today



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## When Do We Use Energy Modeling?



## Why Do We Need This Standard?



- Appendix G/LEED spurred the modeling industry of today
- ~~Modeling at end of design for compliance~~
- Modeling during design to optimize
- Anticipated use cases:
  - 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

Getting Started...



- 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 by ASHRAE Standards Committee
- June 2012: First full-committee meeting!
  - 26 voting members, full roster of 51 people

## Title, Purpose, Scope



**Title:** Energy Simulation Aided Design for Buildings Except Low-Rise Residential Buildings

**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.

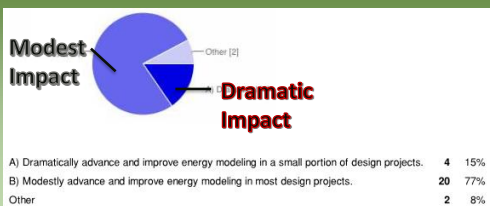


## Brief History

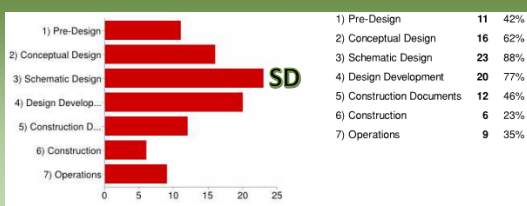
Back to the Drawing Board...

- June 2014: 'Modeling Cycle' concept proposed
- November 2014: Survey of members on key questions

What goal should Standard 209 strive for in it's first years of use?



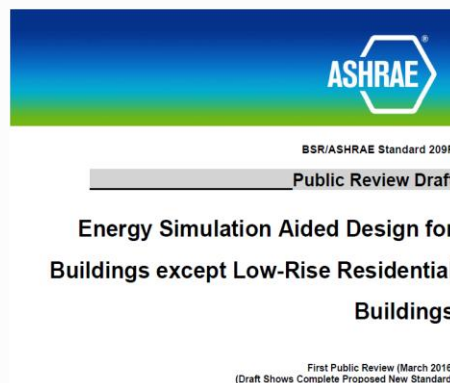
Which of these modeling phases would you like to see as mandatory in the Standard?



## Most Recently...



- First public review
  - March 25 to May 9, 2016
  - 84 Comments received from 14 commenters
- Second public review
  - Last letter ballot approved on March 18, 2017
  - 2<sup>nd</sup> draft and 45 day public review period to be announced soon...

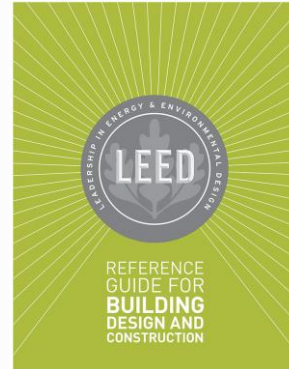


First Public Review (March 2016)  
(Draft Shows Complete Proposed New Standard)

## LEED v4 'Integrative Process' Credit



- By end of SD, 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
  - Program and operational parameters



# Structure



## Sections

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

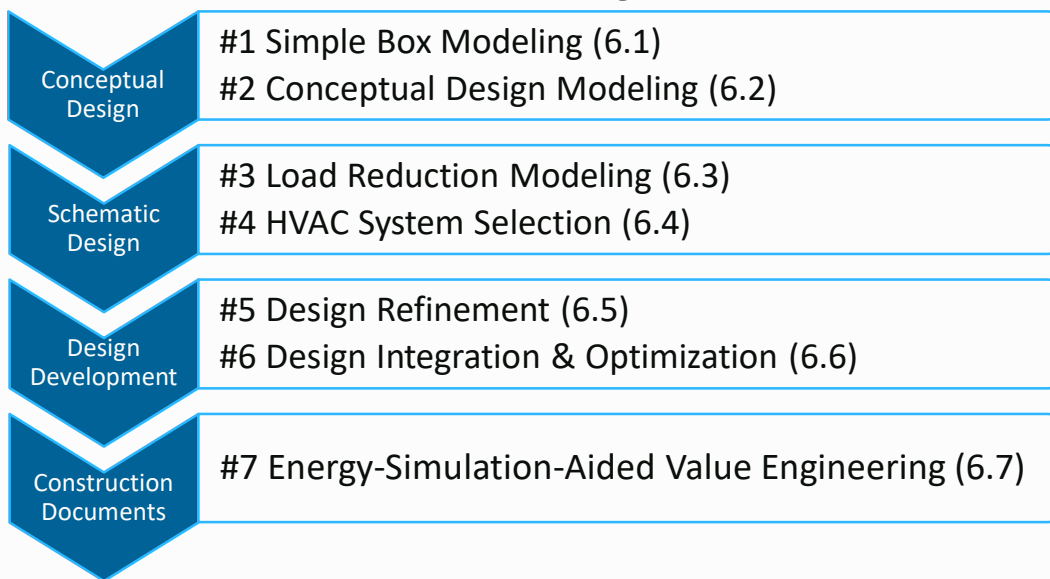
### General Requirements:

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



## Modeling Cycles

Section 6) Design



## Modeling Cycles

Section 7) Construction & Section 8) Operations



Construction

#8 As-Designed Performance (7.1)  
#9 Change Orders (7.2)  
#10 As-Built Energy Performance (7.3)

Operations

#11 Post-Occupancy Energy Performance Comparison  
(8.1)

## General Modeling Cycle Requirements

Section 5.7



- Consolidate steps common to all cycles in one section
  - Energy Baselines and Goals
  - Input Data
  - Reporting
  - Quality Assurance Review
  - Modeler Quality Control





# Compliance

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## What Do I Need to Do To Comply?



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



# Utilization

## 4.2.1 Minimum Requirements

### Required: General Activities + Modeling Cycle #3

5.1 Simulation Software Requirements

5.2 Modeler Credentials

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

Mandatory  
Modeling Cycle



+ 6.3 Modeling Cycle #3  
Load Reduction Modeling



# Utilization

## 4.2.1 Minimum Requirements

### Required: One Additional Modeling Cycle From Ch. 6

5.7 + 6.1 Modeling Cycle #1 – Simple Box Modeling

5.7 + 6.2 Modeling Cycle #2 – Conceptual Design Modeling

MANDATORY 6.3 Modeling Cycle #3 – Load Reduction Modeling

5.7 + 6.4 Modeling Cycle #4 – HVAC System Selection Modeling

5.7 + 6.5 Modeling Cycle #5 – Design Refinement

5.7 + 6.6 Modeling Cycle #6 – Design Integration and Optimization

5.7 + 6.7 Modeling Cycle #7 – Energy Simulation Aided Value Engineering

## Utilization

### 4.2.2 Optional Compliance Levels



#### Optional: If Required by Adopting Authority

As-Designed = 4.2.1 + 7.1 Modeling Cycle #8 – As-Design Energy Performance

As-Built = 4.2.1 + 7.3 Modeling Cycle #10 – As-Built Energy Performance

As-Operated = 4.2.1 + 8.1 Modeling Cycle #11 - Post-Occupancy Energy Performance Comparison

## General Requirements

### 5.2 Modeler Credentials



*The energy modeler or the individual supervising the work of the energy modeler, shall be either*

- (1) a certified Building Energy Modeling Professional (BEMP), or*
- (2) a certified Building Energy Simulation Analyst (BESA) who also fulfills the BEMP eligibility requirements, or*
- (3) an equivalent individual meeting qualifications established by the authority having jurisdiction.*

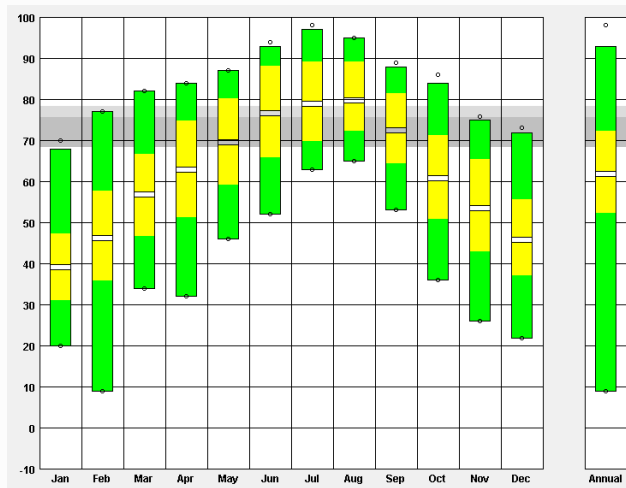
*Informative Note: ASHRAE and AEE are two organizations that can certify a modeler for BEMP or BESA, respectively.*

# General Requirements



## 5.3 Climate and Site Analysis

- Review local climate data
- Assess site characteristics
- Create list of climate- and site-specific design strategies



# General Requirements



## 5.4 Benchmarking and 5.5 Energy Charrette

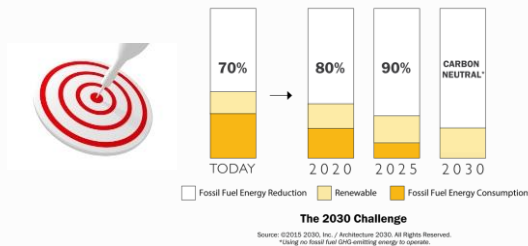
### Benchmarking:

- CBECs database
- Energy Star Target Finder
- DOE Building Performance Database
- Seattle and other cities



### Energy Charrette:

- 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





# General Requirements

## 5.6 Energy Performance Goals in OPR

- High-level energy goals
- Discipline or system-specific energy goals
  - Envelope
  - Lighting/Daylighting
  - Plugs/Process Loads
  - Service Water Heating
  - HVAC
- Informative Appendix D

	Item	Component	Recommendation
	Form/space planning	Proper zoning	Group similar space types within the building footprint.
Roofs		Insulation entirely above deck	R-30.0 c.i.
		Solar reflectance index (SRI)	Comply with Standard 90.1*
Walls		Mass (HC > 7 Btu/ft <sup>2</sup> )	R-13.3 c.i.
		Steel framed	R-13.0 + R-7.5 c.i.
Floors		Below-grade walls	R-7.5 c.i.
		Mass	R-14.6 c.i.
Stabs		Steel framed	R-38.0
		Unheated	Comply with Standard 90.1*
Doors		Heated	R-20 for 24 in.
		Swinging	U-0.50
Vestibules		Nonswinging	U-0.50
		At primary visitor building entrance	Comply with Standard 90.1*
Continuous air barriers		Continuous air barriers	Entire building envelope
		Window-to-wall ratio	40% of net wall (floor-ceiling)
Vertical fenestration (full assembly—NFRC rating)		Thermal transmittance	Nonmetal framing windows = 0.38 Metal framing windows = 0.44
		Solar heat gain coefficient (SHGC)	Nonmetal framing windows = 0.26 Metal framing windows = 0.38
		Light-to-solar gain ratio (LSG)	All orientations ≥ 1.5
		Exterior sun control	South orientation only – PF = 0.5
		All spaces	Comply with LEED for healthcare credits IEQ 8.1 (daylighting) and IEQ 8.2 (views)
		Diagnostic and treatment block	Shape the building footprint and form such that the area within 15 ft of the perimeter exceeds 50% of the footprint.

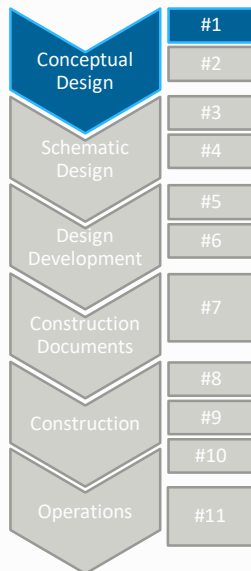


# Modeling Cycle Specifics



## Simple Box Modeling

Modeling Cycle #1 (Section 6.1)

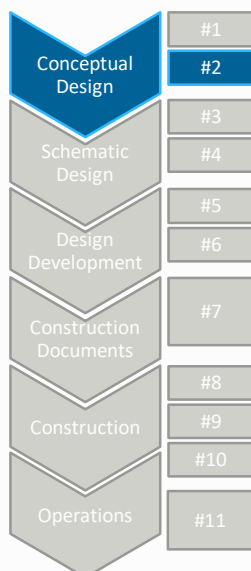


- Establish estimate of annual energy and peak heat/cool (HVAC unchanged)
  - Building geometry
  - Window-to-wall ratio and shading
  - Thermal performance of the envelope
- Completed before geometry and orientation finalized
- Completed before or during the charrette (5.5)
- Informative Appendix C Simple Box Modeling



## Conceptual Design Modeling

Modeling Cycle #2 (Section 6.2)

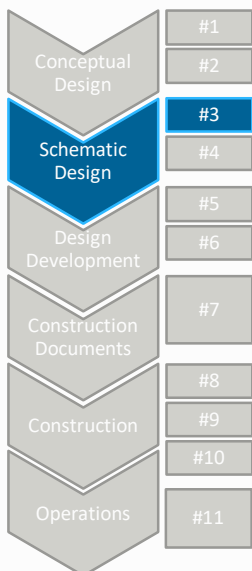


- Complete when form and architecture still flexible, before schematic design begins
- Does not apply if internal equipment/process loads are  $\geq 75\%$  of overall energy use (i.e. data centers)



## Load Reduction Modeling

Modeling Cycle #3 (Section 6.3)

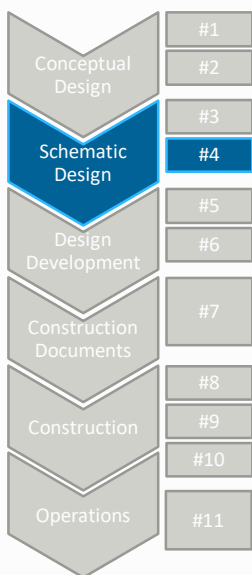


- Required for all projects
  - Complete prior to final selection of HVAC system and before end of schematic design
  - Model at least three (3) strategies from:
    - Building envelope
    - Lighting and daylighting
    - Internal equipment loads\*
    - Outdoor air/energy recovery
    - Passive conditioning and natural ventilation
- \* 2 of 3 strategies must be from this category if internal equipment energy accounts for >60% of total expected energy use



## HVAC System Selection Modeling

Modeling Cycle #4 (Section 6.4)



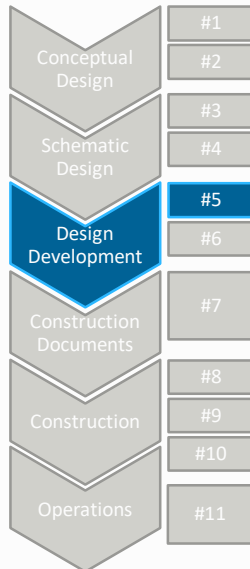
- If used for compliance, must be started after Modeling Cycle #3 is complete.

HVAC System	EUI*	Annual Energy \$ / ft <sup>2</sup>	MEP First Cost	Cumulative 7 Year Evaluation Timeline			Total 7 Year Investment
				Energy	O&M	Total	
GSHP	158.3	\$3.59	\$ 27,206,429	\$ 5,059,705	\$ 4,532,776	\$ 9,592,481	\$ 36,798,909
WSHP	173.9	\$4.09	\$ 26,805,383	\$ 5,757,045	\$ 4,688,433	\$ 10,445,478	\$ 37,250,861
VRF	169.6	\$3.88	\$ 28,272,794	\$ 5,467,189	\$ 4,571,920	\$ 10,039,109	\$ 38,311,903
Chiller - VAV	182.7	\$4.09	\$ 28,387,134	\$ 5,764,808	\$ 5,017,941	\$ 10,782,749	\$ 39,169,883
Chilled Beam	176.2	\$3.98	\$ 28,023,893	\$ 5,606,685	\$ 4,781,578	\$ 10,388,263	\$ 38,412,156



## Design Refinement

Modeling Cycle #5 (Section 6.5)

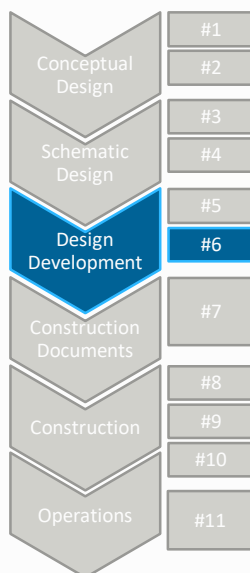


- If used for compliance, must be started after Modeling Cycle #3 is complete and before end of construction document phase.



## Design Integration and Optimization

Modeling Cycle #6 (Section 6.6)



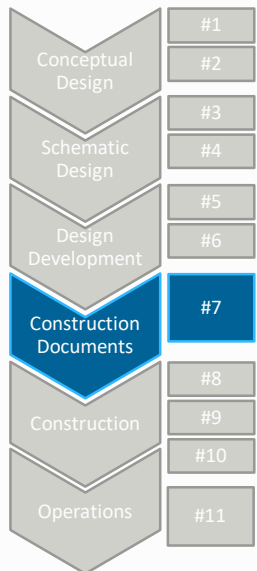
- If used for compliance, must be completed before end of construction document phase.
- Identify at least two (2) design variables and objective
- Identify test range and constraints





# Energy Modeling-Aided VE

Modeling Cycle #7 (Section 6.7)

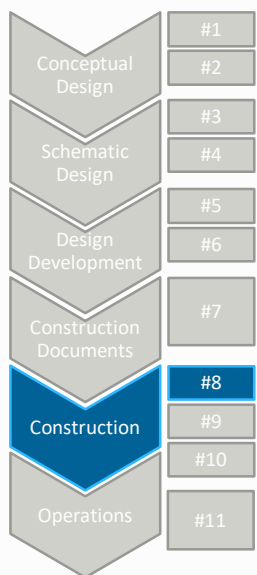


- Must evaluate at least one VE proposal
- First costs must be available
- If used for compliance, VE alternate must negatively impact performance goal(s)



# As-Designed Energy Performance

Modeling Cycle #8 (Section 7.1)

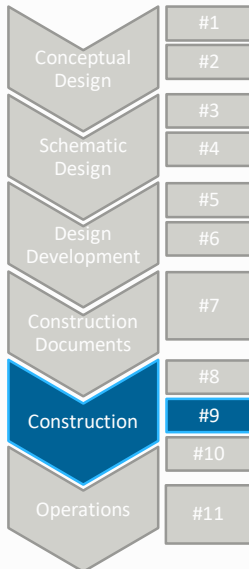


- Optional level of compliance
- LEED EAp2/c1 model



## Change Orders

Modeling Cycle #9 (Section 7.2)

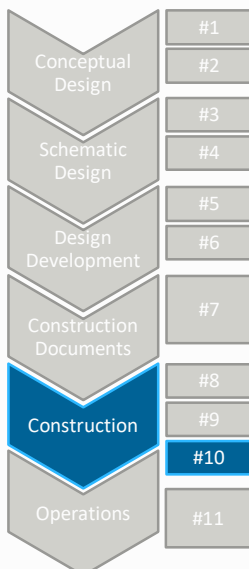


- Define change order process (for modeler)
- Qualitative vs quantitative (model update)
- Must include at least one model update



## As-Built Energy Performance

Modeling Cycle #10 (Section 7.3)

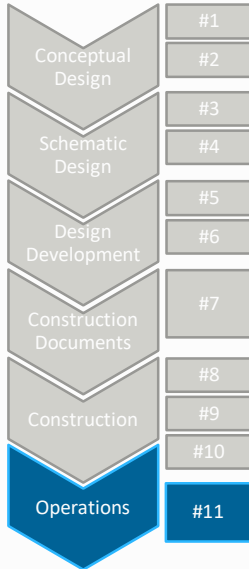


- Optional level of compliance
- LEED EAp2/c1 model update??

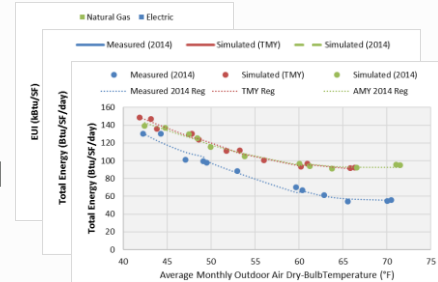


# Post-Occupancy Comparison

Modeling Cycle #11 (Section 8.1)



- Optional, unless adopted by rating authority
- Comparison, not calibration
- 12 month comparison period
- Basic analysis of weather + re-simulate model with AMY\*
- Additional reporting requirements



\* Exceptions:

- 1) AMY file is not publicly or commercially available
- 2) Input file or simulation software is not available when completing this cycle



Thank You For Your Time!

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