



## Evaluating Commercial Buildings for Energy Code Compliance

September 2010

# Thank you!

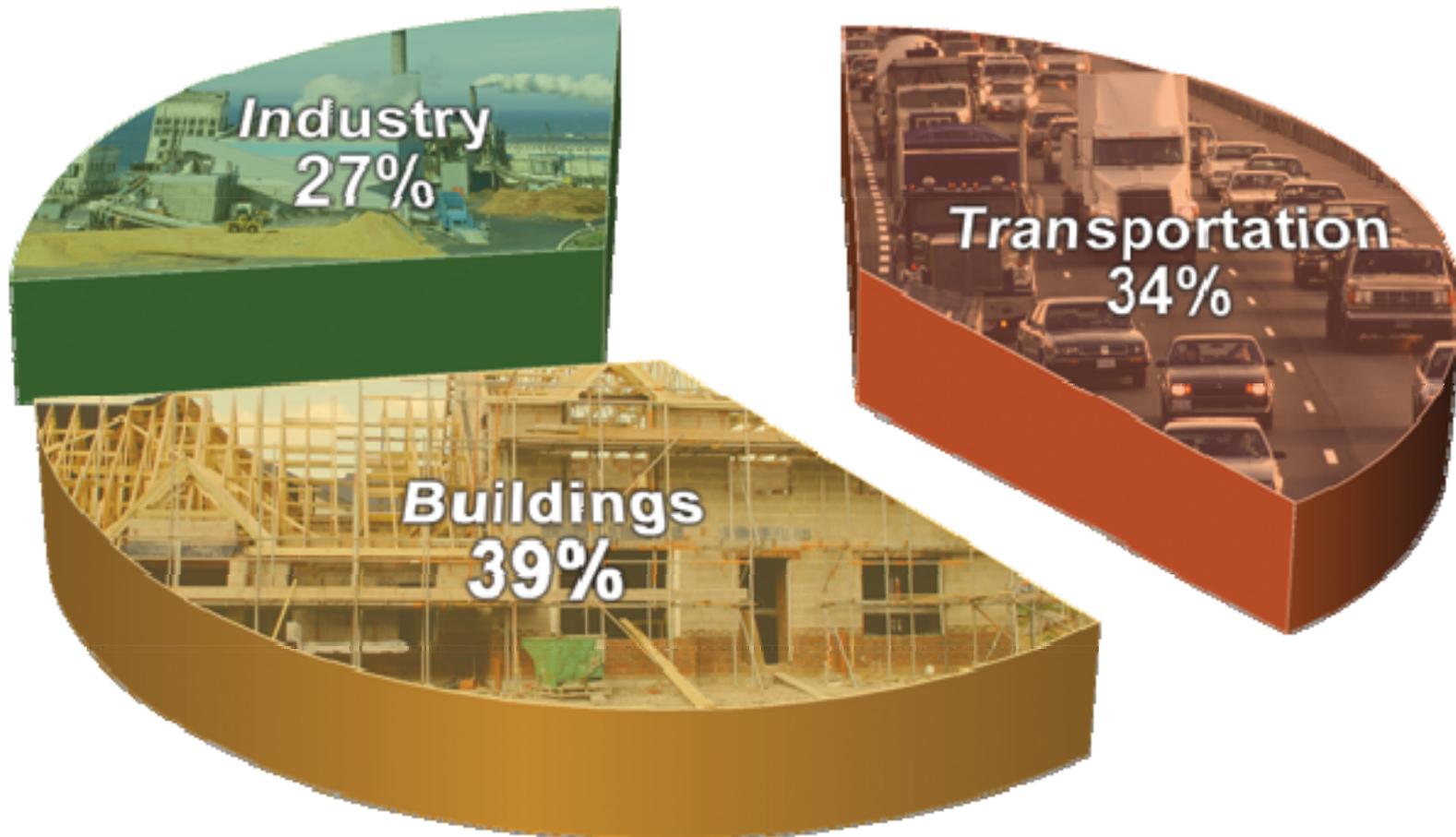
This presentation includes video clips filmed on site at building construction projects. We would like to extend our thanks to the Ben Franklin Transit District of Richland, WA and the Columbia Basin College of Pasco, WA for their generous time and flexibility in allowing us to film onsite.



- **The purpose of this training** is to provide the tools needed and specific training to evaluate compliance with ASHRAE 90.1-07 for commercial buildings. It will also provide useful training for the commercial provisions of the 2009 IECC and general commercial field inspection for energy code compliance of commercial buildings. **The recommended background** for taking this class is significant experience with plan review and /or inspection of commercial buildings.
- With the goal of providing complete and engaging materials, this presentation includes essential videos on plan review.
  - The presentation is not complete without the video clips, hyperlinks are included on the appropriate slides. They can be viewed if you have windows media player, or comparable software.
  - If you are downloading the materials to your computer, the presentation and clips must be kept in the same folder.
- Feedback on these materials is welcome, and should be directed to [techsupport@becp.pnl.gov](mailto:techsupport@becp.pnl.gov). Please note the title of the training materials in the subject line.

- Objectives and Benefits of Adopting Building Energy Codes and Ensuring Compliance
- Compliance Evaluation Procedures
  - Sample Populations
  - Sample Size
  - Sample Distribution
  - Sample Makeup
  - Assigning Compliance Rates
    - Individual Building Metrics
    - State Compliance Rates
- Using the Evaluation Checklists

## *U.S. Energy Use*



**Reduced energy consumption**  
by approximately 0.5-quadrillion  
Btu per year by 2015,  
and 3.5-quadrillion  
Btu per year  
by 2030.

**Reduced CO<sub>2</sub> emissions**  
by roughly 3 percent in terms of  
the projected national CO<sub>2</sub>  
emissions in 2030.

**Savings**

**Consumption**

**Emissions**

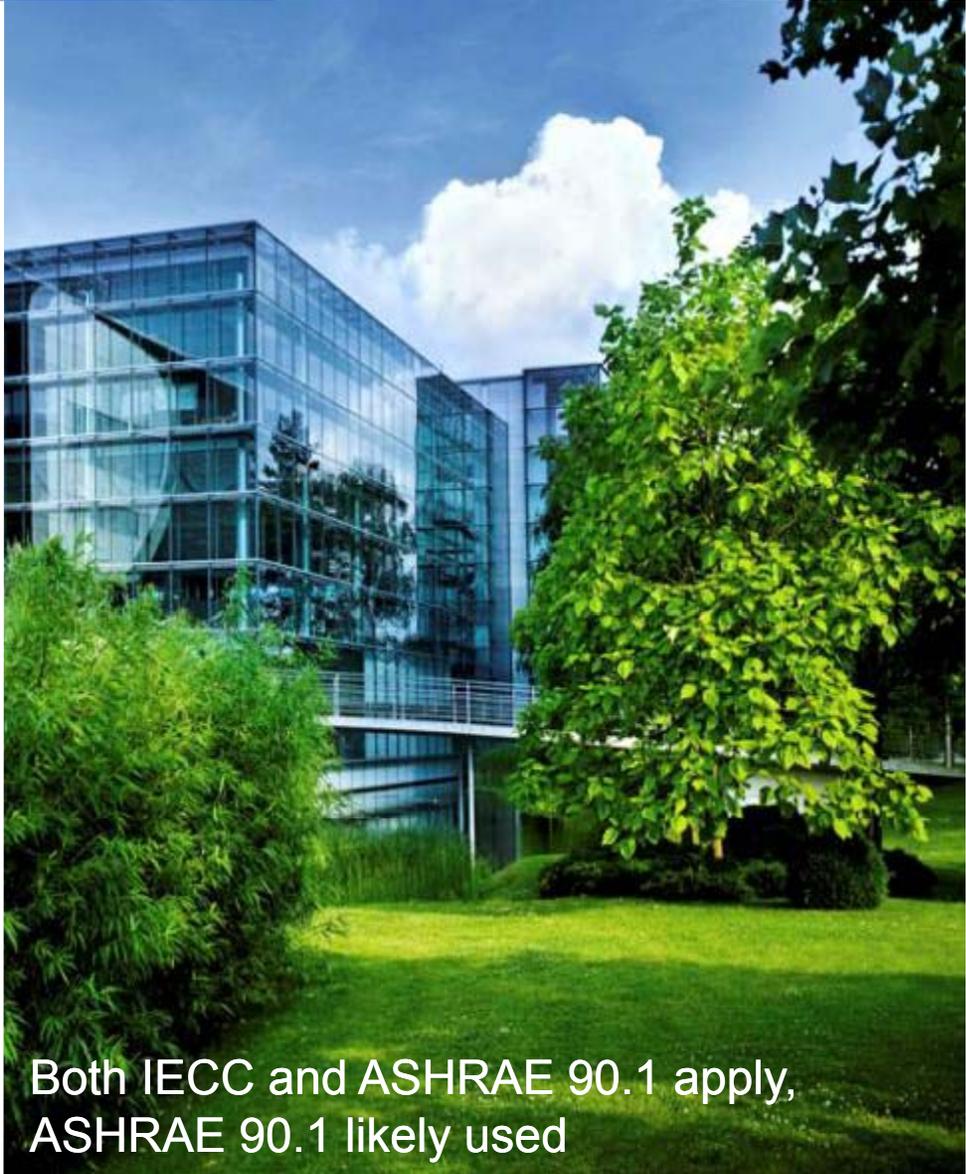
**Rising cost savings**  
more than \$4 billion  
per year back in  
homeowners' pockets by 2015,  
a figure that could rise to over  
\$30 billion per year by 2030

\$1 spent in compliance and enforcement work saves \$6 over life of a building<sup>a</sup>

# Baseline: IECC and ASHRAE 90.1



IECC applies



Both IECC and ASHRAE 90.1 apply,  
ASHRAE 90.1 likely used



Both IECC and ASHRAE 90.1 apply,  
either used to comply

- 44 new residential, 44 ± commercial, and 44 each of renovations to existing residential and commercial
- Distributed throughout state based on climate zone and population
- Distributed over a representative sample of different building sizes and uses

- Evaluating compliance of four distinct building populations:
  - Residential new construction
  - **Commercial new construction**
  - Residential renovations
  - **Commercial renovations**

**Commercial Renovations:** Any work on or in existing commercial buildings where all or part of the work being performed is required to meet code and for which a permit was issued, including additions, alterations, and repairs

# Compliance Evaluation Procedures

## Sample Size

44

plus/minus for sample

- Small: 1-2 stories, single zone, up to 25,000 ft<sup>2a</sup>
- Medium: Larger than 25,000 ft<sup>2</sup> but smaller than 60,000 ft<sup>2</sup>
- Large: Larger than 60,000 ft<sup>2</sup> but smaller than 250,000 ft<sup>2</sup>
- X-Large: Larger than 250,000 ft<sup>2</sup> but smaller than 400,000 ft<sup>2</sup>
- XX-Large: Larger than 400,000 ft<sup>2</sup>

a. Gross square footage of conditioned space



- Reasonable Cross Section of Building
  - Type – New/Renovation
  - Use – Office/Retail
  - Ownership – Tenants/Owners
  - Design/Materials

# Compliance Evaluation Procedures Generating Individual Building Metrics



**Commercial Building Data Collection Checklist**  
ANSI/ASHRAE/IESNA Standard 90.1-2007

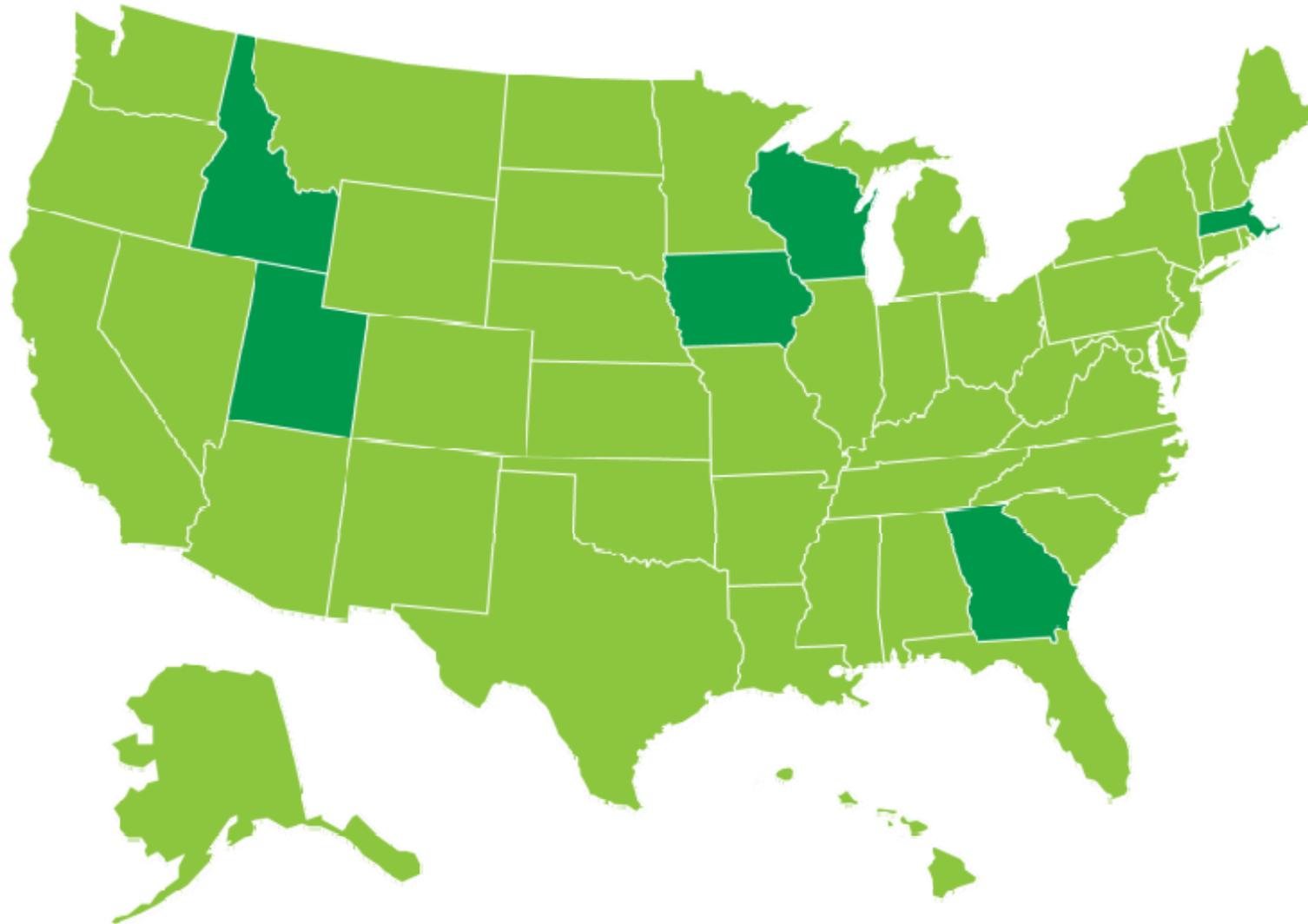
Date: \_\_\_\_\_ Name of Evaluator(s): \_\_\_\_\_ Phone: \_\_\_\_\_ Email: \_\_\_\_\_  
Building Name & Address: \_\_\_\_\_ Conditioned Floor Area: \_\_\_\_\_ ft<sup>2</sup>  
Building Contact: Name: \_\_\_\_\_  
Compliance Approach:  Prescriptive  Trade-Off (Section 5.6)  Performance (ECB Section 11)  
State: \_\_\_\_\_ Jurisdiction: \_\_\_\_\_  Public  Health  Residential  Other  
Building Use:  Office  Retail  Storage  Education  Lodging  Dining  Renovation  
Project Type:  New Construction  Addition  Valuation (if Renovation): \$ \_\_\_\_\_

Plan Review	Complies			Comments/Notes/Findings
	Y	N	N/A	
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

Plan Review: Provide all information with exceptions

Evaluated buildings are each assigned a compliance rating of 0–100% based on the proportion of code requirements that each has met, and the evaluated buildings' scores within a state are averaged to derive an overall compliance metric with an associated confidence.

# Compliance Evaluation Procedures Generating State Metrics



# Compliance Evaluation Procedures Generating Buildings/Data

## Commercial Building Data Collection Checklist ANSI/ASHRAE/IESNA Standard 90.1-2007

Building ID: \_\_\_\_\_ City/Zip: \_\_\_\_\_  
 Date: \_\_\_\_\_ Name of Evaluator(s): \_\_\_\_\_  
 Building Contact Name: \_\_\_\_\_ Phone: \_\_\_\_\_ Email: \_\_\_\_\_  
 Building Name & Address: \_\_\_\_\_ Conditioned Floor Area: \_\_\_\_\_ ft<sup>2</sup>  
 State: \_\_\_\_\_ County: \_\_\_\_\_ Jurisdiction: \_\_\_\_\_  
 Compliance Approach (check all that apply):  Prescriptive  Trade-Off  Performance  
 Compliance Software Used: \_\_\_\_\_ Green Building/Above-Code Program?  Yes  No  
 Building Use:  Office  Retail/Storefront  Warehouse/Storage  Educational/School  Lodging/Hotel/Motel  
 Restaurant/Dining/Fast Food  Public Assembly/Religious  Healthcare  High-Rise Residential  Other  
 Building Ownership:  State  Local  Federal  Other  Other (Specify) \_\_\_\_\_  
 Project Type:  New Building  Existing Building Addition  Existing Building Renovation Valuation (If Renovation): \$ \_\_\_\_\_

● Address for various compliance approaches

✓ Prescriptive

✓ Trade-Off

✓ Performance

● Divided into phase of construction

● Code requirements are divided into tiers based on energy impact

● Record values and capture comments, including generic information (building type, use, size, etc.)

90.1-2007 Section #	Plan Review	Complies			Comments/Assumptions <sup>1</sup>
		Y	N	N/A	
4.2.2 [PR1]	Plans, specifications, and/or calculations provide all information with which compliance can be determined for the <b>building envelope</b> and delineate and document where exceptions to the standard are claimed.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
4.2.2, 6.4.2 [PR2]	Plans, specifications, and/or calculations provide all information with which compliance can be determined for the <b>mechanical systems and equipment</b> and delineate and document where exceptions to the standard are claimed.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
4.2.2, 7.4.1	Plans, specifications, and/or calculations provide all	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

The checklists can be used to gather data during different stages of construction on different buildings that have the same general attributes.



## COMPLIANCE APPROACHES



**Prescriptive**

**Trade-off**

**Performance**

# Using the Evaluation Checklists

## Commercial Building Data Collection Checklist

ANSI/ASHRAE/IESNA Standard 90.1-2007

Building ID:  Climate Zone:

Date:  Name of Evaluator(s):

Building Contact: Name:  Phone:  Email:

Building Name & Address:  Conditioned Floor Area:  ft<sup>2</sup>

State:  County:  Jurisdiction:

Compliance Approach (check all that apply):  Prescriptive  Trade-Off  Performance

Compliance Software Used:  Green Building/Above-Code Program?  Yes  No

Building Use:  Office  Retail/Mercantile  Warehouse/Storage  Education/School  Lodging/Hotel/Motel  
 Restaurant/Dining/Fast Food  Public Assembly/Religious  Healthcare  High-Rise Residential  Other

Building Ownership:  State-owned  Locally-owned  National account  Speculative  Other

Project Type:  New Building  Existing Building Addition  Existing Building Renovation Valuation (If Renovation): \$

90.1-2007 Section #	Plan Review	Complies			Comments/Assumptions <sup>1</sup>
		Y	N	N/A	
4.2.2 [PR1] <sup>1</sup>	Plans and/or specifications provide all information with which compliance can be determined for the <b>building envelope</b> and delineate and document where exceptions to the standard are claimed.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="text"/>
4.2.2, 6.4.2 [PR2] <sup>1</sup>	Plans, specifications, and/or calculations provide all information with which compliance can be determined for the <b>mechanical systems and equipment</b> and delineate and document where exceptions to the standard are claimed.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="text"/>
4.2.2, 7.4.1	Plans, specifications, and/or calculations provide all	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="text"/>

# Using the Evaluation Checklists

### Commercial Building Data Collection Checklist

ANSI/ASHRAE/IESNA Standard 90.1-2007

Building ID: \_\_\_\_\_ Climate Zone: \_\_\_\_\_

Date: \_\_\_\_\_ Name of Evaluator(s): \_\_\_\_\_

Building Contact: Name: \_\_\_\_\_ Phone: \_\_\_\_\_ Email: \_\_\_\_\_

Building Name & Address: \_\_\_\_\_ Conditioned Floor Area: \_\_\_\_\_ ft<sup>2</sup>

State: \_\_\_\_\_ County: \_\_\_\_\_ Jurisdiction: \_\_\_\_\_

Compliance Approach (check all that apply):  Prescriptive  Trade-Off  Performance

Compliance Software Used: \_\_\_\_\_  Yes  No

Building Use:  Office  Retail/Mercantile  Warehouse/Storage  Education/School  Lodging/Hotel/Motel  
 Restaurant/Dining/Fast Food  Public Assembly/Religious  Healthcare  High-Rise Residential  Other

Building Ownership:  State-owned  Locally-owned  National account  Speculative  Other

Project Type:  New Building  Existing Building Addition  Existing Building Renovation Valuation (If Renovation): \$ \_\_\_\_\_

90.1-2007 Section #	Plan Review	Y	N	N/A	Comments/Assumptions <sup>1</sup>
4.2.2 [PR1]	Plans and/or specifications provide all information with which compliance can be determined for the <b>building envelope</b> and delineate and document where exceptions to the standard are claimed.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
4.2.2, 6.4.2 [PR2]	Plans, specifications, and/or calculations provide all information with which compliance can be determined for the <b>mechanical systems and equipment</b> and delineate and document where exceptions to the standard are claimed.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
4.2.2, 7.4.1	Plans, specifications, and/or calculations provide all	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

## Commercial Checklist Data Gathering Stages

- Plan Review
- Footing and Foundation
- Framing/Rough-In
- Plumbing Rough-In
- Mechanical Rough-In
- Rough-In Electrical
- Insulation
- Final

- Plans and specs document compliance for
  - Building envelope
  - Mechanical systems and equipment
  - Service water heating systems and equipment
  - Lighting and electrical systems and equipment
- Detailed instructions for HVAC systems commissioning included on the plans for specifications
- Construction documents require HVAC “as-built” drawings submitted within 90 days of system acceptance

# Using the Evaluation Checklists Plan Review – Service Water Heating



4.2.2, 7.4.1  
[PR3]<sup>1</sup>

Plans, specifications, and/or calculations provide all information with which compliance can be determined for the **service water heating systems and equipment** and delineate and document where exceptions to the standard are claimed.

- Where Do You Start?
  - Step 1 - Identify the type of system
    - Heat and cool source
    - Air distribution system
  - Step 2 – Determine the provisions that apply to that system
  - Step 3 – Review the Mechanical Plans and specifications to determine if the provisions have been addressed

# Using the Evaluation Checklist

## Plan Review - HVAC Systems

- Components that are easy to verify
  - Equipment sizes and efficiencies
  - Motor types (e.g., variable frequency drives)
  - Economizers
- Components that are difficult to verify
  - Control requirements (e.g., temperature reset for chillers and boilers)

### Energy for Lighting in Buildings

- Accounts for nearly one-third of energy use
- Contributes significantly to cooling load

4.2.2,  
8.4.1.1,  
8.4.1.2  
[PR4]<sup>1</sup>

Plans and/or specifications provide all information with which compliance can be determined for the **lighting and electrical systems and equipment** and delineate and document where exceptions to the standard are claimed. Information provided should include interior and exterior lighting power calculations, wattage of bulbs and ballasts, transformers and control devices.

### Additional Evaluation Checklist Plan Review Items

6.7.2.1 [PR5] <sup>1</sup>	Construction documents require HVAC “as-built” drawings submitted within 90 days of system acceptance.
6.7.2.4 [PR6] <sup>1</sup>	Detailed instructions for HVAC systems commissioning included on the plans or specifications for $\geq 50,000$ ft <sup>2</sup> .
8.7.1, 8.7.2 [PR7] <sup>1</sup>	Construction documents require as-built drawings for electric power systems and O&M manual for electrical power systems and equipment.

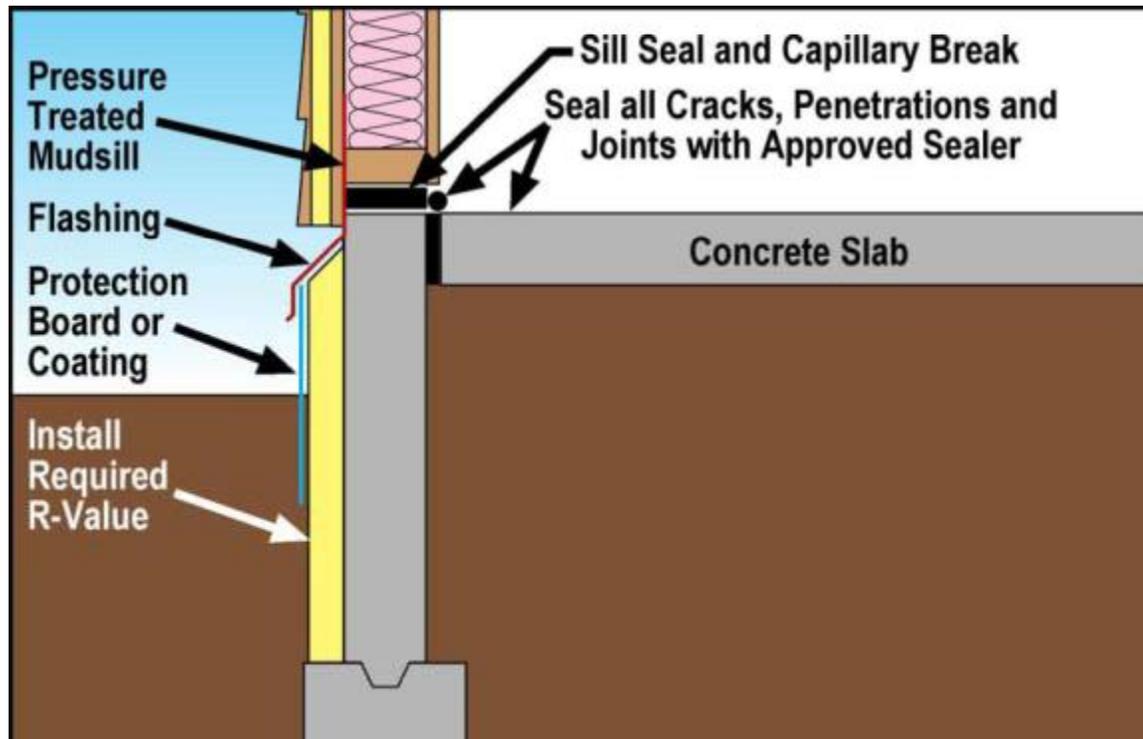
# Using the Evaluation Checklists

## Footing/Foundation Field Inspection

- Exterior insulation protected against damage, sunlight, moisture, wind, landscaping, and equipment maintenance activities
- Insulation in contact with the ground has  $\leq 0.3\%$  water absorption rate per ASTM C272
- Piping, ducts, and plenum are insulated and sealed when installed in or under a slab
- Any SWH piping in or under slab is insulated
- Below-grade wall insulation R-value. Installed per manufacturer's instructions.
- Slab edge insulation R-value, depth/length. Installed per manufacturer's instructions.
- Freeze protection and snow/ice melting system sensors for future connection to controls

2009 Section #	Footing/Foundation Inspection	Verified Value	Complies			Comments/Assumptions
			Y	N	N/A	
5.0.1.7 [FO1]	Exterior insulation protected against damage, sunlight, moisture, wind, landscaping, and equipment maintenance activities.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
5.0.1.8 [FO2]	Insulation in contact with the ground has $\leq 0.3\%$ water absorption rate per ASTM C272.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
6.3.2, 6.4.4.2 [FO3]	Piping, ducts and plenum are insulated and sealed when installed in or under a slab.	R-	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
6.3.3, 7.4.3 [FO4]	Any SWH piping in or under slab is insulated.	R-	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
5.5.1.1 [FO5]	Below-grade wall insulation installed per manufacturer's instructions.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
5.5.3.5 [FO6]	Slab edge insulation R-value, depth/length.	R-ft -	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
5.8.1.2 [FO7]	Slab edge insulation installed per manufacturer's instructions.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
5.8.1.8 [FO8]	Freeze protection and snow/ice melting system sensors for future connection to controls.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
5.8.1.9 [FO9]			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

# Using the Evaluation Checklists Exterior Insulation – Footings/Foundation



5.8.1.7  
[FO1]<sup>1</sup>

Exterior insulation protected against damage, sunlight, moisture, wind, landscaping and equipment maintenance activities.

# Using the Evaluation Checklists Exterior Insulation – Footings/ Foundation



5.8.1.7.3  
[FO2]<sup>1</sup>

Insulation in contact with the ground has  $\leq 0.3\%$  water absorption rate per ASTM C272.

# Using the Evaluation Checklists Insulation in or under Slab- Footings/Foundations



6.3.2, 6.4.4.1, 6.4.4.2 [FO3] <sup>1</sup>	Piping, ducts and plenum are insulated and sealed when installed in or under a slab.
6.5.8.2, 7.4.3 [FO4] <sup>1</sup>	Any SWH piping in or under slab is insulated.

# Using the Evaluation Checklists

## Below-Grade Insulation - Footings/Foundations



5.5.3.3 [FO5] <sup>2</sup>	Below-grade wall insulation R-value.
5.8.1.2 [FO6] <sup>2</sup>	Below-grade wall insulation installed per manufacturer's instructions.

# Using the Evaluation Checklists Below-Grade Insulation - Walls



Photo courtesy of Dow Building Solutions

5.5.3.3  
[FO5]<sup>2</sup>

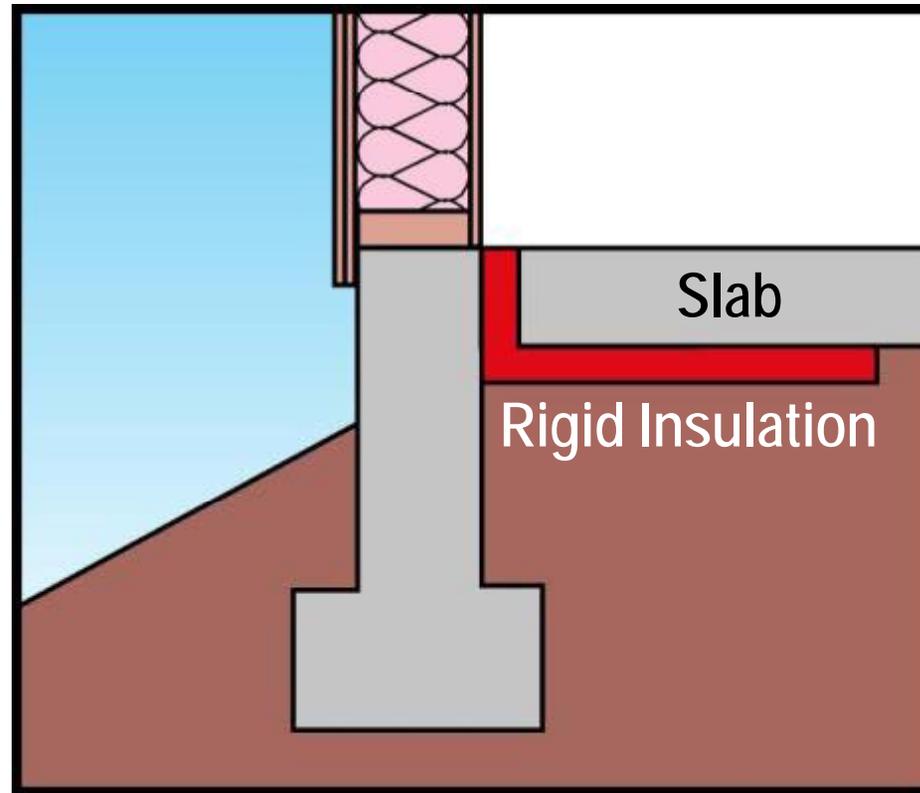
Below-grade wall insulation R-value.

5.8.1.2  
[FO6]<sup>2</sup>

Below-grade wall insulation installed per manufacturer's instructions.

# Using the Evaluation Checklists

## Slab Edge Insulation–Footings/Foundations



5.5.3.5  
[FO7]<sup>2</sup>

Slab edge insulation R-value, depth/length.

5.8.1.2  
[FO8]<sup>2</sup>

Slab edge insulation installed per manufacturer's instructions.

# Using the Evaluation Checklists

## Framing Rough-In Inspection

90.1-2007	Description	Verified	Complies			Comments/Assumptions
			Y	N	N/A	
5.5.1.1	Roof insulation R-value	R-	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
5.8	Performance compliance approach submitted for vertical fenestration area >40% or skylight area >5%		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
5.5.4.2.1	Performance compliance approach submitted for vertical fenestration area >40% or skylight area >5%		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
5.5.4.3.1	Vertical fenestration U-Factor		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
5.5.4.3.2	Skylight fenestration U-Factor		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
5.5.4.3.3	Vertical fenestration SHGC value		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
5.5.4.3.4	Skylight SHGC value		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
5.5.4.4.1	Vertical fenestration SHGC value	SHGC -	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
5.5.4.4.2	Skylight SHGC value	SHGC -	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
5.8.2.1	Fenestration products are certified as to performance labels or certificates provided		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
5.8.2.2	Fenestration products rated in accordance with NFRC performance labels or certificates provided.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
5.8.2.3	Fenestration and doors meet maximum air leakage requirements		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
5.4.3.4	Vestibules installed per approved plans.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

# Using the Evaluation Checklists

## Glazing Video



# Using the Evaluation Checklists

## Roof Insulation R-Value



5.5.3.1 [FR1] <sup>1</sup>	Roof insulation R-value.
5.8.1.2 [FR2] <sup>1</sup>	Roof insulation installed per manufacturer's instructions.

# Using the Evaluation Checklists

## Roof Insulation R-Value



Photos courtesy of MBMA

5.5.3.1 [FR1] <sup>1</sup>	Roof insulation R-value.
5.8.1.2 [FR2] <sup>1</sup>	Roof insulation installed per manufacturer's instructions.

# Using the Evaluation Checklists

## Roof Insulation R-Value



Photos courtesy of MBMA

5.5.3.1 [FR1] <sup>1</sup>	Roof insulation R-value.
5.8.1.2 [FR2] <sup>1</sup>	Roof insulation installed per manufacturer's instructions.

# Using the Evaluation Checklists Buildings with >40% Fenestration



## High Glass Buildings

- > 40% WWR

or

- > 5% SRR

If exceeds must  
document compliance via  
performance

5.5.4.2.1, 5.5.4.2.2  
[FR3]<sup>1</sup>

Performance compliance approach submitted for vertical fenestration area >40% or skylight area >5%.

# Using the Evaluation Checklists Fenestration



 National Fenestration Rating Council® <b>CERTIFIED</b>	<b>World's Best Window Co.</b>  Millennium 2000+ Vinyl-Clad Wood Frame Double Glazing • Argon Fill • Low E Product Type: <b>Vertical Slider</b>	
	<b>ENERGY PERFORMANCE RATINGS</b>	
U-Factor (U.S./I-P)	Solar Heat Gain Coefficient	
<b>0.30</b>	<b>0.30</b>	
<b>ADDITIONAL PERFORMANCE RATINGS</b>		
Visible Transmittance	Air Leakage (U.S./I-P)	
<b>0.51</b>	<b>0.2</b>	
<small>Manufacturer stipulates that these ratings conform to applicable NFRC procedures for determining whole product performance. NFRC ratings are determined for a fixed set of environmental conditions and a specific product size. NFRC does not recommend any product and does not warrant the suitability of any product for any specific use. Consult manufacturer's literature for other product performance information. www.nfrc.org</small>		

5.8.2.2 [FR8] <sup>1</sup>	Fenestration products are certified as to performance labels or certificates provided.
5.8.2.1 [FR9] <sup>2</sup>	Fenestration products rated in accordance with NFRC.

# Using the Evaluation Checklists Fenestration Air Leakage

 National Fenestration Rating Council® <b>CERTIFIED</b>		<b>World's Best          Window Co.</b> Millennium 2000+ Vinyl-Clad Wood Frame Double Glazing • Argon Fill • Low E Product Type: <b>Vertical Slider</b>	
<b>ENERGY PERFORMANCE RATINGS</b>			
U-Factor (U.S./I-P) <b>0.30</b>		Solar Heat Gain Coefficient <b>0.30</b>	
<b>ADDITIONAL PERFORMANCE RATINGS</b>			
Visible Transmittance <b>0.51</b>		Air Leakage (U.S./I-P) <b>0.2</b>	
<small>Manufacturer stipulates that these ratings conform to applicable NFRCC procedures for determining whole product performance. NFRCC ratings are determined for a fixed set of environmental conditions and a specific product size. NFRCC does not recommend any product and does not warrant the suitability of any product for any specific use. Consult manufacturer's literature for other product performance information.  <a href="http://www.nfrcc.org">www.nfrcc.org</a></small>			

## Exceptions:

- Field Fabricated
- Garage door test can be per ANSI/DASMA Standard 105

5.4.3.2  
[FR10]<sup>3</sup>

Fenestration and doors meet maximum air leakage requirements.

# Using the Evaluation Checklists

## Vestibules- Video



5.4.3.4  
[FR11]<sup>3</sup>

Vestibules installed per approved plans.

# Using the Evaluation Checklists

## Plumbing and Rough-In Inspection

- Automatic time switches installed to automatically switch off the recirculating hot-water system or heat trace
- Pump controls installed to limit operation of recirculating pumps
- Piping for recirculating and non-recirculating service hot-water systems insulated
- Heat traps installed on non-circulating storage water tanks

90.1 [2017] Section #	Plumbing Rough-In Inspection	Complies			Comments/Assumptions
		Y	N	N/A	
7.4.4.2 [PL1] <sup>1</sup>	Automatic time switches installed to automatically switch off the recirculating hot-water system or heat trace.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
7.4.4.4 [PL2] <sup>1</sup>	Pump controls installed to limit operation of recirculating pumps	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
7.4.3 [PL3] <sup>2</sup>	Piping for recirculating and non-recirculating service hot-water systems insulated.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
7.4.6 [PL4] <sup>3</sup>	Heat traps installed on non-circulating storage water tanks	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

# Using the Evaluation Checklists Recirculating Controls



7.4.4.2 [PL1] <sup>1</sup>	Automatic time switches installed to automatically switch off the recirculating hot-water system or heat trace.
7.4.4.4 [PL2] <sup>1</sup>	Pump controls installed to limit operation of recirculating pumps

# Using the Evaluation Checklists

## Mechanical Rough-In Inspection

- Demand control ventilation provided for spaces >500 ft<sup>2</sup> and >40 people/1000 ft<sup>2</sup> occupant density and served by systems with air side economizer, auto modulating outside air damper control or design airflow >3,000 cfm
- Insulation exposed to weather protected from damage. Insulation outside of the conditioned space and associated with cooling systems is vapor retardant
- Air economizers provided where required, meet the requirements for design capacity, control signal, and high-limit shut-off and integrated economizer control
- Means provided to relieve excess outside air
- Water economizers provided where required, meet the requirements for design capacity, maximum pressure drop and integrated economizer control and heating system impact

90.1-2007 Section	Mechanical Rough-In Inspection	Verified Value	Complies			Comments/Assumptions
			Y	N	N/A	
6.4.3.9 [ME1] <sup>1</sup>	Demand control ventilation provided for spaces >500 ft <sup>2</sup> and >40 people/1000 ft <sup>2</sup> occupant density and served by systems with air side economizer, auto modulating outside air damper control or design airflow >3,000 cfm.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
6.5.1.1 [ME2] <sup>1</sup>	Insulation exposed to weather protected from damage. Insulation outside of the conditioned space and associated with cooling systems is vapor retardant.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
6.5.1. 6.5.1.1.1, 6.5.1.1.2, 6.5.1.1.3, 6.5.1.3 [ME3] <sup>1</sup>	Air economizers provided where required, meet the requirements for design capacity, control signal, and high-limit shut-off and integrated economizer control.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
6.5.1.5 [ME4] <sup>1</sup>	Means provided to relieve excess outside air.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
6.5.1.2, 6.5.1.2.1, 6.5.1.2.2, 6.5.1.3 [ME5] <sup>1</sup> C	Water economizers provided where required, meet the requirements for design capacity, maximum pressure drop and integrated economizer control and heating system impact.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

# Using the Evaluation Checklists Demand Control Ventilation



Demand control ventilation correlates the volume of outside (fresh) air to the actual occupancy load of the space by monitoring carbon dioxide levels in the air. When a room is occupied for a period of time and carbon dioxide levels rise, the sensors trigger increased outdoor air into the system.

6.4.3.9  
[ME1]<sup>1</sup>

Demand control ventilation provided for spaces >500 ft<sup>2</sup> and >40 people/1000 ft<sup>2</sup> occupant density and served by systems with air side economizer, auto modulating outside air damper control or design airflow >3,000 cfm.

### HVAC System Insulation

- Insulation exposed to weather must be protected
- Insulation covering cooling systems outside the conditioned space should include vapor retardant

6.4.4.1.1  
[ME2]<sup>1</sup>

Insulation exposed to weather protected from damage. Insulation outside of the conditioned space and associated with cooling systems is vapor retardant.

# Using the Evaluation Checklists Economizers



*Courtesy: Carleton College*

6.5.1, 6.5.1.1.1, 6.5.1.1.2,  
6.5.1.1.3, 6.5.1.3  
[ME3]<sup>1</sup>

Air economizers provided where required, meet the requirements for design capacity, control signal, and high-limit shut-off and integrated economizer control.

- To prevent over pressurizing of the building, ensure systems include a means to relieve excess outdoor air during air economizer operations
- The relief air outlet should be located so that recirculation back into the building is avoided

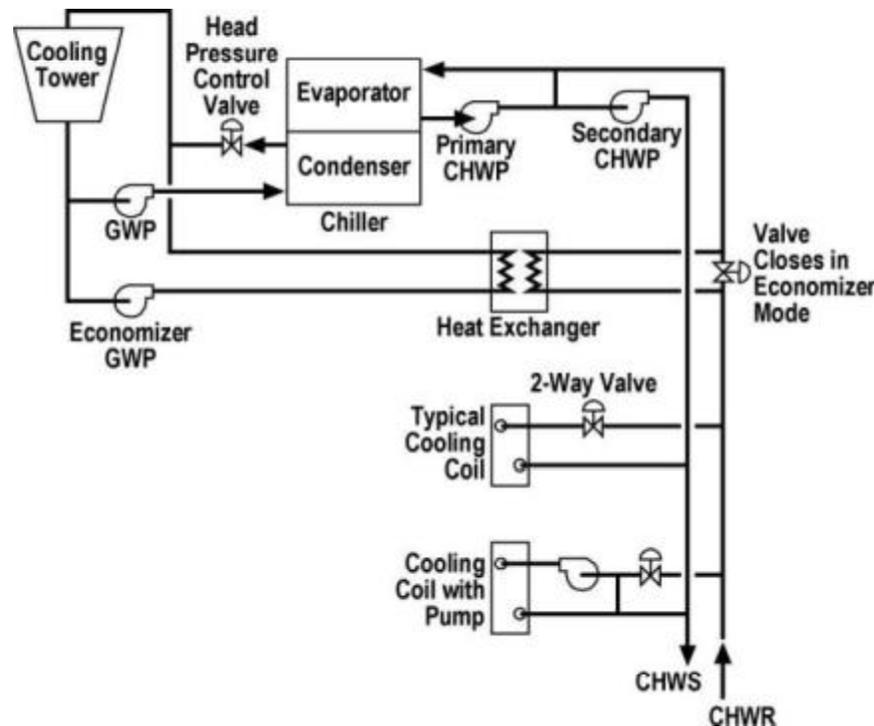
6.5.1.1.5  
[ME4]<sup>1</sup>

Means provided to relieve excess outside air.

# Using the Evaluation Checklists Economizer Requirements

## Economizer Types

Water Pre-cooling Water Economizer with Two-Way Valves



6.5.1.2, 6.5.1.2.1,  
6.5.1.2.2, 6.5.1.3  
[ME5]<sup>1</sup> C

Water economizers provided where required, meet the requirements for design capacity, maximum pressure drop and integrated economizer control and heating system impact.

6.5.1.4  
[ME6]<sup>1</sup>

Economizer operation will not increase heating energy use during normal operation.

# Using the Evaluation Checklists Exhaust Air Recovery System



6.5.6.1  
[ME7]<sup>1</sup>

Exhaust air energy recovery on systems  $\geq 5,000$  cfm and 70% of design supply outside air.

# Using the Evaluation Checklists Fume Hood Exhaust System



*Courtesy: Hamilton Labs*

- VAV hood exhaust and supply systems,
- direct make-up air or heat recovery

6.5.7.2  
[ME8]<sup>1</sup>C

Fume hoods exhaust systems  $\geq 15,000$  cfm have VAV hood exhaust and supply systems, direct make-up air or heat recovery.

# Using the Evaluation Checklists

## Hot Gas Bypass

- Ensure the capacity of the hot gas bypass is limited as indicated in Table 6.5.9
- Hot gas bypass may only be used in cooling systems designed with multiple steps of unloading or continuous capacity modulation

6.5.9  
[ME9]<sup>1</sup> C

Hot gas bypass limited to:  
≤240 kBtu/h – 50%  
>240 kBtu/h – 25%

# Using the Evaluation Checklists HVAC Equipment Efficiency



6.4.1.4  
[ME10]<sup>2</sup>

HVAC equipment efficiency verified.

# Using the Evaluation Checklists HVAC Piping Insulation

- Piping Serving as Part of Heating or Cooling System Must be Insulated in Accordance with Table 6.8.3

**TABLE 6.8.3 Minimum Pipe Insulation Thickness<sup>a</sup>**

Fluid Design Operating Temp. Range (°F)	Insulation Conductivity		Nominal Pipe or Tube Size (in.)				
	Conductivity Btu·in./(h·ft <sup>2</sup> ·°F)	Mean Rating Temp. °F	<1	1 to <1-1/2	1-1/2 to <4	4 to <8	≥8
<b>Heating Systems (Steam, Steam Condensate, and Hot Water)<sup>b,c</sup></b>							
>350	0.32 – 0.34	250	2.5	3.0	3.0	4.0	4.0
251 – 350	0.29 – 0.32	200	1.5	2.5	3.0	3.0	3.0
201 – 250	0.27 – 0.30	150	1.5	1.5	2.0	2.0	2.0
141 – 200	0.25 – 0.29	125	1.0	1.0	1.0	1.5	1.5
105 – 140	0.22 – 0.28	100	0.5	0.5	1.0	1.0	1.0
<b>Domestic and Service Hot-Water Systems</b>							
105+	0.22 – 0.28	100	0.5	0.5	1.0	1.0	1.0
<b>Cooling Systems (Chilled Water, Brine, and Refrigerant)<sup>d</sup></b>							
40 – 60	0.22 – 0.28	100	0.5	0.5	1.0	1.0	1.0
<40	0.22 – 0.28	100	0.5	1.0	1.0	1.0	1.5

<sup>a</sup> For insulation outside the stated conductivity range, the minimum thickness ( $T$ ) shall be determined as follows:

$$T = r \{ (1 + t/r)^{K/k} - 1 \}$$

where  $T$  = minimum insulation thickness (in.),  $r$  = actual outside radius of pipe (in.),  $t$  = insulation thickness listed in this table for applicable fluid temperature and pipe size,  $K$  = conductivity of alternate material at mean rating temperature indicated for the applicable fluid temperature (Btu·in./[h·ft<sup>2</sup>·°F]); and  $k$  = the upper value of the conductivity range listed in this table for the applicable fluid temperature.

<sup>b</sup> These thicknesses are based on energy *efficiency* considerations only. Additional insulation is sometimes required relative to safety issues/surface temperature.

<sup>c</sup> Piping insulation is not required between the control valve and coil on run-outs when the control valve is located within 4 ft of the coil and the pipe size is 1 in. or less.

<sup>d</sup> These thicknesses are based on energy *efficiency* considerations only. Issues such as water vapor permeability or surface condensation sometimes require vapor retarders or additional insulation.

6.4.4.1.3  
[ME13]<sup>2</sup>

HVAC piping insulated.

# Using the Evaluation Checklists

## Return Air Dampers



6.5.1.1.4  
[ME15]<sup>2</sup>

Return air and outdoor air dampers meet minimum air leakage requirements.

# Using the Evaluation Checklists

## Hydronic Heat Pumps

- Hydronic (water loop) Heat Pump Systems
  - Heat pumps connected to heat pump water loop with heat rejection and heat addition
    - Controls capable of providing 20°F dead band between initiation of heat rejection and heat addition
    - Climate zones 3-8:
      - Closed-circuit cooling tower
        - » Automatic valve to bypass all but minimal flow around tower, or
        - » Provide lower leakage positive closure dampers
      - Open-circuit cooling tower
        - » Automatic valve to bypass all heat pump water flow around the tower
      - Open-circuit used in conjunction with a separate heat exchanger
        - » Heat loss to be controlled by shutting down the circulation pump on the cooling tower loop

6.5.2.2.3  
[ME16] <sup>2</sup> C

Hydronic heat pump systems connected to a common water loop meet heat rejection and heat addition requirements.

Verify the fan motor is no larger than the first available motor size greater than the bhp, which must be shown on the design documents

6.5.3.1.2  
[ME17]<sup>2</sup>

HVAC fan motors not larger than the first available motor size greater than the bhp.

# Using the Evaluation Checklists

## VAV Fans



6.5.3.2.1  
[ME18]<sup>2</sup> C

VAV fan motors  $\geq 10$  hp to be driven by mechanical or electrical variable speed drive, or have a vane-axial fan with variable pitch blades, or have controls or devices to limit fan motor demand to  $\leq 30\%$  of design wattage at 50% design air volume at static pressure of  $1/3$  total rated static pressure of the fan.

6.5.3.2.2  
[ME19]<sup>2</sup> C

VAV fans have static pressure sensors positioned so setpoint  $\leq 1/3$  total design pressure.

# Using the Evaluation Checklists DDC Controlled VAV Boxes



6.5.3.2.3  
[ME20]<sup>2</sup> C

Reset static pressure setpoint for DDC controlled VAV boxes reporting to central controller based on the zones requiring the most pressure.

Individual kitchen exhaust hoods larger than 5000 cfm must include make-up  $\geq 50\%$  of exhaust air volume

6.5.7.1  
[ME21]<sup>2</sup>

Kitchen hoods >5K cfm have make up air  $\geq 50\%$  of exhaust air volume.

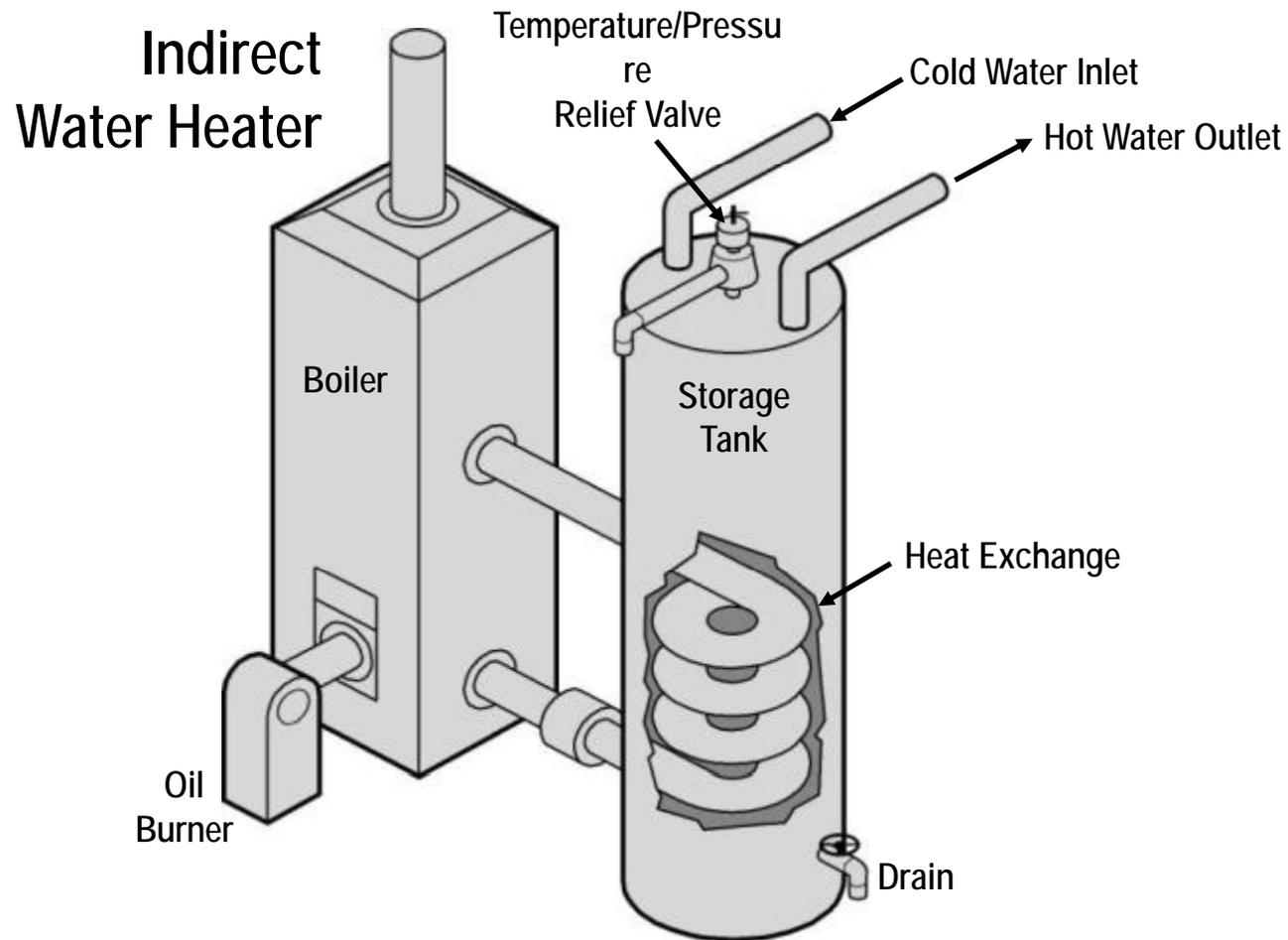
# Using the Evaluation Checklists Service Water Heating Equipment



7.4.2  
[ME22]<sup>2</sup> C

Service water heating equipment meets efficiency requirements.

# Using the Evaluation Checklists Space and Water Heating



7.5.1  
[ME23]<sup>2</sup> C

Combined space and water heating system not allowed unless standby loss less than calculated maximum. AHJ has approved or combined connected load <150 KBtu/h.

# Using the Evaluation Checklists Service Water Heating



Courtesy of Richard Ashworth and High Performance [HVAC.com](http://HVAC.com)

7.5.2  
[ME24]<sup>2</sup> C

Service water heating equipment used for space heating complies with the service water heating equipment requirements.

# Using the Evaluation Checklists

## HVAC Ducts and Plenums Video

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Renewable Energy



# Using the Evaluation Checklists

## Motorized Dampers



6.4.3.4.2, 6.4.3.4.3,  
6.4.3.4.4  
[ME27]<sup>3</sup>

Outdoor air and exhaust systems have motorized dampers that automatically shut when not in use and meet maximum leakage rates. Check gravity dampers where allowed.

# Using the Evaluation Checklists

## Rough-In Electrical Inspection

- Verify separate lighting control devices for specific uses installed per approved lighting plans
- Exit signs do not exceed 5 watts per face
- Exterior grounds lighting over 100 W provides >60 lm/W unless on motion sensor or fixture is exempt from scope of code or from external LPD
- Additional interior lighting power allowed for special functions per the approved lighting plans and is automatically controlled and separated from general lighting
- Feeder connectors sized in accordance with approved plans
- Branch circuits sized for maximum drop of 3%
- Automatic lighting control to shut off all building lighting installed in buildings >5,000 ft<sup>2</sup>
- Independent lighting control installed per approved lighting plans and all manual control readily accessible and visible to occupants
- Automatic lighting controls for exterior lighting installed
- Electric motors meet requirements where applicable
- Ballasted one and three lamp fixtures with >30 W/lamp have two lamp tandem wired ballasts when  $\geq 2$  fixtures in same space on same control

90.1-2007 Section #	Rough-In Electrical Inspection	Complies			Comments/Assumptions
		Y	N	N/A	
9.4.3 [E.2] <sup>1</sup>	Verify separate lighting control devices for specific uses installed per approved lighting plans.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
9.4.3 [E.2] <sup>1</sup>	Exit signs do not exceed 5 watts per face.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
9.5.2 [E.4] <sup>1</sup>	Additional interior lighting power allowed for special functions per the approved lighting plans and is automatically controlled and separated from general lighting.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
9.4.1.2 [E.7] <sup>1</sup>	Feeder connectors sized in accordance with approved plans.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
9.4.1.2 [E.7] <sup>1</sup>	Branch circuits sized for maximum drop of 3%.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
9.4.1.3 [E.7] <sup>1</sup>	Automatic lighting control to shut off all building lighting installed in buildings >5,000 ft <sup>2</sup> .	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
9.4.1.3 [E.7] <sup>1</sup>	Independent lighting control installed per approved lighting plans and all manual control readily accessible and visible to occupants.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
9.4.1.3 [E.7] <sup>1</sup>	Automatic lighting controls for exterior lighting installed.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
10.4.1 [E.10] <sup>1</sup>	Electric motors meet requirements where applicable.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
9.4.2 [E.11] <sup>1</sup>	Ballasted one and three lamp fixtures with >30 W/lamp have two lamp tandem wired ballasts when $\geq 2$ fixtures in same space on same control.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

# Using the Evaluation Checklists

## Lighting Control Devices Video



9.4.1.4  
[EL1]<sup>1</sup>

Verify separate lighting control devices for specific uses installed per approved lighting plans.

# Using the Evaluation Checklists

## Exit Signs

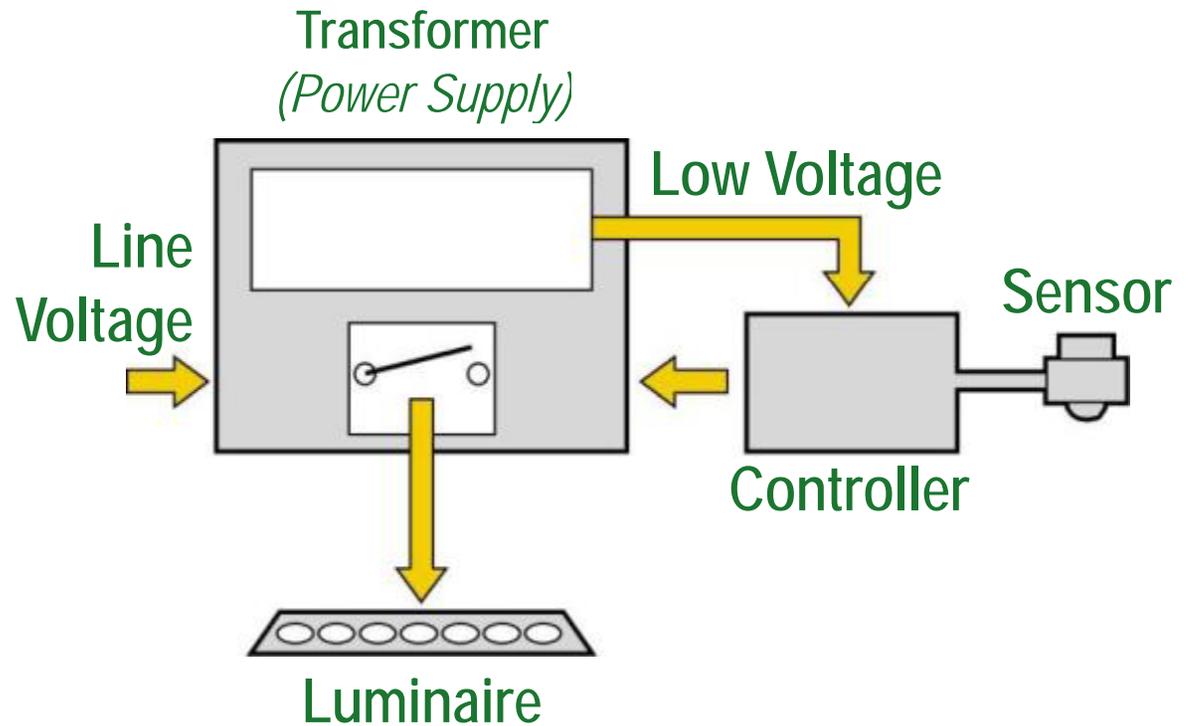


9.4.3  
[EL2] <sup>1</sup>

Exit signs do not exceed 5 watts per face.

# Using the Evaluation Checklists

## Exterior Grounds Lighting Controls



9.4.4  
[EL3] <sup>1</sup>

Exterior grounds lighting over 100 W provides >60 lm/W unless on motion sensor or fixture is exempt from scope of code or from external LPD.

# Using the Evaluation Checklists

## Additional Interior Lighting Power

- Space-by-space increases
  - Specific lighting function
  - Only if specific lighting is installed
  - Only for specified luminaires
  - Shall not be used for any other purpose or space



9.6.2  
[EL4] <sup>1</sup>

Additional interior lighting power allowed for special functions per the approved lighting plans and is automatically controlled and separated from general lighting.

# Using the Evaluation Checklists

## Feeder Connectors and Branch Circuits

- Verify feeder conductors are sized for a maximum voltage drop of 2% at design load
- Verify branch circuit conductors are sized for a maximum voltage drop of 3% at design load

8.4.1.1 [EL5] <sup>2</sup>	Feeder connectors sized in accordance with approved plans.
8.4.1.2 [EL6] <sup>2</sup>	Branch circuits sized for maximum voltage drop of 3%.

# Using the Evaluation Checklists

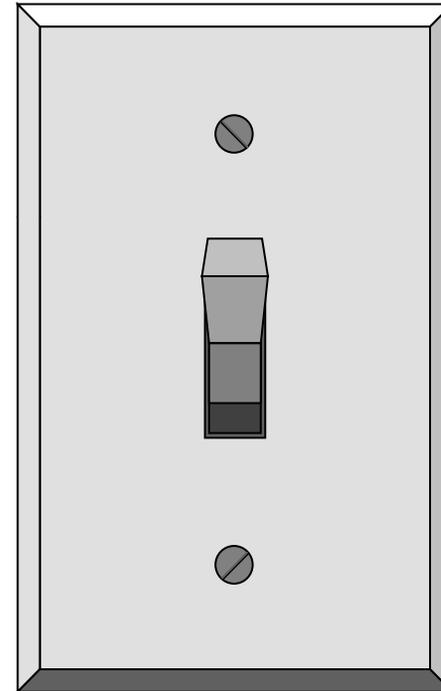
## Automatic Lighting Controls Video



9.4.1.1  
[EL7]<sup>2</sup>

Automatic lighting control to shut off all building lighting installed in buildings >5,000 ft<sup>2</sup>.

- Lighting controls required for each area enclosed by ceiling height partitions
- Switch locations
  - In view of lights
  - “On” or “off” indication from remote location



9.4.1.2  
[EL8]<sup>2</sup>

Independent lighting control installed per approved lighting plans and all manual control readily accessible and visible to occupants.

# Using the Evaluation Checklist

## Exterior Lighting Controls Video



- Auto Controls Turn Lights off During Daylight Hours
  - Photo Cell
  - Automatic Time Switches
    - Seven Day/Seasonal Daylight Program
    - 10 hour Minimum Backup
  - Exception
    - Covered vehicle entrances/exits or parking where security or safety is an issue.

9.4.1.3  
[EL9]<sup>2</sup>

Automatic lighting controls for exterior lighting installed.

Ensure that electric motors comply with Table 10.8, where applicable

**TABLE 10.8 Minimum Nominal Efficiency for General Purpose Design A and Design B Motors<sup>a</sup>**

	Minimum Nominal Full-Load Efficiency (%)					
	Open Motors			Enclosed Motors		
	2	4	6	2	4	6
<b>Number of Poles</b> ⇒						
<b>Synchronous Speed (RPM)</b> ⇒	<b>3600</b>	<b>1800</b>	<b>1200</b>	<b>3600</b>	<b>1800</b>	<b>1200</b>
<b>Motor Horsepower</b>						
1	—	82.5	80.0	75.5	82.5	80.0
1.5	82.5	84.0	84.0	82.5	84.0	85.5

10.4.1  
 [EL10]<sup>2</sup>

Electric motors meet requirements where applicable.

# Using the Evaluation Checklists

## Insulation Inspection Checklist

- All sources of air leakage in building thermal envelope are sealed, caulked, gasketed or weather stripped to minimize air leakage
- Roof insulation R-value and installed per manufacturer's instructions. Blown or poured loose-fill insulation is installed only where the roof slope is  $\leq 3$  in 12
- Above-grade wall insulation R-value and installed per manufacturer's instructions
- Floor insulation R-value and installed per manufacturer's instructions
- Insulation labeled with R-value or insulation certificate providing R-value and other relevant data
- Eaves are baffled to deflect air to above the insulation
- Insulation installed in substantial contact with the inside surface separating conditioned from unconditioned space
- Recessed equipment installed in building envelope assemblies does not compress the adjacent insulation
- Exterior insulation is protected from damage with a protective material

Code	Description	Verified	Complies		
			Yes	No	N/A
90.1-2007 5.4.3.1 [IN1]	All sources of air leakage in the building thermal envelope are sealed, caulked, gasketed or weather stripped to minimize air leakage.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5.5.3.1 [IN1]	Roof insulation R-value.	R-	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5.5.1.2, 5.5.1.3 [IN1]	Roof insulation installed per manufacturer's instructions. Blown or poured loose-fill insulation is installed only where the roof slope is $\leq 3$ in 12.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5.5.3.2 [IN1]	Above-grade wall insulation R-value.	R-	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5.8.1.3 [IN5] <sup>1</sup>	Above-grade wall insulation installed per manufacturer's instructions.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5.5.3.4 [IN6] <sup>2</sup>	Floor insulation R-value.	R-	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5.8.1.3 [IN7] <sup>2</sup>	Floor insulation installed per manufacturer's instructions.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5.8.1.1 [IN8] <sup>2</sup>	Building envelope insulation is labeled with R-value or insulation certificate providing R-value and other relevant data.		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

# Using the Evaluation Checklists

## Wall and Floor Insulation Video



# Using the Evaluation Checklists Above-Grade Wall Insulation



Photo courtesy of SFA (Steel Framing Alliance)

# Using the Evaluation Checklists Above-Grade Wall Insulation



Photos courtesy of Dow Building Solutions

# Using the Evaluation Checklists Above-Grade Wall Insulation



Photos courtesy of Dow Building Solutions

# Using the Evaluation Checklists Above-Grade Wall Insulation



Photo courtesy of MBMA

# Using the Evaluation Checklists Insulation Compression



Photo courtesy of NAIMA (North American Insulation Manufacturers Association)

# Using the Evaluation Checklists Insulation Compression



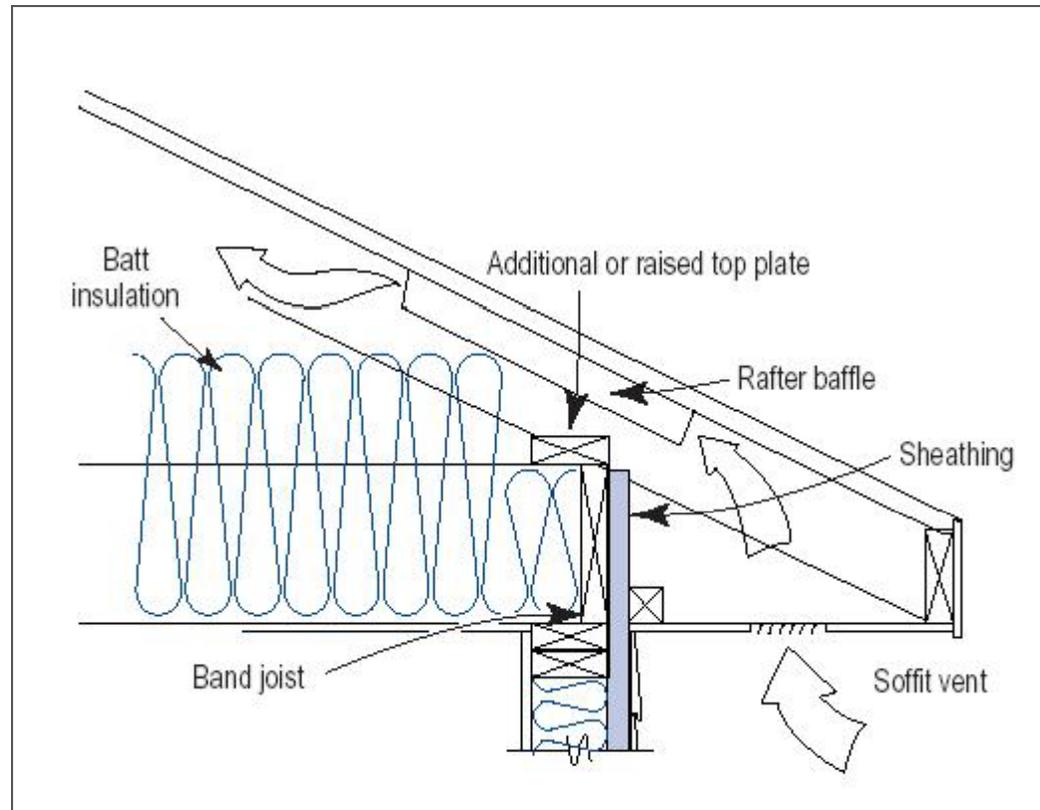
# Using the Evaluation Checklists Roof Insulation – Rigid Application



Photos courtesy of PIMA (Polyisocyanurate  
Insulation Manufacturers Association)

# Using the Evaluation Checklists

## Roof Insulation - Baffling

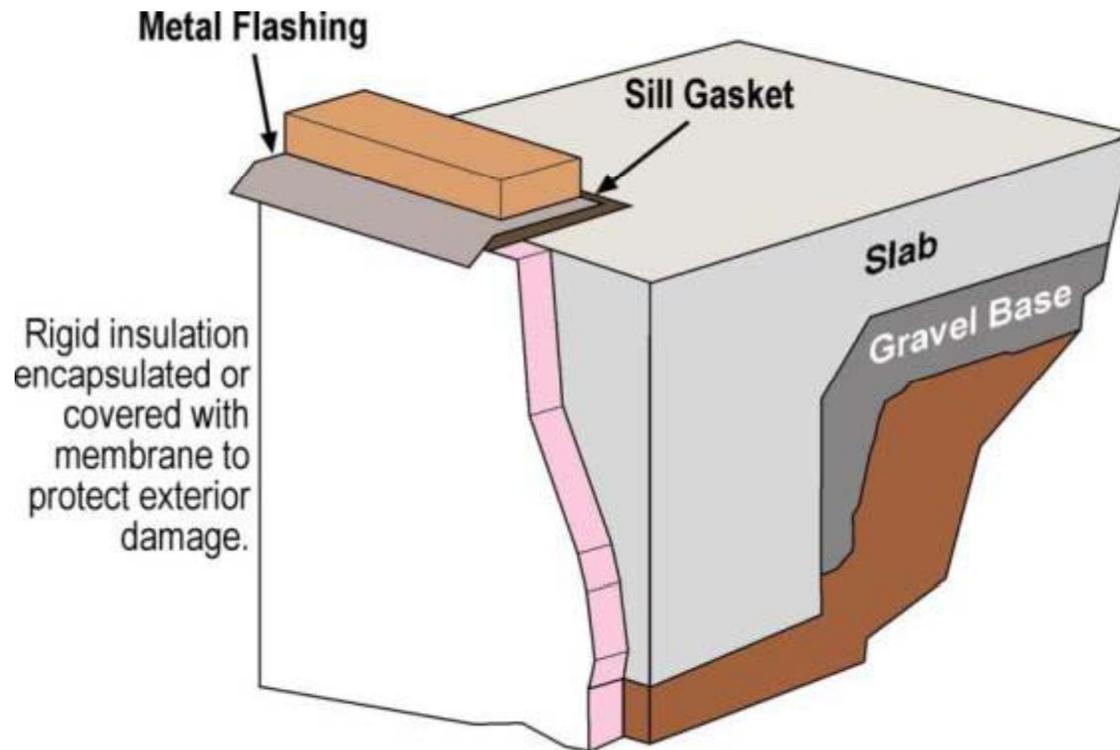


5.8.1.4  
[IN9]<sup>2</sup>

Eaves are baffled to deflect air to above the insulation.

# Using the Evaluation Checklists

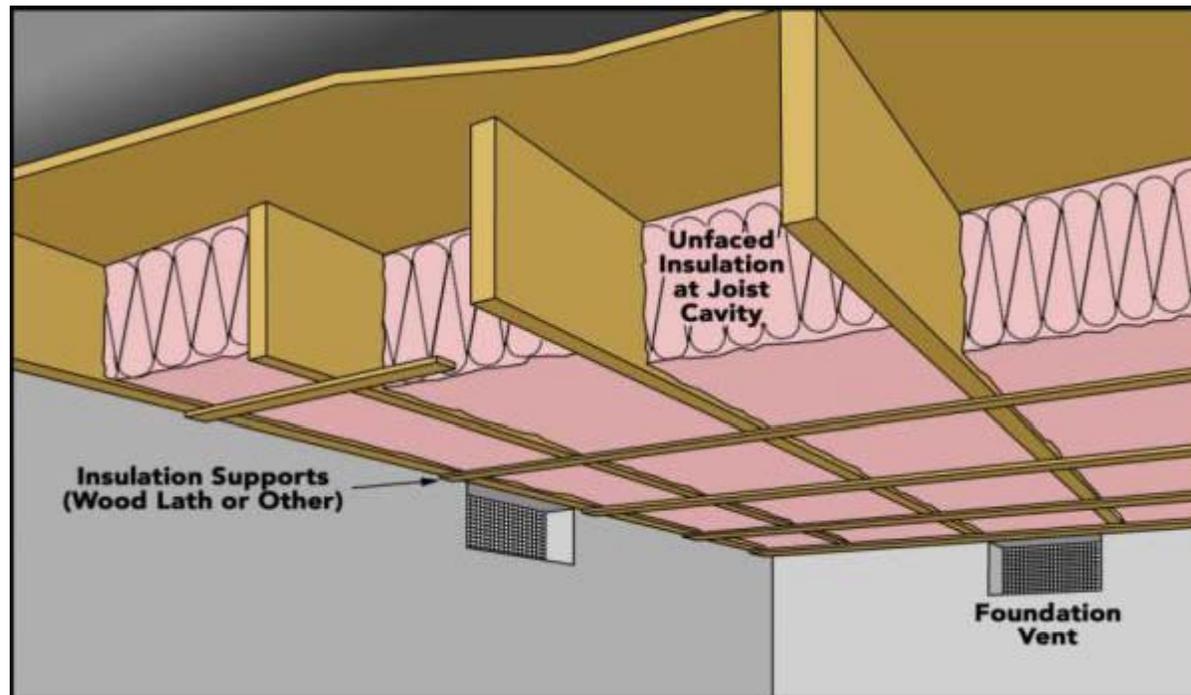
## Insulation Protection



5.8.1.5 [IN10] <sup>2</sup>	Insulation is installed in substantial contact with the inside surface separating conditioned space from unconditional space.
5.8.1.7 [IN12] <sup>2</sup>	Exterior insulation is protected from damage with a protective material.
5.8.1.7.1 [IN14] <sup>2</sup>	Attics and mechanical rooms have insulation protected where adjacent to attic or equipment access.

# Using the Evaluation Checklists

## Foundation Vents & Insulation



5.8.1.7.2  
[IN13]<sup>2</sup>

Foundation vents do not interfere with insulation.

# Using the Evaluation Checklists

## High Albedo Roofs Zones 1-3



5.5.3.1.1  
[IN16]<sup>3</sup>

High-albedo roofs meet solar reflectance of 0.70 and thermal remittance of 0.75 or SRI of 82.

# Using the Evaluation Checklists Roof Insulation



5.8.1.8  
[IN17]<sup>3</sup>

Roof Insulation not installed on suspended ceiling with removable panels.

# Using the Evaluation Checklists

## Final Inspection Checklist

- Weatherseals installed on all loading dock cargo doors in Climate Zones 4-8
  - An air and/or hydronic system balancing report is provided for HVAC systems serving zones >5,000 ft<sup>2</sup> of conditioned area
  - Verify HVAC control systems have been tested to ensure proper operation, calibration and adjustment of controls
  - Installed lamps and fixtures are consistent with what is shown on the approved lighting plans
  - U-factor and air leakage of opaque doors associated with the building thermal envelope meets requirements
  - Heating and cooling to each zone is controlled by a thermostat control
- Temperature controls have the following features: dead band controls, setpoint overlap restrictions, off-hour controls, automatic shutdown, setback controls
- Systems with air capacity >10,000 cfm include optimum start controls

Section #	Final Inspection	Complies			Comments/Assumptions
		Y	N	N/A	
5.4.3.3	Weatherseals installed on all loading dock cargo doors	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
5.4.3.3	An air and/or hydronic system balancing report is provided for HVAC systems serving zones >5,000 ft <sup>2</sup> of conditioned area.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
5.4.3.3	Verify HVAC control systems have been tested to ensure proper operation, calibration and adjustment of controls.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
5.1.3	Installed lamps and fixtures are consistent with what is shown on the approved lighting plans.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
5.4.3.3	U-factor and air leakage of opaque doors associated with the building thermal envelope meets requirements.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
5.4.3.1.1	Heating and cooling to each zone is controlled by a thermostat control	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
5.4.3.2, 5.4.3.3, 5.4.3.3.1, 5.4.3.3.2	Temperature controls have the following features: dead band controls, setpoint overlap restrictions, off-hour controls, automatic shutdown, setback controls.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
5.4.3.3.3	Systems with air capacity >10,000 cfm include optimum start controls.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

Climate zones 4 – 8

Equip cargo doors and loading dock doors with weatherseals to restrict infiltration



5.4.3.3

[F11]<sup>1</sup>

Weatherseals installed on all loading dock cargo doors in Climate Zones 4-8.

Verify the construction documents show the HVAC systems are balanced and a written report provided for all systems serving zones >5,000 ft<sup>2</sup> of conditioned area

6.7.2.3  
[F12] <sup>1</sup>C

An air and/or hydronic system balancing report is provided for HVAC systems serving zones >5,000 ft<sup>2</sup> of conditioned area.

# Using the Evaluation Checklists

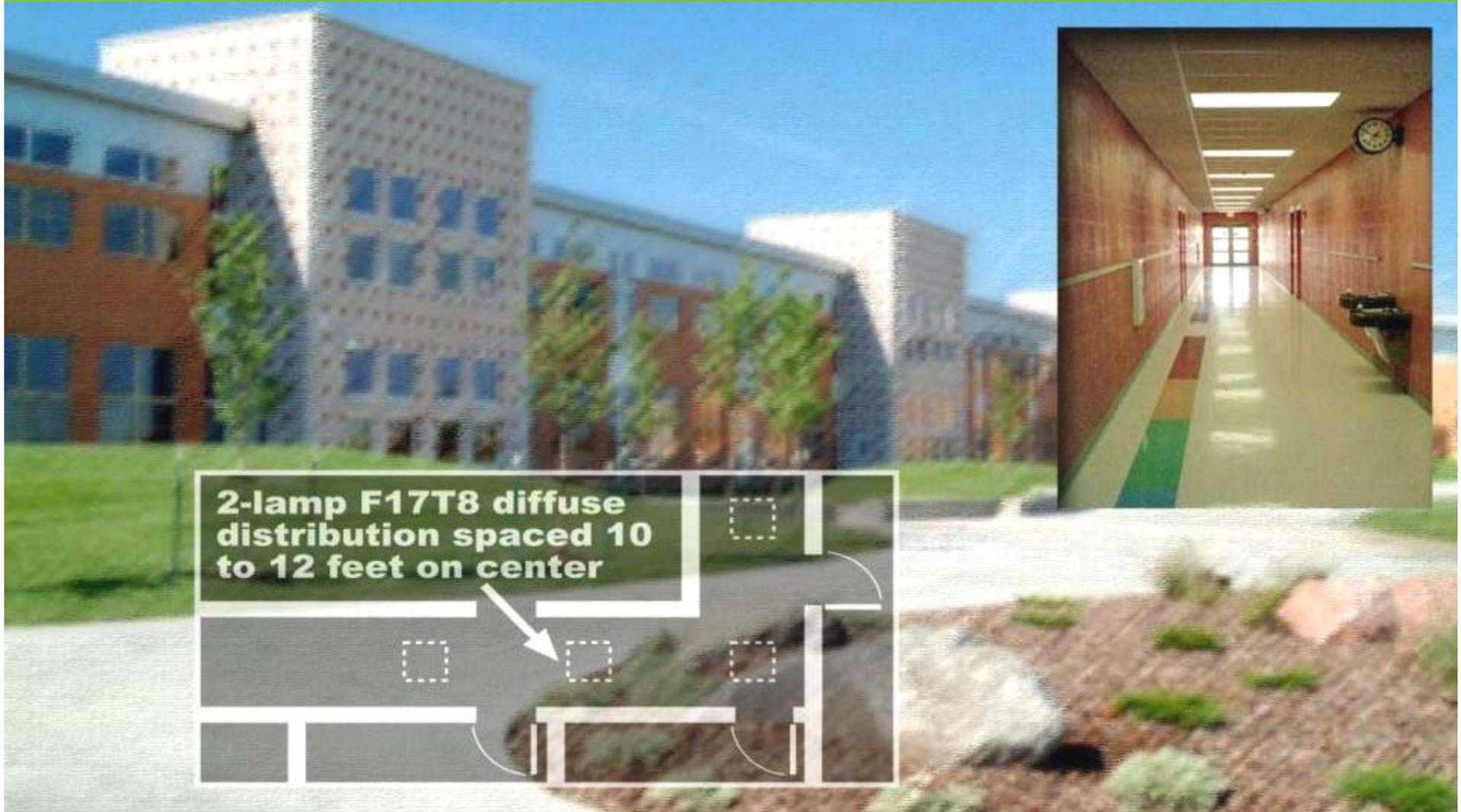
## HVAC Control System Testing Video



6.7.2.4  
[F13] <sup>1</sup>C

Verify HVAC control systems have been tested to ensure proper operation, calibration and adjustment of controls.

# Using the Evaluation Checklists Installed Lamps and Fixtures



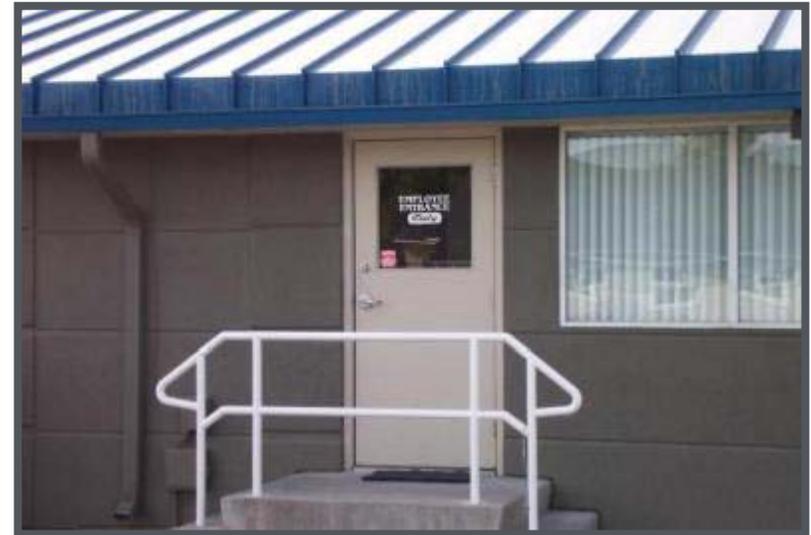
9.1.3  
[F14]<sup>1</sup>

Installed lamps and fixtures are consistent with what is shown on the approved lighting plans.

# Using the Evaluation Checklists Thermal Envelope Requirements

## Opaque Door Requirements

- Permanently installed nameplate on all manufactured doors showing U-factor and Air Leakage Rate
- Opaque doors must meet U-factor requirements of Tables 5.5-1 through 5.5-8



5.8.2.3, 5.5.3.6  
[F15]<sup>2</sup>

U-factor and air leakage of opaque doors associated with the building thermal envelope meets requirements.

# Using the Evaluation Checklists

## Thermostat Control

Heating and cooling to each zone must be thermostatically controlled, based on temperatures within that zone

6.4.3.1.1  
[F16]<sup>2</sup>

Heating and cooling to each zone is controlled by a thermostat control.

# Using the Evaluation Checklists Temperature Controls

## Temperature Controls Must Include:

- Dead band controls,
- Set point overlap restrictions,
- Off-hour controls,
- Automatic shutdown,
- Setback controls.



6.4.3.1.2, 6.4.3.2, 6.4.3.3,  
6.4.3.3.1, 6.4.3.3.2

[F17]<sup>2</sup>

Temperature controls have the following features: dead band controls, set point overlap restrictions, off-hour controls, automatic shutdown, setback controls.

# Using the Evaluation Checklists

## Air Systems Optimum Start Controls

Provides for:

Individual heating and cooling air distribution systems meeting the following criteria:

- A total design supply air capacity exceeding 10,000 cfm
- Served by one or more supply fans
- Control algorithm to be a function of space temp, occupied set point, and time prior to occupancy

6.4.3.3.3

[F18]<sup>2</sup>

Systems with air capacity >10,000 cfm include optimum start controls.

## Checklist Consolidation and Scoring

- BECP will provide an online database and web form
- BECP will provide services to states for converting paper checklists to the electronic format

# BECP – Your Resource



*Additional resources, including:*

- *Code Notes*
- *Technical Assistance to Users*
- *Energy Codes 101*
- *Setting the Standard*
- *Training Materials*
- *Resource Center*

*Are available through the  
Building Energy Codes Program*

[www.energycodes.gov](http://www.energycodes.gov)

# Building Energy Code Program Resources



Energy Efficiency & Renewable Energy

<b>Building Energy Codes Assistance for States</b>	<b>Status of State Energy Codes</b>	Check on the current code status of any U.S. state or territory using BECP's interactive map tool. Also find links to state specific portions of BECP's recent nationwide analysis reports, state-level energy official contact information, and many other details.	<a href="http://www.energycodes.gov/states">www.energycodes.gov/states</a>
	<b>Technical Assistance to States</b>	BECP provides specialized technical assistance to the states in the form of economic analysis, code comparisons, webcast training, and compliance material development requested by states to help them adopt, upgrade, implement, and enforce their building energy codes.	<a href="http://www.energycodes.gov/states/techAssist.stm">http://www.energycodes.gov/states/techAssist.stm</a>
	<b>State Compliance Assistance</b>	BECP has developed an approach states can use for measuring compliance with building energy codes.	<a href="http://www.energycodes.gov/arra/compliance_evaluation.stm">http://www.energycodes.gov/arra/compliance_evaluation.stm</a>
<b>No-cost Compliance Tools</b>	<b>Residential Code Compliance Software</b>	REScheck™ and REScheck-Web™ 	<a href="http://www.energycodes.gov/software.stm">http://www.energycodes.gov/software.stm</a>
	<b>Commercial Code Compliance Software</b>	COMcheck™ and COMcheck-Web™ 	
<b>Training</b>	<b>Codes University</b>	To help stakeholders broaden and deepen their knowledge of building energy codes, BECP is collecting its diverse training resources in an extensive Codes University that features webcasts, training videos, self-paced online courses, presentations, and other BECP materials and tools.	<a href="http://www.energycodes.gov/training">www.energycodes.gov/training</a>
<b>Resource Center</b>	<b>Building Energy Codes Knowledge Base</b>	This knowledge base provides a variety of different media types, including articles, graphics, online tools, presentations, and videos that anyone can use to create their own training and presentations.	<a href="http://resourcecenter.pnl.gov/">http://resourcecenter.pnl.gov/</a>
<b>Advocacy</b>	<b>The Building Codes Assistance Project (BCAP)</b>	BCAP is an initiative of the Alliance to Save Energy, the American Council for an Energy-Efficient Economy, and the Natural Resource Defense Council that provides states with code advocacy assistance on behalf of DOE.	<a href="http://www.bcap-energy.org">www.bcap-energy.org</a>