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Guidelines for Building Science Education

November 2015

CE Metzger
P Huelman
S Rashkin

U.S. DEPARTMENT OF ENERGY

Prepared for the U.S. Department of Energy
under Contract DE-AC05-76RL01830

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BATTELLE
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UNITED STATES DEPARTMENT OF ENERGY
under Contract DE-AC05-76RL01830

Printed in the United States of America

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Pacific Northwest National Laboratory
Richland, Washington 99352

Executive Summary

The U.S. Department of Energy's (DOE) residential research and demonstration program, Building America, has triumphed through 20 years of innovation. Partnering with researchers, builders, remodelers, and manufacturers to develop innovative processes like advanced framing and ventilation standards, Building America has proven an energy efficient design can be more cost effective, healthy, and durable than a standard house.

As Building America partners continue to achieve their stretch goals, they have found that the barrier to true market transformation for high performance buildings is the limited knowledge-base of the professionals working in the building industry. With dozens of professionals taking part in the design and execution of building and selling structures, each person *should* have basic building science knowledge relevant to their role, and an understanding of how various home components interface with each other. Instead, our industry typically experiences a fragmented approach to home building and design.

After obtaining important input from stakeholders at the Building Science Education Kick-Off Meeting, DOE created a Building Science Education Strategy addressing education issues preventing the widespread adoption of high performance homes. This strategy targets the next generation and provides valuable guidance for the current workforce. The initiative includes:

- **Race to Zero Student Design Competition**: Engages universities and provides students who will be the next generation of architects, engineers, construction managers and entrepreneurs with the necessary skills and experience they need to begin careers in clean energy and generate creative solutions to real world problems.
- **Building Science to Sales Translator**: Simplifies building science into compelling sales language and tools to sell high performance homes to their customers.
- **Building Science Education Guidance**: Brings together industry and academia to solve problems related to building science education.

This report summarizes the steps DOE has taken to develop guidance for building science education and outlines a path forward towards creating real change for an industry in need.

The Guidelines for Building Science Education outlined in Appendix A of this report have been developed for external stakeholders to use to certify that their programs are incorporating the most important aspects of building science at the most appropriate proficiency level for their role. The guidelines are intended to be used primarily by training organizations, universities, and certification bodies. Each guideline can be printed or saved as a stand-alone document for ease-of-use by the respective stakeholder group.

In 2015, DOE, with leadership from Pacific Northwest National Laboratory (PNNL), is launching a multi-year campaign to promote the adoption of the Guidelines for Building Science Education in a variety of training settings.

Acknowledgments

This report was prepared by the Pacific Northwest National Laboratory (PNNL) for the U.S. Department of Energy (DOE) Residential Buildings Integration Program. The authors would like to thank David Lee, Eric Werling, and Samuel Rashkin at DOE for providing support and oversight. The authors also recognize Michael Baechler, Manager of the Building America program at PNNL. This work would not be possible without the inspiring dedication of time and effort from Samuel Taylor and the members of the Joint Committee on Building Science Education. The authors would also like to express deep appreciation to the many participants not mentioned by name who helped with the development of the Guidelines for Building Science Education.

Cheryn Metzger, PE PMP LEED AP
Pacific Northwest National Laboratory

Acronyms and Abbreviations

ABET	Accreditation Board for Engineering and Technology
ACI	Affordable Comfort Incorporated
AIA	American Institute of Architects
ASHRAE	American Society of Heating Refrigeration and Air-Conditioning Engineers
BASC	Building America Solution Center
BMI	Building Media Incorporated
BPI	Building Performance Institute
CARE	Center for Advancement of Roof Excellence
CEA	Certified Energy Auditor
DOE	Department of Energy
DOW	DOW Chemical Company
EEBA	Energy & Environmental Building Alliance
EPA	Environmental Protection Agency
FSEC	Florida Solar Energy Center
HUD	United States Department of Housing and Urban Development
HVAC	Heating, Ventilation and Air-Conditioning
IAPMO	International Association of Plumbing and Mechanical Officials
ICC	International Code Council
InterNACHI	International Association of Certified Home Inspectors
LEED	Leadership in Energy and Environmental Design
NAHB	National Association of Home Builders
NAR	National Association of Realtors
NATE	North America Technician Excellence
NCEES	National Council of Examiners for Engineering and Surveying
NFRC	National Fenestration Rating Council
NREL	National Renewable Energy Laboratory
PNNL	Pacific Northwest National Laboratory
REEO	Regional Energy Efficiency Offices

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1.0 Background to Building Science Education Efforts in Building America

The Department of Energy's (DOE) residential research and demonstration program, Building America, has triumphed through 20 years of innovation. Partnering with researchers, builders, remodelers and manufacturers to develop innovative processes like advanced framing and ventilation standards, Building America has proven an energy efficient design can be more cost effective, healthy and durable than a standard house.

As Building America partners continue to achieve their stretch goals they have found that the barrier to true market transformation for high performance homes is the limited knowledge-base of the professionals working in the building industry. With dozens of professionals taking part in the design and execution of building and selling homes, each person *should* have basic building science knowledge relevant to their role, and an understanding of how various home components interface with each other. Instead, our industry typically experiences a fragmented approach to home building and design.

1.1 Building Science Education Kick-Off Meeting

On November 7th, 2012, DOE hosted a summit to discuss how to overcome these education barriers and create a roadmap for building science education efforts going forward. More than 30 participants (see Appendix A for detailed list of participants) represented public and private industry stakeholders, including building science educators, building science researchers, manufacturers, consultants, production builders, training organizations and other government programs.

In addition to helping create the overall strategy for DOE's efforts in building science education, this summit was a first step to engage a diverse set of players in working together more effectively as a group than individuals. This ***'Collective Impact'*** concept is the subject of a research paper by John Kania and Mark Kramer that was published in the winter 2011 edition of the *Stanford Social Innovation Review*. The authors' research revealed examples of "remarkable exception" for implementing large-scale social change and a common basis for their success. The Building America Building Science Education Roadmap outlines the structure of the summit and documents the collective input the industry needs to take to make a difference with future generations.

Although each stakeholder group at the summit fully supported DOE's efforts, it became clear that none of the individual stakeholders were positioned to lead the overarching initiative. With manufacturers, certifications and training organizations focusing on one set of stakeholders no group besides DOE was able to maintain a cross-cutting perspective on the efforts for building science education.

1.2 Overall Building Science Education Strategy at DOE

After obtaining important input from stakeholders at the kick-off meeting, DOE created a building science education strategy addressing education issues preventing the widespread adoption of high performance homes. This strategy targets the next generation and provides valuable guidance for the current workforce. The initiative includes:

- **Race to Zero Student Design Competition**: engages universities and provides students who will be the next generation of architects, engineers, construction managers and entrepreneurs with the necessary skills and experience they need to begin careers in clean energy and generate creative solutions to real world problems.
- **Building Science to Sales Translator**: simplifies building science into compelling sales language and tools to sell high performance homes to their customers.
- **Building Science Education Guidance**: brings together industry and academia to solve problems related to building science education.

The first annual Race to Zero Student Design Competition was hosted by the National Renewable Energy Laboratory (NREL) and the Home Innovation Research Laboratory. The inaugural 2-day competition was held on NREL's ultra-efficient campus in April of 2014. The event was a huge success with over 90% of the students involved reporting they learned more through the competition than they did in the classroom.

The Building Science to Sales Translator has been undergoing a collaborative development process since early 2013. Interested stakeholders have supported DOE in this mission by helping brainstorm, critique and finalize sales terms that adequately represent the benefits of each building science principle in the Building America Solution Center (BASC). The Building Science to Sales Translator will debut as part of the BASC in the fall of 2015.

This report summarizes the steps DOE has taken to develop guidance for building science education and outlines a path forward towards creating real change for an industry in need.

2.0 Development of Building Science Education Guidelines

In addition to the broad strategy that surfaced at the kick-off meeting, specific near-term (before 2018) goals were also established for building science education guidance. These goals may be seen as outcomes of the roadmap linked in the section above, and are also paraphrased below:

- Identify a set of proficiency/skill levels across all stakeholder groups who build, buy or sell residential buildings.
- Establish core competency topics related to building science education.
- Map proficiency levels to core competency topics for key construction trades, university/college programs and transaction process officials.

2.1 Overall Strategy for Development of Building Science Education Guidelines

Based on the goals above, the following two complementary tactics were used to develop Building Science Education Guidelines:

1. Host stakeholder review meetings at relevant building science events to gain valuable input and feedback on the development process and content.
2. Enlist Pat Huelman (Winner of the Excellence in Building Science Education Award in 2013) and the NorthernSTAR Building America team to lead the development of a matrix that cross-ranks job classifications and core competency levels with proficiency guidelines.

The tag-team-approach to these two strategies is shown in the timeline below (Figure 2.1) as a reference for the rest of this section of the report.

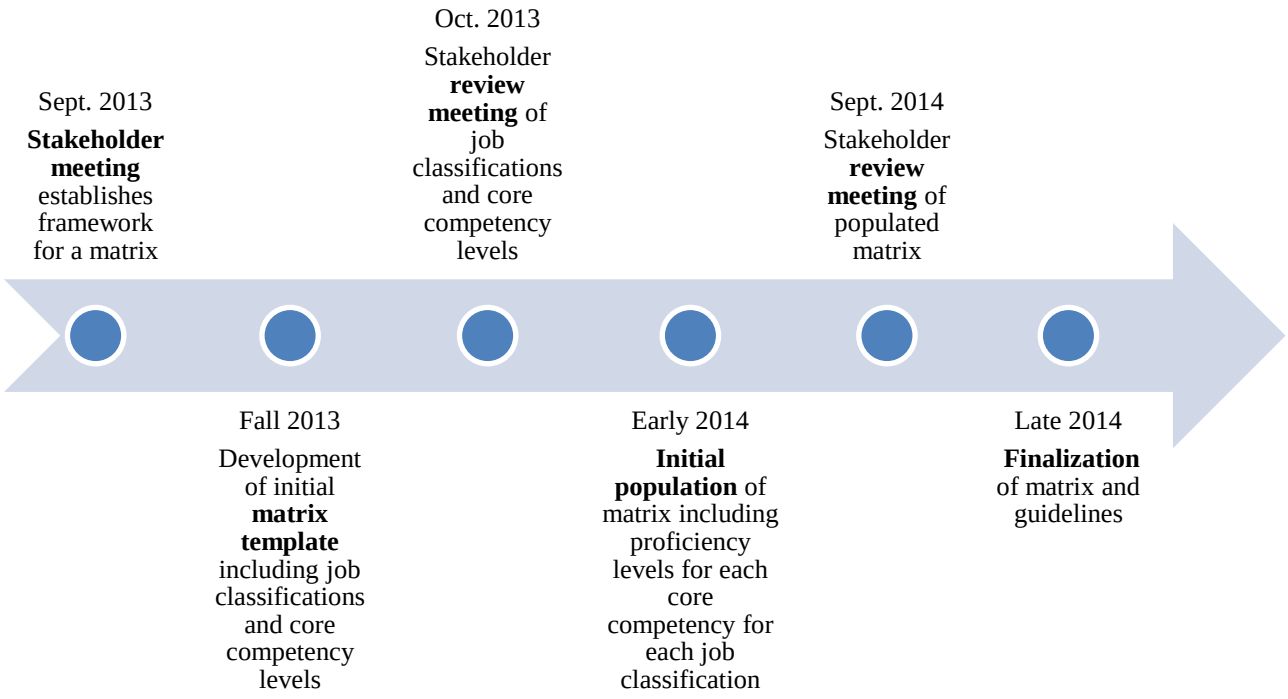


Figure 2.1. Matrix Development Timeline

2.2 Initial Stakeholder Meeting

A meeting was held in conjunction with the 2013 Energy & Environmental Building Alliance (EEBA) conference to review the building science roadmap and to brainstorm the appropriate next steps for developing the guidelines. At this meeting, over 20 participants (see Appendix B for attendee list) helped DOE develop the framework for the Building Science Education Matrix.

2.3 Development of a Matrix Template

In order to achieve the goals stated in the kick-off meeting, the NorthernSTAR team was challenged to find a means to present cross-categorized information on job classifications, core competencies and proficiency levels all at once. Ultimately, a decision was made to use a two dimensional matrix (or table) template, as outlined in Table 2.1 below.

Table 2.1. Matrix Template for Building Science Education Guidelines

	Job Classification #1	**Job Classification #2**	**Job Classification…**
Core Competency #1			
Core Competency #2			
Core Competency…			

It was decided that in each cross-categorized cell, a proficiency level would denote the recommended *level* of knowledge, skill or ability that job classification should maintain.

The first step in filling out this matrix was to determine the important job classifications and core competencies that exist throughout the entire residential buildings industry. After making some progress in this area, it became evident that inclusion of the commercial building jobs and competencies would provide a more complete reference without adding much work to the process.

2.4 Review Meeting of Job Classifications and Core Competency Levels

After the initial list of job classifications and core competencies was established, a review meeting was held in conjunction with the Building America Planning Meeting on October 30th, 2013. Some minor edits were made, but the overall approach and categories were agreed upon by the various stakeholders.

2.5 Initial Population of Matrix

The NorthernSTAR team, along with the Joint Committee on Building Science Education (http://buildingscienceeducation.net/), established proficiency levels that quantify relationships between various job classifications and competencies. The scale was one through six, with six being the ability to design a unique system. Some basic rules-of-thumb were implemented as well. For example, the person authorizing the work should have no less than one proficiency level below the person conducting the work.

2.6 Review Meeting of Populated Matrix

In September of 2014, another meeting was held in conjunction with the EEBA conference in St. Louis, MO. The purpose of this meeting was to review the populated matrix with industry stakeholders. The outcome of this meeting was a fully edited matrix. See the attendee list for the meeting in Appendix C.

2.7 Finalization of Matrix

In late 2014, input from the NorthernSTAR team was combined with the granular input from the review meeting. Where possible, the matrix was also slightly condensed to provide a cleaner picture to stakeholders who may not have been involved throughout the development process.

2.8 Other Stakeholder Engagement

In addition to the DOE hosted meetings, other entities hosted meetings where DOE representatives presented on the matrix development or other related topics. Lively discussions were encouraged at these meetings to gain even more stakeholder input into the guidelines. Table 2.2 shows the date, title, and location of meetings where parts of the DOE strategy were presented. DOE hosted meetings are italicized for reference.

Table 2.2. Building Science Education Meetings with DOE Representation

Date	Meeting	Location
7/30/12	Planning Meeting	Westford, MA
11/7-8/12	*DOE Hosted Kick-Off Meeting*	*NAHBRC Campus - Upper Marlboro, MD*
1/21/13	National Consortium of Housing Research Centers	NAHB –IBS, Las Vegas, NV
3/21/13	Joint Committee on Building Science Education Meeting	Minneapolis, MN
5/2/13	ACI/EEBA/DOE meeting	Denver, CO
8/2/13	Westford Symposium on Building Science	Westford, MA
9/23/13	*DOE Hosted Stakeholder Meeting*	*EEBA - Phoenix, AZ*
10/28/13	*DOE Hosted Review Meeting*	*Washington, DC*
12/2/13	BUILDINGS XII	Clearwater, FL
1/6/14	National Institute of Building Sciences Credentialing Council	Washington, DC
1/17-20/14	ASHRAE	New York, NY
2/2014	National Consortium of Housing Research Centers	Las Vegas, NV
3/24-26/14	ACS	Wash., DC
4/6/14	ASTM/NIBS/JC Workshop	Toronto, ON
4/2014	DOE Building Technologies Office Peer Review Meeting	Alexandria, VA
4/26-28/14	Race to Zero Competition	Golden, CO
6/18-19/14	Penn State Meeting	State College, PA
6/27-7/1	ASHRAE	Seattle, WA
7/9/14	National Consortium of Housing Research Centers Executive Committee Meeting	Alexandria, VA
8/3/14	Westford Symposium on Building Science	Westford, MA
9/22/14	*DOE Hosted Review Meeting*	*EEBA - St. Louis, MO*

3.0 Building Science Education Matrix

The final Building Science Education Matrix can be viewed in Appendix B of this report. The following section of this report defines the final job classifications, core competencies and proficiency levels that appear in the full matrix.

3.1 Job Classifications

It is important for the job classifications of the matrix to adequately represent the full design, installation, and value chain associated with buildings. The 34 job classifications below represent the final recommendations

1. General Public
    a. *Homeowners* – People with building science knowledge obtained through high school education.
2. Builders/Remodelers
    a. *Builders (Owners/Managers)* – Owner of a home-building company who primarily manages the business.
    b. *Builders (General Contractors/Foremen)* – Builder that also works in the field as a general contractor or foreman.
    c. *Remodelers (Owners/Managers)* – Owner of a home-remodeling company or contracting business who primarily manages the business.
    d. *Remodelers (Foremen)* - Remodeler/handyman who works primarily in the field.
    e. *Insulation Contractors* - Foreman of an insulation crew that potentially performs air sealing as well as insulating.
    f. *HVAC Contractors* - Foreman of an HVAC crew, responsible for sizing calculations and specifying equipment (Manuals J, D, etc.) as well as installation and repair.
    g. *Enclosure Service Contractors* – Foreman of a framing, siding, roofing, concrete, or window installation crew.
    h. *Plumbers* – Foreman of a plumbing crew, responsible for system and equipment sizing and specification as well as installation and repair.
    i. *Home Performance Contractors* – Foreman of a crew that performs performance testing such as thermal imaging and blower door testing, while also installing insulation and air sealing.
3. Program and Project Managers
    a. *Utility Program Managers* – Manager of an electric or natural gas utility-based program that supports energy audit programs or product efficiency rebates.
    b. *Green Building Certification Professionals* - Manages the certification of homes or multi-family buildings under green building or energy efficiency programs such as ENERGY STAR, LEED for Homes or Passive House.

c. *Maintenance Professionals* – Responsible for the maintenance of multi-family buildings or homes within a housing association including enclosure, interior, mechanical, and electrical systems.

d. *Facility/Asset Managers* – Manager or owner of multi-family buildings, responsible for investment and upgrade decisions.

4. Transaction Process

   a. *Real Estate Agent/Sales Associate* – Licensed to produce contracts to buy and sell real estate.

   b. *Appraisers* – Licensed to value property for real estate transactions.

   c. *Home Inspectors* – Certified or licensed to inspect and evaluate the physical condition of buildings.

   d. *Insurers* – Licensed to evaluate the risk of a natural or man-made disaster.

   e. *Underwriters* – Licensed to evaluate the risk of a homeowner defaulting on a loan.

5. Design and Construction Professionals

   a. *Architectural Engineers* – Licensed architectural engineer responsible for integrating structural, mechanical, electrical, plumbing, HVAC and/or fire protection engineering with building design.

   b. *Licensed Architects* – Licensed architect responsible for residential design, taking part in the specification of envelope, structural, mechanical and electrical systems.

   c. *Mechanical Engineers* – Licensed to design and specify HVAC systems for buildings.

   d. *Civil/Structural Engineers* – Licensed for site development activities such as surveying and grading streets, storm water retention and sewer.

   e. *Material Science Engineers* – Licensed to design materials and construction products for use in buildings.

   f. *Home Designer* – An architect possibly lacking certification or licensure, experienced with the design and specification of residential structures and interiors. May or may not take part in the specification of envelope, mechanical, structural and electrical systems.

   g. *Interior Designer* – Educated in design and specification of interiors.

   h. *Landscape Architects/Site Planners* – Licensed landscape architect or unlicensed site planner/designer experienced with residential landscape design including grading and site drainage, shading, irrigation systems and plant specifications.

   i. *Construction Managers* – Working on site to supervise, schedule and coordinate construction activities amongst various trades, develop installation sequences and select and purchase appropriate construction materials.

6. Building Science Professionals

   a. *Building Science Forensic Professionals* – Typically a graduate level engineer, architect or other individual who performs on-site investigations to help determine the causes of failure or damage to various components of a building, but primarily focused on the envelope and structure.

   b. *QA/QC & Commissioning Agents (envelope and structure)* – Typically an engineer or architect who ensures the envelope and structure is installed and operating correctly.

c. *QA/QC & Commissioning Agents (mechanical and electrical)* – Typically an engineer or architect who ensures the HVAC, electrical, and plumbing systems are installed and operating correctly.

7. Home Energy Professionals

   a. *Energy Auditor* - A certified (Building Performance Institute (BPI), Certified Energy Auditor (CEA), etc.) professional who measures the energy performance of a home. This can include tasks such as checking energy use of major appliances, inspecting insulation levels, measuring air leakage, using infrared thermography to find thermal bridges and air leaks, and checking the performance and safety of ventilation and mechanical equipment.

   b. *Performance Assessor* – A certified (BPI, CEA, etc.) professional with more home energy assessment experience than the field technician or energy auditor. Additional responsibilities may include management, writing energy assessment and recommendation reports and conducting energy modeling to provide energy ratings and quantify energy savings from recommended improvements.

8. Building/Energy Code Officials

   a. *Code Officials* – Experienced local or state officials responsible for insuring residential structures are built to meet minimum code requirements in their jurisdiction (e.g. building, energy, plumbing, electrical, mechanical and fire codes).

3.2 Core Competency Definitions

1. Integration of the Whole-Building System

   a. The *simultaneous consideration* of the impacts design decisions have on energy use, assembly durability, human comfort and indoor air quality.

   b. The concept of life-cycle cost analysis as it relates to payback, net-present value calculation and *annualized cash flow*.

   c. Understanding the techniques used to minimize disruption to buildings and infrastructure systems due to *natural or man-made disasters*.

   d. *Integrated design and construction* of the building as shown through coordinated trades and disciplines including:

      i. The integration of building science into all construction documentation and specifications

      ii. The integration of building science into on-site energy generation considerations (example: roof which can withstand the weight of solar panels).

   e. *Quality management* as it relates to designing, specifying and verifying the performance of a building.

   f. *Energy modeling* topics including iterative modeling to optimize loads early in the design process, as well as more detailed modeling used to refine variables like glazing specifications, insulation values and HVAC design.

g. Whole-building *cost trade-off analysis (optimized first costs)* to optimize the first cost of a building against future costs associated with items such as energy use and maintenance or replacement.

2. Building Science Principles Related to the Enclosure

   a. *Heat transfer* and the movement of heat by convection, conduction and radiation.

   b. *Moisture transport* (liquid, vapor) and the movement of water. This topic also includes psychometric and phase change effects.

   c. *Convective air transport* including the movement of air across building enclosures as a consequence of pressure differences.

   d. *Material selection* related to indoor air quality effects of off-gassing, comfort effects related to thermal mass storage and the vulnerability of materials to damage due to moisture accumulation.

   e. *Control layers* and the flow of heat, vapor, water air and solar gain through building components.

   f. *Hygrothermal analysis* and the ability to predict the flow of heat and moisture across enclosure assemblies using computer software.

   g. *HVAC* systems including heating, ventilation and air conditioning systems.

   h. *Interactions between HVAC systems and the enclosure.*

   i. *Fenestration considerations* including National Fenestration Rating Council (NFRC) labels, solar orientation, sun angles, shading, daylighting and distribution factors such as window to wall area.

   j. *Water heating* topics including water heater options, distribution systems and conservation strategies.

   k. *Electrical distribution systems* within the building, interfaces with utility infrastructure and integration of renewable electric production.

   l. *Lighting, appliances and miscellaneous electric loads.*

   m. *Control systems* (manual or automated) to control energy-consuming devices such as HVAC systems and lights.

   n. *Indoor environmental quality* including thermal comfort, air movement, moisture content, indoor pollutants and extraction.

3. Operations and Maintenance

   a. *User controls* including all equipment used by building occupants or building operators to control energy-consuming devices and systems (ex: thermostat).

   b. *Preventative maintenance* including actions taken to prevent premature failure of building systems such as HVAC equipment and enclosure systems (ex: cleaning air filters).

   c. Determination of *appropriate replacement choices* upon material or equipment failure.

4. Building Testing and Certification

   a. *Commissioning* important building systems after installation to ensure they perform as expected. This includes continuous commissioning where performance of key systems is periodically verified.

b. *Diagnostic strategies* used to discover the underlying causes of building system failures and implementing solutions to prevent future failures.

c. *Monitoring* the performance of a building and assessing the cause and effect of certain building behavior.

d. Consideration of *national codes and standard* requirements as they relate to building science principles.

e. *Certification programs* including the Environmental Protection Agency's (EPA) Energy Star Certified New Homes program and the U.S. DOE's Zero Energy Ready Home program.

3.3 Proficiency Levels

To obtain the appropriate degree of competency across all job classification groupings, a set of defined proficiency levels was derived from Bloom's Taxonomy[1]. These definitions were used to compare the job expectations of one occupation to another. The six levels defined below range from simple recognition of terms to complex mechanical design.

1. **Remember**: Remember facts, terms and basic concepts.
2. **Understand**: Demonstrate understanding by describing, defining and interpreting concepts.
3. **Apply**: Apply knowledge in familiar situations to solve problems.
4. **Analyze**: Identify causes of unique problems and use past evidence to support actions.
5. **Evaluate**: Identify solutions to unique problems using past evidence to support actions.
6. **Create**: Use fundamental knowledge to create unique plans, patterns and alternatives.

Figure 3.1 shows the relative rigor of each proficiency level – showing that the difference between level one and two is much smaller than the difference between level three and four.

[1] Bloom, B. S. (1956). Taxonomy of Educational Objectives, Handbook I: The Cognitive Domain. New York: David McKay Co Inc

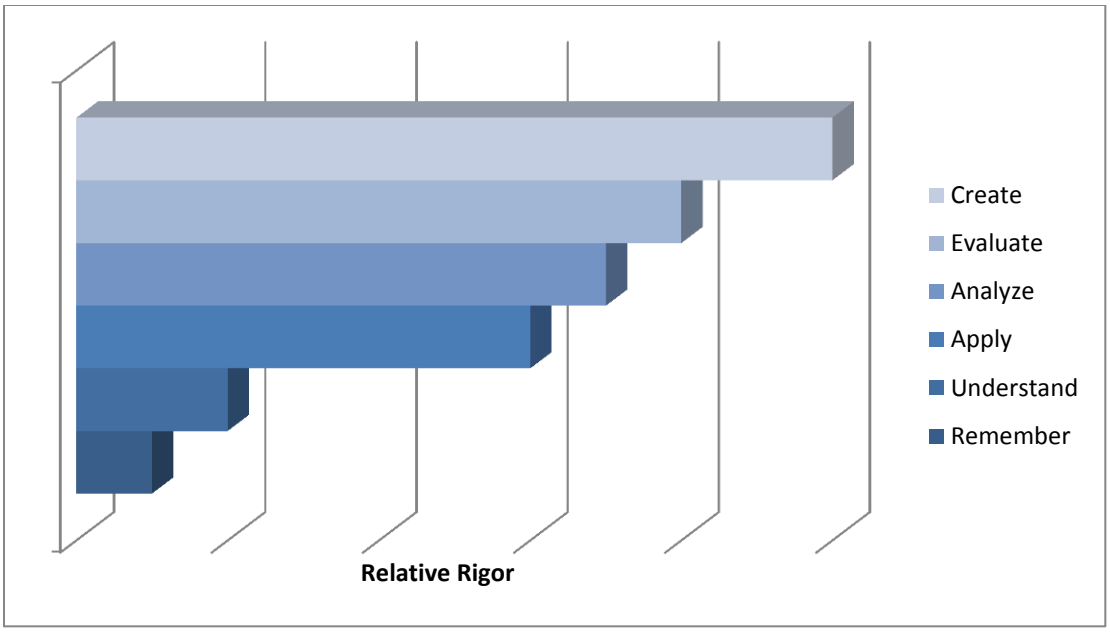


Figure 3.1. Relative Rigor of Proficiency Levels Used in the Matrix

3.4 Completed Matrix

The following goals originally drafted at the 2012 Building Science Education Summit were achieved through many hours of collaboration across the buildings industry:

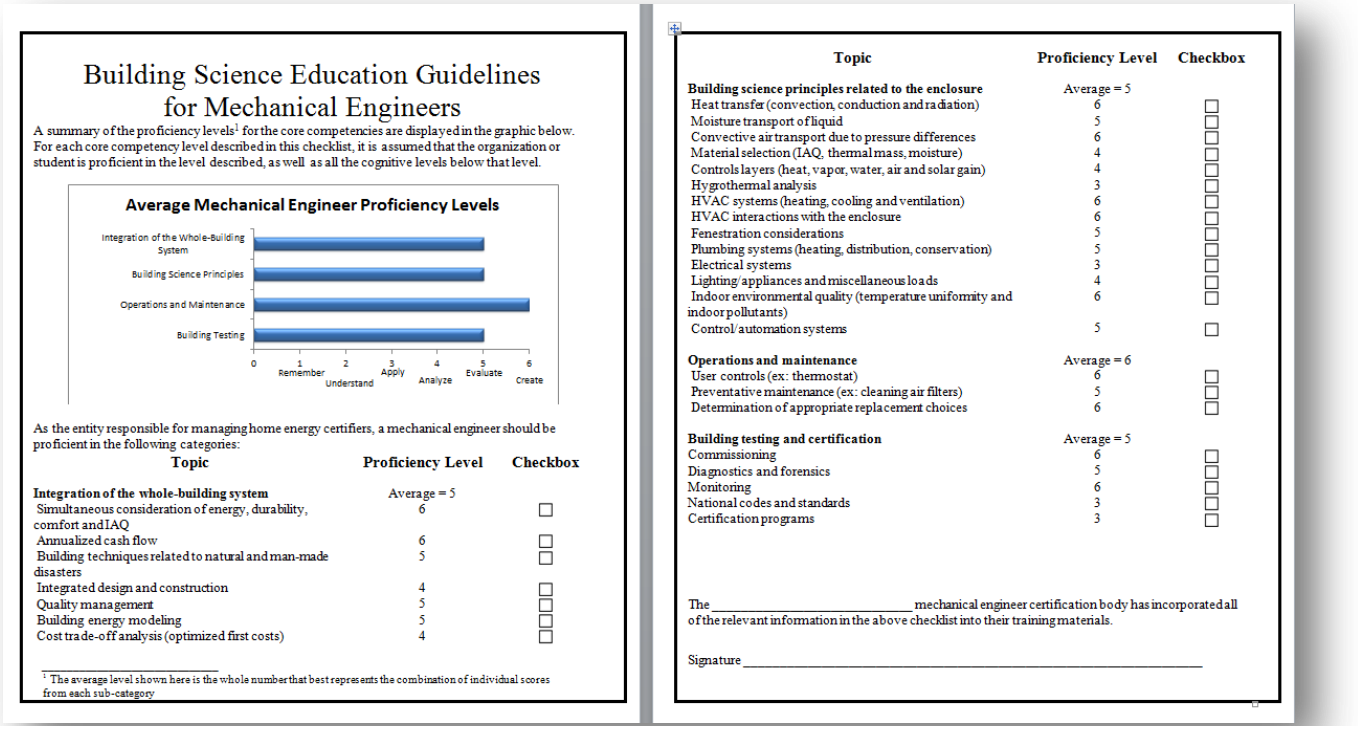
- Identify a set of proficiency/skill levels across all stakeholder groups who build, buy or sell residential buildings.
- Establish core competency topics related to building science education.
- Map proficiency levels to core competency topics for key construction trades, university/college programs, and transaction process officials.

A copy of the full matrix can be seen in Appendix B of this document.

4.0 Building Science Education Guidelines

The following Building Science Education Guidelines have been developed for external stakeholders to use to self-certify their programs. The guidelines are intended to be used primarily by training organizations, universities and certification bodies who would like to include aspects of building science in their curriculum. Each guideline in Appendix A can be printed or saved as a stand-alone document for ease-of-use by the respective stakeholder group. A sample of a guideline is shown in

Figure 4.1 for Architects.



Building Science Education Guidelines for Mechanical Engineers

A summary of the proficiency levels[1] for the core competencies are displayed in the graphic below. For each core competency level described in this checklist, it is assumed that the organization or student is proficient in the level described, as well as all the cognitive levels below that level.

As the entity responsible for managing home energy certifiers, a mechanical engineer should be proficient in the following categories:

Topic	Proficiency Level	Checkbox
Integration of the whole-building system	Average = 5	
Simultaneous consideration of energy, durability, comfort and IAQ	6	☐
Annualized cash flow	6	☐
Building techniques related to natural and man-made disasters	5	☐
Integrated design and construction	4	☐
Quality management	5	☐
Building energy modeling	5	☐
Cost trade-off analysis (optimized first costs)	4	☐
Building science principles related to the enclosure	Average = 5	
Heat transfer (convection, conduction and radiation)	6	☐
Moisture transport of liquid	5	☐
Convective air transport due to pressure differences	6	☐
Material selection (IAQ, thermal mass, moisture)	4	☐
Controls layers (heat, vapor, water, air and solar gain)	4	☐
Hygrothermal analysis	3	☐
HVAC systems (heating, cooling and ventilation)	6	☐
HVAC interactions with the enclosure	6	☐
Fenestration considerations	5	☐
Plumbing systems (heating, distribution, conservation)	5	☐
Electrical systems	3	☐
Lighting/appliances and miscellaneous loads	4	☐
Indoor environmental quality (temperature uniformity and indoor pollutants)	6	☐
Control/automation systems	5	☐
Operations and maintenance	Average = 6	
User controls (ex: thermostat)	6	☐
Preventative maintenance (ex: cleaning air filters)	5	☐
Determination of appropriate replacement choices	6	☐
Building testing and certification	Average = 5	
Commissioning	6	☐
Diagnostics and forensics	5	☐
Monitoring	6	☐
National codes and standards	3	☐
Certification programs	3	☐

The _____ mechanical engineer certification body has incorporated all of the relevant information in the above checklist into their training materials.

Signature _____

[1] The average level shown here is the whole number that best represents the combination of individual scores from each sub-category

Figure 4.1. Sample of a Building Science Education Guideline

5.0 Collective Impact Campaign for the Guidelines for Building Science Education

In 2015, DOE is launching a multi-year campaign to promote the adoption of the Guidelines for Building Science Education in a variety of training settings. The goals of the campaign include:

- Encourage the whole building industry to work towards safe, healthy, durable high performance homes.
- Provide a mechanism for recognizing excellence in the building training and education industry.
- Work with partners to improve the Guidelines for Building Science Education to be representative of the knowledge, skills and abilities appropriate for their workforce.

As found during the initial kick-off meeting, DOE is in a unique position to lead the campaign and help the industry grow as one unit towards a common goal. With leadership from the Pacific Northwest National Laboratory (PNNL), DOE will initially arrange one-on-one meetings to develop partnerships for the campaign. Three partnership development opportunities have been established and will be the focus of the initial campaign efforts:

1. Race to Zero Student Design Competition Universities
2. Trade Associations
3. Other High Impact Partners

Further description of the partnership development strategies are described in the sections below.

5.1 Race to Zero Student Design Competition Universities

The Race to Zero Student Design Competition is intended to provide the next generation of architects, engineers, construction managers and entrepreneurs with skills and experience to start careers in high performance homes. One suggestion students mentioned during the inaugural Race to Zero competition was that it would be helpful if all the professors had access to the same teaching criteria and materials to ensure a level playing field.

With over 40 teams interested in participating in the 2015 Race to Zero competition, DOE will have a captive audience for campaign involvement and guideline feedback. University professors will be asked to fill out the Guidelines for Building Science Education checklists that are representative of the programs they teach in. Some universities will become partners of the campaign without additional support from DOE, while others may require further discussion or additional resource suggestions.

5.2 Trade Associations

For almost every job classification presented in the Guidelines for Building Science Education, there is a corresponding trade association that educates or certifies those professionals. Some examples of trade associations that DOE intends to partner with include:

- National Council of Examiners for Engineering and Surveying (NCEES)
- American Institute of Architects (AIA)
- Energy & Environmental Building Alliance (EEBA)
- International Code Council (ICC)
- International Association of Certified Home Inspectors (InterNACHI)
- National Association of Realtors (NAR)
- North American Technician Excellence (NATE)
- International Association of Plumbing and Mechanical Officials (IAPMO)
- Center for Advancement of Roof Excellence (CARE)

Discussions with a few of these organizations have already begun. Even organizations who have not been involved in the development of the Guidelines for Building Science Education are excited about the opportunities of collective impact.

5.3 Other High Impact Partners

Other high impact partners may provide overarching requirements for multiple sub-programs, such as the Accreditation Board for Engineering and Technology (ABET) who oversees the curriculum approval of most of the engineering programs in the country. Partnership with these high impact partners could result in immediate support from all of the organization's members. Some examples of these partners include:

- Accreditation Board for Engineering and Technology (ABET)
- Regional Energy Efficiency Offices (REEOs)
- State and local energy offices

5.4 Conclusion

By engaging a diverse set of educators towards a common goal, the collective influence on the market will be exponentially more impactful than the incremental influence of individual organizations. DOE looks forward to facilitating this process as part of its Building Science Education Strategy, but the important social change goal can only be achieved with a broad commitment to actively participate in the process.

For more information or to join the campaign, please contact Cheryn Metzger at Cheryn.metzger@pnnl.gov.

Appendix A

Guidelines for Building Science Education

Appendix A

Guidelines for Building Science Education

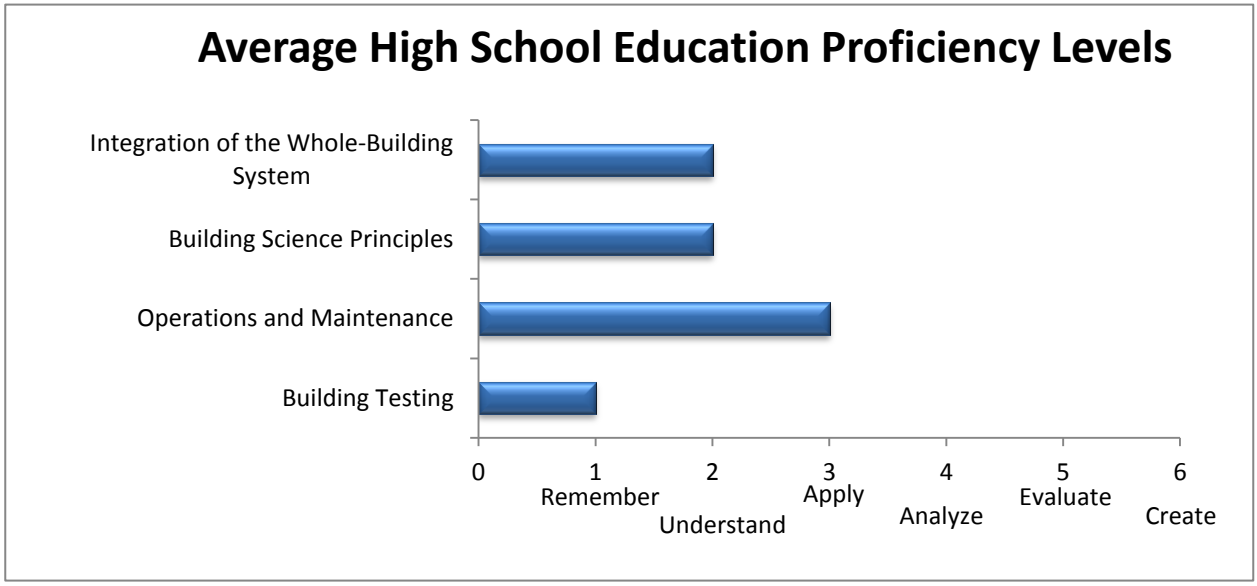
The Guidelines for Building Science Education are expanded upon in this appendix. Stakeholders who work with job classifications listed below can work with DOE and PNNL to self-certify their programs to comply with these guidelines.

Guidelines for High School Education
Guidelines for Builder (Owner)
Guidelines for Builder (Foreman)
Guidelines for Remodeler (Owners)
Guidelines for Remodeler (Foreman)
Guidelines for Insulation Contractors
Guidelines for HVAC Contractor
Guidelines for Enclosure Service Contractors
Guidelines for Plumbers
Guidelines for Home Performance Contractors
Guidelines for Utility Program Managers
Guidelines for "Green" Building Certification Professionals
Guidelines for Maintenance Professionals
Guidelines for Facility/Asset Managers
Guidelines for Real Estate Agents
Guidelines for Appraisers
Guidelines for Home Inspectors
Guidelines for Insurers
Guidelines for Underwriters
Guidelines for Architectural Engineers
Guidelines for Architects
Guidelines for Mechanical Engineers
Guidelines for Civil/Structural Engineers
Guidelines for Material Science Engineers
Guidelines for Home Designers
Guidelines for Interior Designers
Guidelines for Building Landscape Architects
Guidelines for Construction Managers
Guidelines for Building Forensic Professionals
Guidelines for Envelope QA/QC & Commissioning Agents

Guidelines for Mechanical QA/QC & Commissioning Agents
Guidelines for Energy Auditors
Guidelines for Performance Assessor
Guidelines for Code Officials

Building Science Education Guidelines for High School Education

A summary of the proficiency levels[1] for the core competencies are displayed in the graphic below.
For each core competency level described in this checklist, it is assumed that the organization or student is proficient in the level described, as well as all the cognitive levels below that level.



As the entity responsible for managing home energy certifiers, a high school graduate should be proficient in the following categories:

Topic	Proficiency Level	Checkbox
Integration of the whole-building system	Average = 2	
Simultaneous consideration of energy, durability, comfort and IAQ	1	☐
Annualized cash flow	2	☐
Building techniques related to natural and man-made disasters	2	☐
Integrated design and construction	2	☐
Quality management	2	☐
Building energy modeling	2	☐
Cost trade-off analysis (optimized first costs)	2	☐

[1] The average level shown here is the whole number that best represents the combination of individual scores from each sub-category.

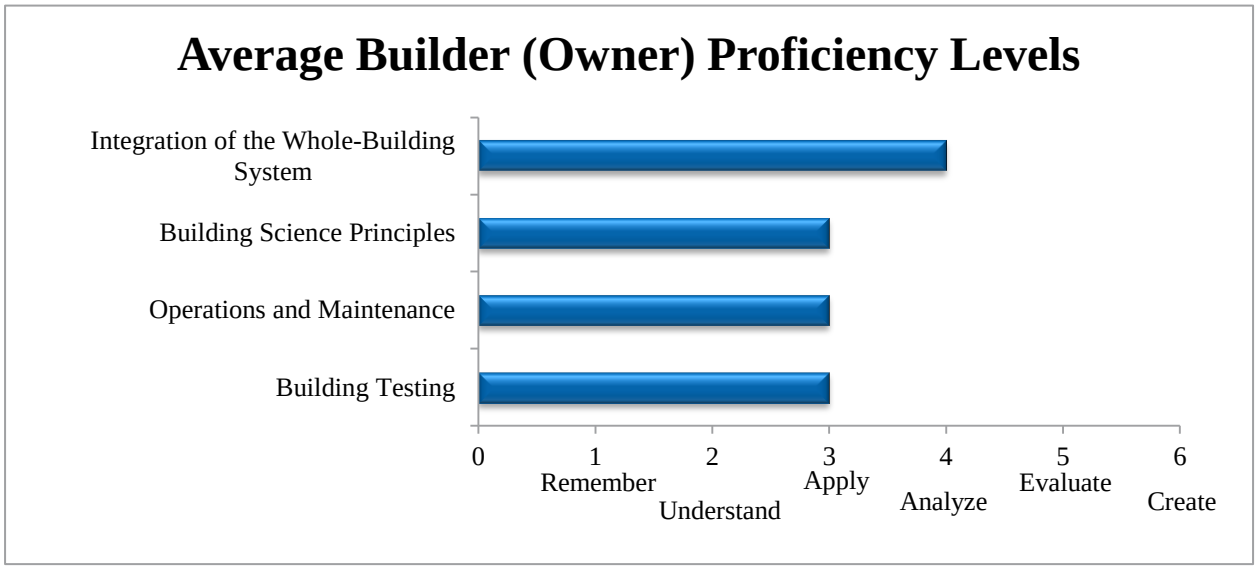
Topic	Proficiency Level	Checkbox
Building science principles related to the enclosure	Average = 2	
Heat transfer (convection, conduction and radiation)	1	☐
Moisture transport of liquid	1	☐
Convective air transport due to pressure differences	1	☐
Material selection (IAQ, thermal mass, moisture)	1	☐
Controls layers (heat, vapor, water, air and solar gain)	1	☐
Hygrothermal analysis	1	☐
HVAC systems (heating, cooling and ventilation)	2	☐
HVAC interactions with the enclosure	2	☐
Fenestration considerations	2	☐
Plumbing systems (heating, distribution, conservation)	2	☐
Electrical systems	2	☐
Lighting/appliances and miscellaneous loads	2	☐
Indoor environmental quality (temperature uniformity and indoor pollutants)	2	☐
Control/automation systems	2	☐
Operations and maintenance	Average = 3	
User controls (ex: thermostat)	3	☐
Preventative maintenance (ex: cleaning air filters)	3	☐
Determination of appropriate replacement choices	2	☐
Building testing and certification	Average = 1	
Commissioning	1	☐
Diagnostics and forensics	1	☐
Monitoring	2	☐
National codes and standards	1	☐
Certification programs	1	☐

The _____ high school education certification body has incorporated all of the relevant information in the above checklist into their training materials.

Signature _____

Building Science Education Guidelines for Builder (Owner)

A summary of the proficiency levels[1] for the core competencies are displayed in the graphic below. For each core competency level described in this checklist, it is assumed that the organization or student is proficient in the level described, as well as all the cognitive levels below that level.



As the entity responsible for managing home energy certifiers, a builder (owner) should be proficient in the following categories:

Topic	Proficiency Level	Checkbox
Integration of the whole-building system	Average = 4	
Simultaneous consideration of energy, durability, comfort and IAQ	4	☐
Annualized cash flow	5	☐
Building techniques related to natural and man-made disasters	3	☐
Integrated design and construction	4	☐
Quality management	5	☐
Building energy modeling	2	☐
Cost trade-off analysis (optimized first costs)	4	☐

[1] The average level shown here is the whole number that best represents the combination of individual scores from each sub-category.

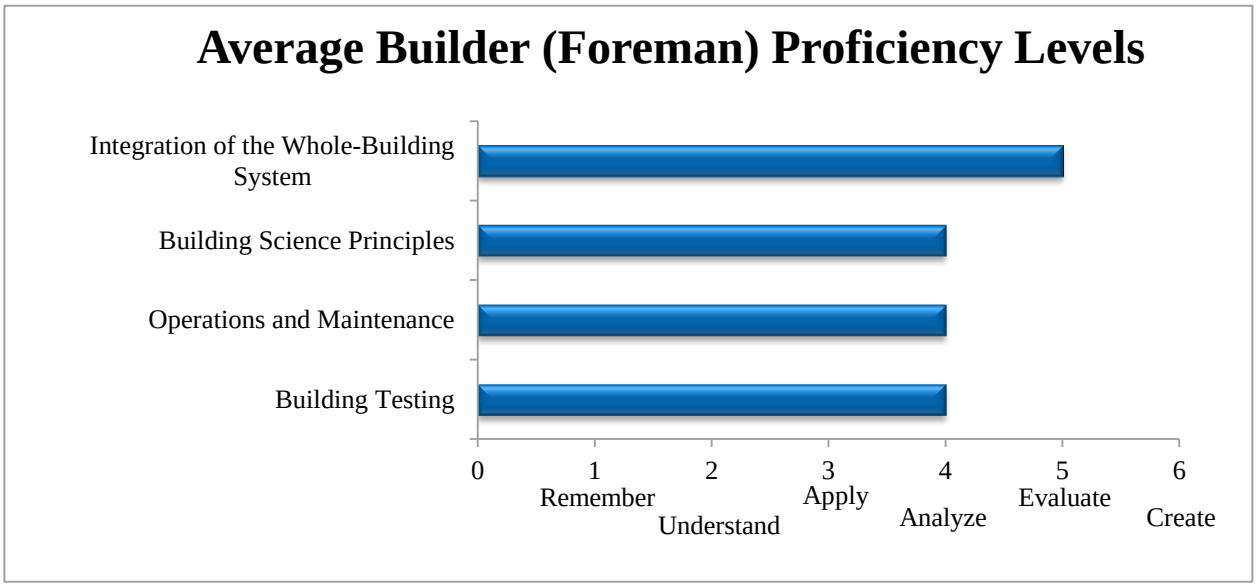
Topic	Proficiency Level	Checkbox
Building science principles related to the enclosure	Average = 3	
Heat transfer (convection, conduction and radiation)	2	☐
Moisture transport of liquid	3	☐
Convective air transport due to pressure differences	3	☐
Material selection (IAQ, thermal mass, moisture)	2	☐
Controls layers (heat, vapor, water, air and solar gain)	4	☐
Hygrothermal analysis	2	☐
HVAC systems (heating, cooling and ventilation)	3	☐
HVAC interactions with the enclosure	3	☐
Fenestration considerations	2	☐
Plumbing systems (heating, distribution, conservation)	3	☐
Electrical systems	2	☐
Lighting/appliances and miscellaneous loads	2	☐
Indoor environmental quality (temperature uniformity and indoor pollutants)	3	☐
Control/automation systems	3	☐
Operations and maintenance	Average = 3	
User controls (ex: thermostat)	3	☐
Preventative maintenance (ex: cleaning air filters)	2	☐
Determination of appropriate replacement choices	3	☐
Building testing and certification	Average = 3	
Commissioning	3	☐
Diagnostics and forensics	3	☐
Monitoring	3	☐
National codes and standards	3	☐
Certification programs	3	☐

The _____ builder (owner) certification body has incorporated all of the relevant information in the above checklist into their training materials.

Signature _____

Building Science Education Guidelines for Builder (Foreman)

A summary of the proficiency levels[1] for the core competencies are displayed in the graphic below. For each core competency level described in this checklist, it is assumed that the organization or student is proficient in the level described, as well as all the cognitive levels below that level.



As the entity responsible for managing home energy certifiers, a builder (foreman) should be proficient in the following categories:

Topic	Proficiency Level	Checkbox
Integration of the whole-building system	Average = 5	
Simultaneous consideration of energy, durability, comfort and IAQ	5	☐
Annualized cash flow	5	☐
Building techniques related to natural and man-made disasters	4	☐
Integrated design and construction	5	☐
Quality management	6	☐
Building energy modeling	3	☐
Cost trade-off analysis (optimized first costs)	5	☐

[1] The average level shown here is the whole number that best represents the combination of individual scores from each sub-category.

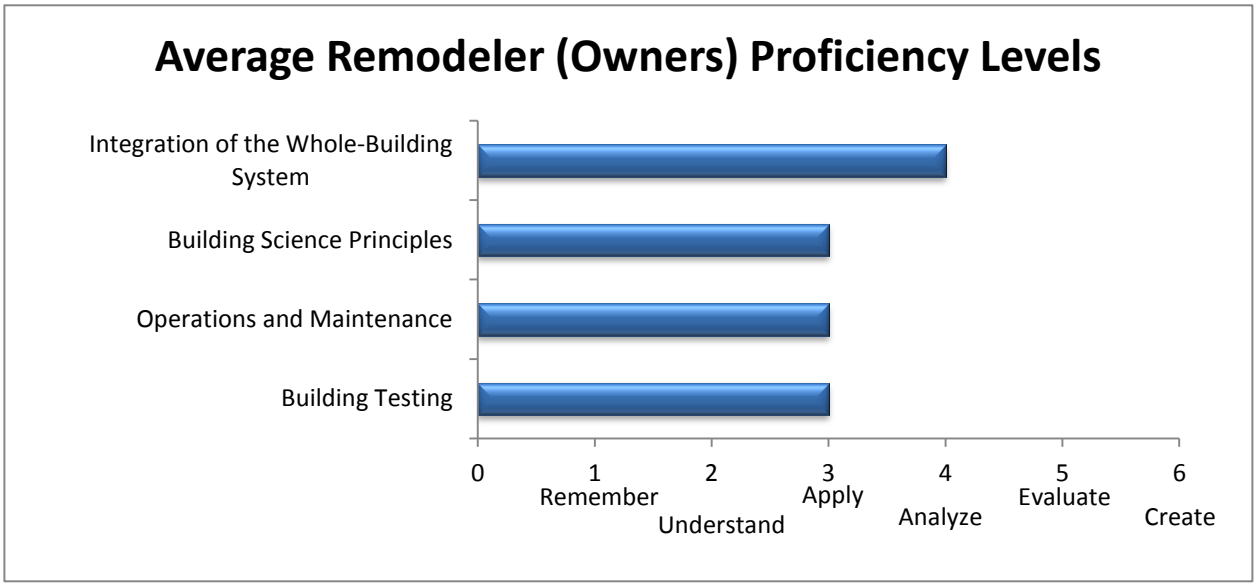
Topic	Proficiency Level	Checkbox
Building science principles related to the enclosure	Average = 4	
Heat transfer (convection, conduction and radiation)	3	☐
Moisture transport of liquid	4	☐
Convective air transport due to pressure differences	4	☐
Material selection (IAQ, thermal mass, moisture)	3	☐
Controls layers (heat, vapor, water, air and solar gain)	5	☐
Hygrothermal analysis	3	☐
HVAC systems (heating, cooling and ventilation)	4	☐
HVAC interactions with the enclosure	4	☐
Fenestration considerations	3	☐
Plumbing systems (heating, distribution, conservation)	4	☐
Electrical systems	2	☐
Lighting/appliances and miscellaneous loads	3	☐
Indoor environmental quality (temperature uniformity and indoor pollutants)	4	☐
Control/automation systems	4	☐
Operations and maintenance	Average = 4	
User controls (ex: thermostat)	4	☐
Preventative maintenance (ex: cleaning air filters)	3	☐
Determination of appropriate replacement choices	4	☐
Building testing and certification	Average = 4	
Commissioning	4	☐
Diagnostics and forensics	4	☐
Monitoring	4	☐
National codes and standards	3	☐
Certification programs	3	☐

The _____ builder (foreman) certification body has incorporated all of the relevant information in the above checklist into their training materials.

Signature _____

Building Science Education Guidelines for Remodeler (Owners)

A summary of the proficiency levels[1] for the core competencies are displayed in the graphic below. For each core competency level described in this checklist, it is assumed that the organization or student is proficient in the level described, as well as all the cognitive levels below that level.



As the entity responsible for managing home energy certifiers, a remodeler (owner) should be proficient in the following categories:

Topic	Proficiency Level	Checkbox
Integration of the whole-building system	Average = 4	
Simultaneous consideration of energy, durability, comfort and IAQ	4	☐
Annualized cash flow	5	☐
Building techniques related to natural and man-made disasters	3	☐
Integrated design and construction	4	☐
Quality management	5	☐
Building energy modeling	2	☐
Cost trade-off analysis (optimized first costs)	4	☐

[1] The average level shown here is the whole number that best represents the combination of individual scores from each sub-category.

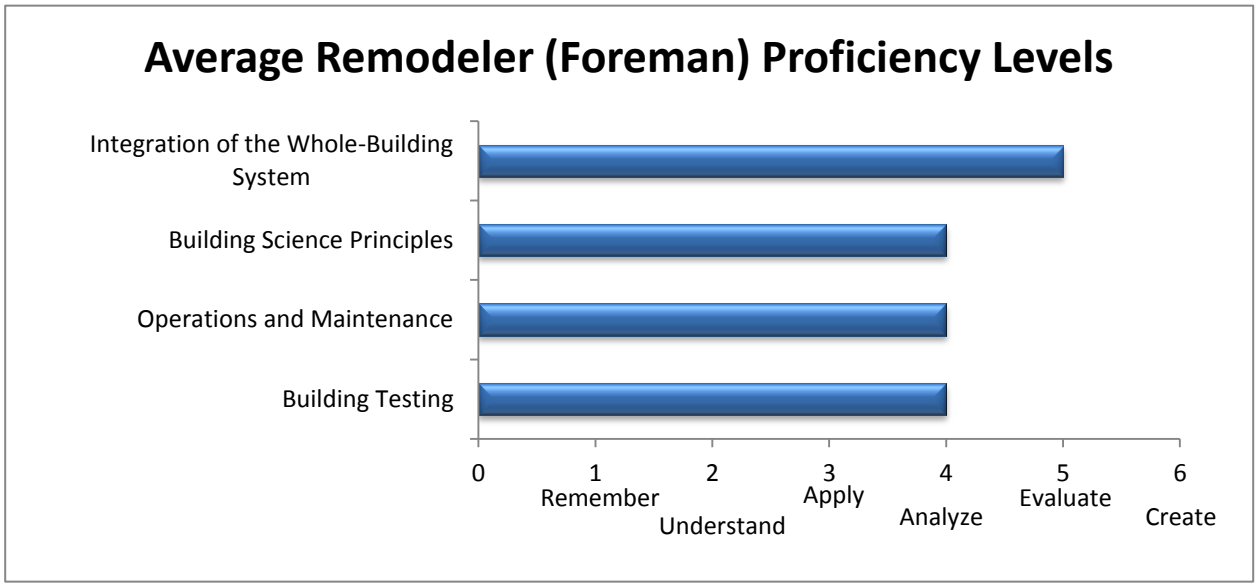
Topic	Proficiency Level	Checkbox
Building science principles related to the enclosure	Average = 3	
Heat transfer (convection, conduction and radiation)	2	☐
Moisture transport of liquid	3	☐
Convective air transport due to pressure differences	3	☐
Material selection (IAQ, thermal mass, moisture)	2	☐
Controls layers (heat, vapor, water, air and solar gain)	4	☐
Hygrothermal analysis	2	☐
HVAC systems (heating, cooling and ventilation)	3	☐
HVAC interactions with the enclosure	3	☐
Fenestration considerations	2	☐
Plumbing systems (heating, distribution, conservation)	3	☐
Electrical systems	2	☐
Lighting/appliances and miscellaneous loads	2	☐
Indoor environmental quality (temperature uniformity and indoor pollutants)	3	☐
Control/automation systems	3	☐
Operations and maintenance	Average = 3	
User controls (ex: thermostat)	3	☐
Preventative maintenance (ex: cleaning air filters)	2	☐
Determination of appropriate replacement choices	4	☐
Building testing and certification	Average = 3	
Commissioning	3	☐
Diagnostics and forensics	3	☐
Monitoring	3	☐
National codes and standards	3	☐
Certification programs	3	☐

The _____ remodeler (owner) certification body has incorporated all of the relevant information in the above checklist into their training materials.

Signature _____

Building Science Education Guidelines for Remodeler (Foreman)

A summary of the proficiency levels[1] for the core competencies are displayed in the graphic below. For each core competency level described in this checklist, it is assumed that the organization or student is proficient in the level described, as well as all the cognitive levels below that level.



As the entity responsible for managing home energy certifiers, a remodeler (foreman) should be proficient in the following categories:

Topic	Proficiency Level	Checkbox
Integration of the whole-building system	Average = 5	
Simultaneous consideration of energy, durability, comfort and IAQ	5	☐
Annualized cash flow	5	☐
Building techniques related to natural and man-made disasters	4	☐
Integrated design and construction	4	☐
Quality management	6	☐
Building energy modeling	3	☐
Cost trade-off analysis (optimized first costs)	5	☐

[1] The average level shown here is the whole number that best represents the combination of individual scores from each sub-category.

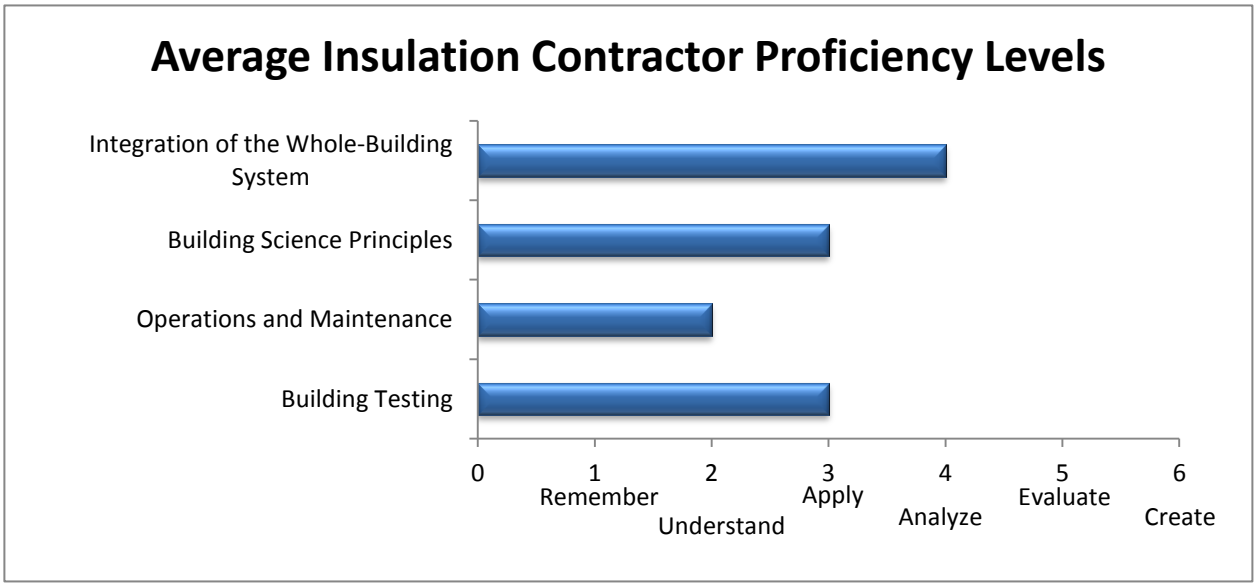
Topic	Proficiency Level	Checkbox
Building science principles related to the enclosure	Average = 4	
Heat transfer (convection, conduction and radiation)	3	☐
Moisture transport of liquid	4	☐
Convective air transport due to pressure differences	4	☐
Material selection (IAQ, thermal mass, moisture)	3	☐
Controls layers (heat, vapor, water, air and solar gain)	5	☐
Hygrothermal analysis	3	☐
HVAC systems (heating, cooling and ventilation)	4	☐
HVAC interactions with the enclosure	4	☐
Fenestration considerations	3	☐
Plumbing systems (heating, distribution, conservation)	4	☐
Electrical systems	3	☐
Lighting/appliances and miscellaneous loads	3	☐
Indoor environmental quality (temperature uniformity and indoor pollutants)	4	☐
Control/automation systems	4	☐
Operations and maintenance	Average = 4	
User controls (ex: thermostat)	4	☐
Preventative maintenance (ex: cleaning air filters)	3	☐
Determination of appropriate replacement choices	5	☐
Building testing and certification	Average = 4	
Commissioning	4	☐
Diagnostics and forensics	4	☐
Monitoring	3	☐
National codes and standards	4	☐
Certification programs	3	☐

The _____ remodeler (foreman) certification body has incorporated all of the relevant information in the above checklist into their training materials.

Signature _____

Building Science Education Guidelines for Insulation Contractors

A summary of the proficiency levels[1] for the core competencies are displayed in the graphic below. For each core competency level described in this checklist, it is assumed that the organization or student is proficient in the level described, as well as all the cognitive levels below that level.



As the entity responsible for managing home energy certifiers, an insulation contractor should be proficient in the following categories:

Topic	Proficiency Level	Checkbox
Integration of the whole-building system	Average = 4	
Simultaneous consideration of energy, durability, comfort and IAQ	5	☐
Annualized cash flow	4	☐
Building techniques related to natural and man-made disasters	4	☐
Integrated design and construction	3	☐
Quality management	6	☐
Building energy modeling	3	☐
Cost trade-off analysis (optimized first costs)	4	☐

[1] The average level shown here is the whole number that best represents the combination of individual scores from each sub-category.

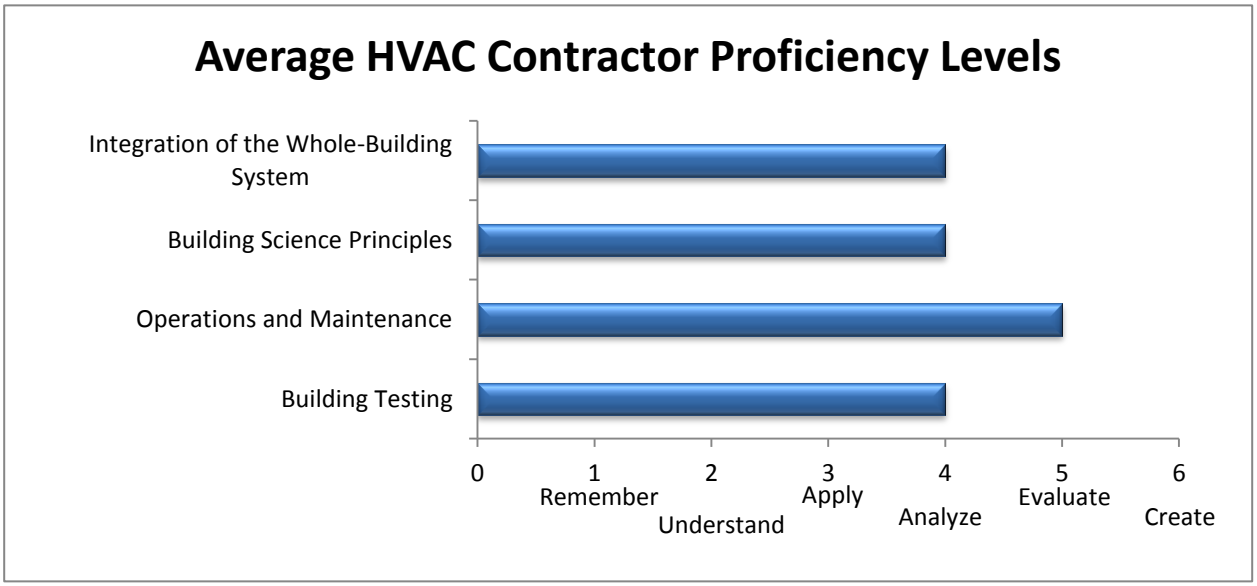
Topic	Proficiency Level	Checkbox
Building science principles related to the enclosure	Average = 3	
Heat transfer (convection, conduction and radiation)	5	☐
Moisture transport of liquid	4	☐
Convective air transport due to pressure differences	4	☐
Material selection (IAQ, thermal mass, moisture)	4	☐
Controls layers (heat, vapor, water, air and solar gain)	5	☐
Hygrothermal analysis	4	☐
HVAC systems (heating, cooling and ventilation)	3	☐
HVAC interactions with the enclosure	3	☐
Fenestration considerations	3	☐
Plumbing systems (heating, distribution, conservation)	2	☐
Electrical systems	2	☐
Lighting/appliances and miscellaneous loads	2	☐
Indoor environmental quality (temperature uniformity and indoor pollutants)	4	☐
Control/automation systems	2	☐
Operations and maintenance	Average = 2	
User controls (ex: thermostat)	2	☐
Preventative maintenance (ex: cleaning air filters)	2	☐
Determination of appropriate replacement choices	3	☐
Building testing and certification	Average = 3	
Commissioning	4	☐
Diagnostics and forensics	4	☐
Monitoring	4	☐
National codes and standards	3	☐
Certification programs	2	☐

The _____ insulation contractor certification body has incorporated all of the relevant information in the above checklist into their training materials.

Signature _____

Building Science Education Guidelines for HVAC Contractors

A summary of the proficiency levels[1] for the core competencies are displayed in the graphic below. For each core competency level described in this checklist, it is assumed that the organization or student is proficient in the level described, as well as all the cognitive levels below that level.



As the entity responsible for managing home energy certifiers, a HVAC contractor should be proficient in the following categories:

Topic	Proficiency Level	Checkbox
Integration of the whole-building system	Average = 4	
Simultaneous consideration of energy, durability, comfort and IAQ	5	☐
Annualized cash flow	4	☐
Building techniques related to natural and man-made disasters	2	☐
Integrated design and construction	4	☐
Quality management	6	☐
Building energy modeling	4	☐
Cost trade-off analysis (optimized first costs)	4	☐

[1] The average level shown here is the whole number that best represents the combination of individual scores from each sub-category.

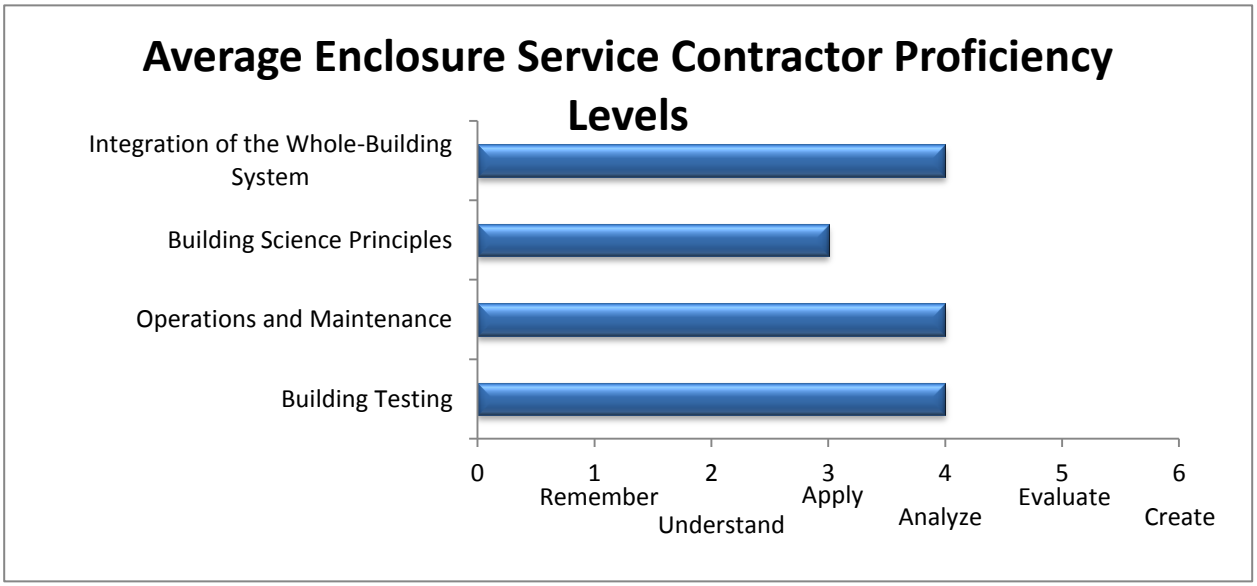
Topic	Proficiency Level	Checkbox
Building science principles related to the enclosure	Average = 4	
Heat transfer (convection, conduction and radiation)	4	☐
Moisture transport of liquid	4	☐
Convective air transport due to pressure differences	4	☐
Material selection (IAQ, thermal mass, moisture)	2	☐
Controls layers (heat, vapor, water, air and solar gain)	4	☐
Hygrothermal analysis	2	☐
HVAC interactions with the enclosure	5	☐
HVAC systems (heating, cooling and ventilation)	5	☐
Fenestration considerations	4	☐
Plumbing systems (heating, distribution, conservation)	3	☐
Electrical systems	3	☐
Lighting/appliances and miscellaneous loads	3	☐
Indoor environmental quality (temperature uniformity and indoor pollutants)	5	☐
Control/automation systems	5	☐
Operations and maintenance	Average = 5	
User controls (ex: thermostat)	5	☐
Preventative maintenance (ex: cleaning air filters)	4	☐
Determination of appropriate replacement choices	5	☐
Building testing and certification	Average = 4	
Commissioning	5	☐
Diagnostics and forensics	5	☐
Monitoring	5	☐
National codes and standards	3	☐
Certification programs	2	☐

The _____ HVAC contractor certification body has incorporated all of the relevant information in the above checklist into their training materials.

Signature _____

Building Science Education Guidelines for Enclosure Service Contractors

A summary of the proficiency levels[1] for the core competencies are displayed in the graphic below. For each core competency level described in this checklist, it is assumed that the organization or student is proficient in the level described, as well as all the cognitive levels below that level.



As the entity responsible for managing home energy certifiers, an enclosure service contractor should be proficient in the following categories:

Topic	Proficiency Level	Checkbox
Integration of the whole-building system	Average = 4	
Simultaneous consideration of energy, durability, comfort and IAQ	5	☐
Annualized cash flow	4	☐
Building techniques related to natural and man-made disasters	5	☐
Integrated design and construction	4	☐
Quality management	6	☐
Building energy modeling	3	☐
Cost trade-off analysis (optimized first costs)	4	☐

[1] The average level shown here is the whole number that best represents the combination of individual scores from each sub-category.

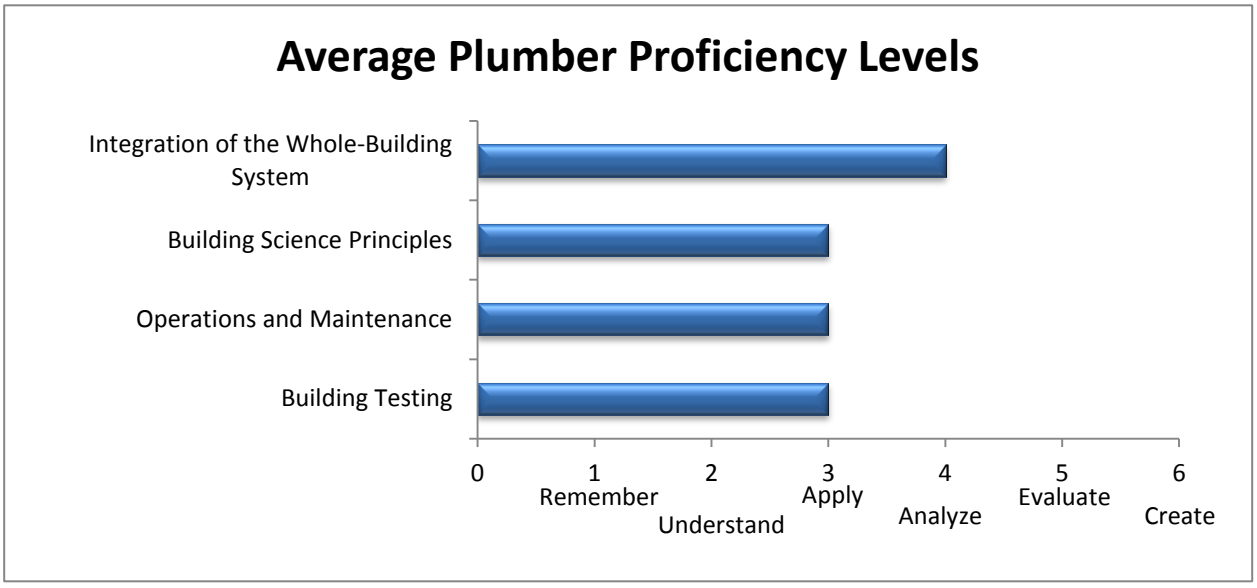
Topic	Proficiency Level	Checkbox
Building science principles related to the enclosure	Average = 3	
Heat transfer (convection, conduction and radiation)	4	☐
Moisture transport of liquid	4	☐
Convective air transport due to pressure differences	3	☐
Material selection (IAQ, thermal mass, moisture)	4	☐
Controls layers (heat, vapor, water, air and solar gain)	5	☐
Hygrothermal analysis	3	☐
HVAC systems (heating, cooling and ventilation)	3	☐
HVAC interactions with the enclosure	3	☐
Fenestration considerations	4	☐
Plumbing systems (heating, distribution, conservation)	3	☐
Electrical systems	3	☐
Lighting/appliances and miscellaneous loads	2	☐
Indoor environmental quality (temperature uniformity and indoor pollutants)	3	☐
Control/automation systems	3	☐
Operations and maintenance	Average = 4	
User controls (ex: thermostat)	3	☐
Preventative maintenance (ex: cleaning air filters)	4	☐
Determination of appropriate replacement choices	5	☐
Building testing and certification	Average = 4	
Commissioning	5	☐
Diagnostics and forensics	4	☐
Monitoring	4	☐
National codes and standards	3	☐
Certification programs	2	☐

The _____ enclosure service contractor certification body has incorporated all of the relevant information in the above checklist into their training materials.

Signature _____

Building Science Education Guidelines for Plumbers

A summary of the proficiency levels[1] for the core competencies are displayed in the graphic below. For each core competency level described in this checklist, it is assumed that the organization or student is proficient in the level described, as well as all the cognitive levels below that level.



As the entity responsible for managing home energy certifiers, a plumber should be proficient in the following categories:

Topic	Proficiency Level	Checkbox
Integration of the whole-building system	Average = 4	
Simultaneous consideration of energy, durability, comfort and IAQ	4	☐
Annualized cash flow	4	☐
Building techniques related to natural and man-made disasters	3	☐
Integrated design and construction	3	☐
Quality management	6	☐
Building energy modeling	2	☐
Cost trade-off analysis (optimized first costs)	4	☐

[1] The average level shown here is the whole number that best represents the combination of individual scores from each sub-category.

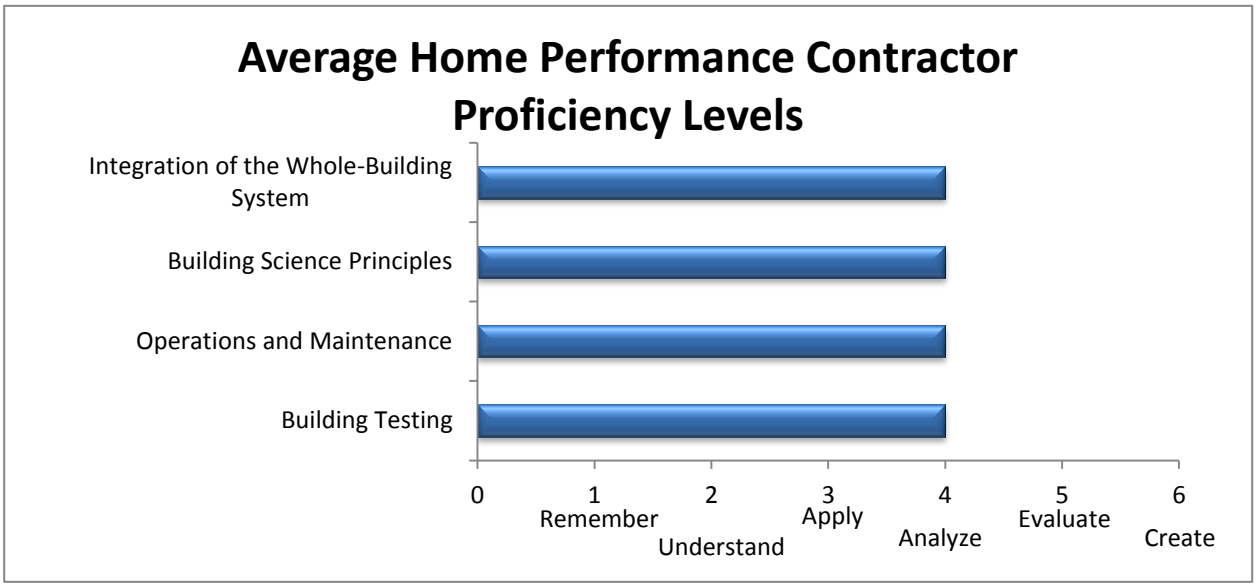
Topic	Proficiency Level	Checkbox
Building science principles related to the enclosure	Average = 3	
Heat transfer (convection, conduction and radiation)	2	☐
Moisture transport of liquid	2	☐
Convective air transport due to pressure differences	3	☐
Material selection (IAQ, thermal mass, moisture)	2	☐
Controls layers (heat, vapor, water, air and solar gain)	2	☐
Hygrothermal analysis	2	☐
HVAC systems (heating, cooling and ventilation)	3	☐
HVAC interactions with the enclosure	3	☐
Fenestration considerations	2	☐
Plumbing systems (heating, distribution, conservation)	5	☐
Electrical systems	2	☐
Lighting/appliances and miscellaneous loads	3	☐
Indoor environmental quality (temperature uniformity and indoor pollutants)	3	☐
Control/automation systems	2	☐
Operations and maintenance	Average = 3	
User controls (ex: thermostat)	2	☐
Preventative maintenance (ex: cleaning air filters)	3	☐
Determination of appropriate replacement choices	4	☐
Building testing and certification	Average = 3	
Commissioning	3	☐
Diagnostics and forensics	4	☐
Monitoring	2	☐
National codes and standards	3	☐
Certification programs	2	☐

The _____ plumber certification body has incorporated all of the relevant information in the above checklist into their training materials.

Signature _____

Building Science Education Guidelines for Home Performance Contractors

A summary of the proficiency levels[1] for the core competencies are displayed in the graphic below. For each core competency level described in this checklist, it is assumed that the organization or student is proficient in the level described, as well as all the cognitive levels below that level.



As the entity responsible for managing home energy certifiers, a home performance contractor should be proficient in the following categories:

Topic	Proficiency Level	Checkbox
Integration of the whole-building system	Average = 4	
Simultaneous consideration of energy, durability, comfort and IAQ	4	☐
Annualized cash flow	4	☐
Building techniques related to natural and man-made disasters	4	☐
Integrated design and construction	4	☐
Quality management	5	☐
Building energy modeling	4	☐
Cost trade-off analysis (optimized first costs)	5	☐

[1] The average level shown here is the whole number that best represents the combination of individual scores from each sub-category.

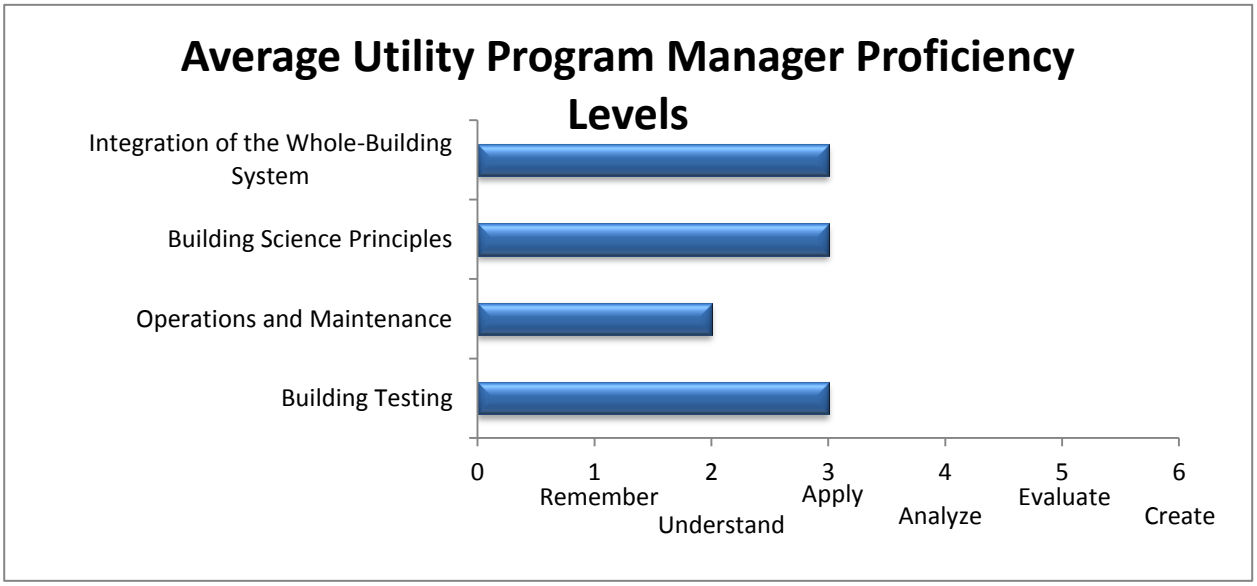
Topic	Proficiency Level	Checkbox
Building science principles related to the enclosure	Average = 4	
Heat transfer (convection, conduction and radiation)	4	☐
Moisture transport of liquid	4	☐
Convective air transport due to pressure differences	4	☐
Material selection (IAQ, thermal mass, moisture)	4	☐
Controls layers (heat, vapor, water, air and solar gain)	4	☐
Hygrothermal analysis	4	☐
HVAC systems (heating, cooling and ventilation)	4	☐
HVAC interactions with the enclosure	4	☐
Fenestration considerations	4	☐
Plumbing systems (heating, distribution, conservation)	4	☐
Electrical systems	3	☐
Lighting/appliances and miscellaneous loads	4	☐
Indoor environmental quality (temperature uniformity and indoor pollutants)	4	☐
Control/automation systems	4	☐
Operations and maintenance	Average = 4	
User controls (ex: thermostat)	4	☐
Preventative maintenance (ex: cleaning air filters)	4	☐
Determination of appropriate replacement choices	5	☐
Building testing and certification	Average = 4	
Commissioning	5	☐
Diagnostics and forensics	5	☐
Monitoring	5	☐
National codes and standards	3	☐
Certification programs	2	☐

The _____ home performance contractor certification body has incorporated all of the relevant information in the above checklist into their training materials.

Signature _____

Building Science Education Guidelines for Utility Program Managers

A summary of the proficiency levels[1] for the core competencies are displayed in the graphic below. For each core competency level described in this checklist, it is assumed that the organization or student is proficient in the level described, as well as all the cognitive levels below that level.



As the entity responsible for managing home energy certifiers, an utility program manager should be proficient in the following categories:

Topic	Proficiency Level	Checkbox
Integration of the whole-building system	Average = 3	
Simultaneous consideration of energy, durability, comfort and IAQ	3	☐
Annualized cash flow	2	☐
Building techniques related to natural and man-made disasters	3	☐
Integrated design and construction	2	☐
Quality management	4	☐
Building energy modeling	3	☐
Cost trade-off analysis (optimized first costs)	3	☐

[1] The average level shown here is the whole number that best represents the combination of individual scores from each sub-category.

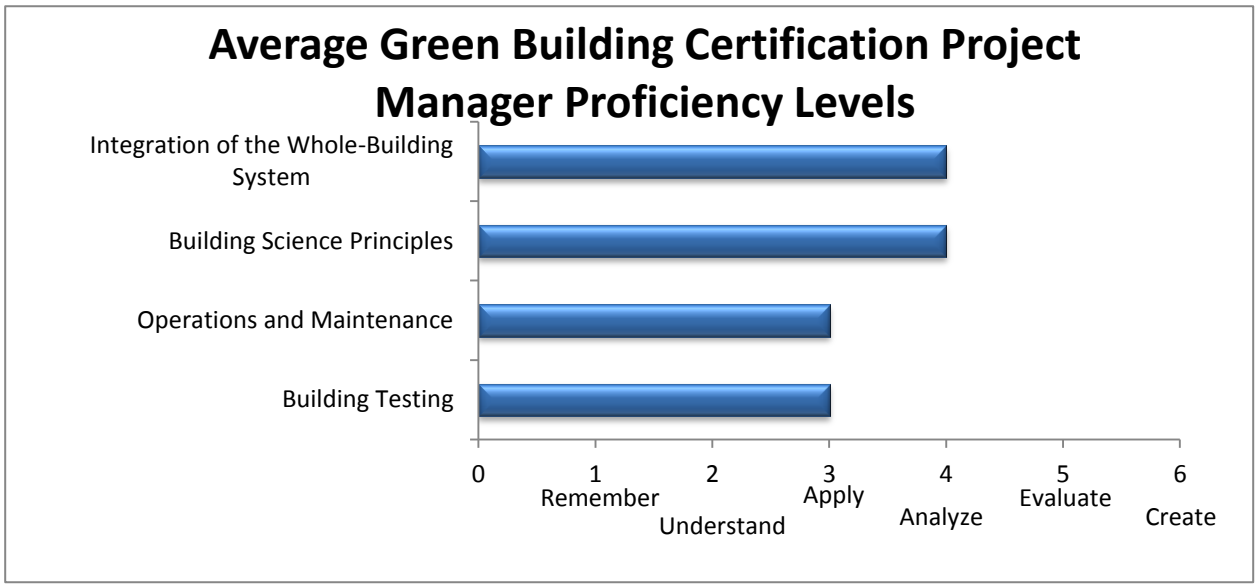
Topic	Proficiency Level	Checkbox
Building science principles related to the enclosure	Average = 3	
Heat transfer (convection, conduction and radiation)	3	☐
Moisture transport of liquid	3	☐
Convective air transport due to pressure differences	3	☐
Material selection (IAQ, thermal mass, moisture)	3	☐
Controls layers (heat, vapor, water, air and solar gain)	3	☐
Hygrothermal analysis	1	☐
HVAC systems (heating, cooling and ventilation)	4	☐
HVAC interactions with the enclosure	3	☐
Fenestration considerations	3	☐
Plumbing systems (heating, distribution, conservation)	3	☐
Electrical systems	3	☐
Lighting/appliances and miscellaneous loads	4	☐
Indoor environmental quality (temperature uniformity and indoor pollutants)	4	☐
Control/automation systems	3	☐
Operations and maintenance	Average = 2	
User controls (ex: thermostat)	2	☐
Preventative maintenance (ex: cleaning air filters)	2	☐
Determination of appropriate replacement choices	3	☐
Building testing and certification	Average = 3	
Commissioning	3	☐
Diagnostics and forensics	3	☐
Monitoring	3	☐
National codes and standards	1	☐
Certification programs	3	☐

The _____ utility program manager certification body has incorporated all of the relevant information in the above checklist into their training materials.

Signature _____

Building Science Education Guidelines for "Green" Building Certification Professionals

A summary of the proficiency levels[1] for the core competencies are displayed in the graphic below. For each core competency level described in this checklist, it is assumed that the organization or student is proficient in the level described, as well as all the cognitive levels below that level.



As the entity responsible for managing home energy certifiers, a green building certification professional should be proficient in the following categories:

Topic	Proficiency Level	Checkbox
Integration of the whole-building system	Average = 4	
Simultaneous consideration of energy, durability, comfort and IAQ	5	☐
Annualized cash flow	5	☐
Building techniques related to natural and man-made disasters	4	☐
Integrated design and construction	4	☐
Quality management	3	☐
Building energy modeling	6	☐
Cost trade-off analysis (optimized first costs)	3	☐

[1] The average level shown here is the whole number that best represents the combination of individual scores from each sub-category.

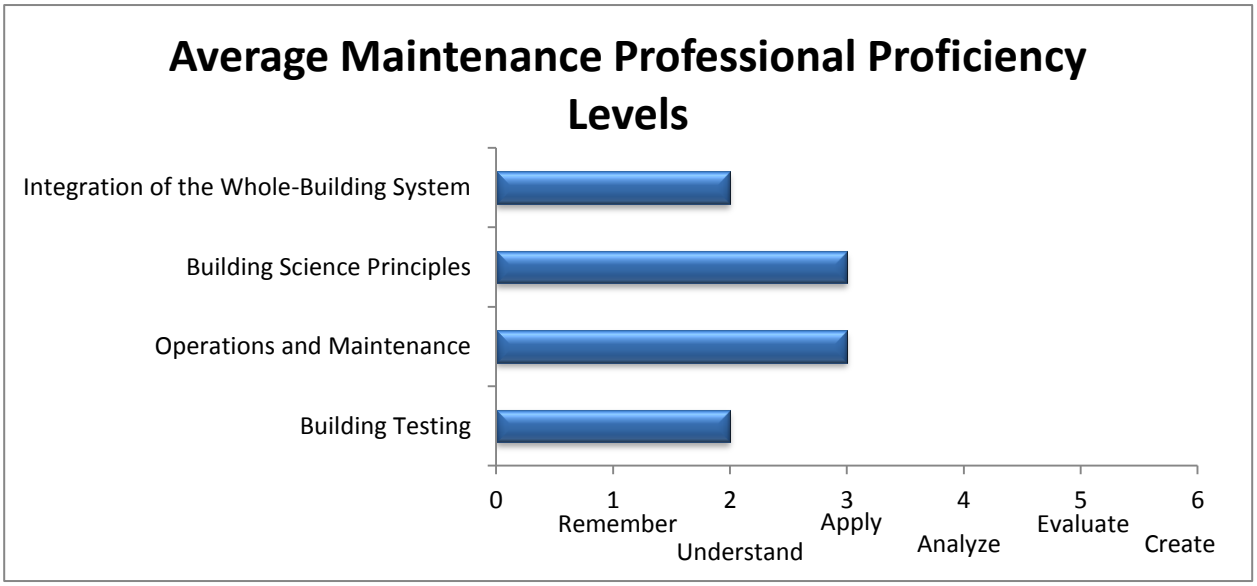
Topic	Proficiency Level	Checkbox
Building science principles related to the enclosure	Average = 4	
Heat transfer (convection, conduction and radiation)	4	☐
Moisture transport of liquid	4	☐
Convective air transport due to pressure differences	5	☐
Material selection (IAQ, thermal mass, moisture)	5	☐
Controls layers (heat, vapor, water, air and solar gain)	5	☐
Hygrothermal analysis	4	☐
HVAC systems (heating, cooling and ventilation)	4	☐
HVAC interactions with the enclosure	4	☐
Fenestration considerations	5	☐
Plumbing systems (heating, distribution, conservation)	4	☐
Electrical systems	2	☐
Lighting/appliances and miscellaneous loads	4	☐
Indoor environmental quality (temperature uniformity and indoor pollutants)	5	☐
Control/automation systems	3	☐
Operations and maintenance	Average = 3	
User controls (ex: thermostat)	3	☐
Preventative maintenance (ex: cleaning air filters)	3	☐
Determination of appropriate replacement choices	3	☐
Building testing and certification	Average = 3	
Commissioning	4	☐
Diagnostics and forensics	4	☐
Monitoring	4	☐
National codes and standards	2	☐
Certification programs	3	☐

The _____ green building certification professional certification body has incorporated all of the relevant information in the above checklist into their training materials.

Signature _____

Building Science Education Guidelines for Maintenance Professionals

A summary of the proficiency levels[1] for the core competencies are displayed in the graphic below. For each core competency level described in this checklist, it is assumed that the organization or student is proficient in the level described, as well as all the cognitive levels below that level.



As the entity responsible for managing home energy certifiers, a maintenance professional should be proficient in the following categories:

Topic	Proficiency Level	Checkbox
Integration of the whole-building system	Average = 2	
Simultaneous consideration of energy, durability, comfort and IAQ	3	☐
Annualized cash flow	3	☐
Building techniques related to natural and man-made disasters	3	☐
Integrated design and construction	2	☐
Quality management	2	☐
Building energy modeling	1	☐
Cost trade-off analysis (optimized first costs)	2	☐

[1] The average level shown here is the whole number that best represents the combination of individual scores from each sub-category.

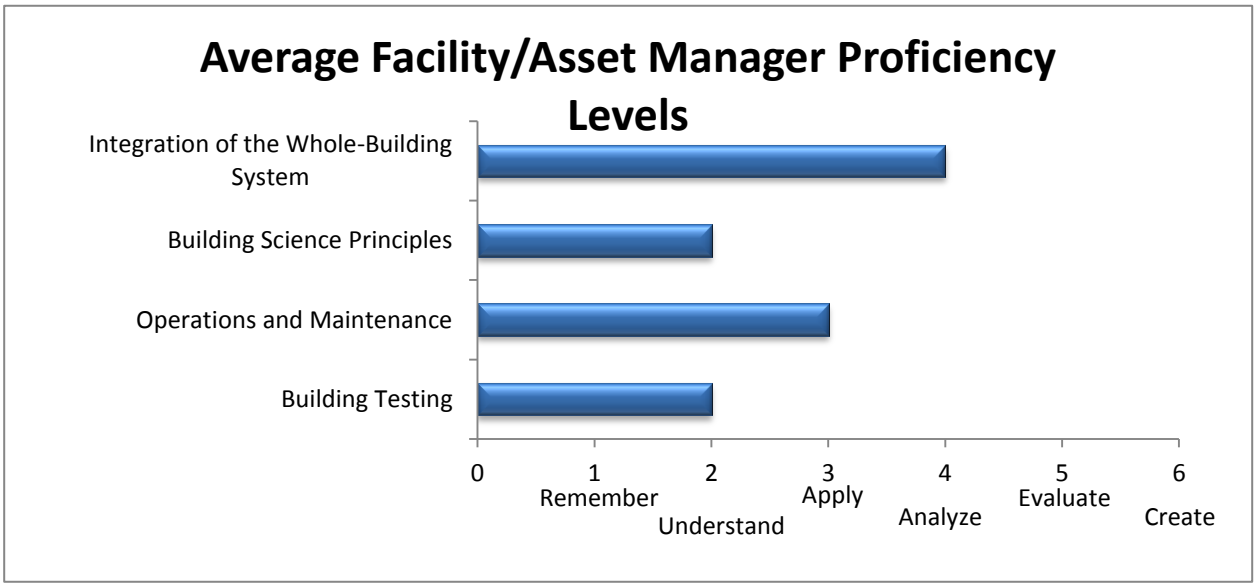
Topic	Proficiency Level	Checkbox
Building science principles related to the enclosure	Average = 3	
Heat transfer (convection, conduction and radiation)	3	☐
Moisture transport of liquid	3	☐
Convective air transport due to pressure differences	3	☐
Material selection (IAQ, thermal mass, moisture)	2	☐
Controls layers (heat, vapor, water, air and solar gain)	3	☐
Hygrothermal analysis	1	☐
HVAC systems (heating, cooling and ventilation)	3	☐
HVAC interactions with the enclosure	3	☐
Fenestration considerations	3	☐
Plumbing systems (heating, distribution, conservation)	3	☐
Electrical systems	3	☐
Lighting/appliances and miscellaneous loads	3	☐
Indoor environmental quality (temperature uniformity and indoor pollutants)	3	☐
Control/automation systems	3	☐
Operations and maintenance	Average = 3	
User controls (ex: thermostat)	3	☐
Preventative maintenance (ex: cleaning air filters)	3	☐
Determination of appropriate replacement choices	3	☐
Building testing and certification	Average = 2	
Commissioning	2	☐
Diagnostics and forensics	3	☐
Monitoring	3	☐
National codes and standards	1	☐
Certification programs	2	☐

The _____ maintenance professional certification body has incorporated all of the relevant information in the above checklist into their training materials.

Signature _____

Building Science Education Guidelines for Facility/Asset Managers

A summary of the proficiency levels[1] for the core competencies are displayed in the graphic below. For each core competency level described in this checklist, it is assumed that the organization or student is proficient in the level described, as well as all the cognitive levels below that level.



As the entity responsible for managing home energy certifiers, a facility/asset manager should be proficient in the following categories:

Topic	Proficiency Level	Checkbox
Integration of the whole-building system	Average = 4	
Simultaneous consideration of energy, durability, comfort and IAQ	3	☐
Annualized cash flow	5	☐
Building techniques related to natural and man-made disasters	3	☐
Integrated design and construction	3	☐
Quality management	4	☐
Building energy modeling	3	☐
Cost trade-off analysis (optimized first costs)	5	☐

[1] The average level shown here is the whole number that best represents the combination of individual scores from each sub-category.

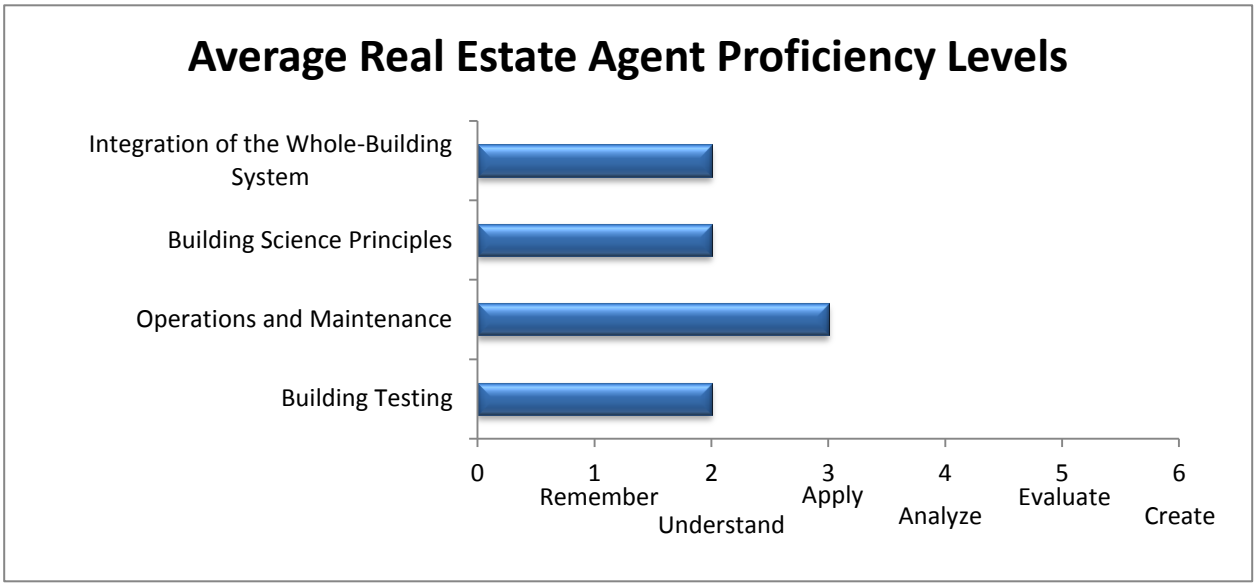
Topic	Proficiency Level	Checkbox
Building science principles related to the enclosure	Average = 2	
Heat transfer (convection, conduction and radiation)	2	☐
Moisture transport of liquid	2	☐
Convective air transport due to pressure differences	2	☐
Material selection (IAQ, thermal mass, moisture)	2	☐
Controls layers (heat, vapor, water, air and solar gain)	2	☐
Hygrothermal analysis	1	☐
HVAC systems (heating, cooling and ventilation)	2	☐
HVAC interactions with the enclosure	2	☐
Fenestration considerations	2	☐
Plumbing systems (heating, distribution, conservation)	2	☐
Electrical systems	2	☐
Lighting/appliances and miscellaneous loads	4	☐
Indoor environmental quality (temperature uniformity and indoor pollutants)	2	☐
Control/automation systems	4	☐
Operations and maintenance	Average = 3	
User controls (ex: thermostat)	2	☐
Preventative maintenance (ex: cleaning air filters)	2	☐
Determination of appropriate replacement choices	4	☐
Building testing and certification	Average = 2	
Commissioning	2	☐
Diagnostics and forensics	2	☐
Monitoring	3	☐
National codes and standards	1	☐
Certification programs	2	☐

The _____ facility/asset manager certification body has incorporated all of the relevant information in the above checklist into their training materials.

Signature _____

Building Science Education Guidelines for Real Estate Agents

A summary of the proficiency levels[1] for the core competencies are displayed in the graphic below. For each core competency level described in this checklist, it is assumed that the organization or student is proficient in the level described, as well as all the cognitive levels below that level.



As the entity responsible for managing home energy certifiers, a real estate agent should be proficient in the following categories:

Topic	Proficiency Level	Checkbox
Integration of the whole-building system	Average = 2	
Simultaneous consideration of energy, durability, comfort and IAQ	3	☐
Annualized cash flow	2	☐
Building techniques related to natural and man-made disasters	2	☐
Integrated design and construction	2	☐
Quality management	2	☐
Building energy modeling	2	☐
Cost trade-off analysis (optimized first costs)	3	☐

[1] The average level shown here is the whole number that best represents the combination of individual scores from each sub-category.

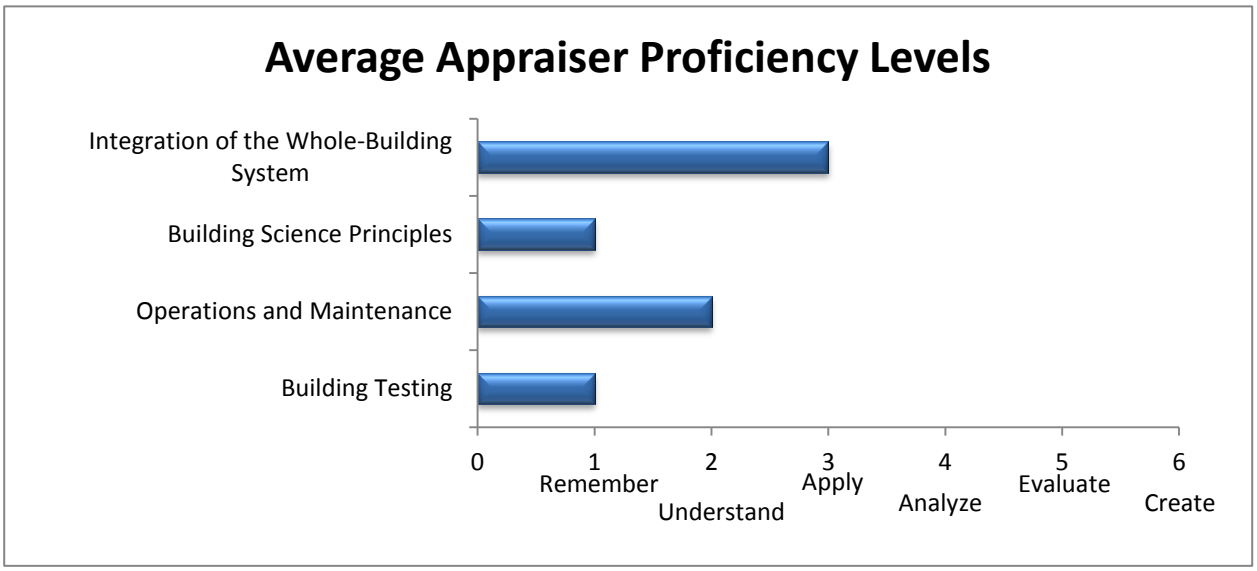
Topic	Proficiency Level	Checkbox
Building science principles related to the enclosure	Average = 2	
Heat transfer (convection, conduction and radiation)	2	☐
Moisture transport of liquid	2	☐
Convective air transport due to pressure differences	2	☐
Material selection (IAQ, thermal mass, moisture)	3	☐
Controls layers (heat, vapor, water, air and solar gain)	2	☐
Hygrothermal analysis	1	☐
HVAC systems (heating, cooling and ventilation)	3	☐
HVAC interactions with the enclosure	2	☐
Fenestration considerations	2	☐
Plumbing systems (heating, distribution, conservation)	2	☐
Electrical systems	2	☐
Lighting/appliances and miscellaneous loads	3	☐
Indoor environmental quality (temperature uniformity and indoor pollutants)	3	☐
Control/automation systems	2	☐
Operations and maintenance	Average = 3	
User controls (ex: thermostat)	3	☐
Preventative maintenance (ex: cleaning air filters)	3	☐
Determination of appropriate replacement choices	3	☐
Building testing and certification	Average = 2	
Commissioning	2	☐
Diagnostics and forensics	2	☐
Monitoring	2	☐
National codes and standards	1	☐
Certification programs	3	☐

The _____ real estate agent certification body has incorporated all of the relevant information in the above checklist into their training materials.

Signature _____

Building Science Education Guidelines for Appraisers

A summary of the proficiency levels[1] for the core competencies are displayed in the graphic below. For each core competency level described in this checklist, it is assumed that the organization or student is proficient in the level described, as well as all the cognitive levels below that level.



As the entity responsible for managing home energy certifiers, an appraiser should be proficient in the following categories:

Topic	Proficiency Level	Checkbox
Integration of the whole-building system	Average = 3	
Simultaneous consideration of energy, durability, comfort and IAQ	3	☐
Annualized cash flow	4	☐
Building techniques related to natural and man-made disasters	3	☐
Integrated design and construction	2	☐
Quality management	0	☐
Building energy modeling	2	☐
Cost trade-off analysis (optimized first costs)	4	☐

[1] The average level shown here is the whole number that best represents the combination of individual scores from each sub-category.

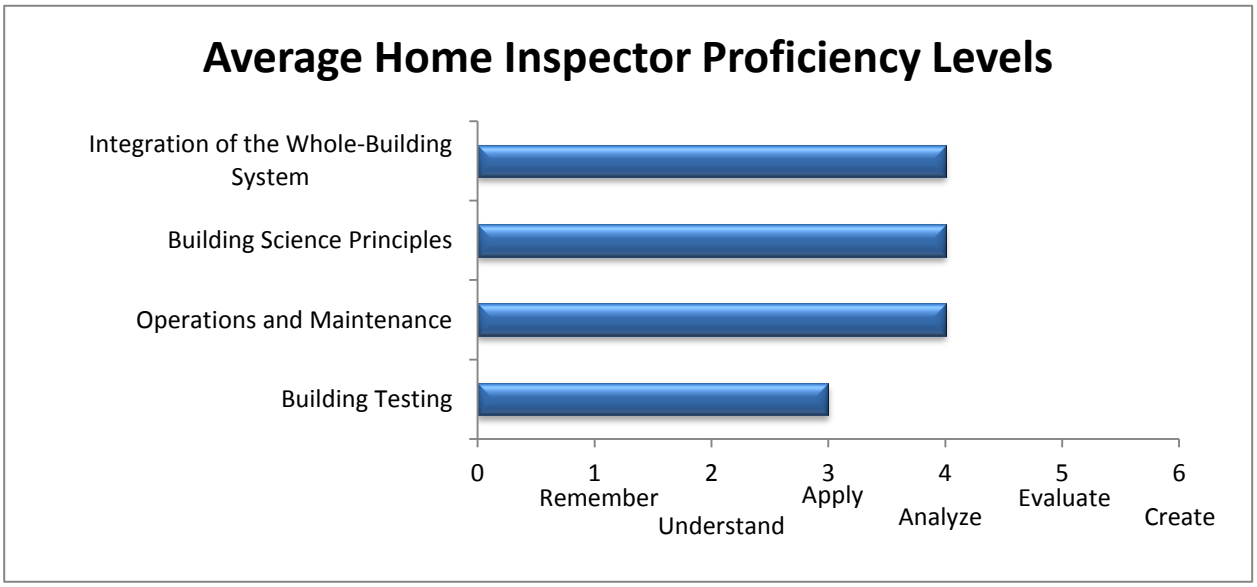
Topic	Proficiency Level	Checkbox
Building science principles related to the enclosure	Average = 1	
Heat transfer (convection, conduction and radiation)	0	☐
Moisture transport of liquid	0	☐
Convective air transport due to pressure differences	0	☐
Material selection (IAQ, thermal mass, moisture)	0	☐
Controls layers (heat, vapor, water, air and solar gain)	2	☐
Hygrothermal analysis	0	☐
HVAC systems (heating, cooling and ventilation)	2	☐
HVAC interactions with the enclosure	2	☐
Fenestration considerations	0	☐
Plumbing systems (heating, distribution, conservation)	0	☐
Electrical systems	0	☐
Lighting/appliances and miscellaneous loads	1	☐
Indoor environmental quality (temperature uniformity and indoor pollutants)	2	☐
Control/automation systems	1	☐
Operations and maintenance	Average = 2	
User controls (ex: thermostat)	2	☐
Preventative maintenance (ex: cleaning air filters)	0	☐
Determination of appropriate replacement choices	3	☐
Building testing and certification	Average = 1	
Commissioning	2	☐
Diagnostics and forensics	0	☐
Monitoring	0	☐
National codes and standards	1	☐
Certification programs	2	☐

The _____ appraiser certification body has incorporated all of the relevant information in the above checklist into their training materials.

Signature _____

Building Science Education Guidelines for Home Inspectors

A summary of the proficiency levels[1] for the core competencies are displayed in the graphic below. For each core competency level described in this checklist, it is assumed that the organization or student is proficient in the level described, as well as all the cognitive levels below that level.



As the entity responsible for managing home energy certifiers, a home inspector should be proficient in the following categories:

Topic	Proficiency Level	Checkbox
Integration of the whole-building system	Average = 4	
Simultaneous consideration of energy, durability, comfort and IAQ	5	☐
Annualized cash flow	3	☐
Building techniques related to natural and man-made disasters	4	☐
Integrated design and construction	3	☐
Quality management	4	☐
Building energy modeling	3	☐
Cost trade-off analysis (optimized first costs)	3	☐

[1] The average level shown here is the whole number that best represents the combination of individual scores from each sub-category.

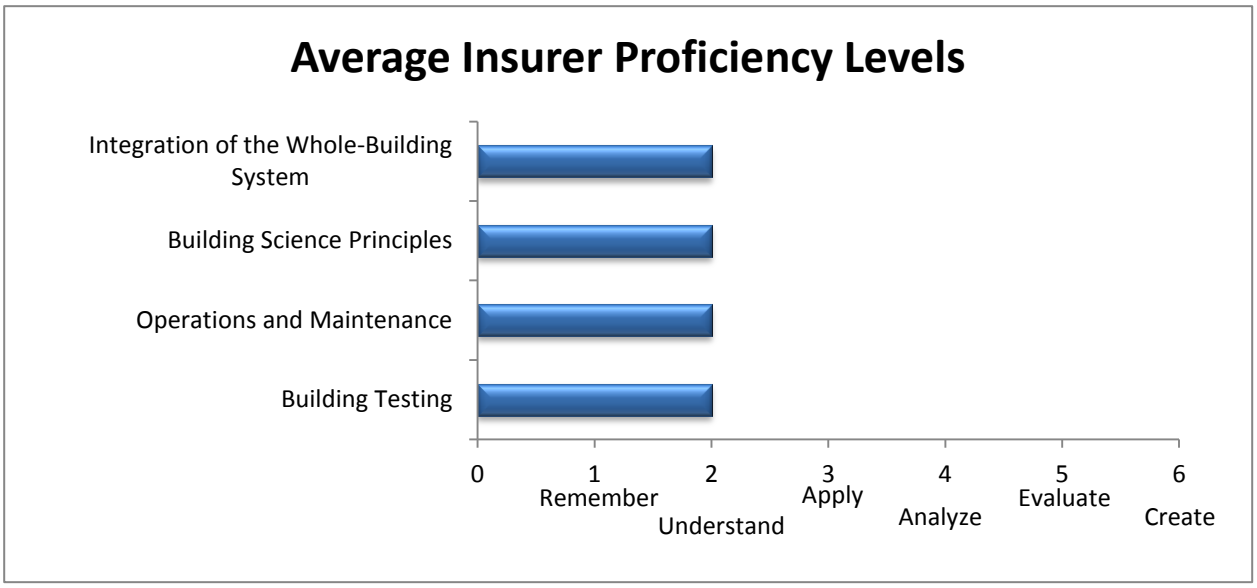
Topic	Proficiency Level	Checkbox
Building science principles related to the enclosure	Average = 4	
Heat transfer (convection, conduction and radiation)	4	☐
Moisture transport of liquid	4	☐
Convective air transport due to pressure differences	4	☐
Material selection (IAQ, thermal mass, moisture)	4	☐
Controls layers (heat, vapor, water, air and solar gain)	4	☐
Hygrothermal analysis	2	☐
HVAC systems (heating, cooling and ventilation)	4	☐
HVAC interactions with the enclosure	4	☐
Fenestration considerations	4	☐
Plumbing systems (heating, distribution, conservation)	4	☐
Electrical systems	4	☐
Lighting/appliances and miscellaneous loads	3	☐
Indoor environmental quality (temperature uniformity and indoor pollutants)	4	☐
Control/automation systems	2	☐
Operations and maintenance	Average = 4	
User controls (ex: thermostat)	4	☐
Preventative maintenance (ex: cleaning air filters)	3	☐
Determination of appropriate replacement choices	4	☐
Building testing and certification	Average = 3	
Commissioning	3	☐
Diagnostics and forensics	4	☐
Monitoring	4	☐
National codes and standards	3	☐
Certification programs	2	☐

The _____ home inspector certification body has incorporated all of the relevant information in the above checklist into their training materials.

Signature _____

Building Science Education Guidelines for Insurers

A summary of the proficiency levels[1] for the core competencies are displayed in the graphic below. For each core competency level described in this checklist, it is assumed that the organization or student is proficient in the level described, as well as all the cognitive levels below that level.



As the entity responsible for managing home energy certifiers, an insurer should be proficient in the following categories:

Topic	Proficiency Level	Checkbox
Integration of the whole-building system	Average = 2	
Simultaneous consideration of energy, durability, comfort and IAQ	2	☐
Annualized cash flow	3	☐
Building techniques related to natural and man-made disasters	4	☐
Integrated design and construction	2	☐
Quality management	2	☐
Building energy modeling	2	☐
Cost trade-off analysis (optimized first costs)	2	☐

[1] The average level shown here is the whole number that best represents the combination of individual scores from each sub-category.

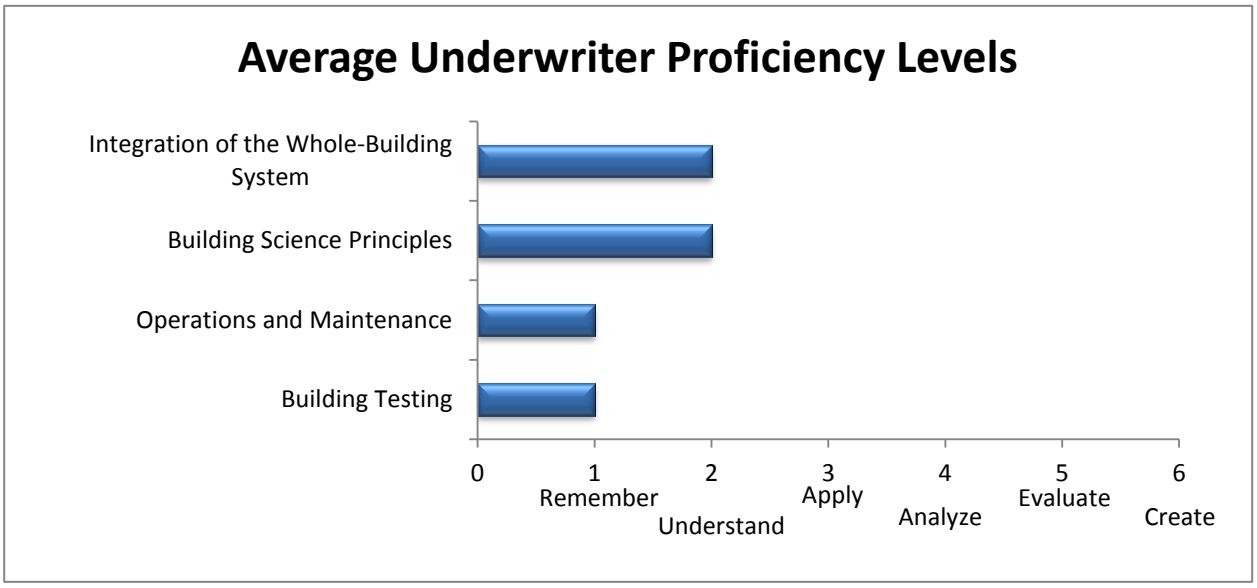
Topic	Proficiency Level	Checkbox
Building science principles related to the enclosure	Average = 2	
Heat transfer (convection, conduction and radiation)	2	☐
Moisture transport of liquid	2	☐
Convective air transport due to pressure differences	2	☐
Material selection (IAQ, thermal mass, moisture)	2	☐
Controls layers (heat, vapor, water, air and solar gain)	2	☐
Hygrothermal analysis	2	☐
HVAC systems (heating, cooling and ventilation)	2	☐
HVAC interactions with the enclosure	1	☐
Fenestration considerations	3	☐
Plumbing systems (heating, distribution, conservation)	2	☐
Electrical systems	2	☐
Lighting/appliances and miscellaneous loads	2	☐
Indoor environmental quality (temperature uniformity and indoor pollutants)	1	☐
Control/automation systems	2	☐
Operations and maintenance	Average = 2	
User controls (ex: thermostat)	1	☐
Preventative maintenance (ex: cleaning air filters)	2	☐
Determination of appropriate replacement choices	2	☐
Building testing and certification	Average = 2	
Commissioning	2	☐
Diagnostics and forensics	3	☐
Monitoring	2	☐
National codes and standards	2	☐
Certification programs	3	☐

The _____ insurer certification body has incorporated all of the relevant information in the above checklist into their training materials.

Signature _____

Building Science Education Guidelines for Underwriters

A summary of the proficiency levels[1] for the core competencies are displayed in the graphic below. For each core competency level described in this checklist, it is assumed that the organization or student is proficient in the level described, as well as all the cognitive levels below that level.



As the entity responsible for managing home energy certifiers, an underwriter should be proficient in the following categories:

Topic	Proficiency Level	Checkbox
Integration of the whole-building system	Average = 2	
Simultaneous consideration of energy, durability, comfort and IAQ	3	☐
Annualized cash flow	4	☐
Building techniques related to natural and man-made disasters	3	☐
Integrated design and construction	1	☐
Quality management	2	☐
Building energy modeling	2	☐
Cost trade-off analysis (optimized first costs)	2	☐

[1] The average level shown here is the whole number that best represents the combination of individual scores from each sub-category.

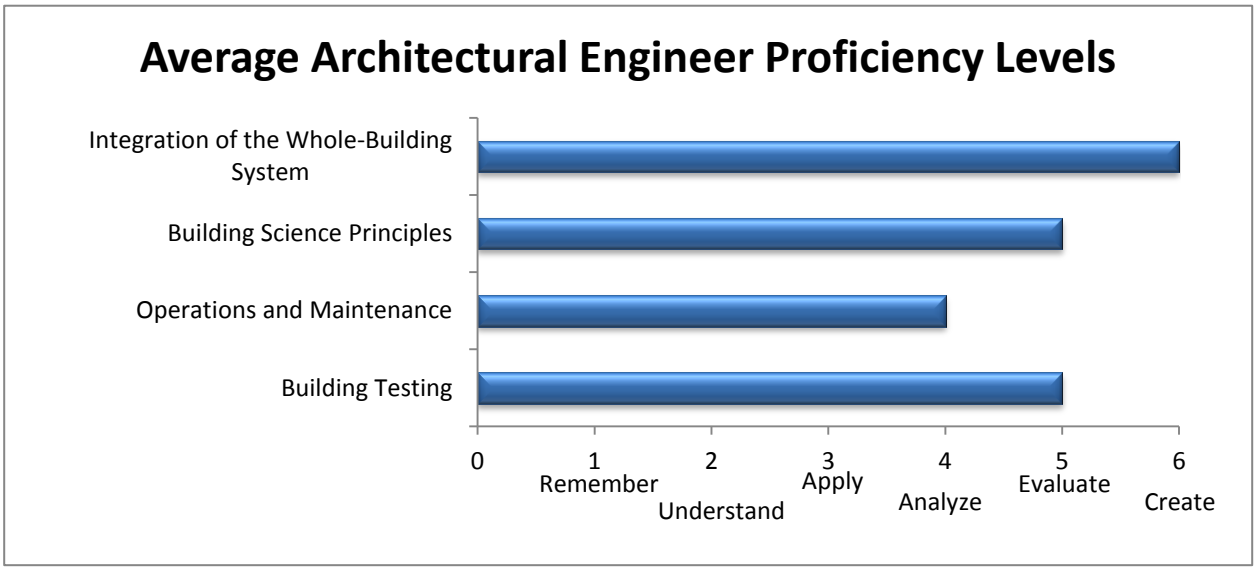
Topic	Proficiency Level	Checkbox
Building science principles related to the enclosure	Average = 2	
Heat transfer (convection, conduction and radiation)	1	☐
Moisture transport of liquid	1	☐
Convective air transport due to pressure differences	1	☐
Material selection (IAQ, thermal mass, moisture)	2	☐
Controls layers (heat, vapor, water, air and solar gain)	1	☐
Hygrothermal analysis	1	☐
HVAC systems (heating, cooling and ventilation)	2	☐
HVAC interactions with the enclosure	1	☐
Fenestration considerations	2	☐
Plumbing systems (heating, distribution, conservation)	2	☐
Electrical systems	2	☐
Lighting/appliances and miscellaneous loads	2	☐
Indoor environmental quality (temperature uniformity and indoor pollutants)	2	☐
Control/automation systems	2	☐
Operations and maintenance	Average = 1	
User controls (ex: thermostat)	1	☐
Preventative maintenance (ex: cleaning air filters)	1	☐
Determination of appropriate replacement choices	2	☐
Building testing and certification	Average = 1	
Commissioning	2	☐
Diagnostics and forensics	1	☐
Monitoring	1	☐
National codes and standards	1	☐
Certification programs	2	☐

The _____ underwriter certification body has incorporated all of the relevant information in the above checklist into their training materials.

Signature _____

Building Science Education Guidelines for Architectural Engineers

A summary of the proficiency levels[1] for the core competencies are displayed in the graphic below. For each core competency level described in this checklist, it is assumed that the organization or student is proficient in the level described, as well as all the cognitive levels below that level.



As the entity responsible for managing home energy certifiers, an architectural engineer should be proficient in the following categories:

Topic	Proficiency Level	Checkbox
Integration of the whole-building system	Average = 6	
Simultaneous consideration of energy, durability, comfort and IAQ	6	☐
Annualized cash flow	6	☐
Building techniques related to natural and man-made disasters	6	☐
Integrated design and construction	5	☐
Quality management	5	☐
Building energy modeling	6	☐
Cost trade-off analysis (optimized first costs)	5	☐

[1] The average level shown here is the whole number that best represents the combination of individual scores from each sub-category.

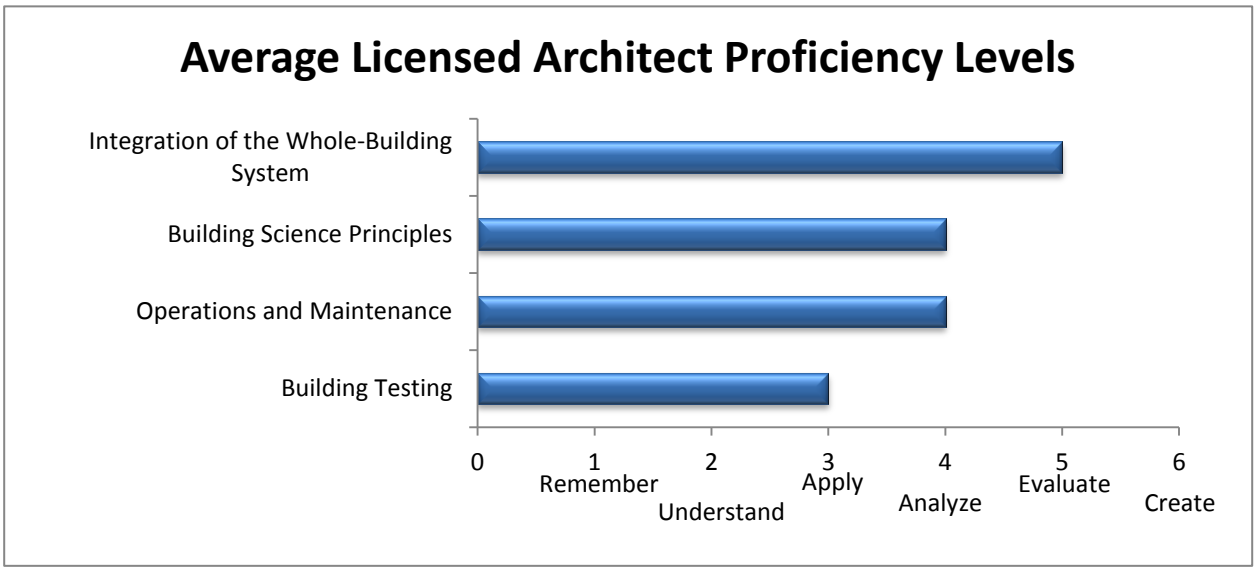
Topic	Proficiency Level	Checkbox
Building science principles related to the enclosure	Average = 5	
Heat transfer (convection, conduction and radiation)	5	☐
Moisture transport of liquid	5	☐
Convective air transport due to pressure differences	5	☐
Material selection (IAQ, thermal mass, moisture)	5	☐
Controls layers (heat, vapor, water, air and solar gain)	6	☐
Hygrothermal analysis	6	☐
HVAC systems (heating, cooling and ventilation)	6	☐
HVAC interactions with the enclosure	5	☐
Fenestration considerations	6	☐
Plumbing systems (heating, distribution, conservation)	6	☐
Electrical systems	5	☐
Lighting/appliances and miscellaneous loads	4	☐
Indoor environmental quality (temperature uniformity and indoor pollutants)	5	☐
Control/automation systems	5	☐
Operations and maintenance	Average = 4	
User controls (ex: thermostat)	3	☐
Preventative maintenance (ex: cleaning air filters)	4	☐
Determination of appropriate replacement choices	5	☐
Building testing and certification	Average = 5	
Commissioning	6	☐
Diagnostics and forensics	5	☐
Monitoring	6	☐
National codes and standards	3	☐
Certification programs	3	☐

The _____ architectural engineer certification body has incorporated all of the relevant information in the above checklist into their training materials.

Signature _____

Building Science Education Guidelines for Licensed Architects

A summary of the proficiency levels[1] for the core competencies are displayed in the graphic below. For each core competency level described in this checklist, it is assumed that the organization or student is proficient in the level described, as well as all the cognitive levels below that level.



As the entity responsible for managing home energy certifiers, a licensed architect should be proficient in the following categories:

Topic	Proficiency Level	Checkbox
Integration of the whole-building system	Average = 5	
Simultaneous consideration of energy, durability, comfort and IAQ	6	☐
Annualized cash flow	6	☐
Building techniques related to natural and man-made disasters	6	☐
Integrated design and construction	5	☐
Quality management	4	☐
Building energy modeling	5	☐
Cost trade-off analysis (optimized first costs)	5	☐

[1] The average level shown here is the whole number that best represents the combination of individual scores from each sub-category.

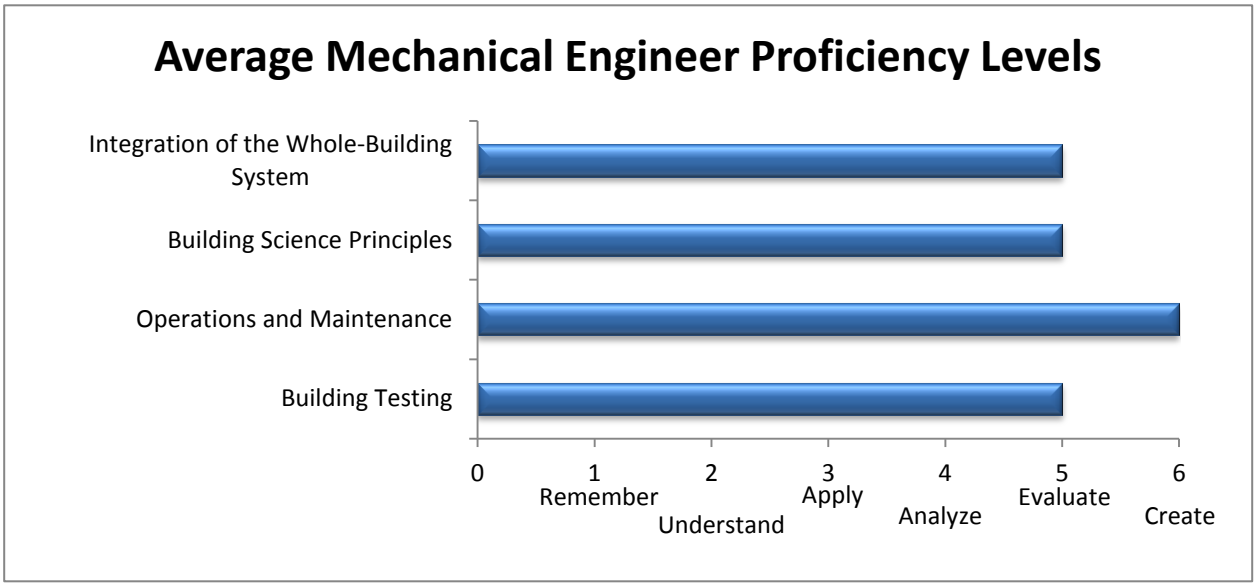
Topic	Proficiency Level	Checkbox
Building science principles related to the enclosure	Average = 4	
Heat transfer (convection, conduction and radiation)	4	☐
Moisture transport of liquid	5	☐
Convective air transport due to pressure differences	5	☐
Material selection (IAQ, thermal mass, moisture)	5	☐
Controls layers (heat, vapor, water, air and solar gain)	6	☐
Hygrothermal analysis	5	☐
HVAC systems (heating, cooling and ventilation)	4	☐
HVAC interactions with the enclosure	4	☐
Fenestration considerations	5	☐
Plumbing systems (heating, distribution, conservation)	3	☐
Electrical systems	3	☐
Lighting/appliances and miscellaneous loads	5	☐
Indoor environmental quality (temperature uniformity and indoor pollutants)	4	☐
Control/automation systems	4	☐
Operations and maintenance	Average = 4	
User controls (ex: thermostat)	4	☐
Preventative maintenance (ex: cleaning air filters)	4	☐
Determination of appropriate replacement choices	5	☐
Building testing and certification	Average = 3	
Commissioning	4	☐
Diagnostics and forensics	3	☐
Monitoring	4	☐
National codes and standards	3	☐
Certification programs	3	☐

The _____ licensed architect certification body has incorporated all of the relevant information in the above checklist into their training materials.

Signature _____

Building Science Education Guidelines for Mechanical Engineers

A summary of the proficiency levels[1] for the core competencies are displayed in the graphic below. For each core competency level described in this checklist, it is assumed that the organization or student is proficient in the level described, as well as all the cognitive levels below that level.



As the entity responsible for managing home energy certifiers, a mechanical engineer should be proficient in the following categories:

Topic	Proficiency Level	Checkbox
Integration of the whole-building system	Average = 5	
Simultaneous consideration of energy, durability, comfort and IAQ	6	☐
Annualized cash flow	6	☐
Building techniques related to natural and man-made disasters	5	☐
Integrated design and construction	4	☐
Quality management	5	☐
Building energy modeling	5	☐
Cost trade-off analysis (optimized first costs)	4	☐

[1] The average level shown here is the whole number that best represents the combination of individual scores from each sub-category.

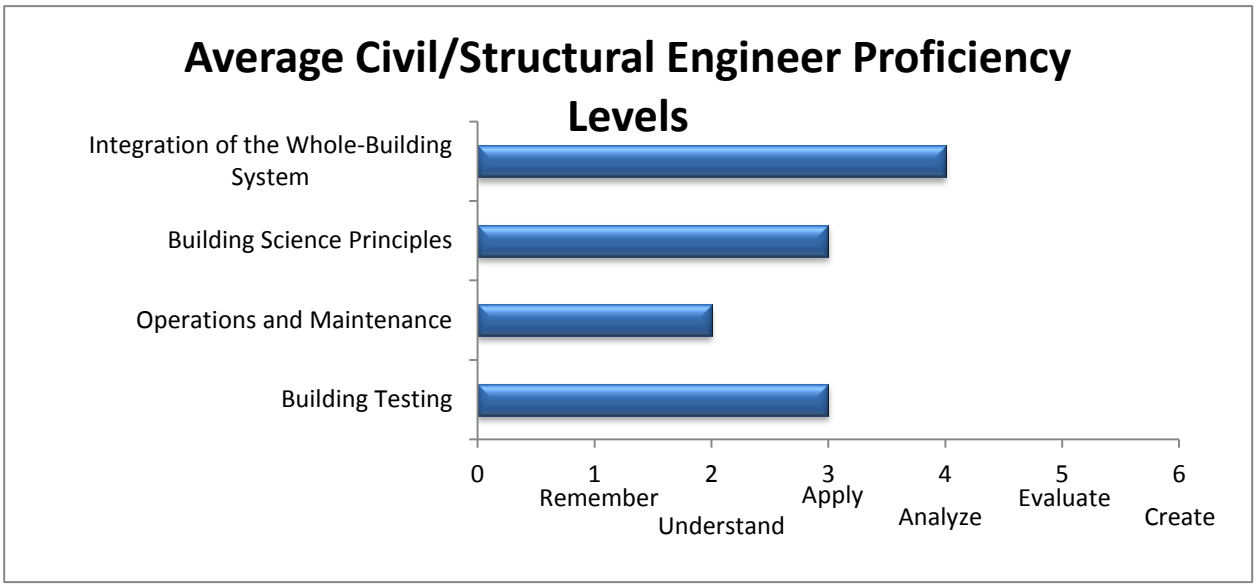
Topic	Proficiency Level	Checkbox
Building science principles related to the enclosure	Average = 5	
Heat transfer (convection, conduction and radiation)	6	☐
Moisture transport of liquid	5	☐
Convective air transport due to pressure differences	6	☐
Material selection (IAQ, thermal mass, moisture)	4	☐
Controls layers (heat, vapor, water, air and solar gain)	4	☐
Hygrothermal analysis	3	☐
HVAC systems (heating, cooling and ventilation)	6	☐
HVAC interactions with the enclosure	6	☐
Fenestration considerations	5	☐
Plumbing systems (heating, distribution, conservation)	5	☐
Electrical systems	3	☐
Lighting/appliances and miscellaneous loads	4	☐
Indoor environmental quality (temperature uniformity and indoor pollutants)	6	☐
Control/automation systems	5	☐
Operations and maintenance	Average = 6	
User controls (ex: thermostat)	6	☐
Preventative maintenance (ex: cleaning air filters)	5	☐
Determination of appropriate replacement choices	6	☐
Building testing and certification	Average = 5	
Commissioning	6	☐
Diagnostics and forensics	5	☐
Monitoring	6	☐
National codes and standards	3	☐
Certification programs	3	☐

The _____ mechanical engineer certification body has incorporated all of the relevant information in the above checklist into their training materials.

Signature _____

Building Science Education Guidelines for Civil/Structural Engineers

A summary of the proficiency levels[1] for the core competencies are displayed in the graphic below. For each core competency level described in this checklist, it is assumed that the organization or student is proficient in the level described, as well as all the cognitive levels below that level.



As the entity responsible for managing home energy certifiers, a civil/structural engineer should be proficient in the following categories:

Topic	Proficiency Level	Checkbox
Integration of the whole-building system	Average = 4	
Simultaneous consideration of energy, durability, comfort and IAQ	5	☐
Annualized cash flow	5	☐
Building techniques related to natural and man-made disasters	5	☐
Integrated design and construction	3	☐
Quality management	5	☐
Building energy modeling	4	☐
Cost trade-off analysis (optimized first costs)	4	☐

[1] The average level shown here is the whole number that best represents the combination of individual scores from each sub-category.

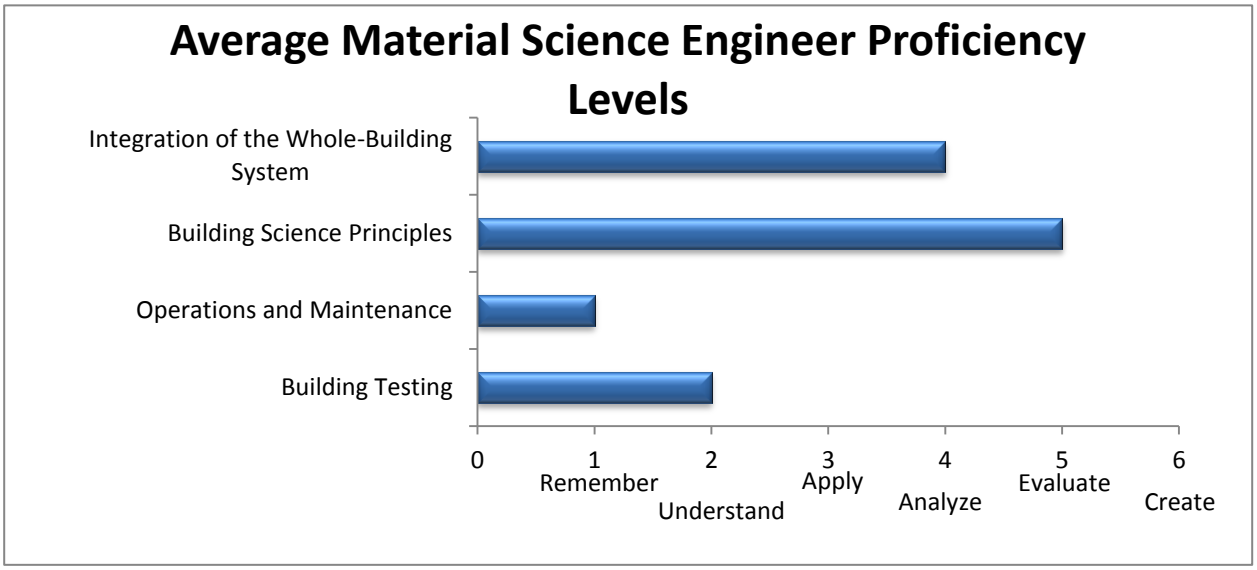
Topic	Proficiency Level	Checkbox
Building science principles related to the enclosure	Average = 3	
Heat transfer (convection, conduction and radiation)	3	☐
Moisture transport of liquid	4	☐
Convective air transport due to pressure differences	3	☐
Material selection (IAQ, thermal mass, moisture)	3	☐
Controls layers (heat, vapor, water, air and solar gain)	3	☐
Hygrothermal analysis	3	☐
HVAC systems (heating, cooling and ventilation)	3	☐
HVAC interactions with the enclosure	2	☐
Fenestration considerations	4	☐
Plumbing systems (heating, distribution, conservation)	3	☐
Electrical systems	3	☐
Lighting/appliances and miscellaneous loads	1	☐
Indoor environmental quality (temperature uniformity and indoor pollutants)	2	☐
Control/automation systems	1	☐
Operations and maintenance	Average = 2	
User controls (ex: thermostat)	1	☐
Preventative maintenance (ex: cleaning air filters)	2	☐
Determination of appropriate replacement choices	4	☐
Building testing and certification	Average = 3	
Commissioning	3	☐
Diagnostics and forensics	3	☐
Monitoring	3	☐
National codes and standards	3	☐
Certification programs	3	☐

The _____ civil/structural engineer certification body has incorporated all of the relevant information in the above checklist into their training materials.

Signature _____

Building Science Education Guidelines for Material Science Engineers

A summary of the proficiency levels[1] for the core competencies are displayed in the graphic below. For each core competency level described in this checklist, it is assumed that the organization or student is proficient in the level described, as well as all the cognitive levels below that level.



As the entity responsible for managing home energy certifiers, a material science engineer should be proficient in the following categories:

Topic	Proficiency Level	Checkbox
Integration of the whole-building system	Average = 4	
Simultaneous consideration of energy, durability, comfort and IAQ	6	☐
Annualized cash flow	6	☐
Building techniques related to natural and man-made disasters	6	☐
Integrated design and construction	3	☐
Quality management	3	☐
Building energy modeling	3	☐
Cost trade-off analysis (optimized first costs)	4	☐

[1] The average level shown here is the whole number that best represents the combination of individual scores from each sub-category.

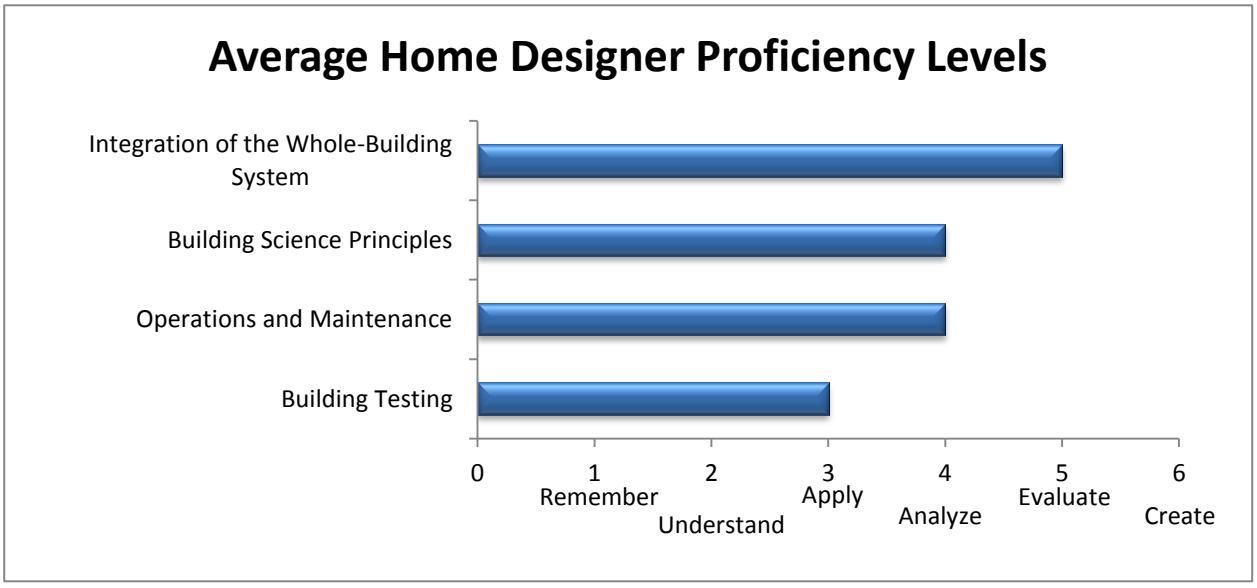
Topic	Proficiency Level	Checkbox
Building science principles related to the enclosure	Average = 5	
Heat transfer (convection, conduction and radiation)	6	☐
Moisture transport of liquid	6	☐
Convective air transport due to pressure differences	6	☐
Material selection (IAQ, thermal mass, moisture)	6	☐
Controls layers (heat, vapor, water, air and solar gain)	6	☐
Hygrothermal analysis	6	☐
HVAC systems (heating, cooling and ventilation)	4	☐
HVAC interactions with the enclosure	5	☐
Fenestration considerations	4	☐
Plumbing systems (heating, distribution, conservation)	4	☐
Electrical systems	4	☐
Lighting/appliances and miscellaneous loads	2	☐
Indoor environmental quality (temperature uniformity and indoor pollutants)	4	☐
Control/automation systems	1	☐
Operations and maintenance	Average = 1	
User controls (ex: thermostat)	1	☐
Preventative maintenance (ex: cleaning air filters)	1	☐
Determination of appropriate replacement choices	1	☐
Building testing and certification	Average = 2	
Commissioning	1	☐
Diagnostics and forensics	1	☐
Monitoring	1	☐
National codes and standards	3	☐
Certification programs	3	☐

The _____ material science engineer certification body has incorporated all of the relevant information in the above checklist into their training materials.

Signature _____

Building Science Education Guidelines for Home Designers

A summary of the proficiency levels[1] for the core competencies are displayed in the graphic below. For each core competency level described in this checklist, it is assumed that the organization or student is proficient in the level described, as well as all the cognitive levels below that level.



As the entity responsible for managing home energy certifiers, a home designer should be proficient in the following categories:

Topic	Proficiency Level	Checkbox
Integration of the whole-building system	Average = 5	
Simultaneous consideration of energy, durability, comfort and IAQ	6	☐
Annualized cash flow	6	☐
Building techniques related to natural and man-made disasters	6	☐
Integrated design and construction	5	☐
Quality management	5	☐
Building energy modeling	5	☐
Cost trade-off analysis (optimized first costs)	5	☐

[1] The average level shown here is the whole number that best represents the combination of individual scores from each sub-category.

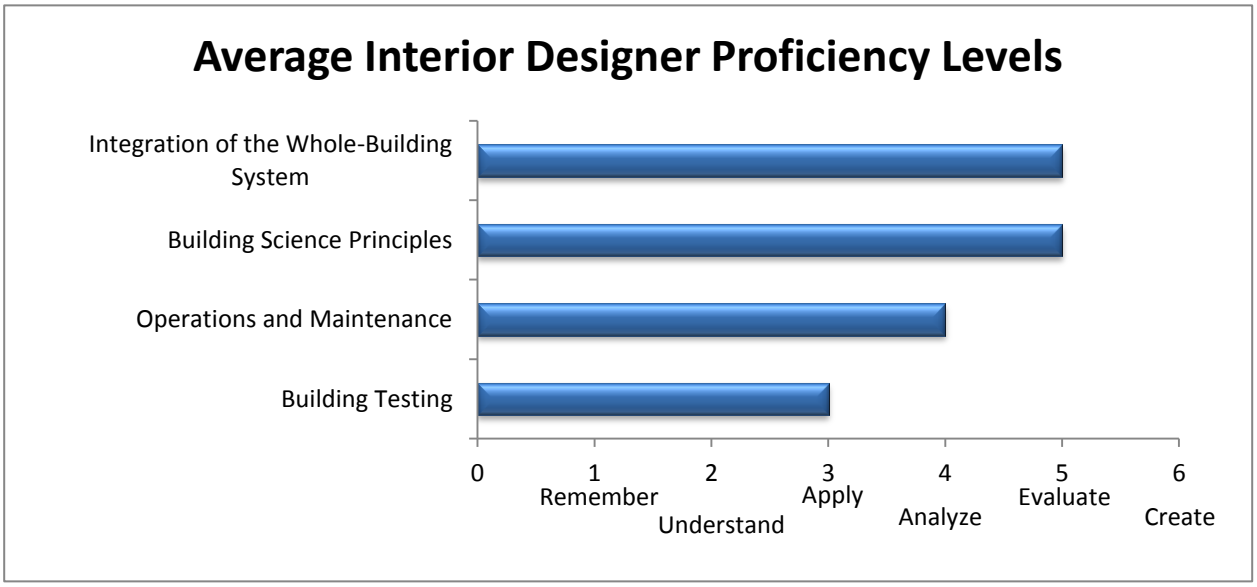
Topic	Proficiency Level	Checkbox
Building science principles related to the enclosure	Average = 4	
Heat transfer (convection, conduction and radiation)	4	☐
Moisture transport of liquid	5	☐
Convective air transport due to pressure differences	5	☐
Material selection (IAQ, thermal mass, moisture)	5	☐
Controls layers (heat, vapor, water, air and solar gain)	6	☐
Hygrothermal analysis	5	☐
HVAC systems (heating, cooling and ventilation)	4	☐
HVAC interactions with the enclosure	4	☐
Fenestration considerations	5	☐
Plumbing systems (heating, distribution, conservation)	3	☐
Electrical systems	3	☐
Lighting/appliances and miscellaneous loads	5	☐
Indoor environmental quality (temperature uniformity and indoor pollutants)	4	☐
Control/automation systems	4	☐
Operations and maintenance	Average = 4	
User controls (ex: thermostat)	4	☐
Preventative maintenance (ex: cleaning air filters)	4	☐
Determination of appropriate replacement choices	5	☐
Building testing and certification	Average = 3	
Commissioning	4	☐
Diagnostics and forensics	3	☐
Monitoring	4	☐
National codes and standards	2	☐
Certification programs	1	☐

The _____ home designer certification body has incorporated all of the relevant information in the above checklist into their training materials.

Signature _____

Building Science Education Guidelines for Interior Designers

A summary of the proficiency levels[1] for the core competencies are displayed in the graphic below. For each core competency level described in this checklist, it is assumed that the organization or student is proficient in the level described, as well as all the cognitive levels below that level.



As the entity responsible for managing home energy certifiers, an interior designer should be proficient in the following categories:

Topic	Proficiency Level	Checkbox
Integration of the whole-building system	Average = 5	
Simultaneous consideration of energy, durability, comfort and IAQ	6	☐
Annualized cash flow	5	☐
Building techniques related to natural and man-made disasters	5	☐
Integrated design and construction	6	☐
Quality management	5	☐
Building energy modeling	5	☐
Cost trade-off analysis (optimized first costs)	5	☐

[1] The average level shown here is the whole number that best represents the combination of individual scores from each sub-category.

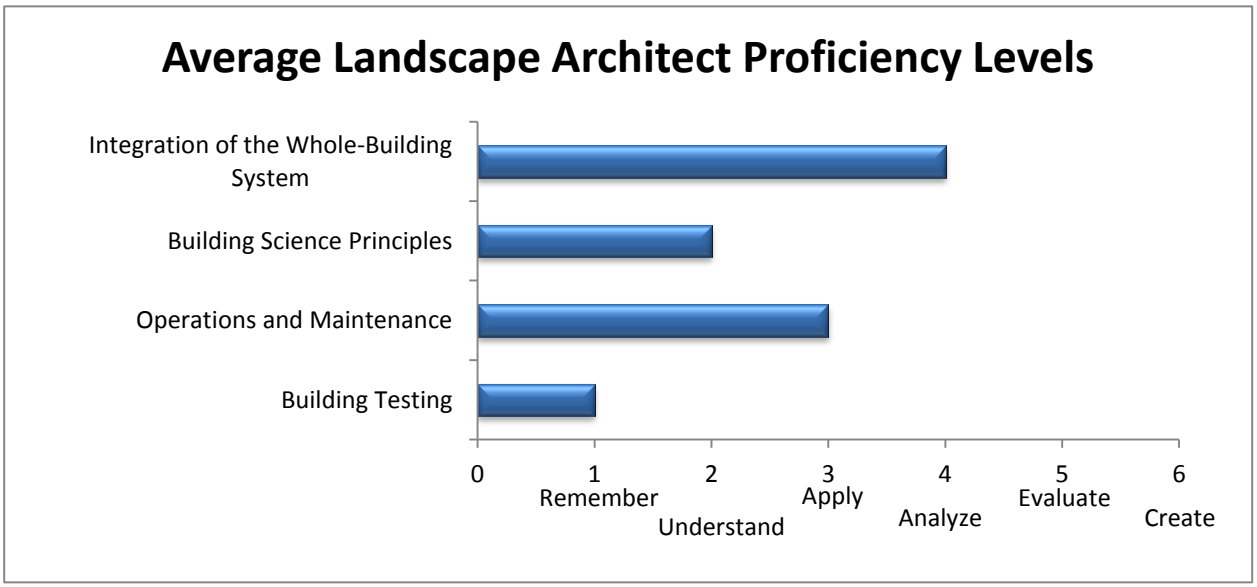
Topic	Proficiency Level	Checkbox
Building science principles related to the enclosure	Average = 5	
Heat transfer (convection, conduction and radiation)	4	☐
Moisture transport of liquid	4	☐
Convective air transport due to pressure differences	4	☐
Material selection (IAQ, thermal mass, moisture)	6	☐
Controls layers (heat, vapor, water, air and solar gain)	5	☐
Hygrothermal analysis	4	☐
HVAC systems (heating, cooling and ventilation)	4	☐
HVAC interactions with the enclosure	4	☐
Fenestration considerations	5	☐
Plumbing systems (heating, distribution, conservation)	4	☐
Electrical systems	4	☐
Lighting/appliances and miscellaneous loads	5	☐
Indoor environmental quality (temperature uniformity and indoor pollutants)	6	☐
Control/automation systems	4	☐
Operations and maintenance	Average = 4	
User controls (ex: thermostat)	4	☐
Preventative maintenance (ex: cleaning air filters)	4	☐
Determination of appropriate replacement choices	5	☐
Building testing and certification	Average = 3	
Commissioning	4	☐
Diagnostics and forensics	3	☐
Monitoring	4	☐
National codes and standards	2	☐
Certification programs	1	☐

The _____ interior designer certification body has incorporated all of the relevant information in the above checklist into their training materials.

Signature _____

Building Science Education Guidelines for Landscape Architects

A summary of the proficiency levels[1] for the core competencies are displayed in the graphic below. For each core competency level described in this checklist, it is assumed that the organization or student is proficient in the level described, as well as all the cognitive levels below that level.



As the entity responsible for managing home energy certifiers, a landscape architect should be proficient in the following categories:

Topic	Proficiency Level	Checkbox
Integration of the whole-building system	Average = 4	
Simultaneous consideration of energy, durability, comfort and IAQ	4	☐
Annualized cash flow	4	☐
Building techniques related to natural and man-made disasters	4	☐
Integrated design and construction	3	☐
Quality management	4	☐
Building energy modeling	3	☐
Cost trade-off analysis (optimized first costs)	3	☐

[1] The average level shown here is the whole number that best represents the combination of individual scores from each sub-category.

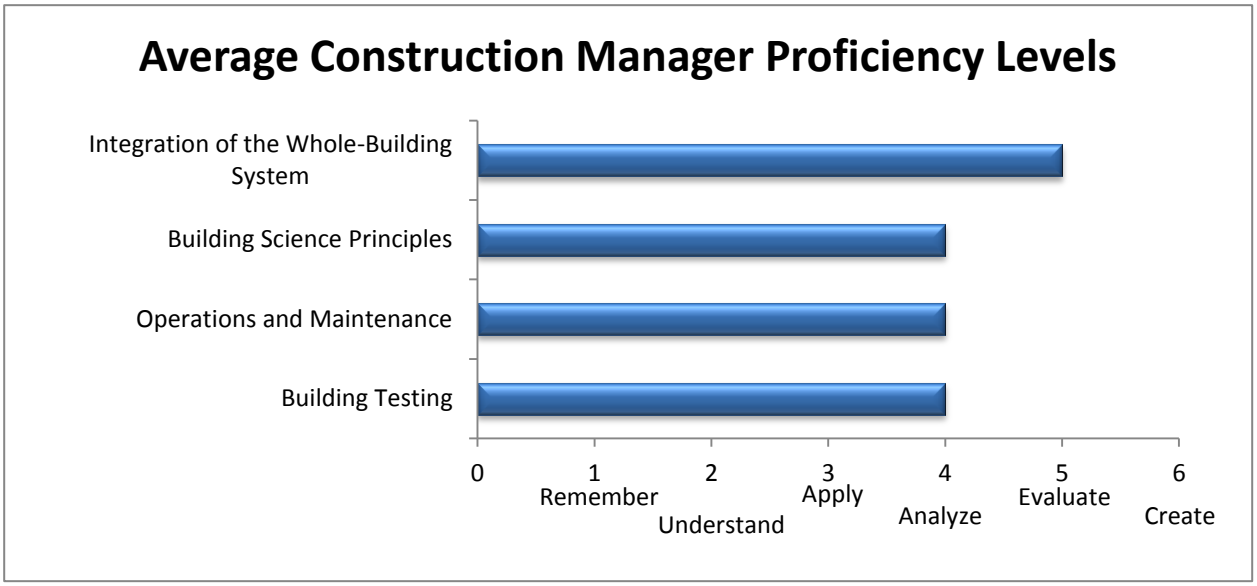
Topic	Proficiency Level	Checkbox
Building science principles related to the enclosure	Average = 2	
Heat transfer (convection, conduction and radiation)	2	☐
Moisture transport of liquid	3	☐
Convective air transport due to pressure differences	2	☐
Material selection (IAQ, thermal mass, moisture)	1	☐
Controls layers (heat, vapor, water, air and solar gain)	1	☐
Hygrothermal analysis	1	☐
HVAC systems (heating, cooling and ventilation)	1	☐
HVAC interactions with the enclosure	1	☐
Fenestration considerations	2	☐
Plumbing systems (heating, distribution, conservation)	2	☐
Electrical systems	2	☐
Lighting/appliances and miscellaneous loads	3	☐
Indoor environmental quality (temperature uniformity and indoor pollutants)	1	☐
Control/automation systems	1	☐
Operations and maintenance	Average = 3	
User controls (ex: thermostat)	2	☐
Preventative maintenance (ex: cleaning air filters)	3	☐
Determination of appropriate replacement choices	3	☐
Building testing and certification	Average = 1	
Commissioning	1	☐
Diagnostics and forensics	2	☐
Monitoring	1	☐
National codes and standards	2	☐
Certification programs	1	☐

The _____ landscape architect certification body has incorporated all of the relevant information in the above checklist into their training materials.

Signature _____

Building Science Education Guidelines for Construction Managers

A summary of the proficiency levels[1] for the core competencies are displayed in the graphic below. For each core competency level described in this checklist, it is assumed that the organization or student is proficient in the level described, as well as all the cognitive levels below that level.



As the entity responsible for managing home energy certifiers, a construction manager should be proficient in the following categories:

Topic	Proficiency Level	Checkbox
Integration of the whole-building system	Average = 5	
Simultaneous consideration of energy, durability, comfort and IAQ	6	☐
Annualized cash flow	6	☐
Building techniques related to natural and man-made disasters	5	☐
Integrated design and construction	5	☐
Quality management	6	☐
Building energy modeling	4	☐
Cost trade-off analysis (optimized first costs)	5	☐

[1] The average level shown here is the whole number that best represents the combination of individual scores from each sub-category.

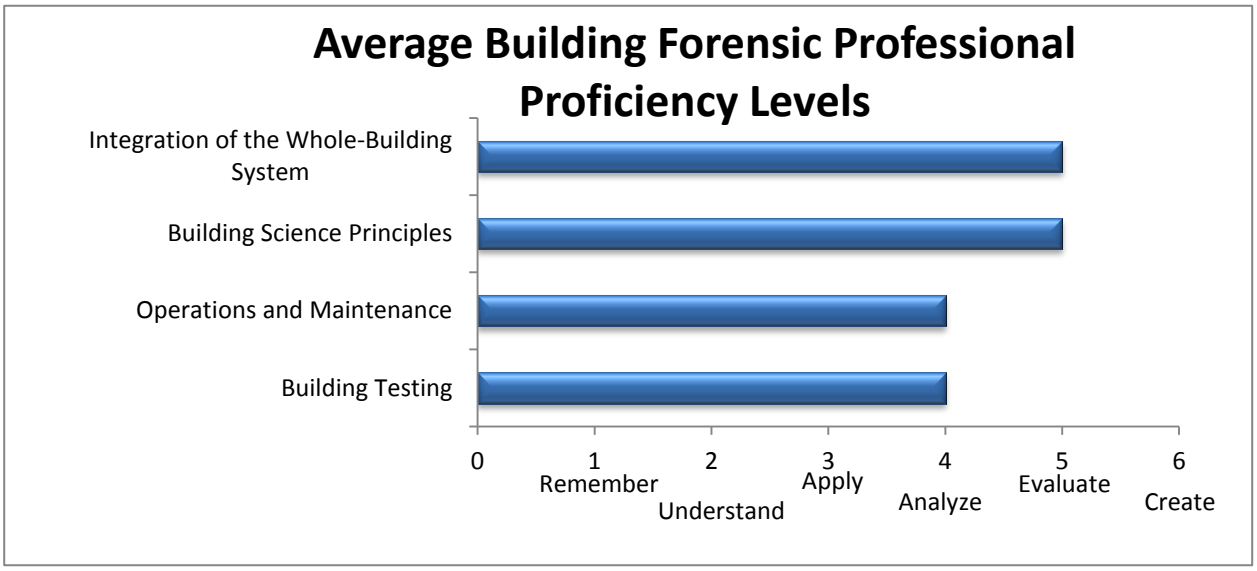
Topic	Proficiency Level	Checkbox
Building science principles related to the enclosure	Average = 4	
Heat transfer (convection, conduction and radiation)	3	☐
Moisture transport of liquid	4	☐
Convective air transport due to pressure differences	4	☐
Material selection (IAQ, thermal mass, moisture)	4	☐
Controls layers (heat, vapor, water, air and solar gain)	5	☐
Hygrothermal analysis	3	☐
HVAC systems (heating, cooling and ventilation)	4	☐
HVAC interactions with the enclosure	3	☐
Fenestration considerations	4	☐
Plumbing systems (heating, distribution, conservation)	3	☐
Electrical systems	3	☐
Lighting/appliances and miscellaneous loads	2	☐
Indoor environmental quality (temperature uniformity and indoor pollutants)	4	☐
Control/automation systems	3	☐
Operations and maintenance	Average = 4	
User controls (ex: thermostat)	5	☐
Preventative maintenance (ex: cleaning air filters)	4	☐
Determination of appropriate replacement choices	4	☐
Building testing and certification	Average = 4	
Commissioning	5	☐
Diagnostics and forensics	4	☐
Monitoring	4	☐
National codes and standards	3	☐
Certification programs	3	☐

The _____ construction manager certification body has incorporated all of the relevant information in the above checklist into their training materials.

Signature _____

Building Science Education Guidelines for Building Forensic Professionals

A summary of the proficiency levels[1] for the core competencies are displayed in the graphic below. For each core competency level described in this checklist, it is assumed that the organization or student is proficient in the level described, as well as all the cognitive levels below that level.



As the entity responsible for managing home energy certifiers, a building forensic professional should be proficient in the following categories:

Topic	Proficiency Level	Checkbox
Integration of the whole-building system	Average = 5	
Simultaneous consideration of energy, durability, comfort and IAQ	6	☐
Annualized cash flow	6	☐
Building techniques related to natural and man-made disasters	6	☐
Integrated design and construction	5	☐
Quality management	5	☐
Building energy modeling	5	☐
Cost trade-off analysis (optimized first costs)	5	☐

[1] The average level shown here is the whole number that best represents the combination of individual scores from each sub-category.

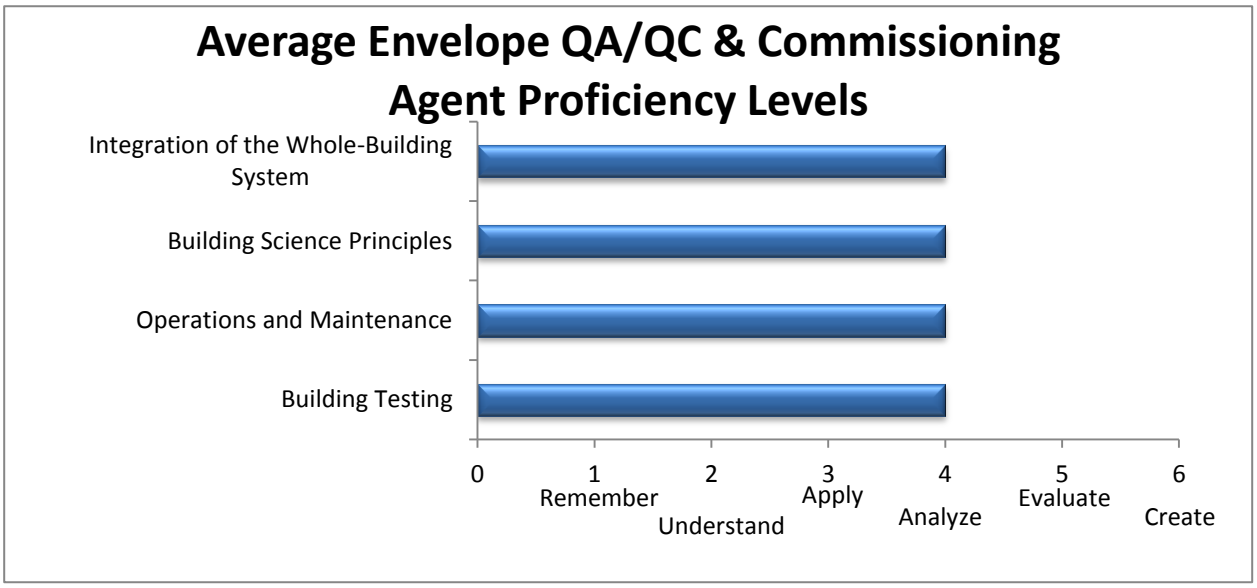
Topic	Proficiency Level	Checkbox
Building science principles related to the enclosure	Average = 5	
Heat transfer (convection, conduction and radiation)	6	☐
Moisture transport of liquid	6	☐
Convective air transport due to pressure differences	6	☐
Material selection (IAQ, thermal mass, moisture)	5	☐
Controls layers (heat, vapor, water, air and solar gain)	6	☐
Hygrothermal analysis	6	☐
HVAC systems (heating, cooling and ventilation)	5	☐
HVAC interactions with the enclosure	6	☐
Fenestration considerations	6	☐
Plumbing systems (heating, distribution, conservation)	5	☐
Electrical systems	4	☐
Lighting/appliances and miscellaneous loads	5	☐
Indoor environmental quality (temperature uniformity and indoor pollutants)	5	☐
Control/automation systems	5	☐
Operations and maintenance	Average = 4	
User controls (ex: thermostat)	4	☐
Preventative maintenance (ex: cleaning air filters)	4	☐
Determination of appropriate replacement choices	5	☐
Building testing and certification	Average = 4	
Commissioning	5	☐
Diagnostics and forensics	5	☐
Monitoring	5	☐
National codes and standards	3	☐
Certification programs	2	☐

The _____ building forensic professional certification body has incorporated all of the relevant information in the above checklist into their training materials.

Signature _____

Building Science Education Guidelines for Envelope QA/QC & Commissioning Agents

A summary of the proficiency levels[1] for the core competencies are displayed in the graphic below. For each core competency level described in this checklist, it is assumed that the organization or student is proficient in the level described, as well as all the cognitive levels below that level.



As the entity responsible for managing home energy certifiers, an envelope QA/QC & commissioning agent should be proficient in the following categories:

Topic	Proficiency Level	Checkbox
Integration of the whole-building system	Average = 4	
Simultaneous consideration of energy, durability, comfort and IAQ	5	☐
Annualized cash flow	1	☐
Building techniques related to natural and man-made disasters	3	☐
Integrated design and construction	4	☐
Quality management	4	☐
Building energy modeling	4	☐
Cost trade-off analysis (optimized first costs)	4	☐

[1] The average level shown here is the whole number that best represents the combination of individual scores from each sub-category.

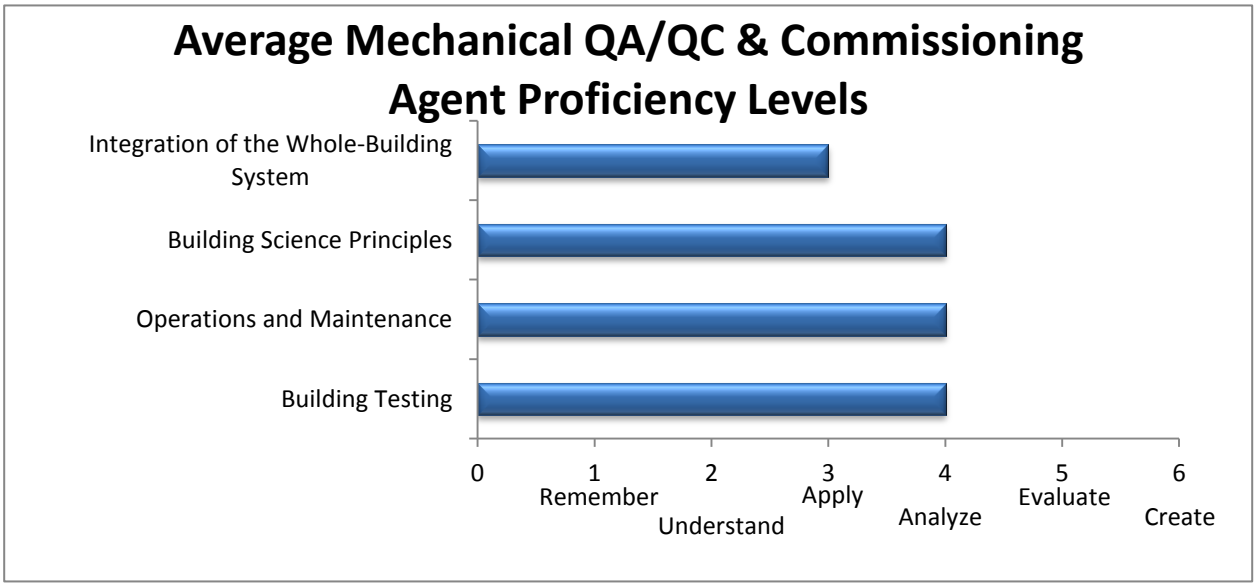
Topic	Proficiency Level	Checkbox
Building science principles related to the enclosure	Average = 4	
Heat transfer (convection, conduction and radiation)	4	☐
Moisture transport of liquid	4	☐
Convective air transport due to pressure differences	4	☐
Material selection (IAQ, thermal mass, moisture)	4	☐
Controls layers (heat, vapor, water, air and solar gain)	5	☐
Hygrothermal analysis	4	☐
HVAC systems (heating, cooling and ventilation)	4	☐
HVAC interactions with the enclosure	3	☐
Fenestration considerations	4	☐
Plumbing systems (heating, distribution, conservation)	4	☐
Electrical systems	3	☐
Lighting/appliances and miscellaneous loads	3	☐
Indoor environmental quality (temperature uniformity and indoor pollutants)	4	☐
Control/automation systems	3	☐
Operations and maintenance	Average = 4	
User controls (ex: thermostat)	4	☐
Preventative maintenance (ex: cleaning air filters)	4	☐
Determination of appropriate replacement choices	4	☐
Building testing and certification	Average = 4	
Commissioning	5	☐
Diagnostics and forensics	5	☐
Monitoring	5	☐
National codes and standards	3	☐
Certification programs	3	☐

The _____ envelope QA/QC & commissioning agent certification body has incorporated all of the relevant information in the above checklist into their training materials.

Signature _____

Building Science Education Guidelines for Mechanical QA/QC & Commissioning Agents

A summary of the proficiency levels[1] for the core competencies are displayed in the graphic below. For each core competency level described in this checklist, it is assumed that the organization or student is proficient in the level described, as well as all the cognitive levels below that level.



As the entity responsible for managing home energy certifiers, a mechanical QA/QC & commissioning agent should be proficient in the following categories:

Topic	Proficiency Level	Checkbox
Integration of the whole-building system	Average = 3	
Simultaneous consideration of energy, durability, comfort and IAQ	4	☐
Annualized cash flow	1	☐
Building techniques related to natural and man-made disasters	3	☐
Integrated design and construction	4	☐
Quality management	4	☐
Building energy modeling	4	☐
Cost trade-off analysis (optimized first costs)	4	☐

[1] The average level shown here is the whole number that best represents the combination of individual scores from each sub-category.

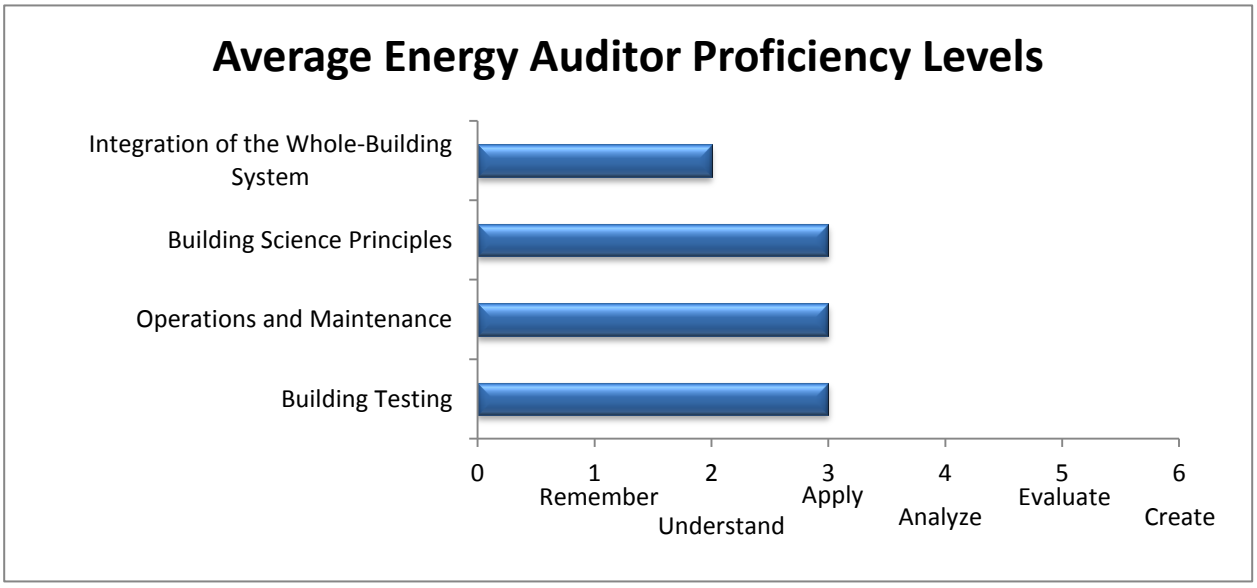
Topic	Proficiency Level	Checkbox
Building science principles related to the enclosure	Average = 4	
Heat transfer (convection, conduction and radiation)	4	☐
Moisture transport of liquid	4	☐
Convective air transport due to pressure differences	4	☐
Material selection (IAQ, thermal mass, moisture)	4	☐
Controls layers (heat, vapor, water, air and solar gain)	5	☐
Hygrothermal analysis	4	☐
HVAC systems (heating, cooling and ventilation)	6	☐
HVAC interactions with the enclosure	4	☐
Fenestration considerations	4	☐
Plumbing systems (heating, distribution, conservation)	4	☐
Electrical systems	4	☐
Lighting/appliances and miscellaneous loads	3	☐
Indoor environmental quality (temperature uniformity and indoor pollutants)	4	☐
Control/automation systems	3	☐
Operations and maintenance	Average = 4	
User controls (ex: thermostat)	4	☐
Preventative maintenance (ex: cleaning air filters)	4	☐
Determination of appropriate replacement choices	4	☐
Building testing and certification	Average = 4	
Commissioning	5	☐
Diagnostics and forensics	5	☐
Monitoring	5	☐
National codes and standards	3	☐
Certification programs	2	☐

The _____ mechanical QA/QC & commissioning agent certification body has incorporated all of the relevant information in the above checklist into their training materials.

Signature _____

Building Science Education Guidelines for Energy Auditors

A summary of the proficiency levels[1] for the core competencies are displayed in the graphic below. For each core competency level described in this checklist, it is assumed that the organization or student is proficient in the level described, as well as all the cognitive levels below that level.



As the entity responsible for managing home energy certifiers, an energy auditor should be proficient in the following categories:

Topic	Proficiency Level	Checkbox
Integration of the whole-building system	Average = 2	
Simultaneous consideration of energy, durability, comfort and IAQ	4	☐
Annualized cash flow	1	☐
Building techniques related to natural and man-made disasters	3	☐
Integrated design and construction	2	☐
Quality management	2	☐
Building energy modeling	3	☐
Cost trade-off analysis (optimized first costs)	2	☐

[1] The average level shown here is the whole number that best represents the combination of individual scores from each sub-category.

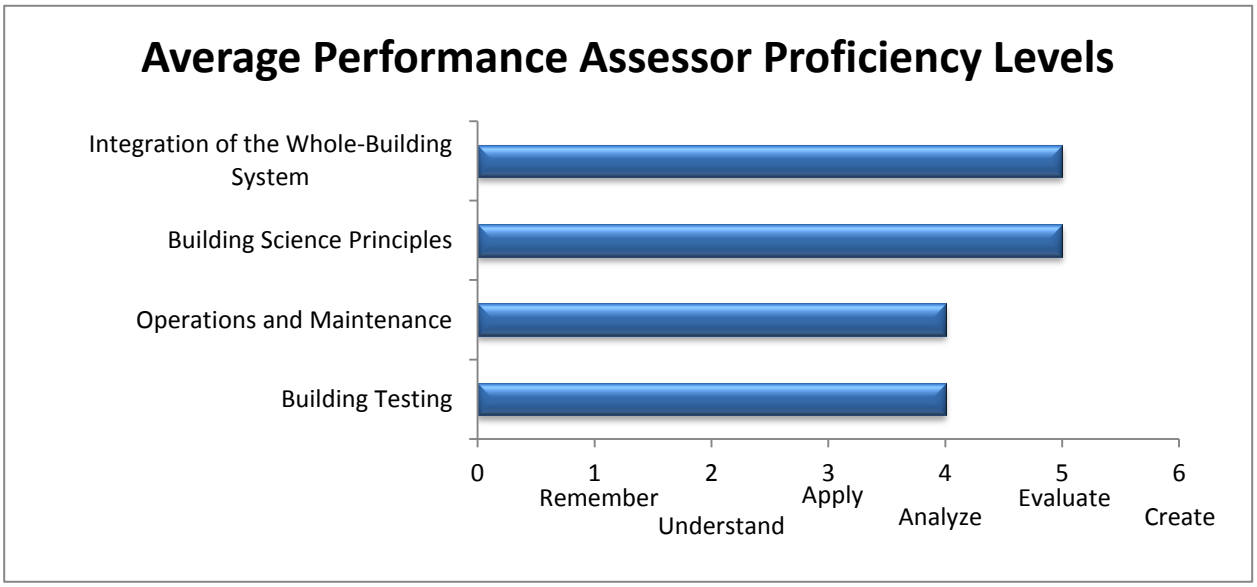
Topic	Proficiency Level	Checkbox
Building science principles related to the enclosure	Average = 3	
Heat transfer (convection, conduction and radiation)	3	☐
Moisture transport of liquid	3	☐
Convective air transport due to pressure differences	3	☐
Material selection (IAQ, thermal mass, moisture)	3	☐
Controls layers (heat, vapor, water, air and solar gain)	3	☐
Hygrothermal analysis	3	☐
HVAC systems (heating, cooling and ventilation)	3	☐
HVAC interactions with the enclosure	3	☐
Fenestration considerations	3	☐
Plumbing systems (heating, distribution, conservation)	3	☐
Electrical systems	3	☐
Lighting/appliances and miscellaneous loads	3	☐
Indoor environmental quality (temperature uniformity and indoor pollutants)	3	☐
Control/automation systems	3	☐
Operations and maintenance	Average = 3	
User controls (ex: thermostat)	3	☐
Preventative maintenance (ex: cleaning air filters)	3	☐
Determination of appropriate replacement choices	3	☐
Building testing and certification	Average = 3	
Commissioning	4	☐
Diagnostics and forensics	4	☐
Monitoring	4	☐
National codes and standards	3	☐
Certification programs	2	☐

The _____ energy auditor certification body has incorporated all of the relevant information in the above checklist into their training materials.

Signature _____

Building Science Education Guidelines for Performance Assessor

A summary of the proficiency levels[1] for the core competencies are displayed in the graphic below. For each core competency level described in this checklist, it is assumed that the organization or student is proficient in the level described, as well as all the cognitive levels below that level.



As the entity responsible for managing home energy certifiers, a performance assessor should be proficient in the following categories:

Topic	Proficiency Level	Checkbox
Integration of the whole-building system	Average = 5	
Simultaneous consideration of energy, durability, comfort and IAQ	5	☐
Annualized cash flow	5	☐
Building techniques related to natural and man-made disasters	4	☐
Integrated design and construction	5	☐
Quality management	5	☐
Building energy modeling	5	☐
Cost trade-off analysis (optimized first costs)	5	☐

[1] The average level shown here is the whole number that best represents the combination of individual scores from each sub-category.

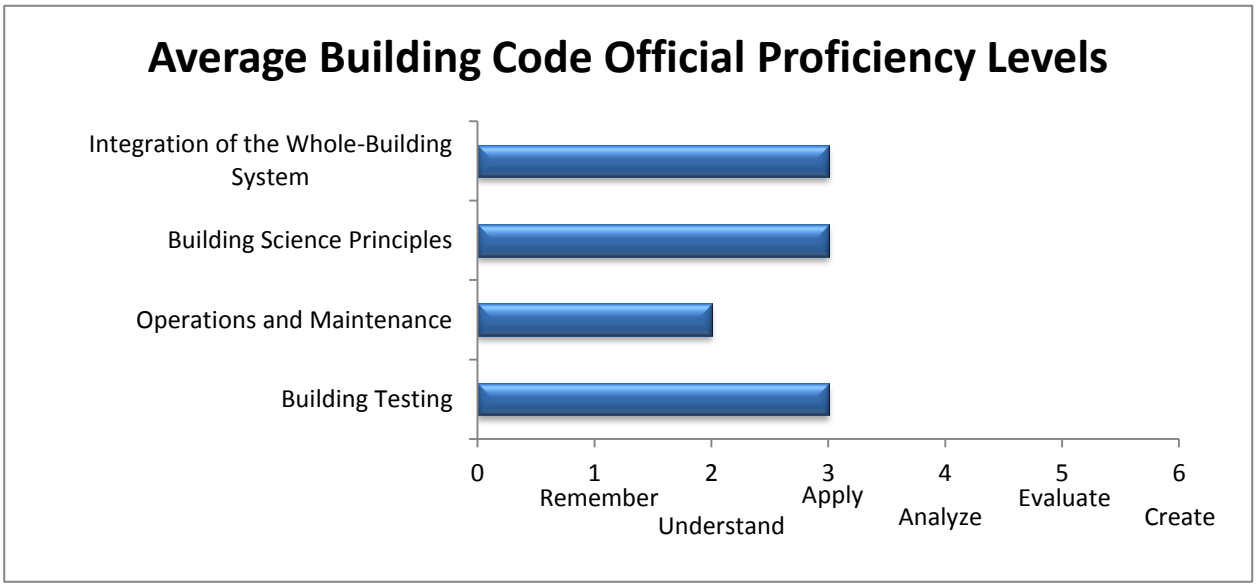
Topic	Proficiency Level	Checkbox
Building science principles related to the enclosure	Average = 5	
Heat transfer (convection, conduction and radiation)	5	☐
Moisture transport of liquid	5	☐
Convective air transport due to pressure differences	5	☐
Material selection (IAQ, thermal mass, moisture)	5	☐
Controls layers (heat, vapor, water, air and solar gain)	5	☐
Hygrothermal analysis	5	☐
HVAC systems (heating, cooling and ventilation)	4	☐
HVAC interactions with the enclosure	5	☐
Fenestration considerations	5	☐
Plumbing systems (heating, distribution, conservation)	4	☐
Electrical systems	4	☐
Lighting/appliances and miscellaneous loads	4	☐
Indoor environmental quality (temperature uniformity and indoor pollutants)	4	☐
Control/automation systems	4	☐
Operations and maintenance	Average = 4	
User controls (ex: thermostat)	4	☐
Preventative maintenance (ex: cleaning air filters)	4	☐
Determination of appropriate replacement choices	4	☐
Building testing and certification	Average = 4	
Commissioning	5	☐
Diagnostics and forensics	5	☐
Monitoring	5	☐
National codes and standards	3	☐
Certification programs	2	☐

The _____ performance assessment certification body has incorporated all of the relevant information in the above checklist into their training materials.

Signature _____

Building Science Education Guidelines for Building Code Officials

A summary of the proficiency levels[1] for the core competencies are displayed in the graphic below. For each core competency level described in this checklist, it is assumed that the organization or student is proficient in the level described, as well as all the cognitive levels below that level.



As the entity responsible for managing home energy certifiers, a building code officials should be proficient in the following categories:

Topic	Proficiency Level	Checkbox
Integration of the whole-building system	Average = 3	
Simultaneous consideration of energy, durability, comfort and IAQ	3	☐
Annualized cash flow	2	☐
Building techniques related to natural and man-made disasters	3	☐
Integrated design and construction	3	☐
Quality management	3	☐
Building energy modeling	2	☐
Cost trade-off analysis (optimized first costs)	2	☐

[1] The average level shown here is the whole number that best represents the combination of individual scores from each sub-category.

Topic	Proficiency Level	Checkbox
Building science principles related to the enclosure	Average = 3	
Heat transfer (convection, conduction and radiation)	3	☐
Moisture transport of liquid	3	☐
Convective air transport due to pressure differences	3	☐
Material selection (IAQ, thermal mass, moisture)	3	☐
Controls layers (heat, vapor, water, air and solar gain)	3	☐
Hygrothermal analysis	3	☐
HVAC systems (heating, cooling and ventilation)	3	☐
HVAC interactions with the enclosure	3	☐
Fenestration considerations	3	☐
Plumbing systems (heating, distribution, conservation)	3	☐
Electrical systems	3	☐
Lighting/appliances and miscellaneous loads	3	☐
Indoor environmental quality (temperature uniformity and indoor pollutants)	3	☐
Control/automation systems	3	☐
Operations and maintenance	Average = 2	
User controls (ex: thermostat)	2	☐
Preventative maintenance (ex: cleaning air filters)	2	☐
Determination of appropriate replacement choices	2	☐
Building testing and certification	Average = 3	
Commissioning	3	☐
Diagnostics and forensics	2	☐
Monitoring	2	☐
National codes and standards	4	☐
Certification programs	2	☐

The _____ building code official certification body has incorporated all of the relevant information in the above checklist into their training materials.

Signature _____

Appendix B

Final Building Science Education Matrix

Appendix B

Final Building Science Education Matrix

JOB CLASSIFICATIONS	1. High School Education	2. Builders/Remodelers	a. Builders (owner/managers)	b. Builders (foreman)	c. Remodelers (owner/manager)	d. Remodeler/Foreman	e. Insulation Contractors	f. HVAC Contractors	g. Enclosure Service Contractors	h. Plumbers	i. Home Performance Contractors	3. Program and Project Managers	a. Utility Program Managers	b. "Green" Building Certification Professionals	c. Maintenance Professionals	d. Facility/Asset Managers	4. Transaction Process	a. Real Estate Agent/Sales Associate	b. Appraisers	c. Home Inspectors	d. Insurers	e. Underwriters	5. Design and Construction Professio	a. Architects/Site Planners	b. Licensed Architects	c. Mechanical Engineers	d. Civil/Structural Engineers	e. Material Science Engineers	f. Designers (home)	g. Designers (interior)	h. Landscape Architects	i. Construction Managers	6. Building Science Professionals	a. Building Science Professionals	b. QA/QC & Forensic Professionals	c. QA/QC & Commissioning Agents	7. Home Energy Professionals	a. Energy Auditors	b. Performance Assessor	8. Building Code Officials
1. Integration of the Whole-Building System																																									
a. Performance (energy, durability, comfort,	1	4	5	4	5	5	5	5	4	4	3	5	3	3	3	3	5	2	3	6	6	6	5	6	6	6	4	6	6	5	4	4	5	3
b. Life cycle cost-effectiveness analysis	2	5	5	5	5	4	4	4	4	4	2	5	3	5	2	4	3	3	4	6	6	6	5	6	6	5	4	6	6	1	1	1	5	2
c. Disaster resistance/resiliency	2	3	4	3	4	4	2	5	3	4	3	4	3	3	2	3	4	4	3	6	6	5	5	6	6	5	4	5	6	3	3	3	4	3
d. Integrated design and construction	2	4	5	4	4	3	4	4	3	4	2	4	2	3	2	2	3	2	1	5	5	4	3	3	5	6	3	5	5	4	4	2	5	3
e. Quality management	2	5	6	5	6	6	6	6	6	5	4	3	2	4	2	2	4	2	2	5	4	5	5	3	5	5	4	6	5	4	4	2	5	3
f. Building and energy modeling	2	2	3	2	3	3	4	3	2	4	3	5	1	3	2	2	3	2	2	6	5	5	4	3	5	5	3	4	5	4	4	3	5	2
g. Cost trade-off analysis	2	4	5	4	5	4	4	4	4	5	3	3	2	5	3	4	3	2	2	5	5	4	4	4	5	5	3	5	5	4	4	2	5	2
2. Building Science Principles																																								
a. Heat transfer (conduction, radiation, conv	1	2	3	2	3	5	4	4	2	4	3	4	3	2	2	2	4	2	1	5	4	6	3	6	4	4	2	3	6	4	4	3	5	3
b. Moisture transport (liquid, vapor, psychro	1	3	4	3	4	4	4	4	2	4	3	4	3	2	2	2	4	2	1	5	5	5	4	6	5	4	3	4	6	4	4	3	5	3
c. Convective mass (air) transport (pressure	1	3	4	3	4	4	4	3	3	4	3	4	3	2	2	2	4	2	1	5	5	6	3	6	5	4	2	4	6	4	4	3	5	3
d. Material selection (IAQ, thermal mass, mo	1	2	3	2	3	4	2	4	2	4	3	5	2	2	3	3	4	2	2	5	5	4	3	6	5	6	1	4	5	4	4	3	5	3
e. Control layers (water, air, vapor, thermal,	1	4	5	4	5	5	4	5	2	4	3	4	3	2	2	2	4	2	1	6	6	4	3	6	6	5	1	5	6	5	5	3	5	3
f. Hygrothermal analysis	1	2	3	2	3	4	2	3	2	4	1	3	1	1	1	1	2	2	1	6	5	3	3	6	5	4	1	3	6	4	4	3	5	3
g. HVAC Systems (heating, cooling, ventilat	2	3	4	3	4	3	5	3	3	4	4	4	3	2	3	3	4	2	2	6	4	6	3	4	4	4	1	4	5	4	6	3	4	3
h. HVAC interactions with enclosure	2	3	4	3	4	3	5	3	3	4	3	4	3	2	2	2	4	1	1	5	4	6	2	5	4	4	1	3	6	3	4	3	5	3
i. Fenestration	2	2	3	2	3	3	4	4	2	4	3	4	3	2	2	3	4	3	2	6	5	5	4	4	5	5	2	4	6	4	4	3	5	3
j. Plumbing systems (heating, distribution,	2	3	4	3	4	2	3	3	5	4	3	4	3	2	2	2	4	2	2	6	3	5	3	4	3	4	2	3	5	4	4	3	4	3
k. Electrical systems	2	2	2	2	3	2	3	3	2	3	3	2	3	2	2	2	4	2	2	5	3	3	3	4	3	4	2	3	4	3	4	3	4	3
l. Lighting, appliances & misc. loads	2	2	3	2	3	2	3	2	3	4	4	4	3	4	3	2	3	2	2	4	5	4	1	2	5	5	3	2	5	3	3	3	4	3
m. Indoor environmental quality (thermal co	2	3	4	3	4	4	5	3	3	4	4	5	3	2	3	2	4	1	2	5	4	6	2	4	4	6	1	4	5	4	4	3	4	3
n. Control/Automation systems	2	3	4	3	4	2	5	3	2	4	3	3	3	4	2	2	2	2	2	5	4	5	1	1	4	4	1	3	5	3	3	3	4	3
3. Operations and Maintenance																																								
a. User interface and controls	3	3	4	3	4	2	5	3	2	4	2	3	3	2	3	2	4	1	1	3	4	6	1	1	4	4	2	5	4	4	4	3	4	2
b. Preventative maintenance	3	2	3	2	3	2	4	4	3	4	2	3	3	2	3	2	3	2	1	4	4	5	2	1	4	4	3	4	4	4	4	3	4	2
c. Replacement & renovation	2	3	4	4	5	3	5	5	4	5	3	3	3	4	3	3	4	2	2	5	5	6	4	1	5	5	3	4	5	4	4	3	4	2
4. Building Testing and Certification																																								
a. Commissioning	1	3	4	3	4	4	5	5	3	5	3	4	2	2	2	2	3	2	2	6	4	6	3	1	4	4	1	5	5	5	5	4	5	3
b. Diagnostics & forensics	1	3	4	3	4	4	5	4	4	5	3	4	3	2	2	2	4	3	1	5	3	5	3	1	3	3	2	4	5	5	5	4	5	2
c. Performance monitoring/assessment	2	3	4	3	3	4	5	4	2	5	3	4	3	3	2	3	4	2	1	6	4	6	3	1	4	4	1	4	5	5	5	4	5	2
d. National codes and standards	1	3	4	3	4	3	3	4	3	3	2	2	3	2	1	1	3	1	1	3	3	3	3	2	3	1	2	3	3	3	3	2	2	5
e. Certification Programs	1	2	1	1	1	1	1	1	1	1	1	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Appendix C

Attendee List from Building Science Education Summit, Nov. 7th, 2012

Appendix C

Attendee List from Building Science Education Summit, Nov. 7th, 2012

Host: Sam Rashkin, Chief Architect, DOE
Facilitator: Sarah Mabbitt, Facilitator, Energetics Incorporated

First	Last	Organization
Building Science Educators		
Ben	Bigelow	Texas A&M University
Tony	Grahme	Univ. of Georgia
Patrick	Huelman	Univ. of Minnesota
Joe	Laquatra	Cornell University
Arn	Mcintyre	Ferris State University
Robert	Reed	Univ. of Missouri
Georg	Reichard	Virginia Tech
Bill	Rose	Univ. of Illinois at Urbana-Champaign
Mike	Mazor	Michigan State University
Building Science Researchers		
Michael	Baechler	PNNL
Pam	Cole	PNNL
Tom	Kenney	NAHB Research Center
Janet	McIlvaine	FSEC
Cheryn	Metzger	NREL
Stacy	Rothgeb	NREL
Building Science Organizations/Product Manufacturers		
Keith	Aldridge	Advanced Energy Corp.
James	Brew	Rocky Mountain Institute
Amy	Fazio	ACI
Jessica	Hunter	Rocky Mountain Institute
Alexis	Karolides	Rocky Mountain Institute
Brian	Lieburn	DOW Building Solutions
Chris	Little	BASF
Sydnery	Roberts	Southface
Craig	Savage	Building Media, Inc.
Karen	Thull	EEBA
Paul	Totten	SGH/NIBS/BETEC/Catholic Univertisty of America
Linda	Wigington	ACI
Government Programs Promoting Building Science		
Elizabeth	Cocke	HUD
Eric	Werling	DOE
Housing Industry Leaders		
CR	Herro	Meritage Homes
John	Sader	Sader Power Enterprises

First	Last	Organization
Building Science Advocates		
Rose	Grant	State Farm Insurance
Sam	Taylor	Sam Taylor

Appendix D

Attendee List for Stakeholder Meeting in Conjunction with EEBA, September 24th, 2013

Appendix D

Attendee List for Stakeholler Meeting in Conjunction with EEBA, September 24th, 2013

Host and Facilitator: Sam Rashkin, U.S. Department of Energy

First	Last	Organization
Sandy	Adomatis	Adomatis Appraisal Services
Lois	Arena	Steven Winter Associates
Michael	Baechler	Pacific Northwest National Laboratories
Aaron	Baugh	Rinnai Corporation
Matt	Belcher	Midwest Energy Efficiency Research Consortium
Loraine	Bittles	LP Building Products
Robert	Broad	Pulte Group
Greg	Cobb	Sonoran
Glenn	Cottrell	IBACOS
Walter	Cuculic	Solar City
Mick	Dalrymple	Arizona State University- Global Institute of Sustainability
Laura	Dwyer	DuPont
Amanda	Evans	Santa Fe Community College, New Mexico Energy$mart Academy Center of Excellence for Green Building and Energy Efficiency
Jeff	Farlow	Pentair
Charlise	Goodbread	BASF
Francois	Gratton	Beazer Homes -Phoenix Division
C.R.	Herro	Meritage Homes
Pat	Huelman	University of Minnesota
Stacy	Hunt	Confluence Communications
Alexis	Karolides	Rocky Mountain Institute
Matt	Keeler	Advanced Energy
Dr. Sanjeev	Khanna	University of Missouri-Midwest Energy Efficiency Center
Brian	Lieburn	DOW
Chris	Little	BASF
Corbett	Lunsford	Green Dream Group
Dave	Mallay	Home Innovation Research Labs
Eric	Martin	FSEC
Carla	Maxwell	Affordable Comfort, Inc.
Cheryn	Metzger	NREL
Martin	Pecholcs	Bayer Material Science
Sam	Rashkin	U.S. Department of Energy
Robert	Reed	Midwest Energy Efficiency Research Consortium (MEERC)

First	Last	Organization
Georg	Richard	Virginia Polytechnic Institute and State University: Myers-Lawson School of Construction
Chad	Riedy	NAHB
Jon	Sader	Sader Power Enterprises
Craig	Savage	BMI
Craig	Schiller	RMI
Brent	Stephens	Illinois Institute of Technology
Sam	Taylor	Energy and Resource Efficiency
Gale	Tedhams	Owens Corning
Melissa	Wahl	Cobblestone Homes
Theresa	Weston	DuPont Building Innovations
Dan	Wildenhaus	Fluid MS

Appendix E

Attendee List for Review Meeting in Conjunction with EEBA, September 22nd, 2014

Appendix E

Attendee List for Review Meeting in Conjunction with EEBA, September 22nd, 2014

Host and Facilitator: Sam Rashkin, U.S. Department of Energy

First	Last	Organization
Stacy	Hunt	Confluence Communications
Duncan	Prahl	IBACOS
Eric	Werling	DOE
Ray	Martinez	Appraisal Institute
David	Fransik	Sierra Homes
Mike	Collignan	Green Builder Coalition
Christine	Barbour	Newport Partners, LLC
Pat	Huelman	University of Minnesota
Joe	Nebbia	Newport Partners, LLC
Laureen	Blissard	Green Builder Coalition
Gary	Klein	Gary Klein Associates
Jim	Urtz	LIUNA Training and Education Fund
Janet	McIlvaine	FSEC
Cheryn	Metzger	PNNL
Sharon Patterson	Grant	EcoEdge
Jim	Williamson	Steven Winter Associates

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