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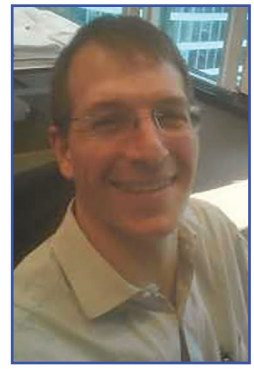

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A Conversation on Standard 90.1-2016

Editor's Note: ANSI/ASHRAE/IES Standard 90.1, *Energy Standard for Buildings Except Low-Rise Residential Buildings,* has been a benchmark and national model code for commercial buildings for over 35 years and indispensable for engineers and other professionals involved in the design of buildings and building systems. Now, with well over 100 addenda incorporated since the 2013 edition, Standard 90.1-2016 will significantly change the way buildings are built as these new modifications find their way into the world's energy codes.

The following roundtable highlights some of the major changes that you can expect to see in building envelope, mechanical system, and lighting requirements. In addition, the article highlights a new performance-based compliance path, climate zone revisions, and the strategic initiatives resulting in the new format.

This roundtable was conducted by *ASHRAE Journal* with Drake Erbe, Member ASHRAE; Dick Lord, Fellow ASHRAE; Len Sciarra, AIA, Member ASHRAE; Eric Richman, Member ASHRAE; Michael Rosenberg, Member ASHRAE; Rahul Athalye, Associate Member ASHRAE; Bing Liu, P.E., Member ASHRAE; and Jason Glazer, P.E., Member ASHRAE.

Q1: What major changes can we expect in the 90.1-2016 standard?

Erbe:

It is the overall goal of each version to create a consensus standard that saves energy and is technically feasible and cost-effective. During the 2013 cycle, it was recognized that there was a need to look at the entire effort strategically in many areas. These included ease of use, preparation for moving to the electronic environment, considering the energy for the entire building not just the areas of current responsibility, a better system for inclusion of the climate data and other reference standards information, and moving towards performance

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methodologies. Therefore, the 2016 version has a new format that we believe will be easier for users, a new way of incorporation of reference material from other standards starting with climate data, and a performance path for compliance that rewards designs for achieving energy cost savings above the standard minimum. The individuals leading the efforts will be outlining the specific changes and items of interest in the following content.

The leadership of the Standing Standards Project Committee 90.1 wishes to thank the volunteers who have given unselfishly of their energy and time to bring this standard to a successful conclusion under the new environment and a compressed timeline. In addition, we wish to thank the Department of Energy and Pacific Northwest National Laboratory for their tremendous assistance and support of this endeavor.

Q2: Can you help us understand the significant differences in the envelope, mechanical, and lighting sections of Standard 90.1-2016 versus the 2013 edition?

Lord:

The new Standard 90.1-2016 includes 52 addenda that were made to mechanical system requirements that are covered in Chapters 6, 7, and 10 of the standard. Some of the major revisions are:

- Update all requirements to reflect the new climate zones and to add Climate Zone 0;
- New requirements for replacement equipment to comply with additional requirements like economizers, fan speed control, and other requirements previously limited to new installations;
- New efficiency requirements for unitary rooftop products, packaged terminal air conditioners (PTAC), and variable refrigerant flow (VRF) products and new requirements for pool dehumidification and dedicated outside air system (DOAS) equipment;
- Requirements for chilled water plant monitoring;
- Economizer fault detection and diagnostics and expanded requirements for hydronic economizers;
- Variable airflow exhaust fan requirements;
- New requirements for chilled water design coil ΔT of 15°F (8.3°C) or greater, and new requirements on variable chilled water flow;
- Lower threshold for variable fan control for cooling towers;
- New efficiency requirements for motors and transformers aligned with DOE requirements; and
- Addition of elevator efficiency requirements to include both usage category and efficiency class.

Sciarra:

The envelope section has four major areas of improvement. The mandatory provisions now include the addition of an envelope verification in support of reduced air infiltration and increased requirements for air leakage of overhead coiling doors. The prescriptive requirements include increased stringency requirements for metal building roofs and walls, fenestration, and opaque

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doors. Requirements for Climate Zone 0 have been added for all assemblies, and there is improved clarity of the standard in defining exterior walls to building orientation to clarify default assumptions for the effective R-value of air spaces and calculation procedures for insulating metal building walls.

Richman:

The lighting section of 90.1-2016 has several differences from the 2013 version. The major changes include:

- A reduction in most of the lighting power density (LPD) limits for both exterior and interior lighting based primarily on the availability of higher LED technology efficacy, which is included to varying degrees in most of the space lighting models used to develop the LPDs.
- Modified lighting control requirements that add additional controls in some interior space types and exterior applications and the addition of control options for others that will allow easier application of the new advanced controls available on the market.

Q3: Standard 90.1 has traditionally included two paths for compliance: the prescriptive path and performance path (also known as the Energy Cost Budget Method). The 2016 standard establishes a third path: a stable whole building performance method. Can you provide an overview of this new fixed-baseline compliance path and help us understand its appropriate application?

Rosenberg:

Standard 90.1 includes two simulation-based performance paths, the Energy Cost Budget (ECB) Method and Appendix G, the Performance Rating Method. Before the 2016 edition of Standard 90.1, only ECB was approved for demonstrating minimum compliance with the standard. Appendix G was the modeling method used to quantify building energy performance for beyond code programs such as the USGBC's LEED rating system, commercial building federal tax credits, and the International Green Construction Code (IgCC).

Beginning with the 2016 edition, Appendix G becomes a second performance path option for compliance with Standard 90.1. This will enable the same building energy models that are used for code compliance to be used for beyond code programs, saving modeling costs and providing credit for good design decisions that are available through the Appendix G approach but are not ECB. For example, Appendix G provides credit for optimized building orientation, optimized window area, "rightsizing" of HVAC equipment, appropriate HVAC equipment type selection, and efficient use of building thermal mass.

The second impactful change is that baseline design is now fixed at a stable level of performance set approximately equal to 90.1-2004. The stringency of the baseline is not meant to change with subsequent versions of the standard. Instead, compliance with new versions of the standard will simply require a reduced Performance Cost Index (PCI). A PCI of one is equal to the 2004 baseline, and a PCI of zero is a net zero energy cost building.

Using this approach, buildings of any era can be rated using the same method. The intent is that any building energy code or beyond code program can use this methodology and merely set the appropriate PCI target for their needs. The multiple uses and stable baseline will encourage the development of software tools that automatically create the baseline building, which will help the market grow and extend the useful life of the software.

Q4: ASHRAE Standard 169-2013 published a new climate zone map based on the updated weather data. Standard 90.1-2016 adopted this map to set up requirements. Can we expect major changes on this new climate zone map? What is the impact

of changing the country-climate zone mapping on energy codes and building energy efficiency in the country?

Athalye:

Using a more recent period of weather data published in the *2009 ASHRAE Handbook—Fundamentals,* ASHRAE Standard 169-2013 remapped counties to climate zones. More than 400 counties out of a total of over 3,000 in the U.S. were reassigned to different climate zones, and most of the counties were reassigned to warmer climate zones. Many code requirements, such as wall insulation, differ based on climate zones. When a county is reassigned to a warmer climate zone, requirements generally become less stringent, and new buildings built in that county are likely to be less energy efficient than before.

Adopting the new county-to-climate zone mapping in ASHRAE Standard 169-2013 results in an overall increase in energy consumption of 0.18% at the national level.[1] The reassignment of climate zones results in an overall reduction in the stringency of Standard 90.1 because most of the reassignments are to warmer climate zones, which have generally less stringent requirements. While the national impact is small, mainly because only about 10% of the counties were reassigned, the impact on individual counties is likely to be higher, especially, in some highly populous counties that have been reassigned to milder climate zones.

Q5: What is the Standard 90.1 Progress Indicator? How is this tool used to track the energy-efficiency improvement of Standard 90.1?

Liu:

To provide ongoing feedback to SSPC 90.1, PNNL estimates the improvement of each edition of Standard 90.1 using a process known as the Progress Indicator. The process uses a suite of 16 prototype buildings modeled in EnergyPlus representing over 80% of the U.S. commercial building floor area and over 70% of the energy consumed in U.S. commercial buildings. Code-compliant versions of each prototype in each of the 16 climate zones referenced in Standard 90.1 are available for each version of Standard 90.1 since 2004, including the 2004, 2007, 2010, and 2013 editions. This combination of prototypes, climate locations, and standard editions results in 1,024 individual building models, which are available for free download ("Commercial Prototype Building Models," www.energycodes.gov/development/commercial/prototype_models).

PNNL uses the Progress Indicator to quantitatively track the progress of Standard 90.1-2016 and report the energy impacts of all approved addenda to the 90.1 committee periodically during its three-year development cycle.

Q6: What can we expect to see about the energy savings from the 2016 edition by comparing to its predecessor 90.1-2013?

Athalye:

PNNL uses the Progress Indicator (PI) methodology[2] to calculate the national impact of 90.1 and other energy codes. PNNL periodically reports the PI results to SSPC 90.1 to track progress of 90.1. In June of this year, the PI analysis reported 4.2% energy savings and 4.8% energy cost savings from 90.1-2016 compared to 90.1-2013. These results are likely to change when the final round of PI analysis is completed in January 2017. Savings are likely to increase as more addenda to 90.1-2013 will be included in the final analysis. The final results will be presented to SSPC 90.1 at the 2017 ASHRAE Winter Conference in Las Vegas.

Q7: What will it take for the states and localities to adopt Standard 90.1-2016?

Erbe:

I believe jurisdictions (state and local) will want to take a very hard look at the 2016 version no matter what level of adoption they are currently using. With the new performance compliance path there is flexibility, surety and opportunity for innovation and creativity, leading to energy savings above that provided by the basic standard. This is an exciting move toward recognition of systems' energy reduction possibilities for the industry and the standard.

Liu:

We don't have a national energy code or standard in the U.S. Building energy standards such as Standard 90.1 are adopted at the state and local levels of government. The adoption of model codes presents a significant opportunity to save energy in buildings. A new report issued by researchers at PNNL—and sponsored by DOE's Building Energy Codes Program—assesses the potential for impact of building energy codes at both state and

national levels.[3] The study shows that big savings in energy and offsets in carbon emissions can be made over the next 25 years if model codes are enacted as law. More specifically, adopted building energy codes would save consumers $126 billion on energy bills and cut carbon emissions by more than 840 million metric tons from 2010 to 2040.

Sciarra:

As the Department of Energy issues a determination that the 2016 edition will save energy, states and municipalities will, in effect, have one of the major arguments answered as to why adopt the 2016 edition. In reality, most state and municipal code adoptions of 90.1 are tied to the adoption of the International Code Council's codes. So as those codes are adopted, so, too, will be 90.1. In terms of increasing adoption, ASHRAE needs to work hard to give its local chapters the tools to start a dialogue with local and state leaders to encourage adoption.

Q8: What do designers, architects, and engineers need to understand in terms of design changes needed to meet the new requirements?

Erbe:

I would offer that the entire built environment community, including designers, architects, and engineers, has the opportunity to increase the number of buildings modeled and positively affect the energy landscape of buildings. For those who are using the standard as the minimum requirements, the efficiency gains and increased stringency will ensure that their buildings will be more energy efficient and cost-effective in those areas that the standard covers.

Glazer:

So many new building designs are using Appendix G as part of earning LEED points. In the future, we expect the same set of Appendix G energy models to be used for showing compliance with Standard 90.1-2016, as well as earning LEED points. This should increase design flexibility as well as saving effort during the design process.

Rosenberg:

Design strategies that save energy, but were previously not recognized by Standard 90.1, will now be encouraged when using the new Appendix G path for compliance. Strategies like optimizing glazing area and building orientation, reducing friction losses of air and hydronic distribution systems, rightsizing mechanical systems, using thermal mass efficiently, and selecting the most efficient mechanical systems are all strategies recognized when using the new compliance path.

Sciarra:

From a design perspective, the 2016 edition addresses building orientation and window performance as well as requirements for air infiltration. So design professionals really need to understand envelope loads and how they play a role in code compliance. In regard to the new modeling path, after reviewing a number of recent projects, many of them are using strictly the prescriptive path and not modeling, so the fixed requirements are still important in many communities.

Richman:

The 2016 edition anticipates and recognizes the use of at least partial LED lighting as common practice in most current building projects. Designers should find that designs using LED technology where practical will easily meet the new LPD limits. The new LPD limits are not all 100% LED, so designers still have flexibility in technology choice while meeting the standard. Designers will also find that controls are an integral part of compliance and that advanced lighting control systems that are becoming more readily available and economic in cost may provide a simple solution for compliance as well as energy savings.

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Roundtable

What topics would you like to see for future roundtables?

Send your suggestions to jayscott@ashrae.org