



Moving Forward

Findings and Recommendations from the Consultative Council

Introduction

Buildings are complex systems embodying ideas, experiences, technologies and practices brought together by different disciplines, users and needs. In forming the National Institute of Building Sciences and its Consultative Council in 1974, the U.S. Congress recognized this complexity and the importance of bringing these diverse actors together to improve building sciences and policy.

Early in 2010, the Institute re-formed the Consultative Council to represent leading organizations within the building community. The Council was charged with identifying the high-level issues currently impacting the building community and offering findings and recommendations related to these issues.

The issues identified for 2010 include:

- Defining High-Performance and Common Metrics,
- Energy and Water Efficiency,
- Codes and Standards Adoption and Enforcement,
- Sustainability,
- Education and Training, and
- Existing Buildings.

The Consultative Council established topical committees consisting of representatives from many organizations. Each committee prepared a report. With the exception of the Existing Buildings report (which will be produced at a later date), findings and recommendations from these reports are summarized below. The committees' full reports will be available in a separate document.

Defining High Performance and Common Metrics

Findings & Recommendations

- **Definition:** Add the following sentence to the Energy Independence and Security Act (EISA) 2007 definition of high performance building: "A building will have achieved optimization on a life-cycle basis when its measured results meet or improve upon legitimate benchmark standards that define high performance."¹
- The Institute's High Performance Building Council should form a Standards Integration Group (SIG) to perform necessary gap analysis (to identify gaps in information where additional work is needed) and coordinate consensus standards and measures development throughout the industry.
- Standards Development Organizations (SDOs) should

develop standards that address attributes of a high-performance building as identified by the SIG's gap analysis. Where practical, SDOs are encouraged to engage in Attribute Groups to discuss the establishment and use of common metrics.

- Industry-wide performance-based standards should address the following four measures: Baseline, Benchmark, Measured Results and Performance Results Index (PRI).
- Owner and project delivery (production) teams should implement a high-performance building system that measures both the project and completed facility metrics according to the standards of accredited SDOs.
- The Institute's High Performance Building Council should provide the leadership and roadmap to implement these recommendations.

¹The Energy Independence and Security Act (EISA) of 2007 (Title IV, Energy Savings in Buildings and Industry, Section 401, Definitions), definition of a "high performance building" is as follows: *A building that integrates and optimizes on a life-cycle basis all major high-performance building attributes, including energy conservation, environment, safety, security, durability, cost-benefit, productivity, functionality and operational considerations.*

Moving Forward | Findings and Recommendations from the Consultative Council

Attributes Development and Optimization

Although the building practices and structures of the past have tended to optimize the pieces and parts of the building process and product, the result has been a less-than-optimized whole building. Alternatively, the current high-performance building initiative looks, first, to optimize the whole building and then, to major systems on down to the parts and pieces. Whole building standards and measures are crucial to this initiative.

In order for standards and measures to be meaningful to anyone, they must be capable of being uniformly measured, expressed and understood by all users. The first step must be the establishment of consensus standards and measures for performance. The second step is the implementation of standards at the project-specific level.

Consensus Standards

In order to ensure standards uniformity and aggregated building optimization, the Institute's High Performance Building Council should convene an SIG to coordinate the work of attribute-focused SDOs. As such, when owners/developers choose to pursue high-performance goals, they should take the opportunity to adopt an SIG family of SDO standards.

SDOs should develop standards based on the identified attributes (energy, environment, safety, security, etc.) to achieve high-performance legitimacy. These standards can be used to help assess to what degree a building is considered a high-performance building.

Project Implementation

As the particular SDOs publish standards and processes for achieving high performance, owners and/or building teams will be equipped to implement a high-performance building system. In order for owners or building teams to make a legitimate claim of high performance, they need to successfully meet all of the requirements and validate the performance and cost-benefit measures.

Common Metrics

The following metrics can be used to help measure the actual performance of a building against the standards. Attribute Groups are encouraged to discuss how such measures can be defined for a particular attribute.

- **Baseline**—a measure of standard performance for specific whole building and major systems when the measure is cost, or for a particular unit of measure for critical components. Standard performance and productivity relates to the market or industry average, based on conventional or customary means and methods at a particular baseline year.
- **Benchmark**—a measure of in-progress high performance according to a viably optimized state. In many cases, this measure is derived as an interpolation between the baseline and an ends goal. Also, in most cases, a target performance value should be determined as well.
- **Measured Results**—a measure of actual results from the completed and operating building.
- **Performance Results Index (PRI)**—a ratio of component measures, where the numerator is the measured result and the denominator is the standard that it is measured against.

A high-performance building exists once the measured results meet or improve upon the benchmark measures, or when the Baseline PRI is 1.0 or less.

The complex nature of the building process and facility operations requires a hierarchical structure, starting with whole-building high performance; then drilling down from the whole building to major systems, sub-systems, components, materials, etc., as well as concepts; and concurrently drilling across to address each attribute. The intersection of each item and attribute would create a "destination" to define relative performance in terms of the metric used, how it is measured and how it is expressed.

Each intersection would be measured and expressed in two ways: (1) the Cost Benefit and (2) the High Performance (HP) Classification of: (a) Fails HP, (b) Meets HP, or (c) Exceeds HP. Individual building components and sub-components may include these cost and classification measures, but overall building

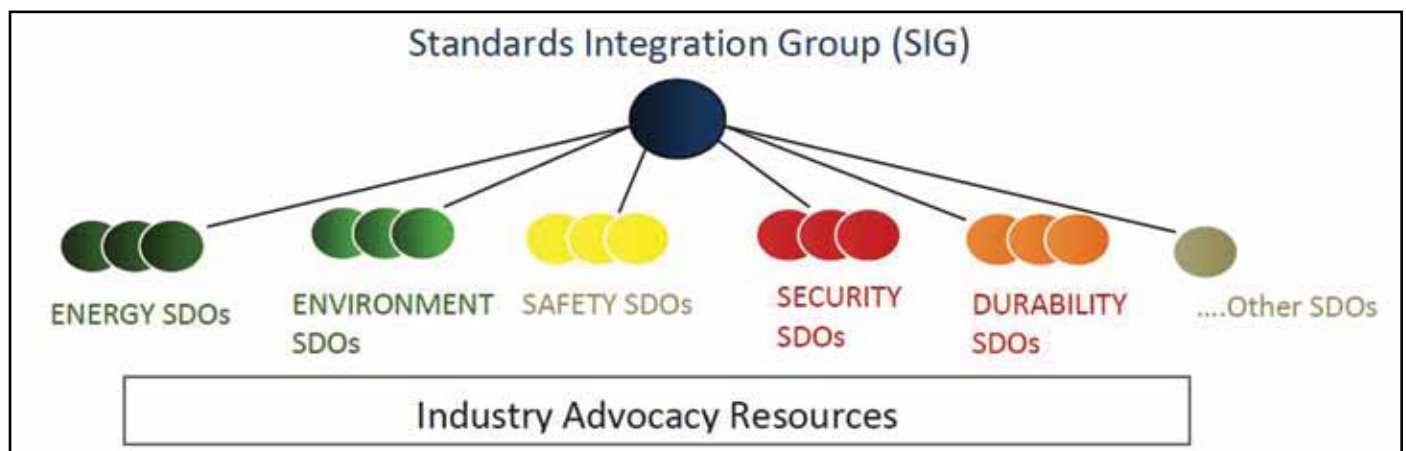


Figure 1—Relationship of the SIG to Standards Development Organizations (SDOs)

Moving Forward | Findings and Recommendations from the Consultative Council

performance would be evaluated according to units of measure relating to energy, carbon, light, sound, force, load, etc., as determined by the respective SDOs.

Implementation

In order to accomplish these recommendations, the Consultative Council proposes a four-step process:

1. The Institute's High Performance Building Council would form a Leadership Council representing all stakeholders (owners; building producers; codes, standards, measures and industry improvement organizations; and government agencies).
2. The Leadership Council would convene a brainstorming session with a broad base of stakeholder volunteers.
3. The Leadership Council would compile the brainstorming results, produce a roadmap for implementation and promote it throughout the marketplace and to policy-making groups. The outcome should address the formation of the various SDO Attribute Groups and SIG, as well as identification of needed research and development projects.
4. The building community would then implement the roadmap.

Energy and Water Efficiency

Findings & Recommendations

- The federal government should redouble its leadership efforts and urgently work with construction community stakeholders to develop widely acceptable energy and water efficiency metrics to be deployed in developing future codes, standards and efficiency programs.
- The federal government should provide monetary incentives in the form of funding and tax incentives for the adoption and enforcement of energy and water efficiency stretch/above baseline codes and standards.
- Investment in energy and water-related infrastructure is desperately needed. Programs aimed at repairing and replacing aging infrastructure would vastly improve efficiencies and create jobs.
- The building community and policymakers should shift towards performance-based code provisions that work towards net-zero energy buildings and away from prescriptive requirements.
- The President and Congress should prioritize, coordinate and support development of a national water strategy.
- The Environmental Protection Agency (EPA), working with other relevant agencies, should establish a plumbing research facility to support plumbing research programs that foster increased levels of water efficiency. Such a facility should be located within the National Institute of Standards and Technology (NIST) or another research institution charged with working with the private sector.
- Congress and the Administration should continue to fund successful labeling incentive programs like Energy Star™ and WaterSense™ and support retrofit incentive programs aimed at removing inefficient consumer appliances and plumbing fixtures from the marketplace.
- The building community and policymakers should support the development of codes and standards establishing requirements for the safe use of alternate water sources, such as reclaimed water, rainwater and gray water, and efficient outdoor irrigation practices.

- The U.S. Department of Energy (DOE) should work with codes and standards developers to provide energy savings analysis on change proposals, utilizing the same tools DOE uses to determine the efficiency of a new edition of a code or standard over a prior edition.

Introduction

Numerous efforts are underway, both in the United States and internationally, to develop comprehensive, performance-based energy metrics. Achieving net-zero energy performing buildings will require a greater understanding of the cost/benefit variables, thus allowing the building community to make informed decisions regarding which technologies to prioritize, develop and implement. The transition away from prescriptive-based specifications towards performance-based metrics also should include goals for the incorporation of systems that allow real-time user monitoring of building energy and water use to facilitate ongoing performance. Such systems will provide a built-in feedback system for continuously improving actual performance and informing the underlying metrics.

Conveying water consumes energy—from the source to the point of treatment, through the treatment process, while distributing water to the point of use, heating water during use and going through the wastewater treatment process. Plumbing distribution systems within buildings need to be designed with a greater focus on water and energy efficiency in residential, commercial and industrial sectors. During the design phase, designers should minimize the distance between the sources of hot water (generally the water heater) and the various points of use within a building.

Efficiency and conservation methods within buildings should continue to be employed in construction designs. However, the backbone of the nation's electrical and water delivery systems also needs significant repair and improvement. With nearly 60 percent of electricity and 20 percent of water being lost before it ever enters service, significant savings will not be realized until the delivery systems become more efficient and waste is reduced.

Moving Forward | Findings and Recommendations from the Consultative Council

The American Society of Civil Engineers, in a 2009 report, gave the U.S. drinking water and wastewater system a D-. The electrical infrastructure fared only slightly better by earning a D+. Both systems require significant investments in technology and distribution systems simply to maintain their current service, let alone to keep up with growing demands.

The assessments of technology performance will continue to benefit the building community as it strives to increase building energy efficiency and, as a result, drive development of new technology applications and design concepts. As technology is assembled into new building designs or renovations to existing buildings, the building community needs a better baseline of actual building performance against which to measure progress. More importantly, the application and use of prescriptive

criteria must be eliminated in favor of stated performance goals or expected outcomes (although, after setting those goals or outcomes, prescriptive guidance to achieve them can be developed).

The United States has a profound need to improve the indoor and outdoor use of water in buildings. The EPA reports that 36 states expect to experience local, regional or statewide water shortages by 2013². The nation employs a very conservative approach of utilizing potable water for nearly all applications, which may not be sustainable in an era of constrained supplies. Before additional improvements in indoor water efficiency can be confidently utilized, research on plumbing-related issues is required to better understand the implications of reduced flows in building supply and drainage pipes.

Codes and Standards Adoption and Enforcement

Findings and Recommendations

- At the state and local level, where code adoption and enforcement is largely conducted, the lack of resources, both financial and technical, significantly affects the ability of state and local officials to ensure that new buildings are satisfying the requirements provided by codes and standards and achieving the inherent benefits.
- Policymakers and the general public often misunderstand the codes and standards development, adoption and compliance process due to its complexities. There needs to be education initiatives to improve understanding.
- Increasing the participation of federal, state and local government agencies in the development of codes and standards would yield more uniformity and more consistently adopted and understood codes, thereby increasing the effectiveness of model building codes.

Introduction

Building codes cover the multidimensional aspects of the design and construction of new and existing buildings. Such codes represent baseline or minimum requirements. They can cover issues such as energy efficiency, life safety, accessibility, indoor air quality and many others.

Buildings last a long time, and codes and standards allow the benefits of improved construction today to be enjoyed for many decades. Continual improvements to codes, when adopted and enforced by jurisdictions, can result in consistent and long-lasting increases in energy efficiency, health, safety and accessibility.

Most model codes and standards are developed according to rigorous principles based on consensus, openness, balance, transparency and due process. In the United States, codes and standards are developed in the private sector, with the input of government agencies, consumer groups and other entities, to

meet the changing demands of society. As technology, building science knowledge and understanding of risk improves, codes and standards evolve to incorporate such improvements. The typical code cycle lasts 3 to 5 years. The U.S. approach to code development allows plenty of time for input and transparency, but many challenges (as well as opportunities) remain on the path to achieving safer buildings that are more accessible and energy efficient.

Standard & Code Adoption: Implementing Best Baseline Practice

Building code requirements most often are established through adoption by state or local governments and by some federal agencies, such as the Department of Justice's Bureau of Prisons (although private developers also may impose these or more stringent requirements as a condition of a construction contract). Increasing code stringency provides new challenges to the building industry at large and to state and local agencies that are charged with administering and enforcing the codes.

The success of the building and construction market to meet code requirements relies on the availability and pricing of products and equipment. Equally important are the appropriate knowledge and skills of designers and contractors. Yet product development and workforce training takes time, which may not be considered when adopting updated codes and standards. Although many in the construction community are aware when code changes are going into effect, they often are reluctant to support code compliance or embrace the changes.

The recent increase in development of stretch/above baseline codes provides a straightforward potential solution. If these codes were to automatically become the next minimum code, they would provide the predictability and experience needed to support significant code compliance. Once established, incentive programs also could be used to promote the stretch code as a

²U.S. EPA, Water Supply and Use in the United States (2008)

Moving Forward | Findings and Recommendations from the Consultative Council

voluntary performance level for construction. Training, resources and financial incentives would work to fuel product development, skills and experience that would carry over to the broader market once the requirements became mandatory.

Resource constraints also tend to dampen the adoption of new codes. Some state policymakers are averse to adopting a code that will require significant and costly support. As codes advance further and faster, more resources will need to be invested to help the industry keep up. If resources are not available, code adoptions may stall.

An outcome-based objective that can be readily verified can assist jurisdictions in solving this problem. For instance, where code compliance is not achieved on an annual basis, penalties in the form of utility surcharges or property tax fines can be imposed. These outcome-based objectives may be more effective in the long run than the present situation, where buildings receive a certificate of occupancy upon completion, with limited or no inspections thereafter (depending upon the occupancy).

Code Compliance

As with code adoption, strengthening energy efficiency, health, safety and accessibility requirements over time presents several challenges to code compliance mechanisms. However, there is potential to significantly improve overall compliance through changes to the process and scope of enforcement, and as noted above, the format of codes.

Administration and enforcement of codes and standards is crucial to realizing safe, healthy, energy efficient and accessible buildings. The responsibility to administer and enforce the building code typically falls upon states or local jurisdictions, and the responsibility to submit compliant design documents for a building permit falls on developers, designers and contractors. Education and communication regarding codes and standards is vital to the effective delivery of both enforcement and compliance.

The process by which code compliance is verified is typically local, with the state having oversight and/or enforcement responsibility for some types of buildings. Local agencies that are authorized and have the proper training and resources will typically enforce the adopted codes. Although empowered by statute and regulations to set forth the local code administration processes, the availability of resources determines the quality and extent to which jurisdictions perform plan reviews and construction inspections. When a state code agency actively supports local governments with the education, training and technical information services necessary to administer and enforce the code, compliance improves.

It is important for all stakeholders to know when a new code is expected to be implemented and to understand its requirements. Many states or jurisdictions start this education process months in advance of the code change and/or allow a window of compliance (e.g. permits can be issued for two different editions of the code during a specified grace period). Effective outreach, education and training greatly enhance acceptance and use of the new code.

Sustainability

Sustainable buildings and related infrastructure advance economic growth, environmental stewardship and social progress. They also are resilient to the effects of natural, accidental and willful hazards. Achieving a sustainable built environment requires numerous approaches, as indicated in the findings and recommendations below.

Findings & Recommendations

- Economic growth, environmental stewardship and social progress form the “triple bottom line” for sustainability that should be addressed in all building and infrastructure projects. Project goals and processes through the whole life cycle, from planning to renovation or removal, should demonstrate explicitly the economic, environmental and social benefits to the communities affected.
- Assuring that concerted actions are taken to achieve sustainability in buildings and communities requires credible, knowledgeable, patient and charismatic leaders (“champions”) for each group of stakeholders (at the national, state, local, industry and project levels). The building community (through the National Institute of Building Sciences and other organizations) should give substantial attention to identifying, informing and empowering potential champions.
- Providing the body of knowledge and tools for sustainable building and infrastructure practices requires substantial, comprehensive and sustained programs of research, development and demonstration (RDD). Policymakers and the building community need mechanisms to coordinate and advance the programs of the numerous public agencies, private foundations and private industries that fund RDD for sustainable buildings and infrastructure. Agencies should consider what interdisciplinary, multi-sponsored research is needed and stimulate the necessary funding, with clear indications of what benefits are to be achieved.
- To achieve true long-term sustainability of buildings and related infrastructure, designers, constructors, operators and owners must incorporate such concepts into the practices, standards and codes used throughout the life cycles of constructed facilities. The multi-faceted nature of sustainability requires that standards and practices state explicit performance requirements and have conformance assessment systems capable of accepting innovations. Building codes and infrastructure regulations should cite up-to-date, performance-based standards to assure acceptability of designs that provide better than minimal performance. As indicated above, the building community should undertake efforts to coordinate the establishment and use of consistent metrics.

Moving Forward | Findings and Recommendations from the Consultative Council

- Formal and continuing education programs should provide future and present generations of professionals and technicians with the multi-disciplinary body of knowledge required to achieve sustainability in buildings. Each discipline or specialty involved in construction needs to understand the economic, environmental and social implications of its work, as well as its own special body of knowledge. Education and training curricula and programs require a well-rounded course of work providing knowledge in a breadth of subject areas with sufficient depth in focused technical areas. Collaborations across all disciplines can assist in defining the background education desired in social, life and physical sciences.
- Nationally recognized professional and technician licensure and certification programs should demonstrate how sustainability can be implemented in regular practice to address the needs of clients, employers and the public. Licensure boards should examine building and infrastructure professionals and technicians for needed knowledge of sustainability. Authoritatively accredited certification programs should be developed to recognize needed professional and technical expertise in sustainability.
- K-12, post-secondary and informal educational programs should teach students about the importance of a sustainable built environment, and should attract capable people to careers in building and infrastructure. All Americans are building occupants and beneficiaries of civil infrastructure. Their involvement is crucial to achieving sustainability goals. The building and infrastructure community should become involved in ongoing governmental and private efforts to address sustainability in K-12, post-secondary and informal education, and assure that appropriate recognition is provided to the importance of the built environment and building community.
- The economy must have a strong financial and insurance capacity to provide society with the benefits of a sustainable built environment. Society needs to understand and fund the potentially higher first costs associated with better economic, environmental and social performance over the project life cycle. To attract the financing required to produce sustainable buildings and infrastructure, investors need studies demonstrating increased public and private returns on investments. Appropriations for public construction should address life-cycle costs and benefits, and policies for accounting, financing, insurance and taxes should facilitate and promote private investment in sustainable buildings and related infrastructure. Budgeting and organizational practices, in both the public and private sectors, also should facilitate achievement of lower life-cycle costs.
- Public involvement in decisions made throughout the life cycle of a building or infrastructure system is needed to assure that the facility contributes to, and is perceived by stakeholders to contribute to, the sustainability of the affected communities. Model practices for public involvement should be developed and disseminated for appropriate types of building and infrastructure projects. These practices should involve interdisciplinary efforts representing typical proponents, participants and stakeholders.
- Buildings are subject to many regulations administered by many different authorities aimed at protecting the public health, safety, welfare and environmental quality. Attempts to improve sustainability in buildings often fall under the jurisdiction of several governmental entities, such as the building department, public health agency, utility commission and architectural review board. While validation and approval of these innovations are necessary, such projects often encounter prohibitively expensive delays in obtaining regulatory permits. Governance-focused organizations should develop and demonstrate model processes for improving the efficiency of the regulatory process for important classes of building and infrastructure projects. Where needed, the statutory authorities of regulatory agencies should be modified to enable participation in a streamlined process.

Education and Training

Buildings have a complex life cycle, from concept, design and construction to commissioning, occupancy, modification/renovation and deconstruction. Education and training within the building professions must reflect this complexity and the specific skill needs at each point in the building's life cycle. These life-cycle considerations include efficient use of energy and water through reduced waste and demand management, improved occupant comfort and health, and upgrading the human-building system interface. In each time period within the building's life cycle, particular segments of the building community must be engaged and have the requisite knowledge to adequately address the unique needs within that time period. (See Figure 2 for an example.)

Essential audiences for education and training include all people who impact the performance of the building during its life cycle. Such audiences include:

- The Owner,
- Commissioning Agent/Authority,
- General Contractor,
- Engineer,
- Architect,
- Installation Contractor,
- Service Contractor,
- Facilities Manager,
- Operations and Management,
- Users/Occupants,

Moving Forward | Findings and Recommendations from the Consultative Council

- Support Contractors (including support contractors not directly related to systems maintenance, i.e., the cleaning service, replenishment services, etc.), and
- Inspectors and Enforcement Personnel.

Requirements may be different across residential, commercial, industrial and specialized buildings (specialized buildings include hospitals, laboratories, schools), so training should specifically relate to the building types for which personnel are responsible.

Structure Life Cycle	Concept	Design	Construction	Commissioning	Occupancy	Modification of Use / System Upgrade	Deconstruction
PEOPLE INVOLVED							
Owner	X	X	X	X	X	X	X
Commissioning Agent	X	X	X	X	X	X	
General Contractor	X	X	X	X		X	X
Engineer		X		X	X	X	
Architect		X				X	
Installation Contractor	D	D	X		X		
Service Contractor				X	X		
Facilities Manager				X	X		
Operations & Maintenance				X	X		
User/Occupants					X		
Support Contractors				X	X		
Inspectors - Enforcement		X	X	X	X	X	X

D - Design/Build Scenario

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Figure 2 – People Involved in the Structure Life Cycle

While it is essential that people who enter a particular career get education and training initially, training must continue throughout their careers. Best practices go stale, equipment and processes change, and new regulatory requirements go into effect. To assure professionals seek out and retain it once received, such education and training must be dynamic and engaging.

Communication across all disciplines engaged in the building process is critical to achieving high-performance requirements. However, changes in current communication channels are needed because buildings are becoming more automated, and the technologies and management processes to operate, maintain and minimize energy consumption are requiring increasing levels of integration.

Incentives are needed to motivate businesses and organizations to see beyond short-term, financially driven bottom lines and look to the future in preparing the U.S. workforce for the challenges, complexities, technologies and competitive demands of the global economy. Without an increased emphasis on education and training of the workforce, industry may not be ready for the economy of tomorrow. Industry is committed, but without incentives, it will be difficult to move forward with decisive and accelerated programs.

Education and training incentive programs should be available to cover all levels and types of businesses and organizations, and should encompass all construction, maintenance and operational core competencies in the three primary building sectors: residential, commercial and industrial. Incentive programs should extend from apprenticeship programs and specific task training to professional development. Programs should include continuing education to achieve or maintain levels of recognized third-party certification or similar levels of accreditation. They also should be available to all Americans, especially veterans and minorities. ■

Participants

Consultative Council Member Organizations

ASTM International
 American Institute of Architects
 American Society of Civil Engineers
 American Society of Heating, Refrigerating and Air-Conditioning Engineers
 Associated General Contractors of America
 Building Owners and Managers Association, International
 Construction Specifications Institute
 ESCO Institute
 Extruded Polystyrene Foam Association
 Illuminating Engineering Society
 International Association of Plumbing and Mechanical Officials
 International Code Council
 National Insulation Association
 National Opinion Research Center at the University of Chicago
 United Association of Journeymen and Apprentices of the Plumbing and Pipefitting Industry

Topical Committee Facilitators

Defining High-Performance & Common Metrics:
 Paul Mendelsohn, American Institute of Architects
 Energy and Water Efficiency:
 Peter DeMarco, International Association of Plumbing and Mechanical Officials
 Education and Training:
 Larry Bulman, United Association of Journeymen and Apprentices of the Plumbing and Pipe Fitting Industry
 Codes and Standards Adoption and Enforcement:
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 Existing Buildings:
 Ron Burton, Building Owners and Managers Association, International