An Evaluation of Current Practices Related to the Development and Implementation of Acceptance Criteria and Product Evaluation Reports

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Abstract

Evaluation Reports (ERs), sometimes called code reports, are based on Acceptance Criteria (AC) and have been used by the construction industry for many decades. They are used to help assess a product's code compliance through the code specified alternate means of compliance (AMC) provision, and are typically for products or systems not addressed in the code. They are also provided to help the building official and design professional determine if products or systems meet the prescriptive requirements and/or intent of the code. They have facilitated the use of new, innovative products through an evolving review and implementation process. ERs have also been used for products that are covered by the code as well as when there is some ambiguity in the code provisions. ERs have become a tool to facilitate, expedite and, in some cases, improve the design, building permit, construction, inspection and quality confirmation processes. Questions have been raised as to how ERs are developed, how they are used, their effectiveness in providing consistency for a more uniform building stock, their accuracy in discerning a products code compliance, and how to improve the existing ER development process. In 2009, the SEAOC Evaluation Reports Committee was tasked with evaluating these questions, keeping in mind the non-seismic and non-structural applications, and providing recommendations for improvement of the ER development process and implementation. Furthermore, while ICC-ES and IAPMO ES are the prominent ER Providers, there are several other organizations that provide reports. Our comments herein target the industry as a whole, and do not necessarily pertain to ICC-ES, IAPMO ES, or any other ER Provider or product certification agency. A key finding is that better understanding of the AC and ER development process as well as proper implementation by all developers and users would result in the immediate and most broad improvement to their appropriate use in the construction industry. As products not specifically covered by the building code are used in most, if not all, buildings and many rely on evaluation reports to assist in determination of a products compliance with the building code, better understanding and improvement of the evaluation report process will help maintain public safety as well as provide more consistency in the built environment. Understanding and improving the existing AC and ER process is extremely important in protecting the public safety, which is the paramount charge to structural engineers and building officials alike.

Document Organization

The primary objective of this white paper is to provide a description of the ER development and implementation processes to industry members (ER Provider, engineer, contractor, building official, etc.). The Evaluation Reports Committee deems this to be essential to improve the consistency and effectiveness of ERs. The white paper sets forth discussion about the processes and provides recommendations for all industry members on how they can contribute to improve ERs and make them a more effective tool as well as to increase consistency and the likelihood of the proper use of new innovative and possibly more cost effective products and systems. While we would encourage the reader to review the entire document and provide feedback, we recommend at least a reading of the Introduction and Recommendations sections to gain a better understanding of the important role ERs play in the construction industry as well as how one may help improve the ER process and implementation.

Introduction

This white paper provides a historical background, a discussion of the need for ERs, identifies key industry members that provide ERs, discusses how criteria that form the basis for evaluating the products are developed, the ER generation process, and concludes with recommendations for improvement. SEAOC is engaged in outreach to industry members in an endeavor to include the perspective of all involved in the development and implementation of ACs and ERs. Specifically, the SEAOC ER Committee had representation and input from practicing structural engineers, building officials, special inspectors, statewide agencies, ER Providers, manufacturers, manufacturers' technical proponents, and others.

The construction industry is introducing new methods, materials, products, and systems at a greater rate today than in previous years. The industry has different methods to justify a part or all of an AMC request, in addition to ERs, for incorporating such changes without waiting for new code and standard provisions and some of those are listed below. Several of these take long periods of time to complete. However ERs prepared by ER Providers and manufacturers' proponents have continued to be a popular method to help demonstrate that an innovative product or system meets the intent of the code. This facilitates the timelier introduction of products into construction before a new standard or code provision is developed and adopted by the AHJ, which may take many years.

The alternate means of code compliance (AMC) provision is in Section 104.11 of the 2009 International Building Code (IBC) and is shown below.

104.11 ***Alternative materials, design and methods of construction and equipment****. ... An alternative material, design or method of construction shall be approved where the building official finds that the proposed design is satisfactory and complies with the intent of the provisions of this code, … equivalent of that prescribed in this code in quality, strength, effectiveness, fire resistance, durability and safety.*

104.11.1 ***Research reports****. … from approved sources.*

104.11.2 ***Tests****. … building official shall have the authority to require tests ...*

Section 104.11 provides a roadmap for the approval of alternative materials, design, and methods of construction not found in the IBC. Below is a summary of the key points (from the perspective of this white paper) of how the code intends for alternatives to be approved based on these three sections.

Section 104.11: The code permits alternatives only when approved by the AHJ. It is the responsibility of the AHJ to evaluate the alternative for compliance with the intent of the code prior to approving. As the complexity of the code and the alternatives has grown, the time and expertise required to evaluate alternatives has increased and often exceeds the resources available within many building departments.

Section 104.11.1: The code provides for the use of valid *research reports* (a.k.a. evaluation reports) when they are issued by sources approved by the AHJ. Research reports that address the intended application can be a valuable tool for building departments if they have confidence in the organization issuing the report. Several organizations worked to become accredited to certify building products in accordance with ISO/IEC Guide 65 in order to demonstrate competence, quality, and independence to the AHJ; however, accreditation is not mandated by the code.

Section 104.11.2: Test reports may be submitted as evidence of code compliance, however the AHJ must review the results to ensure: 1) testing was performed by an approved third-party agency, 2) the alternative was tested following approved standards or procedures, 3) the testing is representative of the intended application, and 4) the results indicate equivalence to those prescribed in the code.

To understand the context of where ERs fit into the industry, following is a list and brief discussion, in no particular order, of possible proponents and techniques for demonstrating alternate means of code compliance in accordance with Section 104.11 of the IBC.

AMC Proponents

1. Design professionals: A design professional can perform a product review and provide a substantiated or unsubstantiated singular professional opinion that a product meets code intent. Typically, when this is performed it is for a specific project to somewhat simplify and provide the best assessment of a product's use for a given project's condition. For the design professional, professional judgment is used to allow for conditions that deviate from code, particularly during construction, with the final concurrence of the AHJ. Depending on the level of documentation substantiation requirements and enforcement policy by the particular AHJ, these changes to the contract documents are often not documented as AMC. Other scenarios in this category involve the development of full product evaluation criteria, design/detailing/inspection requirement development, review, and a peer review process, as required by the codes cited by the governing regulations and ordinances or their policies.

2. Professional organizations and committees: These may consist of teams assembled from those considered experts in their field who work together to develop a guideline document that, although not a standard, gains some level of industry recognition. The most recent example of this is the Pacific Earthquake Engineering Research (PEER) Tall Building Initiative [PEER, 2010]. This document will likely be cited by AMC proponents during their building permit application, similar to the way in which an ER is used. Therefore, the guideline

document is used or utilized similar to an AC, if approved by the AHJ, to evaluate the product and its intended use and to help ensure proper implementation.

3. ISO/IEC Guide 65 Accredited ER Providers: These are the focus of this paper and are discussed in detail, particularly in the Historical Background, and noted to have varying requirements and generally similar processes for developing ERs. The process employed by these Certification Bodies is presented in various ISO/IEC guidelines and/or on their websites. We note that compliance with ISO/IEC Guide 65 is not mandated nor recognized by the building code, yet one benefit of having an entity with this accreditation is to provide a third party to help ensure that the organization is in compliance with their own rules and processes to help create a more fair and consistent process. The Guide focuses on procedural rather than technical quality control and assurance matters.

4. ISO/IEC Guide 65 Accredited Product Certification Providers (PC Providers): These are entities that certify a product's compliance with quality assurance tests or requirements in various codes, standards, or specifications. The process employed by these Certification Bodies is presented in various ISO/IEC guidelines and/or on their websites. We note that compliance with ISO/IEC Guide 65 is not mandated nor recognized by the building code, yet one benefit of having an entity with this accreditation is to provide a third party to help ensure that the organization is in compliance with their own rules and processes to help create a more fair and consistent process.

5. Other ER Providers or PC Providers that are not ISO/IEC Guide 65 Accredited: These are entities that provide ERs, but do not have ISO/IEC Guide 65 accreditation.

AMC Techniques

1. Engineering Assessment: Research or engineering reports are prepared typically based on either available, developed, provided or obtained data or a combination of these as well as that individual engineer's understanding of code intent. They consider the intent of the code and offer an individual professional opinion that the product, material, or system is deemed to be equivalent to what is required by the relevant standard or code.

2. ER by ER Provider: ERs are developed by an ER Provider based on product evaluation in accordance to the applicable code and standards and/or ACs and then published when the product is deemed to comply.

   ACs provide a list of criteria which much be satisfied to obtain an ER such as product description, material type and strength, initial and ongoing quality control and/or assurance requirements, test setup and requirements, load rating methodology, product limitations, detailing requirements, inspection requirements, ER format, and minimum ER content requirements.

   Recently, for some seismic force resisting products, ICC-ES added an evaluation procedure to determine equivalency to code prescribed products. In 2007, an ICC-ES Ad Hoc Task Group of various industry experts and representatives developed an equivalency approach to provide a method to determine the equivalency of prefabricated shear panels evaluated to AC130 – *Prefabricated Wood Shear Panels*, or AC322 – *Prefabricated, Cold-formed, Steel Lateral-Force-Resisting Vertical Assemblies,* to code recognized site built wood framed shear walls. ICC-ES then inserted this methodology as a requirement into AC130 and AC322. Then ICC-ES made the decision to add this methodology to several of its other existing ACs such as AC04 – *Sandwich Panels*, AC230 – *Power-driven Pins for Shear Wall Assemblies with Cold-form Steel Framing and Wood Structural Panels*, and AC269 – *Racking Shear Evaluation of Proprietary Sheathing Materials Attached to Light-Frame Walls with Proprietary Fasteners*. However, the equivalency procedure developed by the Ad Hoc Task Group should be evaluated carefully prior to using it beyond the Task Group's original scope of AC130 and AC322 as different equivalency bench-marks may be deemed necessary. The products covered by AC130 and AC322 are complete prefabricated shear panel assemblies versus individual shear panel components.

3. ATC 63/FEMA P695: This document defines probabilistic procedures and methodologies, including an independent expert panel review throughout the entire process, for determining code-defined system coefficients for seismic lateral force resisting systems. The limitations and detailing used for new systems could be developed, documented, and vetted using ATC 63/FEMA P695.

4. ATC 63-1/FEMA P795: As an off-shoot of the ATC 63/ FEMA P695 project, this methodology targets component equivalency, similar in principle to the ICC-ES approach but based on a quantifiable statistical approach. The limitations and detailing used for new systems could be developed, documented, and vetted using ATC 63-1/FEMA 795.

5. ASCE/SEI 41-06: This standard, *National Standard for Seismic Rehabilitation of Existing Buildings*, provides provisions on how to develop new modeling and acceptance criteria for existing and new component actions. As opposed to the qualitative performance-based language of the provisions for AMC, this standard provides quantifiable provisions.

As noted above, ERs are one of several methods of presenting a position by either an individual or group or ER Provider that a material, product, or system meets the prescriptive code requirements and/or code intent. While ASCE 41 is a code referenced standard, the engineer's report, ER Provider's report, ATC 63/FEMA P695, ATC 63-1/FEMA P795 and ERs are not code provisions or code referenced standards. An ER, like an engineering opinion, may be adopted by an AHJ implicitly through code provisions or explicitly through policy. In all cases, the designer and building official must fully understand and agree with the conditions and limitations of an ER prior to their use or allowance of the product(s) it lists. It is the building official who has the final determination, in accordance with the IBC 104.11, as to whether or not use of the product is in accordance with code intent, whether justified through component equivalency along with compliance with a publicly developed, committee reviewed and approved evaluation criteria (e.g. codes, standards, and/or ACs) or through a more system-wide approach of adherence to requirements of 104.11. The danger is that products, codes, and standards have become more complex and the building official's resources have not grown at the same rate and, in many cases, have actually been reduced. There is increasing pressure from building owners, developers, and builders on design professionals and building officials, especially in economic downturns, to use new products or systems in which the proper evaluation is beyond their expertise or they are not allotted adequate time to properly review a product AMC submittal. With these demands, it would seem the minimum recommendations would be for products to be evaluated to a publically developed, independent committee reviewed and approved criteria by an accredited product evaluation entity.

ER Historical and Current Practice Background

Evaluation Reports (ERs) were originally created to fulfill a need expressed by building officials when they had to evaluate products, methods, and materials (referred to as "products") that were not addressed in the building code or to evaluate product conformance to prescriptive code requirements. The system of ERs was and is embraced by manufacturers of building products as a method for presenting evidence that their products meet code intent. Presenting ERs as a way to demonstrate compliance with code requirements expedites product application in the design process, often times expedites approval from the AHJ over the project and, more importantly, increases the likelihood of the correct determination whether a product or system meets code intent based on public discussion and expert input compared to an individual engineer's and building officials opinion.

To this end, and because jurisdictions have limited technical staff and budgets, a group of building officials formed a research committee to review technical data on products and issue research reports regarding product code compliance to the building officials. These were based on the provisions of the Uniform Building Code (UBC) initially published in 1927 by the Pacific Coast Building Officials Conference (PCBOC). This was the precursor organization to the International Conference of Building Officials (ICBO). This agency developed, published and managed these reports under its subsidiary, ICBO Evaluation Services, and identified the reports as Evaluation Reports.

Subsequently over time, other regional code writing organizations, such as Building Officials and Code Administrators (BOCA) and Southern Building Code Congress International (SBCCI), also became involved in evaluation of building products and sought to improve the process. These were later joined by National Evaluation Service (NES). In 2003, all of these regional code groups (ICBO, BOCA and SBCCI) merged into the International Code Council (ICC) that we know today. In order to continue the historical activity of product evaluation for code compliance, ICC created a subsidiary non-profit organization, ICC Evaluation Services (ICC-ES).

Other organizations and firms (also referred herein as ER Providers), such as American Plywood Association (APA), Architectural Testing, Inc. (ATI), International Association of Plumbing and Mechanical Officials (IAPMO ES), and NTA, Inc., have begun product evaluation services in response to the increased market, driven in part, by the expanded role of ERs in the construction industry.

Some of the ER Providers are accredited by ANSI per ISO/IEC Guide 65, *General requirements for Bodies Operating Product Certification Systems*, including ICC-ES, IAPMO ES, NTA and ATI, while others have varying methods and levels of accreditation. The requirements of Guide 65 are based on a 75% majority vote from national standard organizations from many countries. The American National Standards Institute (ANSI and the International Accreditation Service (IAS), a subsidiary of the International Code Council and established in 1975, are two entities that accredits companies to ISO/IEC Guide 65. Both ANSI and IAS limit accreditation under Guide 65 to specific sectors for which the Product Certification Agency (PCA) qualifies, such as “building products”. Both ANSI and IAS have a list of which entities they’ve accredited on their websites.

The ISO website states that “ISO (International Organization for Standardization) is the world's largest developer and publisher of International Standards. ISO is a network of the national standards institutes of 162 countries, one member per country, with a Central Secretariat in Geneva, Switzerland, that coordinates the system. ISO is a non-governmental organization that forms a bridge between the public and private sectors. On the one hand, many of its member institutes are part of the governmental structure of their countries, or are mandated by their government. On the other hand, other members have their roots uniquely in the private sector, having been set up by national partnerships of industry associations.”

ISO/IEC Guide 65 requires that an organization establish product evaluation procedures to help to better ensure the consistency of evaluations across all ER applicants. These processes are then audited by a third party organization to verify that the organization is properly executing these processes. The audits focus on the identified processes and do not evaluate the technical validity of every individual ER. During the regular audits, the assessors verify the proper implementation of procedures for the issuance of ERs. The system relies on sampling methodology to ensure technical and procedural compliance of the accredited body when issuing evaluation reports. Sampling is performed to ensure technical quality and competence of the issuing body on the day to day performance of its tasks. ISO/IEC Guide 65 accreditation is one tool that helps promote technical and procedural quality and consistency of the AC and ER process and is similar to the ANSI process used by the code adopted standards.

There has been an increase in the number of ER Providers as well as broader use of ERs by industry members, which now include, but are not limited to, design professionals, building officials, inspectors and manufacturers. While there is not a code mandated accreditation requirement to review building products, differences in accreditation, evaluation criteria, and evaluation development require careful consideration when assessing ERs. We note some entities, such as California’s Division of the State Architect (DSA) have policies accepting product ERs issued by entities in compliance with ISO/IEC Guide 65. SEAOC supports the position that ER Providers at least be accredited to Guide 65 and possibly to Guide 65 with additional requirements. We note that even with a similar review process, the specifics of the AC and ER development process may vary depending upon the ER Provider, much like development of different design solutions by different engineers based on different expertise, knowledge, resources and time spent on a given project. In response, the industry members are trying to improve the quality and consistency of the reports and to this end, ISO/IEC Guide 65 has been adopted as the standard of care by ICC-ES, IAPMO ES and others. ICC-ES and IAPMO ES also base the content of an ER on ISO/IEC Guide 7, *Guidelines for Drafting of Standards Suitable for use for Conformity Assessment*.

ERs improve construction industry practice in several ways for most parties involved. Some of the benefits are identified below.

1. Structural engineers have more confidence that a product meets code intent and will be approved by the AHJ, and are therefore more willing to incorporate new and innovative technology.

2. Structural engineers can perform design more efficiently.

3. Building officials use ER’s to facilitate and expedite their process of reviewing and approving ever more complex products to ever more complex codes and standards.

4. Inspectors have a clearly defined scope of field inspection requirements.

5. Structural engineers and contractors can use alternates (new products they are familiar with and/or offer better solutions and/or are more economic) more readily.

6. Manufacturers with ERs gain industry acceptance of their products. Manufacturers provide evidence to only the ER Provider, reducing risk of losing control of proprietary information.

7. Manufacturers differentiate their products from those of competitors who do not seek or obtain a report. This differentiation primarily consists of increased industry confidence that a product complies with the code or code intent as it was reviewed by a third party and this often times facilitates use of the product. Of course, confidence may vary depending on the robustness of the ER Providers AC and ER processes.

8. Building owners and users may have a higher confidence level that the new products used in their buildings are safe and sometimes may offer more economical solutions with a third party review, such as that performed by ER providers.

Acceptance Criteria and Evaluation Reports

Acceptance Criteria are usually prepared prior to writing Evaluation Reports and are the basis for most ERs. However, we provide discussion about the ER first in order to bring context for the AC discussion that follows.

Evaluation Reports

An ER documents a professional position based on the issuer's technical assessment that the product meets the applicable code prescriptive requirements or code intent in cases where code provisions either are absent or lack clarity, or are not sufficient to adequately evaluate the product. Originally, the ER was intended to be used primarily by the building officials to help them determine whether the product, historically a new product or system, complied with the building code. The building official has the sole authority to approve new products for code compliance and is the only person with the authority to approve an AMC application. This allocation of authority is specified in aforementioned Section 104.11 (a.k.a. Alternate Means of Compliance provision) of the IBC, and is widely adopted by the governing jurisdictions. The code states an AMC shall be approved when the building official finds it complies with the intent of the code. This is made difficult often times as building departments may not have adequate resources or expertise to adequately review every AMC and many times feel pressure to approve new products by those desiring they be used and possibly for conditions not covered in the ER. This points to the AC development and ER review process as a possible solution to help best vet new products in a similar public, transparent, committee process, with expert input, as used in the code development process. This process would be used rather than every jurisdiction relying on a single engineer and a single building official to determine product code compliance which results in a wide variety of opinions and, thus, a large variation in building stock code compliance. It would seem the code should provide additional provisions to help raise the ER Provider requirements as well as provide more clarity about an acceptable AMC process (e.g., ISO/IEC Guide 65 accreditation for ER Providers, use of a public committee process with a minimum number of building officials used to develop ACs, etc.).

As previously stated, originally ERs were predominately used for new products, materials, design or construction methods, or systems that were not considered in the development of code provisions; we refer to this as *Scenario 1, Alternate Means of Compliance*. More recently, ERs are also being used for two other scenarios. When a product is not entirely addressed by code, thus leaving it to the industry to interpret or develop evaluation and design guidelines based on the available code provisions, product application, and an understanding of code intent; ERs may be used to facilitate the use of the product, which we refer to as *Scenario 2, Assisting with Interpretation of Code Ambiguities*. In *Scenario 3, Expediting Product Acceptance*, ERs aid in the design procedure for a product that is prescribed by the code, with extensive provisions. To demonstrate conformance with these provisions, a product design requires significant effort and cost each time an AHJ is approached for a building permit. These three scenarios are discussed in more detail below and the scenarios are provided for discussion purposes with recognition that the boundaries of each may overlap.

Scenario 1, Alternate Means of Compliance

If the material, product, or design provisions are not addressed in the code, their use is permitted through an approval process by submitting an application to the governing building official based on the aforementioned Section 104.11 and then the code requires the building official to review and provides requirements to be met in order for building official approval.

Section 104.11 requires that the proposed alternate "….complies with the intent of the provisions of this code, and that the material, method or work offered is, for the purpose intended, at least the equivalent of that prescribed in this code in quality, strength, effectiveness, fire resistance, durability and safety."

Acceptance of an AMC can be based on documentation that satisfies the provisions in Section 104.11 and is not contingent upon an ER being submitted. For example, an AMC submittal can be approved based on a technical report prepared by a registered engineer as well as approved third party test data and calculations, if the building official finds that the report satisfies the criteria. The level of peer review and public scrutiny of a proposal provided by an individual versus an accredited organization or committee will vary. Also, it's noted that there are different types and levels of expertise for those developing as well as those reviewing an AC submittal. In addition, there are different levels of resources needed to properly substantiate, submit and review AMC submittals. This means that there will be a wide range of differences across all engineers and building departments regarding what AMCs are acceptable leading to greater variability of building code compliance across the building stock. Indeed there are some building departments without structural engineers on staff.

Equivalency can be established by comparing performance characteristics of a new product to code-defined provisions and showing that the performance is at least equivalent or better than required by code. This equivalency determination can be very complex and challenging. For some products, numerous characteristics may need to be considered, and, in some cases, it may be necessary to develop new test and load rating as well as detailing and quality control procedures. Establishing the intent of the code can be accomplished by referring to statements in the code (e.g., Section 104.11), commentaries to national standards (e.g., NEHRP Provisions), and other literature (e.g., SEAOC Blue Book). Intent can also be accomplished by discussing the origin of the code provisions, positions of the committee authoring the standards and guidelines, as well as opinions of experts. In some cases, the intent of the code will not be clear or may divulge contradictions, in which case it may have to be inferred through engineering judgment from the design provisions and it's possible that an AMC cannot be approved due to this code ambiguity and/or lack of sufficient evidence or expert opinions.

After the building official determines that the provided data, for a new product, satisfies the criteria of Section 104.11, this code section then requires they approve its use for the specific project for which it was submitted. The building official has significant latitude in determining the criteria for acceptance, the information required for making a determination, and whether the product complies with the criteria. However, there are sometimes significant external pressures exerted on building jurisdictions to approve AMCs without adequate substantiation. Improvement of the existing AC and ER process along with higher confidence in their use would be very helpful to reduce the pressure on a single official within a single jurisdiction by a possibly much larger, external to the building department, entity. With the exception of a seldom-used appeal process, it is the building official who makes the final decision.

Scenario 2, Assisting with Interpretation of Code Ambiguities

The national material and loading standards (ACI 318, AISC 360, AISI S100, ASCE 7, NDS, etc.) and model building codes (IBC, IAPMO, NFPA, etc.) are modified and reissued on three to five-year cycles. While this leads to a robust set of provisions from which to design and construct, new approaches and refinements to code provisions can take a decade or more to achieve. With the rapid pace of technological growth, the products and systems are developing faster than the codes. Therefore, some technology may exceed prescriptive code provisions in performance, but may not fit within the context or framework of the prescriptive code. In these situations, targeted research, criteria, numerical analyses, and physical testing can be developed and performed to demonstrate that the new technology does, in fact, meet the code intent, although perhaps not certain prescriptive code provisions or interpretations of those provisions. Therefore, the AC and ER process becomes a useful extension of the building code provisions, much like code commentary. We stress however that the ACs and ERs are not standards or code provisions, but do serve an important role in the industry.

This category of ER consists of products that can include code-defined products as well as those that explicitly deviate from code prescriptive requirements, yet meet the code intent. This situation could arise where an evaluation procedure or understanding of a condition or environment is improved upon since the code provision was developed.

The quote below from the ICC-ES web site presents a summary to Scenarios 1 and 2 above, which is in line with SEAOC's perspective.

"Generally, it is necessary for ICC-ES to develop acceptance criteria for products and systems that are alternates to what is specified in the code, or that fall under code provisions that are not sufficiently clear for the issuance of an evaluation report. Acceptance criteria are developed by the ICC-ES technical staff in consultation with the report applicant and with input from interested parties; are usually the subject of open public hearings of the ICC-ES Evaluation Committee (made up entirely of code officials); and are approved by the Evaluation Committee after issues raised during the hearings are resolved."

Scenario 3, Expediting Product Implementation

Products that are directly recognized in the code and which do not fall into Scenario 2 category, do not require an AC or ER because the building code already specifies the product and its intended use and provides technical guidance and reference standards for the product.

Thus the building code addresses this kind of product and it sets forth the properties, standards, or tests for which the product must comply. Traditionally, evidence of compliance for these products has consisted of calculations signed by a registered engineer, test reports from approved testing laboratories when the code requires, and engineering reports signed by a professional engineer again when the code requires. When this is done, formal Acceptance Criteria or ERs are not necessary, but documentation is required to demonstrate code compliance.

Therefore, the code development process provides a mechanism to communicate design and quality control requirements as well as inspection scope related to the product. This dictates the proper use of the product and reduces confusion as to the code status of the product. However, this may not afford the most efficient or best design, design review, or quality control and assurance process. In these cases, ERs can provide a standardized document addressing these issues as well as helping to ensure more uniform interpretation of code requirements. ERs may provide useful tables or otherwise summarize technical data so that the product can be easily specified, designed, and reviewed. Post-installed anchors for masonry construction are an example of how ERs provide design capacity values for specific configurations without the need for supporting tests and calculations for every project. Similarly, ERs for wood I-joists provide a summary of the test reports documenting the testing program performed in accordance with the code requirements for determining capacities of wood I-joists. In fact, simple products, such as a 16d common nail, have used an ER for many years to collect and summarize the array of required ASTM tests for utilization by the specifier and building official.

Moreover, as the complexity of the code has grown exponentially [Hamburger, 2010] the industry has adapted to provide cost-effective solutions, both in terms of products and processes. Specifically, ERs are incorporating these complex design procedures and proving product compliance with prescriptive code requirements for defined configurations and limitations. In effect, they have become a design tool for engineers. Furthermore, ERs inform construction industry members about the product. ERs can communicate product descriptions, design values, manufacturer's recommendations, production and application limitations, detailing and installation requirements and recommended inspection practices related to the product. Industry members can expediently select the product for a particular application and have confidence that it will be accepted by the building official. As importantly, construction and inspection trades know how to build and perform the appropriate quality control and verification observation.

Irrespective of the content of an ER, the majority of the reports are based on a technical review, testing, analyses, and quality control review and the requirements for these are typically described in an AC to better help ensure consistency of review and product code compliance based on input from many in the industry versus a singular engineer and building official. As part of the ER development process, criteria is developed, typically through a public vetting and committee voting process, and documented in an AC. This is discussed in the next section.

Acceptance Criteria

The term "Acceptance Criteria" (AC) is used herein as the generic term for criteria, while IAPMO ES refers to it as Evaluation Criteria. AC is a document that states the requirements for which a product is to be evaluated to in order to demonstrate code compliance. Most new and innovative products require development of an AC for their proper evaluation under the provisions of Section 104.11 of the IBC.

Similar products by the same or different manufacturer and reviewed by the same ER Provider are addressed by the same AC, which affords a more consistent level of documentation and review. It's recommended for all product evaluators to follow these AC requirements as they are developed with significant industry input and not based on a singular opinion. However, some manufacturers of similar products obtain ERs from different ER Providers, which may be based on different ACs or different criteria. This increases the likelihood of disparity in degrees and depth of evaluation of the product. Some have offered that it is better for all product evaluations to use a singular AC rather than forcing the industry to determine which AC may be better in determining a product's code compliance. Significant cost and time goes into developing an AC, so some instances have occurred with the use of an existing AC. While this does lead to a reduction of numerous interpretations of code intent and improved consistency, it can result in copyright challenges. We note the following statement on the ICC-ES web site.

"*Acceptance criteria are developed for use solely by ICC-ES for purposes of issuing ICC-ES evaluation reports. They are available to the public as a courtesy to ICC-ES report applicants and to testing laboratories and inspection agencies that provide services to applicants. Acceptance criteria are not for use outside of the ICC-ES system.*"

One non-ICC-ES ER Provider has used ICC-ES AC as a basis for an ER contending it would be covered by the "fair use" doctrine of copyright law. SEAOC has no comment or position on this matter, but notes this does impact consistency of ERs and the number of interpretations of a product's code compliance.

In either case, the AC is the driving document to assist with code interpretation and application. ACs are generally drafted by the manufacturer of the product or their expert consultant in collaboration with the ER Provider's engineers or consultants.

AC may be a complicated document to develop, as there are competing goals to satisfy. For instance, the development of an AC that is more restrictive than code would provide a higher confidence level that a product will meet the code intent or provide needed improvement when the code is deemed inadequate based on recent research. However, care should be taken so that the code is the basis and additional requirements beyond the code need to be vetted well so as not to discriminate against a possibly equal or better product than that already permitted under the current code due to product economics. For example, if an AC is tailored to a particular product and is more restrictive than the code, some manufacturers of similar products, even though they may be code compliant, may not be able to use the AC and are forestalled in obtaining an ER, which compromises their marketplace presence and that may result in good, economical products being sidelined even though they comply with the current code intent. This can also occur with ACs that are benchmarked to an existing code-specified system that achieves a higher performance than that required by code (code-specified systems do not provide a constant performance level; each at least achieve code intent), which is discussed in more depth in the AC development process later in this paper.

In some situations, enhanced criteria have been adopted that reflect a conscious decision to impose a higher performance level than that required by the code. This higher performance level could be due to a belief that the code is not conservative enough to obtain a higher confidence level of safety or, as has been suggested by some, self-imposed by a manufacturer to create barriers for its competitors. If it's deemed the code is not conservative enough, it would seem the code should first be changed and then product must then comply with that new code requirement.

While the above scenarios may influence product economics, the same can occur with respect to product performance. That is to say, if a new product type is proposed to be evaluated under an existing AC, yet the product has new features, behaviors, or failure mechanisms that were not considered during the original development of the AC, this new product may not meet or may exceed the code intent. This supports the premise that existing ACs should be reviewed carefully prior to being used for a new product and tailored on a case-by-case basis for each product, as deemed necessary with consideration of industry's public comments.

In addition, it should be noted that code specified products are sometimes used for different uses other than originally envisioned by the code and are incorrectly perceived to be covered by the code and ACs are thought not necessary. However, when there is doubt if a product is covered by the code or is similar to one in the code, at the minimum it is recommended that the ER Provider take the discussion to the public comment and committee process to ensure that industry, industry experts and committee provide input to whether simple code compliance is adequate or if a product specific AC should be developed. This is especially true for products or systems that greatly affect life safety such as lateral force resisting systems.

ACs, as well as the code itself, are not immune from unintended consequences. One solution has been to provide a very narrow scope in the development of criteria; yet this creates difficulty in producing uniform guidelines. Understanding these complications supports the product-by-product AC development process and may assist developers of ACs by bringing context to the process. Another solution is modification of existing ACs to better address new products through the AC development process as manufacturers of the new products seek an ER. This is a similar process as the code and standards use when new products or systems or methods seek recognition.

AC content is somewhat dependent on the type of ER. In Scenario 1, discussed above, the ER will likely require a more detailed and elaborate AC, whereas in Scenario 3, ERs may only require citation of code provisions, review of calculations and/or test data, discussion of methodology, and quality requirements. Scenario 2 lies somewhere between Scenarios 1 and 3.

AC and ER Development Process

Now that a basic understanding of ACs and ERs has been discussed, we provide a discussion of both development processes and the challenges faced with each, particularly ACs. The following discussion pertains mostly to the more complicated ACs, such as those pertaining to lateral force resisting components and systems not addressed by the code or used in another way not envisioned by the code, but may also afford insight into other structural and non-structural building products.

Acceptance Criteria Process

This discussion of the AC development process is based on policies of ICC-ES and IAPMO ES, since they are currently the primary developers of ACs and both are ISO/IEC Guide 65 accredited. While in general the policies of ICC-ES and IAPMO ES, related to the development of AC, are similar, there are differences in the details. Other issuers of ERs, particularly those without accreditation, may also have different policies.

While both ICC-ES and IAPMO ES are accredited to ISO/IEC Guide 65, they operate somewhat differently during the AC development, review and acceptance procedures. Generally, the organizations consist of "Staff" and "Committee." The Staff or consultants are expected to be technically proficient and collaborate with the proponents and sometimes industry experts to prepare ACs; they provide recommendations to the Committee and do not approve ACs. The Committee consists of building officials, who may or may not be engineers, that convene either by in-person or teleconference meetings throughout the year to review proposals and have the final authority for approving an AC and/or ER. Typically, the Committee agrees with the recommendation of the ER Providers staff whether to approve the AC, approve it with revisions or hold it for further study.

The more detailed discussion of the AC development process below is based on policies of ICC-ES, which has developed ACs longer than other ER Providers and is the largest developer of ACs, and IAPMO ES, the second largest developer of ACs. The policies and processes of ICC-ES and IAPMO ES related to the development of AC differ in the following manner:

1. The ICC-ES Evaluation Committee convenes in formal public hearings three times a year. The IAPMO ES Evaluation Committee schedules public hearings on a case-by-case basis.

2. ICC-ES requests applicants to submit new AC proposals or proposed revisions to existing ACs typically three and a half months prior to the Evaluation Committee meeting. ICC-ES then revises the draft as they feel necessary prior to posting. IAPMO ES requests applicants to submit new AC proposals or revision to existing ACs within a 20 business day public commenting period.

3. ICC-ES posts the drafts of the AC to be discussed at the hearing on its website (public domain) 30 days prior to the hearing to solicit comments from all interested parties. ICC-ES does post the public comments as well as their response with consideration to the public comments. Therefore, there are two opportunities for the public to comment (e.g., one during the website post and one during the public hearing). IAPMO ES posts a new AC for 20 business days to solicit public comment. IAPMO ES does not post the public comments or their response.
4. ICC-ES has a robust, transparent formal hearing process covering numerous new AC proposals and existing AC revision proposals. It involves the physical participation of the Evaluation Committee as well as ICC-ES technical staff and interested industry members. IAPMO ES hearing process involves the Evaluation Committee (typically through a conference call), the IAPMO ES technical staff, IAPMO ES consultants, and interested industry members.

5. ICC-ES hearings involve formal, structured discussions between the public, ICC-ES staff and the Evaluation Committee. All public participants are given the opportunity to express their opinions with opportunity for the Committee and staff to have discussion between themselves and the public participants. At the conclusion of these discussions the Committee votes on the disposition of the criteria. The disposition may be approval, approval-as-amended at the meeting or to hold the criteria for further-study pending resolution of items that the Committee deems necessary. If the Committee holds an AC for further-study, the staff is requested to bring the criteria back to the public hearings when the issues have been resolved. The Committee never "rejects" an AC proposal, but gives the proponent an opportunity to revise the criteria and bring it back to the hearings. The IAPMO ES process regarding resolution of public to health and safety comments are considered in the revision of the AC that was posted to their website for public comments. IAPMO ES staff will revise the AC to reflect the public comments that they believe have to do with health and safety of the public. IAPMO ES will not revise an AC to reflect comments that they believe do not have implications to the health and safety of public. The IAPMO ES staff then presents the IAPMO ES Evaluation Committee with the AC or revised AC for the Evaluation Committee approval or rejection or further study. IAPMO ES evaluation committee may "reject" an AC.

6. ICC-ES determines a compliance date for which products evaluated using the existing AC must comply with the newly adopted revisions. If it's a new AC, products evaluated to it must obviously comply in order to receive an ER. IAPMO ES lists an effective date for which the AC became effective.

For additional information on the IAPMO ES and ICC-ES criteria development processes, refer to their websites at: <*http://www.iapmoes.org/Pages/default.aspx*> and <*http://www.icc-es.org/*>

Acceptance Criteria Content

Acceptance Criteria developed for products or systems typically contain the following information:

1. Purpose: Why the AC is required (e.g., lack of requirements in applicable code).

2. Scope: Description of the limits or the scope of the AC.

3. Referenced Standards: Listing of applicable code and standard references.

4. Basic Information and Test Reports: Minimum submittal information requirements.

5. Test Performance Requirements: Description of tests required, test setups, acceptable boundary conditions, test methods, permitted test variance, load rating methodology (sometimes with displacement as well as strength considerations).

6. Analysis Details: Minimum analysis requirements.

7. Materials and Workmanship: Minimum requirements for materials and product fabrication.

8. Quality Control: Requirements for initial and/or ongoing inspection requirements as well as quality document submittals.

9. Evaluation Report Recognition: Requirements for specific verbiage to be included in the ER.

Some ACs reference other ACs. An example would be a product AC that references an AC on requirements for test reports as well as an AC on requirements for quality documentation submittals.

Acceptance Criteria Procedural Challenges

There are several procedural challenges that, if understood, may be managed effectively and promote positive changes in the development of ACs. The SEAOC ER Committee highlights the significant ones that have arisen from our committee's deliberations below.

1. Industry Input: Consensus standards use a public balloting and vetting process which is used by organizations such as ASTM, ANSI, ICC, NFPA, etc. Some ER Providers strive to create a similar open process through their AC process, but may not obtain the same level of input from industry and industry experts. This may be due, in part, to the shorter time-frame requirements of the AC development process and also industry information overload; the pool of technical expertise resources is stretched to cover the many material and testing standards as well as code development cycles. It must be emphasized that the sole purpose of the ACs is to establish a set of requirements which are intended to help substantiate code compliance of various products.

   ACs are not model building code referenced standards; rather they are criteria documents written in mandatory language that represent a consensus opinion of those involved, which may include industry experts and others that choose to participate in the publicly held committee meeting, where this occurs. The process and quality of ACs, therefore, will vary with the level of industry member input and vetting relevant to the product. In the last two to three years, SEAOC and NCSEA have been more proactive in participating in the ICC-ES AC development process and providing resources for this important effort. Additional resources are required by both organizations to make a long-term and effective influence on the process which affects public safety and the quality of the built environment. It is also believed that other organizations representing non-structural attributes should be involved to a greater extent.

2. Review Period: Compounding the industry input challenge, the public comment period for the AC hearings adheres to a strict timetable so that the AC approvals can be obtained in a timely manner. This presents a difficulty for volunteer organizations, like SEAOC, to review and provide vetted comments. Similarly to the code provision development process, floor amendments to ACs can occur at the Evaluation Committee meetings, making it difficult for SEAOC to respond as there is not time to reengage the resources of the committee.

3. Coordination with Standards and Code: A key set of parameters, called seismic system coefficients, are prescribed in the design load standard (ASCE 7, Table 12) for use in the design of seismic force (lateral force) resisting systems. The lateral system is also required to meet other loading type requirements, such as those associated with wind. These seismic system coefficients have evolved through a qualitative and largely judgment-based vetting process. There is debate today as to the consistency and accuracy of these values. New products (both components and systems) are required to be compared to the code-prescribed systems as a means to obtain these coefficients for use in design. The ER Providers' policy is to not develop system coefficients, and the standards writing bodies such as ASCE 7 concur with this. However, by virtue of a new product being compared to code-prescribed system and detailing provisions, system coefficient assignments must occur.

4. ER Provider Quality Controls (ISO/IEC Guide 65): As previously discussed, ISO/IEC Guide 65 provides a process whereby the issuer certifies the product is compliant with the criteria, with the expectation that others will rely upon the certification and allow the use of the product. ISO/IEC Guide 65 requires that the organization establish product evaluation procedures to ensure the consistency of evaluations across all ER applicants. These processes are then audited (Quality Assurance) by a third party organization. These audits focus on the identified process and do not evaluate the technical validity or applicability of each individual ER.

Individual files are inspected for conformance to the procedural and technical conformance of that particular report to the requirements for issuance (e.g., code and ACs). This verification along with uniform application of the practices provides for more reliable ERs. The use of ISO/IEC Guide 65 is not required by code and only fulfills the role of procedural Quality Assurance. However, it's another tool to help better ensure AC and ER consistency.

Acceptance Criteria Technical Challenges

The most complicated challenge at this time and as highlighted in this paper is the incorporation of new components and systems used to provide buildings' resistance to seismic forces and compatibility with deformations. While this draws much focus, ACs for non-structural components may also have challenges of equal importance; the SEAOC ER Committee encourages all interested parties to participate in the AC development process.

1. AC Source: The issuer of an ER may have their own AC, but in some cases the issuer will use an AC developed by another ER Provider to perform a product evaluation. This may result in the AC containing requirements that exceed code intent, or that it does not include requirements that are all pertinent to the new product. ER Providers, such as ICC-ES, expend financial and technical effort and have copyright ownership of ACs, as cited above in the AC discussion.

2. Determining Seismic Performance Equivalency: There are a number of standards and existing ACs to serve as references in establishing seismic performance characteristics or assessing equivalency, including FEMA documents (P695 and P795), ASCE/SEI 41-06, and AC for pre-fabricated lateral load resisting walls inclusive of an equivalency with light-framed shear walls determination procedure. While some methods may be outdated and there may be debate on the best approach, they are summarized below for reference.

    a. FEMA P695 is a probabilistic approach which utilizes analytical collapse assessment to determine seismic resistance factors for seismic force resisting systems (SFRS). System factors and coefficients are ultimately justified through nonlinear analysis of archetype models subjected to many seismic records. The SFRS must have clearly defined design requirements identifying construction materials, components, and system configuration, as well as any limits to system application. Testing results on the material, component, and system levels are utilized to define strength, stiffness, and ductility properties, as well as serve as a basis for inelastic behavior in the nonlinear analysis. Structural system archetypes are then developed based on anticipated representative applications. Nonlinear static and dynamic analyses are performed, with the static results determining the overstrength factor and trial R coefficient. The R value is validated through nonlinear dynamic analysis based on an acceptable collapse margin ratio, which is determined by the median collapse point through incremental dynamic analysis (IDA) and the MCE ground intensity. This methodology requires an independent peer review throughout this process.

    b. FEMA P795 seeks to provide a simplified application of the FEMA P695 methodology, adapted to evaluate proposed components by demonstrating equivalence with reference components in a reference seismic force resisting system (SFRS), which must be a code-recognized SFRS with sufficient design criteria and test data. The component methodology allows for the complete or partial "mixing" of proposed components with reference components in the reference SFRS. Cyclic and monotonic testing is required to establish equivalency of the proposed and reference components by evaluating critical performance parameters identified in the methodology. Equivalency is demonstrated through probabilistic-based acceptance criteria based on a comparison of median deformation capacity of the components.

    c. Current ICC-ES AC documents refer to the lack of referenced standards in the IBC, or other ordinance or regulation, for establishing code compliance for lateral systems not included in the code. As such, a number of ACs (including AC04, AC130, AC230, AC269, and AC322) cite IBC Section 104.11 AMC to establish seismic coefficients and factors by demonstrating equivalence or compatibility with code-recognized light-frame walls with respect to ductility, drift, and overstrength.

    d. ASCE/SEI 41-06 provides system factors (m factors) for linear analysis and deformation capacities for nonlinear analysis of existing buildings. These factors and capacities are provided for many different building systems and materials typical to existing buildings. The standard also outlines a method for determining these factors and capacities from laboratory test results; however, these have yet to be quantitatively benchmarked to model building codes.

3. Loading Protocol: For decades this has been as challenging and controversial a topic as earthquake ground motions. The development of ACs brings this issue to the forefront. The research work and findings of the ATC 62 document will yield modest recommendations for improvement. This is, in large part, due to the fact that each loading protocol has unique characteristics that lend them to specific applications based on construction materials, geography, actual in-situ loading, or the engineer's opinion, among others. For instance, ASTM E2126 lists three approved loading protocols for determining performance of shear resistance of walls: Sequential Phased Displacement (SPD), ISO 16670 Protocol, and CUREE Basic Loading Protocol. This lack of consensus in defining the "best" loading protocol is typical throughout all loading protocols and materials. For further information on the subject, Krawinkler provides a good summary and discussion [Krawinkler, 2009]. In establishing equivalency, the selection of loading protocol should be the same as that of the benchmark or reference system or component with which equivalency is being demonstrated. Similarly, the reference system should have similar cyclic behavior characteristics (i.e. the comparison of an SCBF and a BRB may provide misleading equivalency measurements).

   With the life safety implications of lateral force resisting systems and a wide disparity of views on testing protocols amongst standards, researchers, and practitioners, as well as the relative benefits of specific protocols for certain applications, an appropriate testing protocol should be selected through a public, transparent process on a case-by-case basis. The distinction between cyclic and monotonic load testing is pertinent to the decision and should be carefully considered. Monotonic test results can significantly overestimate strength and ductility compared to results from cyclic testing. However, monotonic test results may provide valuable information about the performance of the component as it is loaded to collapse. The anticipated performance level of the component will also guide the selection process. For instance, cyclic testing may not be required for components that are expected to remain essentially elastic and, therefore, reducing the need to know the cyclic degradation characteristics.

4. Boundary and Loading Conditions: Defining boundary conditions is key to creating a design methodology that is appropriate and representative of the actual behavior of the system or component. Some of the standards define specific requirements for boundary conditions such as ASTM E2126 load beam requirements. Boundary conditions of a component may be tested or modeled explicitly or be included in the design through rational analysis or statics. Similarly, loading conditions should be identified and included in the testing procedures when determining performance. Concurrent lateral and gravity loading should be considered, as vertical loads may improve or diminish the performance of the system or component. Other considerations, such as bi-directional loading and slackness or tightness of hold-downs for a shear wall, for example, in the system, should be evaluated and documented as well. The methodology behind the definition of the component or system, including boundary and loading conditions, needs to be transparent to facilitate appropriate designs. That is to say, ERs should include guidance on limitations or methodology assumptions that pertain to boundary conditions.

5. Component versus System: Development of ACs for lateral force resisting systems (LFRS) is generally more straight forward than it is for components within a system. For instance, testing of an entire system inherently captures the behavior of each component in the context of overall system performance, whereas testing of an individual component may not be indicative of the performance of the system as a whole. In cases where ACs are developed for components, appropriate measures should be included in the testing or analysis to consider compatibility with other components and overall system behavior through applicable boundary conditions or other techniques. For more information on these challenges, see FEMA P795 and Waltz et al, 2008.

6. Laboratory Testing vs. Numerical Analysis: While laboratory testing is currently widely accepted as the best measure of evaluating system and component performance, evaluation of an entire LFRS may be impractical in a laboratory setting. Numerical analysis may be substituted as an evaluation method; clearly a practical solution for the Tall Building design that seeks to employ alternate structural systems. However, some testing is necessary to determine the strength and stiffness parameters of new systems prior to or alongside numerical analysis.

   Further, the level of evaluation should be commensurate with the desired or anticipated performance level, degree of non-linearity, and confidence of the system, which is a subjective parameter. For an undefined system that is designed to remain essentially elastic, it may be acceptable to utilize an R of, say, 1.0 or 1.5 without performing substantial numerical or laboratory testing. Such an approach would require, however, a substantial amount of engineering judgment and understanding of the entire structure to ensure that all components and attachments are compatible, with no undesired strength hierarchies developed from utilizing an R value of 1.0 or 1.5. A system that is anticipated to undergo significant yielding and inelastic behavior would obviously require more evaluation and performance verification, plausibly through physical testing or a hybrid of component testing and numerical assessment. The suitability of one method over the other should be determined on a case-by-case basis. For numerical, specifically nonlinear, analysis, we refer the reader to Deierlein et al [NEHRP, 2010] for analysis techniques.

7. Code and Standards' Update Cycles: Code and standard updates vary greatly, from annually all the way to untimely. The current model code (IBC) is made up of material standards (e.g., AISC, ACI, AISI, NDS, etc.), which in turn reference testing/material standards (e.g., ASTM) that can be several generations behind their most current form. The use of outdated testing and material standards creates a lag in technology and hinders the industry from meeting the code intent and providing the quality and cost effective product the industry now demands. Common sense mitigates product manufacturers having to repeat their testing using an antiquated testing standard. However, if the manufacturer uses the most current ASTM testing standard, and it is less restrictive than the code referenced standard, procedurally this is probably not acceptable unless it can be shown code intent can be met. Thus, developers and reviewers of ERs should use their professional judgment in selecting testing standards, which may cause what appears to be a less conservative result, and have those vetted through public bodies and recognized committees.

8. Research and Testing Reports: When considering an alternate method of code compliance the building official is allowed to require the submission of research reports (IBC Section 104.11.1) and test reports (IBC Section 104.11.2) where a product is not within the prescribed provisions of the code. The form of these reports is not limited to ERs; rather the building official may permit other forms of documentation and to review them in a fair and consistent manner. The building department can charge additional fees to offset the cost of reviewing alternate methods of compliance and may engage a third party to afford a fair and thorough review, the cost of which is borne by the proponent of the building permit application. This can place an excessive burden on some manufacturers and could lead to a barrier with having their product used, so careful consideration of what information is requested is required.

Evaluation Report Process

An Evaluation Report, sometimes called a code report, presents the product description, design and detailing requirements, limitations, load values, and inspection requirements, based on an AC, and serves as the document that conveys the reviewer's official position regarding the product. An ER provides the context and what aspects of the code it meets, and how to incorporate the product into construction, which affords a method of design, construction and inspection. These in turn are meant to assist the building official in his/her determination that the product meets the intent of the code.

Another term used for ERs are Legacy Reports. ICC-ES refers to ERs as Legacy Reports for those ERs originally issued by BOCA ES, ICBO ES, NES or SBCCI PST and ESI and were still valid when those organizations formed ICC-ES or if a ER was issued by ICC-ES before March 1, 2004. It should be noted that ERs posted to the ER Providers websites are generally considered valid; however, they may have been evaluated to an earlier code than that adopted by the jurisdiction in which an ER may be needed.

ERs are issued for a product after the requirements of a publicly developed and committee reviewed and approved AC are deemed to be met through proper testing, documentation and inspection. Test reports by recognized laboratories are submitted to the ER Provider for review. Quality control documentation is also required to demonstrate that product manufacturing meets the quality control requirements of the code and ER Provider (e.g., ISO/IEC Guide 65, ACs). Initial and ongoing inspections of manufacturing plants are typically required by an ER Provider, and are required based on ISO/IEC Guide 65 Section 13. Following the approval of these items, the ER Provider will issue an ER, which will typically be publicly available on the ER Provider's website. ERs will be reviewed and reissued in the following years per the ER Provider's reexamination process.

Evaluation Report Content

Evaluation Reports typically contain the following information:

1. Report Holder: The applicant for the ER

2. Evaluation Subject: The specific product covered by the report

3. Evaluation Scope: The codes that were used to evaluate the product

4. Properties Evaluated: The properties that were evaluated and whether the product can be used for structural purposes

5. Uses: Identifies the scope of the ER and relates the product evaluated to code provisions

6. Description: Provides a general description of the product and its features

7. Design: Provides design and detailing requirements and limitations

8. Installation: Identifies requirements to help inspectors ensure that the product is installed per code requirements and AC

9. Conditions of Use: Statement that the product complies with or is a suitable alternative to the code

10. Evidence Submitted: Data that was used in evaluating the product

11. Identification: Information that is used to identify the product in the field

Evaluation Report Procedural Challenges

ERs are issued after the reviewer has reviewed the technical information provided and evaluated it in the context of the appropriate AC. There are no opportunities for public comment prior to the initial issuance of an ER.

ACs are not adopted by the model building code and, until recently (e.g., 2010 CBC), were not referred to in state or local jurisdiction building codes. As a result, ACs and ERs are advisory in nature. For products which are not within the scope of the building code, the existence of an ER provides no guarantee that the AMC satisfies the criteria in Section 104.11 just as a building official's or engineer's opinion does not provide a guarantee of a products Section 104.11 compliance. However, it would seem more probable that a product meets code intent if the product was evaluated to an AC developed through a public and robust process with input from multiple sources and industry experts.

The general acceptance of ERs is dependent upon the willingness of the building official to accept them generally on a case-by-case basis and upon the credibility of the ER Provider and the manufacturer. By virtue of a state or jurisdiction incorporating references to an AC in their governing code, the AC has been vetted and found to comply with said codes intent, as enforced by an ordinance or regulation, thereby making the AC applicable in all cases, and, consequently, making the AC and ERs evaluated in accordance with them more effective. However, few if any jurisdictions adopt ACs by reference in their ordinances or regulations.

Evaluation Report Technical Challenges

The lack of care of industry users can lead to incorrect application of the product. Also, care should be taken to use the product in the method described in the report. ER Providers have provided ERs without following publicly vetted ACs and this may lead to improper product evaluation based on the opinion of a single engineer and single building official compared to a ER evaluated to an AC developed in a public, transparent, committee process with industry expert input which is similar to how the code is developed. In addition, many ER Providers continue to post ERs that have been evaluated to codes that are decades old and while their website states it's a valid ER. This has confused users to the appropriateness of an ER evaluated to an older code and may lead to product use that does not comply with the current code.

AC and ER Development and Implementation Recommendations

The SEAOC ER Committee, while comprised of SEAOC members, has received valuable input from a variety of industry representatives including building officials, ER Providers, and manufacturers. The Committee has determined that the most obvious improvement necessary to help best ensure the proper use of ERs and make them more efficient and consistent is to offer a description of what they are and guidance to all industry members on their development and implementation. This begins with a more accurate understanding by the industry of the meaning of the phrase "product approval." While an ER Provider or engineer may render an opinion that a product is compliant with the code, the building official is the only industry member that can provide an approval that the product is in conformance with the governing code, as enforced by an ordinance or regulation, of his/her jurisdiction based on his/her review and professional opinion. A better phrase for "product approval" in reference to ER's may be "product reviewed and recommended", "product ER listed" or "product recognition."

More importantly, it is in the best interest of all industry members to carefully review and fully understand an ER before using or, in the case of a building official, approving a product. The designer/engineer and building official should make sure they understand and agree with the design and configuration limitations; the installer of the product should be aware of the means and methods requirements; and, lastly, the inspector should be knowledgeable regarding proper use, limitations, installation requirements and important items to observe or verify.

To differentiate ERs and, more importantly, to improve consistency and timely development of ACs and ERs, SEAOC recommends that IBC Section 104.11 be revised to include an ER definition, specific requirements regarding the development of an AC and ER, and public vetting and quality assurance requirements, which could include adoption of ISO/IEC Guide 65. This could be done while maintaining the current individual engineer submittal and individual building official review AMC process on a project by project basis. In addition, the SEAOC ER Committee also recommends the model code be revised to provide an updated code intent and equivalency verbiage.

The above general consensus suggestions are detailed and divided, and sometimes duplicated, in the following industry member sections.

General Recommendations for All Industry Members

1. Use the term "ER listed" or "product ER listed" rather than "product approval." A product approval by an evaluation service represents the professional position of the ER Provider. The final approval that the product "meets code" is provided by the building official based on his/her professional opinion after consideration of items provided to him/her in accordance with Section 104.11. Further, there are several ER Providers and an AMC can be provided without an ER. An ER Provider does not provide "product approval"; they provide a professional opinion in an ER, typically based on ACs developed with expert input through a public process, that a product meets code intent. It would seem the AC process is closer to meeting code intent as ACs are developed in a transparent, public process with expert input and voted on by a committee of building officials – similar to how codes and standards are developed - compared to an individual engineer's and an individual building official's opinion.

Recommendations for Structural Engineers Association and Code and Standard Committees

1. Continue the SEAOC ER Committee as a venue for discussion of wider issues outside of the logistical challenges of discussing specific products, ACs, etc. . In the last two to three years, SEAOC and NCSEA have been more proactive in providing resources, but more resources are required to make a long-term and effective influence on the process. It is also believed that other organizations representing non-structural attributes should also be more involved.

2. An immediate action item is to convert this white paper into a presentation for the SEAOC Convention and disseminate to industry members in other forums. A more succinct document could also be prepared from this paper and distributed.

3. There should be greater dialogue and coordination between ER Providers and code provision writers to ensure references to documents are accurately maintained. The modification of an AC can unintentionally lead a code provision reference to a document that has been superseded or does not exist. We suggest code writers provide a stand-alone log of code references that may be of interest to ER Providers, and ER Providers reach out to the code writers when they foresee changes to their documents.

4. Code change proposal to section 104.11

   a. 10411: Introduce AC and ER and expand the various tracks and requirements to obtaining approval for an AMC. Provide clarifying language regarding property preservation, perhaps even functionality. Possible verbiage might be "…An alternative material, design or method of construction shall be *approved* where the *building official* finds that the proposed design is satisfactory and complies with the intent of the provisions of this code in <u>accordance with 101.3</u>~~, and that the material, method or work offered is, for the purpose intended, at least the equivalent of that prescribed in this code in quality, strength, effectiveness, *fire resistance*, durability and safety~~."

   b. 104.11.1 Research Reports: Provide minimum requirements to be classified as a "source" for an ER. Perhaps identify ISO/IEC Guide 65 accreditation as a minimum requirement for a research report (ER). Soliciting public comments and posting these comments as well as the ER Providers response during the development of ACs should be exercised by all ER Providers. The balance between expediting the review to facilitate timely product use in the market place and performing a comprehensive review will be a case-by-case matter. To help increase the quality and achieve a more consistent level of review and timeframe, we recommend a code change requiring some form of process or accreditation for an ER to be classified as such. Additionally, it's been observed that ERs continue to be used even after jurisdictions no longer use the code to which it was evaluated. There has been confusion to whether code or standard or AC changes have taken place. Some have mistakenly permitted ERs evaluated to much older codes to be used in jurisdictions adopting a more recent code as they were unaware of code or standard or AC changes. It's recommended the code should preclude this from occurring with verbiage such as "An approved ER may be used to assist the building official ascertain the products code compliance, but that the ER must be evaluated in accordance to this code."

c. 104.11.2 Tests: Provide minimum requirements to be classified as a "source" for a test report. Perhaps identify ISO/IEC 17025 or IAS accreditation as a minimum for a product test laboratory testing products for an AMC submittal. This section could be updated to reflect the AC, ER, standard and code development processes. Perhaps it could even afford direction on expiration of testing standards. Please also refer to AC and ER Providers, Item 6 below.

5. AC and ER Update Cycle: The length of an updating cycle for these documents should be carefully considered, balancing improvement to product, timeliness, and cost to industry. Some criteria may affect hundreds of products that might require extensive testing, after the AC has been revised.

Recommendations for AC and ER Providers

1. ER Providers, while not responsible for code enforcement, could consider the variations in industry practices and enforcement levels when preparing design criteria and testing requirements in their ACs.

2. The construction industry would benefit from ER Providers posting on their websites which ACs are affected by the upcoming new codes (e.g., AC13 to the 2006 IBC is not affected by the 2009 IBC). This would forewarn the industry when additional testing or analyses are required.

3. ERs should expire permanently as a minimum after a certain number of code cycles (e.g., 2000 IBC ER's expire when 2006 IBC is published) to ensure that products that meet old code requirements are not used in structures requiring they comply with a newer code. Otherwise, confusion might occur, and products that do not meet the new code and/or AC requirements might inadvertently be used. However, this needs to have been done with consideration that different jurisdictions may be under various editions of the building code (e.g., California was under the 1997 for 10 years while most of the nation was under the IBC from 2000 on), but with the realization that currently there are numerous ERs still considered valid that were evaluated to the 1991 UBC which is no longer adopted by any state.

4. At the minimum, ACs should reference applicable code and standards, and provide guidance on what information is to be provided, test requirements, load rating requirements, quality requirements, minimum ER content, and product identification requirements. At the minimum, ERs should include to which code the product was evaluated, a description of the product, references to code or standard and/or AC design requirements, product limitations, tabulated loads and displacements when required, product detailing requirements, inspection requirements, and ER labeling requirements.

5. SEAOC's ER Committee would encourage the sharing of ACs. While the cost of developing an AC is significant and borne by the first proponent and writer, the dissemination of the information would be of great benefit to the entire industry so there are not numerous ACs for industry members to develop or choose which is best. This would then provide more focus on one AC process creating better ACs and more uniform determination of a products compliance with code intent.. Further, the balance between full disclosure and maintaining proprietary information will be a case-by-case matter. The ER should provide sufficient description, design requirements, limitations, detailing guidance, and inspection requirements to best ensure that the industry members will properly use the product . In preparing the ER, we should be mindful that the design, review, and inspection industry members have limited resources and time, so there may be prescriptive requirements and limitations provided in the ER, based on ACs developed publically with committee review and approval, to maintain security of proprietary information while affording safe and effective use of the product.

6. The testing standards used in the AC should permit the use of the code specified standard and more recent standards, albeit if more liberal or conservative. The

supplant of the standard should be required by the AC to be specified in the ER. To assist the users of the ER, the specific difference between the standards and effect on the results should also be included in the ER. In developing the AC and ER, industry stakeholders should be cognitive that there are rare occasions where a more liberal standard may be based on the premise that there have been additional prescriptive requirements in the code, so the product being assessed would also have to meet those requirements in order to adopt the more liberal standard.

7. More time could be provided for review of the proposed ACs by other interested parties prior to "public" hearings.

8. Where criteria were imposed to address perceived problems or ambiguity in the code or standard, the issuers of the ERs should be encouraged to raise the issue with the organization propagating the code or standard. If the author of the standard does not support the proposed change then the issuer of the ERs should be encouraged to modify their criteria to reflect the position of the code's or standard's author.

9. The ER should reference the version of the AC used in its development.

10. The versions of the AC used for all current ERs should be readily available to design professionals and building officials. These may include some versions of criteria that have been updated by more recent versions.

11. Each ER should indicate whether the product or part of the product is addressed in the code or standard(s) or whether it is AMC.

12. All products not addressed by the code or used in an application not envisioned by the original code provisions must be evaluated to an AC developed specifically for that product to address appropriate test, load rating, detailing, inspection and quality requirements.

13. ER Providers or approved, accredited inspections agencies should perform annual manufacturing facility inspections to ensure that the product fabrication and the quality system is the same that was evaluated in the ER development.

14. An ER Provider should have a formal, robust AC and ER formal, third party appeal process that is timely for the applicant who may disagree with the ER Providers stance on a certain issue regarding an AC or ER.

Recommendations for Architect, Designer and Structural Engineer

1. Architects, designers, and engineers should take great care in reading and understanding ERs, ensuring they fully understand the limitations and design assumptions forming the recommendations therein.

2. Permit documents should specifically identify products for which an alternate means of compliance is requested. The building official's acceptance of these products should be obtained.

Recommendations for Design Reviewer, Building Official, Authority Having Jurisdiction, and Inspectors

1. The SEAOC ER Committee recommends that building officials selectively request background information to assist them in their review of ERs, particularly if they are to include the ER in code provisions, unless - based on the information provided and their knowledge of the AC and ER Process - they can confidently reach the determination that the product meets code intent.

2. The Building Official is the final party responsible in determining if a product meets the code intent. If required, as determined by the Building Official, he/she should request technical data used to develop the ER for code compliance or for an alternate means of compliance, which is in accordance with provisions of IBC 104.11.

3. Products are often approved for applications not contained in an ER, yet the approval is based solely on the listing in a report. Building officials should develop a policy for how to effectively evaluate applications not covered in an ER.

Dissenting Opinion: Mark Gilligan and Bill Vaughn

We have been compelled to publish this dissenting position with this White Paper because the document does not address problems associated with the development and use of evaluation reports that we believe should be discussed

The report should discuss the liability implications when a product is used that is not addressed in the building code. Such products are considered code violations unless accepted for use by the building official as an alternate means of compliance. The liability implication is that if there is a problem associated with such a product, its use will be considered as negligence "per say" meaning the engineer cannot use a standard of care defense. What is needed is for the building official to specifically approve the use of the alternate means of compliance (AMC).

A number of building departments have started to charge to process alternate means of compliance. We believe this is the precursor to more formal enforcement of AMCs for many commonly used products.

The report should address the conflict between the state licensing laws which require that engineering reports be stamped and sealed by a professional engineer and the reality that evaluation reports are engineering reports but are not stamped and sealed. Also of concern is the proposal by one manufacturer that the existence of an evaluation report can substitute for the calculation package normally required for moment frames.

The paper should note that the building official's role is to interpret and enforce the building code, no more and no less. The building official cannot impose additional requirements that are not required by the building code. This means that if a product being used is in compliance with the code provisions the building official must allow its use and cannot require an evaluation report.

When a product is being used as an AMC the building official needs to review each proposed AMC on its merits to determining whether the proposed use is consistent with the provisions of the code. He should not arbitrarily require an evaluation report or insist upon an evaluation report from a specific issuer.

We are concerned that evaluation reports have become a black box where it is assumed that the building official and the engineer will accept the product without having access to the data supporting the recommendations in the report. .
We suggest that this black box approach is inconsistent with the provisions of the California Building Code which makes it clear that the building official can require test reports and other data to substantiate code compliance. This implies that the engineer should have access to this same data.

The SEAOC "Recommended Guidelines for the Practice of Structural Engineering in California" in Sections 7.2 and 7.3 recognize that engineers are expected to make informed decisions regarding the products they specify and not rely solely upon the claims of the manufacturer and a third party such as the evaluation report issuer. This suggests that an engineer who makes a product selection solely upon the contents of an evaluation report may have a greater liability exposure in the event there are problems. Thus we believe that engineers need to have access to the technical data they believe they need to evaluate products.

Lack of familiarity with code provisions can also put Code-compliant products without an ER at a commercial disadvantage. This occurs when either engineers believe that they need to see an ER before considering a product or when regulators require an ER as a condition of acceptance. The result is either the expenses and hassles of obtaining an ER or the fewer products and less competition as manufacturers leave or do not enter the CA market.

As a result of arbitrary evaluation report requirements a number of manufacturers have decided not to market reputable products in California where this practice is particularly common. Thus insistence on evaluation reports has resulted in fewer options and higher costs because there is less competition.

The paper should discuss the controversy about how R factors are assigned to shear wall components in ERs. ATC 63 was funded as a result of concerns about the R factor values being recommended by ICC-ES ERs. This lead to the publishing of FEMA P695 and FEMA P795 which provide guidance on how to justify R factors. These methodologies have been endorsed by the ASCE 7 committee but the issuers of evaluation reports have been slow to mandate their use.

The users of ERs should be aware of the underlying economics of the firms that issue ERs. Typically ERs are issued by engineering consulting firms that specialize in reviewing and issuing ERs. Manufacturers of the products pay for the preparation of the ER and the yearly licensing fees. In recent years ICC-ES and IAS have made significant contributions to ICC's income. While this by itself does not necessarily imply a problem, it points out the need for the engineers to be aware of the commercial and economic interests at play.

We are disturbed by a system where the building officials are passive participants who are expected to blindly approve the ER recommendations. We recognize that not all building officials will find it necessary to review the product data but we are disturbed by a system that discourages the building official from undertaking the personal review contemplated by the building code.

We propose several recommendations to improve transparency and to improve the usefulness of evaluation reports. These include:

1. ERs should make it clear whether the product claims to be code compliant or whether it is being used as an AMC

2. ACs should document how the questions of code intent and equivalency are addressed and how the product deviates from the code.

3. The AC should document criteria in excess of that required by the code and/or where the criteria were modified because it was felt that the code was inadequate.

4. The versions of the AC used for current ER should be readily available to design professionals and building officials.

5. The manufacture should make it clear that the design professional and building official can obtain reports and test data used to support the AMC.

6. Permit documents should specifically identify products for which an AMC is requested. The building official's acceptance of these products should be obtained in writing.

We believe that engineers and building officials should understand the limitations of the reports and the products so that they can make informed decisions as opposed to accepting black box recommendations. Evaluation reports can be valuable in focusing the discussion as engineers and building officials evaluate products.

Conclusion

While the issues discussed herein are challenging, they are not unlike issues that building officials face on a regular basis. As with many complex issues, the specifics of each case must be studied carefully. A robust ER process can be of great benefit to the built environment and to public safety in this age of increasing code and product complexity and declining building department resources. Certainly there is no perfect process or document and the building industry must not get lost in the minutia of the many provisions of the building code and lose sight of the primary role of it which is to "safeguard the public health, safety, and general welfare." Oftentimes, the bureaucracy of our processes or systems as well as individuals creating barriers due to personal politics or their not being able to see the larger picture or other reasons may slow down improvement of our codes and building processes and can greatly harm the consistency and safety of our built environment as well as being economically detrimental. However, neither should we rush to use new products or systems without a thorough evaluation of their code compliance based on industry consensus with multiple experts' input rather than on a single manufacturer, engineer, and building official's opinion, which is similar to the building code development. To that end, while this document was intended to present the best description of the current state of the ER use, implementation, and improvement recommendations it is recognized that the evolving ER process may require periodic updates to this document. The SEAOC ER Committee encourages you to provide feedback for inclusion in future updates of this living document.

Key Terminology and Acronyms

Acceptance Criteria (AC)
Alternate Means of Compliance (AMC)
American National Standards Institute (ANSI)
Applied Technology Council (ATC)
Authority Having Jurisdiction (AHJ)
ER Producer/Provider (Organizations which develop ACs and issue ERs, such as ICC-ES, IAPMO ES, NTA, etc.)
Evaluation Criteria (AC),
Evaluation Service Reports (ERs)
Federal Emergency Management Agency (FEMA)
Industry Members denotes all involved in the construction industry (Contractor, Designer, ER Provider, Building Official, etc.)
International Accreditation Service (IAS)
International Association of Plumbing and Mechanical Officials Evaluation Service (IAPMO ES)
International Building Code (IBC)
International Code Council (ICC)
International Code Council Evaluation Services (ICC-ES)
International Electrotechnical Commission (IEC)
International Organization for Standardization (ISO)
NTA, Inc. (NTA)
Pacific Earthquake Engineering Research (PEER)
Product Certification Agency (PCA)
Product Certification Provider (PC Provider)
Product Evaluation Report (ER)
Structural Engineers Association of California (SEAOC)
Uniform Building Code (UBC)

Committee Membership and Acknowledgements

The membership included voting and corresponding members from all sectors of the construction industry. The final document was voted upon by representatives from all regions and those are listed below unless noted otherwise.

Chair:	Mark A. Moore, S.E.
Northern California:	Mark Gilligan, S.E.; Bill Vaughn, S.E.
Central:	Amir Giliani, S.E.
Southern California:	Tom Van Dorpe, S.E.; Herbert Stockinger, S.E.
San Diego:	Andrew Skousen (Initial input only; final review and vote not provided)

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