



November 11, 2008

**TO: PARTIES INTERESTED IN THE GUIDELINE FOR A PROCESS TO DEVELOP A PLAN FOR SEISMIC PERFORMANCE FACTORS FOR ALTERNATIVE LATERAL-FORCE-RESISTING PRODUCTS**

**SUBJECT: Guideline for a Process to Develop a Plan for Seismic Performance Factors for Lateral-Force-Resisting Products, Subject Miscellaneous 1-0808-R1 (KS/BG)**

Dear Madam or Sir:

Attached is the final version of the subject guideline. The subject was on the ICC-ES August 2008 alternative criteria process agenda for the purpose of soliciting comments on the proposed "guideline." Many comments were received and are posted on the web site under "Criteria Development-Alternative Criteria Process-Previous Postings", [http://www.icc-es.org/Criteria\\_Development/0808-alt/index.shtml](http://www.icc-es.org/Criteria_Development/0808-alt/index.shtml). The following has been developed in response to the comments received.

ICC-ES staff would like to thank the interested parties who took the time to submit comments. All comments were considered in the preparation of the enclosed guideline. As you will note we did not agree with all of them, but hope the following will explain the direction taken in the enclosed guideline to establish equivalency targets for code defined lateral-force-resisting (DLFR) systems that can be used to evaluate alternative lateral-force-resisting (ALFR) products.

There still seems to be some confusion regarding the viability of establishing seismic coefficients and factors for ALFR products by means of proving "equivalency" to DLFR systems. IBC Section 104.11 notes that alternative products can be accepted by the building official if certain criteria, outlined in the subject section, are met. This section allows (essentially obligates) building official to review alternative products for code compliance. ICC-ES in turn provides technical information to assist the building official to discharge his responsibility. This does not mean that ICC-ES will review and issue reports indiscriminately, but will only consider this approach for products that are or will be the subject of an ICC-ES evaluation report. It should also be noted that this process and approach has undergone public review to prove equivalency of some ALFR products and has been previously approved by the ICC-ES Evaluation Committee.

The enclosed article by Rawn Nelson, S.E., along with the following references provide additional background on how ICC-ES approached the “equivalency” issue for light-frame bearing walls shear wall systems defined by item A.13 in Table 12.2-1 of ASCE/SEI 7-05

- Line, Philip, Ned Waltz, and Tom Skaggs. “Seismic Equivalence Parameters for Engineered Wood-frame Wood Structural Panel Shear Walls,” Wood Design Focus, July 2008.
- Nelson, Ronald F. “Establishing Seismic Equivalency for Proprietary Prefabricated Shear Panels,” Structure, August 2008, pp. 11-12.
- Serrette, Reynaud. “Qualifications for Equivalence,” Structure, August 2008, pp. 19-23.
- Waltz, Ned and Hamburger, Ronald O. “New Rules for Evaluating Seismic Performance of Prefabricated Shear Panels,” Structure, August 2008, pp. 13-16.
- Waltz, Ned, Tom Skaggs, Philip Line, and David Gromala. “Establishing Seismic Equivalency to Code-Listed Light-Frame Wood Wall Systems,” Proceedings from the World Conference on Timber Engineering, Miyazaki, Japan, 2008.

The work completed to establish equivalency targets for this DLFR system has subsequently been incorporated into relevant ICC-ES Acceptance Criteria such as AC 322, AC 130, and AC 230.

Several comments were received indicating more guidance and details are needed for the task group to develop equivalency criteria for the DLFR system. That is the intent of the enclosed guideline. It is difficult to provide more specific details unless more is known about the DLFR system and the ALFR product under consideration, since each case is potentially different. The guidance provided along with the examples and reference articles, should be sufficient for the task group to develop a plan.

Some statements made by interested parties questioned whether ICC-ES should be reviewing ALFR products for code compliance. These opinions are contrary to the ICC-ES mission of verifying that new products meet the building safety objectives of codes and standards. This question is answered by the public opinions expressed at a recent hearing before the ICC-ES Evaluation Committee. The more relevant question should be; how should ICC-ES review ALFR products for code compliance? Technical expertise is needed to review these types of products for code compliance. This guideline requires the establishment of an expert task group to develop the basis of establishing equivalency to a DLFR system. The guideline also mandates that the information is to be presented and finalized at an open hearing where all points of view can be heard. Even with experts' input to establish the targets to rationalize equivalence to a DLFR, not all conceivable questions related to the alternative products can be answered. It is not our intent to place the alternative ALFR products into the code.

The attached final version notes a major change in the initial direction of the guideline in that the guideline now only provides a method of establishing equivalency to DLFR systems. This change results in the deletion of references to the ATC-63 Project and to AC215. This approach is consistent with the code which permits an equivalency approach similar to the one described in the guideline. As noted by several interested parties the ATC-63 Project has not been completed and it appears there will be changes to the 90% draft. There is also a concern as to how an ALFR product using the ATC-63 Project approach, relates to code complying products (a question as to how the approach complies with Section 104.11 of the IBC). Using an ATC-63 or AC 215 approach for an ALFR may not necessarily achieve a result that is equivalent to the code.

We believe our current consideration of the equivalency approach is an improvement over the existing situation. Most of the products that have been or will be considered under this approach have been in use for many years and have been through some of the recent seismic events successfully. Other than actual field testing of the products, ICC-ES has not received much information substantiating the use of ALFR products in high Seismic Design Categories. Staff also provided comments on this issue in past letters and memoranda. Our goal is to bring some order and improvement to the existing situation in a manner that would help the building officials and designers determine acceptance of ALFR products.

Several comments were also received indicating that all ALFR type product should go through a process that would add the product to Table 12-2.1 in ASCE 7/SEI-05 05 prior to receiving ICC-ES recognition of their seismic performance factors. We do not believe that this would help the existing situation since it has been estimated that if a product started the process today it might be included in the 2015 IBC. This time frame would likely stifle the innovation of new products and systems that have the potential to improve building performance.

One comment questioned the reference to Appendix A in AC322. It is only noted as an example of how one task group solved the situation and the actual parameters of other ALFR products may not be the same. As outlined in the attached guideline, it is envisioned that each DLFR system will be independently reviewed and the critical parameters and target performance levels will be established based upon consensus task group recommendation and judgment.

There were several comments regarding the number of task group members. The number indicated in the guideline is a result of our experience with these types of task groups. As noted the number can be increased, but staff feels a minimum of six members is needed. It is also considered essential that the task group be comprised of members that have specific expertise in the DLFR system being evaluated.

There was a comment that the guideline treats elements and systems similarly. ICC-ES staff is aware of the difference between elements and systems. However, ICC-ES believes that the basic equivalency approach is a viable alternative not only for ALFR elements, but it is also viable for ALFR systems that represent a relatively minor deviation from a DLFR system. As an established precedent, it is important to note the equivalency

approach in Appendix A of AC322, which might be considered an element review, has been used for a system review as outlined in ACI ITG 5.1-07, which is referenced in ACI 318-08.

ICC-ES would like to acknowledge (and is encouraged by) the current work being done under ATC-63-1 on equivalency and hopes the resulting work will provide help to answer several still unanswered questions.

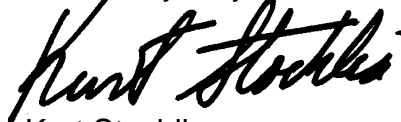
There is concern by some of the current ICC-ES report holders and applicants that ICC-ES will not issue any evaluation reports regarding alternative LFR products, under the 2006 IBC, until the seismic performance issues are completely resolved. ICC-ES has and will continue to issue reports under the 2006 IBC. However, there will be limitations with regards to Seismic Design Categories and/or seismic performance factors for ALFR products that have not yet established equivalence to a DLFR system.

This guideline does not require ICC-ES Evaluation Committee approval since it is a process. However, the guideline can be revised upon receipt of a request, along with justification for the requested change.

As noted in Section 3.4 of the guideline, it is intended that the plan will be incorporated into the appropriate ICC-ES acceptance criteria.

If you have any questions, please contact the undersigned at (800) 423-6587, at extension 3733, or Brian Gerber S.E., at extension 3260. You may also reach us by e-mail at [es@icc-es.org](mailto:es@icc-es.org).

Yours very truly,



Kurt Stochlia

KS/gh:raf

Enclosures

cc: Evaluation Committee

## GUIDELINE FOR A PROCESS TO DEVELOP A SEISMIC PERFORMANCE PLAN FOR ALTERNATIVE LATERAL FORCE RESISTING (LFR) PRODUCTS DESCRIBED IN AN ICC-ES EVALUATION REPORT (ESR)

### 1.0 INTRODUCTION

1.1 **Purpose:** The purpose of this document is to provide a process for developing a seismic performance plan for alternative lateral-force-resisting (ALFR) products that will be the subjects of an ICC-ES evaluation report (ESR). Any plan developed using this guideline shall use an “equivalency” approach to assign seismic performance factors, by verifying equivalence to a defined lateral-force-resisting (DLFR) system.

1.2 **Scope:** This guideline applies to ALFR products not listed or defined in ASCE/SEI 7, Table 12-2.1. Based upon this guideline, a Task Group shall be formed to evaluate a DLFR system defined by Table 12-2.1 of ASCE 7-05 and develop a plan for performance parameters that can be used to evaluate ALFR products for seismic equivalency when used in similar applications. The plan based on this guideline shall be submitted to ICC-ES to establish the dynamic characteristics of the ALFR and demonstrate the lateral-force-resistance and energy dissipation capacity of the ALFR product, to be equivalent to the DLFR.

Once the plan parameters are incorporated into relevant ICC-ES acceptance criteria, the ALFR product applicant shall submit cyclic test data developed through the plan to ICC-ES that will establish the dynamic characteristics of the ALFR product for comparison to the equivalency targets for the DLFR system. Based on this “equivalency”, the seismic performance factors, listed in Section 1.2.1 of this guideline for the DLFR system, can be assigned to the ALFR product.

1.2.1 Seismic performance factors to be assigned shall be the Response Modification Coefficients ( $R$ ), System Over-strength Factor ( $\Omega_0$ ) and the Deflection Amplification Factor ( $C_d$ ).

25                   **1.2.2** A Task Group of experts (the task group) shall be convened to  
26 develop a plan to establish the relevant performance parameters for the DLFR system  
27 noted in Sections 3.1 and 3.2 in this guideline. Design procedures and detailing  
28 requirements consistent with code requirements shall exist for the ALFR product. If  
29 there are no current applicable code requirements, a design procedure shall be  
30 developed through the ICC-ES acceptance criteria process. Where the ALFR product  
31 has unique attributes that differ from the DLFR system that need to be considered, they  
32 shall be addressed by specific detailing procedures and design requirements as part of  
33 the ICC-ES review process.

34                   **1.2.3** Justification shall include cyclic-racking load tests in accordance  
35 with one of the methods described in Sections 1.3 .3 to 1.3.6 of this guideline. The Task  
36 Group may establish the plan based on more than one test method.

37                   **1.2.4** Justification as to the ability of the ALFR products to resist gravity  
38 loads shall be provided in the form of calculations and/or cyclic load testing. If the  
39 gravity load carrying capability of an ALFR product varies from the DLFR system used  
40 to establish equivalency, the differences shall be specifically addressed by design and  
41 detailing requirements for the ALFR product.

42                   **1.2.5** The ability of the ALFR product to resist transverse loads (out of  
43 plane) is outside the scope of this guideline. Products intended to also resist transverse  
44 loads will require justification with substantiating data in the form of calculations and/or  
45 load testing to be submitted as part of the evaluation report application.

46                   **1.3 Codes and Referenced Standards:**

47                   **1.3.1** 2006 *International Building Code*<sup>®</sup> (IBC), International Code  
48 Council.

49                   **1.3.2** ASCE /SEI 7-05, Minimum Design Loads for Buildings and Other  
50 Structures, American Society of Civil Engineers.

51                   **1.3.3** Standard Test Method of Cyclic (Reversed) Test for Shear  
52 Resistance of Framed Walls for Buildings, by the Structural Engineers Association of  
53 Southern California (SEAOSC), dated August 1, 1996 (revised January 20, 1997).

54                   **1.3.4** ASTM E 2126-07, Standard Test Methods for Cyclic (Reversed)  
55 Load Test for Shear Resistance of Walls and Buildings, ASTM International.

56                   **1.3.5** ACI ITG-5.1-07, Acceptance Criteria for Special Unbonded Post-  
57 tensioned Precast Structural Walls Based on Validation Testing and Commentary,  
58 American Concrete Institute.

59                   **1.3.6** AC130, Acceptance Criteria for Prefabricated Wood Shear Panels,  
60 dated November 1, 2007.

61                   **1.3.7** AC322, Acceptance Criteria for Prefabricated, Cold formed, Steel  
62 Lateral-force-resisting Vertical Assemblies, dated March 1, 2008 (revised April 2008).

63                   **1.4 Definitions:**

64                   **1.4.1 The Task Group:** The Task Group shall consist of experts in the  
65 fields of seismic testing, analysis and design, with knowledge of the DLFR system and  
66 ALFR product under consideration. The task group shall comply with the requirements  
67 noted in Sections 3.1 to 3.3 of this guideline.

68                   **1.4.2 Alternative Lateral-force-resisting (ALFR) Product:** For the  
69 purpose of this guideline the alternative ALFR product can be either an ALFR element  
70 or an ALFR system that resists lateral loads induced by seismic forces. An ALFR  
71 element is one that can be substituted as an equivalent element within a predominantly  
72 DLFR system. An ALFR system is one where the entire structure's lateral resistance is  
73 comprised of ALFR elements. This guideline is applicable only to ALFR systems that  
74 are judged by ICC-ES to represent only a minor deviation from the behavior,  
75 redundancy, design procedures, and detailing requirements for an existing DLFR  
76 system.

77                   **1.4.3 Defined Lateral Force Resisting (DLFR) System:** For the  
78 purpose of this guideline, the DLFR system is an existing lateral force resisting system  
79 specifically defined by Table 12-2.1 of ASCE/SEI 7. Should multiple DLFR systems  
80 share the same seismic performance factors, than the historic benchmark system used  
81 to originally rationalize those factors shall be considered as the appropriate DLFR  
82 system for the purpose of establishing equivalency in this guideline.

83 **2.0 BASIC INFORMATION**

84 Testing laboratory, test reports and product sampling used to evaluate an ALFR shall be  
85 in accordance with the ICC-ES Rules of Procedure for Evaluation Reports and the  
86 appropriate ICC-ES acceptance criteria. . Test data used to define the performance of  
87 the DLFR system by the Task Group may be obtained from research reports, journal  
88 articles, and other sources judged reasonable by the Task Group.

89 **3.0 PROCESS REQUIREMENTS.**

90 **3.1 Procedure for Establishing the Task Group:**

91 **3.1.1** The task group shall consist of 6 to 8 members. The task group  
92 shall elect its own chairman. Additional members may be added after consultation with  
93 ICC-ES.

94 **3.1.1.1** Establishment of the Task Group shall be done in  
95 consultation with ICC-ES. The final membership of the Task Group shall be approved  
96 by ICC-ES before work proceeds.

97 **3.1.1.2** The Task Group members shall be independent individuals  
98 not associated with the ALFR product under consideration, except for the ICC-ES report  
99 applicant and/or their consultant.

100 **3.1.1.3** The Task Group shall maintain a balance of members noted  
101 in Section 1.4.1 of this guideline. The task group membership shall include a balance of:  
102 academics, design engineers, representatives from engineering associations, technical  
103 representatives from industry associations with an interest in the DLFR system, DLFR  
104 product manufacturers, and ALFR product manufacturers with an interest in the targets  
105 being established. At least two task group members shall have specific expertise in  
106 laboratory testing and analysis of the DLFR system. Should the membership change  
107 over the course of the work, ICC-ES shall be notified.

108 **3.1.2** It shall be the responsibility of ALFR product interests seeking an  
109 evaluation report or the industry that represents the DLFR system to establish and  
110 maintain the Task Group.

111                   **3.1.3** Task group members shall receive no compensation from ICC-ES.  
112 If compensation is to be considered, it should be established by proponents with an  
113 interest in establishing the DLFR system performance targets.

114                   **3.1.4** A separate Task Group shall be established for each application  
115 unless prior approval is received from ICC-ES.

116                   **3.1.5** The Task Group shall convene by means acceptable to the task  
117 group such as face-to-face meeting or teleconferencing. The location and frequency of  
118 the meetings shall be selected to not create an unreasonable burden or to discourage  
119 the task group members from attendance. The expenses for the meeting or  
120 teleconferencing shall be the responsibility of the ALFR applicant or an industry  
121 association with similar interests. ICC-ES shall be notified of the meeting times and  
122 locations.

123                   **3.1.6** The Task Group shall consider consensus to be the agreement of  
124 at least 2/3 of the Task Group members before. The plan for seismic performance  
125 factors for the specific DLFR system is submitted to ICC-ES. Any dissenting opinions  
126 shall also be submitted to ICC-ES for consideration. If consensus cannot be reached by  
127 the Task Group, the final resolution of the Task Group may be documented and  
128 provided to the ICC-ES Evaluation Committee for consideration. Also see section 3.4 in  
129 this guideline.

130                   **3.2 Task Group Responsibilities:**

131                   **3.2.1** The Task Group shall develop a plan outlining performance targets,  
132 based upon cyclic test data that can be used to characterize the behavior of the DLFR  
133 system over its practical range of application. These targets shall be used to judge  
134 whether or not an ALFR product behaves in a similar (equivalent) fashion.

135                   **3.2.2** The Task Group shall develop a plan to be submitted to ICC-ES  
136 prior to initiating any testing under this guideline.

137                   **3.2.3** The Task Group work shall include, but not be limited to, the  
138 following:

139                   **3.2.3.1**    A benchmark cyclic test database shall be assembled by the  
140 Task Group to characterize the performance of the DLFR system. To the extent  
141 practical, the database shall represent the range of DLFR system applications permitted  
142 and shall be large enough to allow for statistical analysis. When assembling this  
143 database, the Task Group shall use their consensus judgment to evaluate the test  
144 protocols, boundary conditions, and other test details to decide whether an individual  
145 test is appropriate for the purposes of defining the DLFR system performance. At least  
146 two independent laboratories must be represented in the final DLFR system database.

147                   **3.2.3.2**    The Task Group shall be charged with identifying a practical  
148 number of key target parameters from the cyclic tests that can be used to judge similar  
149 product performance. The number of parameters chosen shall be limited to a practical  
150 minimum that the Task Group judges to be the most critical to characterize the DLFR  
151 system performance.

152                   **3.2.3.3**    The task group shall propose target values for the critical  
153 parameters for eventual inclusion into an ICC-ES acceptance criteria. Where  
154 appropriate, the need for maximum and minimum values shall be considered as  
155 necessary to define the range of expected performance for the DLFR system. Without  
156 selecting the extremes of the database, the target performance levels selected by the  
157 Task Group shall permit the ALFR product to perform within a statistically defensible  
158 range of expected DLFR system performance. It is not permissible to use database  
159 averages to set maximum and minimum targets for the judgment of ALFR systems.

160                   **3.2.3.4**    The Task Group work shall consider that a DLFR system  
161 and ALFR product must be capable of surviving the Maximum Considered Earthquake  
162 that is greater in magnitude than the Design Basis Earthquake normally considered in  
163 structural design that complies with the code. As such, parameters developed by the  
164 Task Group shall be tied to tested DLFR system performance as demonstrated by cyclic  
165 test data and not based upon calculations or extrapolation of expected performance in a  
166 Design Basis Earthquake.

167                   **3.2.3.5**   The task group shall review the failure modes and vertical  
168 load carrying capabilities of the DLFR system. Appropriate targets shall be provided to  
169 ensure that the ALFR product behaves in a similar (equivalent) fashion.

170                   **3.2.3.6**   Written justification for items 3.2.3.1 thru 3.2.3.5, including  
171 supporting information, shall be developed by the Task Group.

172                   **3.2.4**   The task group as part of their review shall submit information on  
173 any design limitations or considerations, such as but not limited to redundancy, story or  
174 building heights, soil conditions and near fault effects.

175                   **3.3   Acceptance of the Plan:**

176                   **3.3.1**   The test-based performance targets established to prove  
177 equivalency to the DLFR and developed in accordance with this guideline shall be  
178 submitted to ICC-ES.

179                   **3.3.2**   The Task Group proposal shall be scheduled for an ICC-ES  
180 Committee open hearing. To allow sufficient time for public review and comment on the  
181 plan, the plan shall be available on the ICC-ES web site at least one full cycle of the  
182 alternative criteria development process, prior to being placed on an open hearing  
183 agenda.

184                   **3.3.3**   Upon approval by the committee the performance targets for the  
185 DLFR system shall be added to the relevant ICC-ES Acceptance Criteria for the review  
186 of ALFR products. ■

**METHODOLOGY FOR SEISMIC COEFFICIENT EQUIVALENCY  
for  
PROPRIETARY SHEARWALLS USED IN LIGHT-FRAMED  
CONSTRUCTION**

**Revised September 27, 2007**

**From the “AC322 Seismic Equivalency Task Group”**

**Task Group:**

Rawl Nelson (chair), SEAOC Light Frame Seismic Committee  
Ronald Hamburger, SGH, Structural Consultant (rohamburger@sgh.com)  
Phil Line, AF&PA (Philip\_Line@afandpa.org)  
Borjen Yeh, APA (borjen.yeh@apawood.org)  
Ray Yu, Hardy (RYU@mii.com)  
Dan Dolan, Washington State University (jddolan@wsu.edu)  
Steve Pryor, Simpson (spryor@strongtie.com)  
Tim Timmerman, Shearmax (timmerman@shearmax.com)  
Avik Ghosh, BORM Engineers, Structural Consultant (avikg@borm.com)  
Ned Waltz, Weyerhaeuser ([ned.waltz@weyerhaeuser.com](mailto:ned.waltz@weyerhaeuser.com))  
Reynaud Serrette, University of Santa Clara (riseng@pacbell.net)

**Executive Summary:**

This document summarizes the recommendations of the “AC322 Seismic Equivalency Task Group.” The charge of the Task Group was to establish a methodology, characteristics and parameters by which equivalency of “Proprietary Shearwalls Used in Wood and Light Gage Steel Framed Construction” to a seismic-force-resisting system identified in the code may be determined.

ASCE 7-05 (§12.2.1) states “Seismic force resisting systems that are not contained in Table 12.2-1 are permitted if analytical and test data are submitted that establish the dynamic characteristics and demonstrate the lateral-force resistance and energy dissipation capacity to be equivalent to the structural system listed in Table 12.2-1 for equivalent response modification coefficient,  $R$ , system over-strength coefficient,  $\Omega_0$ , and deflection amplification factor,  $C_d$ , values.”

As indicated herein, the task group has adopted a methodology that identifies characteristics with recommended parameters to identify whether the hysteretic behavior of a proprietary prefabricated shear panel (as a component of a seismic force resisting system) is sufficiently similar to the same characteristics of a given code-prescribed seismic system component.

Recommended numerical values of the parameters are based on the best available data for the code-prescribed system component (wood-structural panels nailed to wood-framing tested under the CUREE protocol). Alternative parameters (i.e., based on steel-stud framing for use in steel-framed buildings) will be developed at a later date. It is anticipated that this approach will serve as a compliment to the ATC-63 project.

## **Background:**

In recent years, the International Code Council Evaluation Service (ICC-ES) has been working to develop new acceptance criteria for cold-formed steel shear panels used in light-frame construction. Drafts of the proposed acceptance criteria, AC322: Prefabricated, Cold-formed Steel Lateral Resisting Assemblies, have been the subject of considerable debate at development hearings. Much of the controversy has centered around two technical topics:

- How to evaluate the ability of a pre-fabricated panel to carry a combination of vertical and lateral load when the elements of the panel that carry the vertical load are degraded during a lateral load test.
- How to assign seismic design coefficients ( $R$ ,  $C_d$ ,  $\Omega_o$ ) to a proprietary shear panel product used as a component within a larger system.

A group of interested parties met in San Francisco on 9 May 2007 to discuss these issues at the offices of Simpson Gumpertz & Heger Inc. Representatives were present from various prefabricated shear panel manufacturers, related trade associations, consulting engineering firms, academia, government, the Structural Engineers Association of California (SEAOC) and ICC-ES. During the meeting, nearly all of the discussion centered about the assignment of seismic design coefficients. The first issue was not addressed.

With regard to the assignment of seismic coefficients, it was established that:

- Pre-fabricated shear panels are typically used as a component within a building containing a code-defined lateral force resisting system as well as other building elements, which though not considered in the structural design of the building's seismic resistance; do provide the building with stiffness, strength and energy dissipation capacity.
- The seismic design coefficients presently contained in the 2006 International Building Code (IBC) for defined systems cannot be directly calculated based upon analysis and cyclic shearwall test data. The reason for this is that code-defined seismic coefficients were developed over a period of many years by committee judgment based largely upon historical performance, limited test data, and comparison with other code-defined systems.

Given the current lack of a definitive mathematical methodology to analyze cyclic shearwall test data for a proprietary product and to assign seismic design coefficients that are both consistent and compatible with code-defined lateral force resistance systems, it was decided that seismic design coefficients for proprietary shearwalls used in light-framed construction could be assigned on an "equivalency" basis.

At the close of the May 9 meeting, a task group was formed out of interested parties to establish the methodology that should be employed to establish “equivalency” for the assignment of seismic design coefficients to proprietary shearwalls used in light-framed construction. The objective of this paper is to document the findings of the task group.

These recommendations to ICC-ES (contained in Appendices A) reflect the consensus of the task group discussions, but it should be noted that not all task group members are in agreement with all provisions. Areas where differences occurred are noted below, with discussion of the dissenter’s opinion.

## **Basis for Establishing Equivalency:**

The task group objective was to provide a practical means by which to judge whether or not a proprietary wall performs in a manner consistent with a “benchmark” code-defined lateral force resisting system when subjected to high intensity, cyclic loading similar to that produced by earthquake shaking. If the cyclic test behavior of a proprietary panel is judged to be “equivalent” and consistent with the behavior of a lateral force resisting system defined in the IBC, then a proprietary pre-fabricated shearwall may be used as a component within that system and share the same seismic design coefficients.

The task group decided that the comparison should be made by comparing critical performance “parameters” from cyclic tests of the proprietary system against similar tests for the benchmark system defined by the code.

## **Benchmark Data Set:**

Given the large variation in performance expected even within a code-defined system, the committee judged that it was not appropriate for the proponent of a proprietary product to simply select test data for a single code-conforming wall panel to prove equivalency. The benchmark established by this single data point may or may not be representative of the level of performance commonly associated with the population of walls that conform to the code-defined system. The benchmark dataset should consist of all wall tests for the code-defined system that can be practically obtained and determined to be appropriate by a committee of interested parties. That review should consider the influence of:

- aspect ratios,
- boundary conditions,
- test protocol selected for the testing (i.e. CUREE, ISO, SPD, etc.)
- skew of the available data set relative to what exists in application, etc.

## **Characteristics and Parameters:**

Once the benchmark data set has been established, the next step in the process undertaken by the committee was to decide which cyclic test performance characteristics should be selected to make comparisons between the proprietary and benchmark systems and what parameter limits should be used for comparison. A large

number of cyclic shearwall test parameters were available for consideration by the task group. The characteristics considered by the group included, but were not limited to:

- indicators of component overstrength:
  - the ratio of peak load to the code-defined LRFD design load
  - the ratio of peak load to the code-defined ASD design load
- indicators of ductility:
  - the ratio of displacement at a post-peak failure point to the LRFD design displacement
  - the ratio of displacement at a post-peak failure point to the ASD design displacement
  - the ratio of displacement at a post-peak failure point to a yield load with various definitions
  - the ratio of displacement at the peak load to the LRFD design displacement
  - the ratio of displacement at the peak load to the ASD design displacement
  - the ratio of displacement at the peak load to a yield load
- energy dissipation
- indicators of deformation compatibility:
  - the displacement at peak load expressed as a percentage of the wall height
  - the displacement at a post-peak failure point expressed as a percentage of the wall height
  - the secant stiffness at the ASD design load divided by the secant stiffness at the peak load

The task group focused on selecting a few, critical parameters that would both ensure that a proprietary panels provides performance that is reasonably compatible with the benchmark system but still allow room for product innovation. The following characteristics and parameters were selected:

1. An upper and lower bound on the ratio of peak strength to the assigned ASD design load. These boundaries were selected to ensure that the proprietary product performs with a component overstrength that is in general alignment with other components of the code-defined system. A lower bound is prescribed to ensure a minimum margin of safety. An upper bound is provided to ensure that elements like component anchorage and connections such as drag struts can be designed using traditional procedures for the code-defined system without the development of special design provisions. It was agreed that manufacturers of proprietary products should report the over strength inherent in their products as part of the evaluation report.
2. Lower bounds on the displacement at a “post peak” failure points (defined as points where the load drops off by more than 20% from the peak load).

This parameter helps to ensure that the proprietary product has a drift capacity that is compatible with code-defined system. Since having additional drift capacity judged to be a benefit, an upper limit was not specified

3. Lower bounds on the ratio of the displacement at a “post peak” failure points (defined as points where the load drops off by more than 20% from the peak load) to the displacement at the assigned ASD design load. When coupled with parameters 1 and 2, this parameter was judged to provide an indication of the occurrence of yielding. It was selected to provide a consistent amount of yielding prior to reaching the peak without engaging in the controversy involved in selecting a consistent yield point from the nonlinear test data. Since having additional ductility was judged to be a benefit, an upper limit was not specified.

Taken alone, it is recognized that none of these three characteristics and their parameters provides sufficient assurance that the proprietary product performs in a manner consistent with the code-defined system. Taken together, their overlapping influences were judged to provide a reasonable measure of compatibility and equivalency.

### **Parameter Envelope Boundaries:**

Once the parameters had been selected, a consistent means must be used to establish upper and/or lower bounds, as appropriate. The task group recognized that:

- The cyclic shearwall test data sets available to serve as a benchmark for code-defined lateral force resisting systems are typically limited.
- The available data sets will not typically provide a comprehensive and statistically valid representation of all possible applications of the code-defined system.
- Even within the test data that are available for a code-defined system, there can be considerable variation in the parameters used to judge equivalence.

The task group discussed whether limits for the selected parameters should be based upon, the extremes of the benchmark data set, the average performance, or something else. In the end, it was decided that:

- Lower bounds for a parameter, where appropriate, shall be established based upon the average performance of the benchmark data set minus one standard deviation.
- Upper bounds for the ratio of peak strength to the assigned ASD design load was selected given the maximum strength reduction factor (multiplier) of 0.57 required by the code for 3.5:1 shear walls, one would anticipate that if the baseline ASD related safety factor for 2:1 aspect ratio walls and higher is 2.8, then for 3.5:1 walls it will be  $2.8/0.57 = 4.91$ , which the group rounded up to 5.0.

It was judged that establishing limits in this fashion should both ensure that a product performs within the expected range of the code-defined system and provides leeway for product innovation.

The task group intent is that for these boundaries to be compared against the average tested performance for each proprietary wall configuration tested in accordance with the methods outlined in AC322. It is not intended that each test replicate pass this criteria, nor is it intended that some aggregate average of multiple panel configurations be compared against the performance benchmark.

### **Parameters Established by the Task Group:**

Throughout the task group discussion, test data from the lateral force resisting system defined in the 2006 IBC as light-frame wood-stud walls sheathed with wood structural panels served as an illustrative example. The benchmark data and parameters developed from it have been included as Appendix A.

The task group determined the following provisions should be part of the AC322 criteria:

1. Any approved testing protocol may be used for a product to be used in wood framed construction. The results, for the purposes of equivalency, shall be compared against CUREE characteristics and limits.
2. Any approved testing protocol may be used for a product to be used in light cold formed steel construction shall be compared against SPD or CUREE characteristics and limits.

The task group intent is that additional lateral force resisting systems be added as benchmark data becomes available.

# Appendix A: Equivalency Characteristics and Parameters for Proprietary Shearwalls Used in Wood Framed Construction

## Definitions:

$V_{asd}$  = allowable stress design capacity per code or as determined from an ICC ES acceptance criteria

$\Delta_{V_{asd}}$  = displacement at  $V_{asd}$

$V_P$  = peak capacity

$\Delta_{.80V_P}$  = displacement at  $0.80 \cdot V_P$

## Testing

Any approved reverse cyclic testing protocol may be used for a product to be used in wood framed construction. The results, for the purposes of equivalency, shall be compared against CUREE characteristics and limits.

## Characteristics and Parameters:

### Ratio of Peak Load Capacity to ASD Design Capacity ( $V_P / V_{asd}$ )

- 1) Must be a minimum of 2.5 (see dissenting opinion in appendix B)
- 2) Maximum not exceed 5.0
- 3) Manufacturer must report and publish recorded over-strength

### Ratio of Post Peak Load Displacement to ASD Design Capacity Displacement ( $\Delta_{.80V_P} / \Delta_{V_{asd}}$ )

- 1) The post peak ratio at 80% peak capacity must be a minimum of 11

### Minimum Post Peak Displacements

- 1) Minimum post peak displacement at 80% peak capacity shall be  $2.8\% h_x$
- 2) Vertical capacity must be maintained this displacement.