ICC EVALUATION SERVICE®

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June 1, 2024

TO: **PARTIES INTERESTED IN POWER-ACTUATED FASTENERS**

SUBJECT: Proposed Revisions to the Acceptance Criteria for Power-actuated Fasteners Driven into Concrete, Steel, and Masonry Elements, Subject AC70-0624-R1 (EL/HS)

Dear Colleague:

After considering proposed revisions from a report holder, the request of a new report applicant and recent activity of the Concrete and Masonry Anchor Manufacturers Association (CAMA) AC70 Task Group, ICC-ES staff proposes minor technical revisions to AC70, in conjunction with updating the criteria to address the 2024 IBC and IRC. These proposals are primarily intended to provide a higher level of safety for use of power-actuated fasteners (PAFs) without requiring retesting for existing report holders at this time.

We welcome your comments on the proposed revisions, which are presented in the enclosed draft. The revisions, which are being posted on the ICC-ES web site for 30 days of public comment and ICC-ES committee ballot, are summarized below:

1. We propose that ASTM E1190-21 be relied upon for new testing programs, in lieu of ASTM E1190-11(2018). The update to ASTM E1190 was a result of a proposal from the CAMA AC70 Task Group. ICC-ES proposes some clarifications regarding the requirements of ASTM E1190-21, as shown in the enclosed criteria draft.

2. We propose language to clarify that while individual fasteners are tested, PAFs are intended to be used in redundant applications. This new language will affect Section 1.2 regarding the scope of the criteria and requires the addition of a definition to Section 1.4. New language will also be included in evaluation reports, as required by Section 6.0 of the proposed criteria draft.

3. We propose revisions to more generally address PAF Assemblies, regardless of the specific function of the assembly and regardless of whether the accessories are premounted on the fasteners or are supplied separately to the jobsite.

4. We propose revisions to Section 1.2 to clarify that determination of load capacities are only addressed for individual fasteners, since testing of groups of closely spaced fasteners has not been considered in the development of AC70. An associated new definition is proposed.

5. The enclosed criteria draft shows revisions to Sections 3.2.4 and 3.6.4, clarifying that allowable tension loads and allowable shear loads are not expected to be equivalent. We consider these revisions to be editorial.

6. The enclosed criteria draft shows editorial updates to address the 2024 IBC and IRC, while removing reference to the 2012 and 2009 code editions, based on current ICC-ES editorial policy. Table 1.3 has been redrafted to address these updates and to list the references alphabetically. We consider these revisions to be editorial.

No compliance date is proposed for the revised criteria. Current report holders will have the option to update their reports to the 2024 IBC and IRC. When this is done, the new language required for evaluation reports, as indicated in Section 6.0, will be added.

In addition to seeking input on proposed revisions, we are seeking public comment only and not ICC-ES committee ballot on the following topics, which may be addressed in the future:

7. While studying technical revisions to AC70 that have been proposed by a report holder (which we are not yet ready to present for public review), we have considered the possible use of a cap on load capacities for PAFs installed in concrete, which would be based on the properties of the concrete. This cap would be similar to that used for other types of concrete anchors that limits the overall strength of the anchor to due to limit states such as concrete breakout or pryout strength. We are interested in input on this additional measure for evaluation of PAFs. We would also like input regarding how the capping values should be determined while considering the fastener diameter, the embedment depth and the spacing and edge distances.

8. Section 1.2.1 Item 7 and Section 6.1.9.4 only address use of PAFs in high Seismic Design Categories for interior, nonstructural walls that are not subject to sustained tension loads and are not a bracing application.

    a. We have received questions from readers of AC70 reports about using PAFs to fasten cold-formed steel track for exterior walls to base materials. We would like to add provisions to AC70 that clearly address use of PAFs for exterior walls. So far, we are considering the requirements of Section 13.5.3 of ASCE 7-22. We would appreciate input regarding testing and analysis that should be required, particularly for use in high seismic design categories and regions subject to high wind speeds.

    b. We have received questions from readers of AC70 reports about using PAFs to resist in-plane seismic loads due to the weight of the partitions. We would appreciate input regarding how this should be addressed.

    c. We have received questions from readers of AC70 reports about what constitutes a “bracing application”. This terminology is taken directly from

ASCE 7. Should this restriction apply to kickers which brace toilet partitions, soffits and similar features, or is this only intended to restrict use in shear walls and other assemblies which brace the primary structural systems for the building? We would appreciate insight regarding the ASCE 7 provision and would also appreciate proposed language to clarify the intended restrictions.

While the Evaluation Committee will be voting on the revised criteria during the 30-day comment period, we will seriously consider all comments from the public and will pull the criteria back for reconsideration if public comments raise major issues. In that case, we would seek a new committee vote; further revise the draft and post it for a new round of public comments; or put the revised criteria on the agenda for a future Evaluation Committee hearing.

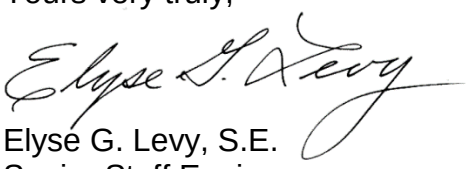
If they are of interest, please review the proposed revisions and send us your comments at the earliest opportunity.

To submit your comments, please use the form on the web site and attach any letters or other materials. If you would like an explanation of the “alternate criteria process,” under which we are soliciting comments, this too is available on the ICC-ES web site.

Please do not try to communicate directly with any Evaluation Committee member about a criteria under consideration, as committee members cannot accept such communications.

Thank you for your interest and your contributions. If you have any questions, please contact me at (800) 423-6587, extension 4315, or Howard Silverman, P.E., Director Anchors and Fastening, at extension 3996. You may also reach us by e-mail at es@icc-es.org.

Yours very truly,



Elyse G. Levy, S.E.
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EL/ls

Encl.

cc: Evaluation Committee

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PROPOSED REVISIONS TO THE ACCEPTANCE CRITERIA FOR POWER-ACTUATED FASTENERS DRIVEN INTO CONCRETE, STEEL AND MASONRY ELEMENTS

AC70

Proposed June 2024

Previously approved February 2019, February 2016, April 2015, January 2015, June 2014, February 2013, October 2012, February 2012, February 2011, February 2010, October 2006, October 2004, October 2003, September 1995

Previously editorially revised January 2021, November 2017

PREFACE

Evaluation reports issued by ICC Evaluation Service, LLC (ICC-ES), are based upon performance features of the International family of codes, and may include other codes, as applicable.

For alternative materials, design and methods of construction and equipment, see Section 104.2.3 of the 2024 *International Building Code*® (IBC), Section R104.2.2 of the 2024 *International Residential Code*® (IRC), Section 104.11 of the 2021 IBC and earlier editions, and Section R104.11 of the 2021 IRC and earlier editions.

ICC-ES may consider alternate criteria for report approval, provided the report applicant submits data demonstrating that the alternate criteria are at least equivalent to the criteria set forth in this document, and otherwise demonstrate compliance with the performance features of the codes. ICC-ES retains the right to refuse to issue or renew any evaluation report, if the applicable product, material, or method of construction is such that either unusual care with its installation or use must be exercised for satisfactory performance, or if malfunctioning is apt to cause injury or unreasonable damage.

Acceptance criteria are developed for use solely by ICC-ES for purposes of issuing ICC-ES evaluation reports

PROPOSED REVISIONS TO THE ACCEPTANCE CRITERIA FOR POWER-ACTUATED FASTENERS DRIVEN INTO CONCRETE, STEEL AND MASONRY ELEMENTS (AC70)

1.0 INTRODUCTION

1.1 Purpose: The purpose of this acceptance criteria is to establish requirements for power-actuated fasteners (PAFs) driven into concrete, steel and masonry elements to be addressed in an ICC Evaluation Service, LLC (ICC-ES), evaluation report under the 2024, 2021, 2018 and 2015~~, 2012 and 2009~~ *International Building Code*® (IBC) and the 2024, 2021, 2018 and 2015~~, 2012 and 2009~~ *International Residential Code*® (IRC). The bases of evaluation are 2024 IBC Section 104.2.3 (2021, 2018 and 2015 IBC Section 104.11) and 2024 IRC Section R104.2.2 (2021, 2018 and 2015 IRC Section~~s~~ R104.11~~ and R301.1~~). This criteria is needed to establish requirements for PAFs addressed in the code, since the code requires pull-out testing of the PAFs for some conditions, and for other limit states, such as lateral strength, allows the PAFs to be qualified through testing as an alternative to the calculation method prescribed in the code. This criteria is also needed to address PAF types and/or sizes and PAF assemblies which are not addressed in the code, and to address uses of PAFs which are not addressed in the code.

1.2 Scope: This acceptance criteria applies to PAFs with a Rockwell C hardness of more than 45, driven into uncracked concrete, hollow core precast concrete slabs, concrete-filled steel deck panels, minimum $^1/_8$-inch-thick (3.2 mm) steel and uncracked concrete masonry elements as alternatives to anchor bolts in concrete and concrete masonry and welds and bolts in steel. This criteria also applies to PAFs addressed in Section J5 of AISI S100.

The fasteners form connections between the base materials and the attached elements. The PAFs are evaluated for use in redundant applications (defined in Section 1.4.10). This criteria addresses performance of individual PAFs. Evaluation of closely spaced fasteners that act as a group (defined in Section 1.4.3) is outside the scope of this criteria.

Except for the specific end uses noted in Section 1.2.2, this criteria only addresses the tension and shear resistance of the PAF installed in the base material for general use and for seismic load resistance as described in Section 1.2.1, while limit states such as pull-over and bearing, which are governed by the properties of attached materials, are outside the scope of this criteria.

Fastener capacities addressed under this criteria are limited to allowable stress design (ASD) values, except for fasteners installed in steel, where fastener capacities may also address load and resistance factor design (LRFD).

1.2.1 Seismic Load Resistance: Seismic load resistance is generally outside the scope of this criteria. However, the fasteners may be allowed for seismic use in any of the following situations:

1. For attachment of nonstructural components listed in Section 13.1.4 of ASCE 7, which are exempt from the requirements of ASCE 7.

2. In steel base materials when used for attaching nonstructural components where the service load on any individual fastener does not exceed the lesser of 250 pounds (1112 N) or the published allowable load.

3. In specific steel base materials and thicknesses, where the allowable loads are determined in accordance with Annex A of this criteria and are noted in the evaluation report, except that use in the design of lateral force–resisting systems shall be outside the scope of the evaluation.

4. In concrete base materials when used for support of acoustical or lay-in panel suspended ceiling applications, distributed systems and distribution systems where the service load on any individual fastener does not exceed the lesser of 90 pounds (400 N) or the published allowable load.

5. In steel base materials when used to construct wood structural panel (WSP) diaphragms complying with the requirements specified in Section 3.8.3.

6. In concrete base materials where used to attach wood foundation sills when complying with the requirements specified in Section 3.8.1.

7. In concrete or steel base materials where used to attach cold-formed steel track of interior, nonstructural walls when complying with the requirements specified in Section 6.1.9.4.

1.2.2 Specific End Uses: This criteria addresses requirements for PAFs intended for general use, and additional requirements for fasteners intended for the following end uses:

- Wood sill plate anchorage to concrete
- Fastening of ceiling clips and similar PAF accessories
- WSP fastening to perimeter and incidental structural steel supports for use in diaphragms primarily supported on wood base material. Qualification of PAFs for use in steel-framed diaphragms is outside the scope of this criteria.
- Connections between steel elements in accordance with AISI S100.

1.3 Referenced Codes, Standards and Other Documents: For the applicable editions of the referenced standards see Table 1.3 at the end of Section 1.3. Titles shown below are for the latest edition of the referenced standard.

1.3.1 2024, 2021, 2018 and 2015~~, 2012 and 2009~~ *International Building Code*® (IBC), International Code Council.

1.3.2 2024, 2021, 2018 and 2015~~, 2012 and 2009~~ *International Residential Code*® (IRC), International Code Council.

1.3.3 ACI 318, Building Code Requirements for Structural Concrete, American Concrete Institute.

1.3.4 AISI S100, North American Specification for the Design of Cold-formed Steel Structural Members, American Iron and Steel Institute.

1.3.5 ANSI/AWC (AF&PA) National Design Specification (NDS) for Wood Construction, American Wood Council.

1.3.6 ANSI/AWC (AF&PA) Special Design Provisions for Wind and Seismic (SDPWS), American Wood Council.

1.3.7 ASCE/SEI 7, Minimum Design Loads and Associated Criteria for Buildings and Other Structures, American Society of Civil Engineers/Structural Engineering Institute.

1.3.8 ASTM A370, Standard Test Method and Definitions for Mechanical Testing of Steel Products, ASTM International.

1.3.9 ASTM C31, Standard Practice for Making and Curing Concrete Test Specimens in the Field, ASTM International.

1.3.10 ASTM C33, Standard Specification for Concrete Aggregates, ASTM International.

1.3.11 ASTM C39, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens, ASTM International.

1.3.12 ASTM C42, Method of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete, ASTM International.

1.3.13 ASTM C90, Standard Specification for Loadbearing Concrete Masonry Units, ASTM International.

1.3.14 ASTM C109, Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens), ASTM International.

1.3.15 ASTM C140, Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units, ASTM International.

1.3.16 ASTM C270, Standard Specification for Mortar for Unit Masonry, ASTM International.

1.3.17 ASTM C330, Standard Specification for Lightweight Aggregates for Structural Concrete, ASTM International.

1.3.18 ASTM C476, Standard Specification for Grout for Masonry, ASTM International.

1.3.19 ASTM C1019, Standard Test Method for Sampling and Testing Grout, ASTM International.

1.3.20 ASTM C1314, Standard Test Methods for Compressive Strength of Masonry Prisms, ASTM International.

1.3.21 ASTM E1190, Standard Test Methods for Strength of Power-~~Driven~~Actuated Fasteners in Structural Members, ASTM International.

1.3.22 TMS 402/ACI 530/ASCE 5, Building Code Requirements for Masonry Structures, The Masonry Society/American Concrete Institute/American Society of Civil Engineers.

1.3.23 Acceptance Criteria for Nails (AC116), ICC Evaluation Service.

1.3.24 Acceptance Criteria for Tapping Screw Fasteners Used in Steel-to-steel Connections (AC118), ICC Evaluation Service.

TABLE 1.3—APPLICABLE EDITIONS OF REFERENCED STANDARDS[1,2]

~~STANDARD~~	~~2021 IBC & IRC~~	~~2018 IBC & IRC~~	~~2015 IBC & IRC~~	~~2012 IBC & IRC~~	~~2009 IBC & IRC~~
~~ACI 318~~	~~2019~~	~~2014~~		~~2011~~	~~2008~~
~~AISI S100~~	~~2016 with S1-18 & S2-20~~	~~2016~~	~~2012~~		
~~NDS~~	~~2018~~		~~2015~~	~~2012~~	~~2005~~
~~SDPWS~~	~~2021~~	~~2015~~		~~2008~~	
~~ASCE/SEI 7~~	~~2016 w/Supp. 1~~	~~2016~~	~~2010~~		~~2005~~
~~ASTM A370~~	~~-08a through -17~~				
~~ASTM C31~~	~~-98 through -18b~~				
~~ASTM C33~~	~~-03 through -18~~				
~~ASTM C39~~	~~-03 through -18~~				
~~ASTM C42~~	~~-03 through -18a~~				
~~ASTM C90~~	~~-03 through -16a~~				
~~ASTM C109~~	~~-16a~~				
~~ASTM C140~~	~~-18~~				
~~ASTM C270~~	~~-04 through -14a~~				
~~ASTM C330~~	~~-04 through -17a~~				
~~ASTM C476~~	~~-02 through -10~~				
~~ASTM C1019~~	~~-16~~				
~~ASTM C1314~~	~~-03[b] through -14~~				
~~ASTM E1190~~	~~-95 through -11~~				
~~TMS 402~~	~~2016~~		~~2013~~	~~2011~~	~~2008~~

STANDARD	2024 IBC & IRC	2021 IBC & IRC	2018 IBC & IRC	2015 IBC & IRC
ACI 318	2019	2019	2014	2014
AISI S100	2016 w/S2-20	2016 w/S2-20	2016	2012
ASCE/SEI 7	2022	2016 w/S-1	2016	2010
ASTM A370	-08a through -~~17~~23			
ASTM C31	-98 through -~~18b~~21a			
ASTM C33	-03 through -18			
ASTM C39	-03 through -18			
ASTM C42	-03 through -18a			
ASTM C90	-03 through -~~16a~~21			
ASTM C109	-16a through -21			
ASTM C140	-18 through -22a			
ASTM C270	-04 through -~~14a~~19ae1			
ASTM C330	-04 through -17a			
ASTM C476	-02 through -~~10~~20			
ASTM C1019	-16 through -20			
ASTM C1314	-03[b] through -~~14~~21			
ASTM E1190	-95 through -~~11~~21 (See note 2)			
NDS	2024	2018	2018	2015
SDPWS	2021	2021	2015	2015

STANDARD	2024 IBC & IRC	2021 IBC & IRC	2018 IBC & IRC	2015 IBC & IRC
TMS 402	2022	2016	2016	2013

[1]When multiple editions of a standard are listed above, this criteria is written using the applicable section numbers for the latest edition, unless otherwise noted.

[2]When a range of editions of a standard are listed above, the editions within the range are deemed to be technically equivalent for the purposes of this criteria. New report applicants ~~are expected to~~ shall use the latest edition referenced. Current report holders, whose evaluation reports are based on data complying with one of the earlier editions of the standard will not need to submit new data to demonstrate compliance with the latest edition of the referenced standard.

1.4 Definitions:

1.4.1 Alignment Tips: Alignment tips are washers, eyelets or other guide members located on the fastener shank to align and retain fasteners in driving equipment.

1.4.2 Available Strength: Available strength is the design strength or allowable strength, as applicable.

1.4.3 Closely Spaced Fasteners: Groups of fasteners which are spaced more closely together than what is shown in Table 1 of ASTM E1190, such that they do not act individually.

1.4.4 Fastener Test Series: A fastener test series is a group of identical fasteners tested under identical conditions. Identical conditions encompass fastener type, diameter, length, embedment, spacing, edge distance, concrete/masonry density/weight, test member thickness and concrete/masonry compressive strength, steel thickness and steel strength.

1.4.5 Incidental Structural Steel: Non-repetitive steel framing members, such as those used for bracing or around openings, which are used in horizontal diaphragms where the WSP sheathing is primarily attached to wood supports.

1.4.6 PAF Accessory: ~~Preassembled c~~Components such as washers or clips which are expected to be permanently affixed to the base material after the PAF is installed. These components may be preassembled with the PAF or supplied separately.

1.4.7 PAF Assembly: A PAF accessory installed with a PAF.

1.4.8 Point Length: Length from the tip of the PAF to the point where the diameter of the shank becomes constant.

1.4.9 Power-actuated Fasteners (PAFs): Power-actuated fasteners are nail-like pins or threaded studs manufactured from heat-treated steel, used to attach materials to concrete, masonry or steel base materials by driving with a power tool.

1.4.10 Redundant Applications: Applications where multiple PAFs support elements that are capable of redistributing the load to neighboring PAFs, in the event of a PAF failure. Examples include, but are not limited to, PAFs used to fasten cold-formed steel track, where the track can redistribute loads and PAF assemblies where the supported elements, such as conduit and ceiling framing can redistribute the loads to neighboring PAF assemblies.

1.4.11 Stabilizer: A stabilizer is an accessory supplied with driving tools and used to reduce flying particles and hold the driving tool perpendicular to material surface.

1.4.12 Test Member: The test member is the structural member, usually a concrete slab, steel plate or masonry prism, receiving fasteners to be tested.

1.4.13 Uncracked Concrete/Masonry: Concrete or masonry elements where analysis indicates no cracking ($f_t < f_r$) due to service loads or deformations. For concrete, f_r is defined in ACI-318, Section 19.2.3.1. For masonry, f_r is defined in TMS 402, Section ~~9.1.9.2~~9.1.9.1.

1.4.14 Additional definitions are noted in Section 3 of ASTM E1190.

1.5 Notation:

COV	=	Coefficient of variation of the test series (=s/F).
d_{ae},	=	Average embedded diameter
f'_c	=	Minimum specified concrete strength at time of installation, psi (kPa).
$f'_{c,test}$	=	Actual compressive strength of concrete test specimen, psi (kPa).
f_{cmu}	=	Specified compressive strength of CMUs, psi (kPa).
$f_{cmu,test}$	=	Measured compressive strength of CMUs, psi (kPa).
f'_g	=	Specified compressive strength of grout, psi (kPa).
$f'_{g,test}$	=	Measured compressive strength of grout, psi (kPa).
f'_m	=	Specified compressive strength of masonry, psi (kPa).
$f'_{m,test}$	=	Measured compressive strength of masonry, psi (kPa).
f_{mor}	=	Specified compressive strength of mortar, psi (kPa).
$f_{mor,test}$	=	Measured compressive strength of mortar, psi (kPa).
f_r	=	Modulus of rupture of concrete or masonry.
f_t	=	Extreme fiber tension stress in concrete or masonry.
F	=	Average ultimate load of the test series, lbf (N). See Section 3.2.4 for Exception.
F_{all}	=	Allowable load for fastener, lbf (N).
F_u	=	Specified tensile strength of steel base material, ksi (MPa).
$F_{u,test}$	=	Actual tensile strength of steel base material, ksi (MPa).
H_c	=	Minimum specified Rockwell C core hardness.
$H_{c,test}$	=	Actual Rockwell C core hardness of tested fasteners.

l_{dp} = PAF point length, inch (mm)

n = Exponent for combined loading.

p = Actual tension load on fastener, lbf (N).

P_a = Allowable tension load on fastener, lbf (N).

P_d = Tension design strength for fastener, lbf (N).

P_u = Average ultimate tension test load from tension test, lbf (N).

$P_{u,45}$ = Average ultimate tension test load from combined load test, lbf (N).

R = Governing base material reduction factor.

R_f = Reduction factor for overstrength of fastener.

s = Standard deviation of the test series.

v = Actual shear load on fastener, lbf (N).

V_a = Allowable shear load on fastener, lbf (N).

V_d = Shear design strength for fastener, lbf (N).

V_u = Average ultimate shear test load from shear test, lbf (N).

$V_{u,45}$ = Average ultimate shear test load from combined load test, lbf (N).

Ω = Safety factor.

ϕ = Resistance factor.

2.0 BASIC INFORMATION

2.1 General: The following information shall be submitted to ICC-ES:

2.1.1 Product Description:

2.1.1.1 Product Identification: Generic or trade name, and catalog number or product designation.

2.1.1.2 General Description: PAF type, PAF accessories and alignment tips. Also shank characteristics. If knurled, the knurl pattern shall be described.

2.1.1.3 Dimensions: PAF and PAF accessory dimensions and tolerances. In addition to the dimensions needed to manufacture the PAF, the following dimensions shall be included in the description of the product for use in the evaluation report:

1. Provide the length of the portion of the fastener that will be in contact with the attached material, in contact with the base material or penetrating through the base material, after installation. For example, this length should not include the head of the PAF or the thickness of washers after installation.

2. For fasteners which are intended to penetrate through steel base material, define the point length, l_{dp}, for use in determining applicability of provisions in AISI S100.

3. For tapered shank fasteners, provide sufficient information to allow determination of the average embedded diameter, d_{ae}, for use in calculations in accordance with AISI S100.

2.1.1.4 Materials: PAF and PAF accessory material specifications, including raw material specifications, protective coatings and physical properties, such as tensile strength and/or hardness.

2.1.2 Installation Instructions: Recommended installation procedures. Report holder's published instructions shall be submitted for installation, application and design.

2.1.3 Packaging and Identification: A description of the method of packaging and manner of field identification prior to or after installation is needed. The report holder's name or insignia and the product's type and size shall be marked on the fastener or packaging units. Packages of PAFs shall be identified in accordance with the product identification provisions of the ICC-ES Rules of Procedure for Evaluation Reports.

2.1.4 Qualification Test Plan: A qualification test plan shall be submitted to and approved by ICC-ES staff prior to any testing being conducted.

2.2 Testing Laboratories: Testing laboratories shall comply with the ICC-ES Acceptance Criteria for Test Reports (AC85) and Section 4.2 of the ICC-ES Rules of Procedure for Evaluation Reports.

2.3 Test Reports: Test reports shall comply with AC85. In addition, test reports shall include the following information:

2.3.1 Information required by the report section of the applicable test standard, such as Section 12 of ASTM E1190.

2.3.2 Method of failure for each test (e.g., concrete or masonry cracking, concrete spalling, fastener pullout, fastener shear, fastener pull-through, steel tear out, or ductile steel failure).

2.3.3 Fastener Identification:

2.3.3.1 Report holder's catalog number or model line designation.

2.3.3.2 Physical dimensions, which may be shown on drawings.

2.3.3.3 PAF accessory dimensions, which may be shown on drawings.

2.3.3.4 Description of coatings or finishes.

2.3.4 Data collection sheets.

2.3.5 The fasteners, tool setting aids and necessary driving aids, such as stabilizers, used in the tests.

2.4 Product Sampling: Sampling of the fasteners for tests under this criteria shall comply with Sections 3.2, 3.3 and 3.4 of AC85.

3.0 TEST AND PERFORMANCE REQUIREMENTS

3.1 Testing and Analysis Requirements: Testing and analysis of PAF performance shall be in accordance with Section 3.1.1 and/or Section 3.1.2, as applicable, based on the uses included in the scope of the evaluation.

3.1.1 PAFs Evaluated for General Use: PAFs evaluated for general use shall be qualified in accordance with Section 3.2 and the applicable base material requirements addressed in Sections 3.3 through 3.7. PAFs installed in steel base materials may be evaluated for Seismic Reliability in accordance with Annex A.

3.1.2 PAFs Evaluated for Specific End Uses: PAFs evaluated for specific end uses shall be qualified in

accordance with the applicable subsection(s) of Section 3.8.

3.2 General Testing and Analysis Requirements:

3.2.1 Fastener Verification: All tested fasteners and PAF accessories shall be proven by the testing laboratory to conform to the report holder's ~~fastener~~ specifications. This evaluation shall include confirmation of equivalent dimensions, chemical composition, and material properties, such as tensile strength and/or hardness. As an alternative to chemical testing, a mill certificate for the raw wire material, corresponding to the tested fastener lot, may be submitted to demonstrate compliance with the chemical composition requirements.

3.2.2 Load Test Program: For determining nominal pull-out (tension) and lateral (shear) strengths used in structural designs, tests shall be done in accordance with Section 4.1 and as otherwise directed by Sections 3.3 through 3.7, as applicable. Fasteners shall be installed into the test member according to the report holder's recommended procedure at the locations recommended by the report holder. Spacing from edges and adjacent fasteners need not exceed the dimensions set forth in Table 1 of ASTM E1190. Fastener embedment shall be observed and recorded.

3.2.3 Combined Loading: The allowable load interaction for fasteners and PAF assemblies subjected to a combination of tension and shear loads shall be as follows:

$$\left(\frac{p}{P_a}\right)^n + \left(\frac{v}{V_a}\right)^n \le 1 \qquad (3\text{-}1)$$

To permit $n = 5/3$ in Equation 3-1, combined load testing must be performed. These tests shall be done by loading the fastener obliquely at a 45° angle from the test member surface. Figure 1 illustrates loading set-up. Other aspects of the test program shall comply with Section 4.1. Results from the oblique load testing shall confirm Equation 3-2. If oblique load tests are not done or if Equation 3-2 is not satisfied, then $n = 1$ in Equation 3-1.

$$\left(\frac{P_{u,45}}{P_u}\right)^{5/3} + \left(\frac{V_{u,45}}{V_u}\right)^{5/3} \ge 1 \qquad (3\text{-}2)$$

3.2.4 Allowable Load Determination: The documents containing allowable load determinations shall be sealed by a registered design professional.

Based on results from the load tests, except as noted in Section 3.6.4 for PAFs installed into steel base materials, the allowable load shall be computed as follows:

$$\sout{P_a = V_a =} F_{all} = \frac{F \cdot R}{\Omega} \qquad (3\text{-}3)$$

where:

F = Average ultimate tension or shear load [lbf (N)] of the test series.

R = Base material reduction factor determined in accordance with the applicable subsection(s) of Sections 3.3 through 3.7.

$$\Omega = \frac{3.5}{1-2COV} \ge 5 \qquad (3\text{-}4)$$

Exception: When testing satisfies the alternate sample size described in Section 8.1 of ASTM E1190 (the COV from ten tests is 15 percent or greater), F shall be taken as the lowest ultimate load of the ten tests and Ω shall be taken as 5.

3.3 Requirements for PAFs Installed into Cast-in-place Concrete Base Material:

3.3.1 Test Member Requirements: Concrete slabs shall be of sufficient size to allow installation of fasteners with spacings and edge distances complying with Table 1 of ASTM E1190. Concrete for test members shall be designed, placed and cured in accordance with IBC Chapter 19. Coarse and fine aggregate in concrete shall comply with either ASTM C33 or ASTM C330. Reinforcement is used only to stabilize test members during transportation. Reinforcing elements in concrete test members shall be outside the potential failure region of each test fastener. The testing laboratory shall control and verify location of reinforcing.

3.3.2 Determination of Test Member Strength:

3.3.2.1 Using Cylinders: Concrete cylinder test specimens shall be prepared in accordance with ASTM C31. Compressive strength cylinders shall be stored and cured in accordance with ~~Section 10.2 of~~ ASTM C31 (field cure). These cylinders shall be tested in accordance with ASTM C39 and Section 3.3.2.3.

3.3.2.2 Using Cores: Where cylinders are unavailable, compressive strength shall be determined by obtaining, preparing and testing drilled cores. Procedures in ASTM C42 shall be followed. One sample from each of three cores shall be tested in accordance with ASTM C42 and Section 3.3.2.3.

3.3.2.3 Testing of Cylinders and Cores:

3.3.2.3.1 Less Than 90 Days Old: For concrete which is less than 90 days old at the time of the load testing, two cylinders or cores shall be tested at the beginning of the load testing and two shall be tested at the end of load testing, as indicated in Table 1. The timing of the first two cylinder or core tests shall be concurrent with the initiation of fastener load testing. The results from the four cylinders or cores shall be averaged to establish the strength of the test member during the test period.

3.3.2.3.2 90 Days Old or More: For concrete aged 90 days or more, the compressive strength shall be the average of three cylinders or cores, determined after at least 90 days of curing, and within 30 days of fastener load testing.

3.3.3 Fastener Installation into Test Member: Fasteners shall be driven into concrete when the report holder's prescribed installation strength is attained with a tolerance of plus 1000 psi (6.9 MPa) or minus 400 psi (2.8 MPa).

3.3.4 Base Material Reduction Factor: When the concrete test member's compressive strength, $f'_{c,test}$, exceeds f'_c by more than 10 percent, but is within 1,000 psi (6,895 kPa), the reduction factor for overstrength of the concrete test specimen shall be calculated as follows:

$$R = \sqrt{\frac{f'_c}{f'_{c,test}}} \qquad (3\text{-}5)$$

3.4 Requirements for PAFs Installed into Hollow Core Precast Concrete Slab Base Material:

3.4.1 Test Member Requirements: Representative hollow core precast concrete slab specimens shall be used as the test members. The concrete thickness at the cores shall be at least $^3/_8$ inch (9.5 mm) greater than the embedment depth of the PAFs.

3.4.2 Determination of Test Member Strength: Test member strength shall be determined in accordance with Section 3.3.2.

3.4.3 Fastener Installation into Test Member: Fasteners installed into hollow core precast concrete slabs must not be in contact with the prestressing strands embedded in the concrete. Installation shall not result in cracking or splitting of the precast or in spalling within the cores beyond the tip of the fasteners.

3.4.4 Base Material Reduction Factor: The base material reduction factor shall be determined in accordance with Section 3.3.4.

3.5 Requirements for PAFs Installed into Concrete-filled Steel Deck Panel Base Material:

3.5.1 Test Member Requirements: The steel deck product name, dimensions, applicable material standard, type and grade shall be addressed in the test report. See Section 3.3.1 for requirements for the concrete.

3.5.2 Determination of Test Member Strength: Concrete test member strength shall be determined in accordance with Section 3.3.2. The yield strength, tensile strength and elongation of the steel deck panel shall be based on testing in accordance with ASTM A370, or on mill certification.

3.5.3 Fastener Installation into Test Member: Fasteners shall be installed through the steel deck panel into the concrete in the locations which will be described in the evaluation report. Fastener capacities for installation in upper flutes shall be based on load testing of fasteners installed in the upper flutes of the deck. Similarly, fastener capacities for installation in lower flutes shall be based on load testing of fasteners installed in the lower flutes of the deck.

The test report on the load testing shall indicate the locations of the installed fasteners, addressing distance from the edge of the deck flute, distance from the end of the slab, and spacing along the deck flute. The direction of the applied shear loading shall also be indicated.

3.5.4 Base Material Reduction Factor: The base material reduction factor shall be the reduction factor for the concrete, determined in accordance with Section 3.3.4.

3.6 Requirements for PAFs Installed into Steel Base Material:

3.6.1 Test member requirements: The steel plate dimensions and applicable material standard shall be addressed in the test report. Steel plates shall be a minimum of $^1/_8$ inch (3.2 mm) thick and shall be of sufficient size to permit installation of fasteners with spacings and edge distances complying with Table 1 of ASTM E1190.

3.6.2 Determination of Test Member Strength: The yield strength, tensile strength and elongation of the steel test members shall be determined by testing in accordance with ASTM A370.

3.6.3 Fastener Penetration / Steel Thickness Requirements:

3.6.3.1 For fasteners installed with partial penetration, the reported base steel thickness will be that tested or greater, provided the penetration depth is no more than two-thirds the thickness of the steel base material. For all other situations, such as when only a portion of the point length penetrates through the steel, the reported penetration / base material thickness will be limited to what was used in the testing.

3.6.3.2 For PAFs that are intended to be installed with the entire fastener tip penetrating through the steel, individual test specimens may have lesser penetration, but the average penetration for a test series shall be equal to or greater than the length of the fastener tip.

3.6.4 Allowable Loads and Design Strengths:

3.6.4.1 Allowable Loads: For fasteners installed into steel base material, the following requirements for determining allowable loads shall apply:

The documents containing allowable load determinations shall be sealed by a registered design professional.

Based on results from the load tests, the allowable strengths for use in Allowable Strength Design (ASD) shall be computed as follows:

$$\cancel{P_a = V_a =} F_{all} = \frac{F \cdot R \cdot R_f}{\Omega} \quad (3\text{-}6)$$

where:

F = See Section 3.2.4, including the Exception.

R = Base material reduction factor determined in accordance with Section 3.6.5.

R_f = Fastener based reduction factor, determined in accordance with Section 3.6.6, as applicable.

Ω = See Section 3.2.4, including the Exception.

Exception: For pull-out (tension) where PAFs and steel base material comply with Sections J5 and J5.2.2 of AISI S100:

Ω = *S*afety factor determined in accordance with Section J5.2.2 of AISI S100.

3.6.4.2 Design Strength: For pull-out (tension) where PAFs and steel base material comply with Sections J5 and J5.2.2 of AISI S100, the design strengths for use in Load and Resistance Factor Design (LRFD) shall be computed as follows:

$$\cancel{P_a = V_a =} F_{des} = \Phi \cdot F \cdot R \cdot R_f \quad (3\text{-}7)$$

where:

ϕ = Resistance factor determined in accordance with Section J5.2.2 of AISI S100.

3.6.5 Base Material Reduction Factor: Design loads derived from tests in steel shall be adjusted for steel strength as follows:

1. If tests have been conducted in one steel strength, the following relationship shall be used to derive the reduction factor for lesser steel strengths:

$$R = 1 - \frac{F_{u,test} - F_u}{100} \quad (3\text{-}8)$$

2. If tests have been conducted in more than one steel tensile strength, with the difference between the maximum and minimum tested steel tensile strengths being greater than or equal to 10 ksi (68.9 MPa), a relationship for the influence of steel tensile strength on fastener capacity may be derived from the test results. Maximum fastener capacity shall be limited to those values associated with the maximum tested steel tensile strength.

3.6.6 Fastener Material Reduction Factor: When failure is attributed to the fastener material, and the average core hardness of the fasteners, $H_{c,test}$, exceeds the minimum specified core hardness, H_c, by more than ten percent, fastener load test results shall be adjusted by the following reduction factor:

$$R_f = \frac{H_c}{H_{c,test}} \quad (3\text{-}9)$$

3.7 Requirements for PAFs Installed into Masonry Base Material: Installation into concrete masonry may be qualified on the basis of installation into individual concrete masonry units (CMUs), or into concrete masonry wall assemblies (comprised of CMUs, mortar and grout, as applicable), consistent with the type of installation to be addressed in the evaluation report.

3.7.1 Installation into Individual CMUs:

3.7.1.1 Test Member Requirements: CMUs shall comply with ASTM C90. The size of the test specimen, including face shell thickness, shall be included in the test report.

3.7.1.2 Determination of Test Member Density and Strength: CMUs from the same lot used in the fastener load testing shall be tested for density and compressive strength. The compressive strength shall be determined in accordance with ASTM C140, based on a minimum of three samples. The compressive strength testing shall be performed within three days of the fastener load testing. The measured density shall be used to classify the CMUs as normal weight, medium weight or lightweight in accordance with ASTM C90.

3.7.1.3 Fastener Installation: The PAFs shall be installed through the face shell of the CMU. The distance from the fastener to the top or bottom edge of the CMU reported in the evaluation report shall be the edge distance applicable to concrete in Table 1 of ASTM E1190, unless testing is performed at a lesser edge distance. Similarly the distance from the fastener to the nearest face of a web reported in the evaluation report shall be $1^1/_2$ inches unless testing is performed at a lesser distance.

3.7.1.4 Base Material Reduction Factor: The base material reduction factor shall be determined as follows:

$$R = \sqrt{\frac{f_{cmu}}{f_{cmu,test}}} \quad (3\text{-}10)$$

where:

f_{cmu} = Specified compressive strength of the CMUs (1,900 psi, minimum).

$f_{cmu,test}$ = Compressive strength of the CMUs, determined in accordance with Section 3.7.1.2.

3.7.2 Installation into Wall Assemblies:

3.7.2.1 Test Member Requirements:

3.7.2.1.1 CMUs: See Section 3.7.1.1.

3.7.2.1.2 Mortar: Mortar shall be prepared in accordance with IBC Section 2103.2 and ASTM C270. The testing laboratory shall report the mortar composition, mortar type, proportions, and compliance with the standard.

3.7.2.1.3 Grout: Grout shall be prepared in accordance with IBC Section 2103.3 and ASTM C476. The testing laboratory shall report grout composition, grout type and proportions.

3.7.2.1.4 Assembly: Masonry test specimens shall be prepared in accordance with IBC Chapter 21. Masonry wall test assemblies shall be grouted or ungrouted, as applicable, and shall be of sufficient size to permit installation of fasteners with spacings and edge distances recommended by the applicant. Reinforcement shall only be used to stabilize test members during transportation. Reinforcing elements in masonry test members shall be outside the potential failure region of each test fastener. The testing laboratory shall control and verify the location of reinforcing.

3.7.2.2 Determination of Test Member Strength:

3.7.2.2.1 CMUs: See Section 3.7.1.2.

3.7.2.2.2 Mortar: Concurrent with testing of PAFs installed in mortar joints, the compressive strength of the mortar shall be determined in accordance with ASTM C109.

3.7.2.2.3 Grout: Concurrent with testing of PAFs installed in the top of grouted cells, the compressive strength of the grout shall be determined in accordance with ASTM C1019.

3.7.2.2.4 Assembly (optional): When masonry compressive strength is determined by prism tests, the prisms shall be prepared and tested in accordance with ASTM C1314 and the following:

3.7.2.2.4.1 Prisms Less Than 90 Days Old: For concrete masonry assemblies which are less than 90 days old at the time of the load testing, two prisms shall be tested at the beginning of the load testing and two shall be tested at the end of load testing, as indicated in Table 1. The timing of the first two prism tests shall be concurrent with the initiation of fastener load testing. The results from the four prisms shall be averaged to establish the strength of the test member during the test period.

3.7.2.2.4.2 Prisms 90 Days Old or More: For concrete masonry assemblies aged 90 days or more, the compressive strength shall be the average of three prisms, determined after at least 90 days of curing, and within 30 days of fastener load testing.

3.7.2.3 Fastener Installation: Fastener locations may include face shells of grouted or ungrouted units, mortar joints, or the top of grouted cells, simulating concrete masonry foundation walls. The fastener position used in the test establishes the position which will be described in the evaluation report. The test report shall include the spacing and edge distance of the fasteners and shall indicate the direction of the loads applied.

3.7.2.4 Base Material Reduction Factors:

3.7.2.4.1 For PAFs Installed into CMU Face Shell: See Section 3.7.1.4.

3.7.2.4.2 For PAFs Installed into Mortar Joint:

Option 1: The base material reduction factor shall be the more severe of the reduction factor for the CMU, determined in accordance with Section 3.7.1.4 and the following reduction factor for the mortar:

$$R = \sqrt{\frac{f_{mor}}{f_{mor,test}}} \quad (3\text{-}11)$$

where:

f_{mor} = The 28-day compressive strength of the applicable mortar type specified in ASTM C270.

$f_{mor,test}$ = The compressive strength of the tested mortar determined in accordance with Section 3.7.2.2.2.

Option 2: The base material reduction factor shall be determined as follows:

$$R = \sqrt{\frac{f'_m}{f'_{m,test}}} \quad (3\text{-}12)$$

where:

f'_m = The compressive strength of the masonry to be specified in the evaluation report.

$f'_{m,test}$ = The measured compressive strength of the masonry determined in accordance with Section 3.7.2.2.4.

3.7.2.4.3 For PAFs Installed into Top of Grouted Cell: The base material reduction factor shall be determined as follows:

$$R = \sqrt{\frac{f'_g}{f'_{g,test}}} \quad (3\text{-}13)$$

where:

f'_g = The specified compressive strength of the grout (2,000 psi, minimum).

$f'_{g,test}$ = The measured compressive strength of the grout determined in accordance with Section 3.7.2.2.3.

3.8 Requirements Based on Intended End Use:

3.8.1 PAFs Used to Attach Wood Sill Plates to Concrete: PAFs used as wood sill plate anchorage shall be limited to Seismic Design Category A or B.

Exception: Under the IBC, in Seismic Design Categories A through F, PAFs may be used in interior, nonstructural wall applications where the wood sill member is fastened directly to concrete, provided the results of the fastener load tests satisfy the shear and tension load requirements in Table 2. The maximum horizontal transverse load on the wall shall be 5 psf (0.24 kN/m^2). Installation requirements shall be in conformance with Table 2.

3.8.1.1 Fastener Verification Testing: Fastener verification tests shall be conducted in accordance with Section 3.2.1.

3.8.1.2 Load Testing: PAFs used to attach wood sill plates to concrete shall be tested in accordance with Section 4.2.

3.8.1.3 Combined Loading: The applicable combined loading equation shall be determined in accordance with Section 3.2.3.

3.8.1.4 Allowable Loads: Allowable loads shall be determined in accordance with Section 3.2.4.

3.8.1.5 Requirements for Concrete Base Material: The requirements for concrete base materials in Section 3.3 shall apply.

3.8.1.6 Corrosion Resistance: Fasteners used to attach code-complying preservative-treated wood foundation sills to concrete foundations shall comply with IBC Section 2304.10.6 or IRC Section ~~R317.3~~R304.3, as applicable.

3.8.2 ~~Ceiling Clip~~PAF Assemblies ~~(and similar)~~: PAF assemblies ~~consisting of a PAF accessory, such as a ceiling clip used for hanging wire to support ceilings, factory mounted on a PAF,~~ shall be evaluated as follows:

3.8.2.1 Component Verification Testing: Fastener verification tests shall be conducted in accordance with Section 3.2.1. The PAF accessory material yield strength, tensile strength and other properties shall be established through mill certification or testing to determine compliance with the manufacturer's specifications.

3.8.2.2 Load Testing: The PAF assemblies shall be tested in accordance with Section 4.3.

3.8.2.3 Combined Loading: The applicable combined loading equation shall be determined in accordance with Section 3.2.3.

3.8.2.4 Allowable Loads: Allowable loads shall be determined in accordance with Section 3.2.4.

Exception: When the PAFs are installed in steel base material, the allowable strengths and design strengths shall be determined in accordance with Section 3.6.4.

3.8.2.5 Requirements Based on Base Material: The requirements for the applicable base materials in Sections 3.3 through 3.6 shall apply.

3.8.3 PAFs Used to Attach WSP Sheathing to Structural Steel Supports for Use in Horizontal Diaphragms: Horizontal diaphragm systems consisting of WSP sheathing fastened to wood supports with nails shall be designed in accordance with SDPWS Tables 4.2A and 4.2B. Where the WSP sheathing used in these diaphragms must be fastened to steel members at the perimeter of the diaphragm and/or at incidental structural steel, PAFs may be evaluated as direct substitutes for the common nails prescribed in Tables 4.2A and 4.2B of SDPWS for attaching WSP sheathing to wood framing. An engineering analysis shall be submitted to show compliance with the following requirements:

1. The PAF diameter must be equal to or larger than the diameter of the applicable common nail prescribed in

Tables 4.2A and 4.2B of SDPWS, but no more than 0.200 inch (5.08 mm) in diameter.

2. When a PAF diameter greater than 0.148 inch (3.76 mm) is used, the minimum distance to the edge of the WSP sheathing at perimeter fastening must be $^3/_4$ inch (19.1 mm).

3. The allowable tension (pullout) load for the PAF, determined in accordance with Sections 3.8.3.2 through 3.8.3.4, is equal to or greater than the reference withdrawal design value for the comparable nail, in accordance with the NDS.

4. The allowable shear load for the PAF, determined in accordance with Sections 3.8.3.2 through 3.8.3.4, is equal to or greater than the reference lateral design load for the comparable nail, in accordance with the NDS, using the thickest applicable wood structural panel from Table 4.2A or 4.2B of the SDPWS, as applicable.

5. Head size/area requirements in accordance with AC116.

3.8.3.1 Fastener Verification Testing: Fastener verification tests shall be conducted in accordance with Section 3.2.1.

3.8.3.2 Load Testing: The PAFs shall be tested for shear and tension capacity in accordance with Section 4.1.

3.8.3.3 Allowable Loads: Allowable loads shall be determined in accordance with Section 3.6.4.

3.8.3.4 Requirements for Steel Base Material: The requirements for steel base materials in Section 3.6 shall apply, except the minimum thickness for the steel base material shall be $^3/_{16}$ inch (4.8 mm).

3.8.4 Steel-to-steel Connections: Connection capacities for steel materials connected together using PAFs shall be determined in accordance with Section J5 of AISI S100 and this section. Evaluation reports may address nominal and available design values for individual limit states, to be used in the determination of connection capacities in accordance with Section J5 of AISI S100, or for specific connection designs which take into account all of the applicable limit states.

3.8.4.1 Connection Strength - Tension: To determine tensile connection strength in accordance with Section J5.2 of AISI S100, the fastener tension strength, pull-out strength and pull-over strength must be known. These characteristics shall be determined as follows:

3.8.4.1.1 PAF Tensile Strength: The nominal and available fastener tensile strengths shall be determined in accordance with Section J5.2.1 of AISI S100, using the specified minimum hardness.

3.8.4.1.2 Pull-out Strength: Nominal and available pull-out strength shall be determined in accordance with Sections 3.2 and 3.6.

3.8.4.1.3 Pull-over Strength: Nominal pull-over strength shall be determined through testing in accordance with Sections 4.1 and 4.3 of AC118, and the applicable safety factor, Ω, and resistance factor, Φ, shall be determined in accordance with Section K2.1 of AISI S100.

Exception: For PAFs with head styles addressed in Figure J5-1 of AISI S100, nominal and available pull-over strength may be determined by calculation in accordance with Section J5.2.3 of AISI S100.

3.8.4.2 Connection Strength - Shear: To determine shear connection strength in accordance with Section J5.3 of AISI S100, the fastener shear strength, bearing and tilting strength, pull-out strength in shear, net section rupture strength and shear strength limited by edge distance must be known. These characteristics shall be determined as follows:

3.8.4.2.1 PAF Shear Strength: The nominal and available fastener shear strengths shall be determined in accordance with Section J5.3.1 of AISI S100, using the specified minimum hardness.

3.8.4.2.2 Tilting and Bearing Strength: Nominal tilting and bearing strength shall be determined through testing in accordance with Sections 4.1 and 4.3 of AC118, and the applicable safety factor, Ω, and resistance factor, Φ, shall be determined in accordance with Section K2.1 of AISI S100. The base material reduction factor shall be based on the strength of the sheet in contact with the PAF head.

Exception: Nominal and available tilting and bearing strength may be determined by calculation in accordance with Section J5.3.2 of AISI S100, provided the PAFs and sheet steel materials comply with the parameters given in Section J5.3.2.

3.8.4.2.3 Pull-out Strength in Shear: Nominal pull-out strength in shear shall be determined through testing, in accordance with Sections 3.2 and 3.6.

Exception: Nominal and available pull-out strength in shear may be determined by calculation in accordance with Section J5.3.3 of AISI S100, provided the PAFs and sheet steel materials comply with the parameters given in Section J5.3.3 of AISI S100.

3.8.4.2.4 Net Section Rupture Strength and Shear Strength limited by Edge Distance: The evaluation report shall state that these limit states have not been considered in the evaluation and must be addressed in the calculations submitted to the code official.

4.0 TEST METHODS

4.1 Fastener Load Testing Procedures:

4.1.1 Sample Size: The minimum sample quantity for each data category shall comply with Section 8 of ASTM E1190.

4.1.2 Testing Methods: Test programs initiated after the approval date of this criteria shall rely upon ASTM E1190-21. Test apparatus shall comply with Section 5 of ASTM E1190, for tensile (pull-out) and shear loading. Test specimens shall comply with Section 7 of ASTM E1190. Test procedures shall comply with Section 9 of ASTM E1190. When testing in accordance with ASTM E1190-21, the loading rate requirements shall be modified by Section 4.1.3. Ultimate load, loading rate, duration of test and failure mode shall be recorded for each test. Each installation failure shall be documented, as well as each installation determined to be "out of spec" in accordance with Section 8.2 of ASTM E1190-21, as applicable.

4.1.3 Loading Rate (Modification of ASTM E1190-21): The loading rate shall be the expected average ultimate load for the test sample divided by 45 seconds. For

the duration of each test, the loading rate shall not increase by more than 10 pounds-force per second.

4.2 Sill Attachment Test Procedure: PAFs shall be tested in accordance with Section 4.1 and the following:

Fasteners shall be placed into the concrete test member through the center of a nominal 2-inch-thick (51 mm) wood member with a specific gravity of 0.5 or greater, which shall be removed prior to testing. The concrete compressive strength shall be within 400 psi (2.8 MPa) of the report holder's prescribed installation strength when the fastener is installed and tested. Any concrete spalling or cracking after installation shall be reported.

For PAFs used to attach sill plates for exterior shear walls, interior shear walls, and interior non-shear walls, the fastener shall be installed with a $1^3/_4$-inch (44.5 mm) edge distance. The shear load shall be applied towards the closest test member edge.

For PAFs used to attach sill plates to slab foundations, away from the edges, the fastener shall be installed with an edge distance equal to or greater than the minimum edge distance, *c*, specified in Table 1 of ASTM E1190.

4.3 ~~Ceiling Clip~~PAF Assemblies ~~(and similar)~~:

4.3.1 Installation: Assemblies shall be installed into test members as a complete unit.

4.3.2 Testing: Testing shall be in accordance with Section 4.1 and the following: Assemblies shall be tested by loading the assembly in the same manner as the loading when assemblies are installed in field conditions, i.e., load attached to the hole where the wire would attach or directly to the wire when pre-mounted on the fastener.

5.0 QUALITY CONTROL

5.1 Quality documentation complying with the ICC-ES Acceptance Criteria for Quality Documentation (AC10) shall be submitted for each facility manufacturing or labeling products that are addressed in the ICC-ES evaluation report. The quality documentation shall include technical drawings for each fastener and the specifications required by Section 2.1. The quality control program shall verify component compliance with specifications described in Section 2.1.

5.2 A qualifying inspection shall be conducted at each manufacturing facility in accordance with the requirements of the ICC-ES Acceptance Criteria for Inspections and Inspection Agencies (AC304).

5.3 An annual inspection shall be conducted at each manufacturing facility in accordance with AC304.

6.0 EVALUATION REPORT REQUIREMENTS

6.1 For PAFs Intended for General Use: The evaluation report shall address the following:

6.1.1 Basic PAF information required by Section 2.1, including product description, installation procedures, packaging and identification.

6.1.2 Allowable tension and shear loads for each PAF.

6.1.3 At the report holder's option, a combined loading equation or allowable oblique loads for a specific angle to the fastener axis.

6.1.4 The allowable seismic tension and shear loads derived in accordance with Annex A, as applicable.

6.1.5 The evaluation report shall include the applicable situations described in Section 1.2.1 where the PAFs can be used for seismic load resistance.

6.1.6 Size and strength requirements for the base materials shall be reported, based on the materials used in the qualification testing, as follows:

6.1.6.1 For concrete: the type (normalweight or lightweight), the specified compressive strength and the minimum thickness (three times the embedment depth, unless lesser thickness is addressed in the testing).

6.1.6.2 For hollow core precast concrete slabs: the specified compressive strength of the concrete and a figure showing the cross section of the hollow core precast concrete slab used in the qualification testing, showing the geometry of the cores, the critical dimensions such as minimum thickness of concrete, the location of the prestressing strands and the intended location of the installed fasteners.

6.1.6.3 For concrete-filled steel deck panels: the concrete type, specified compressive strength and thickness above the deck; and the applicable deck configuration, minimum thickness and minimum steel specifications including minimum specified tensile strength, based on the steel specifications for the deck panels used in the testing.

6.1.6.4 For steel: the specified minimum base metal thickness, minimum yield strength and minimum tensile strength.

6.1.6.5 For individual CMUs: the density of the CMUs (normal weight, medium weight, or lightweight) and the specified compressive strength, if greater than the minimum required by ASTM C90.

6.1.6.6 For concrete masonry wall assemblies: the density and specified compressive strength of the CMUs; the mortar type; and the grout type and specified compressive strength if greater than the minimum required by ASTM C476. If compressive strength of masonry, f'_m, was used in the evaluation, this characteristic shall be addressed in the evaluation report.

6.1.7 The evaluated spacing, edge distance and other installation parameters for the PAFs. The spacing and edge distance shall be based on the dimensions used in the testing.

6.1.8 When the PAFs are intended to be driven through steel plates which are embedded in concrete, the evaluation report shall explicitly address this condition, including applicable spacing and edge distances.

6.1.9 The following statements and conditions of use:

6.1.9.1 Allowable loads in the evaluation report apply to the connection of the fastener to the base material only, unless otherwise noted.

6.1.9.2 Design of the connection of attached material to the base material~~, taking~~ must take into account the properties of the attached material and the need for redundancy, and must comply with the applicable requirements of the IBC.

6.1.9.3 Installation of the PAFs shall be limited to dry, interior conditions, which include exterior walls which are protected by an exterior wall envelope, unless compliance with IBC Section 2304.10.6.3 is demonstrated.

6.1.9.4 When the situation described in Section 1.2.1, Item 7, is applicable, the evaluation report shall include the following statement, modified for applicability: For interior, nonstructural walls that are not subject to sustained tension loads and are not a bracing application, the PAFs may be used to attach steel track to concrete or steel in all Seismic Design Categories. In Seismic Design Categories D, E, and F, the allowable shear load due to transverse pressure shall be no more than 90 pounds (400 N) when attaching to concrete; or 250 pounds (1,112N) when attaching to steel. Substantiating calculations shall be submitted addressing the fastener-to-base-material capacity and the fastener-to-attached-material capacity. Interior nonstructural walls are limited to locations where bearing walls, shear walls or braced walls are not required by the approved plans. The design load on the fastener must not exceed the allowable load established for the concrete or steel base material.

6.1.9.5 For PAFs installed in hollow core precast concrete slabs, the evaluation report shall include a condition of use indicating that: (a) the scope of the evaluation is limited to the holding capacity of the fasteners in the precast concrete slabs; (b) evaluation of the effect of the fastener installations on the integrity of the precast concrete slab is outside the scope of the report; and (c) that this effect must be considered by the registered design professional in responsible charge.

6.1.9.6 For PAFs intended to attach wood side members to qualified base materials, the evaluation report shall indicate that for the purpose of determining the reference lateral design value for the wood, the bending yield strength of the PAF shall be assumed to be the same as that of a nail of the same shank diameter.

6.1.9.7 For installation in concrete or concrete masonry, a statement that use is limited to uncracked concrete or masonry. Cracking occurs when $f_t > f_r$ due to service loads or deformations.

6.1.9.8 The PAFs are intended for use in redundant applications. (The definition for redundant applications in Section 1.4.10 shall be included in the evaluation report.)

6.2 For PAFs Used to Attach Wood Sill Plates to Concrete: The evaluation report shall address the requirements of Sections 6.1.1, 6.1.2, 6.1.6.1, 6.1.7, and the bearing area and thickness of washers, to allow for calculation of pull through capacity. For PAFs intended to be used in interior, nonstructural wall applications, the evaluation report shall address the maximum pressure on the wall [5 psf (0.24 kN/m^2)], maximum fastener spacing and maximum wall height in accordance with Table 2, and shall include the required footnotes to Table 2.

6.3 For PAFs Used to Attach WSP to Structural Steel Supports for Use in Horizontal Diaphragms:

6.3.1 The evaluation report shall address Sections 6.1.1, 6.1.2, 6.1.5, 6.1.6.4, 6.1.7.

6.3.2 The evaluation report shall include the following statements, as applicable: Horizontal diaphragm systems consisting of WSP sheathing fastened to wood supports with nails shall be designed in accordance with SDPWS Tables 4.2A and 4.2B. Where the WSP sheathing used in these diaphragms must be fastened to steel members at the perimeter of the diaphragm and/or at incidental structural steel members, the <applicable PAFs> may be substituted for the <applicable size> or smaller common nails prescribed in SDPWS.

The evaluation report shall also indicate that when the diameter of PAFs used at the perimeter of the diaphragm is greater than 0.148 inch (3.76 mm), the minimum distance required from the center of the PAF to the edge of the WSP is $^3/_4$ inch (19.1 mm). Otherwise, the minimum distance required from the center of the PAF to the edge of the WSP shall be in accordance with SDPWS.

6.3.3 Evaluation reports shall reference IBC Sections 2305.1 and 2306.2, and SDPWS Tables 4.2A and 4.2B, as applicable.

6.4 ~~For Ceiling Clip~~PAF Assemblies ~~(and similar)~~:

6.4.1 The evaluation report shall address the requirements of Sections 6.1.1 through 6.1.8.

6.4.2 The report shall include a description of the PAF accessory material and dimensions, including the dimensions of holes or threaded portions intended to receive connecting wire, rod, etc.

6.4.3 When PAF accessories are supplied separately from the PAF, the specific PAF length used in testing of the PAF assembly shall be reported.

6.4.4 The evaluation report shall include the following statements and conditions of use:

6.4.4.1 Allowable loads in the evaluation report apply to the connection of the PAF accessory to the PAF and to the connection of the PAF to the base material only.

6.4.4.2 Design of the connection of attached material to the PAF accessory, taking into account the properties of the attached material, must comply with the applicable requirements of the IBC.

6.4.4.3 For assemblies installed in hollow core precast concrete slabs see Section 6.1.9.5.

6.5 For Steel-to-steel Connections:

6.5.1 The evaluation report shall address the requirements of Sections 6.1.1, 6.1.4, 6.1.5 and 6.1.7

6.5.2 The evaluation report shall include the allowable strengths and design strengths for specific connection configurations and/or for individual limit states. When individual limit states are reported, the evaluation report shall indicate that connection strength must be determined in accordance with Section J5 of AISI S100.

6.5.3 The evaluation report shall include the specified minimum base metal thickness and minimum tensile strength for the two steel sheets (the one in contact with the PAF head and the one not in contact with the PAF head).

6.5.4 The evaluation report shall include the following statements and conditions of use:

6.5.4.1 Allowable loads in the evaluation report apply to the connection of two pieces of steel in direct contact with one another.

6.5.4.2 Installation of the PAFs shall be limited to dry, interior conditions, which include exterior walls which are protected by an exterior wall envelope.■

TABLE 1—CONCRETE AND MASONRY TEST MEMBER STRENGTH TEST TIME LIMITATIONS

AGE OF CONCRETE AT BEGINNING OF FASTENER TEST	MAXIMUM TIME BETWEEN TEST MEMBER STRENGTH TESTS (TEST PERIOD)	COMMENTS
Less than 21 days	3 days	None
21 – 35 days	7 days	None
36 – 56 days	14 days	None
57 – 90 days	30 days	None
More than 90 days	—	See Section 3.2.2.3.2 or 3.7.2.2.4.2, as applicable

TABLE 2—LOAD AND SPACING REQUIREMENTS FOR WOOD SILL PLATE ANCHORAGE OF INTERIOR NONSTRUCTURAL WALLS[2,3]

NOMINAL FASTENER SHANK DIAMETER (inch)[1]	MINIMUM FASTENER LENGTH (inches)	MINIMUM LOAD REQUIREMENTS FOR SILL PLATE ANCHORAGE (lbs)		FASTENER SPACING (ft.)	MAXIMUM WALL HEIGHT (ft.)
		Allowable Shear Load	Allowable Tensile Load		
0.136 – 0.142	$2^{7}/_{16}$	100	100	2	14
0.143 – 0.155	$2^{3}/_{4}$	150	125	3	14
0.156 – 0.187	3	200	150	4	14
0.188 and greater	3	300	250	4	14

For **SI:** 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 plf = 74.6 N/m, 1 psi = 6.89 kPa.

[1]For step shank fasteners, the smallest diameter of the fastener is considered the shank diameter for purposes of this table.
[2]Spacings are based on attachment through the center of 2-inch nominal thickness wood, with specific gravity of 0.5 or greater, to concrete floor slabs or footings in accordance with Section ~~2308.3.1~~2308.7.1 of the IBC or Section R403.1.6 of the IRC. For species combinations with specific gravities less than 0.5, the required spacings of fasteners shall be computed based on the tributary wall height and the lesser of either the tabulated allowable load or the reference lateral design value taken from the NDS.
[3]Larger category shank diameter may meet minimum load requirements of a smaller category shank diameter provided spacing requirements are also applied.

The following footnotes shall be added to the table in the evaluation report: (continued on next page)
[1]Fasteners shall not be driven until the concrete has reached a minimum concrete compressive strength of 2,500 psi.
[2]Interior nonstructural walls are limited to locations where bearing walls, shear walls or braced walls are not required by the approved plans.
[3]All fasteners shall be installed with a either a preinstalled washer or a minimum $^{3}/_{4}$-inch-diameter, No. 16 gage (0.0598-inch) washer.
[4]Fasteners shall be driven into the center of the sill plate and be at least 1¾ inch from the concrete edge.
[5]Walls shall have fasteners placed at 6 inches from ends of sill plates with maximum spacing between, as shown in this table.

[6]Walls shall be laterally supported at the top and the bottom.
[7]Sill or bottom plates shall comply with IBC Section 2304 and be of lumber with a specific gravity of ___ or greater.
[8]Minimum spacings shall be___ inches on center (per the report holder) or shall comply with Section 12.1.6 of the NDS to prevent splitting of the wood.
[9]Fasteners in contact with treated wood shall have protective coatings complying with IBC Section 2304.10.6 or IRC Section ~~R317.3~~R304.3.
[10]The maximum horizontal transverse load on the wall, in accordance with IBC Section 1607.16, shall be 5 psf (0.24 kN/m^2).

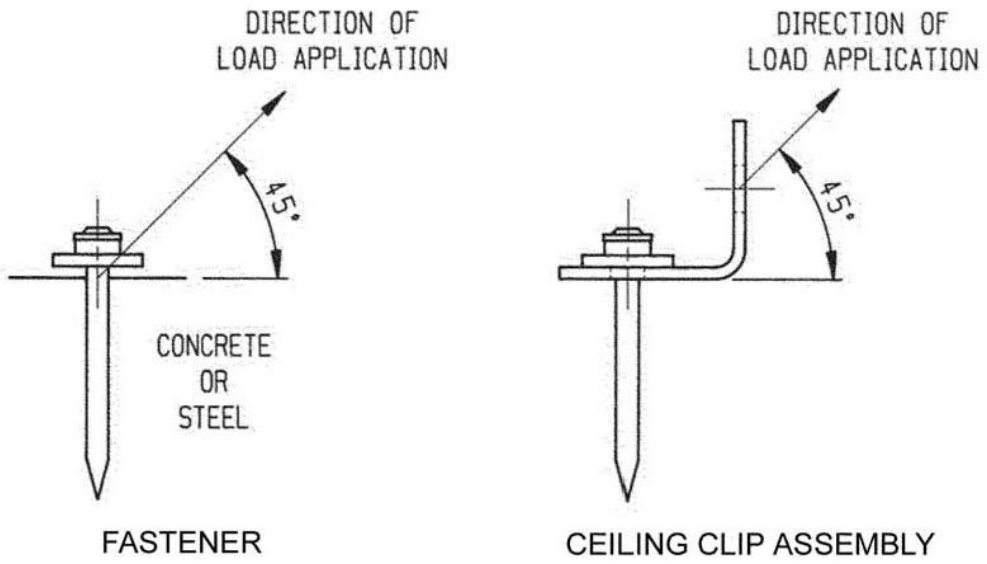

FIGURE 1—<u>45° LOADING FOR</u> FASTENER<u>S</u> AND CEILING CLIP ASSEMBL~~Y~~<u>IES</u>
<u>(Similar for other PAF assemblies)</u>

Annex A
Determining Allowable Seismic Loads for Power-actuated Fasteners Installed into Steel Base Materials

A1.0 General: Allowable seismic loads for power-actuated fasteners (PAFs) installed into specific steel base-material thicknesses and grades shall be substantiated by the simulated seismic tests and related analysis procedures described in Sections A3 and A4.

The tests shall be conducted in each steel base-material thickness and grade for which the fasteners are intended. In lieu of testing in each thickness, the fasteners are permitted to be qualified for a range of thicknesses, provided testing is conducted in the minimum and maximum steel base-material thicknesses, as well as in an intermediate steel base-material thickness, and seismic reliability is consistent in each case.

A2.0 Notation: In addition to notation in Section 1.5 of this criteria, the following notation shall apply to Annex A.

COV_{res} = Coefficient of variation for residual static load tests, percent

$N_{a(seismic)}$ = Allowable seismic tension load to be reported in the evaluation report, lbf (N)

N_{eq} = Maximum tension load to be applied in the simulated seismic tension test in accordance with Figure A1, lbf (N),

N_i = Intermediate tension load to be applied in the simulated seismic tension test in accordance with Figure A1, lbf (N),

N_m = Minimum tension load to be applied in the simulated seismic tension test in accordance with Figure A1, lbf (N),

N_{ref} = Reference tension load for simulated seismic tension test, lbf (N),

N_{res} = Average of the residual static tension loads for the fastener after simulated seismic tension test, lbf (N).

R_e = Earthquake loading reduction factor

$V_{a(seismic)}$ = Allowable seismic shear load to be reported in the evaluation report, lbf (N)

V_{eq} = Maximum shear load to be applied in the simulated seismic shear test in accordance with Figure A2, lbf (N),

V_i = Intermediate shear load to be applied in the simulated seismic shear test in accordance with Figure A2, lbf (N),

V_m = Minimum shear load to be applied in the simulated seismic shear test in accordance with Figure A2, lbf (N),

V_{ref} = Reference shear load for simulated seismic shear test, lbf (N),

V_{res} = Average of the residual static shear loads for fastener after simulated seismic shear test, lbf (N).

Ω_{res} = Safety factor corresponding to residual static load tests.

A3.0 Procedure for Qualifying Allowable Seismic Tension Values:

A3.1 N_{ref} Establishment: The initial N_{ref} shall be equal to $5P_a/R$, where P_a is the allowable tension load previously determined from reference static tests in accordance with Sections 3.2 and 3.6. R shall be determined in accordance with Section 3.6.5, where $F_{u,test}$ is the actual tensile strength of the steel member used in the seismic qualification tests and F_u is the specified tensile strength of the steel test member.

A3.2 Simulated Seismic Tension Testing Procedure: Simulated seismic tension testing shall be conducted in accordance with Sections 3.2 and 3.6, and the following:

A3.2.1 The minimum sample size for tests of each fastener is 10.

A3.2.2 The steel test member's specified tensile strength, F_u, and thickness shall be the same values as used in the reference static tests.

A3.2.3 The tests shall be conducted using a force-controlled data acquisition system.

A3.2.4 The fasteners shall be cyclically tested in accordance with Figure A1 at a loading frequency of 0.1 to 2.0 Hertz. The load levels shown in Figure A1 are defined as follows:

$$N_{eq} = 0.5\ N_{ref}$$
$$N_i = 0.375\ N_{ref}$$
$$N_m = 0.25\ N_{ref}$$

A3.2.5 If the tested fasteners withstand the simulated seismic tension test without failure, then residual static tension tests shall be conducted in accordance with Sections 3.2 and 3.6 to determine N_{res}. If one or more of the tested fasteners fail during the simulated seismic test, N_{ref} and the corresponding N_{eq}, N_i and $N_{m,}$ values shall be reduced and the simulated seismic tension test shall be repeated until no test fastener fails during simulated seismic tests.

A3.3 Analysis of Test Results:

A3.3.1 COV_{res} ≤ 15 Percent: If the COV_{res} associated with N_{res} is less than or equal to 15 percent, then N_{res} shall be compared to N_{ref}. If $N_{res} \geq 0.8N_{ref}$, then seismic reliability has been fully verified and $N_{a(seismic)}$ shall be calculated as follows:

$$N_{a(seismic)} = (R)N_{ref}/5 \leq P_a \quad \text{(Eq. A1)}$$

If $N_{res} < 0.8N_{ref}$, then $N_{a(seismic)}$ shall be calculated as follows:

$$N_{a(seismic)} = (R_e)(R)N_{ref}/5 \quad \text{(Eq. A2)}$$

where:

$$R_e = \frac{N_{res}}{0.8N_{ref}} \leq 1 \quad \text{(Eq. A3)}$$

A3.3.2 COV_{res} > 15 Percent: If the COV_{res} associated with N_{res} is greater than 15 percent, Ω_{res} shall be computed in accordance with Equation (3-2) using COV_{res}. N_{res} shall be compared to $(\Omega_{res}/5)*0.8N_{ref}$, where $\Omega_{res}/5 \geq 1.0$. If $N_{res} \geq (\Omega_{res}/5)*0.8N_{ref}$, then seismic reliability has been fully verified and $N_{a(seismic)}$ shall be calculated as follows:

$$N_{a(seismic)} = (R)N_{ref}/\Omega_{res} \leq P_a \quad \text{(Eq. A4)}$$

If $N_{res} < (\Omega_{res}/5)*0.8N_{ref}$, then $N_{a(seismic)}$ shall be calculated as follows:

$$N_{a(seismic)} = (R_e)(R)N_{ref}/\Omega_{res} \quad \text{(Eq. A5)}$$

where R_e is calculated in accordance with Eq. A3

A4.0 Procedure for Qualifying Allowable Seismic Shear Values:

A4.1 Establish V_{ref}: The initial V_{ref} shall be equal to $5V_a/R$, where V_a is the allowable shear load previously determined from reference static tests in accordance with Sections 3.2 and 3.6. R shall be determined in accordance with Section 3.6.5, where $F_{u,test}$ is the actual tensile strength of the steel member used in the seismic qualification tests and F_u is the specified tensile strength of the steel test member.

A4.2 Simulated Seismic Shear Testing Procedure: Simulated seismic shear testing shall be conducted in accordance with Sections 3.2 and 3.6, and the following:

A4.2.1 The minimum sample size for tests of each fastener is 10.

A4.2.2 The steel test member's specified tensile strength, F_u, and thickness shall be the same values as used in the reference static tests.

A4.2.3 The tests shall be conducted using a force-controlled data acquisition system.

A4.2.4 The fasteners shall be cyclically tested in accordance with Figure A2 at a loading frequency of 0.1 to 2 Hertz. To reduce the potential for uncontrolled slip during load reversal, the alternating shear loading shall be permitted to be approximated by the application of two half-sinusoidal load cycles at the desired frequency connected by a reduced speed ramped load, as shown in Figure A3. The load levels shown in Figure A2 are defined as follows:

$V_{eq} = 0.5\ V_{ref}$
$V_i = 0.375\ V_{ref}$
$V_m = 0.25\ V_{ref}$

A4.2.5 If the tested fasteners withstand the simulated seismic shear test without failure, then residual static shear tests shall be conducted in accordance with Section 4.1.6 to determine V_{res}. If one or more of the tested fasteners fail during the simulated seismic test, V_{ref} and the corresponding V_{eq}, V_i and $V_{m,}$ values shall be reduced and the simulated seismic shear test shall be repeated until no test fastener failures occur during simulated seismic tests.

A4.3 Analysis of Test Results:

A4.3.1 COV_{res} ≤ 15 Percent: If the COV_{res} associated with V_{res} is less than or equal to 15 percent, then V_{res} shall be compared to V_{ref}. If $V_{res} \geq 0.8V_{ref}$, then seismic reliability has been fully verified and $V_{a(seismic)}$ shall be calculated as follows:

$$V_{a(seismic)} = (R)V_{ref}/5 \leq V_a \quad \text{(Eq. A6)}$$

If $V_{res} < 0.8V_{ref}$, then $V_{a(seismic)}$ shall be calculated as follows:

$$V_{a(seismic)} = (R_e)(R)V_{ref}/5 \quad \text{(Eq. A7)}$$

where:

$$R_e = \frac{V_{res}}{0.8V_{ref}} \leq 1 \quad \text{(Eq. A8)}$$

A4.3.2 COV_{res} > 15 Percent: If the COV_{res} associated with V_{res} is greater than 15 percent, Ω_{res} shall be computed in accordance with Equation (3-2) using COV_{res}. V_{res} shall be compared to $(\Omega_{res}/5)*0.8V_{ref}$, where $\Omega_{res}/5 \geq 1.0$. If $V_{res} \geq (\Omega_{res}/5)*0.8V_{ref}$, then seismic reliability has been fully verified and $V_{a(seismic)}$ shall be calculated as follows:

$$V_{a(seismic)} = (R)V_{ref}/\Omega_{res} \quad \text{(Eq. A9)}$$

If $V_{res} < (\Omega_{res}/5)*0.8V_{ref}$, then $V_{a(seismic)}$ shall be calculated as follows:

$$V_{a(seismic)} = (R_e)(R)V_{ref}/\Omega_{res} \quad \text{(Eq. A10)}$$

where R_e is calculated in accordance with Eq. A8

TABLE A1—REQUIRED HISTORY FOR SEISMIC TENSION LOAD

Load Level	Number of Cycles
N_{eq}	10
N_i	30
N_m	100

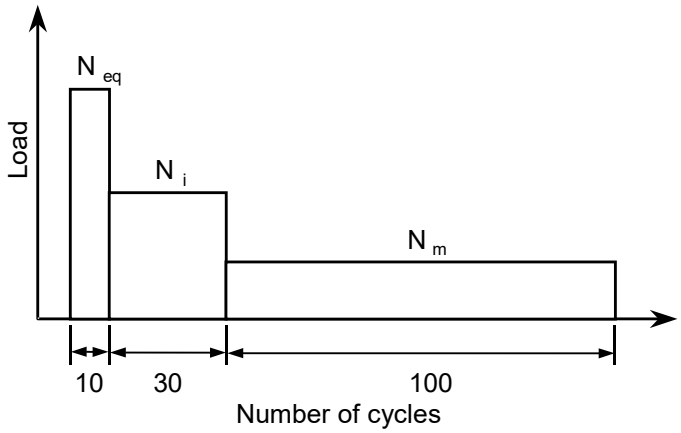

FIGURE A1—LOADING PATTERN FOR SIMULATED SEISMIC TENSION TEST

TABLE A2—REQUIRED HISTORY FOR SEISMIC SHEAR LOAD

Load Level	Number of Cycles
$\pm V_{eq}$	10
$\pm V_i$	30
$\pm V_m$	100

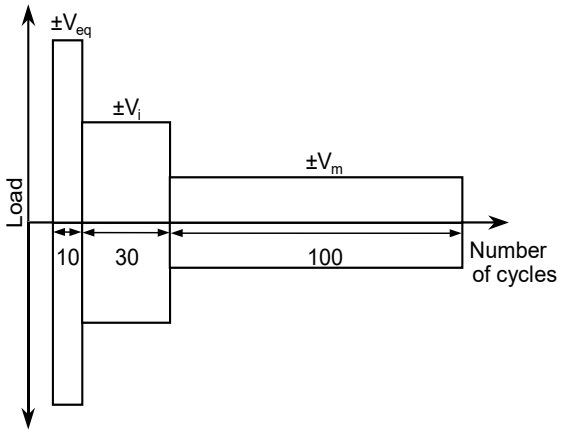

FIGURE A2—LOADING PATTERN FOR SIMULATED SEISMIC SHEAR TEST

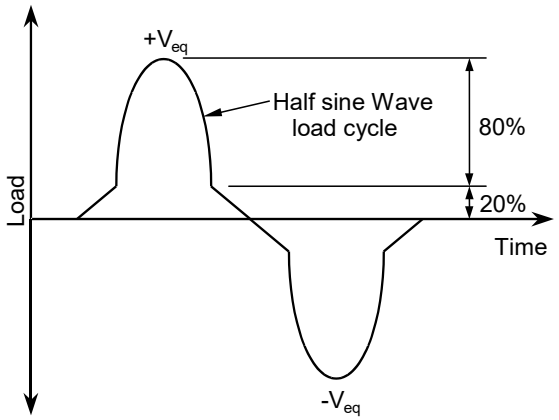

FIGURE A3—ALTERNATIVE LOADING PATTERN FOR SIMULATED SEISMIC SHEAR TEST