STATE OF WASHINGTON

STATE BUILDING CODE COUNCIL

1. State Building Code to be Amended:

- ☒ International Building Code
- ☐ ICC ANSI A117.1 Accessibility Code
- ☐ International Existing Building Code
- ☐ International Residential Code
- ☐ International Fire Code
- ☐ Uniform Plumbing Code
- ☐ State Energy Code
- ☐ International Mechanical Code
- ☐ International Fuel Gas Code
- ☐ NFPA 54 National Fuel Gas Code
- ☐ NFPA 58 Liquefied Petroleum Gas Code
- ☐ Wildland Urban Interface Code

Section(s):
New subsections for Section 1613.5 of the 2015 IBC are proposed as an emergency rule.

Title:
System Specific Requirements for Increased Structural Height Limit

2. Proponent Name (Specific local government, organization or individual):

Proponents: Lee Kranz representing the Washington Association of Building Officials Technical Code Development Committee, City of Bellevue, City of Tacoma, Ron Hamburger SE and Steve Pfeiffer SE.

Date: February 26, 2018

3. Designated Contact Person:

Name:	**Lee Kranz**
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4. Proposed Code Amendment. Reproduce the section to be amended by underlining all added language, striking through all deleted language. Insert new sections in the appropriate place in the code in order to continue the established numbering system of the code. If more than one section is proposed for amendment or more than one page is needed for reproducing the affected section of the code additional pages may be attached. (Examples on the SBCC website)

Code 2015 IBC **Sections** 1613.5, 1613.5.2, 1613.5.3 and 1613.5.4

Note: The yellow highlighted text below is not currently in ASCE 7 but is proposed to be included as part of this code change for IBC Section 1613.5. All text for this proposal is underlined as it is new to the IBC.

Amend section to read as follows:

1613.5 Amendments to ASCE 7. The provisions of Section 1613.5 shall be permitted as an amendment to the relevant provisions of ASCE 7. The text of ASCE 7 shall be amended as indicated in Sections 1613.5.2 through 1613.5.4.

1613.5.2 ASCE 7 Section 12.2.5.4. Amend ASCE 7 Section 12.2.5.4 to read as follows:

12.2.5.4 Increased Structural Height Limit for Steel Eccentrically Braced Frames, Steel Special Concentrically Braced Frames, Steel Buckling-Restrained Braced Frames, Steel Special Plate Shear Walls, and Special Reinforced Concrete Shear Walls.

The limits on height, h_n, in Table 12.2-1 are permitted to be increased from 160 ft (50 m) to 240 ft (75 m) for structures assigned to Seismic Design Categories D or E and from 100 ft (30 m) to 160 ft (50 m) for structures assigned to Seismic Design Category F, if all of the following are satisfied:

1. The structure shall not have an extreme torsional irregularity as defined in Table 12.3-1 (horizontal structural irregularity Type 1b).
2. The steel eccentrically braced frames, steel special concentrically braced frames, steel buckling-restrained braced frames, steel special plate shear walls or special reinforced concrete shear walls in any one plane shall resist no more than 60 percent of the total seismic forces in each direction, neglecting accidental torsional effects.
3. Where floor and roof diaphragms transfer forces from the vertical seismic force-resisting elements above the diaphragm to other vertical force-resisting elements below the diaphragm, these in-plane transfer forces shall be amplified by the over-strength factor, Ω_o for the design of the diaphragm flexure, shear, and collectors.
4. The earthquake force demands in foundation mat slabs, grade beams, and pile caps supporting braced frames and/or walls arranged to form a shear-resisting core shall be amplified by 2 for shear and 1.5 for flexure.
5. The earthquake shear force demands in special reinforced concrete shear walls shall be amplified by the over-strength factor, Ω_o.

1613.5.3 ASCE 7 Section 12.6. Amend ASCE 7 Section 12.6 and Table 12.6-1 to read as follows:

12.6 ANALYSIS PROCEDURE SELECTION

12.6.1 Analysis Procedure

The structural analysis required by Chapter 12 shall consist of one of the types permitted in Table 12.6-1, based on the structure's seismic design category, structural system, dynamic properties, and regularity, or with the approval of the authority having jurisdiction, an alternative generally accepted procedure is permitted to be used. The analysis procedure selected shall be completed in accordance with the requirements of the corresponding section referenced in Table 12.6-1.

Table 12.6-1 Permitted Analytical Procedures

Seismic Design Category	Structural Characteristics	Equivalent Lateral Force Procedure, Section 12.8[a]	Modal Response Spectrum Analysis, Section 12.9[a]	Linear Seismic Response History Procedures, Chapter 16[a]	Nonlinear Seismic Response History Procedures, Chapter 16[b]
B, C	All structures	P	P	P	P
D, E, F	Risk Category I or II buildings not exceeding two stories above the base	P	P	P	P
	Structures of light frame construction	P	P	P	P
	Structures with no structural irregularities and not exceeding 160 ft in structural height	P	P	P	P
	Structures exceeding 160 ft in structural height with no structural irregularities and with $T < 3.5T_s$	P	P	P	P
	Structures not exceeding 160 ft in structural height and having only horizontal irregularities of Type 2, 3, 4, or 5 in Table 12.3-1 or vertical irregularities of Type 4, 5a, or 5b in Table 12.3-2	P	P	P	P
	All other structures ≤ 240 ft in height	NP	P	P	P
	All structures > 240 ft in height	NP	NP	NP	P[c]

[a] P: Permitted; NP: Not Permitted; $T_s = S_{D1}/S_{DS}$.

[b] When nonlinear response history procedure is used, one of the linear procedures shall also be performed.

[c] Refer to Section 12.6.2 for additional requirements.

1613.5.4 ASCE 7 Section 12.6. Amend ASCE 7 Section 12.6 by adding a new Section 12.6.2 as follows:

12.6.2 Nonlinear Response History Procedure for Buildings in Excess of 240 ft (75m) in Height. In addition to any of the linear analysis procedures in Table 12.6-1, a nonlinear dynamic analysis in accordance with ASCE 7 Chapter 16 shall be performed, except that analysis shall be conducted for MCE_R ground motions. Acceptance criteria shall be compatible with providing not greater than a 10 percent, 5 percent or 2-1/2 percent risk of collapse for Risk Category II, III and IV structures, respectively. In addition, proportioning of the seismic force-resisting system shall incorporate a capacity-based approach that identifies the mechanism of nonlinear lateral displacement of the structure, those structural actions expected to yield, and those intended to remain elastic. Design shall be subject to an approved independent structural design review.

Reason statement: The Seattle Building Code has been revised to include amended Section 12.2.5.4, Table 12.6-1 and Section 12.6.2 of ASCE 7-10. Items 3, 4, & 5 of section 12.2.5.4 were added because experience with the structural design and performance evaluation of mid-rise and high-rise structures has shown that to achieve the intended seismic performance, the following design measures are appropriate:

- Floor diaphragms designed for amplified transfer forces, for example at ground level floor structures that act as a backstay to building overturning.
- Mat slab and pile cap foundations designed for amplified forces in flexure and shear.
- Reinforced concrete wall seismic force-resisting systems designed for amplified in-plane wall shear forces.

Sections 1613.5.3 & 1613.5.4 proposed for the 2015 IBC modifies the ASCE 7-10 Standard to require nonlinear response-history analysis (NLRHA), capacity design, and design review (peer review) for any structure in Seismic Design Category D, E, or F taller than 240 feet, including those designed prescriptively. Experience with performance-based tall building designs has raised questions about the expected seismic performance of prescriptively designed tall structures. Specifically, the code-prescriptive design process for tall buildings, applicable to moment-frame and dual-system structures, may not provide intended seismic performance related to issues such as potential story concentrations of lateral displacement, column axial forces, or wall shear demands. Accordingly, these amendments to the Washington State Building Code will require structures taller than 240 feet to use a performance-based seismic design and peer review process. Many buildings exceeding 240' in height built in Seattle and Bellevue since 2002 have used NLRHA, capacity-design, and seismic peer review for "performance-based" designs. This shows the desire on the part of engineers and developers to use this approach rather than the prescriptive design process. Note that when nonlinear analysis is performed, a linear analysis in accordance with the requirements of ASCE 7, Chapter 12 is also required. This requirement has been added because linear analysis is required in the new provisions of ASCE 7-16 Chapter 16 for designs incorporating nonlinear response history analysis.

If approved, this proposal will create consistency and a level playing field with Seattle's code for all buildings of this height throughout Washington State.

5. **Briefly explain your proposed amendment, including the purpose, benefits and problems addressed.** Specifically note any impacts or benefits to business, and specify construction types, industries and services that would be affected. Finally, please note any potential impact on enforcement such as special reporting requirements or additional inspections required.

6. **Specify what criteria this proposal meets.** You may select more than one.
   ☒ The amendment is needed to address a critical life/safety need.

☐ The amendment is needed to address a specific state policy or statute.
☐ The amendment is needed for consistency with state or federal regulations.
☐ The amendment is needed to address a unique character of the state.
☐ The amendment corrects errors and omissions.

7. Is there an economic impact: ☒ Yes ☐ No

Explain:

If there is an economic impact, use the Table below to estimate the costs and savings of the proposal on construction practices, users and/or the public, the enforcement community, and operation and maintenance. If preferred, you may submit an alternate cost benefit analysis.

	Construction[1]		Enforcement[2]		Operations & Maintenance[3]	
Building Type	Costs	Benefits[4]	Costs	Benefits[4]	Costs	Benefits[4]
Residential						
Single family						
Multi-family						
Commercial/Retail	See below	See below	No change	No change	No change	No change
Industrial						
Institutional						

Please send your completed proposal to: sbcc@ga.wa.gov

All questions must be answered to be considered complete. Incomplete proposals will not be accepted.

Economic impact statement: The cost of construction will be higher as a result of this code change because additional reinforcement of the lateral force-resisting system will be required to meet the higher design force demands. The anticipated benefits will be realized in post-earthquake functionality of buildings designed and constructed under these provisions.

[1] $ / square foot of floor area or other cost. Attach data. **Construction** costs are costs prior to occupancy, and include both design and direct construction costs that impact the total cost of the construction to the owner/consumer.

[2] Cost per project plan. Attach data. **Enforcement** costs include governmental review of plans, field inspection, and other action required for enforcement.

[3] Cost to building owner/tenants over the life of the project.

[4] Measurable benefit.