WABO/SEAW Liaison Committee Washington Association of Building Officials and Structural Engineers Association of Washington	**WHITE PAPER 7-2022**

Seismic Design and Gravity Support Requirements for Nonstructural Components	**Issue Date:** March 2022 **Dated:** February 16, 2012
Abstract: This white paper establishes recommendations and guidelines for building officials, design professionals, contractors and building owners relating to seismic anchorage and support of "nonstructural (NS) components" regulated by Chapter 16 of the IBC and Chapter 13 of ASCE 7. Commentary related to practical consideration of the application of code requirements is provided in Section III. References to additional design guidelines, code citations and in-depth engineering for NS components are in Section IV of this report. Code and Standard Reference: • 2018 IBC • ASCE 7-16	**Committee Members:** *Matt Snook (SEAW Co-chair), Lee Kranz (WABO Co-Chair), Shalini Prochazka (SEAW), Nancy Devine (WABO), Larry Lindell (SEAW), Rick Fine (SEAW), Mary Kate McGee (WABO), Nathalie Boeholt (WABO), Chris Ricketts (WABO), Steve Belzak (WABO), Charlie Griffes (SEAW), Julius Carreon (WABO), Hoyt Jeter (WABO).*

Committee Mission Statement:

- *Improve communications between the public jurisdictions that administer building codes and the engineering design community that prepares construction documents.*
- *Improve consistency and quality of engineering submittals and project reviews.*
- *Build consensus between the engineering design community and building officials with regard to code interpretation and submittal requirements.*

I. Introduction

The requirements of IBC Section 1613 and ASCE 7 Chapter 13 are applicable to seismic design requirements for nonstructural (NS) components permanently attached to the interior or exterior of a building or located such that structural failure could compromise public safety. NS components include items such as prefabricated or factory-assembled components or equipment brought to the jobsite that is typically installed in one piece, including rooftop and suspended HVAC equipment, water heaters, boilers, electrical transformers and generators, light fixtures, etc. Also included are site-assembled NS components, such as Type 1 hoods, ductwork, piping, access floors, stairs, storage racks, suspended ceilings, elevators, exterior veneer, cladding and

exterior curtain walls. The NS component category does not typically include furniture or other items of a temporary or portable nature.

There is a public expectation that our buildings will remain standing after an earthquake or a high windstorm and that NS components, including critical life safety systems, will remain in place to provide the function for which they were designed. For this reason, building codes specify lateral and gravity forces that the designer must use to reduce the risk of structural failure.

There are multiple reasons for requiring NS components to be adequately anchored and supported to resist lateral and gravity forces, including the fact that the leading cause of injury during an earthquake is falling objects that either strike occupants or obstruct egress. Also, failure of NS components may hinder recovery efforts after an earthquake, with potentially significant property loss and negative impacts on the community. In many cases, the cost to repair or replace NS components after an earthquake exceeds the cost of repairs to the building in which they are located. The cost to repair or replace NS components after an earthquake can amount to significant percentage of the overall value of the building improvements.

Requirements found in Chapter 13 of ASCE 7 for NS components are based on the NEHRP provisions. The performance goals of these provisions are intended to avoid serious injury or loss of life, avoid loss of function of critical facilities (I_p = 1.5) and minimize repair costs to the extent practical. These requirements are intended to apply to new construction, tenant improvements or alterations installed at any time during the life of the structure.

II. Recommendations and Guidelines

All installations of NS components must meet current building code requirements. Building officials commonly respond to client inquiries about whether or not a building permit and engineering documentation (Construction Drawings and supporting calculations as required) are needed in order to proceed with the installation of NS components. After considering the nature and scope of the installation and referring to the component importance factors in ASCE 7 section 13.1.3, the local building official is responsible to determine if there is a need for a building permit and engineering. Separate mechanical, electrical or plumbing (MEP) permits (whichever is applicable) are typically required even though a building permit may not be required. MEP permits should be withheld for components weighing more than 400 lbs. until the structure supporting the equipment is shown to comply with the building code.

Although every case is unique, there are similarities that provide opportunities to "categorize" types of work to help maintain consistency and predictability for clients and building department personnel. There are 3 main categories as follows:

A. Building Permit Not Typically Required – NS Components Exempt from Seismic Design Requirements – (ASCE 7 Sections 13.1.4 and 13.6)

1. Mechanical, electrical, and architectural components in seismic design category B, other than parapets supported by bearing walls or shear walls, with an importance factor, I_p of 1.0 (See Sec. 13.1.3 of ASCE 7 to determine the importance factor).
2. Mechanical and electrical components in seismic design category C provided that either:
   a. The component Importance Factor, Ip, is equal to 1.0 and the component is positively attached to the structure; or
   b. The component weighs 20 lb or less or, in the case of a distributed system, 5 lb/ft or less.
3. *Base-mounted* mechanical and electrical components in seismic design categories D, E and F with an importance factor, I_p of 1.0, weighing less than 400 lbs., mounted at 4 ft. or less above the floor and provided with flexible connections between the components and associated ductwork, piping and conduit.
4. Distribution systems (such as piping or ducting) weighing 5 lbs./ft. or less and other *suspended* mechanical and electrical components in seismic design categories D, E and F with an importance factor, I_p of 1.0, weighing less than 20 lbs. and provided with flexible connections between the components and associated ductwork, piping and conduit.
5. Although not specified in the code, many jurisdictions do not require a separate building permit or seismic design for hot water tanks 60 gallons or less installed in commercial or residential occupancies if they are strapped to resist horizontal displacement per UPC Chapter 5. A mechanical, electrical, or plumbing permit, as applicable, is typically required to install a hot water tank. Reference IAPMO Guide Criteria (IGC's) 202-2004a.

B. Building Permit and Inspection Are Typically Required – Design and Installation Without Engineering Documentation

1. Fire protection sprinkler piping, pipe hangers, and bracing designed and constructed in accordance with NFPA 13 shall be deemed to meet the force and displacement requirements of ASCE 7.
2. HVAC ductwork (Ip=1.0) not designed to carry toxic, highly toxic, or flammable gases or not used for smoke control installed in accordance with an approved standard such as from ASHRAE or SMACNA. Reference Section 13.6.6 of ASCE 7.
3. Mechanical components weighing 75 lbs. or less installed in line with a duct system. Reference Section 13.6.6 of ASCE 7.
4. Suspended ceilings installed in compliance with applicable subsections of ASCE 7 Section 13.5.6, and references to the ASTM C635, C636 and ASTM E580.
5. When approved by the building official, reference documents may be used for seismic design as long as the design earthquake forces meet the provisions of Section 13.3.1 and seismic interaction with adjacent components are evaluated. Examples of recognized reference documents include the International Seismic Application Technology (I.S.A.T) for restraint and attachment of NS components and the Northwest Wall and Ceiling Bureau Document #401 for installation of suspended ceilings. Reference Section 13.1.7 of ASCE 7.

C. Building Permit, Plan Review and Inspection Are Typically Required – Design and Installation <u>With</u> Engineering Documentation

1. NS components assigned with an importance factor, I_p of 1.5, are considered crucial for public safety.
   There are 4 criteria in Section 13.1.3 of ASCE 7 used to determine the higher importance factor.
   a. (1) Is the component needed for life safety after an earthquake event? Examples include smoke control fans, emergency generators, stairways, etc.
      (2) Are there toxic or explosive substances that could spill? Examples include battery storage racks, chemical storage racks, etc.
      (3) Is the component in an Risk Category IV building and is needed for the continued operation of the facility (see table 1604.5 of the IBC)?
      (4) Are there hazardous substances that the component contains or conveys?

   If the answer to any of these questions is yes, then the component has an Ip of 1.5 and a building permit, engineering and plan review will be required.
2. Mechanical and electrical equipment weighing more than 400 lbs., the center of gravity is located more than 4 ft. above the deck.
3. Mechanical and electrical equipment mounted on a wall or suspended from the structure and weighing more than 20 lbs or more than 5 lbs./ft. in the case of a distributed system
4. Whenever, in the opinion of the building official, engineering is needed to address attachment or support of NS components due to size, shape, weight, location or other considerations.

III. Commentary

A. Practical Considerations

Because resources are typically limited, most building officials must prioritize enforcement objectives. There are several factors to consider when deciding what level of scrutiny to apply to the anchorage and support of NS components. These include but are not limited to:

1. Variation in the size, shape, weight and aspect ratio of nonstructural components
2. Importance of the equipment under consideration relative to life safety (e.g., roof-mounted smoke control fan vs. a toilet exhaust fan)
3. Risk of injury
4. Risk category of the building (e.g., critical facility vs. warehouse)

B. Gravity Loads

It is critical that floors, roofs, raised platforms, sidewall/hanging installations, hanging installations and any structures supporting nonstructural components be designed for the anticipated loads per IBC Chapter 16. IEBC Section 502.4 allows an existing gravity load-carrying element to support an additional 5% of the design load before it must be strengthened or replaced. Elevated structures supporting nonstructural components weighing more than 400 lbs. should be designed and checked for gravity loading by a

Washington State licensed engineer and a building permit obtained if new or additional improvements are necessary to accommodate this additional load.

For new components weighing more than 400 lbs. and for replacement components exceeding 5% of the original unit weight, building officials should consider withholding MEP permits until the structure supporting the equipment is shown to comply with the building code for the gravity loading. Multiple or ganged components in close proximity should be analyzed to confirm that the structure will not become overloaded

C. Lateral Loads

NS components, unless exempt, must be effectively anchored to the structure with detailed connections shown in the construction documents to resist both seismic and wind loads. A complete load path is required and must be verified.

The Seismic Design Category (SDC) for NS components attached to a structure, shall be consistent with that of the building in which it is located. Reference Section 13.1.2 of ASCE 7.

An importance factor (I_p) must also be established. Components that are required to function after an earthquake for life-safety purposes or components containing hazardous materials are of high importance and must be designed with an I_p of 1.5. Section 13.1.3 of ASCE 7 requires that the supports for these NS components be designed with an importance factor of 1.5 for lateral loads. All other components are given an I_p of 1.0.

Each NS component located in an Risk Category IV building must be evaluated to determine if its function is critical for the continued operation of the facility. Improper seismic design or installation of NS components located in essential facilities such as hospitals, police stations, schools, and emergency shelters, all considered Risk Category IV buildings per IBC Table 1604.5, may negatively impact the entire community if structural failure occurs.

Nonstructural components and their supports shall be attached (or anchored) to the structure in accordance with the requirements of Section 13.4 of ASCE 7. For example, use of power-actuated fasteners for seismic anchorage is limited in Seismic Design Categories D, E, or F.

D. Deformation compatibility

The effects of seismic relative displacements shall be considered in combination with displacements caused by other loads as appropriate. Component supports shall be designed to accommodate the seismic relative displacements between points of support determined in accordance with Section 13.3.2.

E. Special Inspections and Seismic Certifications

Special inspection by a WABO-approved agency may be required for the installation of NS components. See IBC Section 1705.

Seismic certifications may be required for mechanical and electrical equipment that must remain operable following the design earthquake or for components with hazardous substances and assigned a component Importance Factor, Ip, of 1.5. Reference ASCE 7 Section 13.2.2.

Thank you to the following original committee members for their contributions to this white paper: Mark D'Amato (SEAW, co-chair), Chris Ricketts (WABO, co-chair), Jerry Barbera (WABO/SEAW), Rick Fine (SEAW), Charlie Griffes (SEAW), Larry Lindell (SEAW), Jon Siu (WABO), Dan Sully (WABO), and Lee Kranz (WABO).

IV. Appendix/Additional information – Reference Documents, Codes Citations, Examples

1. NIST GCR 18-917-43-Recommendations for Improved Seismic Performance of Nonstructural Components at https://www.nehrp.gov/library/guidance_ns.htm

2. NIST GCR 17-917-44 -Seismic Analysis, Design, and Installation of Nonstructural Components and Systems – Background and Recommendations for Future Work at https://www.nehrp.gov/library/guidance_ns.htm

3. FEMA E-74- Reducing the Risks of Nonstructural Earthquake Damage – A Practical Guide at https://www.fema.gov/emergency-managers/risk-management/building-science/earthquakes

4. Factors related to code enforcement for nonstructural mechanical components per City of Seattle Director's Rule 29-2005 may be found at http://www.seattle.gov/dpd/codes/dr/DR2005-29.pdf.

5. The NW Wall and Ceiling Bureau have consolidated all applicable codes related to the installation of suspended ceilings. For suspended acoustical lay-in ceiling installations, go to Document #401 found in the "Technical Documents" section at: https://www.nwcb.org/technical-info.html

6. The OSHPD Preapproved Details (OPD) are standard architectural and engineering details developed by OSHPD FDD for use in California health facilities construction, at the discretion of Registered Design Professionals (RDP). https://oshpd.ca.gov/construction-finance/preapproval-programs/oshpd-preapproved-details-opd/