This document contains resources for vibration durability, including seismic activity, as it relates to refrigerant piping used in HVACR and water heating equipment.

AC units must meet shipping, steady-state operational vibration, and seismic event requirements where applicable. UL/CSA 60335-2-40 requires that all A2L AC units, including VRF, must be shown to be leak free following 180-minute transport per ASTM D4728-06 standard simulation vibration testing and drop testing. Following installation, the unit must be shown to be leak free following 960 operation cycles. Copper tubing is not rigidly mounted to allow for expansion, and vibration is further mitigated by expansion loops for thermal conditions and seismic isolators (required in California Building Code, where applicable). In addition, VRF also requires vibration testing for piping located in the space.

**International Building Code (IBC) and California Building Code (CBC) Requirements**

- Only Category IV buildings (e.g., hospitals, disaster relief) require certificate of seismic code compliance
- Certificate of seismic code compliance may be required for equipment anchorage and restraint systems in some Category III buildings (e.g., high occupancy buildings, power generation facilities)
- There are no seismic requirements for boilers in residential dwellings
- Water heaters must be secured in residential settings

**Standards and Resources to Properly Design and Install Equipment to Withstand Vibrational Activity**

<table>
<thead>
<tr>
<th>Standard/Resource</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Manufacturer Shipping Qualifications</strong></td>
<td>HVACR manufacturers perform shipping and vibration qualification tests and other voluntary tests when designing equipment. These are based on ASTM D4728-06 but with added testing defined by manufacturers. HPAC Engineering published an article on building design considerations and how HVACR equipment can be tested as a single “black box.” The “black box” concept explains that during the shipping of equipment, any components inside the “black box” that survive shipment would likely survive an earthquake.</td>
</tr>
</tbody>
</table>
| **2018 IBC**  
International Building Code (IBC) | • Chapters 16 and 17 of the 2018 International Building Code (IBC) provide procedures and criteria for testing equipment and establishes where additional inspections and testing must be provided, especially regarding seismic activity (Exhibit 2).  
• IBC Sections 1603 and 1605 specify load requirements for building design.  
• IBC Section 1613 specifies earthquake load requirements.  
• IBC Sections 1704 and 1705 include special inspections instructions and considerations for carrying out seismic resistance.  
• 2018 IBC refers to ASCE/SEI Standard 7-16.  
• 2018 IMC Section 301.18 says mechanical system supports shall be designed and installed for seismic forces in accordance with the IBC. |
| **2018 IMC**  
International Mechanical Code (IMC) | • NEHRP Recommended Seismic Provisions for New Buildings and Other Structures.  
National Earthquake Hazards Reduction Program (FEMA) Recommended Seismic Provisions for New Buildings and Other Structures  
• The Federal Emergency Management Authority (FEMA) committed under the National Earthquake Hazard Reduction Program (NEHRP) to improve seismic design and building practices in the U.S.  
• Chapter 13 addresses non-structural components, including HVAC equipment. |
| **NEHRP Recommended Seismic Provisions for New Buildings and Other Structures**  
National Earthquake Hazards Reduction Program (FEMA) Recommended Seismic Provisions for New Buildings and Other Structures | • UL/CSA 60335-2-40 requires that all A2L AC units, including VRF, must be shown to be leak free following 180-minute transport per ASTM D4728-06 standard simulation vibration testing and drop testing.  
• Following installation, the unit must be shown to be leak free following 960 operation cycles. |
| **UL 60335-2-40 3rd edition**  
Household and Similar Electrical Appliances - Safety - Part 2-40: Particular Requirements for Electrical Heat Pumps, Air-Conditioners and Dehumidifiers | • California’s seismic codes are managed by OSHPD  
• Chapters 16 and 17 of the 2019 California Building Code (CBC) provides a variety of procedures and criteria for testing equipment and establishes where additional inspections and testing must be provided, especially regarding seismic activity.  
• Sections 1603 and 1605 specify load requirements for building design. Section 1613 specifies earthquake load requirements.  
• Sections 1704 and 1705 include special inspections instructions and considerations for carrying out seismic resistance.  
• 2019 CBC refers to ASCE/SEI Standard 7-16. |
| **California Building Code (CBC): Title 24, California Code of Regulations**  
(Office of Statewide Health Planning and Development – OSHPD) | • Oregon Codes and Standards  
• Adopted the 2018 IBC and IMC. |
| **Oregon** Codes and Standards | • Washington State Building Code (SBC)  
• Adopted the 2015 IBC into its SBC. Recently adopted the 2018 IBC to become effective July 2020, but may be moved to February 1, 2021. |
**New Madrid Seismic Zone (NMSZ)**

- AR, IN, KY, and TN have statewide seismic building codes. IL, MI, and MO do not have statewide seismic building codes.
- **Arkansas** - Adopted 2012 IBC and 2009 International Mechanical Code (IMC).
- **Indiana** - Adopted 2012 IBC and IMC.
- **Kentucky** - Adopted the 2015 editions of IBC and IRC. In the KBC (Kentucky Building Code) the state has adopted by reference the 2015 edition of the IMC and 2012 IECC.
- **Mississippi** - Adopted the 2018 IBC and IMC.
- **Missouri** - Adopted the 2012 IBC and IMC on state office space and Sec. 107 of the 2012 IBC to be used when there are no local codes.

**Standards and Resources to Properly Design and Install Piping for HVAC Equipment**

<table>
<thead>
<tr>
<th>Standard/Resource</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AHRI Standard 1270 - 2015</strong></td>
<td>Seismic requirements consistent with ASCE 7-10 (previous edition of ASCE 7). Functional compliance testing includes tolerances for allowable outcomes as defined in Table 6 (Exhibit 1). Standard scheduled for reaffirmation in 2020.</td>
</tr>
<tr>
<td><strong>AHRI Standard 1270 - 2015</strong></td>
<td>Seismic requirements consistent with ASCE 7-10 (previous edition of ASCE 7). Functional compliance testing includes tolerances for allowable outcomes as defined in Table 6 (Exhibit 1). Standard scheduled for reaffirmation in 2020.</td>
</tr>
<tr>
<td><strong>ASHRAE Standard 15.2 (Proposed)</strong></td>
<td>ASHRAE 15.2 includes refrigerant piping safeguards, including reference to ASME 31.5. Special requirements for A2L refrigerants in section 8. This proposed standard is targeted for completion by December 2020.</td>
</tr>
<tr>
<td><strong>ASHRAE Practical Guide to Seismic Restraint</strong></td>
<td>Design guide to mechanical, plumbing, and electrical systems for earthquakes. Consistent with 2009 IBC, ASCE 7-10, and 2010 California Building Code. Covers piping connections and includes information on the advantages of different types of flexible connectors, the importance of proper connector orientation, and the need for flexible connector testing to develop accurate stiffness at operating pressure.</td>
</tr>
</tbody>
</table>
• Stringent safety requirements for piping. Design and installation requirements for A2L piping more robust than A1.
• Includes safety requirements associated with A1, B1, A2L, A2, and A3 refrigerants, include in situ and transportation guidance. A3 refrigerants have the most stringent requirements. Toxicity Class B2 and B3 refrigerants are not included in scope.
• VRF installation requires vibration testing for installed piping.

UL 60335-2-89 1st edition
Household and Similar Electrical Appliances - Safety - Part 2-89:
Particular Requirements for Commercial Refrigerating Appliances
with an Incorporated or Remote Refrigerant Unit or Compressor (Proposed)

• Stringent safety requirements for piping. Design and installation requirements for A2L piping more robust than A1.
• Includes safety requirements associated with A1, A2L, A2, and A3 refrigerants, include in situ and transportation guidance. A3 refrigerants have the most stringent requirements. Ammonia refrigerants are not included in scope.
• New edition of 2-89 targeted for review in fall 2020. Targeted publication April or May 2021.