

1	<p>An air handling unit is isolated with internal springs, and the fan discharge inside the AHU is flex connected to the AHU housing. The indoor AHU is floor mounted to a 6" concrete housekeeping pad in the mechanical room on the ground or second floor of a two story building. Are flex connections required for the supply and return air duct connections to the AHU housing? Is it redundant? What are the pros and cons of having the flex connections?</p>	<p>The answer to the first questions is YES. If you want optimal reduction of noise and vibration in your facility, flex connectors on the supply and return to the AHU housing are required. Even though the fan in the AHU is internally isolated and equipped with a flex connector, it does not mitigate the casing-radiated noise that travels from the AHU into the building structure and the supply and return ductwork. Casing-radiated noise, sometimes referred to as panel resonance, is structure-borne noise (vibration) caused by the airborne sound of the fan and other equipment in the AHU impinging on the walls of the AHU. This airborne sound energy along with any turbulence in the AHU causes the AHU housing to vibrate. Flexible connectors between the AHU and the supply and return ductwork will reduce the transmission of vibration from the AHU into the ductwork. For this same reason, we also recommend the use of external vibration isolation. The internal vibration isolators supplied to isolate the fan only isolates vibrations from the fan. External vibration isolation will eliminate vibration coming from the AHU housing. If you think you have or may have a vibration problem, we suggest you contact your local Acoustical Consultant before you start your repairs. A trained acoustical engineer can help you identify your problem(s) and potentially save you a bundle in the end. If using internal or external isolation, please refer to the question "Should both internal and external vibration isolation be used in a single application?" below.</p>
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2	<p>My projects are located in areas that do not normally see earthquakes and I have not had to restrain equipment before. Why am I being asked to do so now?</p>	<p>In reviewing seismic events on a worldwide basis, it has been found that a tremendous amount of damage has occurred as the result of only moderately sized earthquakes in low seismic areas where little or no seismic protection was incorporated during construction. In addition, as the stresses in the earth's crust increase with time, many areas with infrequent earthquakes have also suffered when larger events have finally occurred. This has been deemed unacceptable by FEMA (Federal Emergency Management Agency), the regulatory group that is driving the code requirements.</p>
3	<p>In the past, although the code specified some requirements for minor seismic restraint where my projects are located, the code officials frequently waived the requirement. Why have they suddenly become stubborn about waiving it on current and future projects?</p>	<p>FEMA (Federal Emergency Management Agency), is the agency responsible for relief when an "act of god" event such as an earthquake or hurricane occurs. Over the last 10+ years, the relief dollars that were spent far exceeded expectations and one of the key findings was that the damage costs would have been reduced significantly had the rules in place at the time of building construction not been waived. Insurance companies have also been pressuring localities for better enforcement as they have lost literally billions of dollars during recent earthquakes.</p>

4	<p>If I follow the current code standards, will my building weather an earthquake without any problems?</p>	<p>The codes are based on the maximum "likely" earthquake that has a 2% chance of occurrence in the next 50 years. This means there is a very small chance that an earthquake can occur that is larger than this. The codes are also "life safety" based. This means that during the above earthquake, the building and equipment will hold together well enough so that lives will not be lost. Except in some rare cases in hospitals, etc., there is no requirement that the building and equipment will retain its functionality. If continued functionality is required, a performance-based specification should be considered. (Note: A performance-based spec will typically require that all of the equipment specified for the project be shake table tested to levels consistent with the design seismic forces to ensure its continued functionality.)</p>
5	<p>The seismic design forces have greatly increased with the advent of the current code in my area. In addition, there is a lot more information that I need to have to determine what force is appropriate. Why is this?</p>	<p>During the 1989 and 1994 earthquakes that occurred in California, considerable information was gathered that had not previously been available. When experts reviewed this data, it was found that factors such as soil type, proximity to a known fault, and equipment elevation in a building had a significant impact in the actual forces. The force equations were modified to take this into account.</p>

6	<p>Why do I not have to restrain piping or ductwork that is hung 12" or less from the ceiling?</p>	<p>Items that are hanging on supports react to earthquakes act as though supported on a pendulum. If the pendulum is 12" or less, its natural frequency is outside the range generated by earthquakes. Because of this, the piping and ductwork will move back and forth during an earthquake, but the motion will not be amplified with time. As long as there is nothing that won't prevent 3-4" of lateral motion and the hanger rod is allowed to swing freely with some kind of swivel, pipe/duct systems have consistently survived seismic events with minimal problems. If this motion is restricted by local obstacles, damage can occur and the system would require restraint.</p>
7	<p>Why do I need to provide restraints on equipment that is hung 12" or less from the ceiling?</p>	<p>Although from a philosophic viewpoint it would seem that the rules stated in the questions above should apply to equipment, this is not the case. Equipment behaves more erratically than piping or ductwork during a seismic event because it is more local in nature. Large distributed systems like pipe and duct will tend to move laterally or even exhibit relatively minor variations in the vertical loads but will not tend to rock. Localized components like equipment will rock and as such can generate considerably higher tensile loads in the support system. In some cases this may not be an issue, but there are definitely situations where the installation geometry will develop loads that can cause failure(s) in the support system.</p>

8	Why do I sometimes need to add oversized mounting plates to restraints attached to concrete	The seismic restraint manufacturer has probably designed the steel restraint so that it is stronger than the material it is anchored to. A good example is when there is a requirement to anchor to a thin layer of lightweight concrete. The concrete may not be strong enough on its own to hold the anchors. The addition of a larger mounting plate or embedded steel plate will distribute the forces over a larger area.
9	What is "special inspection" for anchor bolts?	The actual installation of the bolt into the concrete is a critical part of the restraint system. If the bolt is not embedded deeply enough or properly set into the concrete, it could fail in an earthquake. Special Inspection requires an independent authority to watch the installation of the bolt to ensure that it is done properly. For purposes of calculating the correct anchor size, the allowed mathematical value of the anchor can then be increased and save the cost of many more bolts.
10	Is it possible that a building could be uninhabitable after an earthquake, even with no structural damage?	The heating and air conditioning system equipment are considered to be non-structural components of the building. If the building has little or no structural damage but the water piping or air conditioning systems have torn loose or broken down, the building may still be unoccupiable. And the resultant loss of revenue could do more damage to your business than the earthquake did. It is important to have a member of the Vibration Isolation and Seismic Control Manufacturer's Association (VISCMA) design and/or review the anchorage of your systems.

11	I am thinking of replacing an aging air conditioning system. Should I add seismic restraint devices with the installation?	In the event of an earthquake of a magnitude large enough to cause your air conditioning equipment and piping to break loose, you could lose the use of the building and have the risk of people being injured by falling air conditioning equipment, piping and ductwork. The current building codes are written to protect the lives of the people in your building. It is good common sense as well as a practical business decision to make sure your systems are adequately braced. Many insurance companies recognize the importance of this and often give monetary incentives to upgrade your restraint systems.
12	The mechanical equipment is all located on grade outside the building or in a central plant. Do I still need earthquake restraints?	The location of the equipment does not change the requirements for seismic bracing. However, the design forces that must be resisted will change based upon the location of the equipment in or around the building structure.
13	Should both internal and external vibration isolation be used in a single application?	It is possible that the internal springs could resonate with the external springs. This could cause damage to the systems. If the application is near a very vibration sensitive area, the internal isolators should remain locked down; as they are when they are shipped. A good rule of thumb is that you can use one or the other, but not both.

<p>14</p>	<p>Why should I use vibration isolators?</p>	<p><p>All mechanical and electrical equipment generates vibration. Even a small amount of vibration energy traveling through the structure can:</p></p> <ul style="list-style-type: none"> Create unacceptable noise levels in commercial buildings, schools, auditoriums, etc. For example, government standards now require quieter environments for school children to enhance learning. Affect sensitive equipment such as in hospitals, laboratories and high tech manufacturing facilities. Lead to damage to the equipment or the structure. <p><p>Vibration isolation, installed during construction, will minimize the energy transmitted to the structure and provide an economical solution that leads to better and quieter environments.</p></p> <p><p>Generally, most HVAC, electrical and plumbing equipment can develop disturbing noise and vibrations. Properly selecting an isolation system will minimize direct disturbances to occupants. Indirectly, vibration energy allowed to flow unchecked can travel throughout the structure and reappear unpredicted anywhere in the form of disturbing noise or vibrations. A properly written specification isolating all potentially disturbing equipment and line systems is the best insurance policy for an owner.</p></p> <p><p>Additionally, sensitive equipment can be adversely</p>
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affected when located near potentially disturbing equipment. Some examples are:

- Equipment within chip manufacturing facilities
- Hospital or health related equipment
- Research facility equipment

Cost to the owner is minimized when potential problems are addressed in the design stage by the dedicated professionals in the field of noise and vibration control. VISCMA was established to ensure industry standards of manufacturer specified products to meet the demands of specifying engineers and acoustical consultants.

15	If the vibrating equipment is located outside on the ground, do I still need to use vibration isolators?	Even if the equipment is on grade on a separate slab from the building, vibration transmitting to the building structure is still a concern. Also, the addition of isolators will reduce enough vibration that it is possible to add to the effective life of the equipment.
16	When should I use inertia blocks with the vibration isolators?	<p><p>There are three major reasons for including an inertia mass with the isolation. One is that it lowers the center of gravity of the system. For a tall narrow unit, this could make the installation more stable in a seismic event.</p></p> <p><p>Secondly, some pieces of equipment have large unbalanced vibratory forces. An example might be large water pumps or large medical vacuum pumps. In the case of one of these applications, the large unbalanced forces could cause larger than normal amplitudes, or physical movement, of the springs under normal conditions. Large movements can cause undue stresses to flex connectors and piping connections. The inertia block adds mass to the system so that the same amount of force has to move a much greater mass, thus minimizing the amplitude of movement.</p></p> <p><p>The third one is that some equipment manufacturers mandate a common rigid surface to minimize or eliminate flex between two components that are connected by a flex drive. </p></p>

17	<p>I have a structure with long support spans and in order to keep the vibration generated by the roof mounted equipment from causing problems, a spring with more than 2 inches of deflection is needed. However, when I put equipment on these springs , it rocks excessively in a breeze or when I push against it. What can I do to stop this?</p>	<p>The same "softness" in the spring coil that is necessary to reduce the transfer of vibrations into the structure also will allow the equipment to rock more easily. There is nothing that can be done to prevent this. There are things that can be done to minimize the negative effects, however. These are to ensure that the isolated equipment has a low center of gravity; the isolators are spaced as widely as possible; the system is equipped with motion limiting devices; and, if exposed to wind, is protected from direct exposure. This may require the addition of an inertia mass to lower the center of gravity or a surrounding wind barrier protection wall. The use of motion limiting devices should be restricted where possible as, when limiting the motion, they can form a path for the direct transfer of vibration into the structure whenever the equipment is exposed to a sufficient lateral force.</p>
18	<p>What duct needs to be restrained?</p>	<p>All ductwork that is 6 square feet and over in cross-sectional area or over 17 lb./ft. and does not fall into another exemption category shall be restrained to meet the applicable building code. Other exemptions that may apply include ductwork that has not been assigned an importance factor of 1.5 and is part of a building with a Seismic Design Category (SDC) of C, C, E or F; and all ductwork in a SDC A or B building. (This is based on IBC 2012 and ASEC 7-10 requirements.)</p>

19	How far apart do the braces need to be?	Industry standard practice uses a maximum of 30' between transverse restraints and 60' between longitudinal restraints for ductwork. Actual restraint locations will be determined by the seismic design engineer based on duct construction and design force levels.
20	Can I use the "12 inch rule" for ductwork?	The "12 inch rule" exemption has been misapplied in many cases. The only way the 12" exemption rule can apply is if the supports are designed to prohibit significant bending for all hangers on a run of duct. One method is to select hangers that will not permanently deform when exposed to seismic design lateral loads. Another method uses vibration isolators or swivels to provide a swing connection at the top of the hanger support.
21	What is the size exemption for round or flat oval duct?	The cross-sectional size exemption is for any shape of duct. SMACNA used to require all round ductwork 28" larger in diameter to be restrained. This requirement is not used in IBC 2012/ASCE 7-10
22	Can I use wall penetrations as restraint points for ductwork?	Yes, to some degree. It is best determined by a qualified seismic design engineer. Common practice is to use wall penetrations as lateral restraints if the wall is considered strong enough and the design forces small enough. Fire dampers, since they are made to be structurally integral with the wall partition, are commonly used as restraint points for lateral loads and longitudinal loads in one direction (into the wall). Since the duct connection to these devices is designed to allow the duct to fall away, they cannot be used as longitudinal restraint points for forces moving away from the wall.

23	How do I run restraints for ductwork in fire rated hallways?	<p>This is a great example of the need for good phasing on a project. It may be that the restraints have to be installed crossed over the top of the ductwork and before the walls are put in place. It may mean that rigid supports will need to be used in lieu of a cable restraint system. The options should be considered and a method chosen with the assistance of a qualified seismic design engineer. This is a great example of the need for good phasing on a project. It may be that the restraints have to be installed criss-cross over the top of the ductwork and before the walls are put in place. It may mean that rigid supports will need to be used in lieu of a cable restraint system. The options should be considered and a method chosen with the assistance of a qualified seismic design engineer.</p>
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