Selection Guide for Vibration Isolation of HVAC Equipment
KINETICS NOISE CONTROL, INC., is recognized as the major producer of products and systems for the control of noise and vibration. The Company markets products under the trade name KINETICS®. KINETICS® products and engineered systems have been incorporated throughout major industrial and commercial buildings in the United States, Canada, Europe, Australia, and the Far East.

Kinetics Noise Control’s national headquarters and manufacturing facilities are located in Dublin, Ohio, in a 60,000 sq. ft. (5574 m) facility.

The Company provides products, systems, and solutions to everyday problems and for complex applications requiring noise and vibration control analysis.

By using the Kinetics Selection Guide contained in this bulletin, proper isolation can be specified by type and deflection to obtain optimum effectiveness of the isolators. By specifying deflection rather than theoretical isolation efficiency, performance can be assured and can be readily verified in the field.

Kinetics’ engineering and testing facilities are available at all times to assure that each product is tailored to meet project specifications and field conditions. Its staff of professionals welcomes the opportunity to assist in selecting and specifying the company’s products and systems.

Kinetik provides certified engineering drawings when requested for all products to assure compliance with project specifications.

Vibration and vibration-induced noise, major sources of occupant complaint, have steadily increased in today's modern buildings. The problems have been compounded by lighter weight construction and by the positioning of equipment in penthouses or intermediate level mechanical rooms. Not only is the physical vibration in the structure disturbing, but noise which is regenerated by the structural movement may be heard in other remote sections of the structure.

Effectiveness of vibration isolators in bringing about vibration reduction is indicated by the transmissibility of the system. A typical transmissibility curve is shown for vibrating equipment supported on isolators. When the isolated system is excited at its natural frequency, the system will be in resonance, and exciting forces will be amplified rather than reduced. It is desirable to select isolators with a natural frequency as far below the equipment operating speed as possible to achieve the highest degree of vibration control.

The Theoretical Isolation Efficiency shown on the transmissibility curve assumes the isolators are located on a rigid floor. This rigidity seldom occurs in above-grade applications. In practice, considerable building deflection can occur, which may reduce the effectiveness of the vibration isolators. Vibration isolators must be selected to compensate for the floor deflection. Longer spans also allow the structure to be more flexible, permitting the building to be more easily set into motion. With the aid of the Kinetics Selection Guide, building spans, equipment operating speeds, equipment horsepower, damping, and other factors have been taken into consideration.

By specifying Isolator Deflection rather than isolation efficiency, transmissibility, or other theoretical parameters, the consulting engineer can compensate for floor deflection and building resonances by selecting isolators which are satisfactory to provide minimum vibration transmission and which have more deflection than the supporting floor.

By stating that all isolators and equipment bases shall be of the same manufacturer and shall be supplied to the mechanical contractor, the consulting engineer has placed the responsibility on a single source who will be concerned with the vibration transmission from all mechanical equipment in the building, rather than only those which they supply.

When the specifier permits equipment suppliers to provide “appropriate” isolators, which are not manufactured under Kinetics' high standards, he does not assure a satisfactory job, since different brands of isolators may be furnished and no one supplier carries the full responsibility for a building free of vibration and noise as specified.

To apply the information from the Selection Guide, base type, isolator type, and minimum deflection columns are added to the equipment schedule, and the isolator specifications are incorporated into the specifications for the project. Then, for each piece of mechanical equipment, base type, isolator type, and minimum deflection are entered, as tabulated in the Selection Guide.

The Kinetics Selection Guide is available in digital format so consulting engineers can select vibration isolators with the aid of their computer. Digital copies are available through Kinetics representatives, on the Kinetics Noise Control website or by contacting Kinetics directly.
Specifications
The isolator or base selected for a particular application depends on the required deflection, life, cost, and compatibility with associated structures and shall be manufactured by Kinetics Noise Control, Inc. Dublin, Ohio, as follows:

Isolator Types 1 and 2: Rubber isolators are available in pad (type I) and molded (type II) configurations. Pads are used in single or multiple layers. Molded isolators come in a range of 30 to 70 durometer (a measure of stiffness). Material in excess of 70 durometer is usually ineffective as an isolator. Isolators are designed for up to 13 mm deflection, but are used where 8 mm or less deflection is required. Solid rubber and composite fabric and rubber pads are also available. They provide high load capacities with small deflection and are used as noise barriers under columns and for pipe supports. These pad types work well only when they are properly loaded and the mass load is evenly distributed over the entire pad surface. Metal loading plates can be used for this purpose.

Isolator Type 1: Glass fiber with elastic coating (type I). This type of isolation pad is precompressed molded fiberglass pads individually coated with a flexible, moisture-impervious elastomeric membrane. Natural frequency of fiberglass vibration isolators should be essentially constant for the operating load range of the supported equipment. Mass load is evenly distributed over the entire pad surface. Metal loading plates can be used for this purpose.

Isolator Types 3 and 4: Steel springs are the most popular and versatile isolators for HVAC applications because they are available for almost any deflection and have a virtually unlimited life. Spring isolators may have a rubber acoustical barrier to reduce transmission of high-frequency vibration and noise that can migrate down the steel spring coil. They should be corrosion-protect if installed outdoors or in a corrosive environment. The basic types include the following:

Isolator Type 3: Open spring isolators (type 3) consist of top and bottom load plates with adjustment bolts for leveling equipment. Springs should be designed with a horizontal stiffness of at least 80% of the vertical stiffness to ensure stability. Similarly, the springs should have a minimum ratio of 0.8 for the diameter divided by the deflected spring height.

Isolator Type 4: Restrained spring isolators (type 4) have hold-down bolts to limit vertical as well as horizontal movement. They are used with (a) equipment with large variations in mass (e.g., boilers, chillers. cooling towers) to restrict movement and prevent strain on piping when water is removed, and (b) outdoor equipment, such as condensing units and cooling towers, to prevent excessive movement due to wind loads. Spring criteria should be the same as open spring isolators, and restraints should have adequate clearance so that they are activated only when a temporary restraint is needed.

Closed mounts or housed spring isolators consist of two telescoping housings separated by a resilient material. These provide lateral snubbing and some vertical damping of equipment movement, but do not limit the vertical movement. Care should be taken selection and installation to minimize binding and short-circuiting.

Isolator Types 2 and 6: Air springs can be designed for any frequency, but are economical only in applications with natural frequencies of 1.33 Hz or less (150 mm or greater deflection). They do not transmit high-frequency noise and are often used to replace high-deflection springs on problem jobs (e.g., large transformers on upper-floor installations). A constant air supply (an air compressor with an air dryer) and leveling valves are typically required.

Isolator Type 3: Isolation hangers (types 2 and 3) are used for suspended pipe and equipment and have rubber, springs, or a combination of spring and rubber elements. Criteria should be similar to open spring isolators, though lateral stability is less important. Where support rod angular misalignment is a concern, use hangers that have sufficient clearance and/or incorporate rubber bushings to prevent the rod from touching the housing. Swivel or traveler arrangements may be necessary for connections to piping systems subject to large thermal movements.

Precompressed spring hangers incorporate some means of precompression or preloading of the isolator spring to minimize movement of the isolated equipment or system. These are typically used on piping systems that can change mass substantially between installation and operation.

Isolator Type 5: Thrust restraints (type 5) are similar to spring hangers or isolators and are installed in pairs to resist the thrust caused by air pressure. These are typically sized 10 limit lateral movement 106.4 mm or less.

Base Type A: Direct isolation (type A) is used when equipment is unitary and rigid and does not require additional support. Direct isolation can be used with large chillers, some fans, packaged air-handling units, and air-cooled condensers. If there is any doubt that the equipment can be supported directly on isolators, use structural bases (type B) or inertia bases (type C), or consult the equipment manufacturer.

Base Type B: Structural bases (type B) are used where equipment cannot be support at individual locations and/or where some means is necessary to maintain alignment of component pans in equipment. These bases can be used with spring or rubber isolators (types 2 and 3) and should have enough rigidity to resist all starting and operating forces without supplemental hold-down devices. Bases are made in rectangular configurations using structural members with a depth equal to one-tenth the longest span between isolators. Typical base depth is between 100 and 300 mm, except where structural or alignment considerations dictate otherwise.

Structural rails (type B) are used to support equipment that does not require a unitary base or where the isolators are outside the equipment and the rails act as a cradle. Structural rails can be used with spring or rubber isolators and should be rigid enough to support the equipment without flexing. Usual practice is to use structural members with a depth one-tenth of the longest span between isolators, typically between 100 and 300 mm, except where structural considerations dictate otherwise.

continued on page 6
## Selection Guide for Vibration Isolation

### Equipment Type

<table>
<thead>
<tr>
<th>Equipment Type</th>
<th>Equipment Category</th>
<th>Horsepower and Other</th>
<th>RPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refrigeration Machines and Chillers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air Compressors and Vacuum Pumps</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pumps</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooling Towers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boilers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Axial Fans, Plenum Fans, Cabinet Fans, Fan Sections, Centrifugal Fans</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Centrifugal Fans</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Properly</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heat Pumps, Fan-Coils, Computer Room Units</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Condensing Units</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All, AC, H, and V Units</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Packaged Rooftop Equipment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ducted Rotating Equipment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engine-Driven Generators</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Equipment Location

<table>
<thead>
<tr>
<th>Slab on Grade</th>
<th>Up to 20 ft (6 m) Floor Span</th>
<th>20 to 30 ft (6 - 9 m) Floor Span</th>
<th>30 to 40 ft (9 - 12 m) Floor Span</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Type</td>
<td>Isolator Type</td>
<td>Min. Delf. (in. mm)</td>
<td>Base Type</td>
</tr>
<tr>
<td>---------------</td>
<td>-----------------</td>
<td>---------------------</td>
<td>---------------</td>
</tr>
<tr>
<td>Base B</td>
<td>Structural Rail Base, Model SBB</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Base C</td>
<td>Integral Structural Beam Base, Model SFB</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Base D</td>
<td>Roof Curf Rail, Model KSR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Isolator Type 1</td>
<td>Fiberglass Isolation Pad, Model KIP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Isolator Type 2</td>
<td>Fiberglass Isolation Mount, Model AC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Isolator Type 3</td>
<td>Full-stand Gear Spring, Model FD5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Isolator Type 4</td>
<td>Restrained Spring Isolator, Model RMS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Isolator Type 5</td>
<td>Thrust Rebound, Model KSR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Isolator Type 6</td>
<td>Air Spring, Model KAM</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Notes:

- pg 6

Source: 2011 ASHRAE Handbook
Specifications
(continued from page 3)

Base Type C: Concrete bases (type C) are used where the supported equipment requires a rigid support (e.g., flexible-coupled pumps) or excess heaving motion may occur with spring isolators. They consist of a steel pouring form usually with welded-in reinforcing bars, provision for equipment hold-down, and isolator brackets. Like structural bases, concrete bases should be sized to support piping elbow supports, rectangular or T-shaped, and for rigidity, have a depth equal to one-tenth the longest span between isolators. Base depth is typically between 150 and 300 mm unless additional depth is specifically required for mass, rigidity, or component alignment.

Base Type D: Curb isolation systems (type D) are specifically designed for curb-supported rooftop equipment and have spring isolation with a watertight, and sometimes airtight, assembly. Rooftop rails consist of upper and lower frames separated by nonadjustable springs and rest on top of architectural roof curbs. Isolation curbs incorporate the roof curb into their design as well. Both kinds are designed with springs that have static deflections in the 25 to 75 mm range to meet the design criteria described in type 3. Flexible elastomeric seals are typically most effective for weatherproofing between the upper and lower frames. A continuous sponge gasket around the perimeter of the top frame is typically applied to further weatherproof the installation.

Notes for Selection Guide for Vibration Isolation

Note 1: Isolator deflections shown are based on reasonably expected floor stiffness according to floor span and class of equipment. Certain spaces may dictate higher levels of isolation. For example, bar joist roofs may require a static deflection of 38 mm over factories, but 64 mm over commercial office buildings.

Note 2: For large equipment capable of generating substantial vibratory forces and structure borne noise, increase isolator deflection, if necessary, so isolator stiffness is less than one-tenth the stiffness of the supporting structure, as defined by the deflection due to load at the equipment support.

Note 3: For noisy equipment adjoining or near noise-sensitive areas, see the section on Mechanical Equipment Room Sound isolation.

Note 4: Contain designs cannot be installed directly on individual isolators (type A), and the equipment manufacturer or a vibration specialist should be consulted on the need for supplemental support (base type).

Note 5: Wind load conditions must be considered. Restraint can be achieved with restrained spring isolators (type 4), supplemental bracing, snubbers, or limit stops.

Note 6: Certain types of equipment require a curb-mounted base (type D). Airborne noise must be considered.

Note 7: See section on Resilient Pipe Hangers and Supports for hanger locations adjoining equipment and in equipment rooms.

Note 8: To avoid isolator resonance problems, select isolator deflection so that resonance frequency is 40% or less of the lowest normal operating speed of equipment (see Chapter 8 in the 2009 ASHRAE Handbook Fundamentals). Some equipment, such as variable-frequency drives, and high-speed equipment, such as screw chillers and vaneaxial fans, contain very-high-frequency vibration. This equipment creates new technical challenges in the isolation of high-frequency noise and vibration from a building’s structure. Structural resonances both internal and external to the isolators can significantly degrade their performance at high frequencies. Unfortunately, at present no test standard exists for measuring the high-frequency dynamic properties of isolators, and commercially available products are not tested to determine their effectiveness for high frequencies. To reduce the chance of high-frequency vibration transmission, add a 25 mm thick pad (type 1, Note 20) to the base plate of spring isolators (type 3, Note 22, 23, 24). For some sensitive locations, air springs (Note 25) may be required. If equipment is located near extremely noise-sensitive areas, follow the recommendations of an acoustical consultant.

Note 9: To limit undesirable movement, thrust restraints (type 5) are required for all ceiling-suspended and floor-mounted units operating at 1500 Pa or more total static pressure.

Note 10: Pumps over 55 kW may need extra mass and restraints.

Isolation for Specific Equipment

Note 12 Refrigeration Machines: Large centrifugal, screw, and reciprocating refrigeration machines may generate very high noise levels; special attention is required when such equipment is installed in upper-story locations or near noise-sensitive areas. If equipment is located near extremely noise-sensitive areas, follow the recommendations of an acoustical consultant.

Note 13 Compressors: The two basic reciprocating compressors are duct structures. (1) single- and double-cylinder vertical, horizontal or L-head, which are usually air compressors; and (2) Y, W, and multihead or multi-
cylinder air and refrigeration compressors. Single- and double-cylinder compressors generate high vibratory forces requiring large inertia bases (type C) and are generally not suitable for upper-story locations. If this equipment must be installed in an upper-story location or at-grade location near noise-sensitive areas, the expected maximum unbalanced force data must be obtained from the equipment manufacturer and a vibration specialist consulted for design of the isolation system.

**Note 14 Compressors:** When using Y, W, and multihead and multicylinder compressors, obtain the magnitude of unbalanced forces from the equipment manufacturer so the need for an inertia base can be evaluated.

**Note 15 Compressors:** Base-mounted compressors through 4 kW and horizontal tank-type air compressors through 8 kW can be installed directly on spring isolators (type 3) with structural bases (type B) if required, and compressors 101075 kW on spring isolators (type 3) with inertia bases (type C) with a mass I to 2 times the compressor mass.

**Note 16 Pumps:** Concrete inertia bases (type C) are preferred for all flexible-coupled pumps and are desirable for most close-coupled pumps, although steel bases (type B) can be used. Close-coupled pumps should not be installed directly on individual isolators (type A) because the impeller usually overhangs the motor support base, causing the rear mounting to be in tension. The primary requirements for type C bases are strength and shape to accommodate base elbow supports. Mass is not usually a factor, except for pumps over 55 kW, where extra mass helps limit excess movement due to starting torque and forces. Concrete bases (type C) should be designed for a thickness of one-tenth the longest dimension with minimum thickness as follows: (1) for up to 20 kW, 150 mm; (2) for 30 to 55 kW, 200 mm; and (3) for 75 kW and up, 300 mm.

Pumps over 55 kW and multistage pumps may exhibit excessive motion at start-up (“heaving”); supplemental restraining devices can be installed if necessary. Pumps over 90 kW may generate high starting forces; a vibration specialist should be consulted.

**Note 17 Packaged Rooftop Air-Conditioning Equipment:** This equipment is usually installed on low-mass structures that are susceptible to sound and vibration transmission problems. The noise problems are compounded further by curb-mounted equipment, which requires large roof openings for supply and return air.

The table shows type D vibration isolator selections for all spans up to 6 m, but extreme care must be taken for equipment located on spans of over 6 m, especially if construction is open web joists or thin, low-mass slabs. The recommended procedure is to determine the additional deflection caused by equipment in the roof. If additional roof deflection is 6 mm or less, the isolator should be selected for 10 times the additional roof deflection. If additional roof deflection is over 6 mm, supplemental roof stiffening should be installed to bring the roof deflection down below 6 mm, or the unit should be relocated to a stiffer roof position.

For mechanical units capable of generating high noise levels, mount the unit on a platform above the roof deck to provide an air gap (buffer zone) and locate the unit away from the associated roof penetration to allow acoustical treatment of ducts before they enter the building.

Some rooftop equipment has compressors, fans, and other equipment isolated internally. This isolation is not always reliable because of internal short-circuiting, inadequate static deflection, or panel resonances. It is recommended that rooftop equipment over 135 kg be isolated externally, as if internal isolation was not used.

**Note 18 Cooling Towers:** These are normally isolated with restrained spring isolators (type 4) directly under the lower or lower dunage. High deflection isolators proposed for use directly under the motor-fan assembly must be used with extreme caution to ensure stability and safety under all weather conditions. See Note 5.

**Note 19 Fans and Air-Handling Equipment:** Consider the following in selecting isolation systems for fans and air-handling equipment:

1. Fans with wheel diameters of 560 mm and less and all fans operating at speeds up to 300 rpm do not generate large vibratory forces. For fans operating under 300 rpm, select isolator deflection so the isolator natural frequency is 40% or less than the fan speed. For example, for a fan operating at 275 rpm, 0.4 x 275 = 110 rpm. Therefore, an isolator natural frequency of 110 rpm or lower is required. This can be accomplished with a 75 mm deflection isolator (type 3).
2. Flexible duct connectors should be installed at the intake and discharge of all fans and air-handling equipment to reduce vibration transmission 10 air.
3. Inertia bases (type C) are recommended for all class 2 and 3 fans and air-handling equipment because extra mass allows the use of stiffer springs, which limit heaving movements.
4. Thrust restraints (type 5) that incorporate the same deflection as isolators should be used for all fan heads, all suspended fans, and all base-mounted and suspended air-handling equipment operating at 500 Pa or more total static pressure. Restraint movement adjustment must be made under normal operational static pressures.

Engineering Capabilities

Celebrating our 50th year in 2008, Kinetics Noise Control has extensive experience in the design, manufacturing and application of innovative products to control sound and vibration. Kinetics pioneered development of precompressed, molded fiberglass pad isolators that would be incorporated into a dynamic new floor isolation system.

Kinetics Noise Control now produces the industry’s largest selection of inspired products to address vibration and noise control, room acoustics, and seismic restraint concerns for almost any application. Value is added with our experienced team of engineering and customer support personnel ready to work with you.

Kinetics Noise Control features extensive practical experience in both design and application. The experienced staff of over twenty (20) technically trained individuals includes seven (7) licensed professional engineers, two (2) holding Master’s degrees and one (1) who has earned a Ph.D., spread across engineering and manufacturing centers in Ohio, USA, Ontario, Canada, and Hong Kong, China. Our combined technical experience exceeds 400 years with over 250 years directly related to sound, vibration control and seismic issues. Kinetics Noise Control employees hold PE licenses in 30 states and provinces.

Select Projects

- Air Canada, Winnipeg James Armstrong Richard International Airport Manitoba, CA
- Aliante Station - Las Vegas
- Altus Air Force Base, Altus AFB, OK
- ARIA Hotel and Casino at CityCenter, Las Vegas
- Army Aviation Support Facility, Santa Fe, NM
- Barrie Fire Station, Barrie, Ontario CA
- Caledon OPP Station, Caledon (Toronto), Ontario CA
- Casino Niagara
- City of North Las Vegas Water Reclamation Facility, Las Vegas, NV
- Cosmopolitan of Las Vegas
- Ford Plant (Water Treatment Facility), Oakville, Ontario CA
- Ft Carson Firing Range, Ft Carson, CO
- Ft. Detrick: Chevron, Ft. Detrick, MD
- Ft. Lewis BCT Complex, Ft. Lewis, WA
- Grand Hyatt Macau at City of Dreams
- Grand Junction Public Safety Building, Grand Junction, CO
- Hard Rock Hotel Macau at City of Dreams
- Harmon Tower at CityCenter, Las Vegas
- Hollywood Casino, Lawrenceburg, Indiana
- Indian Springs Correctional Facility, Indian Springs, NV
- Ireland Army Community Hospital, Fort Knox, KY
- Langley Air Force Base, Hampton, VA
- The M Resort Spa Casino Las Vegas
- Mandarin Oriental Las Vegas at CityCenter
- Moody Air Force Base Commissary, Moody AFB, GA
- Mt. Sinai Hospital, Toronto, Ontario CA
- New Jersey Air National Guard Operation and Training
- P-767 MH-60S Hangar and Airfield Improvements, Norfolk, VA
- Pearlgate Recreational Multiplex, City of Mount Pearl, Newfoundland, NS, CA
- Peel Regional Police Station, Peel (Toronto), Ontario CA
- Seal Operations Facility P-471, Norfolk, VA
- Syracuse VA Medical Center, Syracuse, NY
- St. Joseph’s Hospital, Hamilton, Ontario CA
- Toronto Police Station, Toronto, Ontario CA
- United States Courthouse, Jefferson City, MO
- USO Tier III, Golden, CO
- VA Hospital Mental Health Outpatient, Salisbury, NC
- Vdara Hotel and Spa at CityCenter, Las Vegas
- Venetian Hotel Phantom Theatre in Las Vegas
- Wm. Jennings Bryan Dorn VA Medical Center, Columbia, SC
- Women’s College Hospital, Toronto, Ontario CA
- Woodstock General Hospital, Woodstock, Ontario CA
- York Regional Police Headquarters, York, Ontario CA

kineticsnoise.com/hvac/
sales@kineticsnoise.com
1-800-959-1229

Ohio, USA  Nevada, USA  Ontario, Canada  Hong Kong, China

Kinetics Noise Control, Inc. is continually upgrading the quality of our products. We reserve the right to make changes to this and all products without notice.