

# **SEISMIC** and **WIND** Restraint Products

55-years of product innovation and manufacturing excellence



## Why are Seismic and Wind Restraint Needed?

For hospitals and healthcare facilities, the damaging effects of earthquakes and wind are of significant concern throughout North America and in many areas of the world. In the U. S., the International Building Code (IBC) mandates the use of seismic restraint for hospital and healthcare facilities even in areas with relatively low seismic activity. Earthquake damage to inadequately restrained piping, mechanical and electrical systems within and on buildings can be extensive even when there is no structural damage to the actual building. Piping, mechanical and electrical equipment knocked off of its supporting structure due to earthquake-related building movement can threaten life, property and the ability of a hospital to operate. The cost of properly restraining your equipment is insignificant when compared to the costs associated with repair, replacement and system downtime as a result of seismic damage.

This brochure presents Kinetics' approach to designing and applying seismic restraint systems. These systems serve to limit the movement of equipment and to keep the equipment captive during a seismic event.



A thorough analysis of seismic and wind restraint hardware and seismic and wind rated vibration isolators requires the consideration of four (4) aspects of the system:

- 1. Attachment of the Equipment to the Restraint:**  
The equipment must be securely attached to the Kinetics restraint system. This attachment must demonstrate sufficient strength to withstand the imposed seismic and wind forces.
- 2. Restraint Design:**  
Kinetics' restraint systems are designed to withstand the equipment imposed seismic and wind forces.
- 3. Attachment of Restraint to the Building Structure:**  
This attachment is typically via bolts, welds, or concrete anchors. In addition, the building attachment interface must be reviewed by the structural engineer of record to ensure that it is capable of withstanding the imposed seismic and wind forces. Typically, this attachment is the 'weakest link' of the overall design, especially when post installed concrete anchors are used.
- 4. Equipment Fragility:**  
The ability of the equipment to continue to operate after being subjected to a seismic or wind force. Fragility information must be obtained from the equipment manufacturer and is not covered in this brochure.

The photos on this page are examples of properly restrained HVAC equipment surviving the 1994 Northridge earthquake unscathed. The photo above is of a rooftop unit installed directly next to a collapsed parking garage in Northridge. To the left is a rooftop installation across from the I-10 collapse.

# Seismic Restraint of Suspended Equipment, Piping and Ductwork

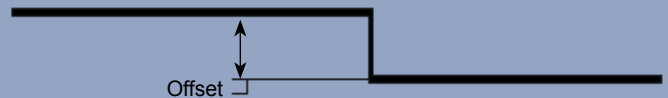
In hospitals and healthcare facilities, the International Building Code (IBC), requires some pipe and duct systems to remain in operation for life-safety purposes following an earthquake. These systems are assigned a Component Importance Factor of 1.5. Life-safety systems typically include but are not limited to fire sprinkler and fire suppression systems, smoke removal and fresh air ventilation systems, infectious disease control systems, medical gas lines, ventilation and humidity control for surgical suites and clean rooms. Pipe and duct systems not considered life-safety whose failure could cause failure of life-safety systems operating near by also needs to be restrained.

The most frequent occurrence of these failures has been in systems that were not restrained in accordance with the building codes or the guidelines issued by SMACNA (Sheet Metal and Air Conditioning Contractors National Association).

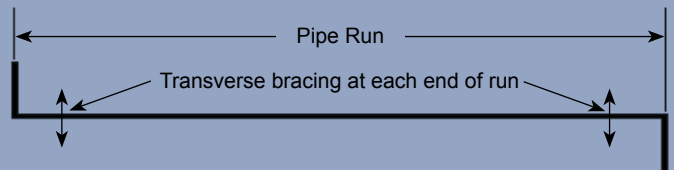
The code bodies have revised their focus in these areas, ensuring that the current Code and Guideline information is followed. Broadly stated, in applications where significant motion can occur, the restraint requirements for piping and ductwork systems are to be adequately sized in both the lateral and axial directions. These restraints must be used with spacings short enough to prevent local failures in the pipe/duct runs between restraints. In the field, seismic restraint systems must attach and interface with numerous piping, ductwork, and electrical systems. It is difficult if not impossible to specify locations for these restraints prior to completion of the runs since the routes of these systems frequently changes over the course of construction. It is recommended that the seismic restraint be installed after the installation of the mechanical and electrical systems. The SMACNA Seismic Restraint Manual offers general guidance for field installation of these restraints. It includes tables with maximum spacing and restraint component sizes for various sizes of piping and ductwork in the various seismic zones. The SMACNA manual is easily understood and can be effectively used by installation contractors on systems already in place. The value listed as "S" in the drawings to the right comes from tabulated data from SMACNA and computation sheets provided by Kinetics Noise Control for case specific applications. *(continued on next page)*

## Definition of a pipe "run"

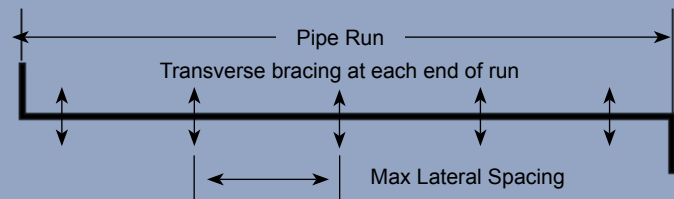
If offset is less than  $S/16$ , treat as straight run



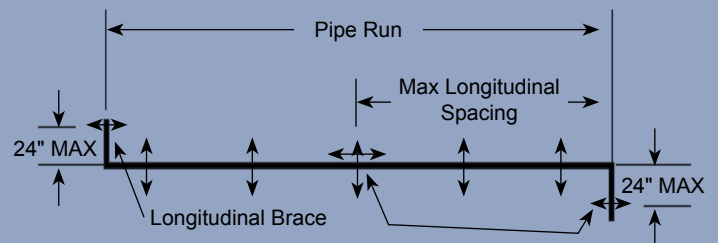
## Minimum number of lateral restraints on a "run"



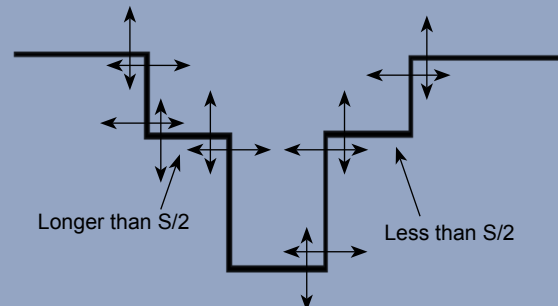
## Additional lateral restraints



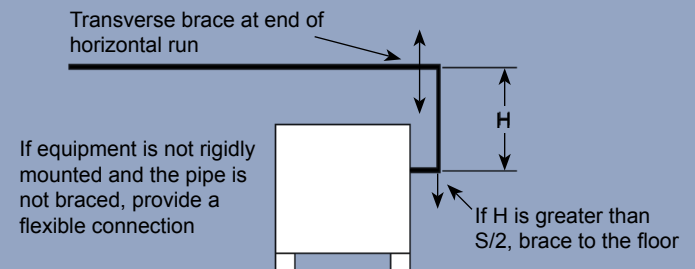
## Minimum number of lateral restraints on a "run"



## Restraining a series of short jogs



## Restraints at termination points



# Seismic Restraint of Suspended Equipment, Piping and Ductwork

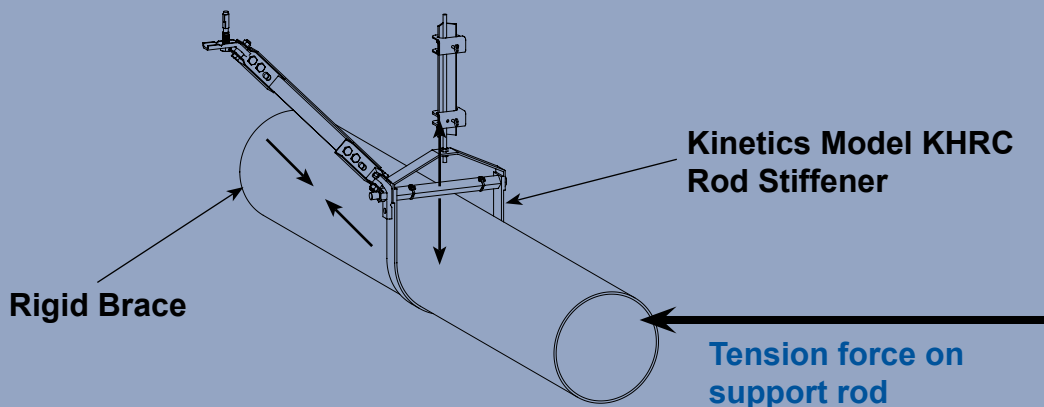
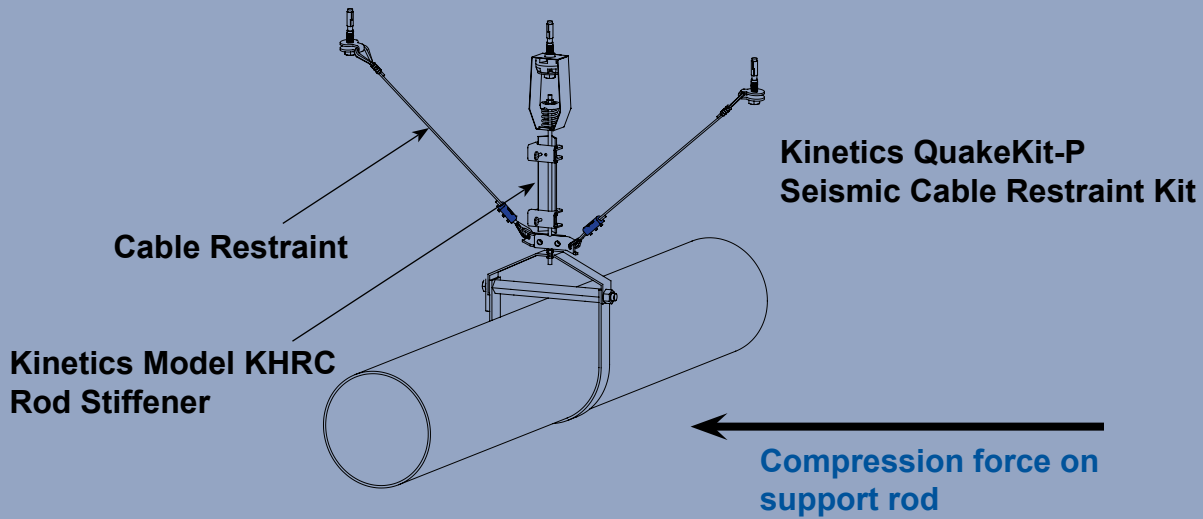
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Typically piping/ductwork systems are restrained either with cable restraints or rigid braces that run upward at an angle from the pipe/duct to the ceiling. Because these links run at an angle, the application of a horizontal load generates a vertical load component on the hanger rod which supports the pipe or duct. This vertical component can frequently be as large as double the horizontal force. This vertical force needs to be taken into account when designing the anchorage.

When using cable restraint systems, the secondary vertical force component generated by the horizontal load is always directed upward, loading the support hanger rod in compression. With rigid braces, the vertical force component can be either in compression or tension, depending on the direction of the seismic load. To resist the compressive load, a stiffener is required on the hanger rod when the critical buckling length of the hanger rod is exceeded.

This dimension is tabulated in the SMACNA guidelines for various piping configurations. Where a rigid brace is used, not only does the long hanger rod require a stiffener, the anchor itself must also be capable of taking a downward load comprised of both the weight load of the pipe and the downward force generated by the seismic event.

It has been found that piping or ductwork that is hung on rods such that the dimension from the top of the pipe/duct to the underside of the supporting surface is 12" or less will not be excessively excited by a seismic event. This is true provided that non-moment generating support hardware is used. It has also been found that pipes under 2-1/2" in diameter are sufficiently small and ductile such that they will flex and not be damaged by an earthquake. The same holds true for ducts that are under 6 ft in cross-sectional area. Most of the codes exclude such systems from seismic restraint requirements.

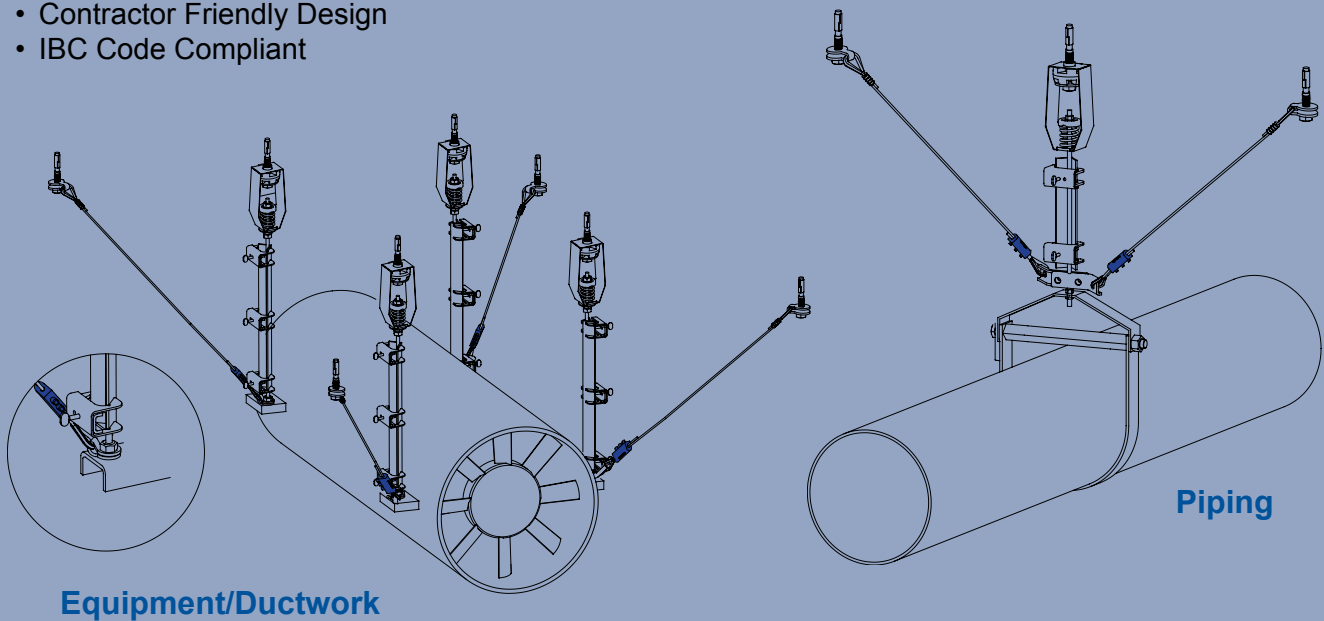




## QuakeLoc™ Seismic Cable Restraint Connector

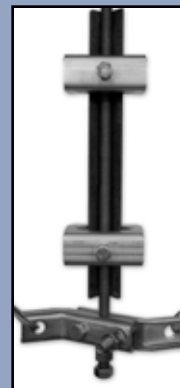
for piping, duct, electrical cable trays, and suspended equipment

- Reduces Installation Time and Cost
- Contractor Friendly Design
- IBC Code Compliant



## Hanging Rod Stiffener Clamp - Model KHRC

- Required to brace threaded rod when rod is used to suspend piping, ductwork, and/or hanging equipment in a seismic zone.
- Designed to easily and securely attach steel stiffening bracing angles (*provided by others*) to the threaded rod, using common hand tools.
- Unique design allows the installation of the angle bracing without disassembling the hanging rod.
- Reference seismic building codes to determine the size and thickness of the bracing angle and quantity of attachment clamps required.





## Seismic Control Spring Isolator Model FHS

- Combination coil spring isolator and seismic restraint for indoor and outdoor floor mounted fans, pumps, air compressors and other mechanical equipment.
- All-directional restraint with vertical limit stops
- Field interchangeable spring coils
- Galvanized housing and epoxy powder coated coils
- Constant free height and operating height
- Equipment motion limited to 0.2" in all directions, at the isolator. Restraint clearance not to exceed 0.25"
- Provides seismic and wind restraint required by current building codes\*
- Available static deflection from 1" to 4"

## Restrained Spring Isolator Model FLSS

- Combination coil spring isolator and seismic restraint for indoor and outdoor floor mounted cooling towers, chillers and boilers.
- All-directional restraint with vertical limit stops
- Field interchangeable spring coils
- Galvanized housing and epoxy powder coated coils
- Constant free height and operating height
- Equipment motion limited to 0.2" in all directions, at the isolator. Restraint clearance not to exceed 0.25"
- Provides seismic and wind restraint required by current building codes\*
- Available static deflection from 1" to 4"

\*Equipment geometry, attachment and anchorage may affect restraint capacity.



## Seismic Snubbers Model HS Series

- Single and double axis horizontal and vertical seismic restraint models available
- Standard capacities of up to 6,500 pounds force
- Restraint capacities to meet all building code requirements
- May be bolted or welded in place
- Replaceable neoprene elements
- Easily inspected for short circuits



## Modular Restraint/Isolator Model FMS

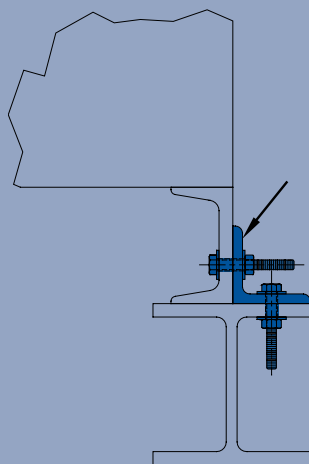
- The unique design of the Patented Kinetics FMS restraint module minimizes the seismic loads transmitted into the anchors or other attachment hardware. As a result, considerably higher seismic ratings are possible versus conventional designs using similar sized connection hardware.
- Restraint capacities to meet all building code requirements for seismic and wind loads\*
- Optional isolation with deflection from 1" to 4"
- Horizontal force capacity ratings ranging to 70,000 lbs
- Easy to install, adjust and inspect



## Vibration Isolation Curb Model ESR

- Structural steel isolated curb with wood nailer
- Provides seismic and wind restraint required by current building codes\*
- Access ports for each coil spring isolator
- Available static deflection from 1" to 4"
- Options:
  - Sloped Roof
  - Acoustical Insulation
  - External Thermal Insulation
  - Concrete Attachment

\*Equipment geometry, attachment and anchorage may affect restraint capacity.



## Seismic Restraint Brackets for floor and curb mounted equipment Model KSMS

**Model KSMS** seismic and wind restraint brackets are used to solid-mount equipment to the building structure. It can be bolted or welded to the equipment, and is attached to the structure by anchoring to concrete or bolting to steel.

# Seismic Engineering Capabilities

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 Seismic Projects

- Air Canada, Winnipeg James Armstrong Richard International Airport Manitoba, CA
- Aliante Station - Las Vegas, NV
- Altus Air Force Base, Altus AFB, OK
- ARIA Hotel and Casino at CityCenter, Las Vegas, NV
- Army Aviation Support Facility, Santa Fe, NM
- Barrie Fire Station, Barrie, Ontario CA
- Caledon OPP Station, Caledon (Toronto), Ontario, Canada
- Casino Niagara, Ontario, Canada
- City of North Las Vegas Water Reclamation Facility, Las Vegas, NV
- Cosmopolitan of Las Vegas, NV
- 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, NV
- Hollywood Casino, Lawrenceburg, IN
- 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, NV
- Mandarin Oriental Las Vegas at CityCenter, NV
- Moody Air Force Base Commissary, Moody AFB, GA
- Mt. Sinai Hospital, Toronto, Ontario Canada
- 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, Canada
- 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 Canada
- Toronto Police Station, Toronto, Ontario Canada
- 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, NV
- Venetian Hotel Phantom Theatre in Las Vegas, NV
- 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



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