



# **Non-Structural Isolation**

**PLATFORMS - 3D ISOLATION - FLOORS - MODULAR SYSTEMS**



**DYNAMIC ISOLATION SYSTEMS**

*The World Leader in Seismic Protection.*



## **DYNAMIC ISOLATION SYSTEMS**

*The World Leader in Seismic Protection.*

### ***Is a DIS system right for you?***

- › Do you value your investments?
- › Are quality and performance important to you?
- › Do you appreciate the high standards and tight tolerances of US manufacturing?
- › Do you believe that striving towards minimum design requirements can be costly?
- › Do you appreciate world class pre- and post-sales support from leading international experts?

*DIS has protected some of the most valuable and high-profile projects in the world, including irreplaceable historic structures and works of art. DIS' world renowned design, support and finished products can be tailored to suit any application and will be executed and delivered in a professional and timely manner.*

*When lives, priceless artifacts, critical operation components, or simply some added peace of mind are at stake, settle for no less than*  
***The World Leader in Seismic Protection.***





# DYNAMIC ISOLATION SYSTEMS

DIS is the World Leader in Seismic Isolation - no other company has completed more isolation projects in more countries than Dynamic Isolation Systems.

**Ideal Non-Structural candidates include:**

- ▶ Computer Servers
- ▶ Modular Data Centers
- ▶ Prefabricated Structures
- ▶ Artwork, Including Statues
- ▶ Industrial Equipment
- ▶ Emergency Command Centers
- ▶ Data Center Floors
- ▶ Medical, High-Tech & Electrical Equipment



Dynamic Isolation Systems design and manufacturing facility in Nevada.

**Non-Structural Isolation**

When isolating an entire structure is not an option, DIS has a number of solutions to protect vital equipment and artwork from the damage or downtime caused by a seismic event.

**An Industry Pioneer**

Dynamic Isolation Systems is an industry pioneer and continues to develop and add technologies to its growing list of seismic protection solutions.



Vertical isolation system component.

DIS designs and manufactures systems for structural and non-structural isolation applications, including: base isolation, viscous wall dampers, pot bearings, sliders, isolated floor systems, modular isolation, isolated platforms, vertical isolation and isolation both horizontally and vertically.

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## DIS Notable Projects



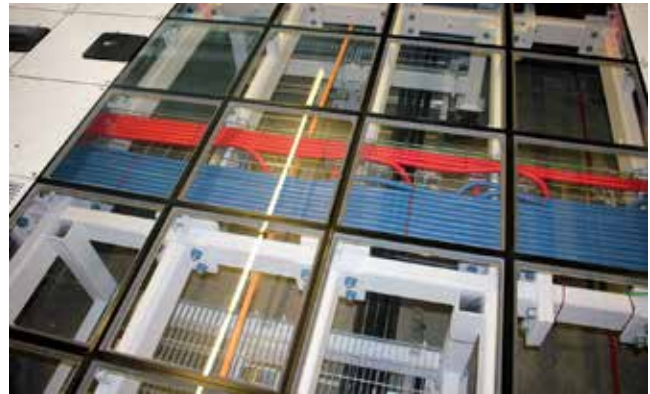
The Computational Research and Theory Facility.

### Berkeley Lab's New Shyh Wang Hall Features First-of-Its-Kind Seismic Floor

The San Francisco Bay Area is a well-known seismically active area. The Computational Research and Theory (CRT) facility at Berkeley Lab was thus designed to include a custom-built seismically isolated floor. The unique floor was developed by DIS to protect the supercomputers housed in the building from a maximum credible earthquake on the nearby Hayward fault.

The basic component of the floor is known as a "Module." Multiple modules are joined by steel beams to construct the floor, with six feet of space separating the modules on all sides. Steel plates span the gap between the isolated floor and the surrounding fixed floor; these plates are only attached to the seismic floor and are able to slide over the fixed floor. Cooling water is fed from fixed pipes located between the modules and attached to the computers via flexible hoses. All other utilities, such as power, networking, smoke detection and sprinklers, are suspended from the substructure and connected to the building proper by flexible connections that can accommodate 18 inches of movement.

Prior to installation in the CRT, DIS conducted full size testing of the seismic floor at the University of California, Berkeley Pacific Earthquake Engineering Research Center, home to the largest 3D shake table in the USA. The testing was critical to validating the design and to better understand the asymmetric floor loadings and the actual performance of the computer racks.



Incorporated cable trays provide easy access and organization.

### Modular Data Center Isolation in Costa Rica



The Modular Data Center shown here went through the 2012 magnitude 7.6 earthquake without damage and performed as expected.

Modular data centers are becoming more popular. They usually consist of one container module housing servers and a second module with cooling and back up power. They have many benefits to the end user, are available with short lead times and are ready to deploy upon delivery. Since the data centers are modular, capital outlays are smaller and incremental as one's IT Infrastructure grows. DIS' Modular Isolation System (MIS) is the only seismic isolation system available for Modular Data Centers. Until recently IT users had redundant systems for everything except earthquake protection.

## DIS Notable Projects



Critical equipment at the Ruskin Dam is protected with a 3D isolation system from DIS.

Seismic isolation is typically engineered to protect against horizontal accelerations during a seismic event. In the Ruskin Dam application there were also significant vertical accelerations. DIS developed a vertical isolation platform that uses linear bearings, springs, and viscous dampers to reduce vertical accelerations on each piece of equipment. The equipment rooms were isolated horizontally with Lead Rubber Bearings and sliding bearings.

The system was extensively shake table tested using earthquake motions at the top of the dam derived from time history analyses. The maximum horizontal and vertical accelerations were 12.7 and 4.7gs respectively. During the testing the isolation systems performed as designed. The spectral accelerations were reduced by up to a factor of 18.

DIS 3D isolation systems are custom configured for each project and meet IEEE 693 High Performance code requirements. Custom design is required as each geographical location has a unique seismic response and the structure modifies the ground motion.

### Dancing Ladies Sculptures Protected with Isolated Platforms

These three bronze sculptures (right) in a Union City, California plaza are each mounted on a DIS Isolated Platform. Without seismic protection, their tall, narrow shape would make them vulnerable to damage during an earthquake. This was an important point to consider as these pieces of artwork are located only 0.6 miles from the Hayward fault line. DIS' Isolated Platforms are a solution that protect the sculptures without unsightly external bracing. The isolation technology is all contained within the low-profile platforms and will allow the sculptures to move +/-30". This project won a SEAONC 2014 Excellence in Structural Engineering Award in the Special-Use Structures category.



Non-Structural Isolation used in Union City, California.

### Seismic Upgrade of the Ruskin Dam Spillway Gates Control Cabinets

Ruskin Dam is an 80-year-old concrete gravity dam on the Stave River in Ruskin, British Columbia, Canada. BC Hydro is upgrading the dam, powerhouse, and associated structures. The dam gates need to be operational after a 10,000-year return period earthquake.

Dynamic Isolation Systems developed, tested and supplied a 3D Isolation system for the seismic upgrade of the spillway gates control buildings and critical equipment.



3D Isolation System was tested at UNR.



# DIS Isolated Platform (IP)

Protection for data centers, medical and industrial equipment, artwork and computer servers.

### Ideal Candidates for Isolated Platforms

- ▶ Computer Servers
- ▶ Medical Equipment
- ▶ Manufacturing Equipment
- ▶ Artwork, Including Statues

### Why Use An Isolated Platform?

Computer servers and systems are key to business operation in today's data-dependent world.

Isolated Platforms provide protection against server downtime and equipment damage in the event of an earthquake.



Salt Lake City Public Safety Building, Utah: Critical equipment is protected by an extensive DIS Isolated Platform System.

***Drastically reduces earthquake hazard.***



40' long Isolated Platform houses two banks of servers and IT equipment.

### More Server Uptime

Protecting data centers and essential equipment against system failure with backup power and mirrored storage are common practice.

However, protection against seismic forces is also vital. Conventional earthquake protection utilizes strengthening techniques which actually increase seismic forces and accelerations. Conversely, Isolated Platforms reduce forces to equipment.

Systems and equipment remain undamaged, operational and online. Seismic isolation has been utilized to achieve Uptime Institute's Tier 4 rating in seismic zones.

### Performance

During a seismic event the Isolated Platform decouples equipment from floor motions and absorbs seismic energy. The floor moves beneath the IP, leaving what it supports largely unaffected. Transmitted accelerations are reduced by up to 5 times.

***Solutions available to suit any application.***

Standard DIS Isolated Platforms are designed for 100psf to 500psf floor loading in moderate to high seismic regions. Custom engineered solutions are available to suit any application.



Overhead cable trays are easily used with DIS' Isolated Platform.

## DIS Isolated Platform (IP)

### Configurations

DIS' patented IP is comprised of Multi-Directional Springs and high-load capacity rolling supports housed within an attractive steel frame. Modules are available in Standard (4ft x 4ft) and Extended (4ft x 6ft) sizes.

*Individual platforms can connect together, allowing versatile layouts.*



The platforms use standard size computer floor tiles.

Platforms can be bolted together on all four sides to create custom layouts, such as for supporting single servers or a long row of server racks.

Platform heights range from 7 to 11 inches, depending on the required load capacity.

### Platforms - Standard

Part No.	Dimensions L x W x H	Capacity (psf)
IP-100S	48" x 48" x 7"	100
IP-200S	48" x 48" x 7"	200
IP-300S	48" x 48" x 9"	300
IP-400S	48" x 48" x 9"	400
IP-500S	48" x 48" x 11"	500

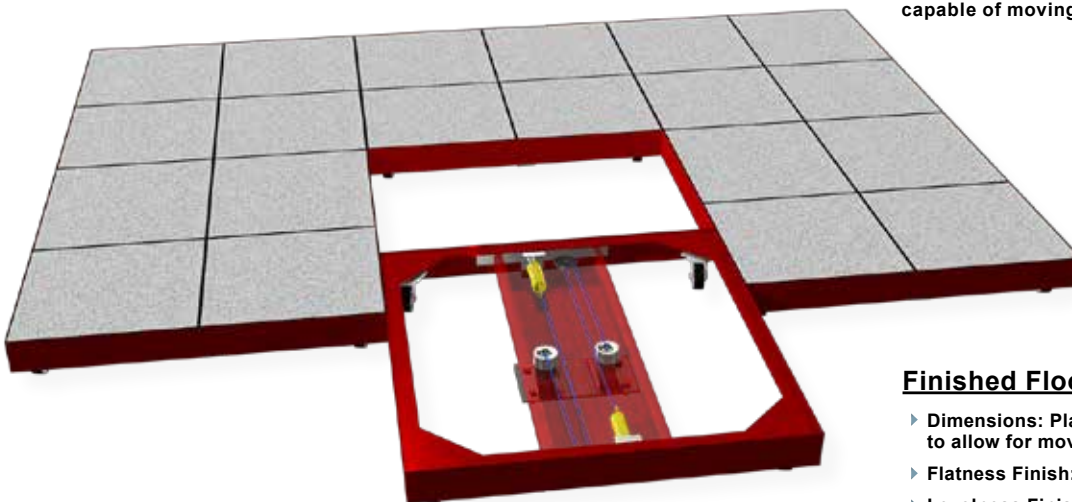
### Platforms - Extended

Part No.	Dimensions L x W x H	Capacity (psf)
IP-100E	48" x 72" x 7"	100
IP-200E	48" x 72" x 7"	200
IP-300E	48" x 72" x 9"	300
IP-400E	48" x 72" x 9"	400
IP-500E	48" x 72" x 11"	500

Patent No. US 8,061,692 B1



These 20 foot tall bronze statues in a California park are isolated on DIS platforms capable of moving  $\pm 30''$  in an earthquake.



### Finished Floor Slab Requirements

- ▶ Dimensions: Plan size 2ft larger than IP to allow for movement
- ▶ Flatness Finish: FF 50
- ▶ Levelness Finish: FL 30
- ▶ Designed to Support: 3,000 lb. point loads



# DIS 3D Isolation

Seismic protection for applications that require acceleration reduction horizontally and vertically.

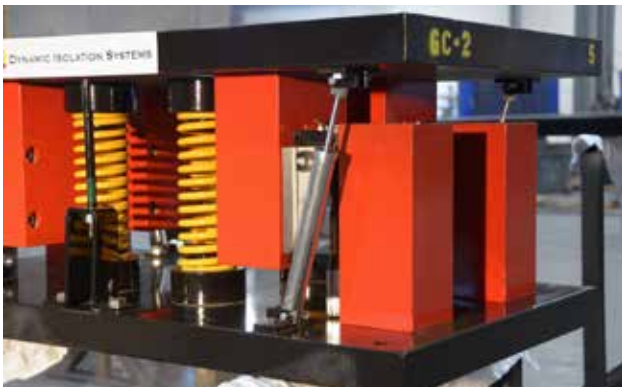
### The Need for 3D Isolation

Seismic isolation is typically engineered to protect against horizontal accelerations during a seismic event. In some applications, however, significant vertical accelerations are present as well. DIS has developed a solution to reduce these forces.

### *Most effective and complete solution for addressing earthquake hazards.*

Dynamic Isolation Systems developed a product which provides isolation from damaging accelerations in both horizontal (X, Y) and vertical (Z) directions.

The solution for isolating in both the horizontal and vertical directions came about when a major hydroelectric dam project needed to protect critical equipment from extreme vertical accelerations.



A component of the 3D Isolation System ready to ship.

The hydroelectric dam equipment was subjected to spectral accelerations up to 17g. These accelerations would damage sensitive equipment following a seismic event causing dam controls to be inoperable.



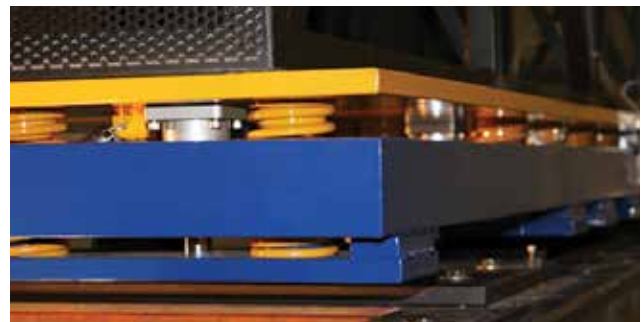
Ruskin Hydroelectric Dam in Canada.



3D shake table testing of DIS' 3D isolation system at Dynamic Certification Laboratories.

### *Meet or exceed code requirements.*

DIS developed 3D isolation systems to reduce forces and accelerations to be within IEEE 693 High Performance requirements. The successful development of 3D isolation led to the client incorporating vertical isolation systems in several additional applications.



3D isolation system shake table test.

DIS' 3D isolation systems are the most effective and complete solution for addressing earthquake hazards. DIS specializes in custom design, development and manufacturing of solutions such as 3D isolation.



## DIS 3D Isolation

Patent No. US 8,061,692 B1

### Configuration

DIS' 3D isolation system uses a series of guided bearings, vertical and horizontal springs and dampers to achieve superior performance during a seismic event.



Shake table testing of DIS' vertical isolation system at the University of Nevada, Reno.

3D isolation system dimensions and capacities are determined on a project by project basis by DIS' team of seismic design experts.



Ruskin Dam isolation system tested at the University of Nevada, Reno.



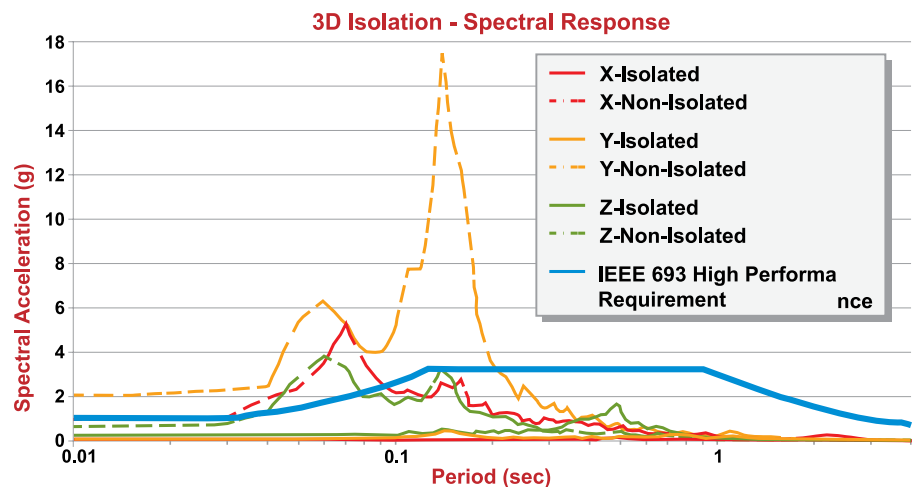
Canada's Ruskin Dam used 3D isolation to protect mission-critical equipment.

### Performance

Several shake table test programs were conducted at the University of Nevada, Reno (UNR) and Dynamic Certification Laboratories (DCL).

***Spectral accelerations reduced by factors of 10 to 20.***

The system performed as designed. The spectral accelerations were reduced by a factor of 18, protecting essential equipment against the most extreme seismic inputs.



Shake table testing shows 3D Isolation reduced spectral accelerations satisfying IEEE 693 High Performance requirements.



## DIS Isolated Floor (IF)

Seismic protection for essential equipment housed within conventionally designed structures.

### Ideal Candidates for Isolated Floors

- ▶ Emergency Operation Centers
- ▶ Data Centers
- ▶ Large Floor Areas
- ▶ Raised Floor Configurations



Installation of a 16,000 square foot isolated floor at the UC Berkeley Computational Research and Theory Facility.

### Why Use An Isolated Floor?

Risk management for computer servers and data centers is an integral part of modern business.

The productivity of an entire company may hinge on reliable and continuous equipment operation.

### *More server up time.*

In addition to backup power and mirrored data storage, seismic isolation is a critical piece of the risk management pie.

DIS Isolated Floor systems provide continuous, single-level flooring with seamless integration of conventional, raised-access floors.

Conventional earthquake protection relies on structural strengthening techniques, which actually increase seismic forces and accelerations. DIS' Isolated Floors reduce seismic forces. Systems and equipment remain undamaged, operational and online both during and after a seismic event.

Seismic isolation has been utilized to achieve Uptime Institutes Tier 4 rating in seismic zones.

### *Floor heights available from 1 to 4 feet.*

### Configuration

DIS' patented Isolated Floor is comprised of Multi-Directional Springs and high-load capacity rolling supports in standard 4ft x 6ft modules which accommodate standard 2ft x 2ft access floor tiles.



Full scale isolated floor with seismic moat.

Modules are connected with either 2ft, 4ft or 6ft stringers and may be connected on all four sides, allowing for custom configurations.

### *Cable trays incorporated for easy access and organization of utilities.*

Under floor utilities may be organized through incorporated cable trays and remain accessible via standard access floor tiles.



Isolated floor system installed at UC Berkeley.

## DIS Isolated Floor (IF)

### Performance

During a seismic event the Isolated Floor decouples the system from the floor slab. The floor slab moves beneath the Isolated Floor system, eliminating damage to equipment.

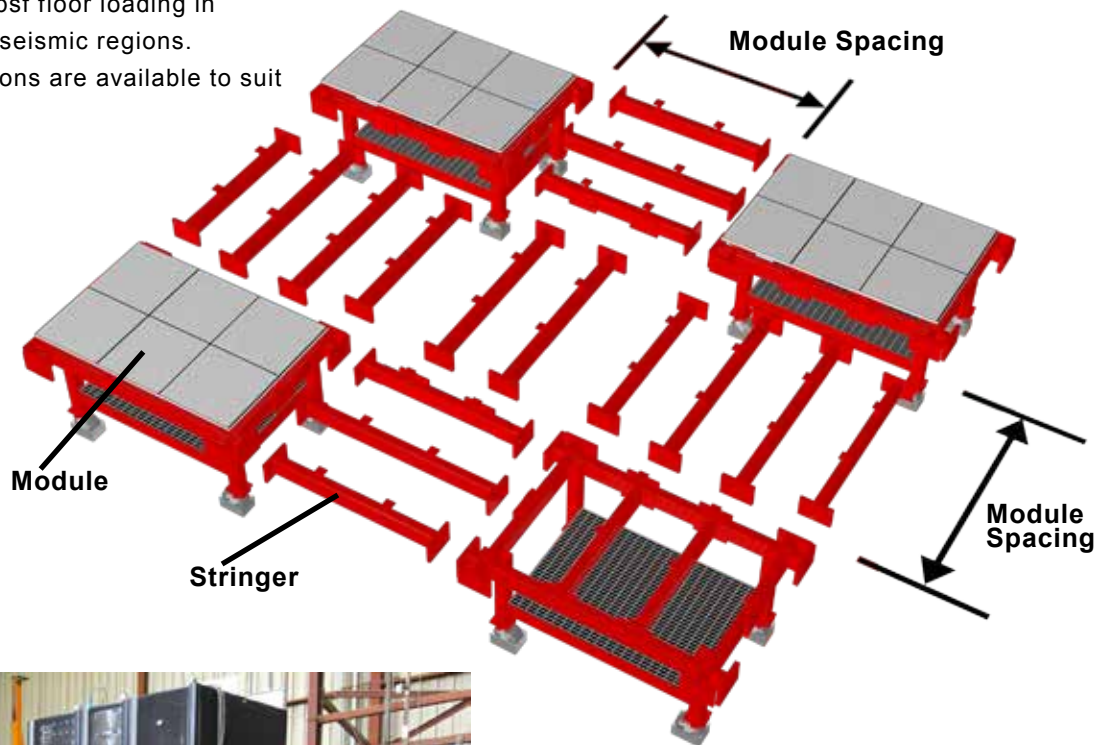
### Isolated Floor Modules

Part No.	Dimensions L x W	Height Range	Module Spacing	Capacity (psf)
IF-100	48" x 72"	12" - 48"	2', 4', 6'	100
IF-200	48" x 72"	18" - 48"	2', 4', 6'	200
IF-300	48" x 72"	24" - 48"	2', 4', 6'	300
IF-400	48" x 72"	24" - 48"	2', 4', 6'	400
IF-500	48" x 72"	24" - 48"	2', 4', 6'	500

Please contact DIS for floor layout details.  
Patent No. US 8,061,692 B1.

***Systems and equipment remain undamaged, operational and online.***

Standard DIS Isolated Floors are designed for 100psf to 500psf floor loading in moderate to high seismic regions. Engineered solutions are available to suit any application.



3D shake table testing of DIS' floor isolation system at the University of California, Berkeley.

### Finished Floor Slab Requirements

- ▶ Dimensions: Plan size 2ft larger than IF to allow for movement
- ▶ Flatness Finish: Ff 50
- ▶ Levelness Finish: FL 30
- ▶ Designed to Support:
  - 3,000 lb. point loads for 100psf areas to
  - 15,000 lb. point loads for 500psf areas



# DIS Modular Isolation System (MIS)

Protect modular data centers from seismic events and downtime.

### Why Use A Modular Isolation System?

Modular data centers are a key component for business operations in today's growing data industry. DIS' Modular Isolation System (MIS) provides protection against server downtime and equipment damage in the event of an earthquake.

**Exceptional performance was seen in a magnitude 7.6 earthquake.**

Installing backup power and having mirrored storage are common practices for protecting data centers and essential equipment.

However, the missing piece of this risk management pie has been the protection from seismic events. This can be provided by DIS' Modular Isolation System.

**Seismic isolation has been used to achieve Uptime Institute's Tier 4 rating in seismic zones.**

Conventional earthquake protection uses strengthening techniques, which actually result in increased seismic forces. The MIS, however, reduces seismic forces. Systems and equipment remain undamaged, operational and online.

**Protection against server downtime and equipment damage.**



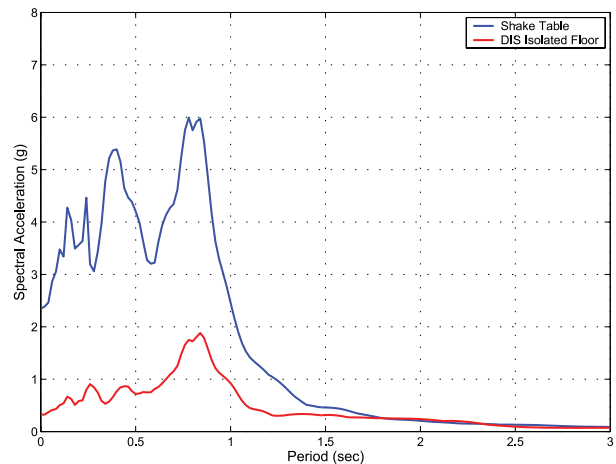
A modular isolation system ready to accept a modular data center.



Modular Data Center In Costa Rica. It performed exceptionally well in a 2012 magnitude 7.6 earthquake.

### Performance

DIS' patented MIS is comprised of Multi-Directional Springs (MDS) and high load capacity rolling supports housed within an attractive steel frame. The frame matches the footprint of a standard modular data center and is only 12" (300mm) tall.



Transmitted accelerations are reduced by up to 5 times.

During seismic events the MIS decouples the data center from the ground and absorbs seismic energy, leaving the data center and its equipment unaffected.

Standard MIS' are designed for 25,000 to 65,000 pound modular data centers in moderate to high seismic regions. Custom solutions are available for any application.

**DIS Modular Isolation System (MIS)**

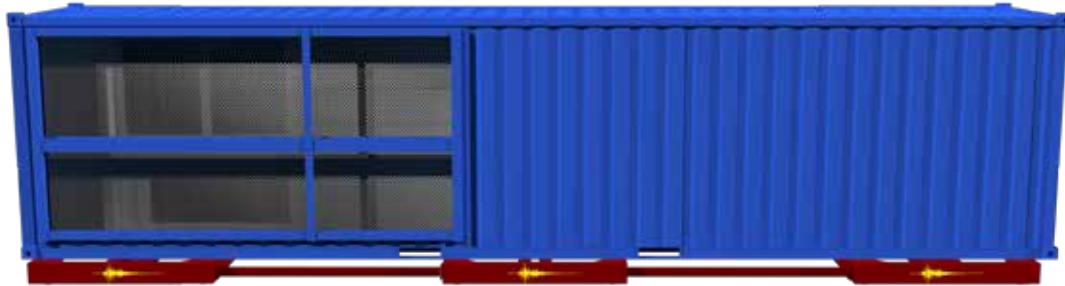
**MIS Options - Standard**

Part No.	Container L x W	Container Weight Range
MIS-20S	20' x 8'	25,000 - 45,000
MIS-40S	40' x 8'	25,000 - 45,000
MIS-53S	53' x 8'	25,000 - 45,000

**MIS Options - Heavy**

Part No.	Container L x W	Container Weight Range
MIS-40H	40' x 8'	45,000 - 65,000
MIS-53H	53' x 8'	45,000 - 65,000

Contact DIS for custom sizes and designs.  
 Patent No. US 8,061,692 B1



MIS-40H and MIS-53H Configuration



MIS-40S and MIS-53S Configuration



MIS-20S Configuration



Dynamic control modules without springs support vertical load and allow seismic movement.



Dynamic control modules with springs support vertical load, control seismic movement, and house DIS' patented Multi-Directional Spring units.

**Concrete Pad requirements**

- ▶ Dimensions: Container size plus 2ft perimeter
- ▶ Flatness Finish: FF 50
- ▶ Levelness Finish: FL 30
- ▶ Designed to support: 10,000 lb. point loads



## Frequently Asked Questions

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### What are the benefits of seismic isolation?

Typical force and acceleration reductions are on the order of 3 to 5 times and can be as much as 20 times.

### What are the maintenance requirements?

DIS isolation systems are maintenance free devices. The area surrounding the devices should be checked periodically to ensure the system can freely translate during a seismic event.



### Are special contractors required for installation?

DIS isolation devices are installed by general contractors and facilities or maintenance crews. Most connections are simply bolted together and anchored to the floor. Detailed installation manuals are provided with all systems and DIS offers on-site installation support.

### What testing has been performed?

DIS' various isolation systems have been extensively shake table tested at university laboratories and independent certification laboratories under full load and earthquake conditions over the past decade.



### Is replacement required after a seismic event?

DIS isolation systems are capable of protecting against multiple large scale events and do not require replacement after an earthquake.

### Has DIS ever had a failure in the field?

DIS has completed hundreds of isolation projects on some of the most high-profile projects in the world, dozens of which have been subjected to seismic events. All systems performed as expected and none have required replacement after an earthquake.



### Are there limits to DIS isolation systems use?

DIS team of international experts in the field of seismic isolation verify that every project receives the solution that best fits its specific needs.

### What about cables and utilities?

Overhead cable trays for utilities can be incorporated into Isolated Platform systems and under floor cable trays for utilities can be incorporated into Isolated Floor systems.

### Are custom designs available?

DIS specializes in custom design applications and can offer a full range of design, detailing, and manufacturing services, including stamping by a licensed engineer if required.



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 The World Leader in Seismic Protection.

$$e_p := 6.0$$

$$D := 20.5 \cdot in$$

$$D = 520.7 \text{ mm}$$

$$N := 30$$

Lead := yes

$$t_p := 0.1046 \cdot in$$

$$t_p = 2.62 \text{ mm}$$

$$t_s := 0.236 \cdot in$$

$$t_s = 2.7 \text{ mm}$$

$$e_s := 0.75 \cdot in$$

$$t_s = 6.0 \text{ mm}$$

$$e_s = 19.1 \text{ mm}$$

$$t_{hp} := 1 \cdot in$$

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$$t_{hp} := 1 \cdot in$$

$$t_{hp} = 25.4 \text{ mm}$$

$$t_{hp} := 1 \cdot in$$

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OPERATIONS MANAGER APPROVAL	(Signature)

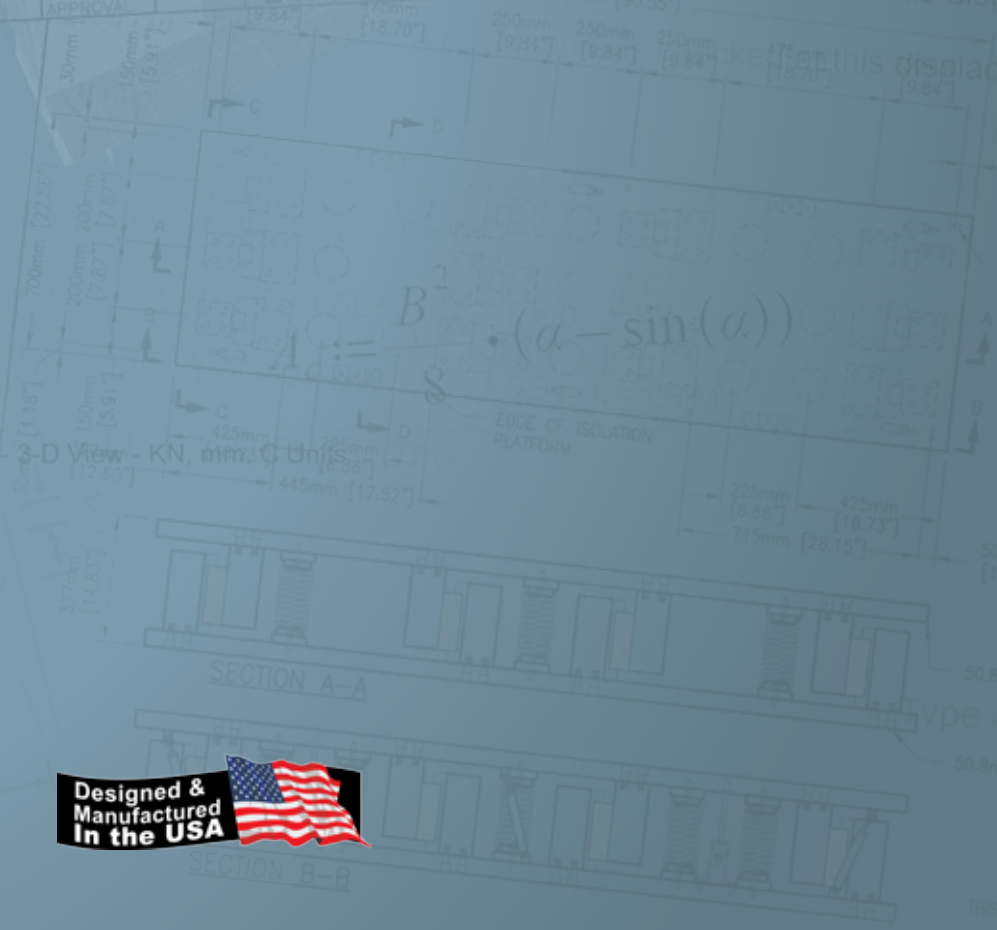
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$$q_c := \frac{\phi}{B} \cdot \left( \frac{B}{4} - \frac{x \cdot B}{2} \right) \cdot E$$

$$\alpha := 2 \cdot \arccos \left( \frac{2 \cdot x \cdot B}{B} \right)$$

$$C := A_c \cdot q_c$$

$$N_t := \frac{N_{bolt}}{4}$$





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