Attachment of Equipment to Restraints

Introduction:

Restraints can be attached to equipment in a number of ways. The most obvious is by directly bolting the equipment mounting face or stud on the restraint devise to the equipment via a factory provided hole in the equipment. Unfortunately many pieces of equipment (particularly those not initially designed for seismic service) do not include mounting provisions. In some cases, several independent components make up the piece of equipment and often, if provided, holes are not well located or of appropriate size for direct connection to the restraint device.

Wherever the restraints are attached to the equipment, the equipment manufacturer must offer assurances that the application of seismically generated forces at these locations will not exceed the structural capabilities of the equipment. When reviewing the forces, the manufacturer must take into account shear, tensile and bending forces at the connection points.

Equipment Directly Bolted to Restraints:

Where equipment can be directly bolted to the restraints and where the pattern is reasonably appropriate, this is the most appropriate method to use. The installer should refer to the certification that was performed on that particular piece of equipment and ensure that the number of attachment points and geometry used are consistent with the mounting pattern on the equipment. If the computation addressed several similar pieces of equipment, the spacing used would have been the smallest of all of those included in the analysis (as this would be the worst case). As such, if the actual bolt pattern found on the equipment is larger than that used in the analysis, mounting using the larger pattern is quite acceptable and would not negate the analysis.

It is further assumed, when performing an analysis or certification, that the hardware used matches the holes or studs in the restraint device. It is not permitted to downsize this hardware relative to that originally intended for the restraint. If the hole in the equipment is larger than the restraint hardware, it must be "fitted" to the bolt used in the restraint. This can be done by welding a washer plate to the equipment, adding a sleeve or using a grommet such as the Kinetics "TG" grommet. The hole size cannot exceed the nominal hardware diameter by more than 1/8".

If the hole in the equipment is smaller than the size required by the restraint, it must either be enlarged (with the equipment manufacturer's knowledge and permission) or the equipment must be fitted with an appropriately sized adapter to allow the use of the larger hardware.

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Equipment Welded to Restraints:

In many instances, there is no provision for bolt down attachment of the equipment, the arrangement is not conducive to seismic restraint or the bolt attachment provisions are simply inadequate. In these cases, welding is the most common method of attachment. Optional welding information is provided on Kinetics Noise Control's standard Certification document. Where this information is not provided, but the acceptable bolt size is known and bending forces are not significant, the following table can be used to size the weld based on the bolt size.

	Weld Equivalents to A307 Hardware					Weld Equivalents to A325 Hardware				
Bolt Dia	1/8 Weld	3/16 Weld	1/4 Weld	3/8 Weld	1/2 Weld	1/8 Weld	3/16 Weld	1/4 Weld	3/8 Weld	1/2 Weld
0.25	1.11	0.74	0.56	0.37	0.28	2.44	1.63	1.22	0.81	0.61
0.375	2.50	1.67	1.25	0.83	0.62	5.50	3.67	2.75	1.83	1.37
0.5	4.44	2.96	2.22	1.48	1.11	9.78	6.52	4.89	3.26	2.44
0.625	6.94	4.63	3.47	2.31	1.74	15.27	10.18	7.64	5.09	3.82
0.75	10.00	6.67	5.00	3.33	2.50	22.00	14.66	11.00	7.33	5.50
0.875	13.61	9.07	6.80	4.54	3.40	29.94	19.96	14.97	9.98	7.48
1	17.77	11.85	8.89	5.92	4.44	39.10	26.07	19.55	13.03	9.78

Weld Length in Inches that are Equivalent to 1 Bolt

When using the above table, each weld used should be approximately centered at the restraint location indicated in the analysis. In addition the leg size must not be larger in size than the thickness of either of the materials that are being welded together. Welds should be made to structural members within the equipment and should not be performed without the knowledge and approval of the equipment manufacturer.

Intermediate Structure:

Intermediate structures are used for a number of reasons. First, cases where the equipment is not structurally adequate for the direct attachment of the restraints. Second, cases where the equipment is "floated" on springs and there are multiple individual components that must be held in proper alignment with one another. Occasions when mass must be added to the system for stability can require an intermediate structure and lastly, when the type of restraint or isolator desired is not directly compatible with the type of mounting arrangement available on the equipment.

If an intermediate structure is fitted, this structure must be designed to withstand the full local restraint loads at their points of attachment and must interface with the equipment in such a fashion that the forces transmitted to the equipment are within the structural capabilities of the equipment. One of the biggest benefits of the use of intermediate frames is to distribute the high point loads (and often bending loads) that can be applied

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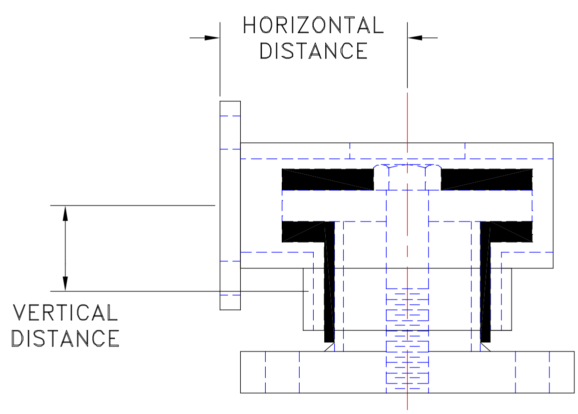
by the restraint components over several connections to the equipment. In the case of bending loads, intermediate structures can sometimes prevent them from being transmitted into the equipment at all.

Cautions and Equipment Durability Design Factors:

When connecting restraints to equipment, they must be connected in such a way as to be "permanently" connected. They cannot be connected to removable panels, doors or covers. They also must not be located in such a way that they obstruct removable panels, doors or covers.

Care must be taken to ensure that the equipment has the capability to resist the seismic loads (particularly bending). Shear and Tensile forces can be obtained directly from Certification documents. These forces act at the center of the snubbing elements in the restraint device. Bending can be determined by factoring in the distance in the horizontal and vertical axis between the center of the snubbing element and the center of the mounting face or stud at the equipment surface.

The maximum moment that the equipment must be capable of withstanding is the sum of the horizontal and vertical moments. The Horizontal moment is the peak horizontal force from the analysis multiplied by the vertical distance from the snubber centerline to the center of the mounting surface face. This must be added to the peak vertical force multiplied by the horizontal distance between the snubber centerline and the center of the mounting surface face.



For floor mounted equipment, the peak vertical force is compressive and depending on the restraint type, may not be the uplift force listed in the standard certification document. If the restraint is separate from the support system or if the spring force is not trapped within the isolator housing (For example an FHS without an oversized baseplate), the uplift force is the appropriate number to use. If the support system does not include a spring or if a spring is used, but it is trapped within a restraint housing (For example and

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FLS), the peak vertical force equals the dead load (expressed as a positive number) plus the uplift force as listed in the standard certification document.

Below is listed some typical output data in which the worst case location is Loc 4. For it, the peak horizontal force would be 775 lb. If the restraint device in this instance included a fully contained spring coil (like an FLS) the peak vertical force would be 976 *(The static load expressed as a positive number),* + 728 *(the uplift load)* according to the procedure above. In this case, it works out to be 1704 lb.

Output Data

Certification Loads (Seismic) (lb)	Loc 1	Loc 2	Loc 3	Loc 4
Static Load	**-552**	**-685**	**-787**	**-976**
Max Uplift Load at Loc:	**728**	**728**	**728**	**728**
Max Horiz Load at Loc:	**439**	**544**	**625**	**775**
Effective Corner Wt	**-553**	**-686**	**-787**	**-976**

Calculated Restraint Safety Factors (Must be greater than or equal to 1)	Loc 1	Loc 2	Loc 3	Loc 4
Restraint SF if Welded to Steel	**2.04**	**1.86**	**1.73**	**1.53**
Restraint SF if Bolted to Steel	**2.04**	**1.86**	**1.73**	**1.53**
Restraint SF if Anchored to Concrete	**.36**	**.34**	**.32**	**.29**
Anchor/Attachment Bolt Size/Qty	**0.375 / 2**	**0.375 / 2**	**0.375 / 2**	**0.375 / 2**
Min Anchor Embedment Req'd	**3"**	**3"**	**3"**	**3"**

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