Force Class for Hanging Piping, Ductwork, Conduit and Equipment

The Kinetics Noise Control "Force Class" design guide is used to size components for use in seismically rated piping and ductwork systems. Addressed in this documentation are guidelines for sizing restraints, hanger rods, rod stiffeners, and anchorage for seismic applications. The guide is quite comprehensive and contains a significant level of detail to allow all aspects of the restraint and anchorage to be optimized where awkward geometry or critical conditions not obvious during the design process occur. The guide can also be used to identify a more standardized, yet conservative, selection of components that would be appropriate for most or all of the restraint locations for a given system.

Components provided by Kinetics, unless otherwise noted, will be sized for these more standardized conditions. In general these are "worst case" conditions depending primarily on the pipe sizes to be restrained with some adjustment for the system's elevation in the structure. Components provided by Kinetics will be cable systems based on 60 degree (worst case) restraint cable angles in conjunction with the longest allowable spans (per SMACNA). In cases where there are a significant number or items trapezed together, components will be selected based on total weight and indications will be included on drawings as appropriate showing where these conditions exist.

The tables described below are shown in the remaining sections of Chapter D4 of this manual. *Note that Tables 1 and 1A are samples and will vary from project to project.*

Tables 1 and 1A – Force Class and Load Determination Tables
Knowing duct size, pipe size, or weight per linear foot of the system being restrained, this series of tables allows the end user to determine or verify the ***Force Class*** rating of the properly sized restraint component. This document is tailored with seismic factors appropriate to the particular project under review, and as such is not applicable to other projects.

The key information listed on this document is in the right-hand column. At the top***, Force Classes*** are identified and corresponding force values in pounds are listed. Below this is the design force in g's for the project in question. The forces are broken down for various elevations within the structure as the forces vary with elevation.

The bottom six tables are set up based on six different restraint spacings. These tables indicate, for systems with a known weight per linear foot and a known spacing between restraints, the required ***Force Class*** rating of the restraint components. The tables offer guidance for 10, 20, 30, 40, 60, and 80 foot restraint spacings.

In the left hand column is reference information that offers a guide to determining the weight per foot for various pipe and duct components. Individual pipe or duct weights can be read directly off the table. For trapezed systems, the combined total weights per foot

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of the individual pipe or duct components should be used.

For applications where "fine tuning" of the components is desired, a second similar table (Table 1A) is available listing the actual force (rather than ***Force Class***). In many cases, this table can be used to justify the use of smaller restraint components for particular locations. Linear interpolation between various weights and spacings is permitted.

Table 2 – Maximum Permitted Restraint Spacing for Piping and Ductwork

There are four tables that make up this family. They address the maximum axial and lateral spacing for piping and conduit (two tables) and ductwork (two tables).

In order to use these tables, the design seismic force in g's or the applicable SMACNA SHL level must be known. g values for various floors are listed in Table 1.

Table 3 – Maximum Permitted Offset in a run and Drop Length for Piping and Ductwork

There are two sets of two tables each that make up this family. They address the maximum allowable centerline offset in a "run" (on the first table) and the maximum drop length that can be left unrestrained (on the second table). One set is for piping/conduit and the other is for ductwork.

As with Table 2, in order to use these tables, the design seismic force in g's or the SMACNA SHL level must be known. See the g values listed for various floors in Table 1.

Tables 4A and 4B – Hanger Rod Sizes and Stiffeners

The two tables that make up 4A indicate the minimum required hanger rod and hanger rod anchor sizes based the tensile forces that result from the static deadweight load in the hanger rod in conjunction with the added seismic force component. In order to use these tables the ***Force Class*** (from Table 1) and the static deadweight load per hanger rod (weight per foot of the supported pipe/conduit/ductwork multiplied by the spacing between hangers [divided by 2 if two supports carry the load]) are needed.

In addition, if a rigid member is used in lieu of cables for restraint, the angle between the strut and the horizontal plane becomes a factor. The angle information is not needed for cable restraints.

Table 4B allows hanger rod stiffeners to be appropriately sized. The upper portion of the table indicates the maximum unstiffened hanger rod length for a given location. The required input information is the ***Force Class*** (Table 1), the hanger rod diameter (as installed, but per Table 4a minimum) and the angle between the horizontal plane and the restraint cable or strut (as installed, but not to exceed 60 degrees).

If the listed maximum unstiffened hanger rod length has been exceeded, a stiffener is required. The lower portion of Table 4B indicates the increase allowed in hanger rod

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length for various sizes and types of stiffeners. Detailed instructions walk the user through the process. For instance, a .62 dia rod stiffened with a .75 dia schedule 40 pipe lists a factor of 2. This indicates that the listed maximum unstiffened hanger rod length (based on ***Force Class***) can be doubled if the hanger rod is fitted with the .75 dia schedule 40 pipe.

(Note: KNC does not provided hanger rods or stiffeners. These items are by others. KNC does provide hanger rod anchors and stiffener attachment hardware.)

Table 4C – Seismic Strut Sizing Table

This table indicates the maximum permitted length for various restraint strut materials subjected to loads as determined by the ***Force Class*** (Table 1) and strut angle (from the horizontal plane).

(Note: KNC does not provide strut members, but does provide hardware that can be used to attach struts made of angle material. Standard KNC-provided components are based on cable restraint systems.)

Table 5 – Cable and Restraint Anchorage Capacity Data

In the upper right portion of this document, cable restraint capacities by ***Force Class*** are listed for various diameter cables (1/8" to 1/2") installed at various angles relative to the horizontal plane (up to a worst case of 60 degrees).

In the left-hand column are capacities for KNC-provided attachment clips and anchors (full embedment of 8 times anchor diameter is assumed). Required input is the ***Force Class*** (Table 1) and restraint cable angle to the horizontal. Data is provided for single anchor, double anchor and quad anchor arrangements.

The lower right-hand column contains similar information, but it is based on the use of through bolts to anchor to the structure in lieu of an anchor bolt.

Also included is a supplement to this table (Table 5A). 5A lists the same information as Table 5 except that the force capacities are listed in lieu of the ***Force Class***. This table can be used in conjunction with the required force table (Table 1A) to potentially "fine tune" the system. Linear interpolation between the parameters listed in table 5A is permitted.

For other information and guidance on the installation of restrained equipment and systems, FEMA Manual 412 should be consulted. The manual is available without charge directly from FEMA (1-800-480-2520) or through Kinetics Noise Control. Kinetics Noise Control takes no responsibility for installations not in compliance with this document or other Kinetics-supplied documentation.

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