TABLE OF CONTENTS

KINETICS Noise Control
Toll Free (USA Only): 800-959-1229
International: 614-889-0480
FAX 614-889-0540
World Wide Web: www.kineticsnoise.com
E-mail: sales@kineticsnoise.com
Dublin, Ohio, USA ▪ Mississauga, Ontario, Canada

Section	Title

KINETICS Noise Control
Toll Free (USA Only): 800-959-1229
International: 614-889-0480
FAX 614-889-0540
World Wide Web: www.kineticsnoise.com
E-mail: sales@kineticsnoise.com
Dublin, Ohio, USA ▪ Mississauga, Ontario, Canada

KINETICS Noise Control
Toll Free (USA Only): 800-959-1229
International: 614-889-0480
FAX 614-889-0540
World Wide Web: www.kineticsnoise.com
E-mail: sales@kineticsnoise.com
Dublin, Ohio, USA ▪ Mississauga, Ontario, Canada

INTRODUCTION

The purpose of this manual is to provide design professionals, contractors, and building officials responsible for the MEP, Mechanical, Electrical, and Plumbing, with the information and guidance required to ensure that the seismic restraints required for a specific project are selected and/or designed, and installed in accordance with the provisions code. This guide will be written in several easily referenced sections that deal with specific portions of the code.

This guide is based on the International Building Code (IBC). The 2000 IBC and the 2003 IBC are very similar, and in fact are almost identical. When they are referenced in this manual, it will be as 2000/2003 IBC. The latest version of the IBC that is currently being adopted by the various states is 2006 IBC. This is the version that will form the core basis for this manual. When appropriate the differences between the 2006 IBC and the 2000/2003 IBC will be pointed out. The intent is to have a working guide that is based on the current 2006 IBC, but is also relevant to the 2000/2003 IBC. The code based requirements for the restraint of pipe and duct are found in the following references.

1. 2007 ASHRAE HANDBOOK – Heating, Ventilating, and Air-Conditioning Applications; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., 1791 Tullie Circle, N.E. Atlanta, GA 30329, 2007; Chapter 54 Pp 54-11 and 54-12.
2. 2000 International Building Code; International Code Council, 5203 Leesburg Pike, Suite 708, Falls Church, Virginia, 22041-3401; 2000.
3. ASCE 7-98 Minimum Design Loads for Buildings and Other Structures; American Society of Civil Engineers, 1801 Alexander Bell Drive, Reston, Virginia 20191-4400, Chapter 9.
4. 2003 International Building Code; International Code Council, Inc., 4051 West Flossmoor Road, Country Club Hills, Illinois 60478-5795; 2002.
5. ASCE/SEI 7-02 Minimum Design Loads for Buildings and Other Structures; American Society of Civil Engineers, 1801 Alexander Bell Drive, Reston, Virginia 20191-4400, Chapter 9.

KINETICS Noise Control
Toll Free (USA Only): 800-959-1229
International: 614-889-0480
FAX 614-889-0540
World Wide Web: www.kineticsnoise.com
E-mail: sales@kineticsnoise.com
Dublin, Ohio, USA ▪ Mississauga, Ontario, Canada

6. 2006 International Building Code; International Code Council, Inc., 4051 West Flossmoor Road, Country Club Hills, Illinois 60478-5795; 2006.
7. ASCE/SEI 7-05 Minimum Design Loads for Buildings and Other Structures; American Society of Civil Engineers, 1801 Alexander Bell Drive, Reston, Virginia 20191-4400, Chapters 1, 2, 11, 13, 20, and 21.
8. SMACNA, Seismic Restraint Manual – Guidelines for Mechanical Systems with Addendum No. 1 2nd Edition; Sheet Metal and Air Conditioning Contractors' National Association, Inc., 4201 Lafayette Center Drive, Chantilly, Virginia 20151-1209, 1998.
9. UNIFIED FACILITIES CRITERIA (UFC) – Seismic Design for Buildings; United States Department of Defense Document UFC 3-310-03A, 1 March 2005; Table 3-3, Pp 3-13 – 3-17.

The selection and installation of the proper seismic restraints for MEP systems requires good coordination with the design professionals and contractors involved with the building project. A good spirit of cooperation and coordination is especially required for projects that have been designated as essential facilities, such as hospitals, emergency response centers, police and fire stations. Coordination between the various design professionals and contractors will be a constant theme throughout this guide. This coordination is vital for the following reasons.

1. The seismic restraints that are installed for a system can and will interfere with those of another unless restraint locations are well coordinated.
2. The space required for the installed restraints can cause problems if non-structural walls need to be penetrated, or other MEP components are in the designed load path for the restraints.
3. The building end of the seismic restraints must always be attached to structure that is adequate to carry the code mandated design seismic loads. It is the responsibility of the structural engineer of record to verify this.

Toll Free (USA Only): 800-959-1229
International: 614-889-0480
FAX 614-889-0540
World Wide Web: www.kineticsnoise.com
E-mail: sales@kineticsnoise.com
Dublin, Ohio, USA ▪ Mississauga, Ontario, Canada

REQUIRED BASIC PROJECT INFORMATION

D2.1 – 2.1 Introduction:

As with any design job, there is certain basic information that is required before seismic restraints can be selected and placed. The building owner, architect, and structural engineer make the decisions that form the basis for the information required to select the seismic restraints for the pipe and duct systems in the building. This is information that should be included in the specification and bid package for the project. It also should appear on the first sheet of the structural drawings. For consistency, it is good practice to echo this information in the specification for each building system, and on the first sheet of the drawings for each system. In this fashion, this information is available to all of the contractors and suppliers that will have a need to know.

D2.1 – 2.2 Building Use – Nature of Occupancy (Section 1.5) [Section 1.5][1]:

How a building is to be used greatly affects the level of seismic restraint that is required for the MEP (Mechanical, Electrical, and Plumbing) components. In the 2006 IBC the building use is defined through the Occupancy Category, which ranges from I to IV. Occupancy Category I is applied to buildings where failure presents a low hazard to human life. At the other end of the range, Occupancy Category IV is applied to buildings which are deemed to be essential. In the previous two versions of the IBC (2000/2003), the building use was defined though the Seismic Use Group which varied from I to III. Table 1-1 of ASCE 7-98/02 and ASCE 7-05 describes which types of buildings are assigned to which Occupancy Category. Table 2-1 below summarizes the information found in Tables 1-1 and 9.1.3 of ASCE 7-98/02 and Table 1-1 of ASCE 7-05, and ties the Seismic Use Group from the previous versions of the IBC to the Occupancy Category. The nature of the building use, or its Occupancy Category, is determined by the building owner and the architect of record.

[1] References in brackets (Section 1.5) and [Section 1.5] apply to sections, tables, and/or equations in ASCE 7-98/02 ASCE 7-05 respectively which forms the basis for the seismic provisions in 2000/2003 IBC and 2006 IBC respectively.

Toll Free (USA Only): 800-959-1229
International: 614-889-0480
FAX 614-889-0540
World Wide Web: www.kineticsnoise.com
E-mail: sales@kineticsnoise.com
Dublin, Ohio, USA ▪ Mississauga, Ontario, Canada

Table 2-1; Building Use vs. Occupancy Category & Seismic Use Group (Table 1-1, Table 9.1.3) [Table 1-1]

Occupancy Category 2000/2003 & 2006 IBC	Seismic Use Group 2000/2003 IBC	Building Use or Nature of Occupancy
I	I	Buildings and structures in which failure would pose a low hazard to human life. These buildings include, but are not limited to: Ø Agricultural buildings and structures. Ø Certain temporary buildings and structures. Ø Minor storage buildings and structures.
II		Buildings and structures that are not listed as Occupancy Category I, III, or IV. Also, cogeneration power plants that do not supply power to the national power grid.
III	II	Buildings and structures, in which failure would pose a substantial hazard to human life, have the potential to create a substantial economic impact, and/or cause a mass disruption of day-to-day civilian life. These buildings include, but are not limited to: Ø Where more than 300 people congregate in one area. Ø Daycare facilities with a capacity greater than 50. Ø Elementary and Secondary school facilities with a capacity greater than 250 and colleges and adult educational facilities with a capacity greater than 500. Ø Healthcare facilities with 50 or more resident patients that do not have surgery or emergency treatment facilities. Ø Jails, prisons, and detention facilities. Ø Power generation stations. Ø Water and sewage treatment facilities. Ø Telecommunication centers. Buildings and structures which are not in Occupancy Category IV which contain enough toxic or explosive materials that would be hazardous to the public if released.
IV	III	Buildings and structures which are designated as essential facilities which include but are not limited to: Ø Hospitals & healthcare facilities with surgical or emergency treatment facilities. Ø Fire, rescue, ambulance, police stations, & emergency vehicle garages. Ø Designated emergency shelters. Ø Facilities designated for emergency preparedness & response. Ø Power generating stations and other public utilities required for emergency response and recovery. Ø Ancillary structures required for the continued operation of Occupancy Category IV buildings and structures. Ø Aviation control towers, air traffic control centers, and emergency aircraft hangers. Ø Water storage facilities and pumping stations required for fire suppression. Ø Buildings and structures required for national defense. Ø Buildings and structures that contain highly toxic and/or explosive materials in sufficient quantity to pose a threat to the public.

Toll Free (USA Only): 800-959-1229
International: 614-889-0480
FAX 614-889-0540
World Wide Web: www.kineticsnoise.com
E-mail: sales@kineticsnoise.com
Dublin, Ohio, USA ▪ Mississauga, Ontario, Canada

D2.1 – 2.3 Site Class – Soil Type (Sections 9.4.1.2.1, 9.4.1.2.2) [Section 11.4.2 & Chapter 20]:

The Site Class is related to the type of soil and rock strata that directly underlies the building site. The Site Class ranges from A to F progressing from the stiffest to the softest strata. Table 2-2 lists the various Site Classes and their corresponding strata.

Generally the structural engineer is responsible for determining the Site Class for a project. If the structural engineer's firm does not have a geotechnical engineer on staff, this job will be contracted to a geotechnical firm. The Site Class is determined in accordance with the references stated above from ASCE 7-98/02 and ASCE 7-05. The site profile is normally obtained by drilling several cores on the property. If there is insufficient information concerning the soil properties, then the default Site Class D is assigned to the project.

Table 2-2; Site Class vs. Soil Type (Table 9.4.1.2) [Table 20.3-1]

Site Class	Soil Type
A	Hard Rock
B	Rock
C	Very Dense Soil & Soft Rock
D	Stiff Soil (Default Site Class)
E	Soft Clay Soil
F	Liquefiable Soils, Quick Highly Sensitive Clays, Collapsible Weakly Cemented Soils, & etc. These require site response analysis.

D2.1 – 2.4 Mapped Acceleration Parameters (Sections 9.4.1.2.4 & 9.4.1.2.5) [Sections 11.4.3 & 11.4.4 and Chapters 21 & 22]

The United States Geological Survey, USGS, has mapped all of the known fault lines in the United States and its possessions. They have assigned ground level acceleration values to each location based on the Maximum Considered Earthquake, MCE, for two earthquake periods, 0.2 sec and 1.0 sec, at 5% damping. The mapped values are listed in terms of %g, where 1g is 32.2 ft/sec^2, 386.4 in/sec^2, 9.8 m/sec^2. The long period values are generally applied to the buildings and other

KINETICS Noise Control
Toll Free (USA Only): 800-959-1229
International: 614-889-0480
FAX 614-889-0540
World Wide Web: www.kineticsnoise.com
E-mail: sales@kineticsnoise.com
Dublin, Ohio, USA ▪ Mississauga, Ontario, Canada

structures since they react more strongly to the long period excitation due to their relatively high mass and low stiffness. The code specifies the use of short period values when evaluating non-structural components, which include pipe and duct, as they respond more strongly to the short period excitation due to their relatively low mass and high stiffness.

The Mapped Acceleration Parameters are available in ASCE 7-98/02 for 2000/2003 IBC and ASCE 7-05 for 2006 IBC, or may be obtained from the USGS cataloged by ZIP Code. The short period Mapped Acceleration Parameter is usually denoted as S_S and the Long period Mapped Acceleration Parameter is denoted as S_1. Note that the values for S_S and S_1 may be different for 2000/2003 IBC and 2006 IBC. Be sure the correct values are being used for the code that is in force in your jurisdiction.

<u>Special Note:</u> For the purpose of making preliminary estimates, the long and short period mapped acceleration parameters for selected U. S. cities are given in Table 2.4, and for selected international cities in Table 2.5. Please be aware that these values do not necessarily represent the maximum acceleration values that may occur in the named cities. For the U. S. cities please refer to the data compiled by the USGS by ZIP CODE. For international locations, local geological assessments should be sought from reputable sources at that location.

The Site Class information is then used to determine the Design Spectral Acceleration Parameters, S_{DS} and S_{D1}, for the short and long period MCE respectively. Equations 2-1 and 2-2 may be used to estimate the Design Spectral Acceleration Parameters.

$$S_{DS} = \frac{2}{3} F_a S_S$$ **Equation 2-1 (9.4.1.2.4-1) [11.4-3]**

And

KINETICS Noise Control
Toll Free (USA Only): 800-959-1229
International: 614-889-0480
FAX 614-889-0540
World Wide Web: www.kineticsnoise.com
E-mail: sales@kineticsnoise.com
Dublin, Ohio, USA ▪ Mississauga, Ontario, Canada
RELEASED ON: 05/06/2008

$$S_{D1} = \frac{2}{3} F_v S_1$$ **Equation 2-2 (9.4.1.2.4-2) [11.4-5]**

Where:

F_a = the short period Site Coefficient which is listed in Table 2-5. The values for F_a which correspond to values of S_S that fall between those listed in Table 2-5 may be obtained through linear interpolation.

F_v = the long period Site Coefficient which is listed in Table 2-6. The values for F_v which correspond to values of S_1 that fall between those listed in Table 2-6 may be obtained through linear interpolation.

S_{DS} = the Design Short Period Spectral Acceleration Parameter which has been corrected for the Site Class.

S_{D1} = the Design Long Period Spectral Acceleration Parameter which has been corrected for the Site Class.

S_S = the Mapped Short Period Acceleration Parameter for the MCE @ 5% damping.

S_1 = the Mapped Long Period Acceleration Parameter for the MCE @ 5% damping.

If not otherwise listed for the project, the structural engineer should be contacted for the values of S_{DS} and S_{D1}. These values are not only required to determine the design accelerations, but also to determine the Seismic Design Category for the building, which will be discussed next.

KINETICS Noise Control
Toll Free (USA Only): 800-959-1229
International: 614-889-0480
FAX 614-889-0540
World Wide Web: www.kineticsnoise.com
E-mail: sales@kineticsnoise.com
Dublin, Ohio, USA ▪ Mississauga, Ontario, Canada

Table S2-3; Mapped Acceleration Parameters for Selected U.S. Cities 2000/2003 IBC & 2006 IBC

State, City	ZIP CODE	S_S 2000 2003	S_S 2006	S_1 2000 2003	S_1 2006
Alabama	-------	------	------	------	------
Birmingham	35217	0.33	0.31	0.12	0.10
Mobile	36610	0.13	0.12	0.06	0.05
Montgomery	36104	0.17	0.16	0.08	0.07
Arkansas	-------	------	------	------	------
Little Rock	72205	0.48	0.50	0.18	0.16
Arizona	-------	------	------	------	------
Phoenix	85034	0.23	0.19	0.07	0.06
Tucson	85739	0.33	0.29	0.09	0.08
California	-------	------	------	------	------
Fresno	93706	0.76	0.78	0.30	0.29
Los Angeles	90026	1.55	2.25	0.60	0.83
Oakland	94621	1.98	1.97	0.87	0.77
Sacramento	95823	0.59	0.64	0.23	0.25
San Diego	92101	1.61	1.62	0.86	0.82
San Francisco	94114	1.50	1.61	0.86	0.82
San Jose	95139	2.17	1.60	0.78	0.60
Colorado	-------	------	------	------	------
Colorado Springs	80913	0.18	0.22	0.06	0.06
Denver	80239	0.19	0.21	0.06	0.06
Connecticut	-------	------	------	------	------
Bridgeport	06606	0.34	0.27	0.09	0.06
Hartford	06120	0.27	0.24	0.09	0.06
New Haven	06511	0.29	0.25	0.08	0.06
Waterbury	06702	0.29	0.25	0.09	0.06
Florida	-------	------	------	------	------
Ft. Lauderdale	33328	0.07	0.06	0.03	0.02
Jacksonville	32222	0.14	0.14	0.07	0.06
Miami	33133	0.06	0.05	0.02	0.02
St. Petersburg	33709	0.08	0.07	0.04	0.03
Tampa	33635	0.08	0.07	0.03	0.03
Georgia	-------	------	------	------	------
Atlanta	30314	0.26	0.23	0.11	0.09
Augusta	30904	0.42	0.38	0.15	0.12
Columbia	31907	0.17	0.15	0.09	0.07
Savannah	31404	0.42	0.43	0.15	0.13
Iowa	-------	------	------	------	------
Council Bluffs	41011	0.19	0.18	0.09	0.08
Davenport	52803	0.13	0.13	0.06	0.06
Des Moines	50310	0.07	0.08	0.04	0.04
Iowa	-------	------	------	------	------
Boise	83705	0.35	0.30	0.11	0.10
Pocatello	83201	0.60	0.63	0.18	0.19

State, City	ZIP CODE	S_S 2000 2003	S_S 2006	S_1 2000 2003	S_1 2006
Illinois	-------	------	------	------	------
Chicago	60620	0.19	0.17	0.07	0.06
Moline	61265	0.14	0.14	0.06	0.06
Peoria	61605	0.18	0.18	0.09	0.08
Rock Island	61201	0.13	0.13	0.06	0.06
Rockford	61108	0.17	0.15	0.06	0.06
Springfield	62703	0.27	0.29	0.12	0.11
Indiana	-------	------	------	------	------
Evansville	47712	0.82	0.72	0.23	0.21
Ft. Wayne	46835	0.17	0.15	0.06	0.06
Gary	46402	0.18	0.16	0.07	0.06
Indianapolis	46260	0.18	0.19	0.09	0.08
South Bend	46637	0.12	0.12	0.06	0.05
Kansas	-------	------	------	------	------
Kansas City	66103	0.12	0.13	0.06	0.06
Topeka	66614	0.19	0.17	0.06	0.05
Wichita	67217	0.14	0.14	0.06	0.05
Kentucky	-------	------	------	------	------
Ashland	41101	0.22	0.19	0.09	0.07
Covington	41011	0.19	0.18	0.09	0.08
Louisville	40202	0.25	0.25	0.12	0.10
Louisiana	-------	------	------	------	------
Baton Rouge	70807	0.14	0.12	0.06	0.05
New Orleans	70116	0.13	0.11	0.06	0.05
Shreveport	71106	0.17	0.15	0.08	0.07
Massachusetts	-------	------	------	------	------
Boston	02127	0.33	0.28	0.09	0.07
Lawrence	01843	0.38	0.33	0.09	0.07
Lowell	01851	0.36	0.31	0.09	0.07
New Bedford	02740	0.26	0.22	0.08	0.06
Springfield	01107	0.26	0.23	0.09	0.07
Worchester	01602	0.27	0.24	0.09	0.07
Maryland	-------	------	------	------	------
Baltimore	21218	0.20	0.17	0.06	0.05
Maine	-------	------	------	------	------
Augusta	04330	0.33	0.30	0.10	0.08
Portland	04101	0.37	0.32	0.10	0.08
Michigan	-------	------	------	------	------
Detroit	48207	0.12	0.12	0.05	0.04
Flint	48506	0.09	0.09	0.04	0.04
Grand Rapids	49503	0.09	0.09	0.04	0.04
Kalamazoo	49001	0.12	0.11	0.05	0.05
Lansing	48910	0.11	0.10	0.04	0.04

KINETICS Noise Control
Toll Free (USA Only): 800-959-1229
International: 614-889-0480
FAX 614-889-0540
World Wide Web: www.kineticsnoise.com
E-mail: sales@kineticsnoise.com
Dublin, Ohio, USA ▪ Mississauga, Ontario, Canada

Table 2-3 Continued; Mapped Acceleration Parameters for Selected U.S. Cities
2000/2003 IBC & 2006 IBC

State, City	ZIP CODE	S_S 2000 2003	S_S 2006	S_1 2000 2003	S_1 2006
Minnesota	-------	------	------	------	------
Duluth	55803	0.06	0.06	0.02	0.02
Minneapolis	55422	0.06	0.06	0.03	0.03
Rochester	55901	0.06	0.06	0.03	0.03
St. Paul	55111	0.06	0.06	0.03	0.03
Missouri	-------	------	------	------	------
Carthage	64836	0.16	0.17	0.09	0.08
Columbia	65202	0.19	0.21	0.10	0.09
Jefferson City	65109	0.22	0.23	0.11	0.10
Joplin	64801	0.15	0.16	0.08	0.08
Kansas City	64108	0.15	0.13	0.06	0.06
Springfield	65801	0.21	0.22	0.10	0.10
St. Joseph	64501	0.12	0.12	0.05	0.05
St. Louis	63166	0.59	0.58	0.19	0.17
Mississippi	-------	------	------	------	------
Jackson	39211	0.19	0.20	0.10	0.09
Montana	-------	------	------	------	------
Billings	59101	0.16	0.17	0.06	0.07
Butte	59701	0.74	0.65	0.21	0.20
Great Falls	59404	0.29	0.26	0.09	0.09
Nebraska	-------	------	------	------	------
Lincoln	68502	0.18	0.18	0.05	0.05
Omaha	68144	0.13	0.13	0.04	0.04
Nevada	-------	------	------	------	------
Las Vegas	89106	0.64	0.57	0.19	0.18
Reno	89509	1.36	1.92	0.50	0.77
New Mexico	-------	------	------	------	------
Albuquerque	87105	0.63	0.59	0.19	0.18
Santa Fe	87507	0.62	0.54	0.19	0.17
New York	-------	------	------	------	------
Albany	12205	0.28	0.24	0.09	0.07
Binghamton	13903	0.19	0.17	0.07	0.06
Buffalo	14222	0.32	0.28	0.07	0.06
Elmira	14905	0.17	0.15	0.06	0.05
New York	10014	0.43	0.36	0.09	0.07
Niagara Falls	14303	0.31	0.28	0.07	0.06
Rochester	14619	0.25	0.21	0.07	0.06
Schenectady	12304	0.28	0.24	0.09	0.09
Syracuse	13219	0.19	0.18	0.08	0.06
Utica	13501	0.25	0.22	0.09	0.07
North Carolina	-------	------	------	------	------
Charlotte	28216	0.35	0.32	0.14	0.11
Greensboro	27410	0.26	0.23	0.11	0.08

State, City	ZIP CODE	S_S 2000 2003	S_S 2006	S_1 2000 2003	S_1 2006
Raleigh	27610	0.22	0.21	0.10	0.08
Winston-Salem	27106	0.28	0.24	0.12	0.09
North Dakota	-------	------	------	------	------
Fargo	58103	0.07	0.08	0.02	0.02
Grand Forks	58201	0.05	0.06	0.02	0.02
Ohio	-------	------	------	------	------
Akron	44312	0.18	0.17	0.06	0.05
Canton	44702	0.16	0.14	0.06	0.05
Cincinnati	45245	0.19	0.18	0.09	0.07
Cleveland	44130	0.20	0.19	0.06	0.05
Columbus	43217	0.17	0.15	0.07	0.06
Dayton	45440	0.21	0.18	0.08	0.07
Springfield	45502	0.26	0.21	0.08	0.07
Toledo	43608	0.17	0.16	0.06	0.05
Youngstown	44515	0.17	0.16	0.06	0.05
Oklahoma	-------	------	------	------	------
Oklahoma City	73145	0.34	0.33	0.09	0.07
Tulsa	74120	0.16	0.16	0.07	0.07
Oregon	-------	------	------	------	------
Portland	97222	1.05	0.99	0.35	0.34
Salem	97301	1.00	0.80	0.4	0.34
Pennsylvania	-------	------	------	------	------
Allentown	18104	0.29	0.26	0.08	0.06
Bethlehem	18015	0.31	0.27	0.08	0.07
Erie	16511	0.17	0.16	0.05	0.05
Harrisburg	17111	0.23	0.20	0.07	0.05
Philadelphia	19125	0.33	0.27	0.08	0.06
Pittsburgh	15235	0.13	0.13	0.06	0.05
Reading	19610	0.30	0.26	0.08	0.06
Scranton	18504	0.23	0.20	0.08	0.06
Rhode Island	-------	------	------	------	------
Providence	02907	0.27	0.23	0.08	0.06
South Carolina	-------	------	------	------	------
Charleston	29406	1.60	2.19	0.45	0.56
Columbia	29203	0.60	0.55	0.19	0.15
South Dakota	-------	------	------	------	------
Rapid City	57703	0.16	0.17	0.04	0.04
Sioux Falls	57104	0.11	0.11	0.04	0.03
Tennessee	-------	------	------	------	------
Chattanooga	37415	0.52	0.46	0.14	0.12
Knoxville	37920	0.59	0.53	0.15	0.12
Memphis	38109	1.40	1.40	0.42	0.38
Nashville	49503	0.09	0.09	0.04	0.04

Toll Free (USA Only): 800-959-1229
International: 614-889-0480
FAX 614-889-0540
World Wide Web: www.kineticsnoise.com
E-mail: sales@kineticsnoise.com
Dublin, Ohio, USA ▪ Mississauga, Ontario, Canada

Table 2-3 Continued; Mapped Acceleration Parameters for Selected U.S. Cities 2000/2003 IBC & 2006 IBC

State, City	ZIP CODE	S_S		S_1	
		2000 2003	2006	2000 2003	2006
Texas	-------	------	------	------	------
Amarillo	79111	0.17	0.18	0.05	0.04
Austin	78703	0.09	0.08	0.04	0.03
Beaumont	77705	0.12	0.10	0.05	0.04
Corpus Christi	78418	0.10	0.08	0.02	0.02
Dallas	75233	0.12	0.11	0.06	0.05
El Paso	79932	0.37	0.33	0.11	0.11
Ft. Worth	76119	0.11	0.11	0.06	0.05
Houston	77044	0.11	0.10	0.05	0.04
Lubbock	79424	0.10	0.11	0.03	0.03
San Antonio	78235	0.14	0.12	0.03	0.03
Waco	76704	0.10	0.09	0.05	0.04
Utah	-------	------	------	------	------
Salt Lake City	84111	1.82	1.71	0.78	0.09
Virginia	-------	------	------	------	------
Norfolk	23504	0.13	0.12	0.06	0.05
Richmond	23233	0.32	0.25	0.09	0.06
Roanoke	24017	0.30	0.26	0.10	0.08
Vermont	-------	------	------	------	------
Burlington	05401	0.47	0.40	0.13	0.10
Washington	-------	------	------	------	------
Seattle	98108	1.56	1.57	0.54	0.54
Spokane	99201	0.38	0.40	0.09	0.11
Tacoma	98402	1.24	1.22	0.40	0.42
Washington, D.C.	-------	------	------	------	------
Washington	20002	0.18	0.15	0.06	0.05
Wisconsin	-------	------	------	------	------
Green Bay	54302	0.07	0.06	0.03	0.03
Kenosha	53140	0.14	0.12	0.05	0.05
Madison	53714	0.12	0.11	0.05	0.04
Milwaukee	53221	0.12	0.11	0.05	0.05
Racine	53402	0.13	0.12	0.05	0.05
Superior	54880	0.06	0.06	0.02	0.2
West Virginia	-------	------	------	------	------
Charleston	25303	0.21	0.19	0.08	0.07
Huntington	25704	0.23	0.20	0.09	0.07
Wyoming	-------	------	------	------	------
Casper	82601	0.38	0.39	0.08	0.08
Cheyenne	82001	0.19	0.20	0.06	0.05
--------------------	-------	------	------	------	------
--------------------	-------	------	------	------	------
--------------------	-------	------	------	------	------
--------------------	-------	------	------	------	------

Toll Free (USA Only): 800-959-1229
International: 614-889-0480
FAX 614-889-0540
World Wide Web: www.kineticsnoise.com
E-mail: sales@kineticsnoise.com
Dublin, Ohio, USA ▪ Mississauga, Ontario, Canada

Table 2-4; Mapped Acceleration Parameters for Selected International Cities
UFC 3-310-03A (1 March 2005)

Country, City	S_S	S_1	Country, City	S_S	S_1	Country, City	S_S	S_1
AFRICA	------	------	**Kenya**	------	------	**South Africa**	------	------
Algeria	------	------	Nairobi	0.62	0.28	Cape Town	1.24	0.56
Alger	1.24	0.56	**Lesotho**	------	------	Durban	0.62	0.28
Oran	1.24	0.56	Maseru	0.62	0.28	Johannesburg	0.62	0.28
Angola	------	------	**Liberia**	------	------	Natal	0.31	0.14
Luanda	0.06	0.06	Monrovia	0.31	0.14	Pretoria	0.62	0.28
Benin	------	------	**Libya**	------	------	**Swaziland**	------	------
Cotonou	0.06	0.06	Tripoli	0.62	0.28	Mbabane	0.62	0.28
Botswana	------	------	Wheelus AFB	0.62	0.28	**Tanzania**	------	------
Gaborone	0.06	0.06	**Malagasy Republic**	------	------	Dar es Salaam	0.62	0.28
Burundi	------	------	Tananarive	0.06	0.06	Zanzibar	0.62	0.28
Bujumbura	1.24	0.56	**Malawi**	------	------	**Togo**	------	------
Cameroon	------	------	Blantyre	1.24	0.56	Lome	0.31	0.14
Douala	0.06	0.06	Lilongwe	1.24	0.56	**Tunisia**	------	------
Yaounde	0.06	0.06	Zomba	1.24	0.56	Tunis	1.24	0.56
Cape Verde	------	------	**Mali**	------	------	**Uganda**	------	------
Praia	0.06	0.06	Bamako	0.06	0.06	Kampala	0.62	0.28
Central African Republic	------	------	**Mauritania**	------	------	**Upper Volta**	------	------
Bangui	0.06	0.06	Nouakchott	0.06	0.06	Ougadougou	0.06	0.06
Chad	------	------	**Mauritius**	------	------	**Zaire**	------	------
Ndjamena	0.06	0.06	Port Louis	0.06	0.06	Bukavu	1.24	0.56
Congo	------	------	**Morocco**	------	------	Kinshasa	0.06	0.06
Brazzaville	0.06	0.06	Casablanca	0.62	0.28	Lubumbashi	0.62	0.28
Djibouti	------	------	Port Lyautey	0.31	0.14	**Zambia**	------	------
Djibouti	1.24	0.56	Rabat	0.62	0.28	Lusaka	0.62	0.28
Egypt	------	------	Tangier	1.24	0.56	**Zimbabwe**	------	------
Alexandria	0.62	0.28	**Mozambique**	------	------	Harare	1.24	0.56
Cairo	0.62	0.28	Maputo	0.62	0.28	**ASIA**	------	------
Port Said	0.62	0.28	**Niger**	------	------	**Afghanistan**	------	------
Equatorial Guinea	------	------	Niamey	0.06	0.06	Kabul	1.65	0.75
Malabo	0.06	0.06	**Nigeria**	------	------	**Bahrain**	------	------
Ethiopia	------	------	Ibadan	0.06	0.06	Manama	0.06	0.06
Addis Ababa	1.24	0.56	Kaduna	0.06	0.06	**Bangladesh**	------	------
Asmara	1.24	0.56	Lagos	0.06	0.06	Dacca	1.24	0.56
Gabon	------	------	**Republic of Rwanda**	------	------	**Brunei**	------	------
Libreville	0.06	0.06	Kigali	1.24	0.56	Bandar Seri Begawan	0.31	0.14
Gambia	------	------	**Senegal**	------	------	**Burma**	------	------
Banjul	0.06	0.06	Dakar	0.06	0.06	Mandalay	1.24	0.56
Guinea	------	------	**Seychelles**	------	------	Rangoon	1.24	0.56
Bissau	0.31	0.14	Victoria	0.06	0.06	**China**	------	------
Conakry	0.06	0.06	**Sierra Leone**	------	------	Canton	0.62	0.28
Ivory Coast	------	------	Freetown	0.06	0.06	Chengdu	1.24	0.56
Abidijan	0.06	0.06	**Somalia**	------	------	Nanking	0.62	0.28
----------------------------------	------	------	Mogadishu	0.06	0.06	Peking	1.65	0.75

Toll Free (USA Only): 800-959-1229
International: 614-889-0480
FAX 614-889-0540
World Wide Web: www.kineticsnoise.com
E-mail: sales@kineticsnoise.com
Dublin, Ohio, USA • Mississauga, Ontario, Canada

Table 2-4 Continued; Mapped Acceleration Parameters for Selected International Cities
UFC 3-310-03A (1 March 2005)

Country, City	S_S	S_1	Country, City	S_S	S_1	Country, City	S_S	S_1
ASIA	------	------	**Jordan**	------	------	**Thailand**	------	------
China	------	------	Amman	1.24	0.56	Bangkok	0.31	0.14
Shanghai	0.62	0.28	**Korea**	------	------	Chinmg Mai	0.62	0.28
Shengyang	1.65	0.75	Kwangju	0.31	0.14	Songkhia	0.06	0.06
Tibwa	1.65	0.75	Kimhae	0.31	0.14	Udom	0.31	0.14
Tsingtao	1.24	0.56	Pusan	0.31	0.14	**Turkey**	------	------
Wuhan	0.62	0.28	Seoul	0.06	0.06	Adana	0.62	0.28
Cyprus	------	------	**Kuwait**	------	------	Ankara	0.62	0.28
Nicosia	1.24	0.56	Kuwait	0.31	0.14	Istanbul	1.65	0.75
Hong Kong	------	------	**Laos**	------	------	Izmir	1.65	0.75
Hong Kong	0.62	0.28	Vientiane	0.31	0.14	Karamursel	1.24	0.56
India	------	------	**Lebanon**	------	------	**United Arab Emirates**	------	------
Bombay	1.24	0.56	Beirut	1.24	0.56	Abu Dhabi	0.06	0.06
Calcutta	0.62	0.28	**Malaysia**	------	------	Dubai	0.06	0.06
Madras	0.31	0.14	Kuala Lumpur	0.31	0.14	**Viet Nam**	------	------
New Delhi	1.24	0.56	**Nepal**	------	------	Ho Chi Min City	0.06	0.06
Indonesia	------	------	Kathmandu	1.65	0.75	**Yemen Arab Republic**	------	------
Bandung	1.65	0.75	**Oman**	------	------	Sanaa	1.24	0.56
Jakarta	1.65	0.75	Muscat	0.62	0.28	**ATLANTIC OCEAN AREA**	------	------
Medan	1.24	0.56	**Pakistan**	------	------	**Azorea**	------	------
Surabaya	1.65	0.75	Islamabad	1.68	0.65	All Locations	0.62	0.28
Iran	------	------	Karachi	1.65	0.75	**Bermuda**	------	------
Isfahan	1.24	0.56	Lahore	0.62	0.28	All Locations	0.31	0.14
Shiraz	1.24	0.56	Peshawar	1.65	0.75	**CARIBBEAN SEA**	------	------
Tabriz	1.65	0.75	**Quatar**	------	------	**Bahama Islands**	------	------
Tehran	1.65	0.75	Doha	0.06	0.06	All Locations	0.31	0.14
Iraq	------	------	**Saudi Arabia**	------	------	**Cuba**	------	------
Baghdad	1.24	0.56	Al Batin	0.31	0.14	All Locations	0.62	0.28
Basra	0.31	0.14	Dhahran	0.31	0.14	**Dominican Republic**	------	------
Israel	------	------	Jiddah	0.62	0.28	Santo Domingo	1.24	0.56
Haifa	1.24	0.56	Khamis Mushayf	0.31	0.14	**French West Indies**	------	------
Jerusalem	1.24	0.56	Riyadh	0.06	0.06	Martinique	1.24	0.56
Tel Aviv	1.24	0.56	**Singapore**	------	------	**Grenada**	------	------
Japan	------	------	All Locations	0.31	0.14	Saint Georges	1.24	0.56
Fukuoka	1.24	0.56	**South Yemen**	------	------	**Haiti**	------	------
Itazuke AFB	1.24	0.56	Aden City	1.24	0.56	Port au Prince	1.24	0.56
Misawa AFB	1.24	0.56	**Sri Lanka**	------	------	**Jamaica**	------	------
Naha, Okinawa	1.65	0.75	Colombo	0.06	0.06	Kingston	1.24	0.56
Osaka/Kobe	1.65	0.75	**Syria**	------	------	**Leeward Islands**	------	------
Sapporo	1.24	0.56	Aleppo	1.24	0.56	All Locations	1.24	0.56
Tokyo	1.65	0.75	Damascus	1.24	0.56	**Puerto Rico**	------	------
Wakkanai	1.24	0.56	**Taiwan**	------	------	All Locations	0.83	0.38
Yokohama	1.65	0.75	All Locations	1.65	0.75	**Trinidad & Tobago**	------	------
Yokota	1.65	0.75	--------------------	------	------	All Locations	1.24	0.56

KINETICS Noise Control
Toll Free (USA Only): 800-959-1229
International: 614-889-0480
FAX 614-889-0540
World Wide Web: www.kineticsnoise.com
E-mail: sales@kineticsnoise.com
Dublin, Ohio, USA ▪ Mississauga, Ontario, Canada

Table 2-4 Continued; Mapped Acceleration Parameters for Selected International Cities
UFC 3-310-03A (1 March 2005)

Country, City	S_S	S_1
Belize	------	------
Beimopan	0.62	0.28
Canal Zone	------	------
All Locations	0.62	0.28
Costa Rica	------	------
San Jose	1.24	0.56
El Salvador	------	------
San Slavador	1.65	0.75
Guatemala	------	------
Guatemala	1.65	0.75
Honduras	------	------
Tegucigalpa	1.24	0.56
Nicaragua	------	------
Managua	1.65	0.75
Panama	------	------
Colon	1.24	0.56
Galeta	0.83	0.38
Panama	1.24	0.56
Mexico	------	------
Ciudad Juarez	0.62	0.28
Guadalajara	1.24	0.56
Hermosillo	1.24	0.56
Matamoros	0.06	0.06
Mazatlan	0.60	0.28
Merida	0.06	0.06
Mexico City	1.24	0.56
Monterrey	0.06	0.06
Nuevo Laredo	0.06	0.06
Tijuana	1.24	0.56
EUROPE	------	------
Albania	------	------
Tirana	1.24	0.56
Austria	------	------
Salzburg	0.62	0.28
Vienna	0.62	0.28
Belgium	------	------
Antwerp	0.31	0.14
Brussels	0.62	0.28
Bulgaria	------	------
Sofia	1.24	0.56
Czechoslovakia	------	------
Bratislava	0.62	0.28
Prague	0.31	0.14
--------------------	------	------

Country, City	S_S	S_1
Denmark	------	------
Copenhagen	0.31	0.14
Finland	------	------
Helsinki	0.31	0.14
France	------	------
Bordeaux	0.62	0.28
Lyon	0.31	0.14
Marseille	1.24	0.56
Nice	1.24	0.56
Strasbourg	0.62	0.28
Germany	------	------
Berlin	0.06	0.06
Bonn	0.62	0.28
Bremen	0.06	0.06
Düsseldorf	0.31	0.14
Frankfurt	0.62	0.28
Hamburg	0.06	0.06
Munich	0.31	0.14
Stuttgart	0.62	0.28
Vaihigen	0.62	0.28
Greece	------	------
Athens	1.24	0.56
Kavalla	1.65	0.75
Makri	1.65	0.56
Rhodes	1.24	0.75
Sauda Bay	1.65	0.56
Thessaloniki	1.65	0.56
Hungary	------	------
Budapest	0.62	0.28
Iceland	------	------
Keflavick	1.24	0.56
Reykjavik	1.65	0.75
Ireland	------	------
Dublin	0.06	0.06
Italy	------	------
Aviano AFB	1.24	0.56
Brindisi	0.06	0.06
Florence	1.24	0.56
Genoa	1.24	0.56
Milan	0.62	0.28
Naples	1.24	0.56
Palermo	1.24	0.56
Rome	0.62	0.28
Sicily	1.24	0.56

Country, City	S_S	S_1
Trieste	1.24	0.56
Turin	0.62	0.28
Luxembourg	------	------
Luxembourg	0.31	0.14
Malta	------	------
Valletta	0.62	0.28
Netherlands	------	------
All Locations	0.06	0.06
Norway	------	------
Oslo	0.62	0.28
Poland	------	------
Krakow	0.62	0.28
Poznan	0.31	0.14
Waraszawa	0.31	0.14
Portugal	------	------
Lisbon	1.65	0.75
Oporto	1.24	0.56
Romania	------	------
Bucharest	1.24	0.56
Spain	------	------
Barcelona	0.62	0.28
Bilbao	0.62	0.28
Madrid	0.06	0.06
Rota	0.62	0.28
Seville	0.62	0.28
Sweden	------	------
Goteborg	0.62	0.28
Stockholm	0.31	0.14
Switzerland	------	------
Bern	0.62	0.28
Geneva	0.31	0.14
Zurich	0.62	0.28
United Kingdom	------	------
Belfast	0.06	0.06
Edinburgh	0.31	0.14
Edzell	0.31	0.14
Glasgow/Renfrew	0.31	0.14
Hamilton	0.31	0.14
Liverpool	0.31	0.14
London	0.62	0.28
Londonderry	0.31	0.14
Thurso	0.31	0.14
U. S. S. R.	------	------
Kiev	0.06	0.06

KINETICS Noise Control
Toll Free (USA Only): 800-959-1229
International: 614-889-0480
FAX 614-889-0540
World Wide Web: www.kineticsnoise.com
E-mail: sales@kineticsnoise.com
Dublin, Ohio, USA ▪ Mississauga, Ontario, Canada

Table 2-4 Continued; Mapped Acceleration Parameters for Selected International Cities
UFC 3-310-03A (1 March 2005)

Country, City	S_S	S_1	Country, City	S_S	S_1	Country, City	S_S	S_1
U. S. S. R.	------	------	Valparaiso	1.65	0.75	Baguio	1.24	0.56
Leningrad	0.06	0.06	**Colombia**	------	------	**Samoa**	------	------
Moscow	0.06	0.06	Bogotá	1.24	0.56	All Locations	1.24	0.56
Yugoslavia	------	------	**Ecuador**	------	------	**Wake Island**	------	------
Belgrade	0.62	0.28	Quito	1.65	0.75	All Locations	0.06	0.06
Zagreb	1.24	0.56	Guayaquil	1.24	0.56	------------------	------	------
NORTH AMERICA	------	------	**Paraguay**	------	------	------------------	------	------
Greenland	------	------	Asuncion	0.06	0.06	------------------	------	------
All Locations	0.31	0.14	**Peru**	------	------	------------------	------	------
Canada	------	------	Lima	1.65	0.75	------------------	------	------
Argentia NAS	0.62	0.28	Piura	1.65	0.75	------------------	------	------
Calgary, Alb	0.31	0.14	**Uruguay**	------	------	------------------	------	------
Churchill, Man	0.06	0.06	Montevideo	0.06	0.06	------------------	------	------
Cold Lake, Alb	0.31	0.14	**Venezuela**	------	------	------------------	------	------
Edmonton, Alb	0.31	0.14	Maracaibo	0.62	0.28	------------------	------	------
East Harmon AFB	0.62	0.28	Caracas	1.65	0.75	------------------	------	------
Fort Williams, Ont.	0.06	0.06	**PACIFIC OCEAN AREA**	------	------	------------------	------	------
Frobisher N. W. Ter.	0.06	0.06	**Australia**	------	------	------------------	------	------
Goose Airport	0.31	0.14	Brisbane	0.31	0.14	------------------	------	------
Halifax	0.31	0.14	Canberra	0.31	0.14	------------------	------	------
Montreal, Quebec	1.24	0.56	Melbourne	0.31	0.14	------------------	------	------
Ottawa, Ont.	0.31	0.28	Perth	0.31	0.14	------------------	------	------
St. John's, Nfld.	1.24	0.56	Sydney	0.31	0.14	------------------	------	------
Toronto, Ont.	0.31	0.14	**Caroline Islands**	------	------	------------------	------	------
Vancouver	1.24	0.56	Koror, Paulau, Is.	0.62	0.28	------------------	------	------
Winnipeg, Man.	0.31	0.14	Ponape	0.06	0.06	------------------	------	------
SOUTH AMERICA	------	------	**Fiji**	------	------	------------------	------	------
Argentina	------	------	Suva	1.24	0.56	------------------	------	------
Buenos Aires	0.25	0.10	**Johnson Island**	------	------	------------------	------	------
Brazil	------	------	All Locations	0.31	0.14	------------------	------	------
Belem	0.06	0.06	**Mariana Islands**	------	------	------------------	------	------
Belo Horizonte	0.06	0.06	Guam	1.24	0.56	------------------	------	------
Brasilia	0.06	0.06	Saipan	1.24	0.56	------------------	------	------
Manaus	0.06	0.06	Tinian	1.24	0.56	------------------	------	------
Porto Allegre	0.06	0.06	**Marshall Islands**	------	------	------------------	------	------
Recife	0.06	0.06	All Locations	0.31	0.14	------------------	------	------
Rio de Janeiro	0.06	0.06	**New Zealand**	------	------	------------------	------	------
Salvador	0.06	0.06	Auckland	1.24	0.56	------------------	------	------
Sao Paulo	0.31	0.14	Wellington	1.65	0.75	------------------	------	------
Bolivia	------	------	**Papua New Guinea**	------	------	------------------	------	------
La Paz	1.24	0.56	Port Moresby	1.65	0.75	------------------	------	------
Santa Cruz	0.31	0.14	**Philippine Islands**	------	------	------------------	------	------
Chile	------	------	Cebu	1.65	0.75	------------------	------	------
Santiago	1.65	0.75	Manila	1.65	0.75	------------------	------	------

Toll Free (USA Only): 800-959-1229
International: 614-889-0480
FAX 614-889-0540
World Wide Web: www.kineticsnoise.com
E-mail: sales@kineticsnoise.com
Dublin, Ohio, USA ▪ Mississauga, Ontario, Canada

Table 2-5; Short Period Site Coefficient, F_a (Table 9.4.1.2.4a) [Table 11.4-1]

Site Class	Mapped MCE Short Period Spectral Response Acceleration Parameter (Linear Interpolation Is Permitted)				
	S_S≤0.25	S_S=0.50	S_S=0.75	S_S=1.00	S_S≥1.25
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	These values to be determined by site response analysis.				

Table 2-6; Long Period Site Coefficient, F_v (Table 9.4.1.2.4b) [Table 11.4-2]

Site Class	Mapped MCE Long Period Spectral Response Acceleration Parameter (Linear Interpolation Is Permitted)				
	S_1 ≤ 0.10	S_1 = 0.20	S_1 = 0.30	S_1 = 0.40	S_1 ≥ 0.50
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.7	1.6	1.5	1.4	1.3
D	2.4	2.0	1.8	1.6	1.5
E	3.5	3.2	2.8	2.4	2.4
F	These values to be determined by site response analysis.				

D2.1 – 2.5 Seismic Design Category (Section 9.4.2.1) [Section 11.6]:

This parameter is of great importance to everyone involved with MEP systems. The Seismic Design Category to which a building has been assigned will determine whether seismic restraints are required or not, and if they qualify for exemption, which MEP components may be exempted, and which will need to have seismic restraints selected and installed. The MEP components within

KINETICS Noise Control
Toll Free (USA Only): 800-959-1229
International: 614-889-0480
FAX 614-889-0540
World Wide Web: www.kineticsnoise.com
E-mail: sales@kineticsnoise.com
Dublin, Ohio, USA ▪ Mississauga, Ontario, Canada

a building will be assigned to the same Seismic Design Category as the building itself. There are six Seismic Design Categories, A, B, C, D, E, and F. The level of restraint required increases from Seismic Design Category A through F. Up through Seismic Design Category D, the Seismic Design Category to which a building or structure is assigned is determined though the use of Tables 2-6 and 2-7.

To determine the Seismic Design Category both the Long (S_{D1}) and Short (S_{DS}) Period Design Response Acceleration Parameter must be determined. The most stringent Seismic Design Category, resulting from the two acceleration parameters, will be assigned to the project.

For Occupancy I, II, or III (Seismic Use Group I or II) structures, if the Mapped Spectral Response Acceleration Parameter is greater than or equal to 0.75, $S_1 \geq 0.75$, then the structure will be assigned to Seismic Design Category E. For Occupancy Category IV (Seismic Use Group III) structures, if the Mapped Spectral Response Acceleration Parameter is greater than or equal to 0.75, $S_1 \geq 0.75$, then the structure will be assigned to Seismic Design Category F. To ensure consistency, the Seismic Design Category should be determined by the structural engineer.

Table 2-7; Seismic Design Category Based on the Short Period Design Response Acceleration Parameter (Table 9.4.2.1a) [Table 11.6-1]

Value of S_{DS}	Occupancy Category (Seismic Use Group)		
	I or II (I)	III (II)	IV (III)
$S_{DS} < 0.167$	A	A	A
$0.167 \leq S_{DS} < 0.33$	B	B	C
$0.33 \leq S_{DS} < 0.50$	C	C	D
$0.50 \leq S_{DS}$	D	D	D

KINETICS Noise Control
Toll Free (USA Only): 800-959-1229
International: 614-889-0480
FAX 614-889-0540
World Wide Web: www.kineticsnoise.com
E-mail: sales@kineticsnoise.com
Dublin, Ohio, USA ▪ Mississauga, Ontario, Canada

Table 2-8; Seismic Design Category Based on the Long Period Design Response Acceleration Parameter (Table 9.4.2.1b) [Table 11.6-2]

Value of S_{D1}	Occupancy Category (Seismic Design Category)		
	I or II (I)	III (II)	IV (III)
$S_{D1} < 0.067$	A	A	A
$0.067 \leq S_{D1} < 0.133$	B	B	C
$0.133 \leq S_{D1} < 0.20$	C	C	D
$0.20 \leq S_{D1}$	D	D	D

D2.1 – 2.6 Summary:

The following parameters will be required by the design professionals having responsibility for MEP systems in a building, and should be determined by the structural engineer of record.

1. Occupancy Category (Seismic Use Group for 2000/2003 IBC): This defines the building use and specifies which buildings are required for emergency response or disaster recovery.
2. Seismic Design Category: This determines whether or not seismic restraint is required.
3. Short Period Design Response Acceleration Parameter (S_{DS}): This value is used to compute the horizontal seismic force used to design and/or select seismic restraints required.

These parameters should be repeated in the specification and drawing package for the particular system, mechanical, electrical, or plumbing, in question.

KINETICS Noise Control
Toll Free (USA Only): 800-959-1229
International: 614-889-0480
FAX 614-889-0540
World Wide Web: www.kineticsnoise.com
E-mail: sales@kineticsnoise.com
Dublin, Ohio, USA ▪ Mississauga, Ontario, Canada

COMPONENT IMPORTANCE FACTOR

D2.1 – 3.1 Introduction:

MEP components and systems are categorized in ASCE 7-98/02 and ASCE 7-05 as non-structural components. There are just two values for the Component Importance Factors for MEP components, 1.0 and 1.5, which are not directly linked to the importance factor for the building structure. The Component Importance Factor is designated as I_P in the body of the code. All MEP components must be assigned a component importance factor. The design professional that has responsibility for the MEP system in question is also responsible for assigning the Component Importance Factor to that system.

D2.1 – 3.2 Criteria for Assigning a Component Importance Factor (Sections 9.6.1 and 9.6.1.5) [Section 13.1.3][1]:

For MEP systems, the Component Importance Factor (I_P) assigned to the components within the system shall be determined as follows.

1. If the MEP system is required to remain in place and function for life-safety purposes following and earthquake the importance factor assigned to the MEP system and its components shall be 1.5. Some examples of this type of system would be;
   a. Fire sprinkler piping and fire suppression systems.
   b. Smoke removal and fresh air ventilation systems.
   c. Systems required for maintaining the proper air pressure in patient hospital rooms to prevent the transmission of infectious diseases.
   d. Systems that maintain proper air pressure, temperature, and humidity in surgical suites, bio-hazard labs, and clean rooms.

[1] References in brackets (Sections 9.6.1 and 9.6.1.5) and [Section 13.1.3] apply to sections, tables, and/or equations in ASCE 7-98/02 and ASCE 7-05 respectively which forms the basis for the seismic provisions in 2000/2003 IBC and 2006 IBC respectively..

KINETICS Noise Control
Toll Free (USA Only): 800-959-1229
International: 614-889-0480
FAX 614-889-0540
World Wide Web: www.kineticsnoise.com
E-mail: sales@kineticsnoise.com
Dublin, Ohio, USA ▪ Mississauga, Ontario, Canada

   e. Medical gas lines.
   f. Steam lines or high pressure hot water lines.

2. If the MEP system contains or is used to transport hazardous materials, or materials that are toxic if released in quantities that exceed the exempted limits a Component Importance Factor of 1.5 shall be assigned to that MEP system and its components. Examples are as follows.
   a. Systems using natural gas.
   b. Systems requiring fuel oil.
   c. Systems used to exhaust laboratory fume hoods.
   d. Boilers, furnaces and flue systems.
   e. Systems that are used to ventilate bio-hazard areas and infectious patient rooms.
   f. Chemical or by-product systems which are required for industrial processes.
3. If the MEP system is in or attached to a building that has been assigned to Occupancy Category IV (Seismic Use Group III), i.e. essential or critical facilities, and is required for the continued operation of that facility following an earthquake, then a Component Importance Factor of 1.5 shall be assigned to that system and its components. Hospitals, emergency response centers, police stations, fire stations, and etc. fall in Occupancy Category IV. The failure of any system could cause the portion of the building it serves to be evacuated and unusable would cause that system and its components to be assigned a Component Importance Factor of 1.5. Even the failure of domestic water lines can flood a building and render it uninhabitable. So, all of the items listed above under items 1 and 2 would apply to facilities in Occupancy Category IV.
4. If the MEP system that is located in or attached to an Occupancy Category IV facility and its failure would impair the operation of that facility, then a Component Importance Factor of 1.5 shall be assigned to that MEP system and its components. This implies that any MEP system or component that could be assigned a Component Importance Factor of 1.0 that is located above an MEP system or component that has been assigned a Component Importance Factor of 1.5 must be reassigned to a Component Importance Factor of 1.5.

KINETICS Noise Control
Toll Free (USA Only): 800-959-1229
International: 614-889-0480
FAX 614-889-0540
World Wide Web: www.kineticsnoise.com
E-mail: sales@kineticsnoise.com
Dublin, Ohio, USA ▪ Mississauga, Ontario, Canada

5. All other MEP systems that are not covered under items 1, 2, 3, or 4 may be assigned a Component Importance Factor of 1.0.

D2.1 – 3.3 Summary:

The Component Importance Factor is very important to the designer responsible for selecting and certifying the seismic restraints for an MEP system or component. This factor is a direct multiplier for the horizontal seismic design force, which shall be discussed in a later section. The Component Importance Factor will also be a key indicator as to whether a particular component will qualify for and exemption or not. If a Component Importance Factor has not been assigned to an MEP system, the designer responsible for selecting the seismic restraints must assume that the Component Importance Factor is equal to 1.5. If the MEP system actually could be assigned a Component Importance Factor of 1.0, this could result in a large increase in the size and number of restraints required along with a corresponding increase in the cost for the system.

It is in the best interest of the design professionals responsible for an MEP system to properly assign the Component Importance Factor to that MEP system. The Component Importance Factor for each MEP system and component should be clearly indicated on the drawings that are distributed to other design professionals, contractors, suppliers, and building officials.

Toll Free (USA Only): 800-959-1229
International: 614-889-0480
FAX 614-889-0540
World Wide Web: www.kineticsnoise.com
E-mail: sales@kineticsnoise.com
Dublin, Ohio, USA ▪ Mississauga, Ontario, Canada
RELEASED ON: 05/06/2008

GENERAL EXEMPTIONS AND REQUIREMENTS

D2.1 – 4.1 Introduction:

The International Building Codes (IBC's) allow certain exemptions to be made for MEP systems and components from the need for seismic restraint. These exemptions are based on the Seismic Design Category, the Component Importance Factor, and the size and weight, of the MEP components.

There are further general provisions in the IBC pertaining to MEP components that must be acknowledged at the outset of a project. These are provisions ranging from the upper bound size for an MEP component in order for it to be considered as a non-structural component to the component certifications and documentation required.

This section will present the general exemptions for MEP systems and components and discuss the general requirements that apply to them.

D2.1 – 4.2 Exemptions for Seismic Design Categories A and B (Section 9.6.1-1 and 9.6.1-3) [Section 13.1.4-1 and 13.1.4-2][1]:

MEP systems and their components that are located in or on buildings that have been assigned to Seismic Design Categories A and B are exempt from the requirements for seismic restraints. These two exemptions point out the need for having the correct seismic deign in formation for the project available to all of the design professionals and contractors during the bidding stage of the project. Being able to use these exemptions can save the MEP contractors as much as 10% to 15% in their costs.

[1] References in brackets (Section 9.6.1-1 and 9.6.1-2) [Section 13.1.4-1 and 13.1.4-2] apply to sections, tables, and/or equations in ASCE 7-98/02 and ASCE 7-05 respectively, which forms the basis for the seismic provisions in 2000/2003 IBC and 2006 IBC respectively.

Toll Free (USA Only): 800-959-1229
International: 614-889-0480
FAX 614-889-0540
World Wide Web: www.kineticsnoise.com
E-mail: sales@kineticsnoise.com
Dublin, Ohio, USA ▪ Mississauga, Ontario, Canada
RELEASED ON: 07/15/2008

For example, a critical piece of information required at the outset is the Site Class. If the Site Class has not been determined by a qualified geotechnical engineer, then Site Class D must be assumed. The resulting combination of the mapped acceleration parameters and soil profile of Site Class D may force the project to be assigned to Seismic Design Category C which in turn forces the requirement for seismic restraints. If instead the Site Class had been determined to be Site Class B by a qualified geotechnical engineer, then the project may have been found to fall into Seismic Design Category A or B, thus eliminating the need for seismic restraints for MEP systems and components.

D2.1 – 4.3 Exemptions for Seismic Design Category C (Section 9.6.1-4) [Section 13.1.4-3]:

MEP systems and components that have been assigned to Seismic Design Category C, and that have been assigned a Component Importance Factor of 1.0, are exempt from the requirements for seismic restraints. In this case it is very important that the design professionals responsible for the various MEP systems and components assign the correct Component Importance Factors to those systems and components. If no Component Importance Factor is assigned, the installing contractor should prudently assume that the Component Importance Factor is equal to 1.5, and provide restraints for that system or component. This is particularly true of duct runs where it is very likely that the ventilation components may also be required for smoke control.

It is also critical to know which MEP systems and components have a component Importance Factor of 1.0 and which ones have a Component Importance Factor of 1.5. To the extent possible, those with Component Importance Factors equal to 1.5 should be installed above those with Component Importance Factors equal to 1.0 in order to reduce the over all number of restraints needed for the project.

KINETICS Noise Control
Toll Free (USA Only): 800-959-1229
International: 614-889-0480
FAX 614-889-0540
World Wide Web: www.kineticsnoise.com
E-mail: sales@kineticsnoise.com
Dublin, Ohio, USA ▪ Mississauga, Ontario, Canada

D2.1 – 4.4 Exemptions for Seismic Design Categories D, E, and F (Sections 9.6.1-5 and 9.1.6-6) [Sections 13.1.4-4 and 13.1.4-5]:

There are basically three exemptions that apply here.

1. MEP components that:
   a. Are in Seismic Design Categories D, E, and F.
   b. Have a Component Importance Factor equal to 1.0,
   c. Have flexible connections between the components and all associated duct, piping, conduit.
   d. Are mounted at 4 ft (1.22 m) or less above a floor level.
   e. And weigh 400 lbs (1780 N) or less.
2. MEP components that:
   a. Are in Seismic Design Categories D, E, and F.
   b. Have a Component Importance Factor equal to 1.0.
   c. Have flexible connections between the components and all associated duct, piping, conduit.
   d. And weigh 20 lbs (89 N) or less.
3. MEP distribution systems that:
   a. Are in Seismic Design Categories D, E, and F.
   b. Have a Component Importance Factor equal to 1.0.
   c. Have flexible connections between the components and all associated duct, piping, conduit.
   d. And weigh 5 lbs/ft (73 N/m) or less.

D2.1 – 4.5 "Chandelier" Exemption (Section 9.6.3.2) [Section 13.6.1]:

This exemption applies to light fixtures, lighted signs, ceiling fans, and other components that are not connected to ducts or piping and which are supported by chains or other wise suspended from

KINETICS Noise Control
Toll Free (USA Only): 800-959-1229
International: 614-889-0480
FAX 614-889-0540
World Wide Web: www.kineticsnoise.com
E-mail: sales@kineticsnoise.com
Dublin, Ohio, USA ▪ Mississauga, Ontario, Canada

the structure by a method that allows the component to swing freely. These components will require no further seismic support provided that all of the following conditions are met.

1. The design load for these components shall be equal to:
    a. 3.0 times the operating load, applied as a gravity design load, for 2000/2003 IBC.
    b. 1.4 times the operating weight of the component acting downward with a simultaneous horizontal load that is also equal to 1.4 times the operating weight for 2006 IBC. The horizontal load is to be applied in the direction that results in the most critical loading and thus the most conservative result.
2. The component shall not impact other components, systems, or structures as it swings through its projected range of motion.
3. The connection to the structure shall allow a 360° range of motion in the horizontal plane. In other words, this must be a "free swinging" connection.

D2.1 – 4.6 Component Size Relative to the Building Structure (Section 9.6.1) [Section 13.1.5]:

For the most part MEP components will be treated as nonstructural components by the code. However, if the MEP component is very large relative to the building it must be treated as a nonbuilding structure, which has a completely different set of design issues. For 2000/2006 IBC, If the weight of the MEP component is greater than or equal to 25% of the combined weight of the MEP Component and the supporting structure, the MEP component must be treated as a nonbuilding structure per Section 9.14 of ASCE 7-98/02. For 2006 IBC, if the weight of the nonstructural component is greater than or equal to 25% of the effective seismic weight of the building as defined in Section 12.7.2 of ASCE 7-05, then that component must be classified as a nonbuilding structure and designed accordingly.

When might this apply? This applies to very large pieces of MEP equipment such as large cooling towers, and the very large air handling units that are placed on the roofs of buildings employing

KINETICS Noise Control
Toll Free (USA Only): 800-959-1229
International: 614-889-0480
FAX 614-889-0540
World Wide Web: www.kineticsnoise.com
E-mail: sales@kineticsnoise.com
Dublin, Ohio, USA ▪ Mississauga, Ontario, Canada

lightweight design techniques. The structural engineer of record will have a value for the effective seismic weight of the building. This must be compared to the operating weight of the MEP component in question.

D2.1 – 4.7 Reference and Accepted Standards (Sections 9.6.1.1 and 9.6.1.2) and Reference Documents [Section 13.1.6]:

Typically reference standards, acceptance standards, and reference documents are other publications that will provide a basis for earthquake resistant design. Examples of reference documents currently in existence would be the SMACNA Seismic Restraint Manual, listed in Section 1.0 Introduction of the guide, and NFPA 13. These documents may be used with the approval of the jurisdiction having authority as long as the following conditions are met.

1. The design earthquake forces used for the design and selection of the seismic restraints shall not be less that those specified in Section 9.6.1.3 of ASCE 7-98/02 and Section 13.3.1 of ASCE 7-05, which is also covered in Section 8.0 of this guide.
2. The seismic interaction of each MEP component with all other components and building structures shall be accounted for in the design of the supports and restraints.
3. The MEP component must be able to accommodate drifts, deflections, and relative displacements that are defined in ASCE 7-05. This means that flexible connections for pipe, duct, and electrical cables for MEP components are in general, a good idea to prevent damage if the MEP component, and/or the pipe, duct, and electrical cables that are attached to it are unrestrained.

D2.1 – 4.8 Allowable Stress Design (Sections 2.3 and 2.4) [Sections 2.3, 2.4, and 13.1.7]:

Reference documents that use allowable stress design may be used as a basis for the design and selection of seismic restraints. However, the design earthquake loads determined in accordance with Section 9.6.1.3 of ASCE 7-98/02 and Section 13.3.1 of ASCE 7-05 must be multiplied by 0.7.

KINETICS Noise Control
Toll Free (USA Only): 800-959-1229
International: 614-889-0480
FAX 614-889-0540
World Wide Web: www.kineticsnoise.com
E-mail: sales@kineticsnoise.com
Dublin, Ohio, USA ▪ Mississauga, Ontario, Canada

D2.1 – 4.9 Submittals and Construction Documents (Sections 9.6.3.6, 9.6.3.15 and A.9.3.4.5) [Sections 13.2.1, 13.2.5, 13.2.6, and 13.2.7]:

Projects that require seismic restraints for MEP systems and components will require project specific certification that the design of the seismic restraints selected for the MEP systems and their components will meet the code, specification, or details which ever is most stringent. This certification is to be provided both in the submittals and in the construction documents.

For the submittal of seismic restraints and supports, the certification may be satisfied by one of the following means.

1. Project and site specific designs and documentation that are prepared and submitted by a registered design professional. Please note that a specific discipline is not mentioned regarding the registered design professional that is responsible for the design and signing and sealing of the documentation.
2. Manufacturer's certification accompanying the submittal the restraints are seismically qualified for the project and site. The certification may be made in any one of three ways as detailed below.
    a. Analysis – this is typical for the seismic restraints used for MEP systems and components. Manufacturers of these seismic restraint devices will normally have families of the various types of restraint devices that have different seismic force capacity ranges. The manufacturer will perform an analysis to determine the project and site specific seismic design loads, and then analyze the MEP system and/or components to determine the required restraint capacities at the restraint attachment points to the system and/or components. The proper restraint will be selected from the manufacturer's standard product offering, or a special restraint may be designed and built for the application. The manufacturer's certification will include a statement signed and seal by a registered design professional that the restraint devices will meet the appropriate code, specification, and/or details.

Toll Free (USA Only): 800-959-1229
International: 614-889-0480
FAX 614-889-0540
World Wide Web: www.kineticsnoise.com
E-mail: sales@kineticsnoise.com
Dublin, Ohio, USA ▪ Mississauga, Ontario, Canada

b. The manufacturer of the restraint devices may have them tested in accordance with ICC-ES AC 156 as outlined in Sections 9.6.3.6 and A.9.3.4.5 of ASCE 7-98/02 and Section 13.2.5 of ASCE 7-05. They will then provide a signed and sealed certification document stating that the restraint devices will provide adequate protection for the MEP system and components.

c. Experience data per the requirements in Sections 9.6.3.6 and A.9.3.4.5 of ASCE 7-98/02 and Section 13.2.6 of ASCE 7-05. This is not a normal avenue for a manufacturer of seismic restraint devices to use to certify their products as being fit for a specific project. In using this method, the manufacturers would incur a great deal of liability.

Section A.9.3.4.5 of ASCE 7-98/02 and Section 13.2.7 of ASCE 7-05 indicates that seismic restraints for MEP systems and components will require construction documents that are prepared and, signed and sealed by a registered design professional. Frequently, the submittal package provided by the manufacturer of the seismic restraints will also have enough information to fulfill this requirement.

The registered design professional mentioned above needs to be one with knowledge and experience in force analysis, stress and analysis, and the proper use of steel, aluminum, elastomers, and other engineering materials in the design of force resisting systems. There are several disciplines that may fulfill these requirements such as, structural engineers, civil engineers, and mechanical engineers involved in the area of machine design.

D2.1 – 4.10 Equipment Certification for Essential Facilities (Sections 9.6.3.6, 9.6.6.15, and A9.3.4.5) [Sections 13.2.2, 13.2.5, and 13.2.6]:

For buildings that have been assigned to Seismic Design Categories C, D, E, and F designated seismic systems will require certification. Designated seismic systems are those whose failure has the potential to cause loss of life or loss of function for buildings that were deemed essential for recovery following an earthquake. Typically essential facilities are those that have been assigned

KINETICS Noise Control
Toll Free (USA Only): 800-959-1229
International: 614-889-0480
FAX 614-889-0540
World Wide Web: www.kineticsnoise.com
E-mail: sales@kineticsnoise.com
Dublin, Ohio, USA ▪ Mississauga, Ontario, Canada

to Occupancy Category IV, see Section 2.2 of this guide. For these types of systems, certification shall be provided as follows.

1. For active MEP systems and components that must remain functional after an earthquake shall be certified by the supplier or manufacturer as being operable after the design level earthquake for the project site based on:
    a. Shake table testing such as that specified in ICC-ES AC 156 as described in Section A.9.3.4.5 of ASCE 7-98/02 and Section 13.2.5 of ASCE 7-05. Evidence of compliance is to be submitted to the jurisdiction having authority and the design professional of record for approval.
    b. Experience or historical data as outlined in Sections 9.6.3.6, 9.6.3.15 and A.9.3.4.5 of ASCE 7-98/02 and Section 13.2.6 of ASCE 7-05. This experience data is to come from a nationally recognized procedures and data base that is acceptable to the authority having jurisdiction. The substantiated seismic capacities from the experience data must meet or exceed the specific seismic requirements for the project. As in a. above evidence of compliance will need to be submitted to the design professional of record, and the jurisdiction having authority for approval.
2. MEP systems and components that contain hazardous materials must be certified as maintaining containment of the hazardous materials following an earth quake. Evidence of compliance must be submitted to the design professional of record and the jurisdiction having authority for approval. This certification may be made through:
    a. Analysis.
    b. Approved shake table testing specified in Section 9.6.3.6 of ASCE 7-98/02 and Section 13.2.5 of ASCE 7-05.
    c. Experience data as described in Section 9.6.3.6 of ASCE 7-98/02 and Section 13.2.6 of ASCE 7-05.

KINETICS Noise Control
Toll Free (USA Only): 800-959-1229
International: 614-889-0480
FAX 614-889-0540
World Wide Web: www.kineticsnoise.com
E-mail: sales@kineticsnoise.com
Dublin, Ohio, USA ▪ Mississauga, Ontario, Canada

D2.1 – 4.11 Consequential or Collateral Damage (Section 9.6.1) [Section 13.2.3]:

The potential interaction of the MEP systems and components with surrounding systems, components or building structures must be considered when locating and restraining the MEP systems and components. The failure of an MEP system or component that has been assigned a Component Importance Factor equal to 1.0 must not cause the failure of an MEP system or component that has been assigned a Component Importance Factor equal to 1.5. This goes back to the issue of assigning a Component Importance Factor of 1.5 to MEP systems or components with a Component Importance Factor of 1.0 whose failure would cause the failure of a system or component with a Component Importance Factor of 1.5.

D2.1 – 4.12 Flexibility of Components and their Supports and Restraints (Sections 9.6.1 and 9.6.1.2) [Section 13.2.4]:

All MEP systems and components that are constructed of normal engineering materials will have a certain amount of flexibility, or springiness. So how these systems and components behave during an earthquake will greatly affect their performance and survivability. The system or component could have a flexibility that would put it to resonance with the building and/or the earthquake, in which case the displacements and stresses in the system would be much larger than expected. Conversely the flexibility of the system or component could be such that it was not in resonance with either the building or the earthquake. In this case, the displacements and stresses may be much lower than a code based analysis would indicate. Therefore, the code indicates that the flexibility of the components and their supports be considered as well as the strength of the parts to ensure that the worst cases are considered.

KINETICS Noise Control
Toll Free (USA Only): 800-959-1229
International: 614-889-0480
FAX 614-889-0540
World Wide Web: www.kineticsnoise.com
E-mail: sales@kineticsnoise.com
Dublin, Ohio, USA ▪ Mississauga, Ontario, Canada

D2.1 – 4.13 Summary:

The exemptions and requirements outlined in this section are intended to assist the MEP design professionals and contractors in planning their project contribution efficiently. Also, they help define the limits of responsibility for each MEP design profession and trade.

Toll Free (USA Only): 800-959-1229
International: 614-889-0480
FAX 614-889-0540
World Wide Web: www.kineticsnoise.com
E-mail: sales@kineticsnoise.com
Dublin, Ohio, USA ▪ Mississauga, Ontario, Canada
RELEASED ON: 07/15/2008

EXEMPTIONS FOR PIPING SYSTEMS

D2.1 – 5.1 Introduction:

The exemptions that apply specifically to piping are covered in Section 9.6.3.11.4 of ASCE 7-98/02 and Section 13.6.8 of ASCE 7-05. The provisions of this section do not cover elevator system piping which is covered in Section 9.6.3.16 of ASCE 7-98/02 and Section 13.6.10 of ASCE 7-05. The piping considered in this section is assumed to be high-deformability piping. This implies pipes made from ductile materials that are joined by welding, brazing, or groove type couplings, similar to VICTAULIC couplings, where the grooves in the pipe have been roll formed rather than cut. Limited deformability piping on the other hand, would be pipes made of ductile materials that are joined by threading, bonding, or the use of groove type couplings where the grooves in the pipe have been machine cut. Low deformability piping would be comprised of pipes made from relatively brittle materials such as cast iron or glass. Also not covered in this section is fire protection piping. Fire protection piping will be covered in a separate publication.

D2.1 – 5.2 The 12″ Rule (9.6.3.11.4-c) [Section 13.6.8-1][1]:

No restraints will be required for piping that meets the requirements of the 12″ Rule for the entire piping run. The 12″ Rule will be said to apply to a piping run if:

1. The piping is supported by rod hangers.
   a. For single clevis supported pipe, all of the hangers in the piping run are 12 in. (305 mm) or less in length from the top of the pipe to the supporting structure.
   b. For trapeze supported pipe, all of the hangers in the piping run are 12 in. (305 mm) or less in length from the top of the trapeze bar to the supporting structure.
2. For 2000/2003 IBC The hanger rods and their attachments are not to be subjected to bending moments. For 2006 IBC the hangers are to be detailed to avoid bending of the

[1] References in brackets (9.6.3.11.4-c) [Section 13.6.8-1] apply to sections, tables, and/or equations in ASCE 7-98/02 and ASCE 7-05 respectively which forms the basis for the seismic provisions in 2000/2003 IBC and 2006 IBC respectively.

Toll Free (USA Only): 800-959-1229
International: 614-889-0480
FAX 614-889-0540
World Wide Web: www.kineticsnoise.com
E-mail: sales@kineticsnoise.com
RELEASED ON: 05/27/2008
KINETICS Noise Control
Dublin, Ohio, USA ▪ Mississauga, Ontario, Canada

hangers and their attachments. This statement very is ambiguous. It does not clearly define the phrase “significant bending”, and leaves it up to the design professional responsible for the piping system, or worse, the contractor responsible for installing the piping system. The past practice by SMACNA and other recognized authorities in the industry to call for the connection between the hanger and the supporting structure to be “non-moment generating”. This means that the connector must be one that allows the piping run to swing freely on its hangers without introducing a bending moment in the hanger.

3. There must be sufficient space around the piping run to accommodate the expected motion of the pipe as it sways back and forth with the earthquake motion in the building.
4. Connections between the piping and the interfacing components must be designed and/or selected to accept the full range of motion expected for both the pipe and the interfacing component.

D2.1 – 5.3 Single Clevis Supported Pipe in Seismic Design Categories A and B (Sections 9.6.1-1 and 9.6.1-3) [Sections 13.1.4-1 and 13.1.4-2]

No seismic restraints are required for piping in building assigned to Seismic Design Categories A and B. This is implied by the general exemptions found in Section 9.6.1 of ASCE 7-98/02 and Section 13.1.4 of ASCE 7-05.

D2.1 – 5.4 Single Clevis Supported Pipe in Seismic Design Category C (Sections 9.6.1-1 and 9.6.3.11.4-d2) [Sections 13.1.4-3 and 13.6.8-2b]

1. For single clevis supported piping in buildings assigned to Seismic Design Category C for which the Component Importance Factor is equal to 1.0, no seismic restraint is required.
2. For piping in Buildings assigned to Seismic Design Category C, for which the Component Importance Factor is equal to 1.5, and for which the nominal size is 2 in. (51 mm) or less; no seismic restraint is required.

KINETICS Noise Control
Toll Free (USA Only): 800-959-1229
International: 614-889-0480
FAX 614-889-0540
World Wide Web: www.kineticsnoise.com
E-mail: sales@kineticsnoise.com
Dublin, Ohio, USA ▪ Mississauga, Ontario, Canada

D2.1 – 5.5 Single Clevis Supported Pipe in Seismic Design Categories D, E, and F (Sections 9.6.3.11.4-d1 and 9.6.3.11.4-d3) [Sections 13.6.8-2a and 13.6.8-2c]

1. For single clevis supported piping in buildings assigned to Seismic Design Categories D, E, and F, for which the Component Importance Factor is equal to 1.5, and for which the nominal size is 1 in. (25 mm) or less; no seismic restraint is required.
2. For single clevis supported piping in buildings assigned to Seismic Design Categories D, E, and F, for which the Component Importance Factor is equal to 1.0, and for which the nominal size is 3 in. (76 mm) or less; no seismic restraint is required.

D2.1 – 5.6 Exemptions for Trapeze Supported Pipe per VISCMA Recommendations:

Neither ASCE 7-98/02 nor ASCE 7-05 specifies how the piping is to be supported. The point is that many pipes of the exempted size may be supported on a common trapeze bar using hanger rods of the same size as would be specified for a single clevis supported pipe. Keep in mind that the purpose of the seismic restraints is to make sure the pipe moves with the building. The amount of force that the hanger rod must carry will be a direct function of the weight of pipe being supported. It is apparent that there must be some limit to how much weight a trapeze bar can support for a given hanger rod size before seismic restraint is required. VISCMA (Vibration Isolation and Seismic Control Manufacturer's Association) has investigated this issue and can make the following recommendations on the application of the exemptions in Sections 5.4 and 5.5 above to trapeze supported pipe, www.viscma.com.

The following basic provisions must apply.

1. The hangers must be ASTM A36 all-thread rod.
2. The threads must be roll formed.
3. The pipes must be rigidly attached to the hanger rods.

Toll Free (USA Only): 800-959-1229
International: 614-889-0480
FAX 614-889-0540
World Wide Web: www.kineticsnoise.com
E-mail: sales@kineticsnoise.com
Dublin, Ohio, USA ▪ Mississauga, Ontario, Canada
RELEASED ON: 05/27/2008

4. Provisions must be made to avoid impact with adjacent pipe, duct, equipment, or building structure, or to protect the pipe from such impact.

D2.1 – 5.6.1 Trapeze Supported Pipe in Seismic Design Categories A and B: (Sections 9.6.1-1 and 9.6.1-3) [Sections 13.1.4-1 and 13.1.4-2]

For trapeze supported piping in Seismic Design Categories A and B, no seismic restraint is required.

D2.1 – 5.6.2 Trapeze Supported Pipe in Seismic Design Category C: (Sections 9.6.1-1 and 9.6.3.11-d2) [Sections 13.1.4-3 and 13.6.8-2b]

1. For trapeze supported piping in buildings assigned to Seismic Design Category C, which have a Component Importance Factor equal to 1.0, and for which the nominal size is 2 in. (51 mm) or less, nor seismic restraint is required.
2. For trapeze supported piping in buildings assigned to Seismic Design Category C, which have a Component Importance Factor equal to 1.5, and for which the nominal size is 2 in. (51 mm) or less, no seismic restraint is required if:
   a. The trapeze bar is supported by 3/8-16 UNC, or larger, hanger rods.
   b. The maximum hanger spacing is 10 ft. on center.
   c. The total weight supported by the trapeze bar is 15 lbs/ft or less.

D2.1 – 5.6.3 Trapeze Supported Pipe in Seismic Design Category D: (Sections 9.6.1-6, 9.6.3.11.4-d2 and 9.6.3.11.4-d3) [Sections 13.1.4-5, 13.6.8-2a, and 13.6.8-2c]

1. For trapeze supported piping in buildings assigned to Seismic Design Category D, which have a Component Importance Factor equal to 1.5, and for which the nominal size is 1 in. (25 mm) or less, no seismic restraint is required if:
   a. The trapeze bar is supported by 3/8-16 UNC, or larger, hanger rods.
   b. The maximum hanger spacing is 7 ft. on center.

KINETICS Noise Control
Toll Free (USA Only): 800-959-1229
International: 614-889-0480
FAX 614-889-0540
World Wide Web: www.kineticsnoise.com
E-mail: sales@kineticsnoise.com
Dublin, Ohio, USA ▪ Mississauga, Ontario, Canada

   c. The total weight supported by the trapeze bar is 4 lbs/ft or less.
2. For trapeze supported piping in buildings assigned to Seismic Design Category D, which have a Component Importance Factor equal to 1.0, and for which the nominal size is 3 in. (76 mm) or less, no seismic restraint is required if:
   a. The trapeze bar is supported by 1/2-13 UNC, or larger, hanger rods.
   b. The maximum hanger spacing is 10 ft. on center.
   c. The total weight supported by the trapeze bar is 25 lbs/ft or less.

D2.1 – 5.6.4 Trapeze Supported Pipe in Seismic Design Categories E and F: (Sections 9.6.1-6, 9.6.3.11.4-d2 and 9.6.3.11.4-d3) [Sections 13.1.4-5, 13.6.8-2a, and 13.6.8-2c]

1. For trapeze supported piping in buildings assigned to Seismic Design Categories E and F, which have a Component Importance Factor equal to 1.5, and for which the nominal size is 1 in. (25 mm) or less, no seismic restraint is required if:
   a. The trapeze bar is supported by 3/8-16 UNC, or larger, hanger rods.
   b. The maximum hanger spacing is 7 ft. on center.
   c. The total weight supported by the trapeze bar is 4 lbs/ft or less.
2. For trapeze supported piping in buildings assigned to Seismic Design Category D, which have a Component Importance Factor equal to 1.0, and for which the nominal size is 3 in. (76 mm) or less, no seismic restraint is required if:
   a. The trapeze bar is supported by 1/2-13 UNC, or larger, hanger rods.
   b. The maximum hanger spacing is 10 ft. on center.
   c. The total weight supported by the trapeze bar is 11 lbs/ft or less.

D2.1 – 5.7 Summary:

The exemptions and allowances outlined in this section can, with careful planning save a lot of time and money. They may also mean the difference between making a profit on a project and breaking even, or worse, losing money. In order to take proper advantage of these exemptions,

Toll Free (USA Only): 800-959-1229
International: 614-889-0480
FAX 614-889-0540
World Wide Web: www.kineticsnoise.com
E-mail: sales@kineticsnoise.com
Dublin, Ohio, USA ▪ Mississauga, Ontario, Canada

the Seismic Design Category to which the project has been assigned must be known. This is readily available from the structural engineer. Also, the design professional who is responsible for the piping system must assign an appropriate Component Importance Factor to the system.

As a sidebar to the previous statement, it should be noted that the specification for the building may increase the Seismic Design Category in order to ensure an adequate safety margin and the continued operation of the facility. This is a common practice with schools, government buildings, and certain manufacturing facilities. Also, the building owner has the prerogative, through the specification, to require all of the piping systems to be seismically restrained. So, careful attention to the specification must be paid, as some or all of the exemptions in this section may be nullified by specification requirements that are more stringent than those provided by the code.

Toll Free (USA Only): 800-959-1229
International: 614-889-0480
FAX 614-889-0540
World Wide Web: www.kineticsnoise.com
E-mail: sales@kineticsnoise.com
Dublin, Ohio, USA ▪ Mississauga, Ontario, Canada

EXEMPTIONS FOR HVAC DUCTWORK

D2.1 – 6.1 Introduction:

The 2000/2003/2006 IBC has some general exemptions that apply to HVAC ductwork based on Component Importance Factor and the size of the duct. At present, there are not as many exemptions for ductwork as there are for piping. The number of exemptions for ductwork changed with SMACNA being dropped as a reference document in the 2003/2006 IBC. This will be discussed below in the appropriate section.

D2.1 – 6.2 The 12″ Rule (Section 9.6.3.10-a) [Section 13.6.7-a][1]:

No seismic restraints will be required for ductwork with a Component Importance Factor equal to 1.0 that meets the requirements of the 12″ Rule for the entire run of ductwork. The 12″ Rule is said to apply to a run of ductwork if:

1. The HVAC ducts a suspended for hangers that are 12″ (305 mm) or less in length for the entire run of ductwork. This is usually measured from the supporting structure to the top of the trapeze bar that is supporting the ductwork.
2. The hangers have been detailed and constructed in order to avoid significant bending of the hanger and its attachments. As with the 12″ rule applied to piping, the industry generally interprets this to mean that the connection of the hanger to the structure must be "non-moment generating", or free swinging.

[1] References in brackets (Section 9.6.3.10-a) [Section 13.6.7-a] apply to sections, tables, and/or equations in ASCE 7-98/02 and ASCE 7-05 respectively which forms the basis for the seismic provisions in 2000/2003 IBC and 2006 IBC respectively.

Toll Free (USA Only): 800-959-1229
International: 614-889-0480
FAX 614-889-0540
World Wide Web: www.kineticsnoise.com
E-mail: sales@kineticsnoise.com
Dublin, Ohio, USA ▪ Mississauga, Ontario, Canada
RELEASED ON: 05/06/2008

D2.1 – 6.3 Size Exemption (Section 9.6.3.10-b) [Section 13.6.7-b]:

No seismic restraints are required for ductwork with a Component Importance Factor equal to 1.0 if the cross-sectional area is less than 6 ft^2 (0.557 m^2).

D2.1 – 6.4 Further Exemptions for Ductwork (Sections 9.6.1.1.2 and 9.6.3.10) [Section 13.6.7]:

There are no further exemptions for ductwork in 2006 IBC. The SMACNA Seismic Restraint Manual does have exemptions for ductwork that has been assigned a Component Importance Factor equal to 1.5. For 2000 IBC the SMACNA Seismic Design Manual was an accepted standard, and ductwork with a cross-sectional area of less than 6 ft^2 (0.557 m^2) may be exempted from the need for seismic restraint. However for 2003 IBC and 2006 IBC, the SMACNA Seismic Design Manual was removed from the design portion of the code and was, instead, incorporated as an Accepted Standard in Section 9.6.1.1.2 of ASCE 7-02, which applies to 2003 IBC. The SMACNA Seismic Restraint Manual is not specifically identified in ASCE 7-05, 2006 IBC instead the following statement was inserted into the design portion of the code.

"HVAC duct systems fabricated and installed in accordance with standards approved by the authority having jurisdiction shall be deemed to meet the lateral bracing requirements of this section."

In other words, it will be up to the local building authority to approve or disapprove SMACNA or any other reference documents. So, the HVAC design professional and contractor will need to petition the local building authority for permission to use the exemptions in the SMACNA Seismic Restraint Manual.

KINETICS Noise Control
Toll Free (USA Only): 800-959-1229
International: 614-889-0480
FAX 614-889-0540
World Wide Web: www.kineticsnoise.com
E-mail: sales@kineticsnoise.com
Dublin, Ohio, USA ▪ Mississauga, Ontario, Canada

D2.1 – 6.5 Restraint Allowance for In-Line Components (Section 9.6.3.10) [Section 13.6.7]:

This allowance deals with components, such as fans, heat exchangers, humidifiers, VAV boxes, and the like, that are installed in-line with the ductwork. Components that have an operating weight of 75 lbs (334 N) or less may be supported and laterally, seismically, braced as part of the duct system. Where the lateral braces, seismic restraints, have been designed and sized to meet the requirements of ASCE 7-98/02 Section 9.6.1.3 or ASCE 7-05 Section 13.3.1. The following requirements will also apply to these components.

1. At least one end of the component must be hard, rigidly, attached to the ductwork. The other end may have a flex connector or be open. The flex connected, or open end, of the component must be supported and laterally braced. This requirement is not mentioned as part of ASCE 7-98, -02, or -05, but is a requirement that is born out of common sense.
2. Devices such as diffusers, louvers, and dampers shall be positively attached with mechanical fasteners.
3. Unbraced piping and electrical power and control lines that are attached to in-line components must be attached with flex connections that allow adequate motion to accommodate the expected differential motions.

D2.1 – 6.6 Summary:

As with the piping exemptions these exemptions and allowances, with careful planning, can save the contractor and the building owner a great deal of effort and money. There is also a great advantage to petition the local building authority to allow the SMACNA Seismic Design Manual to become a reference document for the project. This will allow the exemptions spelled out in the SMACNA Seismic Design Manual to be utilized to best advantage

KINETICS Noise Control
Toll Free (USA Only): 800-959-1229
International: 614-889-0480
FAX 614-889-0540
World Wide Web: www.kineticsnoise.com
E-mail: sales@kineticsnoise.com
Dublin, Ohio, USA ▪ Mississauga, Ontario, Canada

EXEMPTIONS FOR ELECTRICAL

D2.1 – 7.1 Introduction:

The exemptions mentioned in both ASCE 7-98/02 and ASCE 7-05 are actually implied exemptions that are stated as requirements. This section is an attempt to more fully define these provisions for the design professional responsible for the design of the electrical components and distribution systems, and also for the installing contractor who is responsible for bidding and installing the restraints.

D2.1 – 7.2 "Implied" Blanket Exemption Based on Component Importance Factor I_P (Section 9.6.3.14) [Sections 13.6.4 and 13.6.5][1]:

Section 9.6.3.14 of ASCE 7-98/02 states that;

"Attachments and supports for electrical equipment shall meet the force and displacement provisions of Sections 9.6.1.3 and 9.6.1.4 and the additional provisions of this Section. In addition to their attachments and supports, electrical equipment designated as having $I_P = 1.5$, itself, shall be designed to meet the force and displacement provisions of Sections 9.6.1.3 and 9.6.1.4 and the additional provisions of this Section."

In this statement, there really are no implied exemptions for electrical equipment, except that if the supports for the equipment have been designed by the manufacturer to meet the seismic load requirements with the specified mounting hardware, no further analysis and restraint will be required.

In Section 13.6.4 of ASCE 7-05, the text reads as follows.

[1] References in brackets (Section 9.6.3.14) [Sections 13.6.4 and 13.6.5] apply to sections, tables, and/or equations in ASCE 7-98/02 and ASCE 7-05 respectively which forms the basis for the seismic provisions in 2000/2003 IBC and 2006 IBC respectively.

KINETICS Noise Control
Toll Free (USA Only): 800-959-1229
International: 614-889-0480
FAX 614-889-0540
World Wide Web: www.kineticsnoise.com
E-mail: sales@kineticsnoise.com
Dublin, Ohio, USA ▪ Mississauga, Ontario, Canada

"Electrical components with I_P greater than 1.0 shall be designed for the seismic forces and relative displacements defined in Sections 13.3.1 and 13.3.2 …."

ASCE 7-05 Section 13.6.5 states the following;

"Mechanical and electrical component supports (including those with $I_P = 1.0$) and the means by which they are attached to the component shall be designed for the forces and displacements determined in Sections 13.3.1 and 13.3.2. Such supports including structural members, braces, frames, skirts, legs, saddles, pedestals, cables, guys, stays, snubbers, and tethers, as well as elements forged or cast as part of the mechanical or electrical component."

ASCE 7-05 Section 13.6.4 implies that electrical components that have been assigned a Component Importance Factor equal to 1.0, regardless of the Seismic Design Category to which they have been assigned, will not require seismic restraints beyond the attachment provisions normally included with the component, provided that a qualified component is selected. This means that if the component has four mounting feet with holes for Φ3/8″ mounting hardware, then the component should be attached to the structure with four Φ3/8″ bolts, or anchors. Beyond that nothing further is required.

However, ASCE 7-05 Section 13.6.5 insists that the supports must be designed to withstand the code mounted forces and displacements. So, as with ASCE 7-98/02 this is not a general blanket exemption. The manufacturer of the component must be able to certify that the supports designed as part of the component will withstand the seismic requirements for the project using hardware of the appropriate size and strength.

So, while additional analysis and restraint may not be required for electrical components with $I_P = 1.0$, the supports for this equipment must be designed by the manufacturer with sufficient strength to meet the code mandated requirements. After this the design professional of record for a project and the contractor may provide attachment hardware of the appropriate type, size, and

KINETICS Noise Control
Toll Free (USA Only): 800-959-1229
International: 614-889-0480
FAX 614-889-0540
World Wide Web: www.kineticsnoise.com
E-mail: sales@kineticsnoise.com
Dublin, Ohio, USA ▪ Mississauga, Ontario, Canada

strength, as recommended by the manufacturer of the equipment, without doing any further analysis, or providing any further restraint.

While this sounds rather "wishy-washy", it's really not. If the manufacturer of the equipment and its supports certifies that is was design to handle accelerations in excess of the design acceleration for the project, then it may be exempted from the need for further seismic restraint or analysis.

D2.1 – 7.3 Conduit Size Exemption [13.6.5.5-6a]:

There are no specific size exemptions for electrical conduit in 2000/2003 IBC, ASCE 7-98/02. However, 2006 IBC, ASCE 7-05 does have exemptions for electrical conduit. They seem to follow the exemptions, in terms size, that are used for piping. Therefore, it is reasonable to use the exemptions in 2006 IBC for 2000/2003 IBC since it is the most recent version, and takes into account any new testing or analysis.

For 2006 IBC, ASCE 7-05, seismic restraints are not required for conduit that has been assigned a Component Importance Factor equal to 1.5, and whose trade size is 2.5 in. (64mm) or less. When sizing and selecting restraints for electrical conduit, that the weight per linear foot of conduit varies greatly depending on the exact type of conduit being used. Also, when computing the total weight per foot of the conduit plus the cabling, it standard practice to assume that there will be ~40% copper fill for the cabling.

D2.1 – 7.4 Trapeze Supported Electrical Distribution Systems [13.6.5.5-6b]:

As with conduit, no specific exemptions for trapeze supported electrical distribution systems exist in 2000/2003 IBC, ASCE 7-98/02. However, an exemption is allowed under 2006 IBC, ASCE 7-05. It makes sense to argue for the use of this exemption in 2000/2003 IBC as well. The exemption matches the weight limits proposed for trapeze supported pipe in Section 5.6 of this guide.

KINETICS Noise Control
Toll Free (USA Only): 800-959-1229
International: 614-889-0480
FAX 614-889-0540
World Wide Web: www.kineticsnoise.com
E-mail: sales@kineticsnoise.com
Dublin, Ohio, USA ▪ Mississauga, Ontario, Canada

No restraints are required for conduit, bus ducts, or cable trays that are supported on trapeze bars, that have been assigned a Component Importance Factor equal to 1.5, and that have a total weight that is 10 lb/ft (146 N/m) or less. This total weight includes not only the conduit, bus duct, or cable trays, but also includes the trapeze bars as well.

D2.1 – 7.5 Summary:

All of the implied exemptions above are made without regard for the Seismic Design Category to which the building has been assigned. Further, a complete reading of the project specification is in order to ensure that these exemptions have not been negated by the wishes of the building owner.

Toll Free (USA Only): 800-959-1229
International: 614-889-0480
FAX 614-889-0540
World Wide Web: www.kineticsnoise.com
E-mail: sales@kineticsnoise.com
Dublin, Ohio, USA ▪ Mississauga, Ontario, Canada

SESIMIC DESIGN FORCES

D2.1 – 8.1 Introduction:

The code based horizontal seismic force requirements for MEP systems and components are either calculated by the seismic restraint manufacturer as a part of the selection and certification process, or may be determined by the design professional of record for the MEP systems under consideration.

This is an informational section. It will discuss the code based horizontal seismic force demand equations and the variables that go into them. This discussion will provide a deeper understanding for the designer responsible for selecting the seismic restraints for MEP systems and their components and the nature of the seismic forces and the factors that affect them.

D2.1 – 8.2 Horizontal Seismic Design Force (Section 9.6.1.3) [Section 13.3.1][1]:

The seismic force is a mass, or weight, based force, and as such is applied to the MEP component at its center of gravity. Keep in mind that the earthquake ground motion moves the base of the building first. Then the motion of the building will accelerate the MEP component through its supports and/or seismic restraints. The horizontal seismic force acting on an MEP component will be determined in accordance with Equation 9.6.1.3-1 of ASCE 7-98/02 and Equation 13.3-1 of ASCE 7-05.

$$F_P = \frac{0.4 a_P S_{DS} W_P}{\left(\frac{R_P}{I_P}\right)}\left(1 + 2\frac{z}{h}\right)$$

Equation 8-1 (9.6.1.3-1) [13.3-1]

[1] References in brackets (Section 9.6.1.3) [Section 13.3.1] refer to sections and/or tables in ASCE 7-98/02 and ASCE 7-05 respectively which forms the basis for the seismic provisions in 2000/2003 IBC and 2006 IBC respectively.

KINETICS Noise Control
Toll Free (USA Only): 800-959-1229
International: 614-889-0480
FAX 614-889-0540
World Wide Web: www.kineticsnoise.com
E-mail: sales@kineticsnoise.com
Dublin, Ohio, USA ▪ Mississauga, Ontario, Canada

ASCE 7-98/02, and -05 define and upper and lower bound for the horizontal force that is to be applied to the center of gravity of a component. The horizontal seismic force acting on an MEP component is not required to be greater than;

$$F_P = 1.6 S_{DS} I_P W_P$$ **Equation 8-2 (9.6.1.3-2) [13.3-2]**

And the horizontal seismic force acting on an MEP component is not to be less than;

$$F_P = 0.3 S_{DS} I_P W_P$$ **Equation 8-3 (9.6.1.3-3) [13.3-3]**

Where:

F_P = the design horizontal seismic force acting on an MEP component at its center of gravity.

S_{DS} = the short period design spectral acceleration.

a_P =the component amplification factor. This factor is a measure of how close to the natural period of the building the natural period of the component is expected is expected to be. The closer the natural period of the component is to that of the building, the larger a_P will be. Conversely, the further the natural period of the component is away from that of the building, the smaller a_P will be. Typically a_P will vary from 1.0 to 2.5, and is specified by component type in ASCE 7-98/02 and -05 and listed in Table 8-3.

I_P = the component importance factor which be either 1.0 or 1.5.

W_P = the operating weight of the MEP system or component that is being restrained.

R_P = the response modification factor which varies from 1.25 to 5.0 in ASCE 7-98, 1.5 to 5.0 in ASCE 7-02, and 1.50 to 12.0 in ASCE 7-05 by component type. This factor is a measure of the ability of the component and its attachments to the structure to absorb energy. It is really a measure of how ductile or brittle the component and its attachments are. The more flexible, ductile the component and its supports and/or restraints are the larger R_P will be. And conversely, the more brittle and inflexible the component and its supports and/or restraints are, the smaller R_P will

KINETICS Noise Control
Toll Free (USA Only): 800-959-1229
International: 614-889-0480
FAX 614-889-0540
World Wide Web: www.kineticsnoise.com
E-mail: sales@kineticsnoise.com
Dublin, Ohio, USA ▪ Mississauga, Ontario, Canada

be. The values are specified by component type in Table 8-1 for ASCE 7-98, Table 8-2 for ASCE 7-02, and Table 8-3 for ASCE 7-05.

z = the structural attachment mounting height of the MEP component in the building relative to the grade line of the building.

h = the average height of the building roof as measured from the grade line of the building.

The $\mathbf{0.4}$ factor was introduced as a modifier for S_{DS} as a recognition that the MEP components inside the building would react more strongly to the long period earthquake ground motion than to the short period motion. The $\mathbf{0.4}$ factor brings the design level acceleration for the MEP components more in line with the design level acceleration that is applied to the building structure itself.

The $\left(1+2\frac{z}{h}\right)$ term in Equation 8-1 is recognition of the fact that all buildings and structures become more flexible as they increase in height. That is they are much stiffer, stronger, at the foundation level than the roof. Since the ground motion from an earthquake enters the building structure at the foundation level, the actual accelerations imparted an MEP component will be greater the higher in the building they are attached. A building may be likened to a vertically mounted cantilever beam that is being shaken by the bottom. It is a vibrating system that will have a certain natural period that is, in a general fashion, based on its mass and stiffness. If the natural period of the building is at, or close too, the earthquake period, the motion of the building could be extreme. This was the case in the Mexico City earthquake of September 19, 1985.

The horizontal seismic design force must be applied independently to the component in at least two perpendicular directions in the horizontal plane. The horizontal seismic design force must be applied in conjunction with all of the expected dead loads and service loads. The idea here is that the horizontal seismic design force is to be applied in the direction that causes the highest stress in the supports and restraints, and thus produces the most conservative results.

RELEASED ON: 07/18/2008
KINETICS Noise Control
Toll Free (USA Only): 800-959-1229
International: 614-889-0480
FAX 614-889-0540
World Wide Web: www.kineticsnoise.com
E-mail: sales@kineticsnoise.com
Dublin, Ohio, USA ▪ Mississauga, Ontario, Canada

D2.1 – 8.3 Vertical Seismic Design Force (Sections 9.5.2.7 and 9.6.1.3) [Sections 12.4.2.2 and 13.3.1]:

The MEP component, its supports, and its restraints must also be designed for a vertical seismic design force that acts concurrently with the horizontal seismic design force. This vertical seismic design force must be directed such that it also produces the highest stress in the supports and restraints, thus producing the most conservative result. This vertical seismic design force is defined as follows.

$$F_V = \pm 0.2 S_{DS} W_P$$ **Equation 8-4 (9.5.2.1-1/-2) [12.4-4]**

Where:

F_V = the vertical seismic design force.

D2.1 – 8.4 The Evolution of a_P and R_P Factors (Sections 9.6.1.3 and 9.6.3.2 and Table 9.6.3.2) [Sections 13.3.1 and 13.6.1 and Table 13.6-1]:

The MEP component, along with its supports, will also form a vibrating system with a natural period that depends on the mass of the component and the stiffness of the supports. The component amplification factor (a_P) is a measure of how closely the natural period of the component and its supports matches the natural period of the building. For $a_P = 1.0$ the natural periods are not close, while for $a_p = 2.5$ the natural period of the MEP component and their support is very close to that of the building.

The component response modification factor(R_P)is a measure of how much energy the MEP component along with its supports and attachments can absorb without sustaining crippling damage. A common term used throughout the HVAC industry is fragility. As the term implies, it is concerned with how fragile a component might be. That is, how easily a component may be

Toll Free (USA Only): 800-959-1229
International: 614-889-0480
FAX 614-889-0540
World Wide Web: www.kineticsnoise.com
E-mail: sales@kineticsnoise.com
Dublin, Ohio, USA ▪ Mississauga, Ontario, Canada

damaged, and to what degree it might be damaged by a specified load and loading rate. The R_P factor, then, is considered to be an indicator of how fragile an MEP component might be. For $R_P = 1.0$ the component is extremely fragile. For $R_P = 12.0$, on the other hand, would be a component that is very robust.

The values for a_P and R_P are assigned by the ASCE 7 committee based on accumulated experience throughout the building industry. The evolution of these factors may be traced through Tables 8-1; 8-2, and 8-3 which represent 2000 IBC, ASCE 7-98; 2003 IBC, ASCE 7-02; and 2006 IBC, ASCE 7-05 respectively. The different values for the same items in the three tables indicate the lack of knowledge and understanding concerning these components throughout the industry. Only time, experience, and shake table testing will produce true usable values for a_P and R_P.

D2.1 – 8.5 LRFD versus ASD: (Sections 2.3 and 2.4) [Sections 2.3, 2.4 and 13.1.7]

This topic was briefly touched upon in Section 4.8 of this guide. However, more should be said about it in this section dealing the design seismic forces that will be applied to the MEP components. The Civil and Structural Engineering community has adopted the LRFD, Load Resistance Factor Design, philosophy. With this design philosophy the factors controlling the serviceability of the structure as assigned to the design loads. ASD, Allowable Stress Design, is the design philosophy which preceded LRFD. In ASD, the factors controlling the serviceability of the structure are assigned to the yield strength or to the ultimate strength of the material. Traditionally the factors controlling the serviceability of the structure have been known as the Safety Factors, or Factors of Safety.

The forces calculated using Equations 8-1, 8-2, 8-3, and 8-4 will have magnitudes that correspond to LRFD. Many standard components such a concrete anchors, bolts, screws, and etc. will have their capacities listed as ASD values. Components whose capacities are listed as ASD values may be compared to the LRFD results from Equations 8-1 through 8-4 by multiplying the ASD values by 1.4.

KINETICS Noise Control
Toll Free (USA Only): 800-959-1229
International: 614-889-0480
FAX 614-889-0540
World Wide Web: www.kineticsnoise.com
E-mail: sales@kineticsnoise.com
Dublin, Ohio, USA ▪ Mississauga, Ontario, Canada

Table 8-1; Component Amplification and Response Modification Factors for 2000 IBC (Table 9.6.3.2)

Mechanical & Electrical Component[2]	a_P [3]	R_P [4]
General Mechanical Equipment	-----	-----
Boilers and furnaces.	1.0	2.5
Pressure vessels on skirts and free-standing.	2.5	2.5
Stacks & cantilevered chimneys	2.5	2.5
Other	1.0	2.5
Piping Systems	-----	-----
High deformability elements and attachments (welded steel pipe & brazed copper pipe).	1.0	3.5
Limited deformability elements and attachments (steel pipe with screwed connections, no hub connections, and Victaulic type connections).	1.0	2.5
Low deformability elements and attachments (iron pipe with screwed connections, and glass lined pipe).	1.0	1.25
HVAC Systems	-----	-----
Vibration isolated.	2.5	2.5
Non-vibration isolated.	1.0	2.5
Mounted-in-line with ductwork.	1.0	2.5
Other	1.0	2.5
General Electrical	-----	-----
Distributed systems (bus ducts, conduit, and cable trays).	2.5	5.0
Equipment.	1.0	2.5
Lighting fixtures.	1.0	1.25

[2] Components mounted on vibration isolators shall be restrained in each horizontal direction with bumpers or snubbers, and the horizontal seismic design force shall be equal to $2F_P$.
[3] The value for a_P shall not be less than 1.0. Lower values shall not be used unless justified by a detailed dynamic analysis. A value of a_P=1.0 is to be applied to equipment that is rigid or rigidly attached. A value of a_P=2.5 is to be applied to equipment regarded as flexible or flexibly attached.
[4] A value of R_P=1.25 is to be used for component anchorage design with expansion anchor bolts, shallow chemical anchor, shall low deformability cast in place anchors, or when the component is constructed of brittle materials. Shallow anchors are those with an embedment depth to nominal diameter ratio that is less than 8.

Toll Free (USA Only): 800-959-1229
International: 614-889-0480
FAX 614-889-0540
World Wide Web: www.kineticsnoise.com
E-mail: sales@kineticsnoise.com
Dublin, Ohio, USA ▪ Mississauga, Ontario, Canada
RELEASED ON: 07/18/2008

Table 8-2; Component Amplification and Response Modification Factors for 2003 IBC (Table 9.6.3.2)

Mechanical & Electrical Component[5]	a_P [6]	R_P
General Mechanical Equipment	-----	-----
Boilers and furnaces.	1.0	2.5
Pressure vessels on skirts and free standing.	2.5	2.5
Stacks and cantilevered chimneys.	2.5	2.5
Other	1.0	2.5
Piping Systems	-----	-----
High deformability elements and attachments (welded steel pipe & brazed copper pipe).	1.0	3.5
Limited deformability elements and attachments (steel pipe with screwed connections, no hub connections, and Victaulic type connections).	1.0	2.5
Low deformability elements and attachments (iron pipe with screwed connections, and glass lined pipe).	1.0	1.5
HVAC Systems	-----	-----
Vibration isolated.	2.5	2.5
Non-vibration isolated.	1.0	2.5
Mounted-in-line with ductwork.	1.0	2.5
Other	1.0	2.5
General Electrical	-----	-----
Distribution systems (bus ducts, conduit, and cable trays).	2.5	5.0
Equipment	1.0	2.5
Lighting fixtures.	1.0	1.5

[5] Components mounted on vibration isolators shall be restrained in each horizontal direction with bumpers or snubbers. If the maximum bumper/snubber clearance, or air gap, is greater than 1/4 in., the horizontal seismic design force shall be equal to $2F_P$. If the maximum bumper/snubber clearance, air gap, is less than or equal to 1/4 in., the horizontal seismic design force shall be taken as F_P.

[6] The value for a_P shall not be less than 1.0. Lower values shall not be used unless justified by a detailed dynamic analysis. A value of a_P=1.0 is to be applied to equipment that is rigid or rigidly attached. A value of a_P=2.5 is to be applied to equipment regarded as flexible or flexibly attached.

KINETICS Noise Control
Toll Free (USA Only): 800-959-1229
International: 614-889-0480
FAX 614-889-0540
World Wide Web: www.kineticsnoise.com
E-mail: sales@kineticsnoise.com
Dublin, Ohio, USA ▪ Mississauga, Ontario, Canada

Table 8-3; Component Amplification and Response Modification Factors for 2006 IBC [Table 13.6-1]

MECHANICAL AND ELECTRICAL COMPONENTS	a_P [7]	R_P [8]
Air-side HVAC – fans, air handlers, and other mechanical components with sheet metal framing.	2.5	6.0
Wet-side HVAC – boilers, chillers, & other mechanical components constructed of ductile materials.	1.0	2.5
Engines, turbines, pumps compressors, and pressure vessels not supported on skirts.	1.0	2.5
Skirt supported pressure vessels.	2.5	2.5
Generators, batteries, transformers, motors, & other electrical components made of ductile materials.	1.0	2.5
Motor control cabinets, switchgear, & other components constructed of sheet metal framing.	2.5	6.0
Communication equipment, computers, instrumentation and controls.	1.0	2.5
Roof-mounted chimneys, stacks, cooling and electrical towers braced below their C.G.	2.5	3.0
Roof-mounted chimneys, stacks, cooling and electrical towers braced below their C.G.	1.0	2.5
Lighting fixtures.	1.0	1.5
Other mechanical & electrical components.	1.0	1.5
Vibration Isolated Components & Systems	-----	-----
Components & systems isolated using neoprene elements & neoprene isolated floors with elastomeric snubbers or resilient perimeter stops	2.5	2.5
Spring isolated components & systems & vibration isolated floors closely restrained with elastomeric snubbing devices or resilient perimeter stops.	2.5	2.0
Internally isolated components or systems.	2.5	2.0
Suspended vibration isolated equipment including in-line duct devices & suspended internally isolated components.	2.5	2.5
Distribution Systems	-----	-----
Piping in accordance with ASME B31, this includes in-line components, with joints made by welding or brazing.	2.5	12.0
Piping in accordance with ASME B31, this includes in-line components, constructed of high or limited deformability materials with joints made by threading, bonding, compression couplings, or grooved couplings.	2.5	6.0
Piping & tubing that is not in accordance with ASME B31, this includes in-line components, constructed with high deformability materials with joints made by welding or brazing.	2.5	9.0
Piping & tubing that is not in accordance with ASME B31, this includes in-line components, constructed of high or limited deformability materials with joints made by threading, bonding, compression couplings, or grooved couplings.	2.5	4.5
Piping & tubing of low deformability materials, such as cast iron, glass, or non-ductile plastics.	2.5	3.0
Ductwork, including in-line components, constructed of high deformability materials, with joints made by welding or brazing.	2.5	9.0
Ductwork, including in-line components, constructed of high or limited deformability materials, with joints made by means other than welding or brazing.	2.5	6.0
Duct work constructed of low deformability materials such as cast iron, glass, or non-ductile plastics.	2.5	3.0
Electrical conduit, bus ducts, rigidly mounted cable trays, & plumbing.	1.0	2.5
Suspended cable trays.	2.5	6.0

[7] The value for a_P shall not be less than 1.0. Lower values shall not be used unless justified by a detailed dynamic analysis. A value of a_P=1.0 is to be applied to components that are rigid or rigidly attached. A value of a_P=2.5 is to be applied to components regarded as flexible or flexibly attached.

[8] Components mounted on vibration isolators shall be restrained in each horizontal direction with bumpers or snubbers. If the maximum bumper/snubber clearance, or air gap, is greater than 1/4 in., the horizontal seismic design force shall be equal to $2F_P$. If the maximum bumper/snubber clearance, air gap, is less than or equal to 1/4 in., the horizontal seismic design force shall be taken as F_P.

KINETICS Noise Control
Toll Free (USA Only): 800-959-1229
International: 614-889-0480
FAX 614-889-0540
World Wide Web: www.kineticsnoise.com
E-mail: sales@kineticsnoise.com
Dublin, Ohio, USA ▪ Mississauga, Ontario, Canada

D2.1 – 8.6 Summary:

This section has provided an insight into the way in which the seismic design forces for MEP systems and components are to be computed. It is generally not necessary for a designer to actually run the computations for the seismic design forces. These forces are normally computed by the manufacturer of the seismic restraint devices as part of the selection and certification process to ensure that the proper components are selected per the code and the specification.

KINETICS Noise Control
Toll Free (USA Only): 800-959-1229
International: 614-889-0480
FAX 614-889-0540
World Wide Web: www.kineticsnoise.com
E-mail: sales@kineticsnoise.com
Dublin, Ohio, USA ▪ Mississauga, Ontario, Canada

ANCHORAGE OF MEP COMPONENTS TO THE BUILDING STRUCTURE

D2.1 – 9.1 Introduction:

The anchorage, or attachment, of the MEP components and their seismic restraints to the building structure has always been a gray area generally left to the installing contractor with little or no guidance from the design professionals responsible for the MEP systems or the building structure. ASCE/SEI 7-05 does give some general guidance for the making these attachments. However, the design professionals involved with the MEP systems and the building structure must share the responsibility for ensuring the adequacy of these attachments. This section will cover the guidance provided to the design professionals of record in ASCE/SEI 7-05.

D2.1 – 9.2 General Guidelines for MEP Component Anchorage (Section 9.6.1.6 and 9.6.3.4) [Section 13.4][1]:

1. The MEP component, its supports, and seismic restraints must be positively attached to the building structure without relying on frictional resistance generated by the dead weight of the component. The following are some of the acceptable ways and means of attachment.
   a. Bolting
   b. Welding
   c. Post installed concrete anchors
   d. Cast in place concrete anchors
2. There must be a continuous load path of sufficient strength and stiffness between the component and the building structure to withstand the expected seismic loads and displacements. This means that when cable restraints are used for distributed MEP systems, the cables can not bend or wrap around any other component or structure in a straight line path between the component and the structure.

[1] References in brackets (Sections 9.6.1.6 and 9.6.3.4) [Section 13.4] apply to sections, tables, and/or equations in ASCE 7-98/02 and ASCE 7-05 respectively which forms the basis for the seismic provisions in 2000/2003 IBC and 2006 IBC respectively.

Toll Free (USA Only): 800-959-1229
International: 614-889-0480
FAX 614-889-0540
World Wide Web: www.kineticsnoise.com
E-mail: sales@kineticsnoise.com
Dublin, Ohio, USA ▪ Mississauga, Ontario, Canada

3. The local areas of the building structure must be designed with sufficient strength and stiffness to resist and transfer the seismic restraint forces from the MEP systems and components to the main force resisting structure of the building. It is at this point that the design professional of record, and the installing contractor for the MEP system must work closely with the structural engineer of record to make sure that the intended anchorage points for the MEP system seismic restraints have sufficient capacity.

D2.1 – 9.3 Anchorage in (Cracked) Concrete and Masonry (Section 9.6.1.6) [Section 13.4.2]:

1. Anchors for MEP component seismic restraints and supports are to be designed and proportioned to carry the least of the following:
   a. A force equal to 1.3 times the seismic design forces acting on the component and its supports and restraints.
   b. The maximum force that can be transferred to the anchor by the component and its supports.
2. $\boldsymbol{R_P \leq 1.5}$ will be used to determine the component forces unless:
   a. The design anchorage of the component and/or its restraints is governed by the strength of a ductile steel element.
   b. The design of post installed anchors in concrete used for the anchorage of the component supports and restraints is prequalified for seismic applications according to ACI 355.2.
      i. Anchors that have been prequalified per ACI 355.2 will have an ICC-ES ESR Report issued for that anchor stating the fact that it is suitable for seismic applications for the current version of IBC. It will also give the allowable loads, embedments, and edge distances pertinent to the allowable loads.
      ii. Anchors from different manufacturers may not be directly substituted on a one-to-one basis. Each manufacturer will have a different design that will have different allowable loads when tested under ACI 355.2. The allowable loads for equivalent anchor sizes may be radically different.

RELEASED ON: 07/18/2008
KINETICS Noise Control
Toll Free (USA Only): 800-959-1229
International: 614-889-0480
FAX 614-889-0540
World Wide Web: www.kineticsnoise.com
E-mail: sales@kineticsnoise.com
Dublin, Ohio, USA ▪ Mississauga, Ontario, Canada

c. The anchor is designed in accordance with Section 14.2.2.14 of ASCE 7-05.

For 2000 IBC, ASCE 7-98, the "cracked" concrete anchors are not required, and standard post installed wedge type anchors may be used for seismic restraint as long as there is an ICC Legacy report stating that the anchors may be used in seismic applications. For 2003 IBC, ASCE 7-02, there are no specific statements in ASCE 7-02 that require the use of "cracked" concrete anchors in seismic applications. However, ASCE 7-02 Section 9.9 adopts ACI 318-02 as a reference document. ACI 318-02 specifies that the post installed anchors meet ACI 355.2 and "are required to be qualified for moderate or high seismic risk zone usage." ACI 355.2 is the test standard by which post installed anchors are to be pre-qualified for seismic applications in cracked concrete. So, by inference, "cracked" concrete anchors should also be used for 2003 IBC. However, that has not yet been widely enforced since few if any post installed anchors had been qualified to this standard before 2006 IBC was issued.

D2.1 – 9.4 Undercut Anchors (Section 9.6.3.13.2-c) [Section 13.6.5.5-5]:

For both 2000 IBC, ASCE 7-98, and 2006 IBC, ASCE 7-05, post installed expansion, wedge, anchors may not be used for non-vibration isolated mechanical equipment rated over 10 hp (7.45 kW). However, post installed undercut expansion anchors may be used.

For 2003 IBC, ASCE 7-02, post installed expansion, wedge, anchors may not be used for non-vibration isolated mechanical equipment. However, post installed undercut expansion anchors are permitted.

D2.1 – 9.5 Prying of Bolts and Anchors (Section 9.6.1.6.3) [Section 13.4.3]:

The design of the attachment of the MEP component supports and restraints must take into account the mounting conditions such as eccentricity in the supports and brackets, and prying of the bolts or anchors.

KINETICS Noise Control
Toll Free (USA Only): 800-959-1229
International: 614-889-0480
FAX 614-889-0540
World Wide Web: www.kineticsnoise.com
E-mail: sales@kineticsnoise.com
Dublin, Ohio, USA ▪ Mississauga, Ontario, Canada

D2.1 – 9.6 Power Actuated or Driven Fasteners (Section 9.6.1.6.5) [Section 13.4.5]:

Power actuated or driven fasteners, such as powder shot pins, may not be used for tensile load applications in Seismic Design Categories D, E, and F unless specifically approved for this application.

D2.1 – 9.7 Friction Clips (Section 9.6.3.13.2-b) [Section 13.4.6]:

Friction clips may not be used to attach seismic restraints to the component or the building structure. A typical example would be the attachment of a cable restraint to a structural beam with a standard beam clamp. A beam clamp with a restraint strap or safety strap, capable of resisting the applied seismic load that will ensure that the clamp will be prevented from walking off the beam may be used.

D2.1 – 9.8 Summary:

Attachment of the MEP components and their seismic restraints to the building structure is of the utmost importance to maintaining the building function following an earthquake. It is the responsibility of the design professionals of record for the MEP systems to work with the structural engineer of record and the architect of record for the building to ensure that the anchorage points for the MEP component supports and restraints have been properly designed to transfer the design seismic loads as well as any other dead weight and service loads.

KINETICS Noise Control
Toll Free (USA Only): 800-959-1229
International: 614-889-0480
FAX 614-889-0540
World Wide Web: www.kineticsnoise.com
E-mail: sales@kineticsnoise.com
Dublin, Ohio, USA ▪ Mississauga, Ontario, Canada