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EXPLANATION & INSTRUCTIONS FOR THE USE OF: COMPLETE SEISMIC HVAC ENGINEERING SPECIFICATIONS

SVCS

PART 1

SVCS-110-5 BULLETIN

INTRODUCTION TO SEISMIC VIBRATION CONTROL SPECIFICATIONS FOR OFFICE BUILDINGS, COLLEGES, HOSPITAL, THEATERS AND SIMILAR STRUCTURES

To The Specifying Engineer:

Our company started calling on West Coast engineering firms as early as 1960. We opened our L.A. sales and applications office in 1965 when it became important to provide local service to the most seismically active parts of the country in California, Oregon, Washington and Alaska as well as Vancouver, Canada. Very few competitors, and especially Eastern based firms, have had this exposure. While we offered a broad line of restraints, all of these systems were in their very early stages.

In 1971 there was a major earthquake in San Fernando, California that read 6.0 on the Richter scale with horizontal ground accelerations recorded at 0.2 g. In 12 seconds there was tremendous damage to mechanical installations with virtually every type of support failure and the engineering community became concerned.

While we did not consider ourselves expert, in 1971 the San Francisco Chapter of ASHRAE thought enough of what we had been doing to invite Mason as the principal speaker at one of their meetings. In the three month preparation for this presentation, we intensified our studies and developed the concept of deceleration at acceptable levels and the importance of Neoprene cushioning rather than hard stops. Our philosophy was well received, and with the help of CAL-TEC in Pasadena, California, we developed a dynamic analysis program based on a response spectra as the proper approach to the problem. (See Bulletin SCS-100.)

While a few installations followed this method, we found the program far more useful in bomb blast installations in various parts of the world. Specific response spectra are not readily available for all areas, and the response spectra on a particular floor rather than at ground level, almost non-existent. What the program did, however, was give us a better understanding of the phenomena and the need to provide materials with cushioned restraining capabilities far in excess of ground recorded or predicted acceleration levels.

Most specifications are based on the building code in that part of the country. All of these codes work with equations for developing a maximum horizontal and vertical force. The most widely used equation for the horizontal is the following:

$$F_p = \frac{0.4(a_p)(S_{ds})I_p[1+2\frac{z}{h}]W_p}{R_p} \ (0.7)$$

Term	Definition	Value on Page
F_p	Horizontal Seismic Force (G's)	8
a_p	Component Amplification Factor	8
R_p	Component Response Modification Factor	8
S_s	Mapped Spectral Response Acceleration at Short Periods	5,6 &7
F_{pv}	Vertical Seismic Force (G's)	8
z	Attachment Height within the Building	
h	Roof Elevation	
W_p	Weight	
I_p	Importance Factor, I_p=1.5 for Life Safety, Hazardous & Essential systems and 1.0 for all other components	
S_{ds}	Design Spectral Response Acceleration S_{ds}=2/3(S_s x F_a) where Fa is the Soil Site Coefficient	
F_a	Site Coefficient for Site Specific Soil. F_a is 1.7 for S_s up to 0.50, 1.2 for S_s above 0.5 up to 0.75, 1.1 for S_s above 0.75 up to 1.0 and 1.0 for S_s above 1.0	
(0.7)	Conversion Factor from Strength Design to Allowable Stress Design	

For examples of the equation, see page 4.

It is extremely important to work with these exact values when dealing with major structural components, such as the steel framing, as a small percentage force difference might literally mean millions of dollars in savings when working to the requirements of a local code. However, vibration isolation and seismic restraints are always a minuscule percentage of a building's cost and a small percentage of the mechanical equipment contract as well. When we or an acoustical consultant write specifications for spring deflections, we use broad categories such as 0.75"(19mm), 1.5"(38mm), 2.5"(64mm), 3.5"(89mm), 4.5"(114mm), etc. It is not practical to specify spring deflections of 1.625(41mm), 1.83(46mm), 2.3(58mm), etc., as no manufacturer designs to these fine limits. All manufacturers supply one of their standard mountings, rather than a special design specific to those numbers to achieve the specified minimum.

Seismic restraints follow this pattern as well. To keep specifications and submittals practical rather than run calculations for each piece of equipment in every location to the exact code minimum, our suggested specification is broad band. We have selected the higher end of the calculations in a particular zone. When we are the successful vendor, the restraints we submit for your approval are generally well in excess of the specification minimums. Not only have we always preferred to work this way, but we are as concerned with your costs of errors and omissions as our own product liability. Earthquakes involve human lives. Acoustics and vibration control do not.

We cannot ask you to specify higher numbers as the contracting community tends to feel we are "loading" the requirements to increase cost. However, experience has proven that real life resonant forces exceed the static requirements.

In VCS-100, "Complete HVAC Engineering Specifications", we explained what we considered the most important principles to follow in writing specifications to attain proper vibration isolation.

The principles in applying seismic restraints based on static codes are as follows:

1. Use the building code selected by the architect as the model for specifying horizontal and vertical maximum accelerations.

2. Simplify the specifications by specifying the higher level of forces as developed by the selected code in paragraph 1.

3. Never use isolation rails as they rotate and fail when equipment does not have adequate leg strength for direct mounting or a supplementary base is required for other reasons. Always use a one piece reinforced concrete base or a one piece structural steel frame.

4. Do not use the horizontal or vertical spring constant of an unhoused spring to calculate resistive forces. An earthquake is calculated statically, but it is a dynamic event and springs resonate. The spring static resistance has no meaning in seismic restraint design.

5. Limit the motion of spring mounted bases using either separate double acting seismic snubbers with Neoprene cushioned interfaces, or steel springs within self snubbing housings that are also manufactured with Neoprene cushions wherever possible. Restraining housings may be either steel, ductile iron or cast steel. Gray iron castings are not acceptable, as the lack of ductility results in shattering when subjected to shock.

6. Provide anchor bolts or drill in anchors that are seismically approved and properly selected, based on design calculations through the center of gravity. Anchor bolts must be embedded and spaced in accordance with ICC standards.

7. All housekeeping pads must be structurally doweled or bolted to the structure and adequately reinforced to resist the seismic forces on anchor bolts.

8. When steel frames or concrete piers are used to hold equipment at a higher elevation, they must be properly anchored to the structure and rigidly cross braced.

9. Install double arched rubber flexible connectors at the interfaces of equipment and piping where rubber is acceptable for the service. Use braided stainless steel hoses or stainless steel expansion joints in only those applications where the rubber expansion joints are not suitable.

10. All suspended equipment, including piping and duct work whether isolated or not, must be braced against sway and axial motion. Cable braces are recommended for isolated equipment and either cable or solid braces for non-isolated equipment. Suspension rods may require bracing to prevent buckling when subjected to compression stress.

11. Wherever possible use OSHPD or other Government pre-approved seismic devices with pre-approved ratings. When such devices are not available, ratings based on test are more reliable than ratings based on calculations. When testing is impractical, calculation should be made by a professional engineer with a minimum of 5 years experience in the industry. These devices are subtle and both experience and intuition are needed to make calculations meaningful.

12. Engineers and architects already carry "Errors and Omissions" insurance and this should not be a vendor requirement. All acceptable manufacturers should carry product liability with minimum limits of $2,000,000 and $5,000,000 in excess liability.

Specifications and instructions together with the selection guide begin on the following page. We certainly hope that you find this tool useful and we continue to invite your comments as to its improvement.

Very truly yours,
MASON INDUSTRIES, INC.

N. J. Mason

Norman J. Mason, President

GENERAL INSTRUCTIONS

As in VCS-100, we have designed the specification to be written in tabular form. Your specification book would contain all the verbiage in pages 1 through 24. We realize this complete specification is quite long, but providing proper protection is not a simple issue. It is always your option to abbreviate sections, but we have not included anything unnecessary. Only these items called out in the chart that follows are used on a particular project.

The chart is an add on to your equipment schedule. You merely add two columns as shown.

FAN SCHEDULE						Vibration Isolation and/or Seismic Restraints	
Fan No.	Location	Wheel Diam. in (mm)	Arr.	Fan RPM	Motor HP HP (kw)	Isolator, Base, Restraint, Flexible Connector Specification Number	Static Deflection in (mm)
1	Penthouse	60” (1525)	1 SISW	503	30 (22)	7-21	1.50” (36)
2	3rd Floor	49” (1245)	3 SISW	720	25 (19)	7-21	0.75” (19)
3	Penthouse	73” (1850)	3 DIDW	405	75 (56)	5-21-16	3.50” (89)
4	Basement	36” (915)	2 SISW	930	15 (11)	2-20	0.35” (9)
5	3rd Floor	108” (2745)	3 SISW	400	125 (94)	5-21-16	2.50” (64)
6	3rd Floor	2-27” (2-685)	AC Unit	533	10 (7.5)	10A-12	1.00” (25)
7	Penthouse	3-12” (3-305)	AC Unit	630	5 (4)	7	0.75” (19)

PUMP SCHEDULE				Vibration Isolation and/or Seismic Restraints	
Pump No.	Location	Type	Motor HP (kw)		Static Deflection in (mm)
1	Penthouse	Split Casing	75 (56)	5-21-16-23	2.50” (64)
2	2nd Floor	Close Coupled	1/2 (.4)	5-21-16-23	0.75” (19)
3	3rd Floor	End Suction	10 (7.5)	5-21-16-23	0.75” (19)
4	Basement	Close Coupled	3 (2)	2-23	0.35” (9)
5	Basement	Split Casing	50 (38)	Hard Mounted	
6	2nd Floor	Fire Pump		Hard Mounted	

The numbers for the specification column are found in the Seismic Specification Selection Guide pages 9 – 12 of this bulletin. You need only reference the type of equipment and then pick out the appropriate numbers and deflections based on the floor span in the equipment’s location.

In the given example we are assuming that the floor span in the penthouse is 30 ft.(9m) and that there is a 20 ft.(6m) span in other locations. In your application, should the spans be different, you need only refer to the proper floor span tabulation. You will note for pump No. 5 we called out no isolation as it happens to be located in the basement under the garage where any transmitted vibration would annoy no one. Fire pumps (No. 6) are seldom isolated. In preparing your specification this way you have an opportunity to consider every piece of equipment, and there is very little possibility of your overlooking something in the rush of getting a job completed.

The language of the specification is as complete as we could make it without knowing the actual code that you are using. Therefore, in paragraph 1.03 on page 4, you would have to fill the blank space with the code that applies to your project. Typical codes are as in "A" below and you would use one to include in 1.03.

1.03

A. Typical Applicable Codes and Standards (To the specifying engineer, please select from the following and insert them in section 1.03 of the specification.)

1. The International Building Code, IBC-2000/2003 as published by the International Code Council.

2. The Building Construction and Safety Code, NFPA 5000 as published by the National Fire Protection Association.

3. Seismic Design of Buildings, TI-809-04, as published by the US Army Corps of Engineers.

4. State or Local Code by specific reference.

5. NFPA - 13 and 14 for fire protection systems, as published by the National Fire Protection Association.

For example, in Charleston S.C. using a zip code of 29401, S_{ds} is 0.93 based on an Ss of 1.38. For a vibration isolated pump attached to concrete at ground level in a commercial building, the following factors apply, $a_p = 2.5$ and $R_p = 2.5$ for vibration isolation, $I_p = 1$ for a commercial building, and the z/h factor equals zero at ground level. Therefore

$$F_p = \frac{0.4(a_p)(S_{ds})I_p[1+2\frac{z}{h}]W_p}{R_p} (0.7) = 0.26\ W_p \text{ or } 0.26\ G.$$

In the same building the vibration isolated cooling tower on the roof would have a z/h value of one. This would make

$$F_p = \frac{0.4(a_p)(S_{ds})I_p[1+2\frac{z}{h}]W_p}{R_p} (0.7) = 0.78\ W_p \text{ or } 0.78\ G.$$

INSTRUCTION:

In paragraph 1.06 on page 5 of SVCS-110 Part 2, please add the seismic force levels. There is no need to do any calculations, because Fp has been calculated for you on page 8. As explained in the earlier pages, we have rounded these numbers to what we consider to be practical levels. Should you disagree with our suggestions, by all means insert levels of your own choosing.

State, City	ZIP	Ss
ALABAMA		
Birmingham	35217	0.328
Mobile	36610	0.124
Montgomery	36104	0.170
ARKANSAS		
Little Rock	72205	0.461
ARIZONA		
Phoenix	85034	0.226
Tuscon	85739	0.325
CALIFORNIA		
Fresno	93706	0.592
Los Angeles	90026	1.50
Oakland	94621	1.55
Sacramento	95823	0.568
San Diego	92101	1.54
San Francisco	94114	1.50
San Jose	95139	2.05
COLORADO		
Colorado Springs	80913	0.178
Denver	80239	0.187
CONNECTICUT		
Bridgeport	06606	0.332
Hartford	06120	0.274
New Haven	06511	0.285
Waterbury	06702	0.287
WASHINGTON, D.C.		
Washington	20002	0.178
FLORIDA		
Ft. Lauderdale	33328	0.070
Jacksonville	32222	0.142
Miami	33133	0.061
St. Petersburg	33709	0.078
Tampa	33635	0.083
GEORGIA		
Atlanta	30314	0.258
Augusta	30904	0.419
Columbus	31907	0.169
Savannah	31404	0.402
IOWA		
Council Bluffs	41011	0.186
Davenport	52803	0.130
Des Moines	50310	0.073
IDAHO		
Boise	83705	0.344
Pocatello	83201	0.553
ILLINOIS		
Chicago	60620	0.190
Moline	61265	0.135
Peoria	61604	0.174
Rock Island	61201	0.131
Rockford	61108	0.170
Springfield	62703	0.263

State, City	ZIP	Ss
INDIANA		
Evansville	47712	0.754
Ft. Wayne	46835	0.162
Gary	46402	0.173
Indianapolis	46260	0.182
South Bend	46637	0.121
KANSAS		
Kansas City	66103	0.122
Topeka	66614	0.184
Wichita	67217	0.141
KENTUCKY		
Ashland	41101	0.221
Covington	41011	0.186
Louisville	40202	0.247
LOUISIANA		
Baton Rouge	70807	0.144
New Orleans	70116	0.130
Shreveport	71106	0.165
MASSACHUSETTS		
Boston	02127	0.325
Lawrence	01843	0.376
Lowell	01851	0.355
New Bedford	02740	0.261
Springfield	01107	0.260
Worchester	01602	0.271
MARYLAND		
Baltimore	21218	0.199
MAINE		
Augusta	04330	0.318
Portland	04101	0.369
MICHIGAN		
Detroit	48207	0.123
Flint	48506	0.091
Grand Rapids	49503	0.087
Kalamazoo	49001	0.116
Lansing	48910	0.109
MINNESOTA		
Duluth	55803	0.056
Minneapolis	55422	0.057
Rochester	55901	0.055
St. Paul	55111	0.056
MISSOURI		
Carthage	64836	0.149
Columbia	65202	0.178
Jefferson City	65109	0.207
Joplin	64801	0.138
Kansas City	64108	0.122
Springfield	64501	0.120
St. Joseph	64501	0.120
St. Louis	63166	0.586
MISSISSIPPI		
Jackson	39211	0.191

State, City	ZIP	Ss
MONTANA		
Billings	59101	0.134
Butte	59701	0.599
Great Falls	59404	0.248
NEBRASKA		
Lincoln	68502	0.177
Omaha	68144	0.127
NEVADA		
Las Vegas	89106	0.637
NV, Reno	89509	1.29
NEW YORK		
Albany	12205	0.275
Binghampton	13903	0.185
Buffalo	14222	0.319
Elmira	14905	0.173
New York	10014	0.425
Niagara Falls	14303	0.311
Rochester	14619	0.248
Schenectady	12304	0.278
Syracuse	13219	0.192
Utica	13501	0.250
NORTH CAROLINA		
Charlotte	28216	0.345
Greensboro	27410	0.255
Raleigh	27610	0.211
Winston-Salem	27106	0.281
NORTH DAKOTA		
Fargo	58103	0.073
Grand Forks	58201	0.054
OHIO		
Akron	44312	0.179
Canton	44702	0.316
Cincinnati	45245	0.191
Cleveland	44130	0.197
Columbus	43217	0.164
Dayton	45440	0.206
Springfield	45502	0.216
Toledo	43608	0.171
Youngstown	44515	0.163
OKLAHOMA		
Oklahoma City	73145	0.339
Tulsa	74120	0.160
OREGON		
Portland	97222	1.04
Salem	97301	0.929
PENNSYLVANIA		
Allentown	18104	0.289
Bethlehem	18015	0.304
Erie	16511	0.164
Harrisburg	17111	0.224
Philadelphia	19125	0.326
Pittsburgh	15235	0.129
Reading	19610	0.293
Scranton	18504	0.232

State, City	ZIP	Ss
RHODE ISLAND		
Providence	02907	0.267
SOUTH CAROLINA		
Charleston	29406	1.56
Columbia	29203	0.578
SOUTH DAKOTA		
Rapid City	57703	0.153
Sioux Falls	57104	0.113
TENNESSEE		
Chattanooga	37415	0.500
Knoxville	37920	0.589
Memphis	38109	1.25
Nashville	37211	0.305
TEXAS		
Amarillo	79111	0.166
Austin	78703	0.088
Beaumont	77705	0.116
Corpus Christi	78418	0.093
Dallas	75233	0.117
El Paso	79932	0.358
Ft. Worth	76119	0.110
Houston	77044	0.107
Lubbock	79424	0.099
San Antonio	78235	0.133
Waco	76704	0.095
UTAH		
Salt Lake City	84111	1.79
VIRGINIA		
Norfolk	23504	0.132
Richmond	23233	0.300
Roanoke	24017	0.290
VERMONT		
Burlington	05401	0.446
WASHINGTON		
Seattle	98108	1.51
Spokane	99201	0.315
Tacoma	98402	1.23
WISCONSIN		
Green Bay	54302	0.066
Kenosha	53140	0.133
Madison	53714	0.114
Milwaukee	53221	0.120
Racine	53402	0.124
Superior	54880	0.055
WEST VIRGINIA		
Charleston	25303	0.206
Huntington	25704	0.221
WYOMING		
Casper	82601	0.341
Cheyenne	82001	0.183

INTERNATIONAL Ss NUMBERS

Country	City	Ss
AFRICA		
Algeria	Alger	1.24
	Oran	1.24
Angola	Luanda	0.06
Benin	Cotonou	0.06
Botswana	Gaborone	0.06
Burundi.	Bujumbura	1.24
Cameroon	Douala	0.06
	Yaounde	0.06
Cape Verde	Praia	0.06
Central African Republic	Bangui	0.06
Chad	Ndjamena	0.06
Congo	Brazaville	0.06
Djibouti	Djibouti	1.24
Egypt	Alexandria	0.62
	Cairo	0.62
	Port Said	0.62
Equatorial Guinea	Malabo	0.06
Ethiopia	Addis Ababa	1.24
	Asmara	1.24
Gabon	Libreville	0.06
Gambia	Banjul	0.06
Ghana	Accra	1.24
Guinea	Bissau	0.31
	Conakry	0.06
Ivory Coast	Abidijan	0.06
Kenya.	Nairobi	0.62
Lesotho	Maseru	0.62
Liberia	Monrovia	0.31
Libya	Tripoli	0.62
	Wheelus AFB	0.62
Malagasy Republic	Tananarive	0.06
Malawi	Blantyre	1.24
	Lilongwe	1.24
	Zomba	1.24
Mali	Bamako	0.06
Mauritania	Nouakchott	0.06
Mauritius	Port Louis	0.06
Morocco	Casablanca	0.62
	Port Lyautey	0.31
	Rabat	0.62
	Tangier	1.24
Mozambique	Maputo	0.62
Niger	Niamey	0.06
Nigera	Ibadan	0.06
	Kaduna	0.06
	Lagos	0.06
Republic of Rwanda	Kigali	1.24
Senegal	Dakar	0.06
Seychelles	Victoria	0.06
Sierra Leone	Freetown	0.06
Somalia	Mogadishu	0.06
South Africa	Cape Town	1.24
	Durban	0.62
	Johannesburg	0.62
	Natal	0.31
	Pretoria	0.62
Swaziland	Mbabane	0.62
Tanzania	Dar es Salaam	0.62
	Zanzibar	0.62
Togo	Lome	0.31
Tunisia	Tunis	1.24
Uganda	Kampala	0.62
Upper Volta	Ougadougou	0.06
Zaire	Bukavu	1.24
	Kinshasa	0.06
	Lubumbashi	0.62
Zambia	Lusaka	0.62
Zimbabwe	Harare (Salisbury)	1.24
ASIA		
Afghanistan	Kabul	1.65
Bahrain	Manama	0.06
Bangladesh	Dacca	1.24
Brunei	Bandar Seri Begawan	0.31
Burma	Mandalay	1.24
	Rangoon	1.24
China	Canton	0.62
	Chengdu	1.24
	Nanking	0.62
	Peking	1.65
	Shanghai	0.62
	Shengyang	1.65
	Tibwa	1.65
	Tsingtao	1.24
	Wuhan	0.62
Cyprus	Nicosia	1.24
Hong Kong	Hong Kong	0.62
India	Bombay	1.24
	Calcutta	0.62
	Madras	0.31
	New Delhi	1.24
Indonesia	Bandung	1.65
	Jakarta	1.65
	Medan	1.24
	Surabaya	1.65
Iran	Isfahan	1.24
	Shiraz	1.24
	Tabriz	1.65
	Tehran	1.65
Iraq	Baghdad	1.24
	Basra	0.31
Israel	Haifa	1.24
	Jerusalem	1.24
	Tel Aviv	1.24
Japan	Fukuoka	1.24
	Itazuke AFB	1.24
	Misawa AFB	1.24
	Naha, Okinawa	1.65
	Osaka/Kobe	1.65
	Sapporo	1.24
	Tokyo	1.65
	Wakkanai	1.24
	Yokohama	1.65
	Yokota	1.65
Jordan	Amman	1.24
Korea	Kwangju	0.31
	Kimhae	0.31
	Pusan	0.31
	Seoul	0.06
Kuwait	Kuwait	0.31
Laos	Vientiane	0.31
Lebanon	Beirut	1.24
Malaysia	Kuala Lumpur	0.31
Nepai	Kathmandu	1.65
Oman	Muscat	0.62
Pakistan	Islamabad	1.68
	Karachi	1.65
	Lahore	0.62
	Peshawar	1.65
Quatar	Doha	0.06
Saudi Arabia	Al Batin	0.31
	Dhahran	0.31
	Jiddah	0.62
	Khamis Mushayf	0.31
	Riyadh	0.06
Singapore	All	0.31
South Yemen	Aden City	1.24
Sir Lanka	Colombo	0.06
Syria	Aleppo	1.24
	Damascus	1.24
Taiwan	Ail	1.65
Thailand	Bangkok	0.31
	Chinmg Mai	0.62
	Songkhia	0.06
	Udorn	0.31
Turkey	Adana	0.62
	Ankara	0.62
	Istanbul	1.65
	Izmir	1.65
	Karamursel	1.24
United Arab Emirates	Abu Dhabi	0.06
	Dubai	0.06
Viet Nam	Ho Chi Minh City (Saigon)	0.06
Yemen Arab Republic	Sanaa	1.24
ATLANTIC OCEAN AREA		
Azorea	All	0.62
Bermuda	All	0.31
CARIBBEAN SEA		
Bahama Islands	All	0.31
Cuba	Ail	0.62
Dominican Republic	Santo Domingo	1.24
French West Indies	Martinique	1.24
Grenada	Saint Georges	1.24
Haiti	Port au Prince	1.24
Jamaica	Kingston	1.24
Leeward Islands	All	1.24
Puerto Rico	All	0.83
Trinidad & Tobago	All	1.24
CENTRAL AMERICA		
Belize	Beimopan	0.62
Canal Zone	All	0.62
Costa Rica	San Jose	1.24
El Salvador	San Salvador	1.65
Guatemala	Guatemala	1.65
Honduras	Tegucigalpa	1.24
Nicaragua	Managua	1.65
Panama	Colon	1.24
	Galeta	0.83
	Panama	1.24
Mexico	Ciudad Juarez	0.62
	Guadelejara	1.24
	Hermosilio	1.24
	Matamoros	0.06
	Mazatlan	0.60
	Merida	0.06
	Mexico City	1.24
	Monterrey	0.06
	Nuevo Laredo	0.06
	Tijuana	1.24
EUROPE		
Albania	Tirana	1.24
Austria	Salzburg	0.62
	Vienna	0.62
Belgium	Antwerp	0.31
	Brussels	0.62
Bulgaria	Sofia	1.24
Czechoslovakia	Bratislava	0.62
	Prague	0.31
Denmark	Copenhagen	0.31
Finland	Helsinki	0.31
France	Bordeaux	0.62
	Lyon	0.31
	Marseilie	1.24
	Nice	1.24
	Strasbourg	0.62
Germany, Federal Republic		
	Berlin	0.06
	Bonn	0.62
	Bremen	0.06
	Dusseldorf	0.31
	Frankfurt	0.62
	Hamburg	0.06
	Munich	0.31
	Stuttgart	0.62
	Vaihigen	0.62
Greece	Athens	1.24
	Kavalla	1.65
	Makri	1.65
	Rhodes	1.24
	Sauda Bay	1.65
	Thessaloniki	1.65
Hungary	Budapest	0.62
Iceland	Keflavick	1.24
	Reykjavik	1.65
Ireland	Dublin	0.06
Italy	Aviano AFB	1.24
	Brindisi	0.06
	Florence	1.24
	Genoa	1.24
	Milan	0.62
	Naples	1.24
	Palermo	1.24
	Rome	0.62
	Sicity	1.24
	Trieste	1.24
	Turin	0.62
Luxembourg	Luxembourg	0.31
Malta	Valletta	0.62
Netherlands	All	0.06
Norway	Oslo	0.62
Poland	Krakow	0.62
	Poznan	0.31
	Waraszawa	0.31
Portugal	Lisbon	1.65
	Oporto	1.24
Romania	Bucharest	1.24
Spain	Barcelona	0.62
	Bilbeo	0.62
	Madrid	0.06
	Rota	0.62
	Seville	0.62
Sweden	Goteborg	0.62
	Stockholm	0.31
Switzerland	Bern	0.62
	Geneva	0.31
	Zurich	0.62
United Kingdom	Belfast	0.06
	Edinburgh	0.31
	Edzeli	0.31
	Glasgow /Renfrew	0.31
	Hamilton	0.31
	Liverpool	0.31
	London	0.62
	Londonderry	0.31
	Thurso	0.31
U.S.S.R.	Kiev	0.06
	Leningrad	0.06
	Moscow	0.06
Yugoslavia	Belgrade	0.62
	Zagreb	1.24
NORTH AMERICA		
Greenland	All	0.31
Canada	Argentia NAS	0.62
	Calgary, Alb	0.31
	Churchill, Man	0.06
	Cold Lake, Alb	0.31
	Edmonton, Alb	0.31
	E. Harmon, AFB	0.62
	Fort Williams, Ont	0.06
	Frobisher N.W. Ter	0.06
	Goose Airport	0.31
	Halifax	0.31
	Montreal, Quebec	1.24
	Ottawa, Ont	0.62
	St. John's Nfld.	1.24
	Toronto, Ont	0.31
	Vancouver	1.24
	Winnepeg, Man.	0.31
SOUTH AMERICA		
Argentina	Buenos Aires.	0.25
Brazil	Belem	0.06
	Belo Horizonte	0.06
	Brasilia	0.06
	Manaus	0.06
	Porto Allegre	0.06
	Recife	0.06
	Rio de Janeiro	0.06
	Salvador	0.06
	Sao Paulo	0.31
Bolivia	La Paz	1.24
	Santa Cruz	0.31
Chile	Santiago	1.65
	Valparaiso	1.65
Colombia	Bogata	1.24
Ecuador	Quito	1.65
	Guayaquil	1.24
Paraquay	Asuncion	0.06
Peru	Lima	1.65
	Piura	1.65
Uruguay	Montevideo	0.06
Venezuela	Maracaibo	0.62
	Caracas	1.65
PACIFIC OCEAN AREA		
Australia	Brisbane	0.31
	Canberra	0.31
	Melbourne	0.31
	Perth	0.31
	Sydney	0.31
Caroline Islands	Koror, Paulau Is	0.62
	Ponape	0.06
FIJI	Suva	1.24
Johnson Island	All	0.31
Mariana Islands	Guam	1.24
	Saipan	1.24
	Tinian	1.24
Marshall Islands	Ail	0.31
New Zealand	Auckland	1.24
	Wellington	1.65
Papau New Guinea	Port Moresby	1.24
Phillipine Islands	Cebu	1.65
	Manila	1.65
	Bagulo	1.24
Samoa	All	1.24
Wake Island	All	0.06

1.06 Seismic Force Levels

A. The following force levels will be used on this project based on IBC-2000, IBC-2003, TI-809-04 and NFPA-5000.

Changes may be made as codes are updated.

MINIMUM F_p (G's) FORCES EQUAL TO OR EXCEEDING BUILDING CODE LISTED IN 1.03.

IBC-2000 IBC-2003 TI-809-04 NFPA-5000 For Ss* values, see the tables on pages 5,6&7. Values are for Ip = 1.0. Multiply by 1.5 for buildings with ip = 1.5. Values for Ss* are for site class E up to 0.5 and D above 0.5.		"G" Forces for High Deformability Pipe, Bus Ducts, Conduits & Cabletrays **a_p*=1.0, R_p*=3.5**		"G" Forces for Rigidly Mounted Equipment & Limited Deformability Pipe **a_p*=1.0, R_p*=2.5**		"G" Forces for Vibration Isolated Equipment & Pipe Pressure Vessels **a_p*=2.5, R_p*=2.5**		"G" Forces for Low Deformability Pipe **a_p*=1.0, R_p*=1.25**	
		Horiz.	Vert.	Horiz.	Vert.	Horiz.	Vert.	Horiz.	Vert.
Lower Levels and Ground Level	Ss less than 0.15	0.08	0.05	0.08	0.05	0.10	0.05	0.08	0.05
	Ss between 0.15 & 0.25	0.13	0.08	0.13	0.08	0.17	0.08	0.13	0.08
	Ss between 0.26 & 0.50	0.17	0.11	0.17	0.11	0.23	0.11	0.18	0.11
	Ss between 0.51 & 1.00	0.22	0.15	0.22	0.15	0.29	0.15	0.23	0.15
	Ss between 1.01 & 1.50	0.30	0.20	0.30	0.20	0.40	0.20	0.32	0.20
	Ss greater than 1.50	0.50	0.33	0.50	0.33	0.67	0.33	0.53	0.33
Above Ground Level up to 1/4 of the Height of Building	Ss less than 0.15	0.08	0.05	0.08	0.05	0.15	0.05	0.12	0.05
	Ss between 0.15 & 0.25	0.13	0.08	0.13	0.08	0.25	0.08	0.20	0.08
	Ss between 0.26 & 0.50	0.17	0.11	0.17	0.11	0.34	0.11	0.27	0.11
	Ss between 0.51 & 1.00	0.22	0.15	0.22	0.15	0.44	0.15	0.35	0.15
	Ss between 1.01 & 1.50	0.30	0.20	0.30	0.20	0.60	0.20	0.48	0.20
	Ss greater than 1.50	0.50	0.33	0.50	0.33	1.00	0.33	0.80	0.33
Above 1/4 up to 1/2 of the Height of the Building	Ss less than 0.15	0.08	0.05	0.08	0.05	0.20	0.05	0.16	0.05
	Ss between 0.15 & 0.25	0.13	0.08	0.13	0.08	0.34	0.08	0.27	0.08
	Ss between 0.26 & 0.50	0.17	0.11	0.18	0.11	0.46	0.11	0.36	0.11
	Ss between 0.51 & 1.00	0.22	0.15	0.23	0.15	0.58	0.15	0.47	0.15
	Ss between 1.01 & 1.50	0.30	0.20	0.32	0.20	0.80	0.20	0.64	0.20
	Ss greater than 1.50	0.50	0.33	0.53	0.33	1.34	0.33	1.07	0.33
Above 1/2 up to 3/4 of the Height of the Building	Ss less than 0.15	0.08	0.05	0.10	0.05	0.25	0.05	0.20	0.05
	Ss between 0.15 & 0.25	0.13	0.08	0.17	0.08	0.42	0.08	0.34	0.08
	Ss between 0.26 & 0.50	0.17	0.11	0.23	0.11	0.57	0.11	0.46	0.11
	Ss between 0.51 & 1.00	0.22	0.15	0.29	0.15	0.73	0.15	0.58	0.15
	Ss between 1.01 & 1.50	0.30	0.20	0.40	0.20	1.00	0.20	0.80	0.20
	Ss greater than 1.50	0.50	0.33	0.67	0.33	1.67	0.33	1.34	0.33
Above 3/4 of the Height of Building up to the Roof	Ss less than 0.15	0.09	0.05	0.12	0.05	0.30	0.05	0.24	0.05
	Ss between 0.15 & 0.25	0.14	0.08	0.20	0.08	0.50	0.08	0.40	0.08
	Ss between 0.26 & 0.50	0.20	0.11	0.27	0.11	0.68	0.11	0.54	0.11
	Ss between 0.51 & 1.00	0.25	0.15	0.35	0.15	0.88	0.15	0.70	0.15
	Ss between 1.01 & 1.50	0.34	0.20	0.48	0.20	1.20	0.20	0.96	0.20
	Ss greater than 1.50	0.57	0.33	0.80	0.33	2.00	0.33	1.60	0.33

*See definitions on page one of this bulletin.

Table above has rounded values from solving equation $F_p = \frac{0.4(a_p)(S_{ds})I_p[1+2\frac{z}{h}]W_p}{R_p}$ (0.7)

INSTRUCTION:

Use these values to complete specification section 1.06 as previously noted on page 4.

SPECIFICATION SELECTION GUIDE

to be used with Vibration Control Engineering Specifications for HVAC Equipment in Office Buildings, Colleges, Theatres and Similar Structures

	ISOLATION, DEFLECTION AND SEISMIC RESTRAINT CRITERIA FOR 4"(100mm)THRU 6"(150mm)THICK SOLID CONCRETE FLOORS (note 7)									
	Ground Supported Slab or Basement		**20'(6m) Floor Span Possible Floor Defl.-0.67"(17mm)**		**30'(9m) Floor Span Possible Floor Defl.-1.0"(25mm)**		**40'(12m) Floor Span Possible Floor Defl.-1.33"(34mm)**		**50'(15m) Floor Span Possible Floor Defl.-1.67"(42mm)**	
	Isolation & Seismic Spec.	Isolation Deflection in(mm)	Isolation & Seismic Spec.	Isolation Deflection in(mm)	Isolation & Seismic Spec.	Isolation Deflection in(mm)	Isolation & Seismic Spec.	Isolation Deflection in(mm)	Isolation & Seismic Spec.	Isolation Deflection in(mm)
REFRIG. MACHINES										
Absorption Machines	2-23	0.35(9)	6-23	0.75(19)	6-23	0.75(19)	6-23	1.5(38)	6-23	1.5(38)
Centrifugal Chillers or Heat Pumps										
Cooler Condenser Mounted Hermetic Compressors	2-23	0.35(9)	6-23	0.75(19)	6-23 or 9*-23	1.5(38)	6-23 or 9*-23	1.5(38)	6-20-23 or 9*-23	2.5(64)
Cooler Condenser Alongside Hermetic Compressors	2-23	0.35(9)	6-23	0.75(19)	6-23 or 9*-23	1.5(38)	6-23 or 9*-23	1.5(38)	6-23 or 9*-23	2.5(64)
Open Type Compressors (note 3)	2-20-23 or 2-20-23	0.35(9)	6-20-23 or 6-20-23	0.75(19)	6-20-23 or 9*-20-23	1.5(38)	6-20-23 or 9*-20-23	1.5(38)	6-20-23 or 9*-20-23	2.5(64)
Refrig. Reciprocating Compressors										
500 rpm to 750 rpm	6-23	0.75(19)	6-23	1.5(38)	6-23	1.5(38)	6-20-23	2.5(64)	6-20-23	3.5(89)
751 rpm and Over	6-23	0.75(19)	6-23	0.75(19)	6-23 or 9*-23	1.5(38)	6-20-23 or 9*-20-23	2.5(64)	6-20-23 or 9*-20-23	3.5(89)
Reciprocating Chillers or Heat Pumps										
500 rpm to 750 rpm	6-23	0.75(19)	6-23	1.5(38)	6-23	1.5(38)	6-20-23	2.5(64)	6-20-23	3.5(89)
751 rpm and Over	6-23	0.75(19)	6-23	0.75(19)	6-20-23	1.5(38)	6-20-23	2.5(64)	6-20-23	3.5(89)
Refrigeration Screw Compressors	9*-23		9*-23		9*-23		9*-23		9*-23	
PACKAGED STEAM GENERATIONS (Boilers)	2-24	0.35(9)	6-24	0.75(19)	6-24	0.75(19)	6-24	1.5(38)	5,23,24	2.5(64)
Pumps										
Close Coupled										
Thru 5hp (4kw)	2-21-23	0.35(9)	5-16-21-23	0.75(19)	5-16-21-23	0.75(19)	5-16-21-23	1.5(38)	5-16-21-23	1.5(38)
7 1/2hp (5.6kw) and Larger	5-16-21-23	0.75(19)	5-16-21-23	0.75(19)	5-16-21-23	1.5(38)	5-16-21-23	1.5(38)	5-16-21-23	2.5(64)
Base Mounted (note 2)										
Thru 60hp (45kw)	5-16-21-23	0.75(19)	5-16-21-23	0.75(19)	5-16-21-23	1.5(38)	5-16-21-23	1.5(38)	5-16-21-23	2.5(64)
75hp (56kw) and Larger	5-16-21-23 or 8*-16 21-23	0.75(19)	5-16-21-23 or 8*-16 21-23	1.5(38)	5-16-21-23 or 8*-16 21-23	2.5(64)	5-16-21-23 or 8*-16 21-23	2.5(64)	5-16-21-23 or 8*-16 21-23	3.5(89)
PIPE RISERS	5 or 10-25-26	Spec. 5 if floor supported and Spec. 10 if ceiling suspended. Spec. 25 anchors if required, Spec. 26 guides required on all risers. Deflections are based on the expansion or contraction of each riser.								

*NOTE: Isolators in **Red** are Air Springs recommended for highly critical locations.

SPECIFICATION SELECTION GUIDE

to be used with Vibration Control Engineering Specifications for HVAC Equipment in Office Buildings, Colleges, Theatres and Similar Structures

	ISOLATION, DEFLECTION AND SEISMIC RESTRAINT CRITERIA FOR 4"(100mm)THRU 6"(150mm)THICK SOLID CONCRETE FLOORS (note 7)									
	Ground Supported Slab or Basement		20'(6m) Floor Span Possible Floor Defl.-0.67"(17mm)		30'(9m) Floor Span Possible Floor Defl.-1.0"(25mm)		40'(12m) Floor Span Possible Floor Defl.-1.33"(34mm)		50'(15m) Floor Span Possible Floor Defl.-1.67"(42mm)	
	Isol. & Seismic Spec.	Isol. Defl. in(mm)	Isol. & Seismic Spec.	Isol. Defl. in(mm)	Isol. & Seismic Spec.	Isol. Defl. in(mm)	Isol. & Seismic Spec.	Isol. Defl. in(mm)	Isol. & Seismic Spec.	Isol. Defl. in(mm)
FACTORY ASSEMBLED H & V UNITS										
Curb Mounted Roof Top Units	—	—	22	1.0(25)	22	1.5(38)	22	2.5(64)	22	2.5(64)
Suspended Units (for Fan Heads see Blowers Guide)										
Thru 5hp (4kw)	10A-12	1.0(25)	10A-12	1.0(25)	10A-12	1.0(25)	10A-12	1.0(25)	10A-12	1.0(25)
7½ hp (5.6kw) and Larger-275 rpm to 400 rpm	10A-12	1.5(38)	10A-12	1.5(38)	10A-12	1.5(38)	10A-12	1.5(38)	10A-12	1.5(38)
7½ hp (5.6kw) and Larger-401 rpm and Over	10A-12	1.0(25)	10A-12	1.0(25)	10A-12	1.0(25)	10A-12	1.5(38)	10A-12	2.5(64)
Floor Mounted Units (for Fan Heads see Blowers Guide)										
Thru 5hp (4kw)	2	0.35(9)	7	0.75(19)	7	0.75(19)	7	0.25(6)	7	0.75(19)
7½ hp (5.6kw) and Larger-275 rpm to 400 rpm	2	0.35(9)	7	1.5(38)	7	1.5(38)	7	1.5(38)	7	1.5(38)
7½ hp (5.6kw) to 40hp-401 rpm and Over	2	0.35(9)	7	0.75(19)	7	0.75(19)	7	1.5(38)	5-16-20	2.5(64)
50hp (38kw) and Larger-401 rpm and Over	2	0.35(9)	7	0.75(19)	7	1.5(38)	5-16-20	2.5(64)	5-16-20	3.5(89)
AIR COMPRESSOR										
Tank Mounted Type	5-16-21-24	0.75(19)	5-16-21-24	0.75(19)	5-16-21-24	1.5(38)	5-16-21-24	2.5(64)	5-16-21-24	3.5(89)
V - W Type	5-16-21-24	0.75(19)	5-16-21-24	0.75(19)	5-16-21-24	1.5(38)	5-16-21-24	2.5(64)	5-16-21-24	3.5(89)
Horz, Vert, 1 or 2 Cylinders										
275 rpm to 499 rpm	5-16-21-24	2.5(64)	5-16-21-24	2.5(64)	5-16-21-24	2.5(64)	5-16-21-24	3.5(89)	5-16-21-24	3.5(89)
500 rpm to 800 rpm	5-16-21-24	1.5(38)	5-16-21-24	1.5(38)	5-16-21-24	2.5(64)	5-16-21-24	3.5(89)	5-16-21-24	3.5(89)

Specification should read "21" type inertia bases with sufficient mass to limit motion to a theoretical double amplitude of 0.03"(.7mm)

SPECIFICATION SELECTION GUIDE

to be used with Vibration Control Engineering Specifications for HVAC Equipment in Office Buildings, Colleges, Theatres and Similar Structures

ISOLATION, DEFLECTION AND SEISMIC RESTRAINT CRITERIA FOR 4"(100mm)THRU 6"(150mm)THICK SOLID CONCRETE FLOORS (note 7)

	Ground Supported Slab or Basement		20'(6m) Floor Span Possible Floor Defl. 0.67"(17mm)		30'(9m) Floor Span Possible Floor Defl. 1.0"(25mm)		40'(12m) Floor Span Possible Floor Defl. 1.33"(34mm)		50'(15m) Floor Span Possible Floor Defl. 1.67"(42mm)	
	Isolation & Seismic Spec.	Isolation Deflection in(mm)	Engineering Specifications and Minimum Static Deflection as tabulated below (note 1)							
BLOWERS										
Utility Sets										
Floor Mounted (note 5)	2	0.35(9)	Spec 7 for 0.75" (19mm) and 1.5" (38mm) deflection and Spec 5-20-16 for over 1.5" (38mm) deflection with deflection from Blower Minimum Deflection Guide, but not to exceed 2.5" (64mm)							
Roof Mounted	—	—	Spec 5-21-16 with deflection from Blower Minimum Deflection Guide. If roof will not handle concrete base load use Spec 6 for 0.75" (19mm) and 1.5" (38mm) deflection and Spec 6-20 for over 1.5" (38mm) deflection.							
Suspended Unit (note 5)	—	—	Spec 10A-12 with deflection from Blower Minimum Deflection Guide, not to exceed 2.5" (64mm) deflection.							
Centrifugal Blowers (note 6)	2-21	0.35(9)	Spec 5-21-16 with deflection from Blower Minimum Deflection Guide.							
Fan Heads										
Floor Mounted	2-28	0.35(9)	Spec 7-28 if 0.75" (19mm) or 1.5" (38mm) deflection or Spec 5-20-16-28 for deflection over 1.5" (38mm)to 4.5" (114mm) from Blower Minimum Deflection Guide.							
Suspended Units	Spec 10A-12-28 with deflection from Blower Minimum Deflection Guide.									
Tubular Centrifugal and Axial Fans										
Suspended Units	Spec 10A-12 with deflection from Blower Minimum Deflection Guide, Spec 10A-12-28 for over 4" (100) static pressure.									
Floor Mounted with Motor on/in Fan Casing	2	0.35(9)	Spec 7 for 0.75" (19mm) to 1.5" (38mm) deflection and Spec 5-20-16 for over 1.5" (38mm) deflection with deflection from Blower Minimum Deflection Guide, Spec 5-21-16 or 5-16-28 for over 4" (100mm) static pressure.							
Floor Mounted Arrangement 1 or any Separately Mounted Motor	2-21	0.35(9)	Spec 5-21-16 with deflection from Blower Minimum Deflection Guide.							
COOLING TOWERS & CONDENSING UNITS	2	0.35(9)	Spec 6 or 9* with deflection from Blower Minimum Deflection Guide.							
ELECTRICAL EQUIPMENT										
Transformers										
Wall Mounted	3-18	–	3-18	–	3-18	–	3-18	–	3-18	–
Floor Mounted	2-19	0.2(5)	6-19 or 9*-19	0.75(19)	6-19 or 9*-19	1.50(38)	6-19 or 9*-19	2.5(64)	6-19 or 9*-19	3.5(89)
Switchgear & Substations	4-19		4-19		4-19		4-19		4-19	
Generators										
500 rpm to 750 rpm	5-17-21-23	0.75(19)	5-17-21-23	1.50(38)	5-17-21-23	1.50(38)	5-17-21-23	2.5(64)	5-17-21-23	3.5(89)
751 rpm and over	5-17-21-23	0.75(19)	5-17-21-23	0.75(19)	5-17-21-23	1.50(38)	5-17-21-23	2.5(64)	5-17-21-23	3.5(89)
Panelboards	3-18	–	3-18	–	3-18	–	3-18	–	3-18	–
Motor Starters										
Wall Mounted	3-18	–	3-18	–	3-18	–	3-18	–	3-18	–
Floor Mounted	4-19	–	4-19	–	4-19	–	4-19	–	4-19	–
Cable Trays, Bus Ducts & Conduit	12 or 13	–	12 or 13	–	12 or 13	–	12 or 13	–	12 or 13	–

*NOTE: Isolators in **Red** are Air Springs recommended for highly critical locations.

Blower Minimum Deflection Guide

When blowers are 60 HP (45kw) or larger, select deflection requirements for next larger span. A minimum of 2.5” (64mm) should be used unless larger deflections are called for on the chart or these fans are located in the lowest sub-basement or on a slab on grade.

Fan Speed RPM	Required Deflection for Ground Supported Slab or Basement	Required Deflection for 20’ (6m) Floor Span	Required Deflection for 30’ (9m) Floor Span	Required Deflection for 40’ (12m) Floor Span	Required Deflection for 50’ (15m) Floor Span
500 and up	0.35” (9mm)	0.75” (19mm)	1.5” (38mm)	2.5” (64mm)	3.5” (89mm)
375-499	0.35” (9mm)	1.5” (38mm)	2.5” (64mm)	3.5” (89mm)	3.5” (89mm)
300-374	0.35” (9mm)	2.5” (64mm)	2.5” (64mm)	3.5” (89mm)	3.5” (89mm)
225-299	0.35” (9mm)	3.5” (89mm)	3.5” (89mm)	3.5” (89mm)	3.5” (89mm)
175-224	0.35” (9mm)	3.5” (89mm)	4.5” (114mm)	4.5” (114mm)	4.5” (114mm)

Notes:

1. Minimum deflection called for in this specification are not ‘nominal’ but certifiable minimums. The 0.75”(19mm), 1.5”(38mm), 2.5”(64mm), 3.5”(89mm), and 4.5”(114mm) minimums should be selected from manufacturers nominal 1”(25mm), 2”(50mm), 3”(75mm), 4”(100mm) and 5”(125mm) series respectively. Air spring isolation specifications 8 & 9 may be substituted for steel springs above in highly sensitive noise free locations.

2. Vacuum, Condensate or Boiler Feed Pumps shall be mounted with their tanks on a common spec. 21 base with deflections as specified for base mounted pumps.

3. The base described in spec. 20 is used under the drive side. Individual mountings as described in spec. 6 are used under the Cooler and Condenser.

4. This type of compressor is highly unbalanced and sometimes requires inertia bases weighing 5 to 7 times equipment weight to reduce running motion.

5. Limit deflection for utility sets 18” (450mm)wheel diameter and smaller to 1 1/2” (38mm).

6. FLOATING CONCRETE INERTIA BASES. Floating concrete inertia bases do not reduce vibration transmitted to the structure through the mountings. These bases will reduce vibratory motion, provide a very rigid machine base and minimize spring reactions to fan thrust. Engineers preferring steel bases rather than the concrete mentioned above in specification 5-21 should change the designation to 5-20. Concrete is preferred for all fans operating at static pressure above 4” (100mm) and on roof tops.

7. LIGHT FLOOR CONSTRUCTION. When floors or roofs are lighter than 4” (100mm)solid concrete it is desirable to introduce a localized mass under the vibration mountings in the form of a sub-base. This sub-base should be 12” (300mm) thick and 12” (300mm) longer and wider than the mechanical equipment above it. When this mass is provided the 30’ (9m) minimum static deflection requirements will suffice even in longer bays. The mass is also useful for unusually large bays over 50’ (15m). When floors are lighter than the 4” (100mm) concrete or the location is in a particularly sensitive area and the mass described above cannot be introduced, select deflection requirements for the next larger span.

8. For equipment where increased resiliency and decreased accelerations are required, change specification 16 snubbers to specification 17 snubbers.

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