UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2023
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SECTION TABLE OF CONTENTS

DIVISION 22 - PLUMBING

SECTION 22 05 48.00 20

MECHANICAL SOUND, VIBRATION, AND SEISMIC CONTROL

04/06, CHG 1: 05/15

PART 1 GENERAL

1.1 REFERENCES
1.2 RELATED REQUIREMENTS
1.3 DEFINITIONS
1.3.1 Decibels dB
1.3.2 Machinery
1.3.3 Manufacturer
1.3.4 Micropascal uPa
1.3.5 Picowatt pW
1.4 SYSTEM DESCRIPTION
1.4.1 Spring Isolator Data
1.4.2 Machinery Manufacturer's Sound Data
1.4.3 Machinery
1.4.4 Machinery Over 136 Kilograms Machinery Over 300 Pounds
1.4.5 Machinery Vibration Criteria
1.4.6 Machinery Airborne Sound Level Criteria
1.4.6.1 Basic Criteria
1.4.6.2 Sound Data Schedule
1.4.7 Seismic Protection Criteria
1.4.8 Welding
1.5 SUBMITTALS
1.6 QUALITY ASSURANCE
1.6.1 Vibration Isolator Procurement
1.6.2 Unitized Machinery Assemblies

PART 2 PRODUCTS

2.1 CORROSION PROTECTION FOR STEEL PARTS
2.2 NEOPRENE
2.3 FLOOR-MOUNTED ISOLATORS
2.3.1 Neoprene Isolation Pads
2.3.2 Neoprene Isolators
2.4 SPRING ISOLATORS AND PROTECTED SPRING ISOLATORS

2.4.1 Springs
2.4.2 Mounting and Adjustment
2.5 SUSPENSION ISOLATORS
2.5.1 Suspension Neoprene Isolators
2.5.2 Suspension Spring Isolators
2.6 [MACHINERY BASES] [, PLATFORMS] [, RAILS] [SADDLES]
2.7 INERTIA BASES
2.8 FLEXIBLE CONNECTORS FOR PIPING
2.8.1 Elastomeric Flexible Connectors
2.8.2 Metal Flexible Connectors
2.9 FLEXIBLE DUCT CONNECTORS
2.10 SEISMIC SNUBBERS FOR EQUIPMENT
2.11 PIPE GUIDES
2.12 THRUST RESTRAINTS
2.13 SEISMIC PROTECTION COMPONENTS FOR [PIPING] [AND] [DUCTWORK]

PART 3 EXECUTION

3.1 INSTALLATION
3.1.1 Vibration and Noise Isolation Components
3.1.2 Suspension Vibration Isolators
3.1.3 Vertical Stops
3.1.4 Thrust Restraints
3.1.5 Flexible Pipe and Duct Connectors
3.1.6 Seismic Snubbers
3.1.7 Machinery
3.1.7.1 Stability
3.1.7.2 Lateral Motion
3.1.7.3 Unbalanced Machinery
3.1.7.4 Nonrotating Machinery
3.1.7.5 Unitized Machinery Assemblies
3.1.7.6 Roof and Upper Floor Mounted Machinery
3.1.8 [Piping] [and] [High Pressure Ductwork]
3.1.8.1 High Pressure Ductwork
3.1.8.2 Piping Connected to Vibration Isolated Machinery
3.1.8.3 Steam Pressure Reducing Valves
3.1.8.4 Condenser Water
3.1.8.5 Chilled, Hot, and Dual Temperature Piping
3.1.9 Water and Steam Distribution Piping Application
3.1.10 Pipe Hanger and Support Installation
3.1.10.1 Pipe Hangers
3.1.10.2 High Temperatures
3.1.10.3 Valves
3.1.10.4 Machinery Without Flexible Connections
3.1.10.5 300 Millimeters Twelve Inch and Larger Pipe
3.1.10.6 Pipe Risers
3.1.10.7 Supports at Base of Pipe Risers
3.1.10.8 Pipe Anchors
3.1.11 High Pressure Ductwork Hanger and Support Installation
3.1.11.1 Duct Risers
3.1.11.2 Supports at Base of Duct Risers
3.1.11.3 Duct Anchors
3.1.12 Equipment Room Sound Isolation
3.1.12.1 Pipe Penetrations
3.1.12.2 Duct Penetrations
3.1.12.3 Ducts Passing Through Equipment Rooms
3.1.13 Machinery Foundations and Subbases
3.1.13.1 Machinery Subbases
3.1.13.2 Common Machinery Foundations

3.1.13.3 Foundation and Subbase Concrete
3.1.13.4 Anchor Bolts and Grout
3.1.14 Inertia Bases
3.1.15 Seismic Restraints for [Piping] [and] [Ductwork]
3.1.16 Suspended Machinery Platforms
3.1.17 Electrical Connections
3.1.18 Systems Not To Be Vibration Isolated
3.2 FIELD QUALITY CONTROL
3.2.1 Field Inspections
3.2.2 Spring Isolator Inspection
3.2.3 Tests
3.2.3.1 Equipment Vibration Tests
3.2.3.2 Equipment Sound Level Tests

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC / NASA	**UFGS-22 05 48.00 20 (April 2006)**
	Change 1 - 05/15

Preparing Activity: NAVFAC	**Replacing without change UFGS-15070N (September 1999)**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2023
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SECTION 22 05 48.00 20

MECHANICAL SOUND, VIBRATION, AND SEISMIC CONTROL
04/06, CHG 1: 05/15

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NOTE: This guide specification covers the requirements for vibration isolation and seismic snubbing for mechanical and electrical equipment.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).
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NOTE: This specification includes vibration isolators and stops, seismic snubbers, machinery bases and the installation, inspection, and testing of the vibration isolation of machinery and systems.
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NOTE: The following information shall be shown on the project drawings:

1. Extent of piping systems depicting isolation hangers on the piping flow diagram. Pipe risers having low thermal expansion such as condenser and chilled water lines may be isolated from the building structure by providing vibration isolation units at the base and isolation guides at floor

slabs two to three stories apart. Hot water systems risers and similar piping having high thermal expansion will generally require one or more anchors and expansion joints to obtain satisfactory support with spring isolation hangers.

2. Details of vibration isolation supports and guides not shown on drawings, such as column supported spring isolators for cooling towers, and equipment supports and isolation when equipment is located on roofs of light construction.

3. Vibration isolators. Indicate in equipment schedule and details. Indicate where vibration isolation is to be provided for piping and ductwork. Detail isolators only to the extent necessary to indicate type or identify types in notes or symbol legend.

4. Flexible connectors for equipment.

5. Flexible duct connectors.

6. Seismic snubbers. Indicate in equipment schedules and details. When specified as an option detail shop fabricated seismic snubbers.

7. Seismic sway bracing and cables for piping and ductwork.

8. Flexible connectors for piping and ductwork. Indicate types.

9. Equipment bases, rails, and saddles.

10. Inertia bases.

11. Anchor bolts. Indicate sizes in equipment schedules or details for rigidly fixed machinery.

12. Suspended equipment platforms. Indicate vibration isolator details.

13. Pipe guides.

14. Equipment data. Indicate or specify equipment rpm vibration amplitudes and forces, maximum noise levels, weight, dimensions, and power maximum and minimum limits, and static and dynamic balancing of requirements.

15. Sound data Schedule. Indicate the maximum airborne sound power or sound pressure levels for each machinery. Indicate the distance from the sound source (in case of sound power data) or measurement location (in case of sound pressure data) to the typical station.

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PART 1 GENERAL

1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

AHRI 575	(2017) Method of Measuring Machinery Sound Within an Equipment Space
ANSI/AHRI 370	(2015; Addendum 1 2016) Sound Rating of Large Outdoor Refrigerating and Air-Conditioning Equipment

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 360	(2016) Specification for Structural Steel Buildings

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A123/A123M	(2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or

	Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM C94/C94M	(2022a) Standard Specification for Ready-Mixed Concrete
ASTM D471	(2016a) Standard Test Method for Rubber Property - Effect of Liquids
ASTM D2240	(2015; E 2017) Standard Test Method for Rubber Property - Durometer Hardness
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1403	(2008) Accepted Industry Practice for Industrial Duct Construction, 2nd Edition
SMACNA 1793	(2012) Architectural Sheet Metal Manual, 7th Edition
SMACNA 1966	(2020) HVAC Duct Construction Standards Metal and Flexible, 4th Edition
SMACNA 1981	(2008) Seismic Restraint Manual Guidelines for Mechanical Systems, 3rd Edition

1.2 RELATED REQUIREMENTS

The provisions of Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS apply to this section.

1.3 DEFINITIONS

1.3.1 Decibels dB

Measure of sound level. Decibels are referenced to either 20 uPa for sound pressure levels or one pW for sound power levels. dBA is the overall "A" weighted sound level.

1.3.2 Machinery

The vibration or noise producing equipment that must be isolated.

1.3.3 Manufacturer

The fabricator or supplier of vibration-isolation or seismic-protection materials and equipment. For mechanical equipment and machinery the term machinery manufacturer will be used.

1.3.4 Micropascal uPa

10 to the minus 6 power newtons per square meter.

1.3.5 Picowatt pW

10 to the minus 12 power watts.

1.4 SYSTEM DESCRIPTION

1.4.1 Spring Isolator Data

For each type and size of spring isolator, submit the spring outside diameter, deflection, operating spring height, unloaded spring height, solid spring height, the ratio of the outside diameter to the operating spring height, the load to deflection ratio of the springs, and weight and sizes of structural steel members.

1.4.2 Machinery Manufacturer's Sound Data

For each piece of indicated machinery to be vibration isolated, the calculated sound power test data or sound pressure test data as levels in dB in the eight octave bands between 63 and 8,000 Hz. Refer sound power levels to one pW and sound pressure levels to 20 uPa. Submit the overall "A" weighted scale sound pressure level in dB. Submit the standard test procedure used to obtain the sound power or pressure data for the applicable vibration isolation equipment size.

1.4.3 Machinery

For each item of machinery, compare spring static deflections with the specified minimum static deflection, to show that the calculated spring static deflections are not less than the minimum static deflections specified. Rated spring static deflections are not acceptable in lieu of calculated spring static deflections. [When seismic protection is required, substantiating calculations are required.]

1.4.4 Machinery Over 136 Kilograms Machinery Over 300 Pounds

For machinery items over 136 kg 300 pounds, provide calculations for shear, pull-up, primary overturning, and secondary overturning.

1.4.5 Machinery Vibration Criteria

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NOTE: Include the vibration isolation schedule on the drawings. Provide information in project specifications, if drawings do not show the vibration isolation schedule. Further details may be found in the current ASHRAE System Handbook, Chapter titled "Sound and Vibration Control." Refer to TABLES 1A and 1B for vibration isolator selection. DO NOT INCLUDE THE ENTIRE TABLES 1A AND 1B IN THE PROJECT SPECIFICATIONS.

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NOTE: For equipment rooms containing air-conditioning, heating, pumping and air compressor equipment, review manufacturer's recommendations for vibration and noise isolation and seismic snubbing. When vibrating, rotating, or pulsating machinery are to be located at other than

on grade, coordinate with the structural designer to avoid problems caused by machinery induced vibrations in the building structure. For heavy vibrating machinery located anywhere, completely review vibration isolation requirements. Coordinate with the designer about the maximum allowable levels of sound and vibration in equipment locations. Refer to both the Applicable Publications and the following publications for guidance in sound, vibration isolation, and seismic restraint devices for mechanical equipment and systems:

INTERNATIONAL CODE COUNCIL (ICC)

UFC 3-301-01, "Structural Engineering".

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NOTE: The following table serves only as a guideline. Delete items that are not applicable.

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TABLE 1A						
Vibration Isolator Types and Minimum Static Deflection						
(MSD, mm) for 100-200 mm slab on grade and column supported.						
Column Spacing	Slab on earth and 0-9 meter		9.1-12 meters		12.1-15 meters	
Equipment	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))
Absorption Refrigeratic Machines	SV-R	25.40	SV-R	44.45	SV-R	69.85
Centrifugal Chillers or Heat Pumps						
Hermetic Type	SV-B	44.45	SV-B	63.50	SV-B	88.90
Open Type	SV-1	44.45	SV-I	63.50	SV-I	88.90
Reciprocating Air or Refrigeration Compressors						
500 to 750 rpm	S-R	44.45	S-R	63.50	S-R	88.90

TABLE 1A						
Vibration Isolator Types and Minimum Static Deflection						
(MSD, mm) for 100-200 mm slab on grade and column supported.						
Column Spacing	Slab on earth and 0-9 meter		9.1-12 meters		12.1-15 meters	
Equipment	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))
751 rpm and up	S-R	38.10	S-R	63.50	S-R	88.90
Reciprocating Chillers or Heat Pumps						
500 to 750 rpm	SV-R	44.45	SV-R	63.50	SV-R	88.90
751 rpm and up	SV-R	38.10	SV-R	63.50	SV-R	88.90
Packaged Boilers	SV	25.40	SV	63.50	SV-R	88.90
Closed Coupled Pumps						
Up to 5 1/2 kW	S-I	25.40	S-I	25.40	S-I	25.40
Over 5 1/2 kW	S-I	38.10	S-I	63.50	S-I	63.50
Base Mounted Pumps						
Up to 15 kW	S-I	38.10	S-I	63.50	S-I	63.50
15 to 56 kW	S-I	38.10	S-I	63.50	S-I	88.90
Over 56 kW	S-I	63.50	S-I	88.90	S-I	88.90
Cooling Towers and Evaporative Condensers		SV with deflections specified for centrifugal blowers when springs are supported on beams. Use deflection listed for column supported floors with up to 9 meters column spacing when springs are located on columns or bearing walls.				
Factory Assembled Air Handling Equipment AH, AC and HV Units (Note (2))						

TABLE 1A						
Vibration Isolator Types and Minimum Static Deflection						
(MSD, mm) for 100-200 mm slab on grade and column supported.						
Column Spacing	Slab on earth and 0-9 meter		9.1-12 meters		12.1-15 meters	
Equipment	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))
Suspended Units						
Up to 3 3/4 kW	H	25.40	H	25.40	H	25.40
Over 3 3/4 kW						
Up to 400 rpm	H	44.45	H	44.45	H	44.45
Over 401 rpm	H	25.40	H	38.10	H	63.50
Floor Mounted Units						
Up to 3 3/4 kW	S	25.40	S	25.40	S	25.40
Over 3 3/4 kW						
Up to 400 rpm	S-R	44.45	S-R	44.45	S-R	63.50
Over 401 rpm	S-R	25.40	S-R	38.10	S-R	63.50
Centrifugal Blowers						
175 - 224 rpm	S-B	120.65	S-B	120.65	S-B	120.65
225 - 299 rpm	S-B	95.25	S-B	120.65	S-B	120.65
300 - 374 rpm	S-B	69.85	S-B	114.30	S-B	120.65
375 - 499 rpm	S-B	63.50	S-B	88.90	S-B	114.30
Over 500 rpm	S-B	44.45	S-B	63.50	S-B	88.90
Tubular Centrifugal and Axial Fans (Note (2))						
Suspended		H with deflection specified for centrifugal blowers				

TABLE 1A						
Vibration Isolator Types and Minimum Static Deflection						
(MSD, mm) for 100-200 mm slab on grade and column supported.						
Column Spacing	Slab on earth and 0-9 meter		9.1-12 meters		12.1-15 meters	
Equipment	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))
Floor Mounted Arrangements 1 & 9	S-B with deflections specified for centrifugal blowers					
Utility Fans (Note (2))						
Suspended	H with deflections specified for centrifugal blowers but not to exceed 69.85 mm					
Floor-Mounted	S-R with deflections not specified for centrifugal blowers but not to exceed 69.85 mm					
High Pressure Fans (Over 1494 Pa Static Pressure) and Other Machineries Producing Thrust (Note (2))	HR recommended for minimizing undesirable thrust effects					
Internal Combustion Engines and Engine Driven Equip						
750 rpm and over	S	38.10	S	63.50	S	88.90
Dimmer Banks and Transformers						
Up to 454 kg	NM	8.89	NM	8.89	NM	88.90
Over 454 kg	SV	25.40	SV	25.40	SV	25.40
NOTES:						
(1) Equipment Vibration Isolation Schedule Designations (Hyphenated designations are combinations of the following:)						
B - Welded structural steel bases.						
H - Spring isolators (suspended equipment and piping). Where required, provide with adjustable preloading devices.						
HR - Thrust restraints						

TABLE 1A						
Vibration Isolator Types and Minimum Static Deflection						
(MSD, mm) for 100-200 mm slab on grade and column supported.						
Column Spacing	Slab on earth and 0-9 meter		9.1-12 meters		12.1-15 meters	
Equipment	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))
I - Concrete inertia bases with steel forms.						
NM - Neoprene mounts.						
NP - Neoprene pads.						
R - Structural steel rail for equipment mounts.						
S - Freestanding spring isolators (floor-mounted equipment).						
SV - Freestanding spring isolators (floor-mounted equipment).						
SX - Freestanding spring isolators with adjustable cushioned vertical stops and cushioned horizontal stops (floor-mounted equipment. Protected spring isolators SX may be substituted wherever S or SV is specified and shall meet all requirements.						
(2) Fans						
a. When fan motors are 56 kW or larger, use the deflection requirements for the next wider column spacing. Except for building slab on grade a minimum of 63.50 mm should be used unless larger deflections are specified in the centrifugal blower table.						
b. Provide sway brace isolators for tubular centrifugal and axial fans when the fan pressure exceeds 996 Pa.						
c. Provide inertia bases for all fans in lieu of structural steel bases or rails specified above when the fan pressure exceeds 996 Pa.						
d. With attaching brackets, suspension spring isolators bridge between the structure and the thrust-producing machinery such as high-pressure fan. Both types H and HR normally provide reaction in tension, while types S, SV, and SX normally provide reaction in compression. Thrust restraints are low-cost and effective components available from manufacturers. Use thrust restraints to eliminate the need for or reduce the magnitude of inertia mass when the mass is only used to reduce the displacement effects of the thrust.						

TABLE 1A						
Vibration Isolator Types and Minimum Static Deflection						
(MSD, inches) for 4-8 inch slab on grade and column supported.						
Column Spacing	Slab on earth and 0-30 feet		31-40 feet		41-50 feet	
Equipment	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))
Absorption Refrigeration Machines	SV-R	1.0	SV-R	1.75	SV-R	2.75
Centrifugal Chillers or Heat Pumps						
Hermetic Type	SV-B	1.75	SV-B	2.5	SV-B	3.5
Open Type	SV-1	1.75	SV-I	2.5	SV-I	3.5
Reciprocating Air or Refrigeration Compressors						
500 to 750 rpm	S-R	1.75	S-R	2.5	S-R	3.5
751 rpm and up	S-R	1.5	S-R	2.5	S-R	3.5
Reciprocating Chillers or Heat Pumps						
500 to 750 rpm	SV-R	1.75	SV-R	2.5	SV-R	3.5
751 rpm and up	SV-R	1.5	SV-R	2.5	SV-R	3.5
Packaged Boilers	SV	1.0	SV	2.5	SV-R	3.5
Closed Coupled Pumps						
Up to 7-1/2 hp	S-I	1.0	S-I	1.0	S-I	1.0
Over 7-1/2 hp	S-I	1.5	S-I	2.5	S-I	2.5
Base Mounted Pumps						

TABLE 1A						
Vibration Isolator Types and Minimum Static Deflection						
(MSD, inches) for 4-8 inch slab on grade and column supported.						
Column Spacing	Slab on earth and 0-30 feet		31-40 feet		41-50 feet	
Equipment	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))
Up to 20 hp	S-I	1.5	S-I	2.5	S-I	2.5
20 to 75 hp	S-I	1.5	S-I	2.5	S-I	3.5
Over 75 hp	S-I	2.5	S-I	3.5	S-I	3.5
Cooling Towers and Evaporative Condensers		SV with deflections specified for centrifugal blowers when springs are supported on beams. Use selection listed for column supported floors with up to 30 foot column spacing when springs are located on columns or bearing walls.				
Factory Assembled Air Handling Equipment AH, AC and HV Units (Note (2))						
Suspended Units						
Up to 5 hp	H	1.0	H	1.0	H	1.0
Over 5 hp						
Up to 400 rpm	H	1.75	H	1.75	H	1.75
Over 401 rpm	H	1.0	H	1.5	H	2.5
Floor Mounted Units						
Up to 5 hp	S	1.0	S	1.0	S	1.0
Over 5 hp						
Up to 400 rpm	S-R	1.75	S-R	1.75	S-R	2.5
Over 401 rpm	S-R	1.0	S-R	1.5	S-R	2.5

TABLE 1A						
Vibration Isolator Types and Minimum Static Deflection						
(MSD, inches) for 4-8 inch slab on grade and column supported.						
Column Spacing	Slab on earth and 0-30 feet		31-40 feet		41-50 feet	
Equipment	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))
Centrifugal Blowers						
175 - 224 rpm	S-B	4.75	S-B	4.75	S-B	4.75
225 - 299 rpm	S-B	3.75	S-B	4.75	S-B	4.75
300 - 374 rpm	S-B	2.75	S-B	4.5	S-B	4.75
375 - 499 rpm	S-B	2.5	S-B	3.5	S-B	4.5
Over 500 rpm	S-B	1.75	S-B	2.5	S-B	3.5
Tubular Centrifugal and Axial Fans (Note (2))						
Suspended	H with deflection specified for centrifugal blowers					
Floor Mounted Arrangements 1 & 9	S-B with deflections specified for centrifugal blowers					
Utility Fans (Note (2))						
Suspended	H with deflections specified for centrifugal blowers but not to exceed 2.75 inches					
Floor-Mounted	S-R with deflections not specified for centrifugal blowers but not to exceed 2.75 inches					
High Pressure Fans (6 Inch Water-Column Static Pressure) and Other Machineries Producing Thrust (Note (2))	HR recommended for minimizing undesirable thrust effects					
Internal Combustion Engines and Engine Driven Equip						
750 rpm and over	S	1.5	S	2.5	S	3.5

TABLE 1A						
Vibration Isolator Types and Minimum Static Deflection						
(MSD, inches) for 4-8 inch slab on grade and column supported.						
Column Spacing	Slab on earth and 0-30 feet		31-40 feet		41-50 feet	
Equipment	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))
Dimmer Banks and Transformers						
Up to 1000 lbs.	NM	0.35	NM	0.35	NM	3.5
Over 1000 lbs.	SV	1.0	SV	1.0	SV	1.0
NOTES:						
(1) Equipment Vibration Isolation Schedule Designations (Hyphenated designations are combinations of the following:)						
B - Welded structural steel bases.						
H - Spring isolators (suspended equipment and piping). Where required, provide with adjustable preloading devices.						
HR - Thrust restraints						
I - Concrete inertia bases with steel forms.						
NM - Neoprene mounts.						
NP - Neoprene pads.						
R - Structural steel rail for equipment mounts.						
S - Freestanding spring isolators (floor-mounted equipment).						
SV - Freestanding spring isolators (floor-mounted equipment).						
SX - Freestanding spring isolators with adjustable cushioned vertical stops and cushioned horizontal stops (floor-mounted equipment. Protected spring isolators SX may be substituted wherever S or SV is specified and shall meet all requirements.						
(2) Fans						
a. When fan motors are 75 hp or larger, use the deflection requirements for the next wider column spacing. Except for building slab on grade a minimum of 2.5 inches should be used unless larger deflections are specified in the centrifugal blower table.						

TABLE 1A						
Vibration Isolator Types and Minimum Static Deflection						
(MSD, inches) for 4-8 inch slab on grade and column supported.						
Column Spacing	Slab on earth and 0-30 feet		31-40 feet		41-50 feet	
Equipment	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))
b. Provide sway brace isolators for tubular centrifugal and axial fans when the fan pressure exceeds 4 inches water column.						
c. Provide inertia bases for all fans in lieu of structural steel bases or rails specified above when the fan pressure exceeds 4 inches water column.						
d. With attaching brackets, suspension spring isolators bridge between the structure and the thrust-producing machinery such as high-pressure fan. Both types H and HR normally provide reaction in tension, while types S, SV, and SX normally provide reaction in compression. Thrust restraints are low-cost and effective components available from manufacturers. Use thrust restraints to eliminate the need for or reduce the magnitude of inertia mass when the mass is only used to reduce the displacement effects of the thrust.						

****

NOTE: The following table serves only as a guideline. Delete items that are not applicable.

****

TABLE 1B		
Class II Vibration Isolator Types and Minimum Static Deflection		
(MSD, mm) for basements below grade and floor slabs on earth		
Equipment	Type (Note (1))	MSD
Absorption Refrigeration Machines	NP	6.35
	NM	8.89
Centrifugal Chillers or Heat Pumps		
Hermetic Type	NP	6.35
	NM	8.89
Open Type	NM-I	8.89
Reciprocating Air or Refrigeration Compressors		

TABLE 1B		
Class II Vibration Isolator Types and Minimum Static Deflection		
(MSD, mm) for basements below grade and floor slabs on earth		
Equipment	Type (Note (1))	MSD
500 to 750 rpm	S	25.40
751 rpm and up	S	25.40
Reciprocating Chillers or Heat Pumps		
500 to 750 rpm	SV	25.40
751 rpm and up	SV	25.40
Packaged Boilers	NP	6.35
	NM	8.89
Pumps		
Closed Coupled	NP	6.35
Up to 5 1/2 kW	NM	8.89
Over 5 1/2 kW	S-I	25.40
Base Mounted		
Up to 15 kW	S-I	25.40
15 to 56 kW	S-I	25.40
Over 56 kW	S-I	25.40
Cooling Towers and Evaporative Condensers	NP	6.35
	NM	8.89
Factory Assembled Air Handling Equipment AH, AC and HV Units (Note (2))		
Suspended Units		
Up to 3 3/4 kW	H	25.40
Over 3 3/4 kW		
Up to 400 rpm	H	44.45
Over 401 rpm	H	25.40
Floor Mounted Units		
Up to 3 3/4 kW	NP	6.35
	NM	8.89
Over 3 3/4 kW		
Up to 400 rpm	NM	8.89
Over 401 rpm	NM	8.89
Centrifugal Blowers		
175 - 224 rpm	NM-B	8.89
225 - 299 rpm	NM-B	8.89
300 - 374 rpm	NM-B	8.89

TABLE 1B		
Class II Vibration Isolator Types and Minimum Static Deflection		
(MSD, mm) for basements below grade and floor slabs on earth		
Equipment	Type (Note (1))	MSD
375 - 499 rpm	NM-B	8.89
Over 500 rpm	NM-B	8.89
Tubular Centrifugal and Axial Fans (Note (2))		
Suspended	H with deflections specified for centrifugal blowers	
Floor Mounted Arrangements 1 & 9	NM	8.89
Utility Fans (Note (2))		
Suspended and centrifugal	H with deflections specified for	
Floor-Mounted	NM	8.89
High Pressure Fans (Over 1494 Pa Static Pressure) and Other Machineries Producing Thrust (Note (2))		HR recommended for minimizing undesirable thrust effects
Internal Combustion Engines and Engine Driven Equip		
750 rpm and over	S	25.40
Dimmer Banks and Transformers		
Up to 454 kg	NP	6.35
	NM	8.89
Over 454 kg	SV	25.40
NOTES: Note (1) and Note (2) are same as for TABLE 1A.		

TABLE 1B		
Class II Vibration Isolator Types and Minimum Static Deflection		
(MSD, inches) for basements below grade and floor slabs on earth		
Equipment	Type (Note (1))	MSD
Absorption Refrigeration Machines	NP	0.25
	NM	0.35
Centrifugal Chillers or Heat Pumps		

TABLE 1B		
Class II Vibration Isolator Types and Minimum Static Deflection		
(MSD, inches) for basements below grade and floor slabs on earth		
Equipment	Type (Note (1))	MSD
Hermetic Type	NP	0.25
	NM	0.35
Open Type	NM-I	0.35
Reciprocating Air or Refrigeration Compressors		
500 to 750 rpm	S	1.0
751 rpm and up	S	1.0
Reciprocating Chillers or Heat Pumps		
500 to 750 rpm	SV	1.0
751 rpm and up	SV	1.0
Packaged Boilers	NP	0.25
	NM	0.35
Pumps		
Closed Coupled	NP	0.25
Up to 7 1/2 hp	NM	0.35
Over 7 1/2 hp	S-I	1.0
Base Mounted		
Up to 20 hp	S-I	1.0
20 to 75 hp	S-I	1.0
Over 75 hp	S-I	1.0
Cooling Towers and Evaporative Condensers	NP	0.25
	NM	0.35
Factory Assembled Air Handling Equipment AH, AC and HV Units (Note (2))		
Suspended Units		
Up to 5 hp	H	1.0
Over 5 hp		
Up to 400 rpm	H	1.75
Over 401 rpm	H	1.0
Floor Mounted Units		
Up to 5 hp	NP	0.25
	NM	0.35
Over 5 hp		
Up to 400 rpm	NM	0.35

TABLE 1B		
Class II Vibration Isolator Types and Minimum Static Deflection		
(MSD, inches) for basements below grade and floor slabs on earth		
Equipment	Type (Note (1))	MSD
Over 401 rpm	NM	0.35
Centrifugal Blowers		
175 - 224 rpm	NM-B	0.35
225 - 299 rpm	NM-B	0.35
300 - 374 rpm	NM-B	0.35
375 - 499 rpm	NM-B	0.35
Over 500 rpm	NM-B	0.35
Tubular Centrifugal and Axial Fans (Note (2))		
Suspended	H with deflections specified for centrifugal blowers	
Floor Mounted Arrangements 1 & 9	NM	0.35
Utility Fans (Note (2))		
Suspended and centrifugal	H with deflections specified for	
Floor-Mounted	NM	0.35
High Pressure Fans (Over 6 Inch Water-ColumnStatic Pressure) and Other Machineries Producing Thrust Note (2))		HR recommended for minimizing undesirable thrust effects
Internal Combustion Engines and Engine Driven Equip		
750 rpm and over	S	1.0
Dimmer Banks and Transformers		
Up to 1000 lbs.	NP	0.25
	NM	0.35
Over 1000 lbs.	SV	1.0
NOTES: Note (1) and Note (2) are same as for TABLE 1A.		

Provide vibration isolators [and seismic snubbers] for mechanical and electrical machinery and associated piping and ductwork [as indicated], to minimize transmission of vibrations and structure borne noise to the building structure or spaces or from the building structure to the machinery. Comply with the following vibration schedule.

1.4.6 Machinery Airborne Sound Level Criteria

****

NOTE: Depict on drawings one table for each piece of machinery proposed for the project. Provide information in project specification, if drawings do not show the sound data schedule." Depict on the Table as follows: (1) Machine Airborne Sound Power Levels (dB) or (2) the Machine Airborne Sound Pressure Levels (dB) with maximum level expressed in pressure re 20 uPa or Power re one pW for octave band level center frequencies in Hz at 63, 125, 250, 500, 1,000, 2,000, 4,000, 8,000 Hz and overall level dB. Indicate the sound power level or sound pressure levels, depending upon applicable measurement standard. Refer to UFC 3-450-01 and TABLE 2A in below note for sound data selection. Further details may be found in the current ASHRAE System Handbook, Chapter titled "Sound and Vibration Control." When no standard exists, solicit sound data from manufacturer and refer to UFC 3-450-01 for guidance. The dB(A) scale and peak pressure level noise values specified are stated to preclude adding requirements of OPNAVFAC INST 5100.23B concerning hearing conservation and noise abatement programs.
****

****
NOTE: The following serves only as a simplified guideline, without considering different types of the same kind of equipment. Delete items that are not applicable.
****

TABLE 2A

Sound Data Schedule

Equipment	Maximum Sound Power Level (dB)							
	Octave Band Level Center Frequency (Hz)							
	63	125	250	500	1000	2000	4000	8000
Air Handling Unit	94	90	89	89	89	84	82	79
Make-Up Air Fan	91	91	80	84	82	76	71	65
Air Conditioning Unit	100	96	90	89	86	80	75	72
Boiler	75	72	72	75	76	63	55	50
Chiller	98	98	96	95	93	94	88	81
Cooling Tower	110	110	105	102	98	95	92	87

TABLE 2A								
Sound Data Schedule								
Equipment	Maximum Sound Power Level (dB)							
	Octave Band Level Center Frequency (Hz)							
	63	125	250	500	1000	2000	4000	8000
Air Compressor	90	89	92	93	92	92	90	81
Pump	85	80	82	82	80	77	74	72
Fan	55	50	48	47	48	46	42	37

1.4.6.1 Basic Criteria

For each piece of machinery in the human work environment, do not exceed the maximum airborne sound levels 84 dB A-weighted scale, continuous or intermittent, or 140 dB peak sound pressure-level, impact or impulse, noise.

1.4.6.2 Sound Data Schedule

****

NOTE: Depict on drawings one table for each piece of machinery proposed for the project. Provide information in project specification, if drawings do not show the sound data schedule." Depict on the Table as follows: (1) Machine Airborne Sound Power Levels (dB) or (2) the Machine Airborne Sound Pressure Levels (dB) with maximum level expressed in pressure re 20 uPa or Power re one pW for octave band level center frequencies in Hz at 63, 125, 250, 500, 1,000, 2,000, 4,000, 8,000 Hz and overall level dB. Indicate the sound power level or sound pressure levels, depending upon applicable measurement standard. Refer to UFC 3-450-01 and TABLE 2A in below note for sound data selection. Further details may be found in the current ASHRAE System Handbook, Chapter titled "Sound and Vibration Control." When no standard exists, solicit sound data from manufacturer and refer to UFC 3-450-01 for guidance. The dB(A) scale and peak pressure level noise values specified are stated to preclude adding requirements of OPNAVFAC INST 5100.23B concerning hearing conservation and noise abatement programs.

****

****

NOTE: The following serves only as a simplified guideline, without considering different types of the same kind of equipment. Delete items that are not applicable.

****

TABLE 2A								
Sound Data Schedule								
Equipment	Maximum Sound Power Level (dB)							
	Octave Band Level Center Frequency (Hz)							
	63	125	250	500	1000	2000	4000	8000
Air Handling Unit	94	90	89	89	89	84	82	79
Make-Up Air Fan	91	91	80	84	82	76	71	65
Air Conditioning Unit	100	96	90	89	86	80	75	72
Boiler	75	72	72	75	76	63	55	50
Chiller	98	98	96	95	93	94	88	81
Cooling Tower	110	110	105	102	98	95	92	87
Air Compressor	90	89	92	93	92	92	90	81
Pump	85	80	82	82	80	77	74	72
Fan	55	50	48	47	48	46	42	37

1.4.7 Seismic Protection Criteria

****

NOTE: Protect electrical and mechanical machinery installations in Seismic Zones 3 and 4 of the Uniform Building Code Seismic Map. Horizontal force factors of 1.00 are assigned to essential building or structures. 0.60 factors are assigned to non-essential buildings or structures. A non-essential building or structure is one that does not require complete operation of emergency or life saving machinery to provide services after an earthquake. An essential building or structure requires these services of its restrained machinery.

****

Use a Horizontal Force Factor minimum [60 percent] [100 percent] of the machinery weight considered passing through the machinery center of gravity in any horizontal direction. Unless vibration isolation is required to protect machinery against unacceptable structure transmitted noise or vibration, protect the structure or machinery from earthquakes by rigid structurally sound attachment to the load-supporting structure. Protect each piece of vibration-isolated machinery with protected spring isolators or separate seismic restraint devices. Determine by calculations the number and size of seismic restraints needed for each machinery. Verify seismic restraint vendor's calculations by a registered

professional engineer. Provide seismic snubbers and protected spring isolators rated in three principle axes. Verify ratings by independent laboratory testing, [by analysis of an independent licensed structural engineer][, or] [by R-number ratings by California State].

1.4.8 Welding

AWS D1.1/D1.1M.

1.5 SUBMITTALS

****
NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

Choose the first bracketed item for Navy, Air Force, and NASA projects, or choose the second bracketed item for Army projects.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are [for Contractor Quality Control approval.][for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

[Inertia Bases

][Machinery Bases

][Platforms

][Rails

][Saddles

] SD-03 Product Data

Isolators

Flexible Connectors

Flexible Duct Connectors

Pipe Guides

[Seismic Snubbers

][Vertical Stops

][Thrust Restraints

][Inertia Bases

][Machinery Bases

][Machinery Foundations and Subbases

][Platforms

][Rails

][Saddles

] Machinery Manufacturer's Sound Data

SD-05 Design Data

****
NOTE: When maximum and minimum limits of equipment size, weight, etc., are critical to the buildings' structural design, these limits shall be indicated or specified.
****

[Inertia Bases

][Machinery Bases

][Platforms

][Rails

][Saddles

] Each Item of Machinery

Each Item of Machinery over 136 Kilograms Machinery Over 300 Pounds

Submit design calculations for [inertia bases], [machinery bases], [platforms], [rails], and [saddles], either by the machinery manufacturer for the recommended machinery mounting or by the vibration-isolation equipment manufacturer.

SD-06 Test Reports

[Seismic Snubbers

] Equipment Vibration Tests

Equipment Sound Level Tests

[Protected Spring Isolators

][Submit seismic protection rating in three principal axes certified by an independent laboratory or analyzed by an independent licensed structural engineer.

] SD-08 Manufacturer's Instructions

Vibration and Noise Isolation Components

[Seismic Protection Components

]1.6 QUALITY ASSURANCE

1.6.1 Vibration Isolator Procurement

For each piece of machinery to be isolated from vibration, supply the [inertia base], [machinery base], [platform], [rails], [saddles], [vibration isolators], [seismic snubbers], and other associated materials and equipment as a coordinated package by a single manufacturer or by the machinery manufacturer. Select isolators that provide uniform deflection even when machinery weight is not evenly distributed. This requirement does not include the flexible connectors or the hangers for the associated piping and ductwork.

1.6.2 Unitized Machinery Assemblies

Mounting of unitized assemblies directly on vibration isolation springs is acceptable if machinery manufacturer certifies that the end supports of the assemblies have been designed for such installation.

PART 2 PRODUCTS

****

NOTE: Include the vibration isolation schedule on the drawings. Provide information in project specifications, if drawings do not show the vibration isolation schedule. Further details may be found in the current ASHRAE System Handbook, Chapter titled "Sound and Vibration Control." Refer to TABLES 1A and 1B for vibration isolator selection. DO NOT INCLUDE THE ENTIRE TABLES 1A AND 1B IN THE PROJECT SPECIFICATIONS.

****

****

NOTE: Depict on drawings one table for each piece of machinery proposed for the project. Provide information in project specification, if drawings do not show the sound data schedule." Depict on the Table as follows: (1) Machine Airborne Sound Power Levels (dB) or (2) the Machine Airborne Sound Pressure Levels (dB) with maximum level expressed in pressure re 20 uPa or Power re one pW for octave band level center frequencies in Hz at 63, 125, 250, 500, 1,000, 2,000, 4,000, 8,000 Hz and overall level dB. Indicate the sound power level or sound pressure levels, depending upon applicable measurement standard. Refer to UFC 3-450-01 and TABLE 2A in second note in paragraph MACHINERY AIRBORNE SOUND LEVEL CRITERIA for sound data selection. Further details may be found in the current ASHRAE System Handbook, Chapter titled "Sound and Vibration Control." When no standard exists, solicit sound data from manufacturer and refer to UFC 3-450-01 for guidance. The dB(A) scale and peak pressure level noise values specified are stated to preclude adding requirements of OPNAVFAC INST 5100.23B concerning hearing conservation and noise abatement programs.

****

2.1 CORROSION PROTECTION FOR STEEL PARTS

[ASTM A123/A123M] [ASTM A653/A653M] hot-dipped galvanized, or equivalent manufacturer standard coatings. Where steel parts are exposed to the weather, provide galvanized coating of at least 0.61 kg 2 ounces of zinc per square meter foot of surface. Coat springs with neoprene.

2.2 NEOPRENE

ASTM D471 and ASTM D2240, Grade Durometer 40, 50, or 60, and oil resistant.

2.3 FLOOR-MOUNTED ISOLATORS

2.3.1 Neoprene Isolation Pads

Provide pads at least 6 mm 1/4 inch thick with cross-ribbed or waffle design. For concentrated loads, provide steel bearing plates bonded or cold cemented to the pads.

2.3.2 Neoprene Isolators

Provide molded neoprene isolators having steel base plates with mounting holes and, at the top, steel mounting plates with mounting holes or threaded inserts. Provide elements of type and size coded with molded letters or color-coded for capacity identification. Embed metal parts completely in neoprene.

2.4 SPRING ISOLATORS AND PROTECTED SPRING ISOLATORS

Provide spring isolators or protected spring isolators that are adjustable and laterally stable with free-standing springs of horizontal stiffness at

minimum 80 percent of the vertical (axial) stiffness. For machine-attached and floor-attached restraining elements, separate from metal-to-metal contact by neoprene cushions 3 mm 1/8 inch thick minimum. Provide neoprene acoustic friction pads at least 6 mm 1/4 inch thick.

2.4.1 Springs

Provide springs with base and compression plates, to keep spring ends parallel during and after deflection to operating height. Provide outside coil diameters at least 0.8 of the operating height. At operating height, springs shall have additional travel to complete (solid) compression equal to at least 50 percent of the operating deflection.

2.4.2 Mounting and Adjustment

Provide base and compression plates with mounting holes or threaded fittings. Bolt leveling adjustment bolts to machinery or base.

2.5 SUSPENSION ISOLATORS

Provide hangers with suspension isolators encased in open steel brackets. Isolate hanger rods from isolator steel brackets with neoprene-lined opening.

2.5.1 Suspension Neoprene Isolators

Provide double-deflection elements with minimum 10 mm 3/8 inch deflection.

2.5.2 Suspension Spring Isolators

Provide hangers with springs and molded neoprene elements in series. Provide isolators with adjustable spring-preloading devices where required to maintain constant pipe elevations during installation and when pipe operational loads are transferred to the springs.

2.6 [MACHINERY BASES] [, PLATFORMS] [, RAILS] [SADDLES]

ASTM A36/A36M and AISC 360.

2.7 INERTIA BASES

ASTM A36/A36M steel, ASTM C94/C94M ([20 MPa] [2,500 psi] [_____]) concrete.

2.8 FLEXIBLE CONNECTORS FOR PIPING

Straight or elbow flexible connectors rated for temperatures, pressures, and fluids to be conveyed. Provide flexible connectors with the strength 4 times operating pressure at highest system operating temperature. Provide elbow flexible connectors with a permanently set angle.

2.8.1 Elastomeric Flexible Connectors

Fabricated of multiple plies of tire cord fabric and elastomeric materials with integral reinforced elastomeric flanges with galvanized malleable iron back up rings.

2.8.2 Metal Flexible Connectors

Fabricated of Grade E phosphor bronze, monel or corrugated stainless steel tube covered with comparable bronze or stainless steel braid restraining and pressure cover.

2.9 FLEXIBLE DUCT CONNECTORS

Provide flexible duct connectors fabricated in accordance with [SMACNA 1403] [SMACNA 1966].

[2.10 SEISMIC SNUBBERS FOR EQUIPMENT

Factory-fabricated, omni-directional with factory set air gaps between 3 mm 1/8 inch minimum and 6 mm 1/4 inch maximum. Load capacity of each snubber at 50 percent neoprene element deflection shall be [0.5g] [1.0g] minimum. Provide replaceable neoprene elements [6 mm] [19 mm] [1/4 inch] [3/4 inch] [_____] minimum thickness.

]2.11 PIPE GUIDES

Factory-fabricated. Weld steel bar guides to the pipe at a maximum radial spacing of 60 degrees. The outside diameter around the guide bars shall be smaller than the inside diameter of the guide sleeve in accordance with standard field construction practice. For pipe temperatures below 16 degrees C 60 degrees F, provide metal sleeve, minimum 16 kg per cubic meter one pound per cubic foot density insulation.

2.12 THRUST RESTRAINTS

Adjustable spring thrust restraints, able to resist the thrust force with at least 25 percent unused capacity. The operating spring deflection shall be not less than 50 percent of the static deflection of the isolation supporting the machinery.

[2.13 SEISMIC PROTECTION COMPONENTS FOR [PIPING] [AND] [DUCTWORK]

[Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS.] [SMACNA 1981.]

]PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Vibration and Noise Isolation Components

****

NOTE: Include the vibration isolation schedule on the drawings. Provide information in project specifications, if drawings do not show the vibration isolation schedule. Further details may be found in the current ASHRAE System Handbook, Chapter titled "Sound and Vibration Control." Refer to TABLES 3A and 3B for vibration isolator selection. DO NOT INCLUDE THE ENTIRE TABLES 3A AND 3B IN THE PROJECT SPECIFICATIONS.

****

Install vibration-and-noise isolation materials and equipment [as

indicated and] in accordance with machinery manufacturer's instructions.

3.1.2 Suspension Vibration Isolators

Provide suspension isolation hangers for piping, suspended equipment, and suspended equipment platforms in mechanical equipment rooms, [as indicated and] as specified. For operating load static deflections of 6 mm 1/4 inch or less, provide neoprene pads or single deflection neoprene isolators. For operating load static deflections over 8 to 10 mm 5/16 to 3/8 inch, provide double-deflection neoprene element isolators. For operating load static deflections over 10 mm 3/8 inch, provide isolators with spring and neoprene elements in series.

3.1.3 Vertical Stops

For machinery affected by wind pressure or having an operational weight different from installed weight, provide resilient vertical limit stops which prevent spring extension when weight is removed. Provide vertical stops for machinery containing liquid, such as water chillers, evaporative coolers, boilers, and cooling towers. Spring isolated or protected spring isolated machinery must rock and move freely within limits of stops or seismic restraint devices.

3.1.4 Thrust Restraints

Where required, provide pairs of thrust restraints, symmetrically installed on both sides of the steady state line of thrust.

3.1.5 Flexible Pipe and Duct Connectors

Install flexible connectors in accordance with the manufacturer's instructions. When liquid pulsation dampening is required, flexible connectors with spherical configuration may be used. [Provide restraints for pipe connectors at pumps to prevent connector failure upon pump startup.]

[3.1.6 Seismic Snubbers

Provide snubbers as close as possible to each vibration isolator as indicated. After installing and leveling of the machinery, adjust snubbers in accordance with the snubber manufacturer's instructions.

]3.1.7 Machinery

****

NOTE: When maximum and minimum limits of equipment size, weight, etc., are critical to the buildings' structural design, these limits shall be indicated or specified.

****

Provide vibration isolators, flexible connectors [and seismic snubbers] in accordance with manufacturer's recommendations. Machinery with spring isolators or protected spring isolators shall rock or move freely within limits of stops or seismic snubber restraints.

3.1.7.1 Stability

Isolators shall be stable during starting and stopping of machinery without traverse and eccentric movement of machinery that would damage or

adversely affect the machinery or attachments.

3.1.7.2 Lateral Motion

The installed vibration isolation system for each piece of floor or ceiling mounted machinery shall have a maximum lateral motion under machinery start up and shut down conditions of not more than 6 mm 1/4 inch. Restrain motions in excess by approved spring mountings.

3.1.7.3 Unbalanced Machinery

Provide foundation suspension systems specifically designed to resist horizontal forces for machinery with large unbalanced horizontal forces. Vibration isolator systems shall conform to the machinery manufacturer's recommendations.

3.1.7.4 Nonrotating Machinery

Mount nonrotating machinery in systems which includes rotating or vibrating machinery on isolators having the same deflection as the hangers and supports for the pipe connected to.

3.1.7.5 Unitized Machinery Assemblies

****
NOTE: The following table serves only as a guideline. Delete items that are not applicable.
****

TABLE 3A						
Vibration Isolator Types and Minimum Static Deflection						
(MSD, mm) for 100-200 mm slab on grade and column supported.						
Column Spacing	Slab on earth and 0-9 meter		9.1-12 meters		12.1-15 meters	
Equipment	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))
Absorption Refrigeratio Machines	SV-R	25.40	SV-R	44.45	SV-R	69.85
Centrifugal Chillers or Heat Pumps						
Hermetic Type	SV-B	44.45	SV-B	63.50	SV-B	88.90

TABLE 3A						
Vibration Isolator Types and Minimum Static Deflection						
(MSD, mm) for 100-200 mm slab on grade and column supported.						
Column Spacing	Slab on earth and 0-9 meter		9.1-12 meters		12.1-15 meters	
Equipment	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))
Open Type	SV-1	44.45	SV-I	63.50	SV-I	88.90
Reciprocating Air or Refrigeration Compressors						
500 to 750 rpm	S-R	44.45	S-R	63.50	S-R	88.90
751 rpm and up	S-R	38.10	S-R	63.50	S-R	88.90
Reciprocating Chillers or Heat Pumps						
500 to 750 rpm	SV-R	44.45	SV-R	63.50	SV-R	88.90
751 rpm and up	SV-R	38.10	SV-R	63.50	SV-R	88.90
Packaged Boilers	SV	25.40	SV	63.50	SV-R	88.90
Closed Coupled Pumps						
Up to 5 1/2 kW	S-I	25.40	S-I	25.40	S-I	25.40
Over 5 1/2 kW	S-I	38.10	S-I	63.50	S-I	63.50
Base Mounted Pumps						
Up to 15 kW	S-I	38.10	S-I	63.50	S-I	63.50
15 to 56 kW	S-I	38.10	S-I	63.50	S-I	88.90
Over 56 kW	S-I	63.50	S-I	88.90	S-I	88.90

TABLE 3A						
Vibration Isolator Types and Minimum Static Deflection						
(MSD, mm) for 100-200 mm slab on grade and column supported.						
Column Spacing	Slab on earth and 0-9 meter		9.1-12 meters		12.1-15 meters	
Equipment	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))
Cooling Towers and Evaporative Condensers		SV with deflections specified for centrifugal blowers when springs are supported on beams. Use deflection listed for column supported floors with up to 9 meters column spacing when springs are located on columns or bearing walls.				
Factory Assembled Air Handling Equipment AH, AC and HV Units (Note (2))						
Suspended Units						
Up to 3 3/4 kW	H	25.40	H	25.40	H	25.40
Over 3 3/4 kW						
Up to 400 rpm	H	44.45	H	44.45	H	44.45
Over 401 rpm	H	25.40	H	38.10	H	63.50
Floor Mounted Units						
Up to 3 3/4 kW	S	25.40	S	25.40	S	25.40
Over 3 3/4 kW						
Up to 400 rpm	S-R	44.45	S-R	44.45	S-R	63.50
Over 401 rpm	S-R	25.40	S-R	38.10	S-R	63.50
Centrifugal Blowers						
175 - 224 rpm	S-B	120.65	S-B	120.65	S-B	120.65
225 - 299 rpm	S-B	95.25	S-B	120.65	S-B	120.65

TABLE 3A						
Vibration Isolator Types and Minimum Static Deflection						
(MSD, mm) for 100-200 mm slab on grade and column supported.						
Column Spacing	Slab on earth and 0-9 meter		9.1-12 meters		12.1-15 meters	
Equipment	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))
300 - 374 rpm	S-B	69.85	S-B	114.30	S-B	120.65
375 - 499 rpm	S-B	63.50	S-B	88.90	S-B	114.30
Over 500 rpm	S-B	44.45	S-B	63.50	S-B	88.90
Tubular Centrifugal and Axial Fans (Note (2))						
Suspended		H with deflection specified for centrifugal blowers				
Floor Mounted Arrangements 1 & 9		S-B with deflections specified for centrifugal blowers				
Utility Fans (Note (2))						
Suspended		H with deflections specified for centrifugal blowers but not to exceed 69.85 mm				
Floor-Mounted		S-R with deflections not specified for centrifugal blowers but not to exceed 69.85 mm				
High Pressure Fans (Over 1494 Pa Static Pressure) and Other Machineries Producing Thrust (Note (2))		HR recommended for minimizing undesirable thrust effects				
Internal Combustion Engines and Engine Driven Equip						
750 rpm and over	S	38.10	S	63.50	S	88.90
Dimmer Banks and Transformers						
Up to 454 kg	NM	8.89	NM	8.89	NM	88.90
Over 454 kg	SV	25.40	SV	25.40	SV	25.40

TABLE 3A						
Vibration Isolator Types and Minimum Static Deflection						
(MSD, mm) for 100-200 mm slab on grade and column supported.						
Column Spacing	Slab on earth and 0-9 meter		9.1-12 meters		12.1-15 meters	
Equipment	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))

NOTES:

(1) Equipment Vibration Isolation Schedule Designations (Hyphenated designations are combinations of the following:)

B - Welded structural steel bases.

H - Spring isolators (suspended equipment and piping). Where required, provide with adjustable preloading devices.

HR - Thrust restraints

I - Concrete inertia bases with steel forms.

NM - Neoprene mounts.

NP - Neoprene pads.

R - Structural steel rail for equipment mounts.

S - Freestanding spring isolators (floor-mounted equipment).

SV - Freestanding spring isolators (floor-mounted equipment).

SX - Freestanding spring isolators with adjustable cushioned vertical stops and cushioned horizontal stops (floor-mounted equipment. Protected spring isolators SX may be substituted wherever S or SV is specified and shall meet all requirements.

(2) Fans

a. When fan motors are 56 kW or larger, use the deflection requirements for the next wider column spacing. Except for building slab on grade a minimum of 63.50 mm should be used unless larger deflections are specified in the centrifugal blower table.

b. Provide sway brace isolators for tubular centrifugal and axial fans when the fan pressure exceeds 996 Pa.

c. Provide inertia bases for all fans in lieu of structural steel bases or rails specified above when the fan pressure exceeds 996 Pa.

TABLE 3A						
Vibration Isolator Types and Minimum Static Deflection						
(MSD, mm) for 100-200 mm slab on grade and column supported.						
Column Spacing	Slab on earth and 0-9 meter		9.1-12 meters		12.1-15 meters	
Equipment	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))
d. With attaching brackets, suspension spring isolators bridge between the structure and the thrust-producing machinery such as high-pressure fan. Both types H and HR normally provide reaction in tension, while types S, SV, and SX normally provide reaction in compression. Thrust restraints are low-cost and effective components available from manufacturers. Use thrust restraints to eliminate the need for or reduce the magnitude of inertia mass when the mass is only used to reduce the displacement effects of the thrust.						

TABLE 3A						
Vibration Isolator Types and Minimum Static Deflection						
(MSD, inches) for 4-8 inch slab on grade and column supported.						
Column Spacing	Slab on earth and 0-30 feet		31-40 feet		41-50 feet	
Equipment	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))
Absorption Refrigeration Machines	SV-R	1.0	SV-R	1.75	SV-R	2.75
Centrifugal Chillers or Heat Pumps						
Hermetic Type	SV-B	1.75	SV-B	2.5	SV-B	3.5
Open Type	SV-1	1.75	SV-I	2.5	SV-I	3.5

TABLE 3A						
Vibration Isolator Types and Minimum Static Deflection						
(MSD, inches) for 4-8 inch slab on grade and column supported.						
Column Spacing	Slab on earth and 0-30 feet		31-40 feet		41-50 feet	
Equipment	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))
Reciprocating Air or Refrigeration Compressors						
500 to 750 rpm	S-R	1.75	S-R	2.5	S-R	3.5
751 rpm and up	S-R	1.5	S-R	2.5	S-R	3.5
Reciprocating Chillers or Heat Pumps						
500 to 750 rpm	SV-R	1.75	SV-R	2.5	SV-R	3.5
751 rpm and up	SV-R	1.5	SV-R	2.5	SV-R	3.5
Packaged Boilers	SV	1.0	SV	2.5	SV-R	3.5
Closed Coupled Pumps						
Up to 7-1/2 hp	S-I	1.0	S-I	1.0	S-I	1.0
Over 7-1/2 hp	S-I	1.5	S-I	2.5	S-I	2.5
Base Mounted Pumps						
Up to 20 hp	S-I	1.5	S-I	2.5	S-I	2.5
20 to 75 hp	S-I	1.5	S-I	2.5	S-I	3.5
Over 75 hp	S-I	2.5	S-I	3.5	S-I	3.5

TABLE 3A						
Vibration Isolator Types and Minimum Static Deflection						
(MSD, inches) for 4-8 inch slab on grade and column supported.						
Column Spacing	Slab on earth and 0-30 feet		31-40 feet		41-50 feet	
Equipment	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))
Cooling Towers and Evaporative Condensers	SV with deflections specified for centrifugal blowers when springs are supported on beams. Use selection listed for column supported floors with up to 30 foot column spacing when springs are located on columns or bearing walls.					
Factory Assembled Air Handling Equipment AH, AC and HV Units (Note (2))						
Suspended Units						
Up to 5 hp	H	1.0	H	1.0	H	1.0
Over 5 hp						
Up to 400 rpm	H	1.75	H	1.75	H	1.75
Over 401 rpm	H	1.0	H	1.5	H	2.5
Floor Mounted Units						
Up to 5 hp	S	1.0	S	1.0	S	1.0
Over 5 hp						
Up to 400 rpm	S-R	1.75	S-R	1.75	S-R	2.5
Over 401 rpm	S-R	1.0	S-R	1.5	S-R	2.5
Centrifugal Blowers						
175 - 224 rpm	S-B	4.75	S-B	4.75	S-B	4.75
225 - 299 rpm	S-B	3.75	S-B	4.75	S-B	4.75

TABLE 3A						
Vibration Isolator Types and Minimum Static Deflection						
(MSD, inches) for 4-8 inch slab on grade and column supported.						
Column Spacing	Slab on earth and 0-30 feet		31-40 feet		41-50 feet	
Equipment	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))
300 - 374 rpm	S-B	2.75	S-B	4.5	S-B	4.75
375 - 499 rpm	S-B	2.5	S-B	3.5	S-B	4.5
Over 500 rpm	S-B	1.75	S-B	2.5	S-B	3.5
Tubular Centrifugal and Axial Fans (Note (2))						
Suspended	H with deflection specified for centrifugal blowers					
Floor Mounted Arrangements 1 & 9	S-B with deflections specified for centrifugal blowers					
Utility Fans (Note (2))						
Suspended	H with deflections specified for centrifugal blowers but not to exceed 2.75 inches					
Floor-Mounted	S-R with deflections not specified for centrifugal blowers but not to exceed 2.75 inches					
High Pressure Fans (6 Inch Water-Column Static Pressure) and Other Machineries Producing Thrust (Note (2))	HR recommended for minimizing undesirable thrust effects					
Internal Combustion Engines and Engine Driven Equip						
750 rpm and over	S	1.5	S	2.5	S	3.5
Dimmer Banks and Transformers						
Up to 1000 lbs.	NM	0.35	NM	0.35	NM	3.5
Over 1000 lbs.	SV	1.0	SV	1.0	SV	1.0

TABLE 3A						
Vibration Isolator Types and Minimum Static Deflection						
(MSD, inches) for 4-8 inch slab on grade and column supported.						
Column Spacing	Slab on earth and 0-30 feet		31-40 feet		41-50 feet	
Equipment	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))

NOTES:

(1) Equipment Vibration Isolation Schedule Designations (Hyphenated designations are combinations of the following:)

B - Welded structural steel bases.

H - Spring isolators (suspended equipment and piping). Where required, provide with adjustable preloading devices.

HR - Thrust restraints

I - Concrete inertia bases with steel forms.

NM - Neoprene mounts.

NP - Neoprene pads.

R - Structural steel rail for equipment mounts.

S - Freestanding spring isolators (floor-mounted equipment).

SV - Freestanding spring isolators (floor-mounted equipment).

SX - Freestanding spring isolators with adjustable cushioned vertical stops and cushioned horizontal stops (floor-mounted equipment. Protected spring isolators SX may be substituted wherever S or SV is specified and shall meet all requirements.

(2) Fans

a. When fan motors are 75 hp or larger, use the deflection requirements for the next wider column spacing. Except for building slab on grade a minimum of 2.5 inches should be used unless larger deflections are specified in the centrifugal blower table.

b. Provide sway brace isolators for tubular centrifugal and axial fans when the fan pressure exceeds 4 inches water column.

c. Provide inertia bases for all fans in lieu of structural steel bases or rails specified above when the fan pressure exceeds 4 inches water column.

TABLE 3A						
Vibration Isolator Types and Minimum Static Deflection						
(MSD, inches) for 4-8 inch slab on grade and column supported.						
Column Spacing	Slab on earth and 0-30 feet		31-40 feet		41-50 feet	
Equipment	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))
d. With attaching brackets, suspension spring isolators bridge between the structure and the thrust-producing machinery such as high-pressure fan. Both types H and HR normally provide reaction in tension, while types S, SV, and SX normally provide reaction in compression. Thrust restraints are low-cost and effective components available from manufacturers. Use thrust restraints to eliminate the need for or reduce the magnitude of inertia mass when the mass is only used to reduce the displacement effects of the thrust.						

Unitized assemblies such as chillers with evaporator and condenser, and top mounted centrifugal compressor or unitized absorption refrigeration machines, structurally designed with end supports, may be mounted on steel rails and springs in lieu of steel bases and springs. Where the slab or deck is less than 100 mm 4 inches thick, provide spring isolation units with the deflection double that of the vibration isolation schedule, up to a maximum static deflection of 127 mm 5 inches.

3.1.7.6 Roof and Upper Floor Mounted Machinery

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NOTE: The following table serves only as a guideline. Delete items that are not applicable.

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TABLE 3A						
Vibration Isolator Types and Minimum Static Deflection						
(MSD, mm) for 100-200 mm slab on grade and column supported.						
Column Spacing	Slab on earth and 0-9 meter		9.1-12 meters		12.1-15 meters	
Equipment	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))
Absorption Refrigeration Machines	SV-R	25.40	SV-R	44.45	SV-R	69.85
Centrifugal Chillers or Heat Pumps						
Hermetic Type	SV-B	44.45	SV-B	63.50	SV-B	88.90
Open Type	SV-1	44.45	SV-I	63.50	SV-I	88.90
Reciprocating Air or Refrigeration Compressors						
500 to 750 rpm	S-R	44.45	S-R	63.50	S-R	88.90
751 rpm and up	S-R	38.10	S-R	63.50	S-R	88.90
Reciprocating Chillers or Heat Pumps						
500 to 750 rpm	SV-R	44.45	SV-R	63.50	SV-R	88.90
751 rpm and up	SV-R	38.10	SV-R	63.50	SV-R	88.90
Packaged Boilers	SV	25.40	SV	63.50	SV-R	88.90
Closed Coupled Pumps						
Up to 5 1/2 kW	S-I	25.40	S-I	25.40	S-I	25.40
Over 5 1/2 kW	S-I	38.10	S-I	63.50	S-I	63.50
Base Mounted Pumps						

TABLE 3A						
Vibration Isolator Types and Minimum Static Deflection						
(MSD, mm) for 100-200 mm slab on grade and column supported.						
Column Spacing	Slab on earth and 0-9 meter		9.1-12 meters		12.1-15 meters	
Equipment	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))
Up to 15 kW	S-I	38.10	S-I	63.50	S-I	63.50
15 to 56 kW	S-I	38.10	S-I	63.50	S-I	88.90
Over 56 kW	S-I	63.50	S-I	88.90	S-I	88.90
Cooling Towers and Evaporative Condensers		SV with deflections specified for centrifugal blowers when springs are supported on beams. Use deflection listed for column supported floors with up to 9 meters column spacing when springs are located on columns or bearing walls.				
Factory Assembled Air Handling Equipment AH, AC and HV Units (Note (2))						
Suspended Units						
Up to 3 3/4 kW	H	25.40	H	25.40	H	25.40
Over 3 3/4 kW						
Up to 400 rpm	H	44.45	H	44.45	H	44.45
Over 401 rpm	H	25.40	H	38.10	H	63.50
Floor Mounted Units						
Up to 3 3/4 kW	S	25.40	S	25.40	S	25.40
Over 3 3/4 kW						
Up to 400 rpm	S-R	44.45	S-R	44.45	S-R	63.50
Over 401 rpm	S-R	25.40	S-R	38.10	S-R	63.50

TABLE 3A						
Vibration Isolator Types and Minimum Static Deflection						
(MSD, mm) for 100-200 mm slab on grade and column supported.						
Column Spacing	Slab on earth and 0-9 meter		9.1-12 meters		12.1-15 meters	
Equipment	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))
Centrifugal Blowers						
175 - 224 rpm	S-B	120.65	S-B	120.65	S-B	120.65
225 - 299 rpm	S-B	95.25	S-B	120.65	S-B	120.65
300 - 374 rpm	S-B	69.85	S-B	114.30	S-B	120.65
375 - 499 rpm	S-B	63.50	S-B	88.90	S-B	114.30
Over 500 rpm	S-B	44.45	S-B	63.50	S-B	88.90
Tubular Centrifugal and Axial Fans (Note (2))						
Suspended		H with deflection specified for centrifugal blowers				
Floor Mounted Arrangements 1 & 9		S-B with deflections specified for centrifugal blowers				
Utility Fans (Note (2))						
Suspended		H with deflections specified for centrifugal blowers but not to exceed 69.85 mm				
Floor-Mounted		S-R with deflections not specified for centrifugal blowers but not to exceed 69.85 mm				
High Pressure Fans (Over 1494 Pa Static Pressure) and Other Machineries Producing Thrust (Note (2))		HR recommended for minimizing undesirable thrust effects				
Internal Combustion Engines and Engine Driven Equip						
750 rpm and over	S	38.10	S	63.50	S	88.90

TABLE 3A						
Vibration Isolator Types and Minimum Static Deflection						
(MSD, mm) for 100-200 mm slab on grade and column supported.						
Column Spacing	Slab on earth and 0-9 meter		9.1-12 meters		12.1-15 meters	
Equipment	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))
Dimmer Banks and Transformers						
Up to 454 kg	NM	8.89	NM	8.89	NM	88.90
Over 454 kg	SV	25.40	SV	25.40	SV	25.40
NOTES:						
(1) Equipment Vibration Isolation Schedule Designations (Hyphenated designations are combinations of the following:)						
B - Welded structural steel bases.						
H - Spring isolators (suspended equipment and piping). Where required, provide with adjustable preloading devices.						
HR - Thrust restraints						
I - Concrete inertia bases with steel forms.						
NM - Neoprene mounts.						
NP - Neoprene pads.						
R - Structural steel rail for equipment mounts.						
S - Freestanding spring isolators (floor-mounted equipment).						
SV - Freestanding spring isolators (floor-mounted equipment).						
SX - Freestanding spring isolators with adjustable cushioned vertical stops and cushioned horizontal stops (floor-mounted equipment. Protected spring isolators SX may be substituted wherever S or SV is specified and shall meet all requirements.						
(2) Fans						
a. When fan motors are 56 kW or larger, use the deflection requirements for the next wider column spacing. Except for building slab on grade a minimum of 63.50 mm should be used unless larger deflections are specified in the centrifugal blower table.						

TABLE 3A						
Vibration Isolator Types and Minimum Static Deflection						
(MSD, mm) for 100-200 mm slab on grade and column supported.						
Column Spacing	Slab on earth and 0-9 meter		9.1-12 meters		12.1-15 meters	
Equipment	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))
b. Provide sway brace isolators for tubular centrifugal and axial fans when the fan pressure exceeds 996 Pa.						
c. Provide inertia bases for all fans in lieu of structural steel bases or rails specified above when the fan pressure exceeds 996 Pa.						
d. With attaching brackets, suspension spring isolators bridge between the structure and the thrust-producing machinery such as high-pressure fan. Both types H and HR normally provide reaction in tension, while types S, SV, and SX normally provide reaction in compression. Thrust restraints are low-cost and effective components available from manufacturers. Use thrust restraints to eliminate the need for or reduce the magnitude of inertia mass when the mass is only used to reduce the displacement effects of the thrust.						

TABLE 3A						
Vibration Isolator Types and Minimum Static Deflection						
(MSD, inches) for 4-8 inch slab on grade and column supported.						
Column Spacing	Slab on earth and 0-30 feet		31-40 feet		41-50 feet	
Equipment	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))
Absorption Refrigeratic Machines	SV-R	1.0	SV-R	1.75	SV-R	2.75
Centrifugal Chillers or Heat Pumps						
Hermetic Type	SV-B	1.75	SV-B	2.5	SV-B	3.5

TABLE 3A						
Vibration Isolator Types and Minimum Static Deflection						
(MSD, inches) for 4-8 inch slab on grade and column supported.						
Column Spacing	Slab on earth and 0-30 feet		31-40 feet		41-50 feet	
Equipment	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))
Open Type	SV-1	1.75	SV-I	2.5	SV-I	3.5
Reciprocating Air or Refrigeration Compressors						
500 to 750 rpm	S-R	1.75	S-R	2.5	S-R	3.5
751 rpm and up	S-R	1.5	S-R	2.5	S-R	3.5
Reciprocating Chillers or Heat Pumps						
500 to 750 rpm	SV-R	1.75	SV-R	2.5	SV-R	3.5
751 rpm and up	SV-R	1.5	SV-R	2.5	SV-R	3.5
Packaged Boilers	SV	1.0	SV	2.5	SV-R	3.5
Closed Coupled Pumps						
Up to 7-1/2 hp	S-I	1.0	S-I	1.0	S-I	1.0
Over 7-1/2 hp	S-I	1.5	S-I	2.5	S-I	2.5
Base Mounted Pumps						
Up to 20 hp	S-I	1.5	S-I	2.5	S-I	2.5
20 to 75 hp	S-I	1.5	S-I	2.5	S-I	3.5
Over 75 hp	S-I	2.5	S-I	3.5	S-I	3.5

TABLE 3A						
Vibration Isolator Types and Minimum Static Deflection						
(MSD, inches) for 4-8 inch slab on grade and column supported.						
Column Spacing	Slab on earth and 0-30 feet		31-40 feet		41-50 feet	
Equipment	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))
Cooling Towers and Evaporative Condensers		SV with deflections specified for centrifugal blowers when springs are supported on beams. Use selection listed for column supported floors with up to 30 foot column spacing when springs are located on columns or bearing walls.				
Factory Assembled Air Handling Equipment AH, AC and HV Units (Note (2))						
Suspended Units						
Up to 5 hp	H	1.0	H	1.0	H	1.0
Over 5 hp						
Up to 400 rpm	H	1.75	H	1.75	H	1.75
Over 401 rpm	H	1.0	H	1.5	H	2.5
Floor Mounted Units						
Up to 5 hp	S	1.0	S	1.0	S	1.0
Over 5 hp						
Up to 400 rpm	S-R	1.75	S-R	1.75	S-R	2.5
Over 401 rpm	S-R	1.0	S-R	1.5	S-R	2.5
Centrifugal Blowers						
175 - 224 rpm	S-B	4.75	S-B	4.75	S-B	4.75
225 - 299 rpm	S-B	3.75	S-B	4.75	S-B	4.75

TABLE 3A						
Vibration Isolator Types and Minimum Static Deflection						
(MSD, inches) for 4-8 inch slab on grade and column supported.						
Column Spacing	Slab on earth and 0-30 feet		31-40 feet		41-50 feet	
Equipment	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))
300 - 374 rpm	S-B	2.75	S-B	4.5	S-B	4.75
375 - 499 rpm	S-B	2.5	S-B	3.5	S-B	4.5
Over 500 rpm	S-B	1.75	S-B	2.5	S-B	3.5
Tubular Centrifugal and Axial Fans (Note (2))						
Suspended		H with deflection specified for centrifugal blowers				
Floor Mounted Arrangements 1 & 9		S-B with deflections specified for centrifugal blowers				
Utility Fans (Note (2))						
Suspended		H with deflections specified for centrifugal blowers but not to exceed 2.75 inches				
Floor-Mounted		S-R with deflections not specified for centrifugal blowers but not to exceed 2.75 inches				
High Pressure Fans (6 Inch Water-Column Static Pressure) and Other Machineries Producing Thrust (Note (2))		HR recommended for minimizing undesirable thrust effects				
Internal Combustion Engines and Engine Driven Equip						
750 rpm and over	S	1.5	S	2.5	S	3.5
Dimmer Banks and Transformers						
Up to 1000 lbs.	NM	0.35	NM	0.35	NM	3.5
Over 1000 lbs.	SV	1.0	SV	1.0	SV	1.0

TABLE 3A						
Vibration Isolator Types and Minimum Static Deflection						
(MSD, inches) for 4-8 inch slab on grade and column supported.						
Column Spacing	Slab on earth and 0-30 feet		31-40 feet		41-50 feet	
Equipment	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))

NOTES:

(1) Equipment Vibration Isolation Schedule Designations (Hyphenated designations are combinations of the following:)

B - Welded structural steel bases.

H - Spring isolators (suspended equipment and piping). Where required, provide with adjustable preloading devices.

HR - Thrust restraints

I - Concrete inertia bases with steel forms.

NM - Neoprene mounts.

NP - Neoprene pads.

R - Structural steel rail for equipment mounts.

S - Freestanding spring isolators (floor-mounted equipment).

SV - Freestanding spring isolators (floor-mounted equipment).

SX - Freestanding spring isolators with adjustable cushioned vertical stops and cushioned horizontal stops (floor-mounted equipment. Protected spring isolators SX may be substituted wherever S or SV is specified and shall meet all requirements.

(2) Fans

a. When fan motors are 75 hp or larger, use the deflection requirements for the next wider column spacing. Except for building slab on grade a minimum of 2.5 inches should be used unless larger deflections are specified in the centrifugal blower table.

b. Provide sway brace isolators for tubular centrifugal and axial fans when the fan pressure exceeds 4 inches water column.

c. Provide inertia bases for all fans in lieu of structural steel bases or rails specified above when the fan pressure exceeds 4 inches water column.

TABLE 3A						
Vibration Isolator Types and Minimum Static Deflection						
(MSD, inches) for 4-8 inch slab on grade and column supported.						
Column Spacing	Slab on earth and 0-30 feet		31-40 feet		41-50 feet	
Equipment	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))	Type (Note (1))	MSD (Note (1))
d. With attaching brackets, suspension spring isolators bridge between the structure and the thrust-producing machinery such as high-pressure fan. Both types H and HR normally provide reaction in tension, while types S, SV, and SX normally provide reaction in compression. Thrust restraints are low-cost and effective components available from manufacturers. Use thrust restraints to eliminate the need for or reduce the magnitude of inertia mass when the mass is only used to reduce the displacement effects of the thrust.						

TABLE 1B		
Class II Vibration Isolator Types and Minimum Static Deflection		
(MSD, mm) for basements below grade and floor slabs on earth		
Equipment	Type (Note (1))	MSD
Absorption Refrigeration Machines	NP	6.35
	NM	8.89
Centrifugal Chillers or Heat Pumps		
Hermetic Type	NP	6.35
	NM	8.89
Open Type	NM-I	8.89
Reciprocating Air or Refrigeration Compressors		
500 to 750 rpm	S	25.40
751 rpm and up	S	25.40
Reciprocating Chillers or Heat Pumps		
500 to 750 rpm	SV	25.40
751 rpm and up	SV	25.40
Packaged Boilers	NP	6.35
	NM	8.89
Pumps		
Closed Coupled	NP	6.35

TABLE 1B		
Class II Vibration Isolator Types and Minimum Static Deflection		
(MSD, mm) for basements below grade and floor slabs on earth		
Equipment	Type (Note (1))	MSD
Up to 5 1/2 kW	NM	8.89
Over 5 1/2 kW	S-I	25.40
Base Mounted		
Up to 15 kW	S-I	25.40
15 to 56 kW	S-I	25.40
Over 56 kW	S-I	25.40
Cooling Towers and Evaporative Condensers	NP	6.35
	NM	8.89
Factory Assembled Air Handling Equipment AH, AC and HV Units (Note (2))		
Suspended Units		
Up to 3 3/4 kW	H	25.40
Over 3 3/4 kW		
Up to 400 rpm	H	44.45
Over 401 rpm	H	25.40
Floor Mounted Units		
Up to 3 3/4 kW	NP	6.35
	NM	8.89
Over 3 3/4 kW		
Up to 400 rpm	NM	8.89
Over 401 rpm	NM	8.89
Centrifugal Blowers		
175 - 224 rpm	NM-B	8.89
225 - 299 rpm	NM-B	8.89
300 - 374 rpm	NM-B	8.89
375 - 499 rpm	NM-B	8.89
Over 500 rpm	NM-B	8.89
Tubular Centrifugal and Axial Fans (Note (2))		
Suspended	H with deflections specified for centrifugal blowers	
Floor Mounted Arrangements 1 & 9	NM	8.89
Utility Fans (Note (2))		

TABLE 1B		
Class II Vibration Isolator Types and Minimum Static Deflection		
(MSD, mm) for basements below grade and floor slabs on earth		
Equipment	Type (Note (1))	MSD
Suspended and centrifugal	H with deflections specified for	
Floor-Mounted	NM	8.89
High Pressure Fans (Over 1494 Pa Static Pressure) and Other Machineries Producing Thrust (Note (2))		HR recommended for minimizing undesirable thrust effects
Internal Combustion Engines and Engine Driven Equip		
750 rpm and over	S	25.40
Dimmer Banks and Transformers		
Up to 454 kg	NP	6.35
	NM	8.89
Over 454 kg	SV	25.40
NOTES: Note (1) and Note (2) are same as for TABLE 3A.		

TABLE 3B		
Class II Vibration Isolator Types and Minimum Static Deflection		
(MSD, inches) for basements below grade and floor slabs on earth		
Equipment	Type (Note (1))	MSD
Absorption Refrigeration Machines	NP	0.25
	NM	0.35
Centrifugal Chillers or Heat Pumps		
Hermetic Type	NP	0.25
	NM	0.35
Open Type	NM-I	0.35
Reciprocating Air or Refrigeration Compressors		
500 to 750 rpm	S	1.0
751 rpm and up	S	1.0
Reciprocating Chillers or Heat Pumps		
500 to 750 rpm	SV	1.0
751 rpm and up	SV	1.0

TABLE 3B		
Class II Vibration Isolator Types and Minimum Static Deflection		
(MSD, inches) for basements below grade and floor slabs on earth		
Equipment	Type (Note (1))	MSD
Packaged Boilers	NP	0.25
	NM	0.35
Pumps		
Closed Coupled	NP	0.25
Up to 7 1/2 hp	NM	0.35
Over 7 1/2 hp	S-I	1.0
Base Mounted		
Up to 20 hp	S-I	1.0
20 to 75 hp	S-I	1.0
Over 75 hp	S-I	1.0
Cooling Towers and Evaporative Condensers	NP	0.25
	NM	0.35
Factory Assembled Air Handling Equipment AH, AC and HV Units (Note (2))		
Suspended Units		
Up to 5 hp	H	1.0
Over 5 hp		
Up to 400 rpm	H	1.75
Over 401 rpm	H	1.0
Floor Mounted Units		
Up to 5 hp	NP	0.25
	NM	0.35
Over 5 hp		
Up to 400 rpm	NM	0.35
Over 401 rpm	NM	0.35
Centrifugal Blowers		
175 - 224 rpm	NM-B	0.35
225 - 299 rpm	NM-B	0.35
300 - 374 rpm	NM-B	0.35
375 - 499 rpm	NM-B	0.35
Over 500 rpm	NM-B	0.35
Tubular Centrifugal and Axial Fans (Note (2))		

TABLE 3B		
Class II Vibration Isolator Types and Minimum Static Deflection		
(MSD, inches) for basements below grade and floor slabs on earth		
Equipment	Type (Note (1))	MSD
Suspended	H with deflections specified for centrifugal blowers	
Floor Mounted Arrangements 1 & 9	NM	0.35
Utility Fans (Note (2))		
Suspended and centrifugal	H with deflections specified for	
Floor-Mounted	NM	0.35
High Pressure Fans (Over 6 Inch Water-Column Static Pressure) and Other Machineries Producing Thrust (Note (2))		HR recommended for minimizing undesirable thrust effects
Internal Combustion Engines and Engine Driven Equip		
750 rpm and over	S	1.0
Dimmer Banks and Transformers		
Up to 1000 lbs.	NP	0.25
	NM	0.35
Over 1000 lbs.	SV	1.0
NOTES: Note (1) and Note (2) are same as for TABLE 3A.		

On the roof or upper floors, mount machinery on isolators with vertical stops. Rest isolators on beams or structures designed and installed in accordance with the SMACNA 1793, Plate 61.

3.1.8 [Piping] [and] [High Pressure Ductwork]

Provide vibration isolation for [piping] [and] [high pressure ductwork with over 1494 Pa 6 inches water column]. The isolator deflections shall be equal to or greater than the static deflection of the vibration isolators provided for the connected machinery as follows:

[3.1.8.1 High Pressure Ductwork

For a distance of 15 meters 50 feet from fans, exhausters and blowers.

]3.1.8.2 Piping Connected to Vibration Isolated Machinery

For a distance of 15 meters 50 feet or 50 pipe diameters, whichever is greater.

3.1.8.3 Steam Pressure Reducing Valves

Connected piping for a distance of 15 meters 50 feet or 50 pipe diameters, whichever is greater.

3.1.8.4 Condenser Water

For the full length of the piping.

3.1.8.5 Chilled, Hot, and Dual Temperature Piping

For risers from pumps and for the first 6 meters 20 feet of the branch connection of the main supply and return piping at each floor.

3.1.9 Water and Steam Distribution Piping Application

Resiliently support piping with combination spring and neoprene isolation hangers. Provide spring elements with 16 mm 5/8 inch static deflection; install the hanger with spacing so that the first harmonic natural frequency is not less than 360 Hz. Provide double-deflection neoprene elements. For the first two isolation hangers from the rotating equipment of 90 mm 3 1/2 inch and smaller piping systems, ensure a deflection equal to the equipment-isolation static deflection. For the first four piping isolation hanger supports from rotating equipment of 100 mm 4 inch and larger piping systems, use resilient hanger-rod isolators at a fixed elevation regardless of load changes. Incorporate an adjustable preloading device to transfer the load to the spring element within the hanger mounting after the piping system has been filled with water.

3.1.10 Pipe Hanger and Support Installation

3.1.10.1 Pipe Hangers

Provide eye-bolts or swivel joints for pipe hangers to permit pipe thermal or mechanical movement without angular misalignment of hanger vibration isolator.

3.1.10.2 High Temperatures

Where neoprene elements of vibration isolator may be subjected to high pipe temperatures, above 71 degrees C 160 degrees F, provide metal heat shields or thermal isolators.

3.1.10.3 Valves

Provide vibration isolation hangers and supports at modulating, pressure reducing, or control valves which will induce fluid pulsations. When required or indicated, isolate valves with flexible connectors.

3.1.10.4 Machinery Without Flexible Connections

When piping is not connected to vibrating machinery with flexible connectors, provide the first four hangers with isolation elements designed for deflections equal to equipment vibration isolator deflections (including static, operating, and start-up).

3.1.10.5 300 Millimeters Twelve Inch and Larger Pipe

Suspend 300 mm 12 inch and larger pipe vibration hangers from resilient hanger rod isolators. Resilient hanger rod isolators shall be capable of supporting pipe during installation at a fixed elevation regardless of load changes. Provide an adjustable preloading device to transfer the load to isolation element after operational load is applied. Provide 300 mm 12 inch and larger pipe supports with unrestrained stable springs for 25 mm one inch deflection and with built-in leveling device and resilient vertical limit stops to prevent spring elongation when partial load is removed. Provide isolators capable of providing rigid anchoring during erection of piping so that it can be erected at a fixed elevation.

3.1.10.6 Pipe Risers

Provide pipe riser supports with bearing plates and two layers of 6 mm 1/4 inch thick ribbed or waffled neoprene pad loaded to not more than 345 kPa 50 psi. Separate isolation pads with 6 mm 1/4 inch steel plate. Weld pipe riser clamps at anchor points to the pipe and to pairs of vertical acoustical pipe anchor mountings which shall be rigidly fastened to the steel framing.

3.1.10.7 Supports at Base of Pipe Risers

Piping isolation supports at the base of risers shall be two layers of 13 mm 1/2 inch thick heavy-duty neoprene pad separated by 6 mm 1/4 inch thick steel plate. Use bearing plates sized to provide a pad loading of not more than 3447 kPa 500 psi. Weld the stanchion between the pipe and isolation support to the pipe and weld or bolt to the isolation support. Bolt isolation support to the floor slab with resilient sleeves and washers. Where supplementary steel is required to support piping, provide a maximum deflection of 2 mm 0.08 inches at the mid-span of this steel under the load. Rigidly support piping from the supplementary steel with the supplementary steel isolated from the building structure with isolators.

3.1.10.8 Pipe Anchors

Attach each end of the pipe anchor to an omni-directional pipe isolator which in turn shall be rigidly fastened to the steel framing or structural concrete. Provide a telescoping pipe isolator of two sizes of steel tubing separated by a minimum 13 mm 1/2 inch thick pad of heavy-duty neoprene or heavy-duty neoprene and canvas. Provide vertical restraints by similar material to prevent vertical travel in either direction. The load on the isolation material shall not exceed 3447 kPa 500 psi.

[3.1.11 High Pressure Ductwork Hanger and Support Installation

Provide ductwork with vibration isolation hangers and supports where required or indicated. Connect ductwork to equipment with flexible duct connectors. Segment ductwork with flexible duct connectors.

3.1.11.1 Duct Risers

Provide duct riser supports within shafts with suitable bearing plates and two layers of 6 mm 1/4 inch thick ribbed or waffled neoprene pad loaded to not more than 345 kPa 50 psi. Separate isolation pads with 6 mm 1/4 inch steel plate.

3.1.11.2 Supports at Base of Duct Risers

For duct isolation supports at the base of risers, provide two layers of 13 mm 1/2 inch thick heavy-duty neoprene pad separated by 6 mm 1/4 inch thick steel plate. Use bearing plates sized to provide a pad loading of not more than 3447 kPa 500 psi. Weld the stanchion between the duct and isolation support to the pipe, and weld or bolt to the isolation support. Bolt isolation support to the floor slab with resilient sleeves and washers. Where supplementary steel is required to support ducts, provide a maximum deflection of 6 mm 1/4 inch at the midspan of this steel under the supported load. Rigidly support duct from the supplementary steel and the supplementary steel isolators.

3.1.11.3 Duct Anchors

Attach each end of the duct anchor to an omni-directional isolator which in turn shall be rigidly fastened to the steel framing or structural concrete as indicated. Vertical restraints shall be provided by similar material arranged to prevent vertical travel in either direction. The load on the isolation material shall not exceed 3447 kPa 500 psi.

]3.1.12 Equipment Room Sound Isolation

Do not allow direct contact between pipe or ducts and walls, floor slabs, roofs, ceilings or partitions of equipment rooms.

3.1.12.1 Pipe Penetrations

Provide galvanized Schedule 40 pipe sleeves and tightly pack annular space between sleeves and pipe with insulation having a flame spread rating not more than 25 and a smoke developed rating not more than 50 when tested in accordance with ASTM E84, maximum effective temperature 538 degrees C 1000 degrees F, bulk density 96 kg/cu. meter 6 pounds/cu. ft. minimum. Provide uninsulated pipe with a 25 mm one inch thick mineral fiber sleeve the full length of the penetration and seal each end with an [interior] [or] [exterior and weather resistant] non-hardening compound. Provide sealant and mineral-fiber sleeve of a flame spread rating not more than 25 and a smoke developed rating not more than 50 when tested in accordance with ASTM E84.

3.1.12.2 Duct Penetrations

Pack openings around ducts with mineral fiber insulation the full length of the penetration having a flame spread rating not more than 25 and a smoke developed rating not more than 50 when tested in accordance with ASTM E84. At each end of duct opening provide sealing collars and seal with an [interior] [or] [exterior and weather resistant] non-hardening compound.

3.1.12.3 Ducts Passing Through Equipment Rooms

Provide with sound insulation equal to the sound attenuation value of the wall, floor, or ceiling penetrated.

3.1.13 Machinery Foundations and Subbases

Provide cast in place anchor bolts as recommended by the machinery manufacturer.

3.1.13.1 Machinery Subbases

****
NOTE: Delete this paragraph when the specification of subbases conflicts with contract drawings.
****

Provide concrete subbases at least 102 mm 4 inches high for floor mounted equipment [except elevators]. Rest subbases on structural floor and reinforce with steel rods interconnected with floor reinforcing bars by tie bars hooked at both ends. Provide at least 50 mm 2 inch clearance between subbases and inertia bases, steel bases, and steel saddles with machinery in operation.

3.1.13.2 Common Machinery Foundations

Mount electrical motors on the same foundations as driven machinery. Support piping connections, strainers, valves, and risers on the same foundation as the pumps.

3.1.13.3 Foundation and Subbase Concrete

Cast concrete foundations and subbases of ASTM C94/C94M [20 MPa] [2500 psi] [_____] concrete reinforced with steel bars as indicated or recommended by machinery manufacturer.

3.1.13.4 Anchor Bolts and Grout

Secure machinery to foundations and inertia bases with anchor bolts. Grout equipment with baseplates, the full area under baseplates with premixed non-shrinking grout. After grout has set, remove wedges, shims, and jack bolts and fill spaces with grout.

3.1.14 Inertia Bases

Install inertia bases in accordance with the recommendations of the machinery manufacturer or inertia base manufacturer, as applicable.

[3.1.15 Seismic Restraints for [Piping] [and] [Ductwork]

Provide seismic restraints in accordance with SMACNA 1981.

]3.1.16 Suspended Machinery Platforms

Provide with vibration-isolation hangers.

3.1.17 Electrical Connections

Provide flexible conduit or multiple conductor cable connections for machinery with sufficient extra length to permit [50 mm] [2 inch] [_____] minimum displacement in any direction without damage.

3.1.18 Systems Not To Be Vibration Isolated

Do not provide vibration isolation for electrical raceways and conduits or for fire protection, storm, sanitary, and domestic water piping systems which do not include pumps or other vibrating, rotating, or pulsating equipment including control and pressure reducing valves.

3.2 FIELD QUALITY CONTROL

Provide equipment and apparatus required for performing inspections and tests. Notify Contracting Officer [14] [_____] days prior to machinery [sound] [vibration] [seismic] testing. Rebalance, adjust, or replace machinery with noise or vibration levels in excess of those given in the machinery specifications, or machinery manufacturer's data.

3.2.1 Field Inspections

Prior to initial operation, inspect the vibration isolators [and seismic snubbers] for conformance to drawings, specifications, and manufacturer's data and instructions. Check for vibration and noise transmission through connections, piping, ductwork, foundations, and walls. Check connector alignment before and after filling of system and during operation. Correct misalignment without damage to connector and in accordance with manufacturer's recommendations.

3.2.2 Spring Isolator Inspection

After installation of spring isolators or protected spring isolators, and seismic restraint devices, the machinery shall rock freely on its spring isolators within limits of stops or seismic restraint devices. Eliminate or correct interferences.

3.2.3 Tests

Adjust, repair, or replace isolators as required to reduce vibration and noise transmissions to specified levels.

3.2.3.1 Equipment Vibration Tests

Perform vibration tests to determine conformance with vibration isolation schedule specified [specified] [indicated].

3.2.3.2 Equipment Sound Level Tests

Measure continuous or intermittent steady state noise with a sound level meter set for low response. Measure impact or impulse noise as dB peak sound pressure level (20 uPa) with an impact noise analyzer. Measure work distance from person to machinery noise center. Perform sound level tests to determine conformance with sound level schedule [specified] [indicated].

a. Interior Machinery Sound

In accordance with AHRI 575, measure the sound data for air conditioning and refrigeration machinery, such as fans, boilers, valves, engines, turbines, or transformers. Measure the sound pressure levels around mechanical and electrical machinery located in equipment spaces, one meter 3 feet horizontally from the edge closest to the acoustical center of the machinery at points one meter and 1.68 meter 3 feet and 5.5 feet above floor. Take measurements at the center of each side of the machinery. Locate the microphone at least one meter 3 feet from the observer and measuring instruments. Observer shall not be between the machinery and the measuring instrument.

b. Exterior Machinery Sound

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NOTE: ANSI/AHRI 370 is applicable only for outdoor refrigerating and air-conditioning equipment.
****

Measure sound data [in accordance with ANSI/AHRI 370] for machinery radiating noise outside the building in such applications as grade installations, area-ways, wall and roof installations for cooling towers, refrigerant condensers, engine driven generator sets, fans, air conditioning machinery, heat pumps, evaporative coolers, exhaust silencers, and air intakes.

-- End of Section --