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Preparing Activity: NASA Superseding
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UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMLR dated October 2010

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SECTION 23 05 48

VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

11/10

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SECTION 23 05 48

VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT 11/10

NOTE: This guide specification covers the requirements for vibration-isolation systems for air-conditioning equipment.

Provisions of the following specifications should be coordinated with equipment selection, specifications, and the drawings.

For equipment speeds under 250 revolutions per minute (rpm), special consideration is required.

This specification is arranged to be used in either of the following two ways:

The part entitled, "Vibration-Isolation Systems Application," and selected or rewritten text thereunder may be published as part of the bound specification. Drawing schedules shall include applicable data listed under Part 2.

Or, the part entitled, "Vibration Isolation-Systems Application," may be deleted when required applicable content is scheduled on the drawings.

Drawing schedules shall include the following data: equipment number; mass of inertia block if different from that specified or if not specified; minimum number of isolators for complex applications; lowest equipment rpm; impeller size; power; isolation provisions in the form of "C-CIB-1.75" which includes mounting, base, and minimum deflection in millimeter inches. This method is recommended in view of anticipated need to rewrite or supplement this basic specification to ensure suitability of provisions for specific project applications.

Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable items(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 \(CCR\)](#).

PART 1 GENERAL

1.1 REFERENCES

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 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.

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.

ACOUSTICAL SOCIETY OF AMERICA (ASA)

ASA S2.40 (1984; R 2001) Mechanical Vibration of Rotating and Reciprocating Machinery - Requirements for Instruments for Measuring Vibration Severity

ASA S2.71 (1983; R 2006) Guide to the Evaluation of Human Exposure to Vibration in Buildings

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE HVAC APP IP HDBK (2007; Errata 2010) HVAC Applications Handbook, I-P Edition

ASHRAE HVAC APP SI HDBK (2007; Errata 2010) HVAC Applications Handbook, SI Edition

NATIONAL ENVIRONMENTAL BALANCING BUREAU (NEBB)

NEBB PROCEDURAL STANDARDS

(2005) Procedural Standards for Testing,
Adjusting and Balancing (TAB) of
Environmental Systems

1.2 GENERAL REQUIREMENTS

NOTE: If Sections 23 00 00 AIR SUPPLY,
DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEMS and
Section 23 05 15 COMMON PIPING FOR HVAC are not
included in the project specification, applicable
requirements therefrom should be inserted and the
following paragraphs deleted. Vibration isolation
considerations for systems other than A/C equipment
should be addressed in each respective section.

Section 23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEMS
applies to work specified in this section to the extent applicable.

Section 23 05 15 COMMON PIPING FOR HVAC applies to work specified in this
section to the extent applicable.

All vibration-control apparatus must be the product of a single
manufacturing source, where possible. Human exposure levels should be
considered using ASA S2.71 and NEBB PROCEDURAL STANDARDS.

NOTE: Select the following paragraphs if text under
"Vibration-Isolation Systems Application" is deleted
and required isolation provisions are scheduled on
the drawings.

Scheduled isolation mounting is in millimeter inches and is a minimum
static deflection.

Spans referred to in Part 2, "Vibration-Isolation Systems Application,"
must mean longest bay dimension.

Determine exact mounting sizes and number of isolators by the isolator
manufacturer based on equipment that will be installed. Check equipment
revolutions per minute (rpm) and spring deflections to verify that
resonance cannot occur.

Five [_____] working days prior to commencement of installation, submit
installation drawings for vibration isolator systems including equipment
and performance requirements.

Indicate within outline drawings for vibration isolator systems, overall
physical features, dimensions, ratings, service requirements, and weights
of equipment.

Within ten [_____] working days of Contract Award, submit equipment and
performance data for vibration isolator systems including equipment base
design; inertia-block mass relative to support equipment weight; spring
loads and free, operating, and solid heights of spring; spring diameters;

nonmetallic isolator loading and deflection; disturbing frequency; natural frequency of mounts; deflection of working member; and anticipated amount of physical movement at the reference points.

Ensure data includes the following:

- a. Mountings
- b. Bases
- c. Isolators
- d. Floor-Mounted Piping
- e. Vertical Piping

1.3 SUBMITTALS

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project. Submittals should be kept to the minimum required for adequate quality control.

A "G" following a submittal item indicates that the submittal requires Government approval. Some submittals are already marked with a "G". Only delete an existing "G" if the submittal item is not complex and can be reviewed through the Contractor's Quality Control system. Only add a "G" if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation 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.

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" designation; submittals not having a "G" designation are [for Contractor Quality Control approval.] [for information only. When used, a designation following the "G" designation 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

Installation Drawings

Outline Drawings

SD-03 Product Data

Equipment and Performance Data

Isolators

SD-06 Test Reports

Type of Isolator

Type of Base

Allowable Deflection

Measured Deflection

PART 2 PRODUCTS

2.1 TYPE OF VIBRATION-ISOLATION PROVISIONS

NOTE: Use only those standards as necessary.

Design for vibration isolation using [NEBB PROCEDURAL STANDARDS] [ASHRAE HVAC APP SI HDBK, ASHRAE HVAC APP IP HDBK, Chapter 37,] as applicable to the following sections.

Submit test reports for testing vibration isolation for each [type of isolator](#) and each [type of base](#), and meet referenced standards contained within this section. Include in test reports [allowable deflection](#) and [measured deflection](#) also meeting referenced standards within this section.

2.1.1 Materials

Rubber must be natural rubber. Elastomer must be chloroprene. Shore A durometer measurement of both materials and range between 40 and 60.

Inorganic materials such as precompressed, high-density, fibrous glass encased in a resilient moisture-impervious membrane may be used in lieu of specified natural rubber and elastomers. Where this substitution is made, ensure specified deflections are modified by the manufacturing source to accommodate physical characteristics of inorganic materials and to provide equal or better vibration isolation.

Ensure weather-exposed metal vibration-isolator parts are corrosion protected. Chloroprene coat springs.

2.1.2 Mountings

Provide the following mountings:

[Type A: Composite pad, with [6.3 millimeter 0.25-inch](#) thick elastomer

top and bottom layers, molded to contain a pattern with nonslip characteristics in all horizontal directions. Elastomer loading must not exceed 275 kilopascal 40 pounds per square inch (psi). Minimum overall thickness must be 25 millimeter 1 inch. Maximum deflections up to 6.3 millimeter 0.25-inch are allowed.

] [Type B: Double [rubber-in-shear] [elastomer-in-shear] with molded-in steel reinforcement in top and bottom. Maximum deflections up to 12.7 millimeter 0.50 inch are allowed.

] [Type C: Free-standing laterally stable open-spring type for deflections over 12.7 millimeter 0.50 inch, with built-in bearing and leveling provisions, 6.3 millimeter 0.25-inch thick Type A base elastomer pads, and accessories. Outside diameter of each spring must be equal to or greater than 0.9 times the operating height of the spring under rated load.

] [Type D: Partially housed type, containing one or more vertically restrained springs with at least 12.7 millimeter 0.50 inch clearance maintained around springs, with adjustable limit stops, 6.3 millimeter 0.25-inch thick Type A base elastomer pads, and accessories.

] [Type E: Pendulum-suspension configuration with free-standing stable spring with resilient horizontal and vertical restraints to allow maximum movements of 6.3 millimeter 0.25 inch in each direction, 6.3 millimeter 0.25-inch thick Type A base elastomer pads.

] [Type F: Combination [spring and rubber-in-shear] [elastomer-in-shear] steel framed for hanger-rod mounting. Minimum total static deflection must be 25 millimeter 1 inch.

]

NOTE: Use air springs where springs are not practical. Consider use where spring deflection exceeds 89 millimeter 3.5 inches. Mount equipment on type base with "outrigger" brackets. Detail dependable air supply and connection provisions including hose connections where necessary.

Servo-controlled air spring isolators with natural frequencies for most applications can be provided. System loads can range from 227 to 226,796 kilogram 500 to 500,000 pounds. Servo-mechanisms will maintain height of isolated mass within 0.13 millimeter 0.005 inch.

[Type G: Air spring with body constructed of reinforced elastomer specifically suitable for application environment. Select air spring to provide a natural frequency equal to 127 millimeter 5 inches of deflection of conventional specified steel springs. Provide facilities for dead-level adjustment and height-control of supported equipment.

] 2.1.3 Bases

Provide the following bases:

[Type U: Unit isolators without rails, structural-steel bases, or inertia blocks.

-] [Type R: Rails, [connected] [disconnected] mill-rolled structural steel, of sufficient dimension to preclude deflection at midpoint of unsupported span in excess of 1/1,440th of the span between isolators, power transmission, component misalignment, and any overhung weight. Where Type R bases are specified and the equipment proposed requires additional base support, use a Type S base.
-] [Type S: Structural-steel bases common to a supported assembly, made from welded-joint mill-rolled structural steel with closed-perimeter configuration, isolators attached to outrigger supports.
-] Height of steel members must be sufficient to provide stiffness required to maintain equipment manufacturer's recommended alignment and duty efficiency of power-transmission components. Height of steel member must not result in member deflection at midpoint of unsupported span of more than 1/1,440th of the span between isolators. Minimum height must be 127 millimeter 5 inches.

NOTE: The following concrete inertia-block thickness and mass criteria are of necessity, general in scope and should be reviewed for each application and rewritten to reflect specific job conditions.

Mass of inertia block may range from one to three times the weight of supported equipment. Usually a 1 to 1 ratio is satisfactory and 1-1/2 to 1 ratio is not unusual. It is very difficult to achieve an equal weight between equipment and inertia base on air-handling units, especially where they may be large size.

Due to more complex forming and isolator construction required, blocks with recessed isolator-mounting provisions are more expensive and should be specified only to eliminate hazard to personnel.

- [Type CIB: Concrete inertia blocks must be common to the entire assembly, and have welded-joint construction, mill-rolled structural-steel perimeters, welded-in No. 4 reinforcing bars 200 millimeter 8 inches on center each way near the bottom of the block, outrigger-isolator mounting provisions, anchor bolts, and be filled with 20.68 Megapascal 3,000 psi cured-strength concrete.
-] Configuration of inertia bases must be rectangular to accommodate equipment supported.

Minimum thickness of inertia base, in addition to providing suitable mass, must be sufficient to provide stiffness to maintain equipment manufacturer's recommended alignment and duty efficiency of power-transmission components. Minimum thickness must be sufficient to result in base deflection at midpoint of unsupported span of not more than 1/1,440th of the span between isolators. Minimum thickness, the preceding requirements notwithstanding, must be 8 percent of the longest base dimension.

NOTE: Pump bases should be as stiff as practical.
300 millimeter 12-inch thick bases are common. To
attain stiffness, mass to 1-1/2 times weight of
assembly may be considered. Modify thickness in the
following paragraph as required.

Pumps with flexible couplings must not have inertia bases less than 200
millimeter 8 inches thick.

Minimum mass of concrete inertia block must be equal in weight to supported
equipment.

2.2 VIBRATION-ISOLATION SYSTEMS APPLICATION

Vibration isolation design per [NEBB PROCEDURAL STANDARDS] [ASHRAE HVAC APP SI HDBK,ASHRAE HVAC APP IP HDBK, Chapter 37,] [ASA S2.40].

NOTE: The following empirical recommendations are
based on floors 102 to 152 millimeter 4 to 6 inches
thick and without subbase or "housekeeping" pad.
Spring deflections may be reduced for floors which
are 200 millimeter 8 inches thick. "Basement below
grade" is considered as on "undisturbed earth." "On
grade" is considered as on some fill.

Review "provisions" for each application.

Where isolator deflection is specified for inside
locations and project equipment application is
roof-mounted and weather-exposed; add 13 millimeter
1/2 inch to specific deflection, use Type D
isolators and type U, R, or S bases.

Reciprocating compressor-condenser (rcc) criteria
are for inside location, with water-cooled condenser
integrally mounted.

Extreme care should be used in isolating
field-erected cooling-tower mechanical-equipment
supports. Too much mechanical-equipment support
movement may reduce propeller to fan ring clearance,
normally about 13 millimeter 1/2 inch, to 0. Type U
isolators cannot be used on certain units because
construction may be such that adequately spaced
support points are not available. Recommendations
specified are for package units only. Review all
structural-steel supports and vibration-isolation
provisions with cooling-tower and vibration-isolator
manufacturers for field-erected cooling towers with
mountings to be applied as follows:

Type A under basin alone which may suffice in 50
percent of cases.

Type D the under basin or structural-steel supports

only, with deflections similar to those specified for package tower springs.

Type E under mechanical-equipment supports with Type A under basin 75 to 100 millimeter 3 to 4 inch Type E deflection.

Wherever practical, avoid putting pumps on vibration isolators.

Where deflections exceed 90 millimeter 3.5 inches, consider air springs.

2.2.1 Centrifugal Water Chiller Package Locations

		ON GRADE	ON GRADE	ON GRADE
	BASEMENT	6096 MM	9144 MM	12192 MM
TYPE	BELOW-GRADE	FLOOR-SPAN	FLOOR-SPAN	FLOOR-SPAN
<u>EQUIPMENT</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>
Hermetic	A-U-6.3	B-U-13	D-S-44.5	D-S-63
Open Type	B-U-9.7	D-U-25	D-CIB-44.5	D-CIB-63

*TYPE OF MOUNTING, BASE, AND MINIMUM DEFLECTION IN MILLIMETER

		ON GRADE	ON GRADE	ON GRADE
	BASEMENT	20-FOOT	30-FOOT	40-FOOT
TYPE	BELOW-GRADE	FLOOR-SPAN	FLOOR-SPAN	FLOOR-SPAN
<u>EQUIPMENT</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>
Hermetic	A-U-0.25	B-U-0.50	D-S-1.75	D-S-2.5
Open Type	B-U-0.38	D-U-1.0	D-CIB-1.75	D-CIB-2.5

*TYPE OF MOUNTING, BASE, AND MINIMUM DEFLECTION IN INCHES

2.2.2 Reciprocating Water Chiller Package Locations

		ON GRADE	ON GRADE	ON GRADE
	BASEMENT	6096 MM	9144 MM	12192 MM
TYPE	BELOW-GRADE	FLOOR-SPAN	FLOOR-SPAN	FLOOR-SPAN
<u>EQUIPMENT</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>
500 to 750 rpm	D-U-25	D-U-38	D-S-63	D-CIB-69
750 rpm and over	D-U-25	D-U-25	D-R-50	D-CIB-63

*TYPE OF MOUNTING, BASE, AND MINIMUM DEFLECTION IN MILLIMETER

		ON GRADE	ON GRADE	ON GRADE
	BASEMENT	20-FOOT	30-FOOT	40-FOOT
TYPE	BELOW-GRADE	FLOOR-SPAN	FLOOR-SPAN	FLOOR-SPAN
<u>EQUIPMENT</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>
500 to				

		ON GRADE	ON GRADE	ON GRADE
	BASEMENT	20-FOOT	30-FOOT	40-FOOT
TYPE	BELOW-GRADE	FLOOR-SPAN	FLOOR-SPAN	FLOOR-SPAN
<u>EQUIPMENT</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>
750 rpm	D-U-1.0	D-U-1.5	D-S-2.5	D-CIB-2.75

750 rpm
and over D-U-1.0 D-U-1.0 D-R-2.0 D-CIB-2.5

*TYPE OF MOUNTING, BASE, AND MINIMUM DEFLECTION IN INCHES

2.2.3 Absorption Water Chiller Package Locations

		ON GRADE	ON GRADE	ON GRADE
	BASEMENT	6096 MM	9144 MM	12192 MM
TYPE	BELOW-GRADE	FLOOR-SPAN	FLOOR-SPAN	FLOOR-SPAN
<u>EQUIPMENT</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>
Standard	A-U-6	D-U-25	D-U-38	D-U-69

*TYPE OF MOUNTING, BASE, AND MINIMUM DEFLECTION IN MILLIMETER

		ON GRADE	ON GRADE	ON GRADE
	BASEMENT	20-FOOT	30-FOOT	40-FOOT
TYPE	BELOW-GRADE	FLOOR-SPAN	FLOOR-SPAN	FLOOR-SPAN
<u>EQUIPMENT</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>
Standard	A-U-0.25	D-U-1.0	D-U-1.5	D-U-2.75

*TYPE OF MOUNTING, BASE, AND MINIMUM DEFLECTION IN INCHES

2.2.4 Reciprocating Compressor/Condenser Locations

		ON GRADE	ON GRADE	ON GRADE
	BASEMENT	6096 MM	9144 MM	12192 MM
TYPE	BELOW-GRADE	FLOOR-SPAN	FLOOR-SPAN	FLOOR-SPAN
<u>EQUIPMENT</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>

500 to
750 rpm D-U-25 D-U-38 D-U-63 D-CIB-69

750 to
and over D-U-25 D-U-25 D-U-50 D-CIB-63

*TYPE OF MOUNTING, BASE, AND MINIMUM DEFLECTION IN MILLIMETER

		ON GRADE	ON GRADE	ON GRADE
	BASEMENT	20-FOOT	30-FOOT	40-FOOT
TYPE	BELOW-GRADE	FLOOR-SPAN	FLOOR-SPAN	FLOOR-SPAN
<u>EQUIPMENT</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>
500 to 750 rpm	D-U-1.0	D-U-1.5	D-U-2.5	D-CIB-2.75

750 to
and over D-U-1.0 D-U-1.0 D-U-2.0 D-CIB-2.5

*TYPE OF MOUNTING, BASE, AND MINIMUM DEFLECTION IN INCHES

		ON GRADE	ON GRADE	ON GRADE
	BASEMENT	20-FOOT	30-FOOT	40-FOOT
TYPE	BELOW-GRADE	FLOOR-SPAN	FLOOR-SPAN	FLOOR-SPAN
<u>EQUIPMENT</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>

2.2.5 Reciprocating Refrigeration Compressor Locations

		ON GRADE	ON GRADE	ON GRADE
	BASEMENT	6096 MM	9144 MM	12192 MM
TYPE	BELOW-GRADE	FLOOR-SPAN	FLOOR-SPAN	FLOOR-SPAN
<u>EQUIPMENT</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>

500 to
750 rpm C-U-25 C-U-38 C-U-63 C-CIB-69

750 rpm
and over C-U-25 C-U-25 C-U-50 C-CIB-63

*TYPE OF MOUNTING, BASE, AND MINIMUM DEFLECTION IN MILLIMETER

		ON GRADE	ON GRADE	ON GRADE
	BASEMENT	20-FOOT	30-FOOT	40-FOOT
TYPE	BELOW-GRADE	FLOOR-SPAN	FLOOR-SPAN	FLOOR-SPAN
<u>EQUIPMENT</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>

500 to
750 rpm C-U-1.0 C-U-1.5 C-U-2.5 C-CIB-2.75

750 rpm
and over C-U-1.0 C-U-1.0 C-U-2.0 C-CIB-2.5

*TYPE OF MOUNTING, BASE, AND MINIMUM DEFLECTION IN INCHES

2.2.6 Centrifugal Pump Locations

		ON GRADE	ON GRADE	ON GRADE
	BASEMENT	6096 MM	9144 MM	12192 MM
TYPE	BELOW-GRADE	FLOOR-SPAN	FLOOR-SPAN	FLOOR-SPAN
<u>EQUIPMENT</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>

Close-
couple
through
3728 watt None -R-8.9 C-S-25 C-S-25

Bedplate-
mounted
through
3728 watt None C-CIB-25 C-CIB-38 C-CIB-44.5

5592 watt None C-CIB-25 C-CIB-44.5 C-CIB-44.5

*TYPE OF MOUNTING, BASE, AND MINIMUM DEFLECTION IN MILLIMETER

		ON GRADE	ON GRADE	ON GRADE
	BASEMENT	20-FOOT	30-FOOT	40-FOOT
TYPE	BELOW-GRADE	FLOOR-SPAN	FLOOR-SPAN	FLOOR-SPAN
<u>EQUIPMENT</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>

Close-couple through 5 hp	None	-R-0.35	C-S-1.0	C-S-1.0
Bedplate-mounted through 5 hp	None	C-CIB-1.0	C-CIB-1.5	C-CIB-1.75
7-1/2 hp	None	C-CIB-1.0	C-CIB-1.75	C-CIB-2.5

*TYPE OF MOUNTING, BASE, AND MINIMUM DEFLECTION IN INCHES

2.2.7 Air-Cooled Condensing Unit Locations

	6096 MM	9144 MM	12192 MM
	ROOF-SPAN	ROOF-SPAN	ROOF-SPAN
<u>TYPE EQUIPMENT</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>

Through 5 hp over 900 rpm	B-U-13	D-U-25	D-U-44.5
Over 5 hp to 500 rpm	B-U-13	D-U-44.5	D-U-63
500 rpm and over	B-U-13	D-U-25	D-U-44.5

*TYPE OF MOUNTING, BASE, AND MINIMUM DEFLECTION IN MILLIMETER

	20-FOOT	30-FOOT	40-FOOT
	ROOF-SPAN	ROOF-SPAN	ROOF-SPAN
<u>TYPE EQUIPMENT</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>

Through 5 hp over 900 rpm	B-U-0.5	D-U-1.0	D-U-1.75
Over 5 hp to 500 rpm	B-U-0.5	D-U-1.75	D-U-2.5
500 rpm and over	B-U-0.5	D-U-1.0	D-U-1.75

*TYPE OF MOUNTING, BASE, AND MINIMUM DEFLECTION IN INCHES

2.2.8 Low-Pressure Suspended Air-Handling Unit (AHU) Locations

Vibration-isolation provisions apply to ceiling-suspended Air Moving and Conditioning Association Class A packaged central-station units.

<u>TYPE EQUIPMENT</u>	<u>6096 MM ROOF-SPAN PROVISIONS*</u>	<u>9144 MM ROOF-SPAN PROVISIONS*</u>	<u>12192 MM ROOF-SPAN PROVISIONS*</u>
Through 3728 watt	F-U-25	F-U-25	F-U-25
5592 watt and over 250 to 500 rpm	F-U-44.5	F-U-44.5	F-U-44.5
500 rpm and over	F-U-25	F-U-31.8	F-U-39.4

*TYPE OF MOUNTING, BASE, AND MINIMUM DEFLECTION IN MILLIMETER

<u>TYPE EQUIPMENT</u>	<u>20-FOOT ROOF-SPAN PROVISIONS*</u>	<u>30-FOOT ROOF-SPAN PROVISIONS*</u>	<u>40-FOOT ROOF-SPAN PROVISIONS*</u>
Through 5 hp	F-U-1.0	F-U-1.0	F-U-1.0
7-1/2 hp and over 250 to 500 rpm	F-U-1.75	F-U-1.75	F-U-1.75
500 rpm and over	F-U-1.0	F-U-1.25	F-U-1.55

*TYPE OF MOUNTING, BASE, AND MINIMUM DEFLECTION IN INCHES

2.2.9 Low-Pressure AHU Locations

Vibration-isolation provisions apply to floor-mounted Air Moving and Conditioning Association Class A packaged central-station units.

<u>TYPE EQUIPMENT</u>	<u>BASEMENT BELOW-GRADE PROVISIONS*</u>	<u>ON GRADE 6096 MM FLOOR-SPAN PROVISIONS*</u>	<u>ON GRADE 9144 MM FLOOR-SPAN PROVISIONS*</u>	<u>ON GRADE 12192 MM FLOOR-SPAN PROVISIONS*</u>
Through 3728 watt	B-U-8.9	C-U-25	C-U-25	C-U-25
5592 watt and over 250 to 500 rpm	B-U-8.9	C-U-44.5	C-U-44.5	C-U-44.5
500 rpm	B-U-8.9	C-U-25	C-U-38	

*TYPE OF MOUNTING, BASE, AND MINIMUM DEFLECTION IN MILLIMETER

<u>TYPE EQUIPMENT</u>	<u>BASEMENT BELOW-GRADE PROVISIONS*</u>	<u>ON GRADE 20-FOOT FLOOR-SPAN PROVISIONS*</u>	<u>ON GRADE 30-FOOT FLOOR-SPAN PROVISIONS*</u>	<u>ON GRADE 40-FOOT FLOOR-SPAN PROVISIONS*</u>
Through 5 hp	B-U-0.35	C-U-1.0	C-U-1.0	C-U-1.0
7-1/2 hp and over				

		ON GRADE	ON GRADE	ON GRADE
	BASEMENT	20-FOOT	30-FOOT	40-FOOT
TYPE	BELOW-GRADE	FLOOR-SPAN	FLOOR-SPAN	FLOOR-SPAN
<u>EQUIPMENT</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>
250 to 500 rpm	B-U-0.35	C-U-1.75	C-U-1.75	C-U-1.75
500 rpm	B-U-0.35	C-U-1.0	C-U-1.5	

*TYPE OF MOUNTING, BASE, AND MINIMUM DEFLECTION IN INCHES

2.2.10 Medium- And High-Pressure AHU Locations

Vibration-isolation provisions apply to floor-mounted Air Moving and Conditioning Association Classes B and C packaged central-station units.

		ON GRADE	ON GRADE	ON GRADE
	BASEMENT	6096 MM	9144 MM	12192 MM
TYPE	BELOW-GRADE	FLOOR-SPAN	FLOOR-SPAN	FLOOR-SPAN
<u>EQUIPMENT</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>
Through 3728 watt	B-U-8.9	C-U-25	C-U-25	C-U-25
5592 watt and over 250 to 500 rpm	B-U-8.9	C-U-44.5	C-U-44.5	C-U-44.5
500 rpm	B-U-8.9	C-U-25	C-U-38	

*TYPE OF MOUNTING, BASE, AND MINIMUM DEFLECTION IN MILLIMETER

		ON GRADE	ON GRADE	ON GRADE
	BASEMENT	20-FOOT	30-FOOT	40-FOOT
TYPE	BELOW-GRADE	FLOOR-SPAN	FLOOR-SPAN	FLOOR-SPAN
<u>EQUIPMENT</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>
Through 20 hp 250 to 300 rpm	B-U-0.35	C-U-2.5	C-U-2.5	C-U-3.5
300 to 500 rpm	B-U-0.35	C-U-1.75	C-U-1.75	C-U-2.5
500 rpm and over	B-U-0.35	C-U-1.0	C-U-1.0	C-U-1.75
Over 20 hp 250 to 300 rpm	B-U-0.35	C-U-2.5	C-CIB-3.5	C-CIB-3.5
300 to 500 rpm	B-U-0.35	C-U-2.5	C-CIB-2.5	C-CIB-3.5
500 rpm and over	B-U-0.35	C-U-1.0	C-CIB-1.75	C-CIB-2.5

		ON GRADE	ON GRADE	ON GRADE
	BASEMENT	20-FOOT	30-FOOT	40-FOOT
TYPE	BELOW-GRADE	FLOOR-SPAN	FLOOR-SPAN	FLOOR-SPAN
<u>EQUIPMENT</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>

*TYPE OF MOUNTING, BASE, AND MINIMUM DEFLECTION IN INCHES

2.2.11 Air-Moving Device Locations

Vibration-isolation provisions apply to [housed] [unhoused] free-standing fans of any pressure rating, located in [field-erected [field-] [factory-] fabricated central-station units] [unhoused [return-air] [supply-air] service].

		ON GRADE	ON GRADE	ON GRADE
	BASEMENT	6096 MM	9144 MM	12192 MM
TYPE	BELOW-GRADE	FLOOR-SPAN	FLOOR-SPAN	FLOOR-SPAN
<u>EQUIPMENT</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>

Through 14.9 kilowatt 250 to 300 rpm	B-U-8.9	C-U-63	C-U-63	C-U-89
300 to 500 rpm	B-U-8.9	C-U-44.5	C-U-44.5	C-U-63
500 rpm and over	B-U-8.9	C-U-25	C-U-25	C-U-44.5
Over 14.9 kilowatt 250 to 300 rpm	B-U-8.9	C-U-63	C-CIB-89	C-CIB-89
300 to 500 rpm	B-U-8.9	C-U-63	C-CIB-63	C-CIB-89
500 rpm and over	B-U-8.9	C-U-25	C-CIB-44.5	C-CIB-63

*TYPE OF MOUNTING, BASE, AND MINIMUM DEFLECTION IN MILLIMETER

		ON GRADE	ON GRADE	ON GRADE
	BASEMENT	20-FOOT	30-FOOT	40-FOOT
TYPE	BELOW-GRADE	FLOOR-SPAN	FLOOR-SPAN	FLOOR-SPAN
<u>EQUIPMENT</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>

Through 20 hp 200 to 300 rpm	B-U-0.35	C-S-2.5	C-S-2.5	C-S-3.5
300 to 500 rpm	B-U-0.35	C-S-1.75	C-S-1.75	C-S-2.5
500 rpm				

	BASEMENT	ON GRADE 20-FOOT	ON GRADE 30-FOOT	ON GRADE 40-FOOT
TYPE	BELOW-GRADE	FLOOR-SPAN	FLOOR-SPAN	FLOOR-SPAN
<u>EQUIPMENT</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>
and over	B-U-0.35	C-S-1.0	C-S-1.5	C-S-1.75

Over 20 hp

250 to 300 rpm	B-U-0.35	C-S-2.75	C-CIB-3.5	C-CIB-5.0
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300 to 500 rpm	B-U-0.35	C-S-1.75	C-CIB-2.5	C-CIB-3.5
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500 rpm and over	B-U-0.35	C-S-1.0	C-CIB-1.75	C-CIB-2.5
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*TYPE OF MOUNTING, BASE, AND MINIMUM DEFLECTION IN INCHES

2.2.12 Cross-Flow Cooling Tower Locations

NOTE: For blank spaces see notes at beginning of paragraph entitled, "Vibration-Isolation Systems Application. Design vibration isolators capable of supporting towers exposed to wind loading of 30 pounds per square foot 1437 pascal.

	6096 MM ROOF-SPAN	9144 MM ROOF-SPAN	12192 MM ROOF-SPAN
<u>TYPE EQUIPMENT</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>
Package under tower base to 500 rpm	B-U-8.9	D-U-50	D-U-63
500 rpm and over	B-U-8.9	D-U-25	D-U-44.5

Field erected
under tower
base; all rpm

Under mechanical-
equipment
supporting
frame to 500 rpm

500 rpm and over

*TYPE OF MOUNTING, BASE, AND MINIMUM DEFLECTION IN MILLIMETER

	20-FOOT ROOF-SPAN	30-FOOT ROOF-SPAN	40-FOOT ROOF-SPAN
<u>TYPE EQUIPMENT</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>	<u>PROVISIONS*</u>
Package under tower base to 500 rpm	B-U-0.35	D-U-2.0	D-U-2.5

<u>TYPE EQUIPMENT</u>	<u>20-FOOT ROOF-SPAN PROVISIONS*</u>	<u>30-FOOT ROOF-SPAN PROVISIONS*</u>	<u>40-FOOT ROOF-SPAN PROVISIONS*</u>
500 rpm and over	B-U-0.35	D-U-1.0	D-U-1.75
Field erected under tower base; all rpm			
Under mechanical- equipment supporting frame to 500 rpm			
500 rpm and over			

*TYPE OF MOUNTING, BASE, AND MINIMUM DEFLECTION IN INCHES

2.2.13 Blow-Through Cooling Tower Locations

<u>TYPE EQUIPMENT</u>	<u>6096 MM ROOF-SPAN PROVISIONS*</u>	<u>9144 MM ROOF-SPAN PROVISIONS*</u>	<u>12192 MM ROOF-SPAN PROVISIONS*</u>
Under tower base to 500 rpm	B-U-8.9	C-S-63	C-S-89
500 rpm and over	B-U-8.9	C-S-25	C-S-44.5

*TYPE OF MOUNTING, BASE, AND MINIMUM DEFLECTION IN MILLIMETER

<u>TYPE EQUIPMENT</u>	<u>20-FOOT ROOF-SPAN PROVISIONS*</u>	<u>30-FOOT ROOF-SPAN PROVISIONS*</u>	<u>40-FOOT ROOF-SPAN PROVISIONS*</u>
Under tower base to 500 rpm	B-U-0.35	C-S-2.5	C-S-3.5
500 rpm and over	B-U-0.35	C-S-1.0	C-S-1.75

*TYPE OF MOUNTING, BASE, AND MINIMUM DEFLECTION IN INCHES

2.3 PIPE AND DUCT VIBRATION ISOLATION

NOTE: Drawings should show pipe and duct isolation required by project conditions.

Hanger-rod length should be long enough to dissipate conducted heat which might be detrimental to elastomers.

Drawings should show type and spacing of pipe isolators in accordance with the following guide:

Pipe Size (DN) Millimeter	Distance To Be Isolated	Maximum Spacing Between Isolators
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<u>Inclusive</u>	<u>Millimeter</u>	<u>Millimeter</u>
25	3048	3048
50	4572	3048
75	6096	3048
100	7620	3048
150	9144	3048
200	12192	3048
250	13716	3048
300	15240	3048
406	18288	3048
<u>Pipe Size Inches Inclusive</u>	<u>Distance To Be Isolated Feet</u>	<u>Maximum Spacing Between Isolators Feet</u>
1	10	10
2	15	10
3	20	10
4	25	10
6	30	10
8	40	10
10	45	10
12	50	10
16	60	10

Coordinate duct and piping drawings and specifications with respect to connected vibration-isolated equipment deflections, expansion joints, and other flexible equipment connections.

In addition to springs and rubber, high-density fibrous-glass segment pipe saddles may be used for vibration isolation.

- [Type G: Provide isolators with in-series contained steel springs and preformed fibrous-glass or chloroprene-elastomer elements for connecting to building-structure attachments. Load devices by supported system during operating conditions to produce a minimum spring and elastomer static deflection of 25 millimeter and 10 millimeter 1 inch and 3/8 inch, respectively.
-]

NOTE: Use Type H and Type J isolators where
necessary to support pipe beyond tabulated distance.

- [Type H: Provide isolators with contained chloroprene-elastomer elements for connecting to building-structure attachments. Load devices by supported system during operating conditions to produce a minimum elastomer static deflection of 10 millimeter 3/8 inch.
-] [Type J: Provide isolators with elastomers mounted on floor-supported columns or directly on the floor. Load devices by supported system during operating conditions to produce a minimum elastomer static deflection of 10 millimeter 3/8 inch.

] [2.3.1 Floor-Mounted Piping

Type K: Provide isolators with springs mounted on floor-supported columns or directly on the floor. Load devices by supported system during operating conditions to produce a minimum spring static deflection of 25 millimeter 1 inch.

] 2.3.2 Vertical Piping

NOTE: For pipe approximately DN100 4 inches and
larger.

Do not use Type 1 typical vertical pipe attachments
on vibration-isolated pipe.

- [Type L: Provide isolators which are pipe base-support devices with one or more contained steel springs. Load devices by supported system during operating conditions to produce a minimum static deflection of 25 millimeter 1 inch. Equip devices with precompression and vertical-limit features, as well as a minimum 6.4 millimeter 1/4-inch thick elastomer sound pad and isolation washers, for mounting to floor.
-] [Type M: Isolators must be elastomer mounted baseplate and riser pipe-guide devices. Elastomer elements must be contained double acting, and elastomers under rated load must have a minimum static deflection of 10 millimeter 3/8 inch. Size isolator to accommodate thermal insulation within the stationary guide ring.

]

PART 3 EXECUTION

3.1 INSTALLATION

Install equipment in accordance with manufacturer's recommendations.

- [Rails, structural steel bases, and concrete inertia blocks must be raised not less than 25 millimeter 1 inch above the floor and be level when equipment supported is under operating load.
-] [Ensure vibration-isolation installation and deflection testing after equipment start-up is directed by a competent representative of the manufacturer.

] 3.2 TESTS AND REPORTS

[Ensure vibration-isolation devices are deflection tested. Submit test reports in accordance with paragraph entitled, "Submittal Procedures," substantiating that all equipment has been isolated as specified and that minimum specified deflections have been met. Make all measurements in the presence of the Contracting Officer.

] -- End of Section --