Simple Vibrating Machine

\[ F_v \approx r \]
\[ F_v \approx m \]
\[ F_v \approx \text{RPM}^2 \]

\( m \) represents mass,
\( r \) represents radius,
\( \text{RPM} \) represents revolutions per minute,
\( F_v \) represents vibratory force.

Fv: Vibratory Force
Vibration Isolators

Open Spring Mount

- Adjustment Bolt
- Ductile Holders Top and Bottom
- 1/4" Non-Skid Neoprene Acoustical Isolation Pad

Neoprene Element with Projecting Rod Isolation Bushing

- Steel Frame
- Neoprene Spring Cup with Projecting Rod Isolation Bushing
- Rod Can Swing 30° Before Contracting Resilent Bushing

Spring and Neoprene Hanger

Double Deflection Neoprene Mount

- Cap Screw Secures Equipment
- Steel Plates Top and Bottom Neoprene Covered to Prevent Corrosion
Isolator Natural Frequency (fn)

\[ fn = 188 \sqrt{\frac{1}{d}} \]

Where:
- ‘d’ is Isolator Static Deflection (in)
- ‘fn’ is in Cycles per Minute or RPM

Natural Frequency (fn) versus Static Deflection (d)
Isolation Efficiency (E)

\[ E = 100 \left(1 - \frac{1}{(fd/fn)^2} - 1\right) \]

Where:
- 'fd' is Driving Frequency in RPM
- 'fn' is Isolator Natural Frequency

<table>
<thead>
<tr>
<th>fd/fn</th>
<th>Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5</td>
<td>20%</td>
</tr>
<tr>
<td>2</td>
<td>67%</td>
</tr>
<tr>
<td>3</td>
<td>88%</td>
</tr>
<tr>
<td>4</td>
<td>93%</td>
</tr>
<tr>
<td>5</td>
<td>96%</td>
</tr>
<tr>
<td>6</td>
<td>97%</td>
</tr>
<tr>
<td>7</td>
<td>97.9%</td>
</tr>
<tr>
<td>8</td>
<td>98.4%</td>
</tr>
<tr>
<td>9</td>
<td>98.8%</td>
</tr>
<tr>
<td>10</td>
<td>99%</td>
</tr>
</tbody>
</table>
Problems with Efficiency Calculation

1. Does not take size of equipment into account
2. Does not account for equipment location

Cooling Tower on Roof

10 HP Pump: Slab on Grade
Structural Deflection

Floor Span
Housed Mounts

1. Variable weight equipment (Chillers, Cooling Towers)
2. Equipment exposed to Wind or Seismic Loads
WIND SHEAR

ASCE STANDARD ANSI/ASCE 7-98 MINIMUM DESIGN LOADS FOR BUILDINGS and OTHER STRUCTURES - 6. WIND LOADS

\[ q_z = \text{Velocity Pressure} = 0.00256 \times K_z \times K_{zt} \times K_d \times V^2 \times l \]

\[ K_z = 1.16 \quad (\text{Assumed } z=30\text{ft., Exposure D}) - \text{Table 6-5 p.59} \]
\[ K_{zt} = (1 + (K_1 \times K_2 \times K_3))^2 = 1.00 \quad (\text{Assumed no escarpment}) \]
\[ K_d = 0.90 - \text{Table 6-6 p.60} \]
\[ l = \text{Importance Factor} = 1.15 \quad (\text{Category III}) - \text{Table 6-1 p.54} \]
\[ V = \text{Basic Wind Speed} = 130 \text{ mph} - \text{Fig 6-1b p.35} \]
\[ = 51.94 \text{ lbs./ft.}^2 \]

\[ G = \text{Gust Effect Factor} = 0.85 - \text{Section 6.5.8.1 p.26} \]
\[ C_f = \text{Force Coefficient} = 1.3 \quad (\text{Square wind normal}) - \text{Table 6-10 p.64} \]
\[ A_f = \text{projected area normal to wind} = 61 \text{ ft.}^2 \]

\[ F_w = q_z \times G \times C_f \times A_f \quad \{\text{Eq.13 p.27}\} \]
\[ = 3501 \text{ lbs.} \]
Steel Support Bases

1. Equipment with Frame not Rigid enough for Isolator Support
2. Equipment with remote motors

BASERAIL DEPTH GREATER THAN OR EQUAL TO 1/10 LARGEST SPAN BETWEEN ISOLATORS

WELDED STEEL CROSS BRACING

WELDED STRUCTURAL STEEL FRAME

HEIGHT SAVING BRACKETS

WIDE FLANGE STEEL BASE
Inertia Bases
Stability and Alignment

BASE DEPTH GREATER THAN OR EQUAL TO 1/12 LARGEST SPAN BETWEEN ISOLATORS
Flexible Connectors

- Hooked Interlock
- Solid Steel Ring
- Molded-In Reinforcing Ring
- Flange Stops
- Multi-Layered Kevlar® Tire Cord Fabric Reinforcement with PEROXIDE CURED EPDM Cover, Liner and Fabric Frictioning

MECHANICS OF SOUND REDUCTION

- Positive Pulsation
- Negative Pulsation
- Normal Pressure Position
- Normal Volume
PIPE ISOLATION

HANGERS AT FIRST FOUR SUPPORT LOCATIONS NEXT TO MECHANICAL EQUIPMENT SHALL HAVE MINIMUM DEFLECTION EQUAL TO THAT OF THE EQUIPMENT ISOLATORS

3/4" DEFLECTION FOR PIPE TO 3" DIA
1" 2" DEFLECTION FOR 4" - 6" DIA
2-1/2" 2" DEFLECTION OVER 6" DIA
PIPING

SPRING MOUNT

ANCHOR

GUIDE

RISERS

OBSOLETE METHODS

Expansion
Loops

Expansion
Joints

Revolutionary
Spring
Supported
Riser System

PRIOR TO
ADJUSTMENT

INITIAL
DEFLECTION

1" (25 mm)
CLEARANCE

AFTER
ADJUSTMENT

THermal GROWTH

ANCHOR

l

(1) ANCHORED HORIZONTAL RUN

(2) SPRING SUPPORTED HORIZONTAL RUN

(3) SPRING SUPPORTED EQUIPMENT

UPPER ELBOW OF EXPANDING RISER

FIGURE E

FIGURE A

FIGURE B

FIGURE C

FIGURE G
DUCT ISOLATION

ISOLATE SUPPLY DUCTS FOR 50 FT FROM FANS
(3/4" DEFLECTION)

HANGER WITH EY-HOOKS
Acoustical Package

More than 8 dBA or almost half the radiated RTU noise can be reduced by installing Mason Industries RSC-dB Acoustical Package directly under the unit. Two sealed layers of gypsum board attached to the RSC’s “floating” upper base member limit acoustical energy radiated from the unit’s bottom. The acoustical barrier is supported by steel members running around the perimeter and across the width of the curb.
INSTALLATION INSTRUCTIONS:
1. MT Air Springs are shipped with precompression chains for optimum performance at the published height.
2. Equipment should be blocked at the installed height.
3. Install the Air Spring.
4. Remove nuts “A” top and bottom and remove chains prior to inflation.
5. If Leveling Valves are used, allow air to flow into the system until the Air Springs take the load and blocking can be removed.
6. If system is installed without Leveling Valves, start to inflate each Air Spring to the calculated pressure.
   a) If blocking can be removed prior to reaching the calculated pressure, operate at the lower pressure.
   b) If all springs are at calculated pressure and blocking is still tight, increase pressure evenly at each location until blocks can be removed.
7. Systems installed without Leveling Valves will require periodic manual replenishment.
SPECIFICATION SELECTION GUIDE

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

<table>
<thead>
<tr>
<th></th>
<th>Ground Supported Slab or Basement</th>
<th>20' Floor Span Possible Floor Defl. - 0.67&quot;</th>
<th>30' Floor Span Possible Floor Defl. - 1.0&quot;</th>
<th>40' Floor Span Possible Floor Defl. - 1.33&quot;</th>
<th>50' Floor Span Possible Floor Defl. - 1.57&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Note 1</td>
<td></td>
<td>Note 1</td>
<td>Note 1</td>
<td>Note 1</td>
<td>Note 1</td>
</tr>
</tbody>
</table>

REFRIGERATION MACHINES

Absorption Machines
- A-K 0.35  C-K 0.75  C-K 0.75  C-K 1.5  C-K 1.5

Centrifugal Chillers or Heat Pumps
- Cooler Condenser Mounted Hermetic-Compr. A-K 0.35  C-K 0.75  C-K 1.5  C-K 1.5  C-H-K 2.5
- Cooler Condenser Alongside Hermetic-Compr. A-K 0.35  C-K 0.75  C-K 1.5  C-K 1.5  C-K 2.5
- Open Type Compressors (note 3) A-G-K 0.35  C-G-K 0.75  C-G-K 1.5  C-G-K 1.5  C-G-K 2.5

Refrigeration Screw Compressors
- P-J-K Freq. 3Hz

Refrigeration Reciprocating Compressors
- 500 rpm to 750 rpm
  - B 0.75  B 1.5  B 1.5  B-H 2.5  B-H 3.5
  - 751 rpm and Over
    - B 0.75  B 0.75  B 1.5  B-H 2.5  B-H 3.5

Reciprocating Chillers or Heat Pumps
- 500 rpm to 750 rpm
  - C-K 0.75  C-K 1.5  C-K 1.5  C-H-K 2.5  C-H-K 3.5
  - 751 rpm and Over
    - C-K 0.75  C-K 0.75  C-H-K 1.5  C-H-K 2.5  C-H-K 3.5

PACKAGED STEAM GENERATORS (Boilers)
- A-L 0.35  C-L 0.75  C-L 0.75  C-L 1.5  C-L 2.5

PUMPS

Close Coupled
- Thru 5 HP A-J-K 0.35  B-J-K 0.75  B-J-K 0.75  B-J-K 1.5  B-J-K 1.5
- 7½ HP and Larger B-J-K 0.75  B-J-K 0.75  B-J-K 1.5  B-J-K 1.5  B-J-K 2.5

Base Mounted (note 2)
- Thru 60 HP B-J-K 0.75  B-J-K 0.75  B-J-K 1.5  B-J-K 1.5  B-J-K 2.5
- 75 HP and Larger B-J-K 0.75  B-J-K 1.5  B-J-K 2.5  B-J-K 2.5  B-J-K 3.5

VIBRATION ISOLATION AND DEFLECTION CRITERIA FOR 4" THRU 6" THICK SOLID CONCRETE FLOORS (note 7)
BMK CONCRETE FORM BASE
SPECIFICATION J

SFDEJ MOLDED EXPANSION JOINT
SPECIFICATION K