



Seismic Restraints for Mechanical Equipment

An Online Continuing Education Course for Engineers

Course Number: M-5003

Credit: 5 Hours / 5 PDH / 5 CPD

TABLE OF CONTENTS

INTRODUCTION	2
EQUIPMENT	4
Air Compressors	4
Air Conditioning Units and Heat Pumps	6
Air Handling Units	8
Air Separators	11
Boilers, Furnaces, Humidifiers, Water Heaters	12
Chillers	14
Coils and Heat Exchangers	16
Condensers and Condensing Units	18
Cooling Towers, Evaporative Coolers, Fluid Coolers	20
Fans	22
Heaters	23
Pumps	26
Tanks and Gas Cylinders	28
VAV Boxes, Duct Silencers, Fan-coil Units	30
ATTACHMENT TYPES	32
Rigid Floor-mounted/Pad-mounted Attachment	32
Roof-mounted Attachment	48
Suspended Attachment	62
Vibration-isolated/Floor-mounted Attachment	77
Wall-mounted Attachment	88
ANCHORS	96
General	96
Cast-in-place Anchors	103
Lag Bolts	104
Masonry and Drywall Anchors	106
Steel Bolt Connections	114
Welding	119
Anchor Sizes for Equipment Less than 400 Pounds	121
SPECIAL CASES	124
Cables	124
Control Panels	130
Housekeeping Pads	135
Residential Equipment	139
ANCHOR SELECTION GUIDE	141
GLOSSARY	149
INDEX	157

INTRODUCTION

This course shows equipment installers how to attach mechanical equipment to a building to minimize earthquake damage. Many attachment examples are presented, to include anchoring and the use of special devices called *seismic restraint devices*.

Seismic restraint devices include vibration isolation systems, cable or strut suspension systems, roof attachment systems, and steel shapes.

Please note that this course does not replace:

- Printed instructions shipped with the equipment.
- Instructions in contract drawings and specifications.
- Code-required, industry-accepted practices.

Please note that this course does not cover:

- Non-building structural framing required to elevate equipment above the floor.

This course contains these sections:

- *Equipment*: Arranged according to different kinds of mechanical equipment such as Air Compressors, Cooling Towers, Pumps, etc.
- *Attachment Types*: Gives instructions on installing equipment in different arrangements known as *attachment types*.
- *Anchors*: Shows many many different types of anchors used to connect equipment to a building.
- *Special Cases*: Covers housekeeping pads, cable assemblies, supports for control panels, and residential equipment.

Start with the Equipment section that best represents the equipment you are installing.

- Use the Table of Contents to find the correct starting page.

- Using the table in the Equipment section, find the type of equipment you are installing in column 1. The method for installing this equipment is shown in column 2 and the attachment type is shown in column 3. An example is shown below:

column 1	column 2	column 3
<i>Typical Equipment</i>	<i>How is equipment to be installed?</i>	<i>Attachment Type</i>
Any box or cabinet fan	Connected to angles mounted to the floor	Rigid with angles <i>Go to page 36</i>

- Turn to the page number for the attachment type in column 3.

Follow the instructions for the attachment type you have selected. These instructions will refer you to the correct anchor section so you can make the connection to the building structure.

All instructions in this course are arranged in order using numbered steps.

- Please follow every step in the sequence shown.

Special precautions are marked:



A flag means you should take special care before continuing. Read all the information next to a flag before attaching the equipment.



A warning sign means you can cause serious damage to the building, the device, or the equipment if you do not follow the instructions exactly.



A book means you should refer to the manufacturer's printed instructions before continuing.

Note that a Glossary and an Index are also available to facilitate use of this course.

EQUIPMENT

Air Compressors



Be sure to refer to construction drawings and specifications, seismic restraint submittals, and manufacturer's instructions.

Step 1: Identify equipment



Figure 1: Housed air compressor (water-cooled).

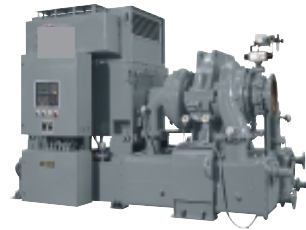


Figure 2: Air compressor skid-mounted (water-cooled).



Figure 3: Air compressor with vertical tank (air-cooled).



Figure 4: Reciprocating type air compressor with horizontal tank (air-cooled).



Figure 5: Skid-mounted equipment including large filter dryers.

Step 2: Select the type of attachment

Using the following table, select how the equipment is to be installed, select the attachment type that best matches the installation you have selected, then turn to the page under the attachment type.

<i>Typical Equipment</i>	<i>How is equipment to be installed?</i>	<i>Attachment Type</i>
Any compressor except housed or skid-mounted	Mounted directly to the floor	Rigid <i>Go to page 32</i>
	Floor-mounted on vibration isolators using restrained springs or open springs and snubbers	Vibration-isolated <i>Go to page 77</i>
Housed or skid-mounted compressors	Connected to angles mounted to the floor	Rigid with angles <i>Go to page 36</i>

Table 1: Air compressor installation types.

Air Conditioning Units and Heat Pumps



Be sure to refer to construction drawings and specifications, seismic restraint submittals, and manufacturer’s instructions.

Step 1: Identify equipment



Figure 6: Small rooftop air conditioning unit or heat pump (air-cooled).



Figure 7: Large rooftop air conditioning unit (air-cooled).



Figure 8: Indoor air conditioning unit or heat pump (floor-mounted or suspended with remote condenser).



Figure 9: Self-contained water-cooled unit (floor-mounted or raised floor-mounted).



Figure 10: Through-the-wall air conditioning unit or heat pump.

Step 2: Select the type of attachment

Using the following table, select how the equipment is to be installed, select the attachment type that best matches the installation you have selected, then turn to the page under the attachment type.

Typical Equipment	How is equipment to be installed?	Attachment Type
Any AC unit or heat pump	Mounted directly to the floor	Rigid Go to page 32
	Connected to angles mounted to the floor	Rigid with angles Go to page 36
	Floor-mounted on vibration isolators using restrained springs or open springs and snubbers	Vibration-isolated Go to page 77
Self-contained unit; use manufacturer's base designed for raised floor	Installed on a raised floor	Raised floor Go to page 43
Any rooftop unit	Roof-mounted on a post and beam	Post and beam Go to page 48
	Connected to a manufactured isolation curb on a post and beam	Isolated curb on a post and beam Go to page 58
	Vibration isolated on a post and beam	Isolation springs on a post and beam Go to page 60
	Directly connected to a sheet metal curb with nailer	Pre-manufactured curb Go to page 51
	Directly connected to a wood roof curb	Wood curb Go to page 57
Indoor AC unit or heat pump	Suspended from building structure above with rods and cables	Rods and cables Go to page 62
	Suspended from building structure above with angles	Suspended with angles Go to page 68
	Suspended from building structure above with isolators, rods, and cables	Isolator rods and cables Go to page 70
Through-the-wall unit	Supported by the wall	Wall-mounted with angles Go to page 90

Table 2: AC unit and heat pump installation types.

Air Handling Units



Be sure to refer to construction drawings and specifications, seismic restraint submittals, and manufacturer’s instructions.

Step 1: Identify equipment



Figure 11: Small rooftop air handling unit.



Figure 12: Large rooftop air handling unit.



Figure 13: Horizontal indoor air handling unit (floor-mounted or suspended).



Figure 14: Vertical indoor air handling unit (floor-mounted).

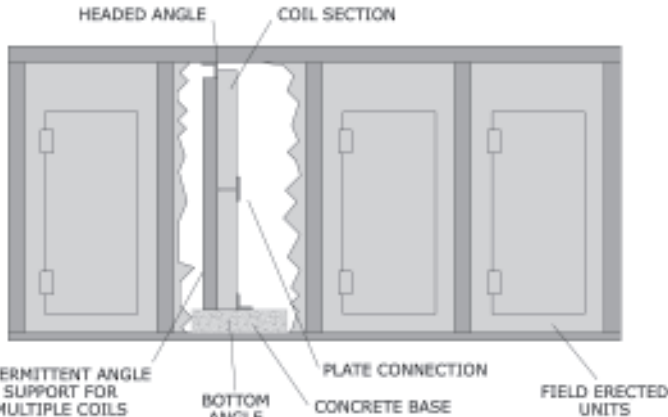


Figure 15: Built-up air handling units.

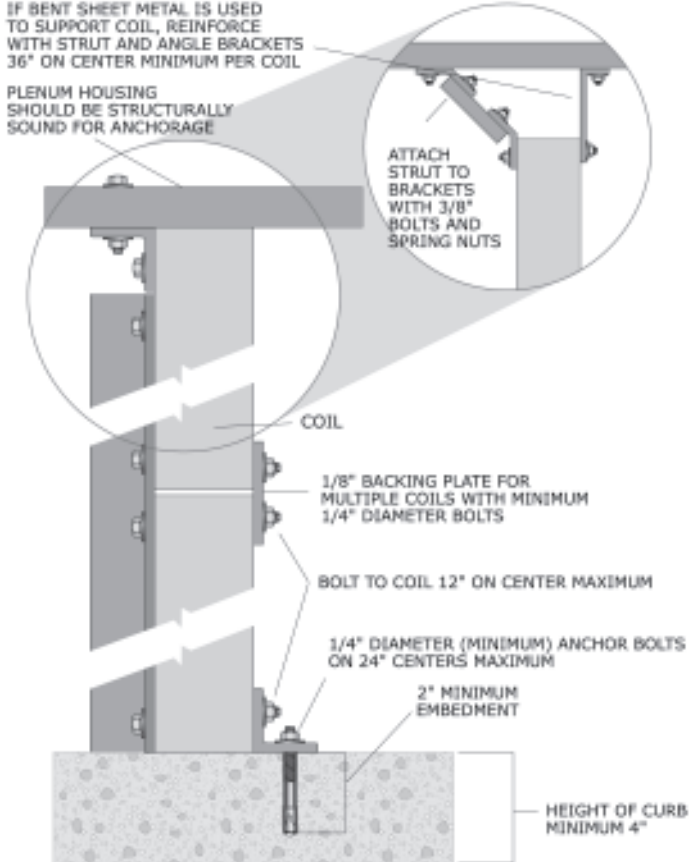


Figure 16: Coils in air handling units.

Step 2: Select the type of attachment

Using the following table, select how the equipment is to be installed, select the attachment type that best matches the installation you have selected, then turn to the page under the attachment type.

Typical Equipment	How is equipment to be installed?	Attachment Type
Indoor air handling unit with a rigid base	Mounted directly to the floor	Rigid Go to page 32
Indoor air handling unit	Connected to angles mounted to the floor	Rigid with angles Go to page 36
	Suspended from structure above with rods and cables	Rods and cables Go to page 62
	Suspended from structure above with angles	Suspended with angles Go to page 68
	Suspended from structure above with vibration isolation, rods, and cables	Isolated suspended with rods and cables Go to page 77
Weight-limited rooftop unit (see manufacturer's literature)	Directly connected to a sheet metal curb with nailer	Pre-curb Go to page 44
	Directly connected to a wood roof curb	Wood curb Go to page 44
Any rooftop unit	Connected to a manufactured vibration isolation curb on a post and beam	Isolated post and beam Go to page 44
	Roof-mounted on a post and beam	Post and beam Go to page 44
Large rooftop unit	Vibration isolation on a post and beam	Isolated on a post and beam Go to page 44
Any air handling unit	Floor-mounted on vibration isolation using restrained springs or open springs and snubbers	Vibration-isolated Go to page 77

Table 3: Air handling unit installation types.

Air Separators



Be sure to refer to construction drawings and specifications, seismic restraint submittals, and manufacturer's instructions.

Step 1: Identify equipment



Figure 17: Air separator (rigid).

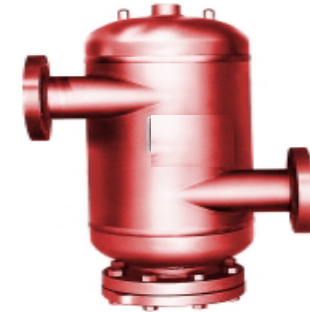


Figure 18: Air separator (suspended).

To view the remainder of the course material and to take the quiz for PDH credit, you must purchase the course. Close this window and click "Add to cart" on the product page.

Step 2: Select the type of attachment

Using the following table, select how the equipment is to be installed, select the attachment type that best matches the installation you have selected, then turn to the page under the attachment type.

How is equipment to be installed?	Attachment Type
Connected to angles mounted to the floor	Rigid with angles Go to page 36
Suspended from the building structure above with rods and cables	Rods and cables Go to page 62
Suspended from the building structure above with angles	Suspended with angles Go to page 68
Supported from the wall with angles	Wall-mounted with angles Go to page 90

Table 4: Air separator installation types.