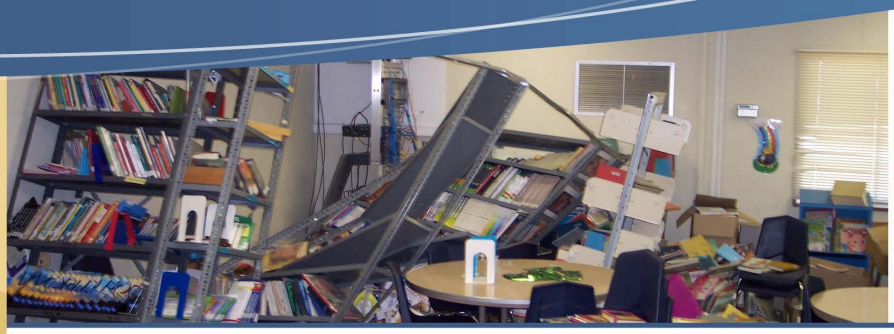

GUIDE AND CHECKLIST FOR NONSTRUCTURAL EARTHQUAKE HAZARDS IN SCHOOLS

December 2025

Cal OES
GOVERNOR'S OFFICE
OF EMERGENCY SERVICES

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Guide and Checklist for Nonstructural Earthquake Hazards in California Schools

A Practical Guide for Schools and Commercial Buildings

A project of:
California Governor's Office of Emergency Services (Cal OES)

This document is an update of the Guide and Checklist for Nonstructural Earthquake Hazards in California Schools, published by the California Governor's Office of Emergency Services (Cal OES), last updated in 2011. This edition was funded by a FEMA National Hazard Mitigation Grant.

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Disclaimer

Points of view or opinions expressed in this document are those of the authors and do not necessarily represent the official position or policies of Cal OES.

The California Division of the State Architect (DSA) publication *IR A-22 : Construction Projects and Items Exempt from DSA Review* addresses scope of construction work that is eligible to be exempt from plan review and approval by DSA. All public school construction projects, including those exempt from DSA review, approval, and construction oversight, must comply with the currently effective Title 24, California Code of Regulations (CCR), including design by licensed design professionals and testing and inspections of construction work.

The recommendations included in this document are intended to reduce seismic risks associated with nonstructural components commonly found in schools and commercial buildings, including but not limited to mechanical systems, ceiling systems, partitions, light fixtures, furnishings, and other building contents. Earthquake engineering involves multiple sources of uncertainty and cannot accurately predict the performance of nonstructural elements or guarantee adequate earthquake protection even if the guidelines in this publication are followed.

This publication does not address risks associated with the failure of structural elements. The recommendations contained herein do not guarantee the safety of any individual structure or facility during an earthquake and should be interpreted and used in a manner consistent with the overall unique safety requirements of each school or commercial facility.

Expertise of qualified California licensed architect or structural engineer is recommended to increase the probability that intended levels of earthquake protection will be achieved. Liability for any losses that may occur in an earthquake or as a result of using this publication is specifically disclaimed. The State of California specifically disclaims liability for any injury, death, or property damage that may occur during or after an earthquake as a result of the use of this publication.

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Table of Contents

Chapter 1: Introduction

The purpose of this guide is to empower school communities to identify and eliminate common earthquake hazards in their facilities. Schools that take steps to mitigate against disasters and prepare for emergencies can respond effectively and help support the entire community to recover from a disaster. This guide identifies potential earthquake hazards associated with nonstructural components of school and commercial buildings and provides recommendations for mitigating those hazards.

Nonstructural components include furniture and contents, architectural features such as suspended ceilings, partitions, exterior cladding and canopies, and mechanical, electrical, and plumbing equipment and distribution systems. Nonstructural components become hazards when they slide, break, fall, or tip over during an earthquake. Damage to these components can injure students and faculty during or after an earthquake, disrupt education, and be costly to repair. Securing nonstructural items inside buildings reduces the potential for casualties and helps keep schools open for learning. It is also essential for (1) maintaining safe and clear exit ways for evacuation and access; (2) reducing the potential for chemical spills, fires, and gas leaks; (3) maintaining the security of school facilities during and after an earthquake; and (4) reducing the cost of repairs after an earthquake.

Refer to Chapter 2 to learn more about nonstructural components and why they matter in earthquakes.

2018 Anchorage Earthquake damage to Matanuska-Susitna Borough School District, Alaska (from Earthquake Engineering Research Institute)

2014 South Napa Earthquake damage to Napa Valley Unified School District, California (from M. Quattrocchi).

Using this Publication

PURPOSE

This guide is intended to enable users to:

- Understand what nonstructural earthquake hazards are and why they are important to address in California schools;
- Identify nonstructural hazards in schools;
- Identify mitigation actions for reducing these hazards; and
- Implement the mitigation actions.

INTENDED USERS

This publication is intended for use by:

- School principals, teachers, administrators, and parents who become aware of potential seismic hazards and opportunities for mitigation;
- Personnel charged with school building condition and safety, including school facility directors, school maintenance and operations directors, and custodians; and
- Contracted personnel, such as construction managers.

While designed as a user-friendly and nontechnical document, it is nonetheless expected that those evaluating school facilities have a cursory understanding of building components and terminology.

APPLICABILITY TO FACILITIES BEYOND SCHOOLS

Although the focus of this guide is schools, the recommendations for hazard mitigation apply to similar components located in commercial buildings, offices, residences, and other buildings. Advice directed to school personnel within this guide applies similarly to commercial building owners, office workers, and maintenance staff.

ORGANIZATION

Following an overview of earthquake hazards associated with nonstructural components commonly found in California schools (Chapter 2), this guide explains how to use checklists and installation details to identify and mitigate common nonstructural hazards in schools (Chapter 3).

Checklists for identifying nonstructural earthquake hazards in schools and classrooms are provided as Parts A through D. Nonstructural component installation instructions, referred to as **Details**, are provided as Part E.

Four **Help Guides** at the end of the document (Parts F through I) provide additional information on selected topics.

CHECKLISTS

Using the **School Hazard Checklist**, a comprehensive three-part review of nonstructural hazards can be completed for an entire school building, inside and out. A shorter, two-page **Classroom Checklist** is also provided to help identify the most common hazards within an individual classroom. For each hazard, the checklists provide recommended actions to mitigate the hazard.

DETAILS

Select nonstructural hazards identified with the checklist can be mitigated by referring to **Details**. Each **Detail** includes illustrations and installation instructions, sufficiently detailed for use by school facilities or maintenance personnel.

The intent of the **Details** contained in the guide is to provide suggested mitigation solutions, subject to certain conditions of use, where design by a licensed design professional and/or review and approval by DSA is not required by code. However, nothing in this publication is intended to permit a lesser standard than established by current code requirements.

Details are not provided for more complex and varied nonstructural components or conditions where evaluation and mitigation require a California-licensed architect or structural engineer for design and may require approval by the Division of the State Architect (DSA).

INSTALLATION OF NEW COMPONENTS

When installing a new nonstructural component, a review of the relevant **Detail** is recommended. Each **Detail** includes component illustration(s), notes, conditions of use, an installation material list, and steps for proper installation.

EXISTING CONDITIONS

Although various existing conditions are depicted in the **Details**, users of this guide are expected to review the specific conditions at the component installation location for consistency with the illustrations, notes, and conditions of use. Where existing conditions differ from the information in the **Details,** it is expected that school staff will consult with a California-licensed architect or structural engineer.

Chapter 2: Why Nonstructural Components Matter

Nonstructural components are all the parts of a building that are not the structural system; that is, all the architectural, mechanical, electrical, and plumbing systems, as well as furniture, fixtures, equipment, and contents. Examples of nonstructural components that are vulnerable to earthquake damage include shelving, overhead lights, ceilings, water heaters, equipment, partition walls, veneer, piping, and air conditioning ducts. This section identifies potential earthquake hazards associated with nonstructural components commonly found in California schools and commercial buildings.

Furniture and Contents

Furniture and contents include items such as bookshelves, monitors, rolling computer carts, and other items likely to be brought into the school on a routine basis by teachers or staff. They may be suspended overhead, attached to a wall, rest on a counter, sit on the floor, or be on rollers. Earthquake shaking can cause classroom furniture and contents to quickly overturn and even move across a room. These components can fall on occupants, causing injury. They can spill their contents and block doors, preventing safe exiting. Items such as unsecured terrariums with heat lamps or unprotected gas cylinders can lead to fires.

2014 South Napa Earthquake damage to Napa Valley Unified School District, California (from M. Quattrocchi).

2018 Anchorage Earthquake damage to Matanuska-Susitna Borough School District, Alaska (from Earthquake Engineering Research Institute).

2010 Mexicali Earthquake damage to Calexico Unified School District, California (from California Division of the State Architect).

The following table presents principal concerns associated with common furniture and contents.

Principal Concerns for Unbraced Furniture and Contents	
Bookcase	Bookcases are often tall, narrow, and heavily loaded. They may overturn during an earthquake, striking occupants or blocking exits. Unrestrained books may fall and strike occupants.
Freestanding Bookcase	Freestanding bookcases, such as library shelving, may fall over during an earthquake, striking occupants or blocking exits. Unrestrained books may fall and strike occupants.
File cabinet	File cabinets are often tall, narrow, and heavily loaded. They may slide, tip, or overturn during an earthquake, striking occupants or blocking exits. Unlatched drawers may open during an earthquake, which may cause the cabinet to fall over.
Metal Locker	Unsecured metal lockers may fall, striking occupants or blocking hallways and exits.
Teacher's Cabinet	Unsecured teacher's cabinets may fall, striking occupants or blocking hallways and exits.
Wall-Mounted Shelf	Shelves may slide off their supports, and items may fall off shelves, striking occupants below.
Wall-Mounted Monitor	Unsecured TVs and monitors may fall off the mounting brackets, striking occupants below or blocking exits.
Ceiling-Mounted Video Projector	Unsecured overhead projectors or speakers may fall from their mounting brackets, striking occupants below or blocking exits.
Dry Erase Board	Unsecured dry erase boards may become dislodged, striking occupants or blocking doors and exits.
Pictures or Wall Decorations	Unsecured wall-hung items, such as pictures, decorations or signs, may fall, striking occupants or blocking exits.
Signage	Unsecured signs may fall, striking occupants or blocking exits.
Display Cases, Trophies, Art Objects	Display cases may fall, striking occupants or blocking doors and exits. Unsecured items may fall off or out of the display case, striking occupants or creating debris.
Hanging Display	Hanging displays may fall, striking occupants below or blocking exits; displays may sway, striking nearby objects and causing them to be damaged or fall.

Principal Concerns for Unbraced Furniture and Contents (continued)	
Desktop or Countertop Equipment	Unsecured desktop or countertop equipment may fall off, striking occupants or blocking doors and exits. Unsecured office equipment may break as it falls, posing a threat to operational recovery.
Equipment on Wheels	Equipment on wheels may roll during an earthquake, striking occupants or blocking exits. Where equipment is on a rolling cart, the equipment may fall off the cart.
Fire Extinguisher	Unsecured fire extinguishers may fall off the wall and damage the shut-off valve or hose, releasing contents. A damaged fire extinguisher may not be functional in an emergency. Unsecured fire extinguishers may fall, striking occupants.
Gas Cylinders or Tanks	Unsecured cylinders or tanks, including oxygen and compressed air tanks, may fall over and damage the shut-off valve, releasing hazardous or flammable contents. A tank with a damaged shut-off valve may result in the tank or valve becoming a projectile. Unsecured cylinders may topple and roll, striking occupants or blocking exits.
Aquariums and Terrariums	Unsecured aquariums and terrariums may fall, striking occupants and blocking exits. Broken aquariums may flood adjacent spaces. Heat lamps in broken terrariums may cause fires.
Kilns	Kilns may tip over, striking occupants or damaging the kiln.
Shop or Gym Equipment	Freestanding shop or gym equipment that is tall and heavy may tip over or slide. Equipment may fall, striking occupants or blocking exits.
Refrigerator	Unsecured refrigerator may slide or tip, striking occupants and blocking doors and exits.
Bleachers	Foldable or telescopic gym seating may come unlatched from the folded position and strike occupants.

Building Components and Equipment

Building components and equipment include architectural and mechanical, electrical, and plumbing (MEP) infrastructure. These components may be original to the building or installed during large renovation projects. Architectural elements include partitions, suspended ceilings, and light fixtures. MEP elements include mechanical, electrical, and plumbing equipment such as electrical panels and water heaters. MEP elements also include distribution systems, such as piping, ducts, and electrical conduit. This category also includes commercial kitchen equipment.

These building elements are common in schools and, if unanchored or improperly installed, can become extremely hazardous during an earthquake. These components may be heavy and are often installed overhead, creating an even greater hazard. Ceilings and light fixtures can fall, striking occupants and block exit ways. Fire sprinkler lines can break, flooding classrooms and destroying expensive equipment. Mechanical equipment may tip over, breaking gas pipes and causing fires. Repairing damage to building infrastructure can be expensive and require long periods of school closure.

2018 Anchorage Earthquake damage to Matanuska-Susitna Borough School District, Alaska (from Earthquake Engineering Research Institute).

2018 Anchorage Earthquake damage to Matanuska-Susitna Borough School District, Alaska (from Earthquake Engineering Research Institute).

2014 South Napa Earthquake damage to Napa Valley Unified School District, California (from M. Quattrocchi).

The following table presents principal concerns associated with common building components and equipment.

Principal Concerns for Unbraced Building Components and Equipment	
Light Fixture (hanging or pendant)	Improperly supported light fixtures may fall, striking occupants below, blocking exits, or damaging electrical wiring that could start a fire or electrocute occupants. Fixtures that swing may strike or damage other nearby objects.
Light Fixture (ceiling-recessed)	If ceiling grid is damaged, lights may fall, striking occupants below or blocking exits for evacuation during an emergency.
Ceiling HVAC Register	If ceiling grid is damaged, heating ventilation air-conditioning (HVAC) registers may fall, striking occupants below or blocking exits for evacuation during an emergency.
Suspended Ceiling	Unbraced suspended ceilings may fall, striking occupants and blocking exits.
Decorative Ceiling or Lattice Work	Unsecured decorative ceiling/lattice work may fall, striking occupants below or blocking hallways and exits during an emergency.
Interior Walls	Nonstructural interior walls may be constructed with lightweight materials (gypsum wall board over metal or wood studs) or heavy materials (masonry or brick). Walls may be full height (extend from floor to roof) or partial height with bracing (top of wall occurs just above the ceiling and braces are provided up to the roof). If the partition is used to support other nonstructural items, the wall will be subject to additional loading. Heavy walls are particularly vulnerable to failing in an earthquake and may strike occupants and block exits.
Free-standing and Cubical Partitions	Tall, free-standing partitions may tip over, striking occupants and blocking exits.
Built-in Casework	Built-in cabinets and casework may separate from wall and tip over. Upper casework may fall, striking occupants below or blocking exits.
Electrical Cabling	Unsecured cables may fall and pull down other items, resulting in loss of function.
Suspended Electrical Conduit	Conduit may fall, striking occupants below and blocking exits. Damage to conduit may result in loss of electricity.

Principal Concerns for Unbraced Building Components and Equipment (continued)	
Suspended Piping	Pipes may fall, striking occupants below or blocking exits. Gas pipes may break, causing fire or explosion. Pressure pipes may break, becoming a live "whip" that could injure occupants. Water pipes may break causing flooding. Steam pipes may break, burning occupants below or nearby.
Suspended Ductwork	Unsecured ducts may fall, injuring occupants below. Fallen ducts may block exits.
Electrical Equipment	Unsecured electrical equipment may slide or fall, interrupting vital utility services in an emergency, injuring occupants, blocking exits, or damaging electrical wiring that would cause electrical shocks or fires.
Mechanical Equipment	Unsecured mechanical equipment may slide or fall, striking occupants nearby; blocking exits; damaging electrical wiring, water lines, or gas lines; and causing interruption to vital utility services.
Plumbing Equipment	Unsecured plumbing equipment may slide or fall, striking occupants, spilling hot water on floor or occupants, rupturing gas lines, flooding areas, blocking exits, and causing interruption to vital utility services.
Water Heater	Unsecured water heater may slide or fall, striking occupants, spilling hot water on floor or occupants, or rupturing gas lines.
Suspended Space Heaters or AC Units	Unsecured suspended space heaters/AC units may fall, striking occupants below, damaging electrical wires that may cause electrical shocks and fire, or blocking doors and exits during an emergency. They may sway, damaging nearby pipes, ducts, ceilings, walls, or conduits.
Commercial Kitchen Equipment	Kitchen equipment is often on wheels to accommodate cleaning. Unrestrained kitchen equipment may roll around or tip over striking occupants, blocking exits, and rupturing gas and water lines.
Vending Machines	Vending machines may tip over, striking occupants and blocking exits.
Open Shelving Storage Racks	Storage racks may overturn, and contents may fall. Broken glass, spilled chemicals, and loss of inventory may result. Exits may be blocked.

Exterior Components

Exterior components include nonstructural components on or outside of the building such as cladding, canopies, and fences. Nonstructural building exterior components that are improperly anchored can be hazardous during an earthquake as they can fall onto outdoor occupied spaces, such as playgrounds and assembly areas, block building exits, or block driveways used for emergency vehicles.

Exterior components are also some of the more difficult hazards to evaluate, often requiring review of the original construction drawings, invasive exterior investigation, or recognizing signs of stress (e.g., separating plaster soffit). Their mitigation measures are too varied and dependent on specific existing conditions to be provided within the scope of this guide. It is expected that when evaluating exterior building components, users of this guide will consult with a California-licensed architect or structural engineer.

2018 Anchorage Earthquake damage to Anchorage School District, Alaska (from the Earthquake Engineering Research Institute).

The following table presents principal concerns associated with common exterior components. Some of the components listed are technically structural rather than nonstructural, such as covered walkways. These structural components are included

here because they present earthquake hazards similar to nonstructural components and may be overlooked in structural seismic evaluations.

Principal Concerns for Exterior Components	
Windows or Entry Glass	Glass may fall, injuring occupants or blocking doors and exits.
Tile Roofing	Unsecured roof tiles may fall, injuring occupants below or blocking hallways and exits.
Lath and Plaster Soffit	Plaster that is cracked, deteriorated, or supported with corroded steel wires or framing may collapse, striking occupants below or blocking hallways and exits.
Heavy Cladding	Heavy cladding not properly anchored to the building structure may fall off the building, striking occupants below or blocking exits.
Veneer	Adhered or anchored veneer on the building exterior such as tile, masonry, and stone may fall off the building, striking occupants below or blocking exits.
Cantilevered Canopies	Cantilevered canopies (those that project from the face of the building without posts) braced with chains (rather than solid shapes) may collapse, striking occupants below or blocking exits.
Freestanding Canopies	Canopies that are not properly designed or are deteriorated may collapse. Those that are near entrances pose the most risk of striking occupants or blocking exits.
Freestanding Walls and Fences	Unreinforced masonry walls and fences are brittle and therefore vulnerable to failure in an earthquake. Walls and fences with inadequate foundations may tip over or collapse completely. Falling walls and fences may cause injury or block access for pedestrians and emergency vehicles. When fences serve as a security perimeter, their failure may result in a security breach.
Covered Walkways	Where covered walkways connect buildings, they are susceptible to failure when those buildings shake during earthquakes. Damaged walkways can fall, striking occupants and blocking exits.
Solar Panels	Solar panels not anchored or ballasted in accordance with modern codes may fall off roofs, injuring occupants and blocking exits.
Signs, Marquees, and Scoreboards	Unsecured signs, marquees, and scoreboards may fall, injuring occupants and blocking exits.

Specialty Components

In addition to classrooms and offices, schools include a wide variety of specialty spaces for Career Technology Education (CTE), visual and performing arts, and athletics. Examples of these spaces include theaters, art rooms, athletic facilities, wood shops, and teaching kitchens. These spaces include unique nonstructural components with unique hazards. For example, theatres often have lighting, rigging, and cloud ceilings that can fall if inadequately braced and block important exit paths for large groups.

Evaluation and anchorage of these components will often require engineering, but the hazards associated with some of these components may be reduced using the strategies provided in this guide for similar components.

The following photos show examples of specialty components in undamaged conditions.

Applied technology lab equipment at San Mateo Union School District in California (from Technical Imagery Studios).

Weight room equipment at Fremont Union High School in California (from M. Quattrocchi).

Teaching kitchen at Mountain View-Los Altos Union High School District in California (from Technical Imagery Studios).

Machine shop at Napa Valley Unified School District in California (from M. Quattrocchi).

Performing arts theater at San Mateo Union High School District, California (from Technical Imagery Studios).

Chapter 3: How to Use Checklists and Details for Component Installation

Addressing nonstructural earthquake hazards in an existing school facility consists of two steps: identifying problems and fixing them. In this guide, checklists serve the first step and installation details serve the second. The checklists in this guide can be used to survey a single room or an entire school district for nonstructural earthquake hazards. The completed checklist serves as both a list of hazards and a roadmap for addressing them. For common components with straightforward fixes, the checklist points to an installation detail. These details provide instructions for how to anchor or brace the component such that it is no longer hazardous.

This chapter of the guide provides practical guidance on how to use the checklists and details to make a school safer in earthquakes.

Checklists

This guide presents two checklists for identifying nonstructural earthquake hazards in California schools. For each hazard, the checklist provides recommended actions to mitigate the hazard.

- The **School Checklist** consists of a three-part form grouped by category: furniture and contents; building components and equipment; and exterior components. It covers over fifty component types and can be used to conduct a comprehensive review of nonstructural hazards throughout a school building, inside and out.

  See page A-1 for the checklist section on *Furniture and Contents*.

  See page B-1 for the checklist section on *Building Components and Equipment*.

  See page C-1 for the checklist section on *Exterior Components*.

- The **Classroom Checklist** is a short form that can be used to identify the most common nonstructural hazards within an individual classroom.

  See page D-1 for *Classroom Checklist*.

Print multiple copies of the checklists as needed to review all rooms and areas of a school.

COMPLETING THE CHECKLIST

It is recommended to record the facility name, room ID, survey date, and surveyor ID on each checklist for future reference.

For each component, the checklist includes a yes/no question designed to help the surveyor identify whether the component poses a hazard.

- If the answer is **Yes**, the component is unlikely to pose a hazard.
- If the answer is **No**, action to mitigate the hazard is required.
- If the answer is **Do not know**, further evaluation is required. In some cases, the surveyor may find it helpful to review the **Detail** associated with the component in question and determine whether restraints exist similar to those shown in the component illustration. A more knowledgeable surveyor may refer to resources such as FEMA E-74 for information about restraining more complex components. Alternatively, it may be necessary to engage a qualified design professional to review the condition to determine if there is a hazard posed.

For each component, the checklist indicates the **Recommended Action(s)** to be taken to mitigate the hazard. In some cases, a **Detail** is referenced or the surveyor is directed to engage a design professional. **For the purpose of this Guide, the term "design professional" shall be defined as a California licensed architect or structural engineer.**

If the component is not present in the space being reviewed, the surveyor checks the **Not present** box.

Finally, a space is provided for the surveyor to make notes. This may be used to indicate where there are multiple components or special conditions.

Seismic bracing of pipes and electrical conduit is essential for keeping schools open after an earthquake. When completing the *Building Components and Equipment* checklist section, refer to **Help Guide: Pipe and Conduit Bracing** (page F-1) for guidance in determining if pipes and conduit are already braced or not.

Details for Nonstructural Component Installation

Installation instructions are provided for a variety of nonstructural components commonly found in schools. For each component, the **Detail** shows how to anchor or brace the component to minimize the likelihood that it will fall, slide, or tip over in the event of an earthquake. The **Detail** can be used as guidance to secure existing components and to install new components as they are brought into the school. Each **Detail** can be directly implemented by school facility directors, custodians, and

contracted personnel, such as construction managers. Some of the work may be completed by classroom volunteers.

Some nonstructural components are complex and have multiple anchorage options that are too varied to be provided with generic anchorage illustrations. For these components, it is expected that school staff will consult with a California-licensed architect or structural engineer to design the necessary anchorage.

Each **Detail** includes an illustration, material list, conditions of use, and installation instructions.

Where individuals with construction experience and access to specialty tools are required for installation, the **Detail** includes this symbol.

ILLUSTRATION

Each **Detail** includes a 3D illustration. The illustration shows a representative version of the component, the context of the supporting structure (i.e., walls, floor, and/or ceiling), and the anchorage hardware. Although blue highlighting is used to draw attention to special elements (typically the anchorage hardware), all illustrations are readable if printed in black and white.

MATERIAL LIST

Each **Detail** includes a material list to specify the anchorage hardware required for the installation. Quantities are not listed in the material list, but can be determined by reviewing the illustration and the installation instructions.

The material list includes fasteners and connection hardware. Fasteners include wood screws, sheet metal screws, concrete expansion anchors, and powder-actuated fasteners. Fasteners vary depending on whether the base material is wood, steel, or concrete. Connection hardware includes steel angles, steel wire, chain, channel strut and bolts, pipe clamps, and wall plates.

All of the materials listed are generic and typically available at local hardware supply stores. Where concrete anchors are used (e.g., expansion anchors, powder-actuated fasteners), it is recommended that the user purchase items that have an ICC Evaluation Report (ICC-ES) Report and are rated for seismic use in cracked concrete. Where adhesives are used, it is recommended that the user purchase items that are specifically indicated for seismic use.

There are proprietary products available that may simplify some of the anchorage details. If desired, the user should install such products in accordance with the requirements of the individual product.

Use of the proper fastener is essential. Refer to **Help Guide: Selecting the Right Fastener** (page G-1) for guidance in selecting the right fastener for your condition.

CONDITIONS OF USE

Users of this guide are expected to review their specific component and support structure for consistency with the **Detail**.

Each **Detail** includes a list of **Conditions of Use**. This identifies limits of the **Detail**, such as weight limit for the component and requirements for the support structure.

Details for floor-supported items are typically limited to 400 pounds and **Details** for wall- or ceiling-mounted items are typically limited to 20 pounds. Above this weight, an engineered seismic design by a structural engineer and approval by California Division of State Architect (DSA) is typically required.

Where conditions vary from the illustrations or notes, or do not comply with the stated **Conditions of Use**, it is expected that school staff will consult with a California licensed architect or structural engineer for evaluation and any necessary mitigation design.

Where heavy items are secured to walls, it is imperative that wall studs be full height or fully braced. Refer to **Help Guide: Securing to Existing Stud Walls** (page H-1) for guidance in determining whether a wall is adequate for use in securing heavy items.

INSTALLATION INSTRUCTIONS

Each **Detail** includes step-by-step instructions for proper installation of the component.

Some of the steps require installation verification to ensure proper installation and to provide quality assurance. Installation verification instructions are provided in ***bold and italics*** to emphasize the importance of checking compliance with the instructions. Complete the installation verification before moving on to the next step.

See Section E for the **Details**. For a list of all details, refer to the following table.

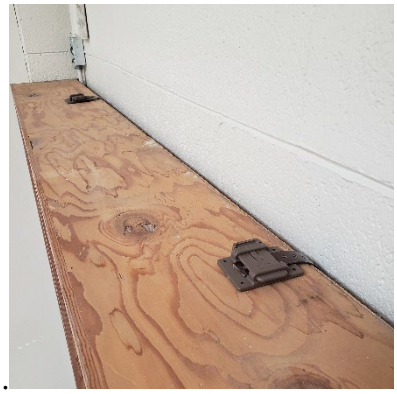
Details for Component Installation

No.	Name	
1	Short Bookcase	
2	Short File Cabinet	
3	Tall Bookcase (with solid backing)	
4	Tall Bookcase (without solid backing)	✓
5	File Cabinet (floor mount)	✓
6	Lateral File Cabinet	
7	File Cabinet (floor and wall mount)	✓
8	Metal Lockers	
9	Teacher's Cabinet	
10	Display Case with Trophies/Art Objects	
11	Desktop/Countertop Equipment	
12	Equipment on Wheels	✓
13	Wall-Mounted Shelf	
14	Wall-Mounted Monitor (less than 20 lbs)	
15	Wall-Mounted Monitor (up to 50 lbs)	
16	Dry Erase Board	
17	Wall Decoration or Picture	

No.	Name	
18	Signage	
19	Ceiling-Mounted Video Projector	✓
20	Hanging Display	✓
21	Light Fixture (ceiling recessed)	✓
22	Ceiling Diffuser/HVAC Register	✓
23	Small Conduit and Cables	✓
24	Water Heater	✓
25	Free-Standing/Cubical Partition	✓
26	Refrigerator Between Cabinets	
27	Refrigerator (floor mount)	✓
28	Fire Extinguisher (cabinet mount)	
29	Fire Extinguisher (bracket mount)	
30	Gas Cylinders (floor mount)	✓
31	Gas Cylinders (wall mount)	✓
32	Electric Kiln	✓
33	Open Shelving Storage Rack	✓

✓ *Indicates that experience or specialty tools are required*

The following are some mitigation examples.



Seismic restraint strap with adhesive fastener used on low bookcase and desktop printer (photo from Humboldt County Office of Education).

Floor mount for tall bookcase in library (photo from Estructure).

Restraint strap to secure heavy contents (photo from Humboldt County Office of Education).

MODIFICATIONS TO INSTALLATION INSTRUCTIONS

In general, it is not advised to modify the installation procedure for conditions that are not consistent with the **Detail**. However, the following two cases are addressed:

- **Gaps between walls and wall-mounted components:** Many of the details rely on attaching components to a wall. In some cases, there will be a gap between the component and the wall. For example, there may be a baseboard preventing a bookshelf from being placed tight to a wall, or a refrigerator may have wires and piping that require a gap. In cases where a metal angle or clip is used for the attachment to the wall, the angle may be extended to accommodate the gap. In cases where the component is fastened directly to the wall (such as **Detail 3**), the details call for limiting the gap to ¼ inch. If the gap is larger than this, install wood shims between the component and the wall. The length of the shim should match the width of the component and should be located at each row of fasteners. The thickness of the shim should match the gap, and the height of the shim should be approximately 3 inches. Provide longer fasteners to maintain the required embedment in the wall stud.
- **Attaching to concrete masonry walls**: When mounting equipment to concrete or concrete masonry unit (also called CMU, concrete block, or cinderblock) walls, modifications may be necessary. If the concrete or CMU wall is full height, it is generally acceptable to modify a detail showing a wood or metal stud wall by using concrete anchors instead of wood screws or sheet metal screws. Concrete anchors (either expansion anchors or screw anchors) should be selected for the wall material (concrete or CMU), have an ICC-ES Report, and be rated for seismic use in cracked concrete. Follow the manufacturer's requirements for installation and testing.

Refer to **Help Guide: Additional Actions and Resources for School Earthquake Safety** (page H-1) for more resources about school earthquake safety.

Facility Name:		Survey Date:	
Room ID:		Surveyor ID:	

School Earthquake Hazard Checklist: *Furniture and Contents* (5 pages)

Bookcases (Located Near Walls)	□ **Not present**
Are bookcases secured to the wall or floor? □ **Yes** □ **No** → Secure to wall per **Detail 1, 3, or 4**. Move heavy items to lower shelves. □ **Do not know** → Further evaluation required.	**Notes:**
Bookcases (Located Away from Walls)	□ **Not present**
Are freestanding bookcases (i.e., bookcases located away from walls): • Secured to the floor; • Attached back-to-back such that the combined depth is more than two-thirds the height; **or** • Connected to the tops of adjacent bookcases with steel bracing that connects to a wall or floor above? □ **Yes** □ **No** → Move against wall and secure per **Detail 1, 3,** or **4**. If unable to move to a wall, engage a design professional to develop a mitigation design. □ **Do not know** → Further evaluation required.	**Notes:**
File Cabinets	□ **Not present**
Are file cabinets with depth or width less than two thirds the height secured to the wall or floor? □ **Yes** □ **No** → Secure short file cabinets per **Detail 2.** Secure tall file cabinets per **Detail 5 or 7**. Secure lateral file cabinets per **Detail 6**. □ **Do not know** → Further evaluation required.	**Notes:**
Lockers	□ **Not present**
Are lockers secured to the wall? □ **Yes** □ **No** → Secure to wall per **Detail 8**. □ **Do not know** → Further evaluation required.	**Notes:**
Teacher's Cabinets	□ **Not present**
Are teacher's cabinets secured to a wall? □ **Yes** □ **No** → Secure to wall per **Detail 9**. □ **Do not know** → Further evaluation required.	**Notes:**
Wall-Mounted Shelves	□ **Not present**
Are wall-mounted shelves fastened to shelf brackets that are securely attached to the wall? □ **Yes** □ **No** → Secure to wall per **Detail 13**. Secure contents to shelves. □ **Do not know** → Further evaluation required.	**Notes:**

Continues on next page.

Facility Name:		Survey Date:	
Room ID:		Surveyor ID:	

School Earthquake Hazard Checklist: *Furniture and Contents* (continued)

Wall-Mounted Monitors	□ **Not present**
Are monitors secured to the wall? □ **Yes** □ **No** → Secure monitors weighing up to 20 pounds to the wall per **Detail 14** and weighing up to 50 pounds to the wall per **Detail 15**. For larger monitors, mounts with arm extensions, or special mounting conditions, engage a design professional to develop a mitigation design. □ **Do not know** → Further evaluation required.	**Notes:**
Ceiling-Mounted Video Projectors	□ **Not present**
Is the projector support: • Connected directly from the structure above (i.e., not the suspended ceiling) **and** • Rigid and strong enough to resist manually pushing it from side-to-side in all directions? □ **Yes** □ **No** → Secure video projectors weighing up to 20 pounds to the structure above per **Detail 19**. For larger projectors or special mounting conditions, engage a design professional to develop a mitigation design. □ **Do not know** → Further evaluation required.	**Notes:**
Dry Erase Boards	□ **Not present**
Are all dry erase boards, chalk boards, and bulletin boards securely attached to the wall? □ **Yes** □ **No** → Secure to wall per **Detail 16**. □ **Do not know** → Further evaluation required.	**Notes:**
Wall Decorations and Pictures	□ **Not present**
Are pictures and wall decorations heavier than 3 pounds hung with a closed hook? □ **Yes** □ **No** → Secure to wall per **Detail 17**. □ **Do not know** → Further evaluation required.	**Notes:**
Signage	□ **Not present**
Are signs securely attached to the wall? □ **Yes** □ **No** → Secure to wall per **Detail 18**. For larger signs, engage a design professional to develop a mitigation design. □ **Do not know** → Further evaluation required.	**Notes:**

Continues on next page.

Facility Name:		Survey Date:	
Room ID:		Surveyor ID:	

School Earthquake Hazard Checklist: *Furniture and Contents* (continued)	
Display Cases	□ **Not present**
Are display cases secured to the wall? Are the items in the case secured to the shelves? □ **Yes** □ **No** → Secure to wall per **Detail 10**. Secure contents to shelves. □ **Do not know** → Further evaluation required.	**Notes:**
Hanging Displays	□ **Not present**
Are hanging displays supported directly from the structure above (i.e., not just the ceiling) with a closed hook, and is there clearance for it to swing without striking nearby objects? □ **Yes** □ **No** → Secure to structure above per **Detail 20**. For unique items and special mounting conditions, engage a design professional to develop a mitigation design. □ **Do not know** → Further evaluation required.	**Notes:**
Desktop and Countertop Equipment	□ **Not present**
Are items on desktops, counters, or lab benches securely attached to the counter surface as needed in order to prevent them from sliding, tipping, falling or breaking? □ **Yes** □ **No** → Engage a design professional to develop a mitigation design. Note: If items DO NOT meet any of the above-listed criteria, and are not securely attached, secure to the surface of desk, counter or bench per **Detail 11**. □ **Do not know** → Further evaluation required.	**Notes:**
Equipment on Wheels	□ **Not present**
Is equipment on wheels: • Located away from exits **and** • Secured to the wall, if the height is more than two times the depth or width? □ **Yes** □ **No** → Secure tall or heavy equipment to wall per **Detail 12**. When not in use, lock wheels. Secure equipment to cart. □ **Do not know** → Further evaluation required.	**Notes:**
Continues on next page.	

Facility Name:		Survey Date:	
Room ID:		Surveyor ID:	

School Earthquake Hazard Checklist: *Furniture and Contents* (continued)	
Fire Extinguishers	□ **Not present**
Are fire extinguishers secured to the wall? □ **Yes** □ **No** → Secure cabinet-mounted fire extinguishers to wall per **Detail 28**. Secure bracket-mounted fire extinguishers to wall per **Detail 29**. □ **Do not know** → Further evaluation required.	**Notes:**
Gas Cylinders and Tanks	□ **Not present**
Are gas cylinders and tanks secured to the wall or kept within an anchored storage rack? □ **Yes** □ **No** → Secure to wall per **Detail 30** or keep within storage rack that is secured to floor per **Detail 31**. □ **Do not know** → Further evaluation required.	**Notes:**
Aquariums and Terrariums	□ **Not present**
Are aquariums and terrariums secured to a desk or counter? □ **Yes** □ **No** → Secure to counter surface per **Detail 11.** For larger tanks, engage a design professional to develop a mitigation design. □ **Do not know** → Further evaluation required.	**Notes:**
Kilns	□ **Not present**
Are kilns secured to the floor? □ **Yes** □ **No** → Secure to floor per **Detail 32.** For larger and other types of kilns, engage a design professional to develop a mitigation design. □ **Do not know** → Further evaluation required.	**Notes:**
Shop and Athletic Equipment	□ **Not present**
Is shop and gym equipment secured to the floor or wall? □ **Yes** □ **No** → Engage a design professional to develop a mitigation design. □ **Do not know** → Further evaluation required.	**Notes:**
Refrigerators	□ **Not present**
Are refrigerators secured to the floor or wall? □ **Yes** □ **No** → Secure to wall or floor per **Detail 26** or **Detail 27**. For larger refrigerators and special conditions, engage a design professional to develop a mitigation design. □ **Do not know** → Further evaluation required.	**Notes:**
Continues on next page.	

Facility Name:		Survey Date:	
Room ID:		Surveyor ID:	

School Earthquake Hazard Checklist: *Furniture and Contents*	(last page)
Other Items	□ **Not present**
Describe other heavy, tall, or overhead items:	

Facility Name:		Survey Date:	
Room ID:		Surveyor ID:	

School Earthquake Hazard Checklist: *Building Components and Equipment* (5 pages)

Hanging Light Fixtures	□ **Not present**
Are hanging (pendant) light fixtures secured to the structure (i.e., not just the ceiling) with a closed hook? Is there clearance for the light fixtures to swing without striking nearby objects? □ **Yes** □ **No** → Engage a design professional to develop a mitigation design. □ **Do not know** → Further evaluation required.	**Notes:**
Ceiling-Recessed Light Fixtures	□ **Not present**
Are light fixtures that are recessed in suspended ceiling systems supported with wires connected to the structure above? □ **Yes** □ **No** → Secure light fixtures up to 56 pounds to structure above per **Detail 21**. For heavier lights and other configurations, engage a design professional to develop a mitigation design. □ **Do not know** → Further evaluation required.	**Notes:**
Ceiling Diffusers and HVAC Registers	□ **Not present**
Are ceiling diffusers and HVAC registers supported with wires that are connected to the structure above? □ **Yes** □ **No** → Secure to structure above per **Detail 22**. □ **Do not know** → Further evaluation required.	**Notes:**
Suspended Ceilings	□ **Not present**
In rooms with areas over 144 square feet, are suspended ceilings braced? □ **Yes** □ **No** → Engage a design professional to develop a mitigation design. Preapproved designs are available. □ **Do not know** → Further evaluation required.	**Notes:**
Decorative Ceilings or Lattice Work	□ **Not present**
Are decorative ceilings and lattice work braced? □ **Yes** □ **No** → Engage a design professional to develop a mitigation design. □ **Do not know** → Further evaluation required.	**Notes:**
Interior Walls (Partitions)	□ **Not present**
Are interior walls lightweight and either full height or braced? □ **Yes** □ **No** → Engage a design professional to evaluate existing walls and, if required, develop a mitigation design. □ **Do not know** → Further evaluation required.	**Notes:**

Continues on next page.

Facility Name:		Survey Date:	
Room ID:		Surveyor ID:	

School Earthquake Hazard Checklist: ***Building Components and Equipment***	(continued)
Free-standing or Cubical Partitions	□ **Not present**
Are free-standing and cubical partitions interconnected to form a stable footprint? □ **Yes** □ **No** → Engage a design professional to develop a mitigation design. If 4 feet tall or less, option to configure per **Detail 25**. □ **Do not know** → Further evaluation required.	**Notes:**
Built-in Casework	□ **Not present**
Are cabinets and casework, especially upper casework, securely fastened to wall? □ **Yes** □ **No** → Engage a design professional to develop a mitigation design. Secure doors and drawers with latches. □ **Do not know** → Further evaluation required.	**Notes:**
Light Electrical Cabling and Small Conduits	□ **Not present**
Is light cabling (5 pounds per foot or lighter) and small conduit (2-inch diameter or smaller) supported along its length? □ **Yes** □ **No** → Support per **Detail 23**. □ **Do not know** → Further evaluation required.	**Notes:**
Heavy Electrical Cabling and Large Conduits	□ **Not present**
Is suspended heavy cabling (weighing more than 5 pounds per foot) and large conduit (2½-inch diameter and larger) braced in transverse and longitudinal directions? □ **Yes** □ **No** → Engage a design professional to evaluate and, if required, develop a mitigation design. □ **Do not know** → Further evaluation required.	**Notes:**
Fire Sprinkler Pipes	□ **Not present**
Are fire sprinkler feed and cross mains braced in transverse and longitudinal directions? Do all branch lines have end-of-line restraints? □ **Yes** □ **No** → Engage a design professional to evaluate and, if required, develop a mitigation design. □ **Do not know** → Further evaluation required.	**Notes:**
Large Pipes	□ **Not present**
Are suspended large pipes (3½-inch diameter and larger) braced in transverse and longitudinal directions? □ **Yes** □ **No** → Engage a design professional to evaluate and, if required, develop a mitigation design. □ **Do not know** → Further evaluation required.	**Notes:**
Continues on next page.	

Facility Name:		Survey Date:	
Room ID:		Surveyor ID:	

School Earthquake Hazard Checklist: ***Building Components and Equipment*** (continued)	
Pipes Conveying Hazardous Materials	□ **Not present**
Are suspended pipes that convey hazardous materials braced in transverse and longitudinal directions? □ **Yes** □ **No** → Engage a design professional to evaluate and, if required, develop a mitigation design. □ **Do not know** → Further evaluation required.	**Notes:**
Pipes Conveying Gas	□ **Not present**
Do pipes conveying gas have seismic shut-off valves? □ **Yes** □ **No** → Install seismic shut-off valve. □ **Do not know** → Further evaluation required.	**Notes:**
Utility Connections to Equipment	□ Not present
Do utilities have flexible connections where attached to equipment? □ **Yes** □ **No** → Engage a design professional to evaluate and, if required, develop a mitigation design. □ **Do not know** → Further evaluation required.	**Notes:**
Large Ducts	□ **Not present**
Are large ducts (cross-sectional area larger than 6 square feet) braced in transverse and longitudinal directions? □ **Yes** □ **No** → Engage a design professional to evaluate and, if required, develop a mitigation design. □ **Do not know** → Further evaluation required.	**Notes:**
Electrical Equipment	□ **Not present**
Is electrical equipment secured to the floor or wall? □ **Yes** □ **No** → Engage a design professional to evaluate and, if required, develop a mitigation design. □ **Do not know** → Further evaluation required.	**Notes:**
Mechanical Equipment	□ **Not present**
Is mechanical equipment secured to the floor or wall? □ **Yes** □ **No** → Engage a design professional to evaluate and, if required, develop a mitigation design. □ **Do not know** → Further evaluation required.	**Notes:**
Plumbing Equipment	□ **Not present**
Is plumbing equipment secured to the floor or wall? □ **Yes** □ **No** → Engage a design professional to evaluate and, if required, develop a mitigation design. □ **Do not know** → Further evaluation required.	**Notes:**
Continues on next page.	

Facility Name:		Survey Date:	
Room ID:		Surveyor ID:	

School Earthquake Hazard Checklist: ***Building Components and Equipment***	(continued)
Water Heaters	□ **Not present**
Are water heaters secured to the wall? Are there flexible connections for gas lines that are attached to the water heater? □ **Yes** □ **No** → Secure water heaters up to 75 gallons in capacity to wall per **Detail 24**. For larger water heaters and special conditions, engage a design professional to develop a mitigation design. □ **Do not know** → Further evaluation required.	**Notes:**
Suspended Space Heaters and Air Conditioning Units	□ **Not present**
Are all suspended space heaters and air conditioning units supported from structure above, braced in all directions, and are there flexible connections for utilities attached to the equipment? □ **Yes** □ **No** → Engage a design professional to evaluate and, if required, develop a mitigation design. □ **Do not know** → Further evaluation required.	**Notes:**
Commercial Kitchen Equipment	□ **Not present**
Is commercial kitchen equipment (e.g., refrigerators, freezers, stoves, fryers) secured to the wall or floor? □ **Yes** □ **No** → Engage a design professional to develop a mitigation design. □ **Do not know** → Further evaluation required.	**Notes:**
Vending Machines	□ **Not present**
Are vending machines secured to the wall or floor? □ **Yes** □ **No** → Engage a design professional to develop a mitigation design. □ **Do not know** → Further evaluation required.	**Notes:**
Open Shelving Storage Racks	□ **Not present**
Are open shelving storage racks secured to the wall or floor? □ **Yes** □ **No** → Secure to wall per **Detail 33**. For other configurations, engage a design professional to develop a mitigation design. □ **Do not know** → Further evaluation required.	**Notes:**
Continues on next page.	

Facility Name:		Survey Date:	
Room ID:		Surveyor ID:	

School Earthquake Hazard Checklist: ***Building Components & Equipment***	(last page)
Other Items	□ **Not present**
Describe other heavy, tall, or overhead items:	

Facility Name:		Survey Date:	
Room ID:		Surveyor ID:	

School Earthquake Hazard Checklist: *Exterior Hazards* (2 pages)

Windows/Entry Glass	□ **Not present**
Does all glass near exitways have safety glazing? □ **Yes** □ **No** → Replace with safety glazing. Landscape around hazardous areas to keep occupants out. □ **Do not know** → Further evaluation required.	**Notes:**
Tile Roofing	□ **Not present**
If roofing has tiles, are the roof tiles secured to the roof? □ **Yes** □ **No** → Engage a design professional to develop a mitigation design. □ **Do not know** → Further evaluation required.	**Notes:**
Lath and Plaster Soffit	□ **Not present**
Are lath and plaster soffits free of large cracks, excessive sagging, and separation from the substrate? □ **Yes** □ **No** → Engage a design professional to evaluate and, if required, develop a mitigation design. □ **Do not know** → Further evaluation required.	**Notes:**
Heavy Cladding	□ **Not present**
Is the building cladding constructed with lightweight materials or were heavy cladding panels and connections engineered to resist earthquakes? □ **Yes** □ **No** → Engage a design professional to evaluate and, if required, develop a mitigation design. □ **Do not know** → Further evaluation required.	**Notes:**
Veneer	□ **Not present**
Has the veneer been adequately maintained? Is it free of cracked and loose sections? Are the anchors free of corrosion? □ **Yes** □ **No** → Engage a design professional to evaluate and, if required, develop a mitigation design. □ **Do not know** → Further evaluation required.	**Notes:**
Canopies	□ **Not present**
Are canopies braced to the structure with steel shapes (not chains) to provide restraint and prevent bouncing? □ **Yes** □ **No** → Engage a design professional to evaluate and, if required, develop a mitigation design. □ **Do not know** → Further evaluation required.	**Notes:**
Continues on next page.	

Facility Name:		Survey Date:	
Room ID:		Surveyor ID:	

School Earthquake Hazard Checklist: *Exterior Hazards*	(last page)
Freestanding Walls and Fences	□ **Not present**
Are freestanding masonry walls and fences plumb? □ **Yes** □ **No** → Engage a design professional to evaluate and, if required, develop a mitigation design. □ **Do not know** → Further evaluation required.	**Notes:**
Signs, Marquees, Scoreboards, and Exterior Lettering	□ **Not present**
Are all signs, marquees, scoreboards, and exterior lettering secured? □ **Yes** □ **No** → Engage a design professional to evaluate and, if required, develop a mitigation design. □ **Do not know** → Further evaluation required.	**Notes:**
Solar Panels	□ **Not present**
Are solar panels anchored to the structure or ballasted? □ **Yes** □ **No** → Engage a design professional to evaluate and, if required, develop a mitigation design. □ **Do not know** → Further evaluation required.	**Notes:**
Bleachers	□ **Not present**
Are bleachers secured to the floor or wall and are foldable bleachers fitted with a restraining element when folded? □ **Yes** □ **No** → Engage a design professional to evaluate and, if required, develop a mitigation design. □ **Do not know** → Further evaluation required.	**Notes:**
Other Items	□ **Not present**
Describe other heavy, tall, or overhead items:	

Facility Name:		Survey Date:	
Room ID:		Surveyor ID:	

Classroom Earthquake Hazard Checklist (2 pages)

Note: This list is not all-inclusive. It focuses on the most common classroom furnishings and contents, and provides recommended actions to reduce earthquake hazards in the classroom.

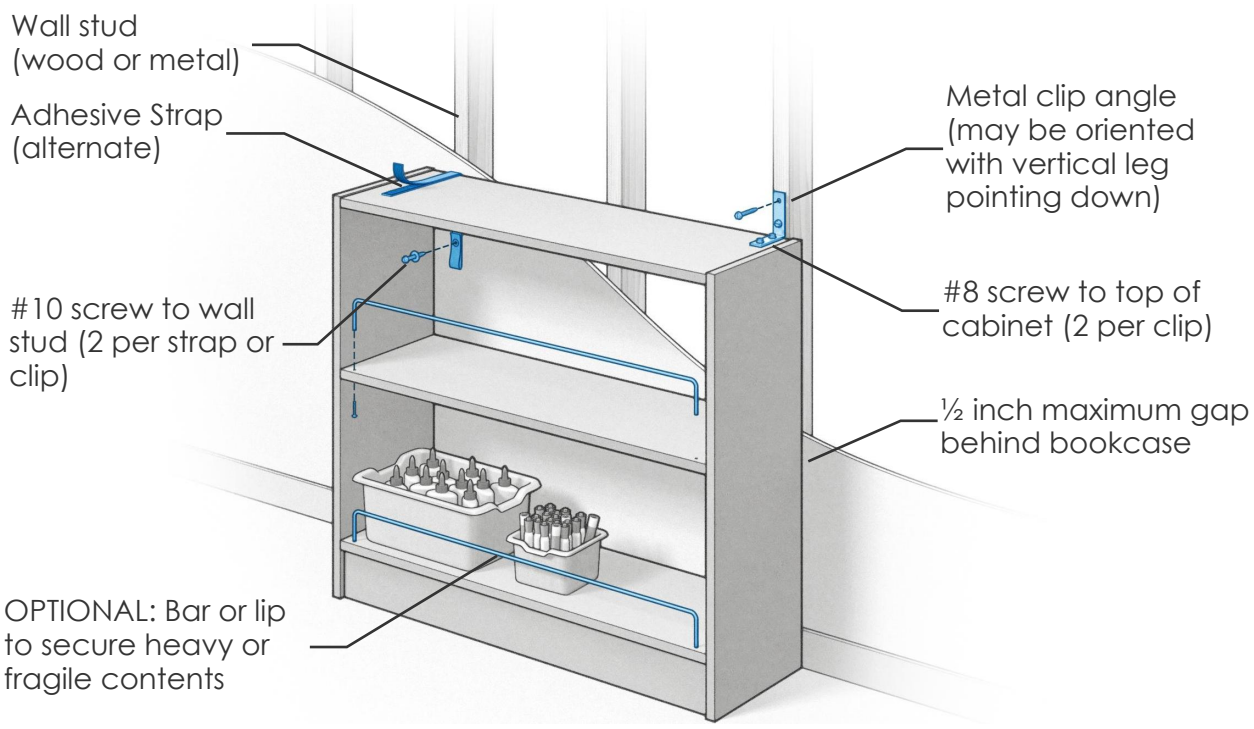
Bookcases	□ **Not present**
Are bookcases secured to the wall or floor? □ **Yes** □ **No** → Secure to wall per **Detail 1, 3, or 4**. Move heavy items to lower shelves. □ **Do not know** → Further evaluation required.	**Notes:**
File Cabinets	□ **Not present**
Are file cabinets with depth or width less than two thirds the height secured to the wall or floor? □ **Yes** □ **No** → Secure short file cabinets per **Detail 2.** Secure tall file cabinets per **Detail 5 or 7**. Secure lateral file cabinets per **Detail 6**. □ **Do not know** → Further evaluation required.	**Notes:**
Teacher's Cabinets	□ **Not present**
Are teacher's cabinets secured to a wall? □ **Yes** □ **No** → Secure to wall per **Detail 9**. □ **Do not know** → Further evaluation required.	**Notes:**
Wall-Mounted Shelves	□ **Not present**
Are wall-mounted shelves fastened to shelf brackets that are securely attached to the wall? □ **Yes** □ **No** → Secure to wall per **Detail 13**. Secure contents to shelves. □ **Do not know** → Further evaluation required.	**Notes:**
Wall-Mounted Monitor	□ **Not present**
Are all monitors secured to the wall? □ **Yes** □ **No** → Secure monitors weighing up to 20 pounds to the wall per **Detail 14** and weighing up to 50 pounds to the wall per **Detail 15**. For larger monitors, mounts with arm extensions, or special mounting conditions, engage a design professional to develop a mitigation design. □ **Do not know** → Further evaluation required.	**Notes:**
Ceiling-Mounted Video Projectors	□ **Not present**
Is the projector support: • Connected directly from the structure above (i.e., not the suspended ceiling) **and** • Rigid and strong enough to resist manually pushing it from side-to-side in all directions? □ **Yes** □ **No** → Secure video projectors weighing up to 20 pounds to the structure above per **Detail 19**. For larger projectors or special mounting conditions, engage a design professional to develop a mitigation design. □ **Do not know** → Further evaluation required.	**Notes:**

Continues on next page.

Facility Name:		Survey Date:	
Room ID:		Surveyor ID:	

Classroom Earthquake Hazard Checklist (last page)	
Dry Erase Boards	□ **Not present**
Are all dry erase boards, whiteboards, chalk boards, and bulletin boards securely attached to the wall? □ **Yes** □ **No** → Secure to wall per **Detail 16.** □ **Do not know** → Further evaluation required.	**Notes:**
Wall Decorations and Pictures	□ **Not present**
Are pictures and wall decorations heavier than 3 pounds hung with a closed hook? □ **Yes** □ **No** → Secure to wall per **Detail 17**. □ **Do not know** → Further evaluation required.	**Notes:**
Hanging Displays	□ **Not present**
Are hanging displays supported directly from the structure above (i.e., not just the ceiling) with a closed hook and is there clearance for it to swing without striking nearby objects? □ **Yes** □ **No** → Secure to structure above per **Detail 20**. For unique items and special mounting conditions, engage a design professional to develop a mitigation design. □ **Do not know** → Further evaluation required.	**Notes:**
Desktop and Countertop Equipment, Aquariums, Terrariums	□ **Not present**
Are items on desktops, counters, or lab benches, including aquariums and terrariums, securely attached to the counter surface as needed in order to prevent them from sliding, tipping, falling or breaking? □ **Yes** □ **No** → Engage a design professional to develop a mitigation design. Note: If items DO NOT meet any of the above-listed criteria, and are not securely attached, secure to the surface of desk, counter or bench per **Detail 11**. □ **Do not know** → Further evaluation required.	**Notes:**
Equipment on Wheels	□ **Not present**
Is equipment on wheels: • Located away from exits **and** • Secured to the wall, if the height is more than two times the depth or width? □ **Yes** □ **No** → Secure tall or heavy equipment to wall per **Detail 12**. When not in use, lock wheels. Secure equipment to cart. □ **Do not know** → Further evaluation required.	**Notes:**

1 Short Bookcase



Material List

- Metal clip angles (2½ by 2½ by ⅛ inch thick by ¾ inch wide) or seismic adhesive straps
- #10 wood screws by 2 inch long (wood studs) or #10 sheet metal screws by 1½ inch long (metal studs)
- #8 wood screws by ¾ inch long

Conditions of Use

- Weight including contents is 400 pounds or less
- Height is 5 feet or less
- Solid top shelf: ¾ inch minimum solid wood or particle board

Installation

STEP 1: Locate wall studs. Attach to two wall studs minimum for bookcases up to 4 feet wide and three wall studs minimum for bookcases up to 8 feet wide.

STEP 2: Screw clip angles or adhesive straps to wall stud.

At wood studs: Install two #10 wood screws through clip or strap into middle of stud.

Verify screws are embedded at least 1¼ inches into wood stud.

At metal studs: Install two #10 sheet metal screws through clip or strap into stud.

Verify screws are embedded into metal stud.

STEP 3: Place bookcase against wall with ½ inch maximum gap between wall and bookcase.

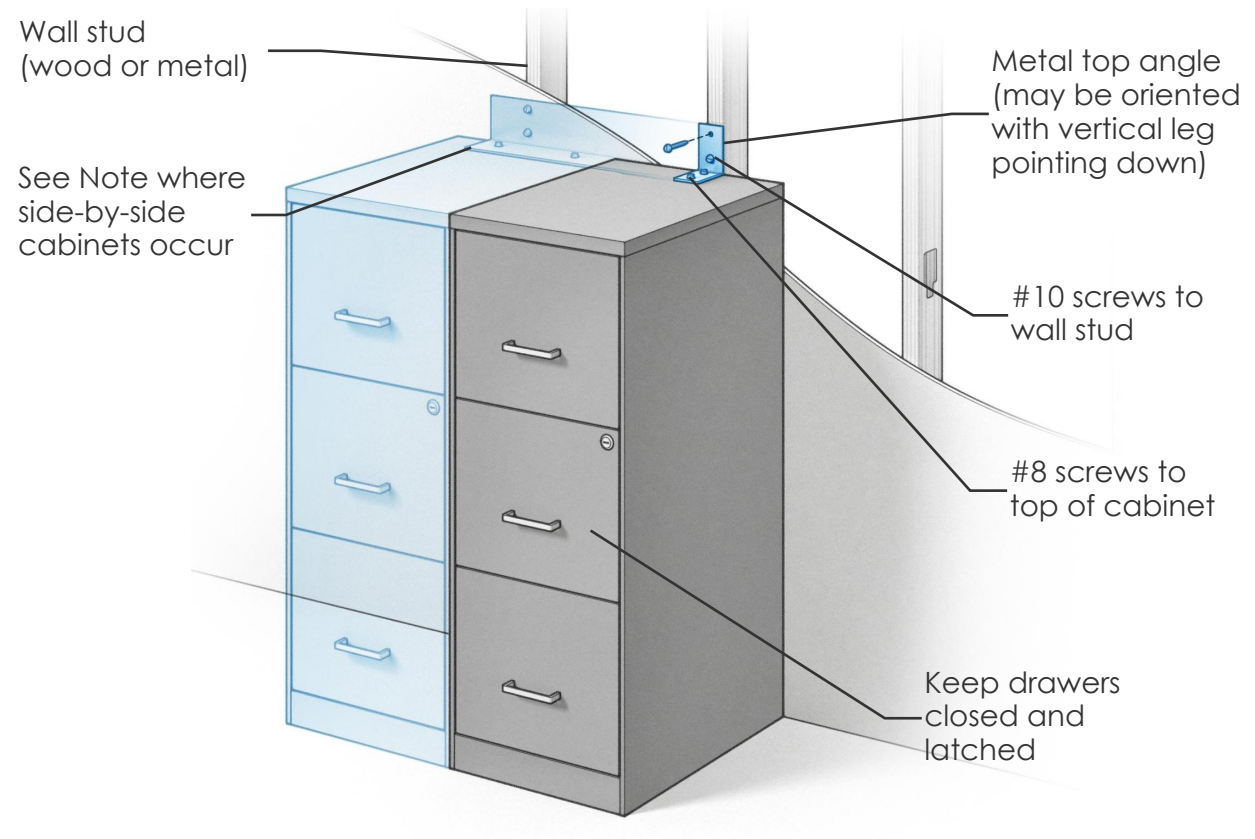
STEP 4: Attach clip angle or strap to bookcase.

At metal clip: Screw two #8 wood screws into top of bookcase.

At adhesive strap: Attach adhesive strap to top of bookcase per product instructions.

Pull top of bookcase away from wall with at least 50 pounds of force to verify adhesive installation.

2 Short File Cabinet



Material List

- Metal top angle (3 inch by 3 inch by ⅛ inch thick and 2 inches long)
- #10 wood screws by 2½ inch long (wood studs) or #10 sheet metal screws by 1½ inch long (metal studs)
- #8 sheet metal screws by ¾ inch

Conditions of Use

- Height is 42 inches or less
- No more than three drawers
- Weight including contents is 400 pounds or less

Installation

STEP 1: Place cabinet against wall with 1 inch maximum gap between back of cabinet and wall.

STEP 2: Locate wall studs.

STEP 3: Attach angle to wall stud.

At wood studs: Install two #10 wood screws through angle into center of each stud.

Verify screws are embedded at least 1¼ inches into wood stud.

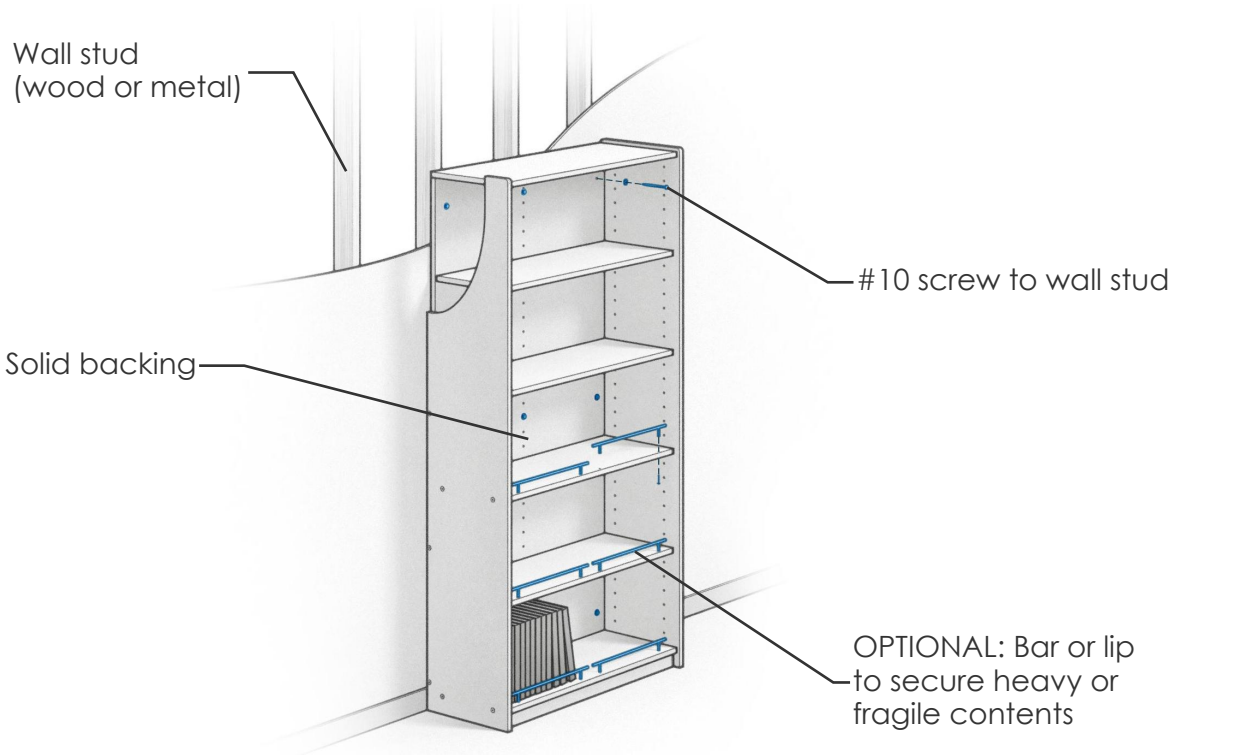
At metal studs: Install two #10 sheet metal screws through angle into each stud.

Verify screws are embedded into metal stud.

STEP 4: Screw angle into top of cabinet with three #8 screws.

Note: For side-by-side cabinets, use one continuous angle across the tops of all cabinets with two #8 screws to top of each cabinet and two #10 screws to each wall stud.

3 Tall Bookcase (with solid backing)



Material List

- #10 wood screws by 2½ inch long (wood studs) or #10 sheet metal screws by 1½ inch long (metal studs)

Conditions of Use

- Full height wall studs
- Height is 6 feet or less
- Weight including contents is 400 pounds or less
- Solid backing: metal or ⅜ inch minimum solid wood or particle board

Installation

STEP 1: Place bookcase against wall with ¼ inch maximum gap between wall and bookcase. (For larger gap, see note.)

STEP 2: Locate wall studs. Use at least two wall studs for bookcases up to 4 feet wide and three wall studs for bookcases up to 8 feet wide.

Verify wall studs are full height or fully braced.

STEP 3: Attach bookcase to wall studs with three rows of screws. Locate top row of screws within 1 foot of top shelf of bookcase, middle row of screws near mid-height, and bottom row of screws within 1 foot of bottom.

At wood studs: Install wood screws through bookcase into studs.

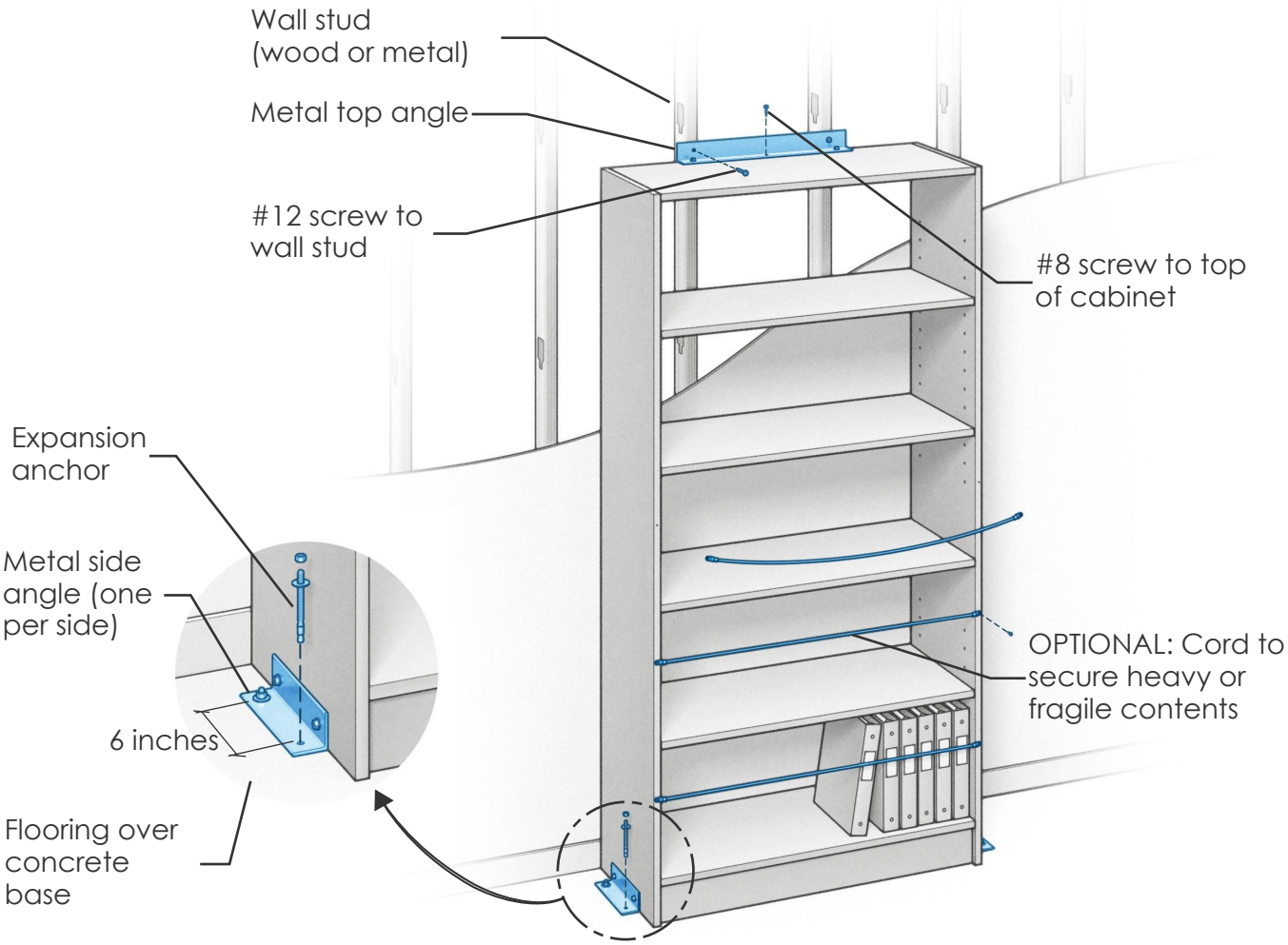
Verify screws are embedded at least 1¼ inches into wood stud.

At metal studs: Install sheet metal screws through bookcase into studs.

Verify screws are embedded into metal stud.

Note: Where gap between bookcase and wall is larger than ¼ inch, provide shims. See Modifications to Installation Instructions.

4 Tall Bookcase (without solid backing)



Material List

- Metal top angle (2 inch by 2 inch by ⅛ inch thick by 20 inches long)
- Metal side angles (2 inch by 2 inch by ¼ inch thick by 8 inches long)
- #12 by 2½ inch wood screw (wood studs) or #12 sheet metal screw by 1½ inch long (metal studs)
- #8 screws by ¾ inch long
- ⅜ inch diameter expansion anchors by 2½ inch long

Conditions of Use

- Full height wall studs
- Height is 6 feet or less
- Weight including contents is 400 pounds or less
- Flooring over 3¼ inch minimum concrete
- Solid top shelf: ¾ inch minimum solid wood or particleboard

Installation

4 Continued

STEP 1: Place bookcase against wall with ½ inch maximum gap between wall and bookcase.

STEP 2: Locate wall studs.

Verify wall studs are full height or fully braced.

STEP 3: Attach top angle to two studs.

At wood studs: Install wood screws through angle into center of studs.

Verify screws are embedded at least 1¼ inches into wood stud.

At metal studs: Install sheet metal screws through angle into studs.

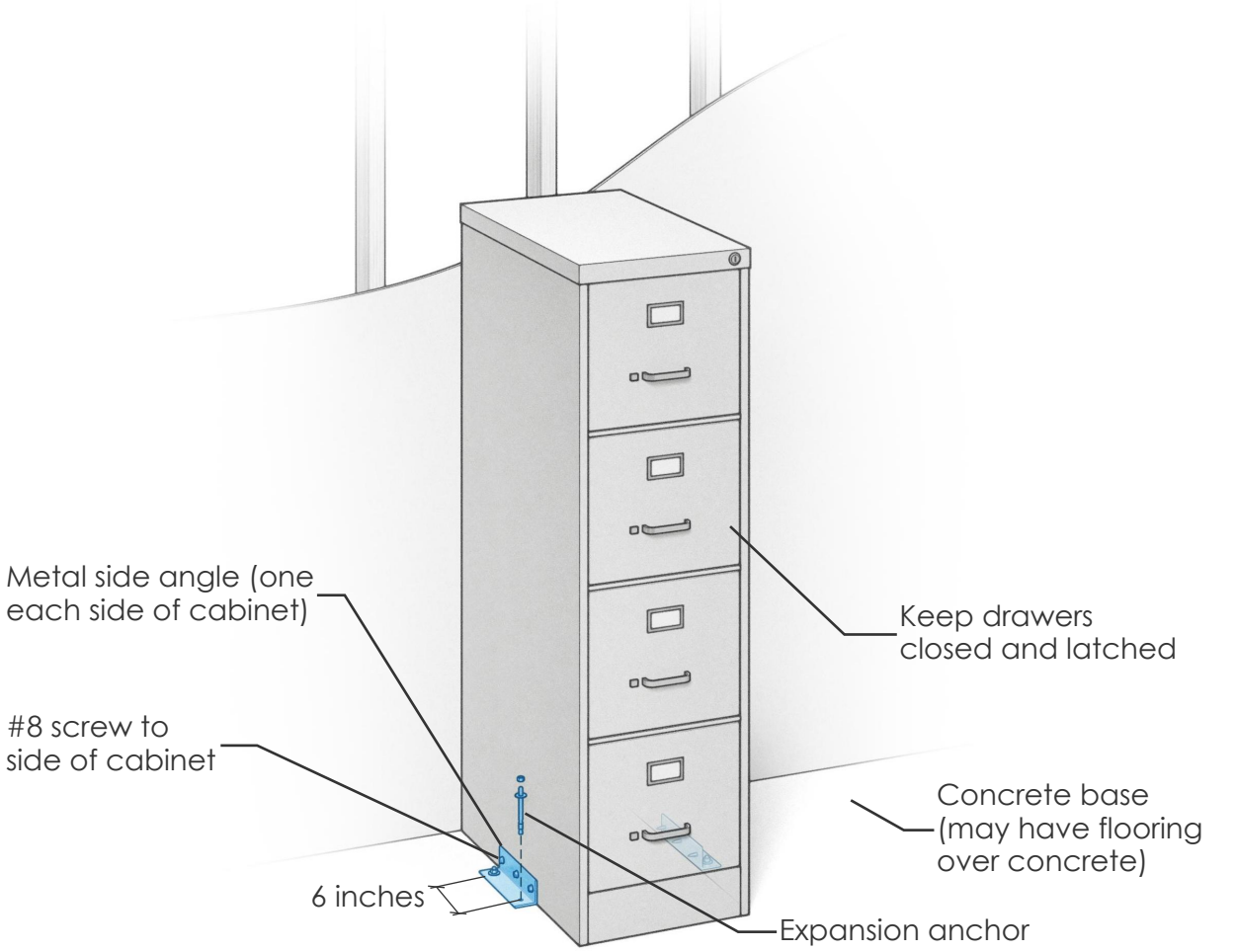
Verify screws are embedded into metal stud.

STEP 4: Screw top angle into bookcase with three #8 screws.

STEP 5: Attach side angles to floor with two ⅜ inch diameter expansion anchors with 1½ inch embedment into concrete floor. Follow expansion anchor product instructions, including those for testing and inspection.

STEP 6: Screw each side angle into bookcase with two #8 screws.

5 File Cabinet (floor mount)



Material List

- Metal side angles (2 inch by 2 inch, ¼ inch, 8 inch long)
- #8 sheet metal screws
- ⅜ inch diameter expansion anchors

Conditions of Use

- Weight including contents is 400 pounds or less
- Flooring over 3¼ inch minimum concrete

Installation

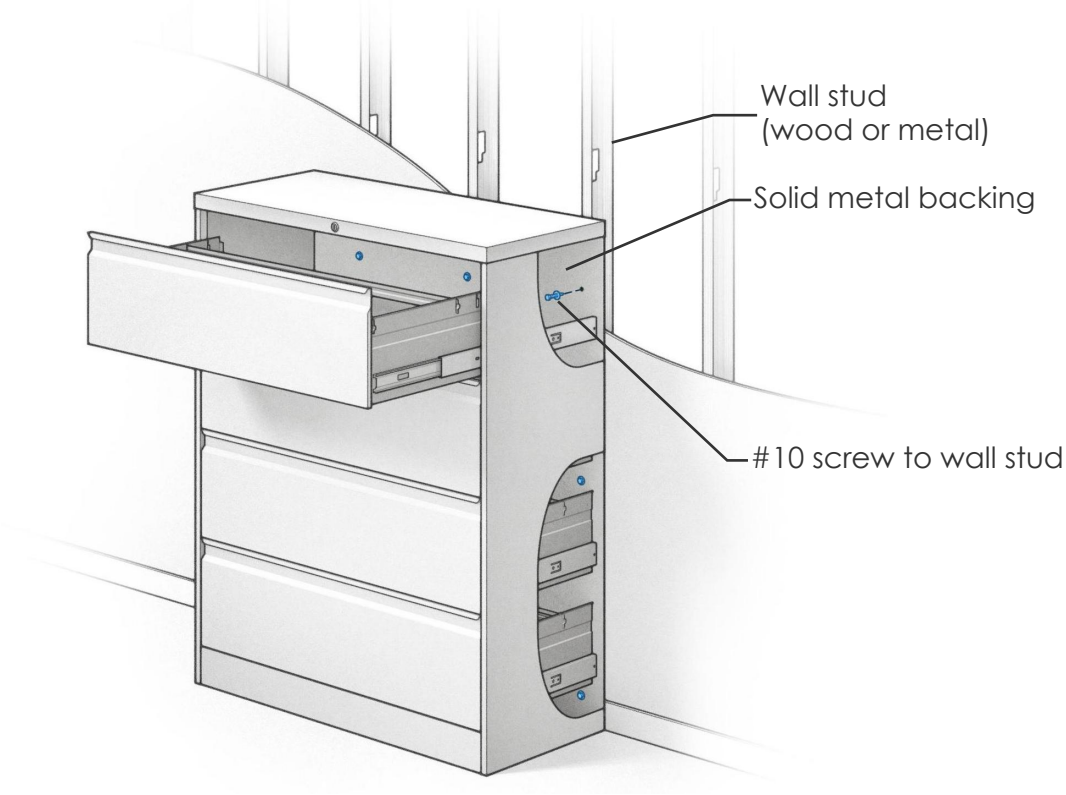
STEP 1: Place file cabinet in final position.

STEP 2: Attach each side angle to floor with two ⅜ inch diameter expansion anchors with 1½ inch embedment into concrete floor. Follow expansion anchor product instructions, including those for testing and inspection.

STEP 3: Screw each side angle into file cabinet with three #8 screws.

Note: Where two cabinets are side by side, interconnect cabinets with two columns of #8 sheet metal screws spaced at 16 inches on center. Locate one column near the front of the cabinet and one column near the rear of the cabinet. Install floor angles on each side of the combined cabinet base.

6 Lateral File Cabinet



Material List

- #10 wood screw by 2½ inch long (wood studs) or #10 sheet metal screw by 1½ inch long (metal studs)

Conditions of Use

- Full height wall studs
- Weight including contents is 400 pounds or less
- Solid metal cabinet backing

Installation

STEP 1: Place cabinet against wall with ¼ inch maximum gap between wall and cabinet. (For larger gap, see note.)

STEP 2: Locate wall studs. Use at least two wall studs for cabinets up to 4 feet wide and at least three wall studs for cabinets up to 6 feet wide.

Verify wall studs are full height or fully braced.

STEP 3: Attach cabinet to wall studs with three rows of screws. Locate top row of screws within 1 foot of top of cabinet, middle row of screws near mid-height, and bottom row of screws within 1 foot of bottom.

At wood studs: Install wood screws through cabinet metal back into studs.

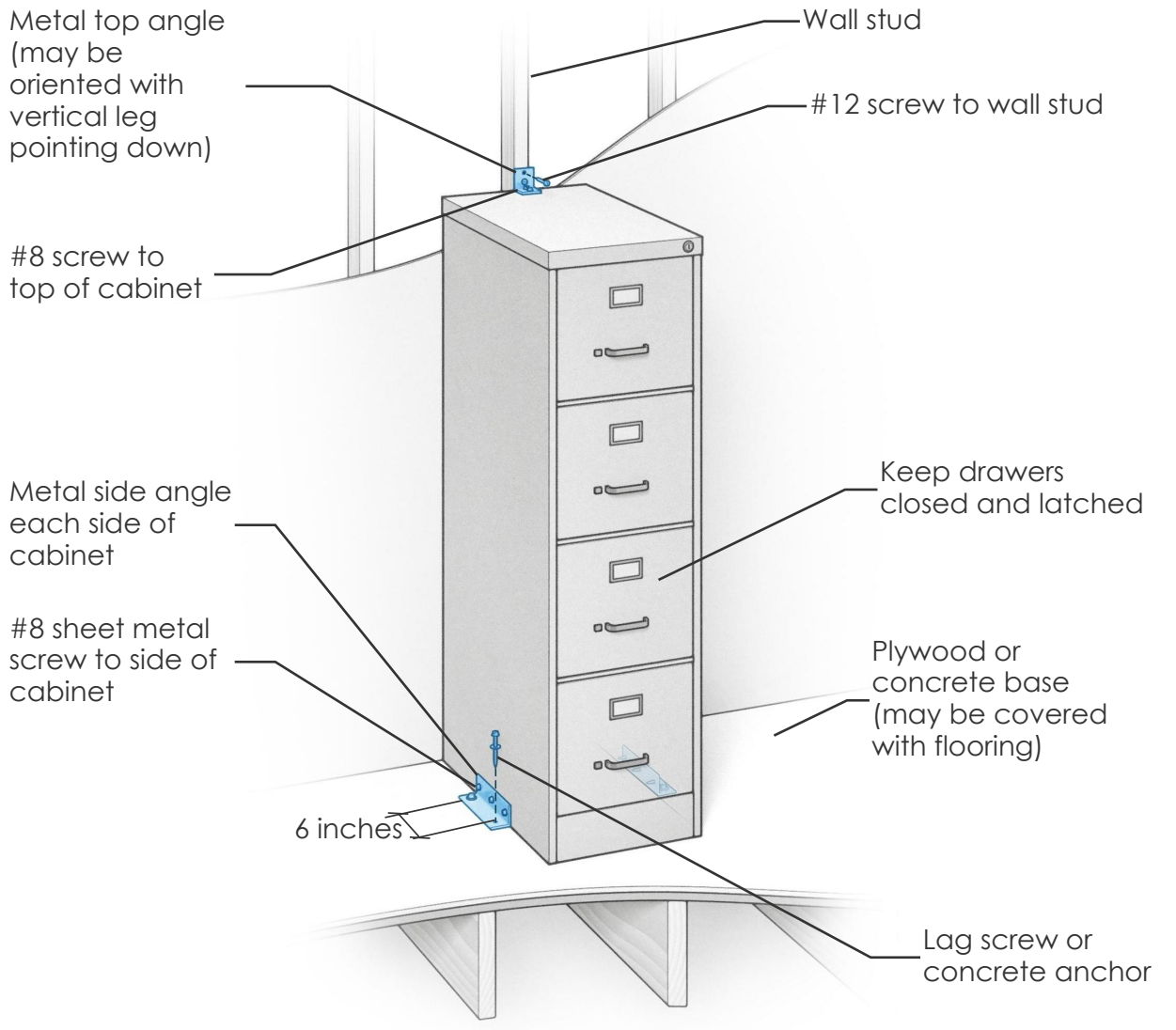
Verify screws are embedded at least 1¼ inches into wood stud.

At metal studs: Install sheet metal screws through cabinet metal back into studs.

Verify screws are embedded into metal stud.

Note: Where gap between cabinet and wall is larger than ¼ inch, provide shims. See Modifications to Installation Instructions.

7 File Cabinet (floor and wall mount)



Material List

- Metal top angle (2 inch by 2 inch by ¼ inch thick, 2 inches long)
- Metal side angles (2 inch by 2 inch by ¼ inch thick, 8 inches long)
- #10 wood screw by 2½ inch long (wood studs) or #10 sheet metal screw by 1½ inch long (metal studs)
- #8 by ¾ inch sheet metal screws
- ¼ inch diameter wood lag screws (wood floor) or ¼ inch diameter concrete anchors (concrete floor)

Conditions of Use

- Full height wall studs
- Weight including contents is 400 pounds or less
- Flooring over ¾ inch minimum plywood or 3¼ inch minimum concrete

Installation

7 Continued

STEP 1: Place cabinet against wall with ½ inch maximum gap between back of cabinet and wall.

STEP 2: Locate wall studs.

Verify wall studs are full height or fully braced.

STEP 3: Attach top angle to wall stud.

At wood studs: Install two wood screws through angle into center of stud.

Verify screws are embedded 1¼ inch minimum into wood stud.

At metal studs: Install two sheet metal screws through angle into stud.

Verify screws are embedded into metal stud.

STEP 4: Screw top angle into file cabinet with two #8 screws.

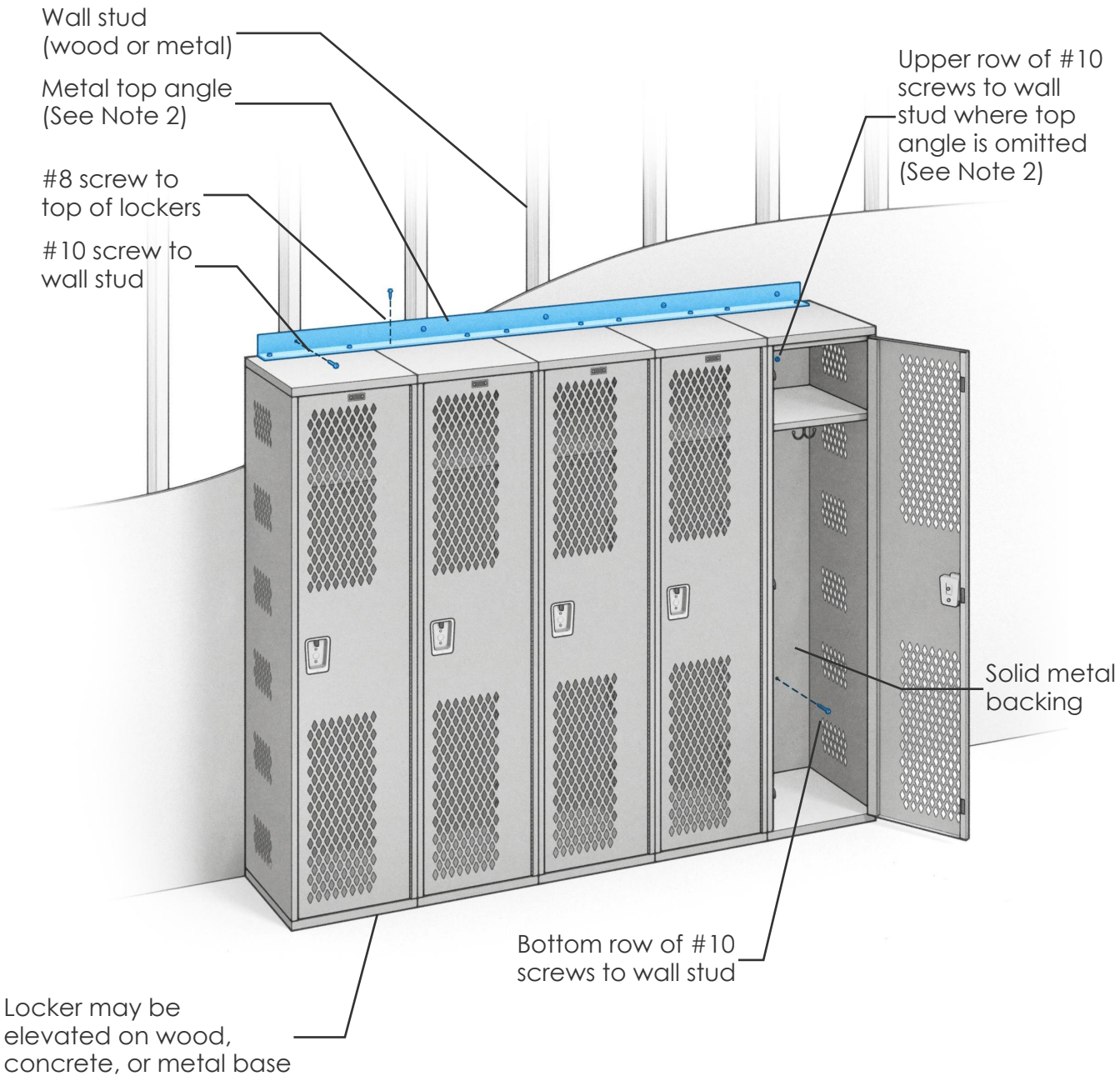
STEP 5: Attach each side angle to floor:

At wood floor: Install two lag screws with ¾ inch embedment into floor.

At concrete floor: Install two ¼ inch diameter expansion anchors with 1½ inch embedment into concrete floor. Follow expansion anchor product instructions, including those for testing and inspection.

STEP 6: Screw each side angle into file cabinet with three #8 screws.

8 Metal Lockers



Material List

- Metal top angle (2 inch by 2 inch by ⅛ inch thick) continuous over length of lockers
- #10 wood screw by 2½ inch long (wood studs) or #10 sheet metal screw by 1½ inch long (metal studs)
- #8 sheet metal screws

Conditions of Use

- Full height wall studs
- Locker with solid metal backing

Installation

8 Continued

STEP 1: Place lockers against wall with ¼ inch maximum gap between lockers and cabinet. (For larger gap, see Note 1.)

STEP 2: Locate wall studs.

Verify wall studs are full height or fully braced.

STEP 3: Attach top angle to studs.

At wood studs: Install #10 wood screws through angle into each stud.

Verify screws are embedded at least 1¼ inches into wood stud.

At metal studs: Install #10 sheet metal screws through angle into each stud.

Verify screws are embedded into metal stud.

STEP 4: Attach top angle to lockers with two #8 sheet metal screws at each locker.

STEP 5: Attach lockers to wall studs with bottom row of screws. Locate screws within 1 foot of floor.

At wood studs: Install #10 wood screw through locker into each stud.

Verify screws are embedded at least 1¼ inches into wood stud.

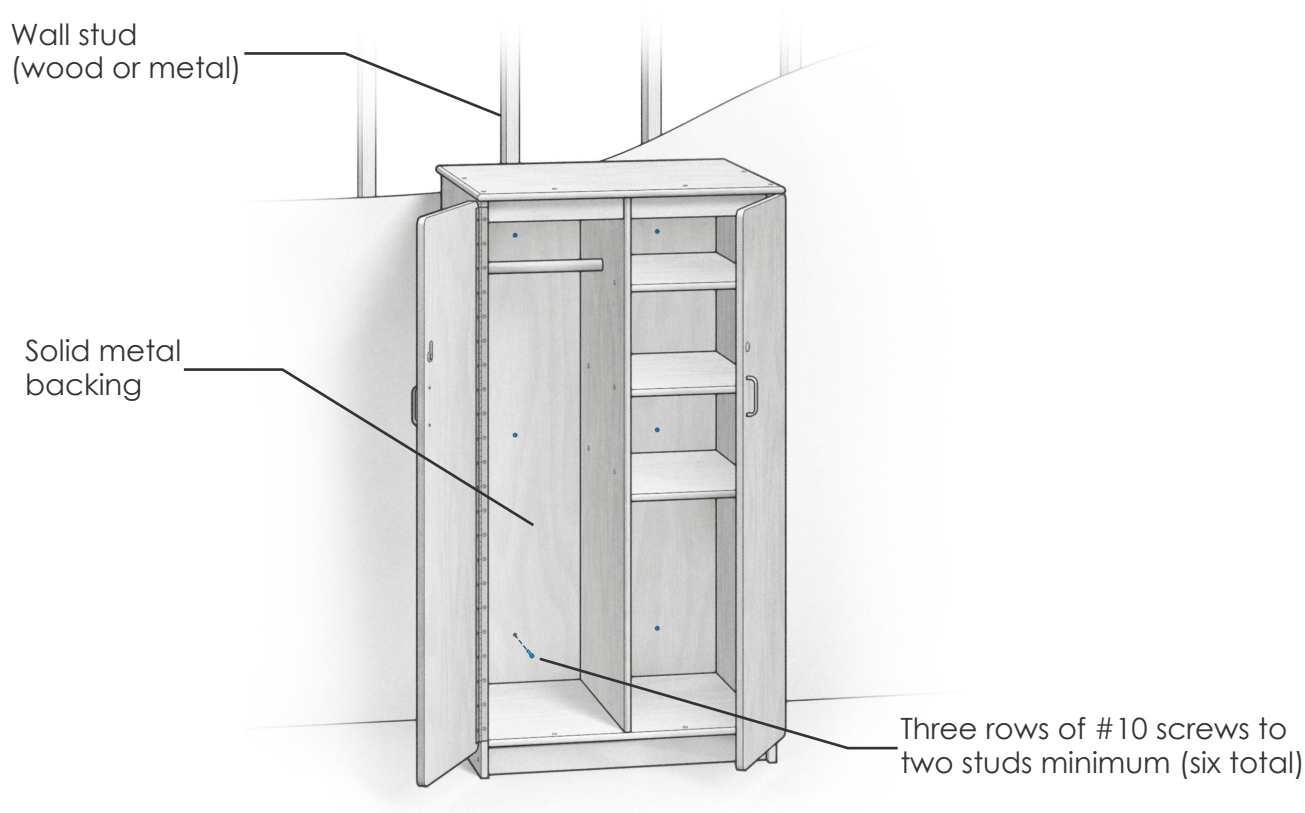
At metal studs: Install #10 sheet metal screw through locker into each stud.

Verify screws are embedded into metal stud.

Notes:

1. Where gap between lockers and wall is larger than ¼ inch, provide shims. See Modifications to Installation Instructions.
2. Top angle may be omitted if each individual locker can be fastened with two rows of screws through the metal backing directly into wall studs.

9 Teacher's Cabinet



Material List

- #10 wood screw by 2½ inch long (wood studs) or #10 sheet metal screw by 1½ inch long (metal studs)

Conditions of Use

- Full height wall studs
- Height is 6 feet or less
- Weight including contents is 400 pounds or less
- Solid backing: ⅜ inch minimum solid wood or particle board

Installation

STEP 1: Place cabinet against wall with ¼ inch maximum gap between wall and cabinet. (For larger gap, see Note.)

STEP 2: Locate wall studs.

Verify wall studs are full height or fully braced.

STEP 3: Attach cabinet to at least two wall studs with three rows of screws. Locate top row of screws within 1 foot of top of cabinet, middle row of screws near mid-height, and bottom row of screws within 1 foot of bottom.

At wood studs: Install wood screws through cabinet into studs.

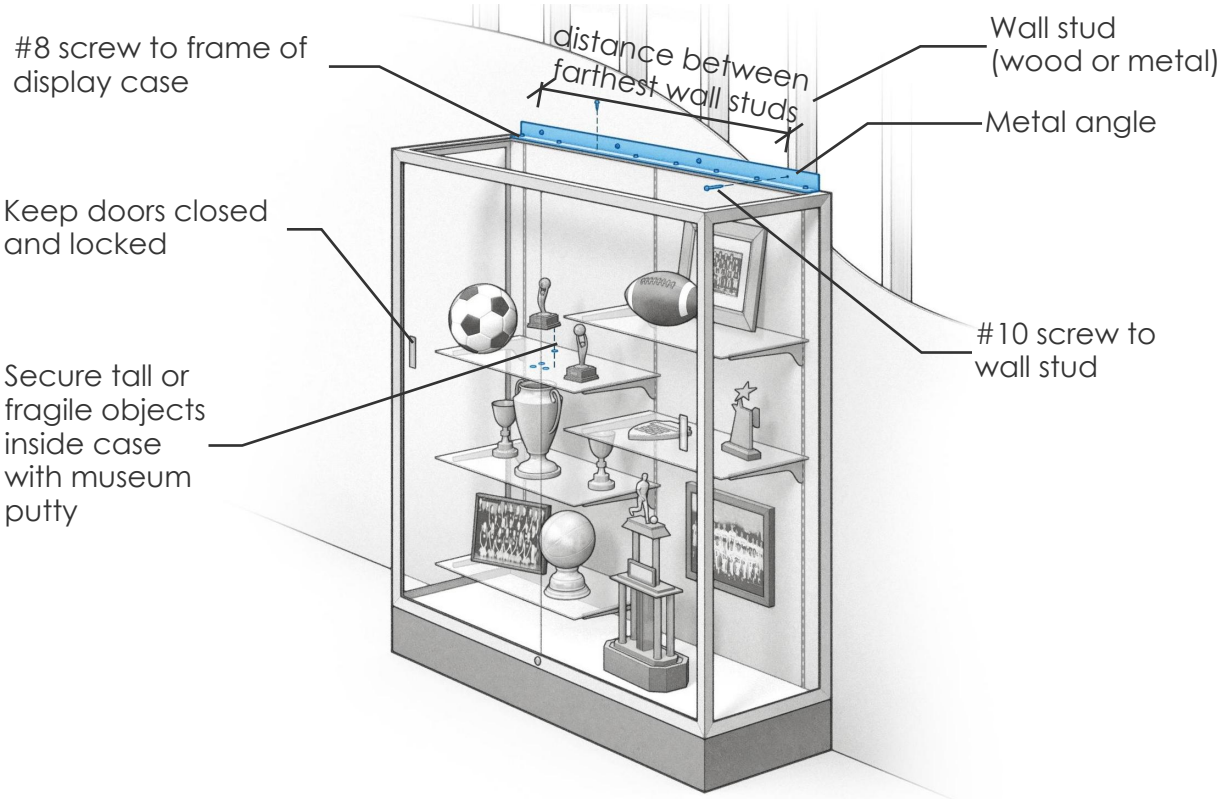
Verify screws are embedded at least 1¼ inches into wood stud.

At metal studs: Install sheet metal screws through cabinet into studs.

Verify screws are embedded into metal stud.

Note: Where gap between cabinet and wall is larger than ¼ inch, provide shims. See Modifications to Installation Instructions.

10 Display Case with Objects



Material List

- Metal angle (2 inch by 2 inch by ⅛ inch thick, length equal to distance between two farthest studs [see Step 2] plus 3 inches)
- #10 wood screws by 2½ inch long (wood studs) or #10 sheet metal screws by 1½ inch long (metal studs)
- #8 by ¾ inch sheet metal screws

Conditions of Use

- Weight including contents is 400 pounds or less
- Height is 6 feet or less
- Display cabinet has robust wood or metal frame

Installation

STEP 1: Place display case against wall with ½ inch maximum gap between back of cabinet and wall.

STEP 2: Locate wall studs. Measure distance between two farthest studs located behind the display case to determine necessary length of angle.

Verify wall studs are full height or fully braced.

STEP 3: Attach angle to each wall stud behind the display case.

At wood studs: Install wood screws through angle into center of studs.

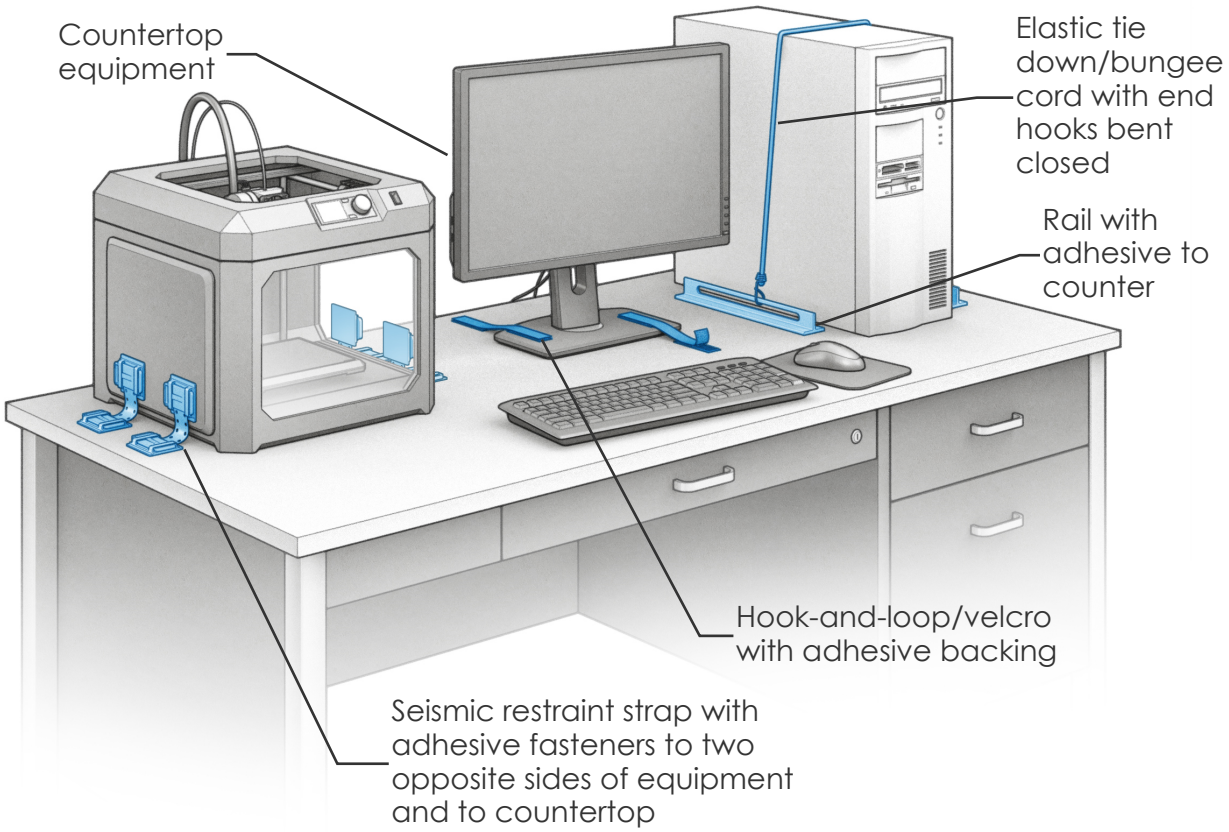
Verify screws are embedded at least 1¼ inches into wood stud.

At metal studs: Install sheet metal screws through angle into center of studs.

Verify screws are embedded into metal stud.

STEP 4: Screw angle into display cabinet with #8 screws spaced every 8 inches.

11 Desktop and Countertop Equipment



Material List

- Seismic restraint product suitable for the type, use, weight, and dimensions of the equipment

Conditions of Use

Item is NOT:

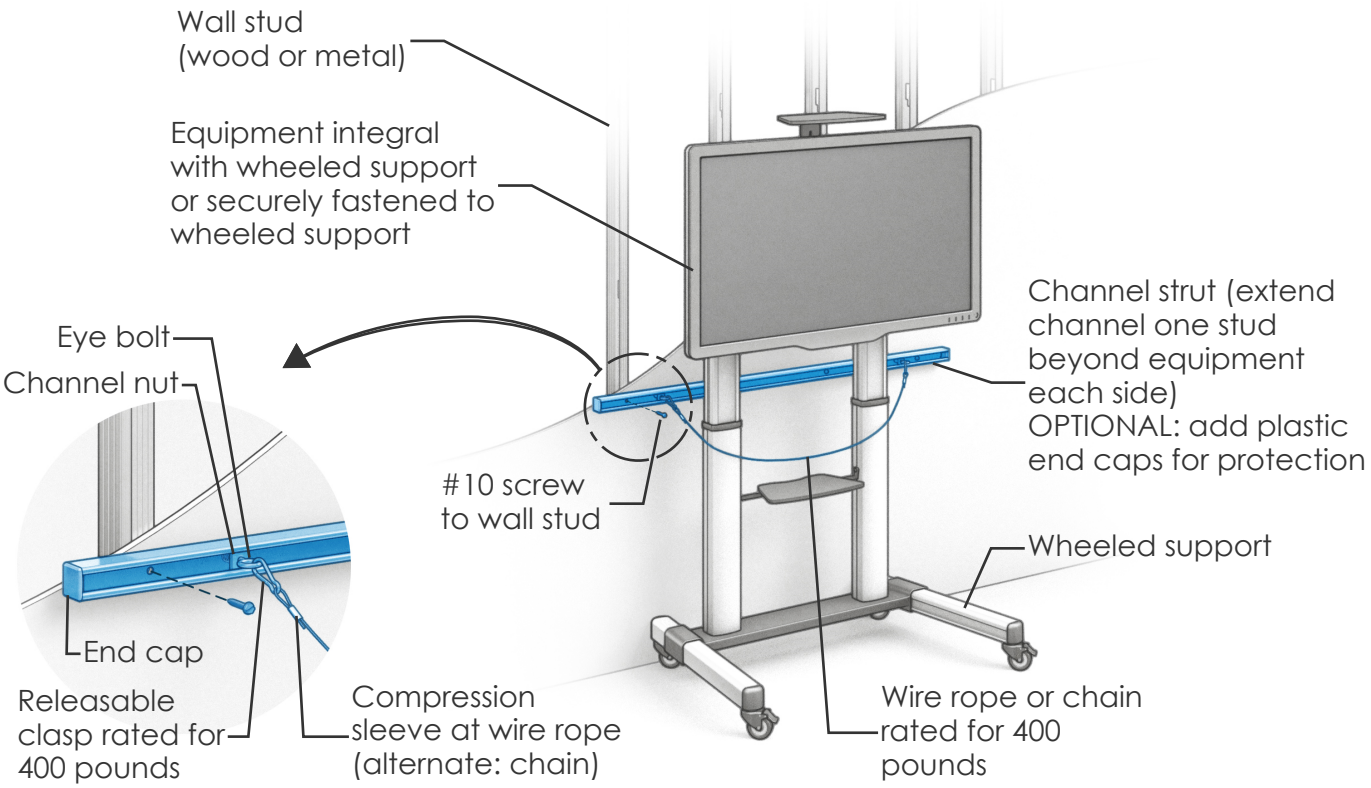
- Heavier than 100 pounds, or
- Permanently attached to the building's electrical, gas, or water systems (e.g., hard-plumbed ice maker), or
- Important for continued operations of the school following an earthquake (e.g., network server), or
- High value or difficult to replace (e.g., specialty lab equipment), or
- Taller than 2 feet, or
- Containing hazardous materials.

Installation

STEP 1: For each piece of equipment, select a suitable seismic restraint product.
STEP 2: Install seismic restraint products per the manufacturer's installation requirements.

Verify installation by pushing on the item with a force approximately equal to the weight of the item. Installation is acceptable is there is no discernable movement when pushed in any direction.

12 Equipment on Wheels



Material List

- 1⅝ inch by 1⅝ inch by 12 gauge channel strut by 3 foot long
- #10 wood screw by 2½ inch long (wood studs) or #10 sheet metal screw by 1½ inch long (metal studs)
- ¼ inch diameter eye bolts and nuts for channel strut
- Releasable clasps rated for 400 pounds
- ⅛ inch diameter wire rope with compression sleeves or chain rated for 400 pounds

Conditions of Use

- Individual equipment is securely fastened to wheeled support
- Total weight is 400 pounds or less and center of gravity is less than 4 feet above floor surfaces

Installation

STEP 1: Determine strut placement. Strut should be located between mid-height of equipment and 1 foot below top of equipment.

STEP 2: Locate wall studs.

STEP 3: Attach strut to three studs minimum.

At wood studs: Install wood screw through strut into center of each stud.

Verify screws are embedded at least 1¼ inches into wood stud.

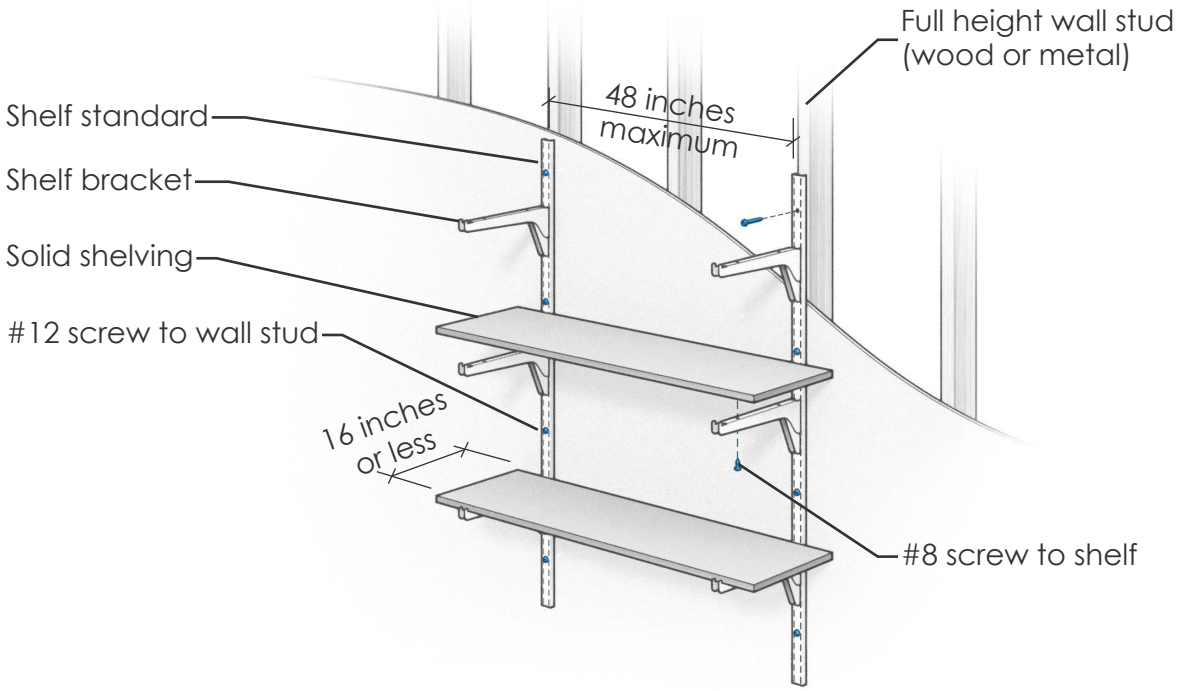
At metal studs: Install sheet metal screw through strut into center of each stud.

Verify screws are embedded into metal stud.

STEP 4: Install eye bolt with channel nut to strut on each side of equipment.

STEP 5: Fit chain or wire snug around equipment and clasp to eye bolt each end.

13 Wall-Mounted Shelf



Material List

- Heavy-duty metal shelf standard (¾ inch wide, ½ inch deep, 16 gauge thick)
- Heavy-duty shelf bracket (16 gauge)
- Solid shelving: ¾ inch minimum solid wood or particle board
- #8 wood screw by 2½ inch long (wood studs) or #8 sheet metal screw by 1½ inch long (metal studs)

Conditions of Use

- Full height wall studs
- Maximum 16 inch shelf depth

Installation

STEP 1: Locate wall studs.

Verify wall studs are full height or fully braced.

STEP 2: Place shelf standards to align with wall studs. Standards shall be located within 6 inches of each end of the shelf and spaced at maximum 48 inches apart. Standard shall extend 6 inch minimum above top shelf and 12 inch minimum below bottom shelf.

STEP 3: Attach standards to wall studs with screws spaced at 6 inches apart vertically.

At wood studs: Install wood screws through standard into center of studs.

Verify screws are embedded at least 1¼ inches into wood stud.

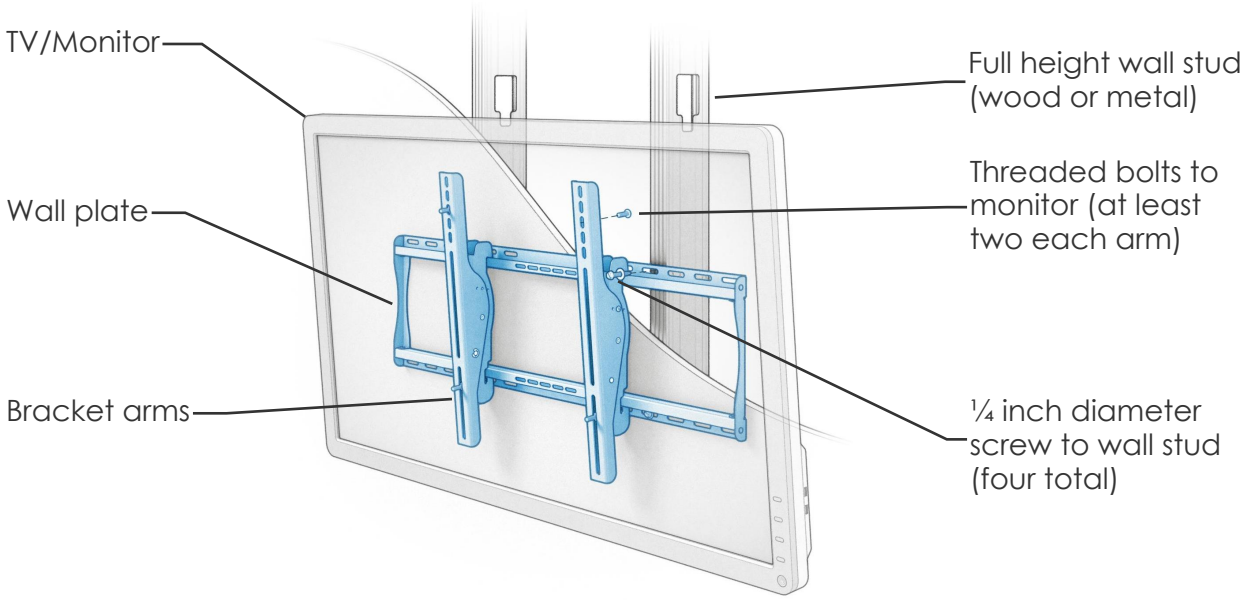
At metal studs: Install sheet metal screws through standard into studs.

Verify screws are embedded into metal stud.

STEP 4: Install shelf brackets per manufacturer's instructions.

STEP 5: Screw shelf to angle brackets with #8 by ½ inch wood screw.

14 Wall-Mounted Monitor (up to 20 pounds)



Material List

- Bracket rated for seismic loading and weight of monitor
- ¼ inch diameter wood screw by 2½ inch long (wood studs) or ¼ inch sheet metal screw by 1½ inch long (metal studs)
- 6 milllimeter threaded bolts

Conditions of Use

- Full height wall studs
- Weight of monitor plus bracket is 20 pounds maximum
- Flat mount or tilt type bracket (no arm extension)

Installation

STEP 1: Locate nearest wall studs to the left and right of the center of the screen.

Verify wall studs are full height or fully braced.

STEP 2: Level wall plate and use to mark mounting holes. Locate mounting holes on stud centerlines.

STEP 3: Attach wall plate to wall studs with four screws.

At wood studs: Install wood screws through wall plate into center of stud.

Verify screws are embedded at least 1¼ inches into wood stud.

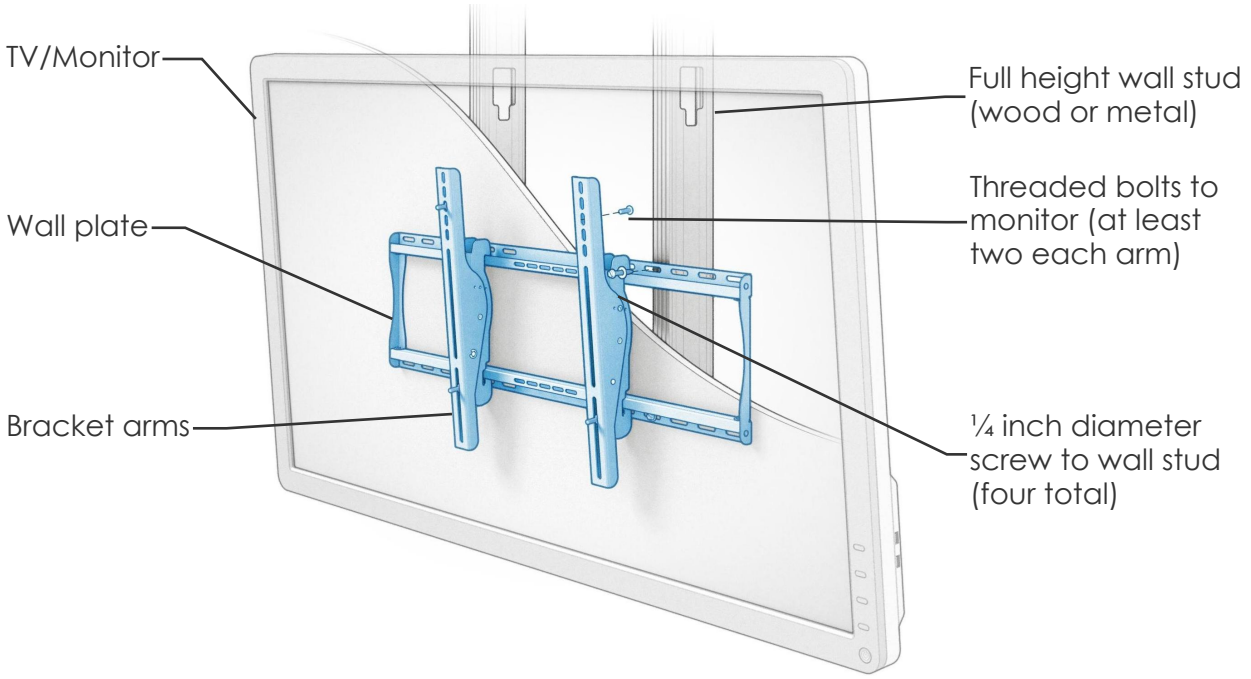
At metal studs: Install sheet metal screws through wall plate into studs.

Verify screws are embedded into metal stud.

STEP 4: Attach bracket arms to back of monitor with four threaded bolts minimum.

STEP 5: Hang monitor with bracket arms onto top rail of wall plate and latch or tighten per manufacturer's instructions.

15 Wall-Mounted Monitor (up to 50 pounds)



Material List

- Bracket rated for seismic loading and weight of monitor
- ¼ inch diameter wood screw by 2½ inch long (wood studs) or ¼ inch sheet metal screw by 1½ inch long (metal studs)
- 6 milllimeter threaded bolts

Conditions of Use

- Full height wall studs (metal studs are 20 gauge minimum)
- Weight of monitor plus bracket is 50 pounds maximum
- Flat mount or tilt type bracket (no arm extension)

Installation

STEP 1: Locate nearest wall studs to the left and right of the center of the screen.

Verify wall studs are full height or fully braced. Where metal studs occur, verify wall studs are 20 gauge minimum.

STEP 2: Level wall plate and use to mark mounting holes. Locate mounting holes on stud centerlines.

STEP 3: Attach wall plate to wall studs with four screws.

At wood studs: Install wood screws through wall plate into center of stud.

Verify screws are embedded at least 1¼ inches into wood stud.

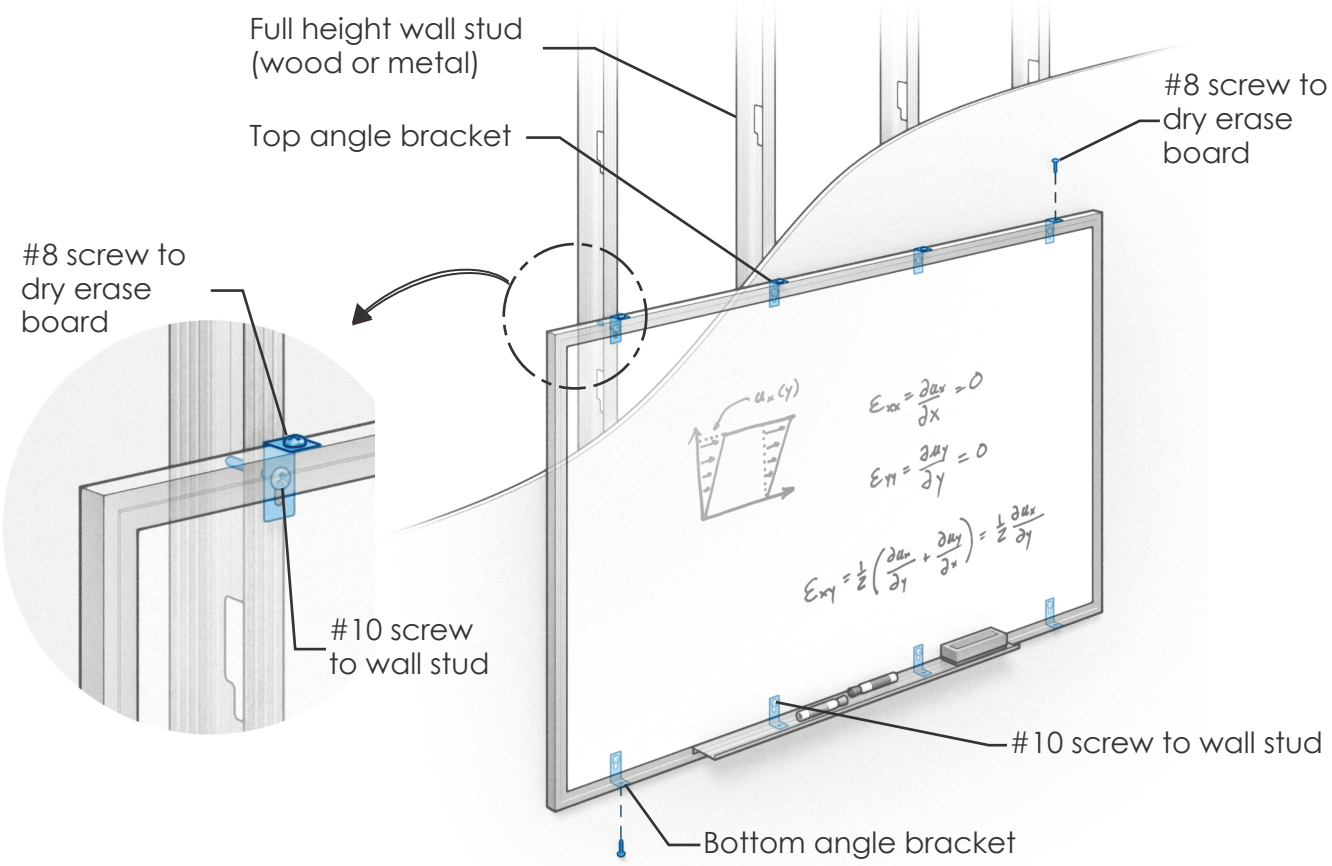
At metal studs: Install sheet metal screws through wall plate into studs.

Verify screws are embedded into metal stud.

STEP 4: Attach bracket arms to back of monitor with four threaded bolts minimum.

STEP 5: Hang monitor with bracket arms onto top rail of wall plate and latch or tighten per manufacturer's instructions.

16 Dry Erase Board



Material List

- Angle brackets by board manufacturer
- #10 wood screw by 2½ inch long (wood studs) or #8 sheet metal screw by 1½ inch long (metal studs)
- #8 by ½ inch sheet metal screws

Conditions of Use

- Full height wall studs
- Maximum weight of 80 pounds for 4 foot wide board or 120 pounds for 8 foot wide board

Installation

STEP 1: Locate wall studs.

Verify wall studs are full height or fully braced.

STEP 2: Locate bottom angle brackets to align with wall studs.

STEP 3: Attach bottom angle brackets to wall studs.

At wood studs: Install wood screw through each bracket into center of stud.

Verify screws are embedded 1¼ inch minimum into wood stud.

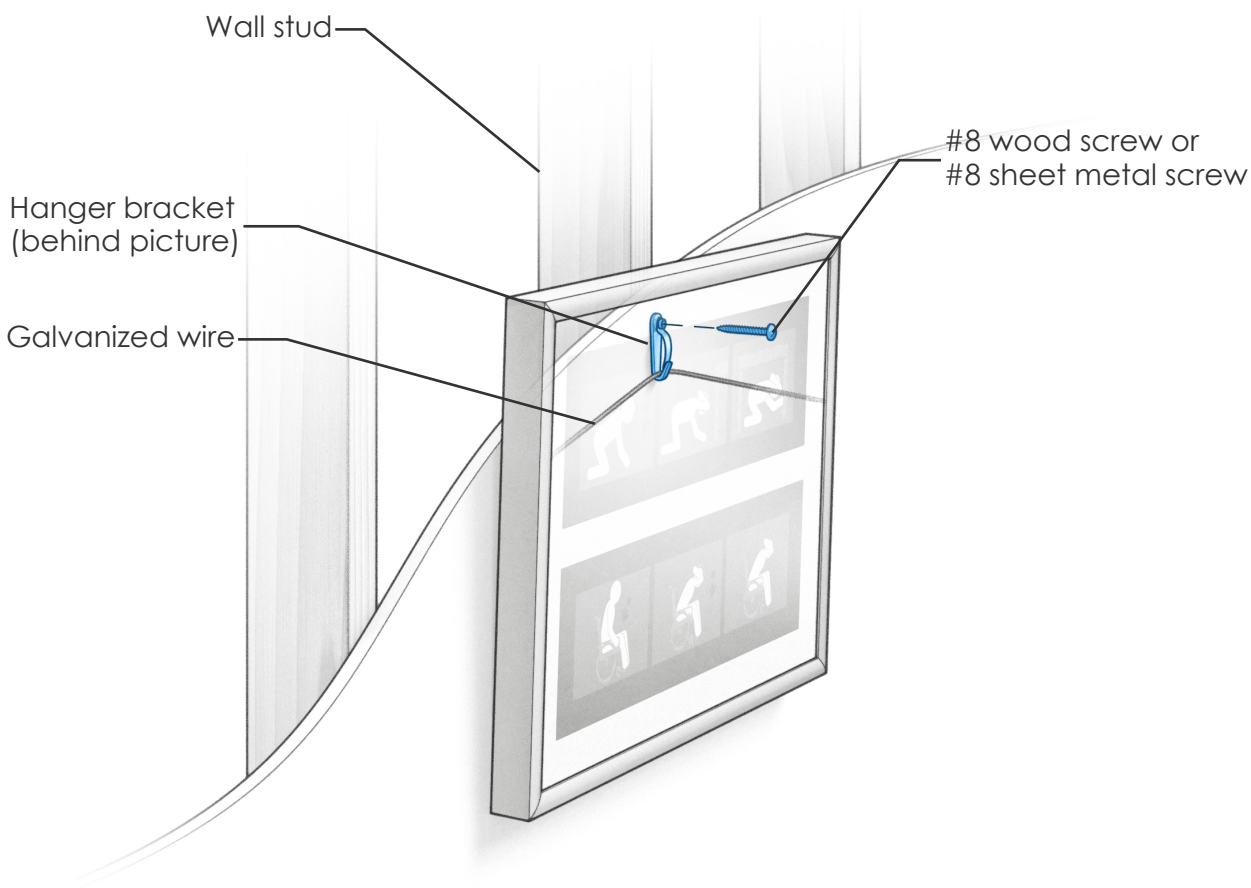
At metal studs: Install sheet metal screw through each bracket into stud.

Verify that screws are embedded into metal stud.

STEP 4: Repeat Steps 2 and 3 for top angle brackets.

STEP 5: Set board on bottom brackets and secure board to top and bottom brackets with #8 sheet metal screws.

17 Wall Decoration or Picture



Material List

- Hanger bracket with closed hook rated for the weight of the item
- #8 wood screw by 1½ inch long (wood studs) or #8 sheet metal screw by 1½ inch long (metal studs)
- Galvanized picture hanging wire

Conditions of Use

- Weight of item is 20 pounds or less

Installation

STEP 1: Attach hanger wire to item at two locations.

Verify that attachment can support weight of item by pulling on wire with 2 times the weight of the item.

STEP 2: Locate wall stud.

STEP 3: Attach hanger bracket to wall stud with #8 wood screw (wood stud) or #8 sheet metal screw (metal stud).

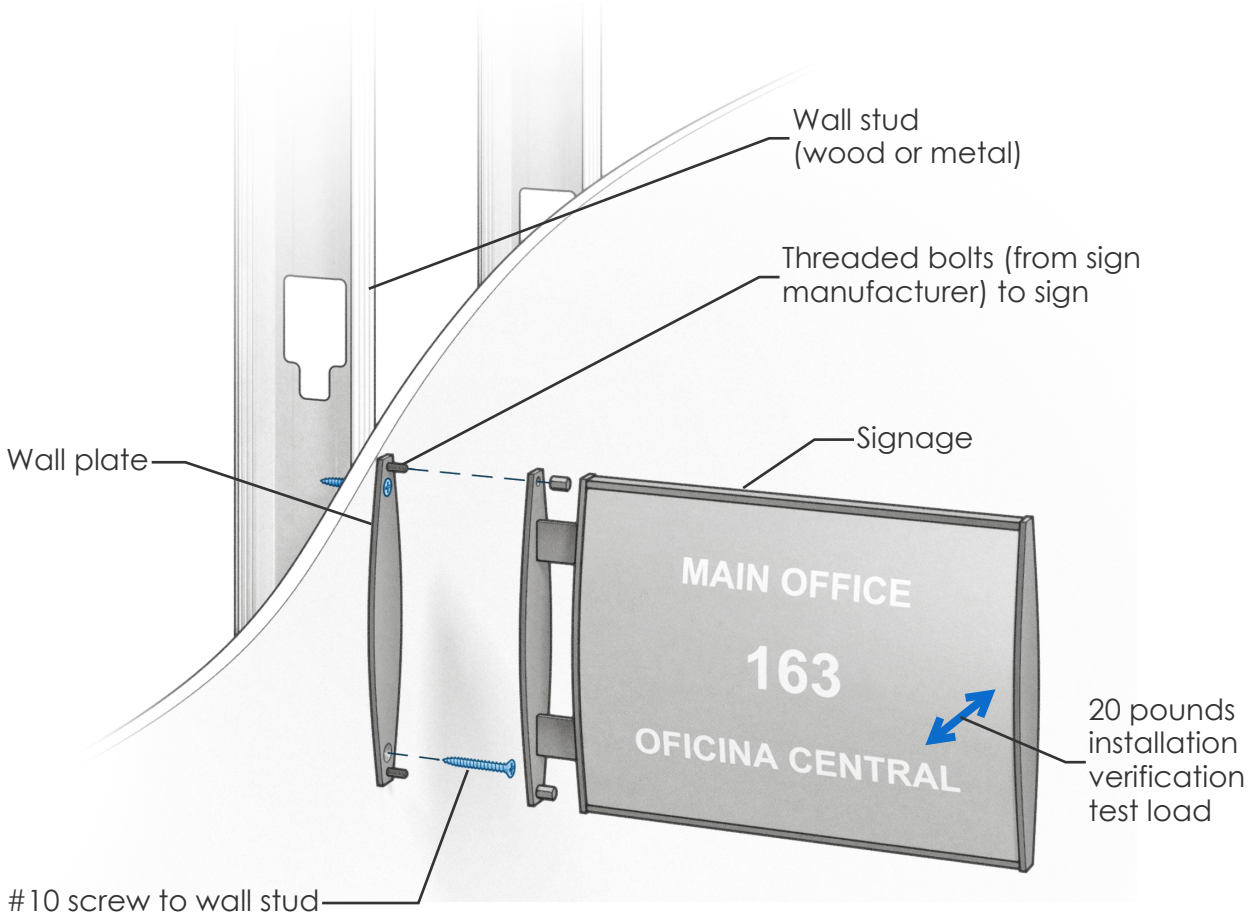
Verify screw is embedded in stud.

STEP 4: Hang item on bracket.

STEP 5: Close hanger bracket.

Verify that hanger is closed and picture wire cannot "jump" out of hanger.

18 Signage



Material List

- #10 wood screw by 2½ inch long (wood studs) or #10 sheet metal screw by 1½ inch long (metal studs)
- 6-millimeter threaded bolts or alternate fasteners where provided by manufacturer

Conditions of Use

- Weight including bracket is 20 pounds or less

Installation

STEP 1: Locate wall stud.

STEP 2: Attach wall plate to wall stud with at least two screws.

At wood studs: Install wood screws into center of stud.

Verify screws are embedded at least 1¼ inches into wood stud.

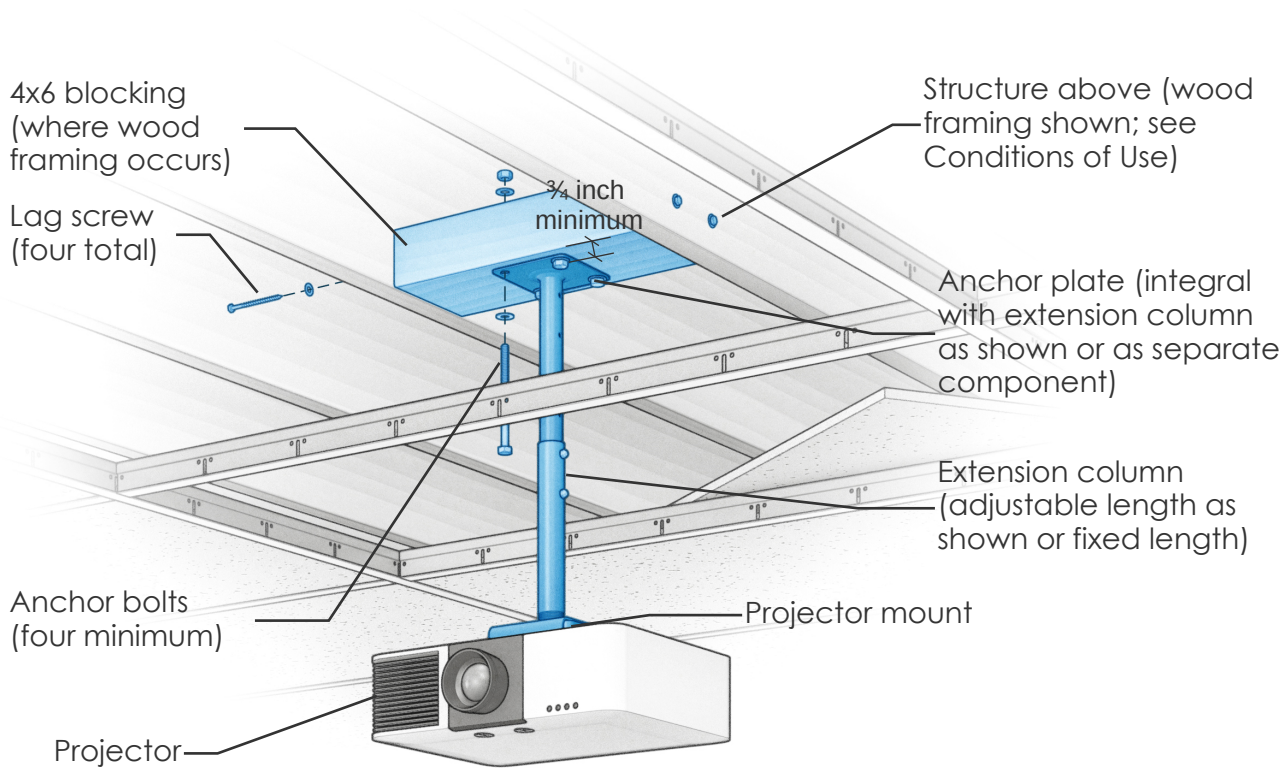
At metal studs: Install sheet metal screws into studs.

Verify screws are embedded into metal stud.

STEP 3: Attach sign to wall plate with two threaded bolts or per manufacturer's installation instructions.

Verify installation by pushing and pulling on edge of sign parallel to wall with a force of approximately 20 pounds. Installation is acceptable if there is no discernable movement.

19 Ceiling-Mounted Video Projector



Material List

- Ceiling mount kit rated for weight and type of projector, including: projector mount, extension column, anchor plate, and fastener hardware
- For structural support: 4x6 wood blocking and ¼ inch diameter lag screws (wood framing) or 1⅝ inch by 1⅝ inch by 12 gauge channel strut and ⅜ inch diameter concrete expansion anchors (metal deck with concrete fill) or 1⅝ inch by 1⅝ inch by 12 gauge channel strut and #12 sheet metal screws (untopped metal deck)
- For anchor plate attachment: ⅜ inch diameter bolts by 5 inch long with nuts and washers (wood framing) or ⅜ inch expansion anchors (concrete slab) or ⅜ inch diameter bolts and channel nuts (metal deck with concrete fill or untopped metal deck)

Conditions of Use

- Weight of projector is 20 pounds or less
- Distance from projector to structure above is 5 feet or less
- Structure above consists of wood framing (2x framing minimum at 24 inches on center maximum) or concrete slab (4 inch thick minimum) or metal deck with concrete fill or untopped metal deck
- Anchor plate accommodates at least four fasteners (¼ inch diameter minimum) spaced at 3 inches minimum

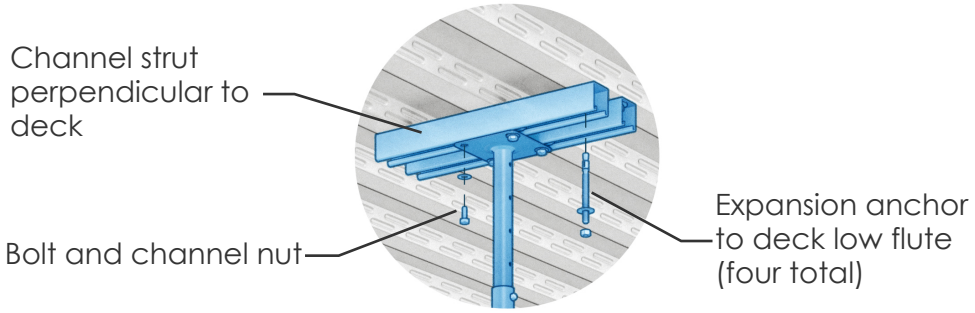
STEP 1: Identify bolt size and bolt spacing for anchor plate.

STEP 2: Install structural support for anchor plate.

At wood framing (see previous page): Install 4x6 minimum wood blocking member between joists with two ¼ inch diameter lag screws through joists into each end of blocking (four total). Where anchor plate bolt spacing exceeds 4 inches, increase size of blocking or use multiple blocking members so that anchor bolts will be at least ¾ inch from edge of blocking. Length of lag screws shall be sufficient to achieve 2 inch embedment in blocking.

At metal deck with concrete fill (see below): Install channel struts. Orient the struts perpendicular to the deck direction and space them to match the anchor plate bolt spacing. Attach each channel strut to at least two low deck flutes with ⅜ inch diameter expansion anchors with 2 inch embedment into concrete. Follow expansion anchor product instructions, including those for testing and inspection.

Metal deck with concrete fill



At untopped metal deck: Install channel struts similar to above. Orient the struts perpendicular to the deck direction and space them to match the anchor plate bolt spacing. Attach each channel strut to at least three low deck flutes with two #12 sheet metal screws at each low flute.

STEP 3: Attach anchor plate to structural support with minimum of four fasteners:

At wood framing: Use anchor plate as template to mark mounting holes on blocking. Drill holes in wood blocking at marked mounting holes. Holes should be ⅛ inch diameter larger than the bolt size. Install bolts through anchor plate and blocking.

At concrete floor: Attach anchor plate directly to underside of concrete with minimum of four ¼ inch diameter expansion anchors with 1½ inch embedment into concrete. Follow expansion anchor product instructions, including those for testing and inspection.

At metal deck with concrete fill: Attach anchor plate to channel strut minimum of four bolts and channel nuts.

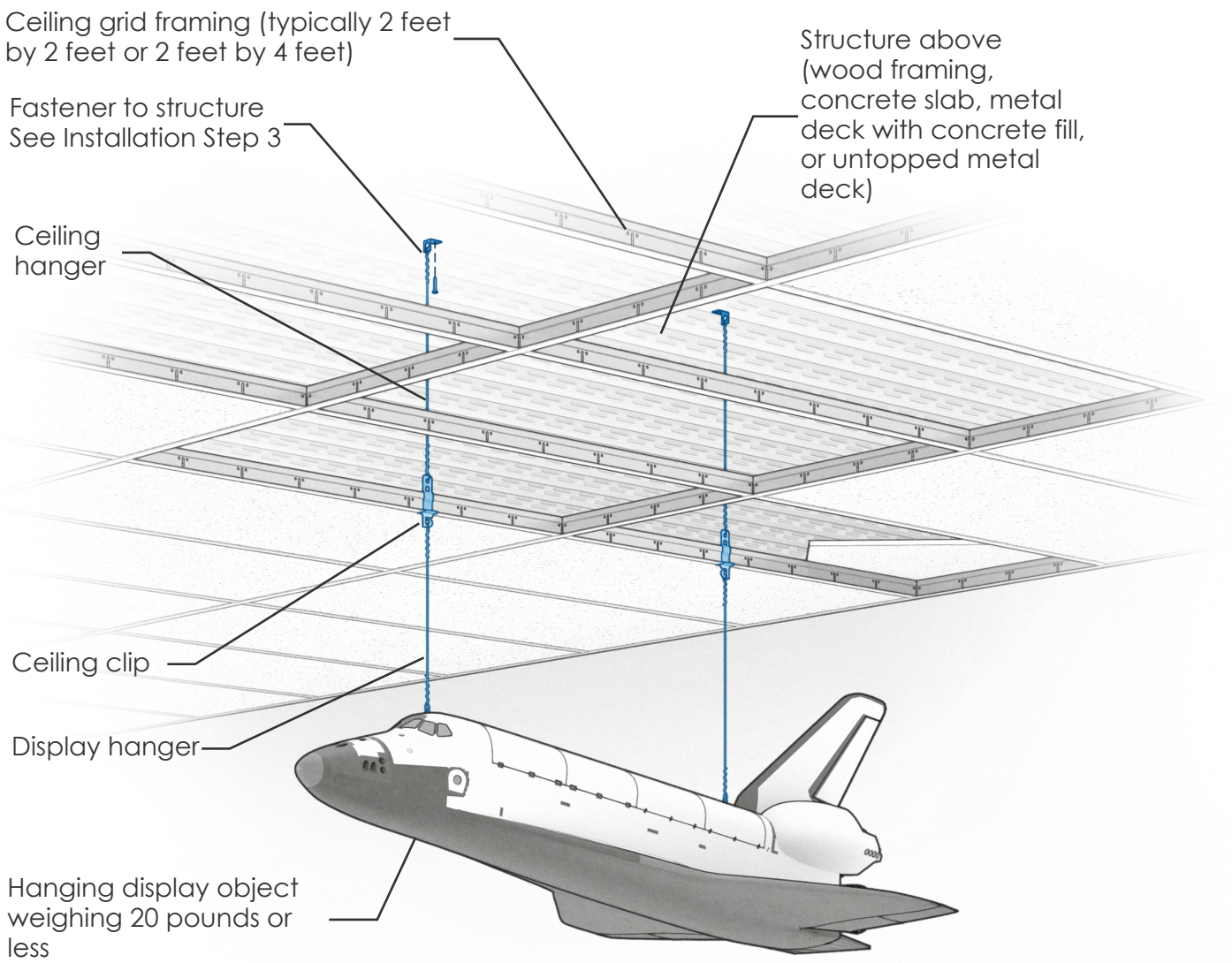
STEP 4: Where applicable, attach extension column to anchor plate and adjust column length per manufacturer's installation instructions.

STEP 5: Attach projector mount to extension column per manufacturer's instructions.

STEP 6: Attach projector to projector mount per manufacturer's instructions.

Verify installation by pushing and pulling on projector with a force of approximately 50 pounds. Installation is acceptable if there is no discernable movement.

20 Hanging Display



Material List

- T-bar ceiling clip
- Ceiling hanger: 12 gauge, galvanized, soft-annealed, mild steel wire
- Display hanger: same as ceiling hanger or as suited to the display
- ¼ inch diameter closed eye screw (wood framing) or 12 gauge by ¾ inch wide clip with concrete anchor (concrete slab) or 12 gauge by ¾ inch wide clip with #12 sheet metal screw (untopped metal deck)

Conditions of Use

- Acoustic Ceiling Tile (ACT) grid
- Weight is 10 pounds or less (for single hanger) or 20 pounds or less (for two hangers)
- Clear space around display allows it to swing in any direction without hitting another object

STEP 1: For items up to 10 pounds, attach at least one display hanger to the display item. For items up to 20 pounds, attach at least two hanger wires to the display item.

Pull on the hanger with a force of approximately 20 pounds. Installation is acceptable if there is no discernable movement.

Note: If the total weight of the display item is under 5 pounds, **STEP 2** and **STEP 3** may be skipped.

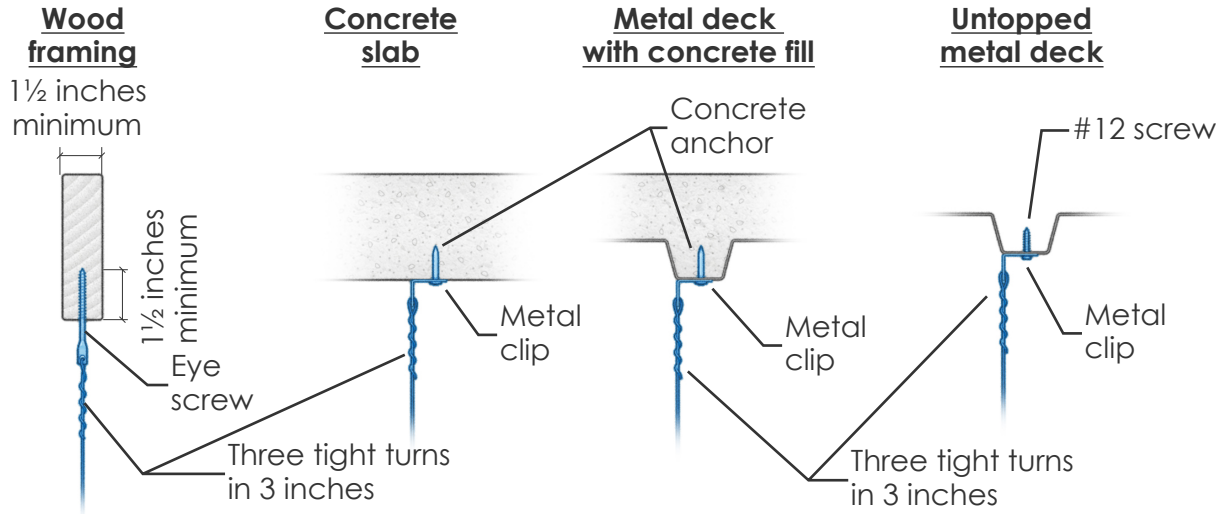
STEP 2: Identify corresponding fastener points for attaching to the ceiling grid and to the structure above.

STEP 3: Install fasteners to structure above.

At wood joists: Install ¼ inch diameter screw into center of 2x minimum wood joist with 1½ inch minimum penetration.

At concrete slab or metal deck with concrete fill: Attach metal clip to bottom of deck with power-actuated fastener (0.143 inch diameter by ¾ inch embedment minimum).

At untopped metal deck: Attach metal clip to bottom of deck with #12 sheet metal screw.



STEP 4: Fasten top of 12 gauge ceiling wire by inserting wire through fastener hole and wrapping wire around itself three times in 3 inches.

Pull down on installed wire with a weight of 50 pounds. Installation is acceptable if there is no discernable movement.

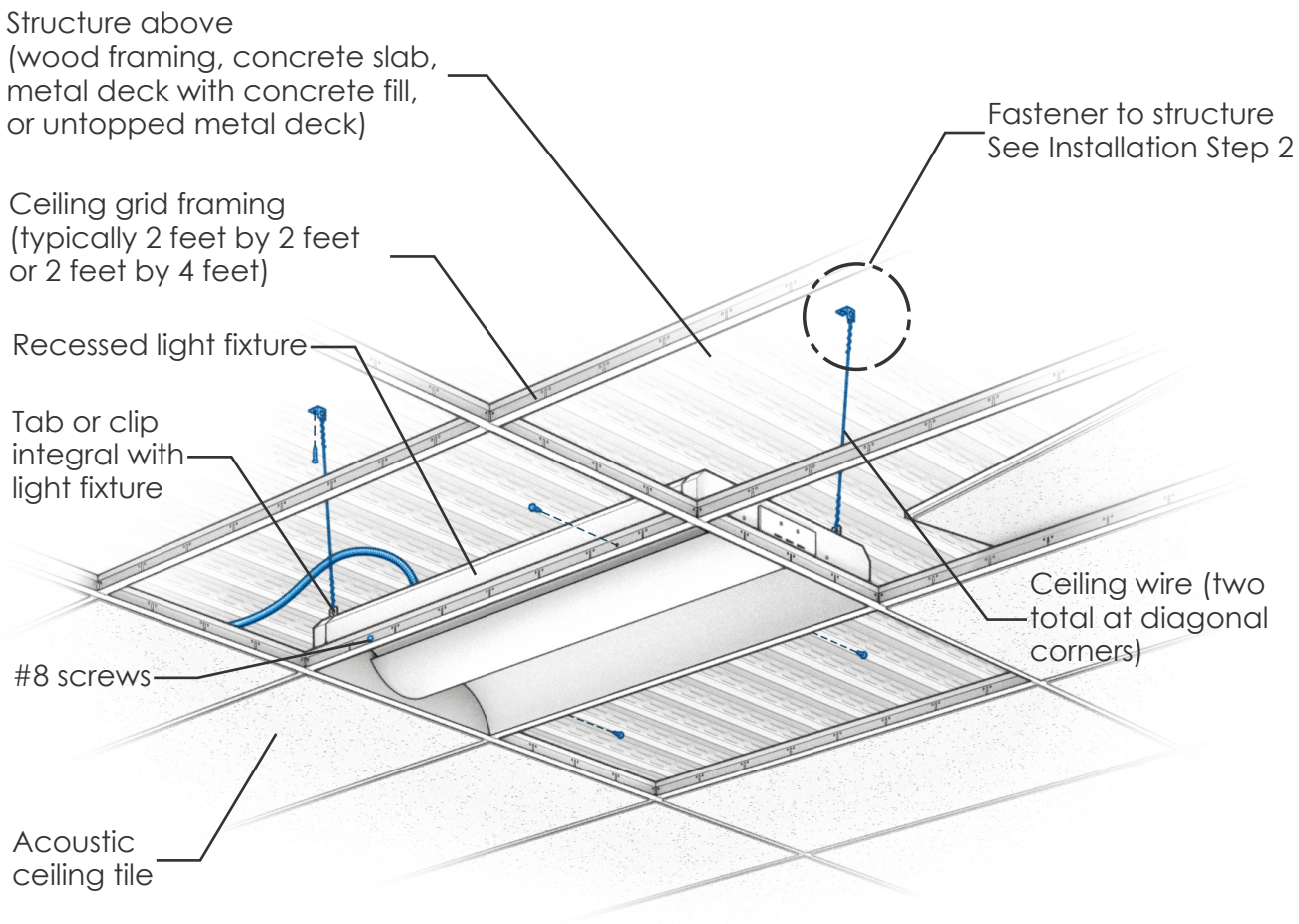
STEP 5: Install ceiling clips to T-bar grid. Ceiling clip must wrap entirely around T-bar grid and have connection point on top for ceiling hanger and on bottom for display hanger.

STEP 6: Install bottom end of ceiling wire to ceiling clip with same wrapping as in Step 4. Wires need not be taut and need not be perfectly vertical.

STEP 7: Attach display hanger to ceiling clips. If using a hook, bend hook closed to secure.

Verify clear space around light fixture allows it to swing in any direction without contacting obstruction.

21 Light Fixture (ceiling recessed)



Material List

- #8 sheet metal screws
- 12 gauge, galvanized, soft-annealed, mild steel wire
- ¼ inch diameter closed eye screw (wood framing) or 12 gauge by ¾ inch wide clip with concrete anchor (concrete slab) or 12 gauge by ¾ inch wide clip with #12 sheet metal screw (untopped metal deck)

Conditions of Use

- Acoustic Ceiling Tile (ACT) grid
- Weight of light is 56 pounds or less
- Fixture has tab or clips for attaching wire

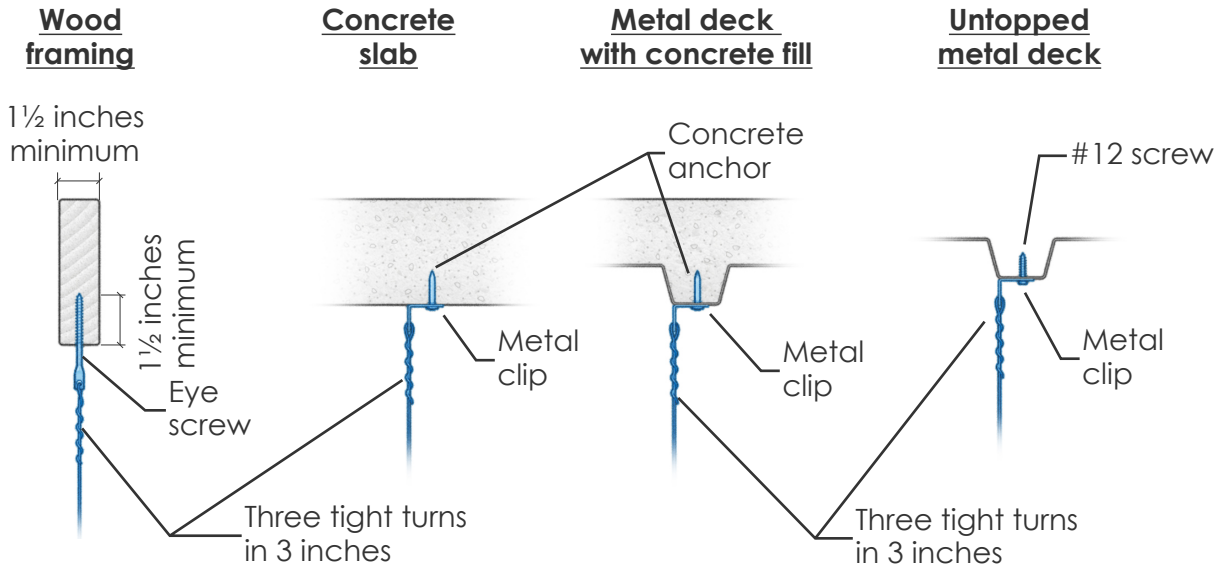
STEP 1: Fasten light to ceiling grid with two #8 screws on two opposite sides of light fixture (four screws total).

STEP 2: Install fasteners to structure above. Locate fasteners above two diagonally opposite corners of light fixture.

At wood joists: Install ¼ inch diameter screw into center of wood joist (2x minimum) with 1½ inch penetration.

At concrete slab or metal deck with concrete fill: Attach metal clip to bottom of deck with power-actuated fastener (0.143 inch diameter with at least ¾ inch embedment into concrete).

At untopped metal deck: Attach metal clip to bottom of deck with #12 sheet metal screw.

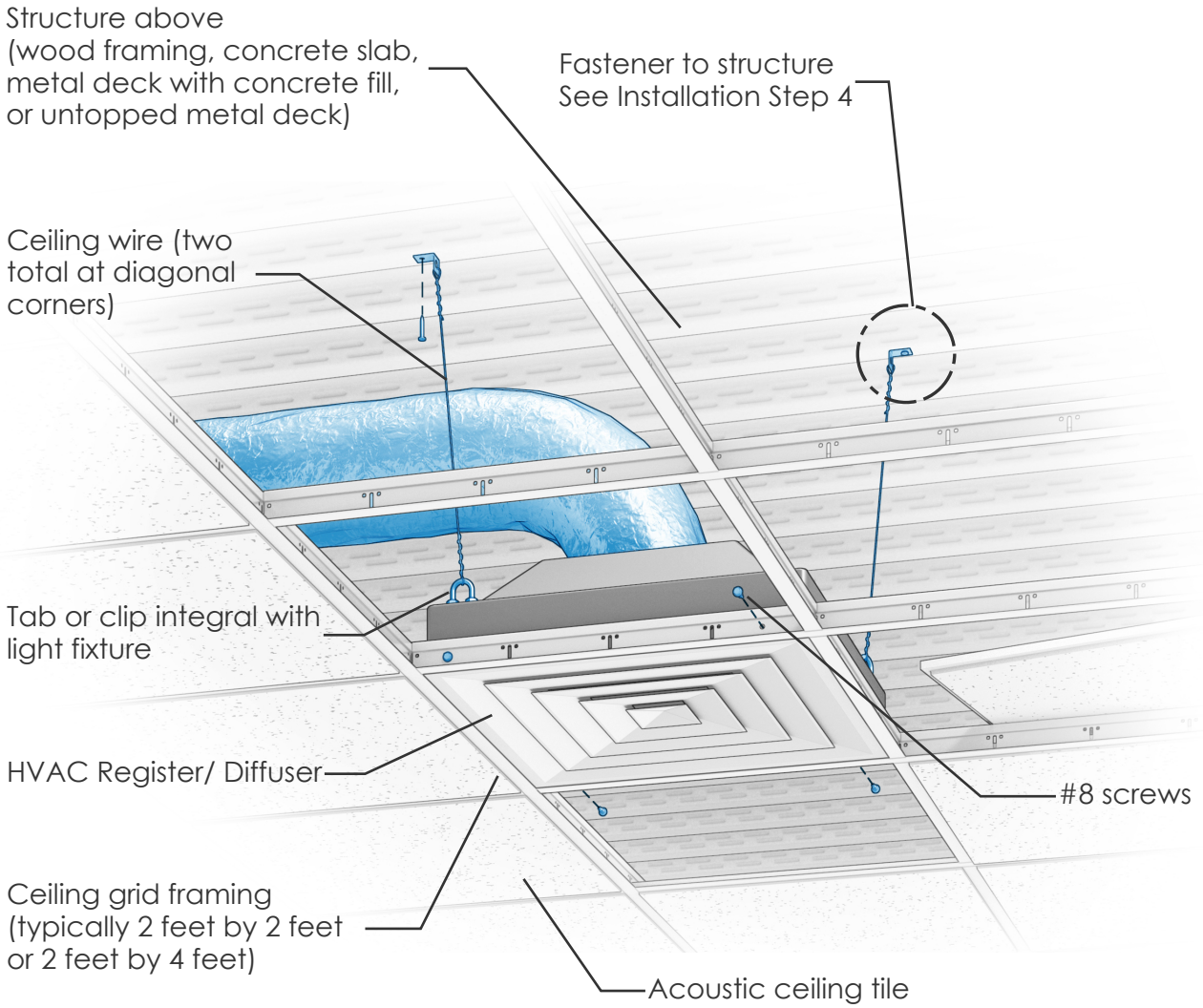


STEP 3: Fasten top of 12 gauge ceiling wire by inserting wire through fastener hole and wrapping wire around itself three times in 3 inches.

Pull down on installed wire with a weight of 200 pounds and confirm there is no discernable movement.

STEP 4: Install other end of wire to fixture with same wrapping as in Step 3. Wires need not be taut and need not be perfectly vertical (may slope up to 45 degrees).

22 Ceiling Diffuser/HVAC Register



Material List

- #8 sheet metal screws
- 12 gauge, galvanized, soft-annealed, mild steel wire
- ¼ inch diameter closed eye screw (wood framing) or 12 gauge by ¾ inch wide clip with concrete anchor (concrete slab) or 12 gauge by ¾ inch wide clip with #12 sheet metal screw (untopped metal deck)

Conditions of Use

- Acoustic Ceiling Tile (ACT) grid
- Fixture has tab or clips for attaching wire
- Weight of diffuser or register is 56 pounds or less

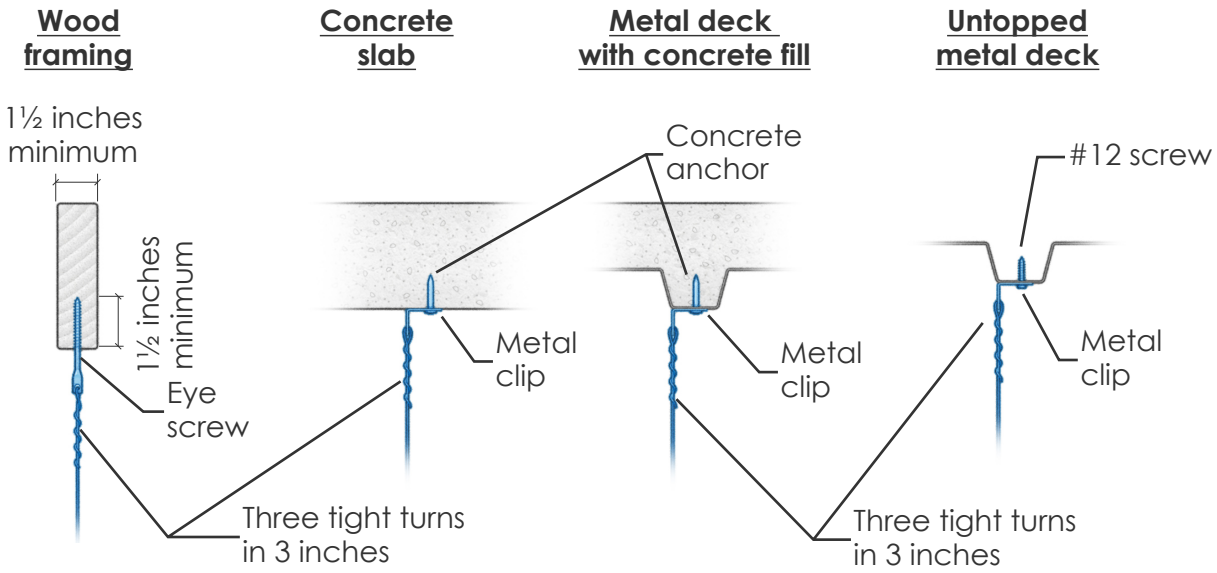
STEP 1: Fasten ceiling diffuser/HVAC register to ceiling grid with two #8 screws on two opposite sides of fixture (four screws total).

STEP 2: Install fasteners to structure above. Locate fasteners above two diagonally opposite corners of fixture.

At wood joists: Install ¼ inch diameter screw into center of 2x minimum wood joist with 1½ inch minimum penetration.

At concrete slab or metal deck with concrete fill: Attach metal clip to bottom of deck with power-actuated fastener (0.143 inch diameter by ¾ inch embedment minimum).

At untopped metal deck: Attach metal clip to bottom of deck with #12 sheet metal screw.

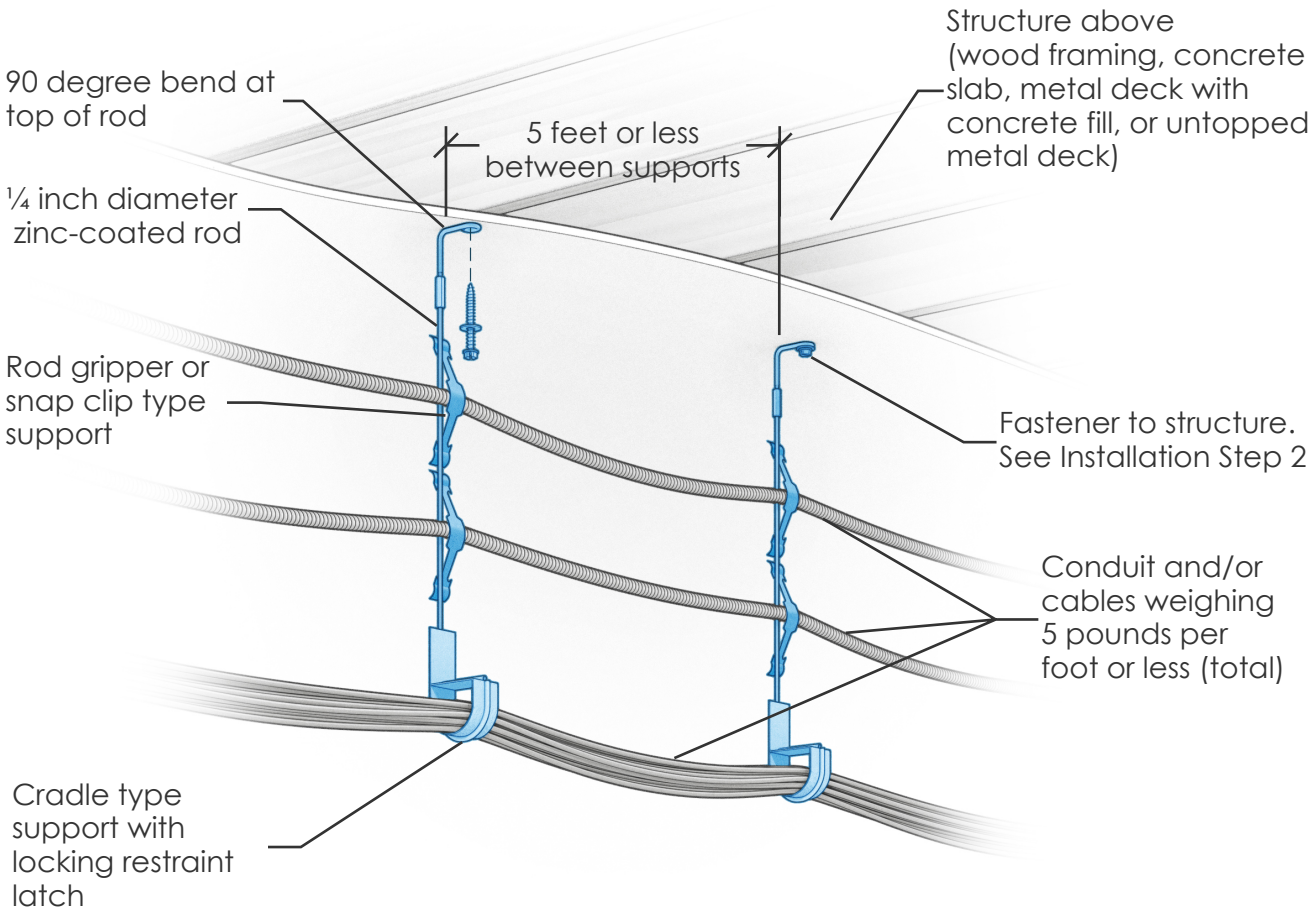


STEP 3: Fasten top of 12 gauge ceiling wire by inserting wire through fastener hole and wrapping wire around itself three times in 3 inches.

Pull down on installed wire with a weight of 200 pounds and confirm there is no discernable movement.

STEP 4: Install other end of wire to fixture with same wrapping as in Step 3. Wires need not be taught and need not be perfectly vertical (may slope up to 45 degrees).

23 Small Conduit and Cables



Material List

- ¼ inch diameter zinc-coated rod with 90 degree bend
- Low voltage conduit supports such as rod grippers, snap clips, cradles with locking restraint latches, and/or conduit hangers
- #10 wood screw (wood framing) or 0.143 inch by ¾ inch embedment power actuated fastener (concrete slab or metal deck with concrete fill) or #10 sheet metal screw (untopped metal deck)

Conditions of Use

- Weight of all cables and conduit combined is 5 pounds per foot or less
- All conduit are 2.5 inch diameter or less

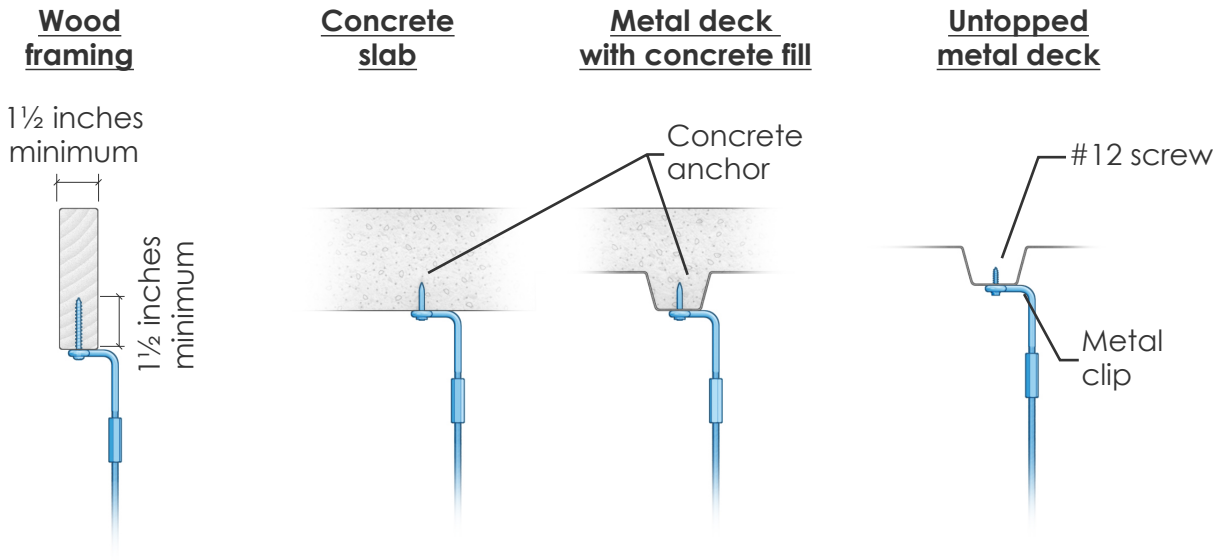
STEP 1: Assemble rod with conduit supports, such as rod grippers, snap clips, cradles with locking restraint latches, and/or conduit hangers, as applicable.

STEP 2: Fasten rod to structure above.

At wood joists: Install #10 wood screw into center of 2x minimum wood joist with 1½ inch minimum penetration.

At concrete slab or metal deck with concrete fill: Attach metal clip to bottom of deck with power-actuated fastener (0.143 inch diameter by ¾ inch embedment minimum).

At untopped metal deck: Attach to bottom of deck with #10 sheet metal screw.

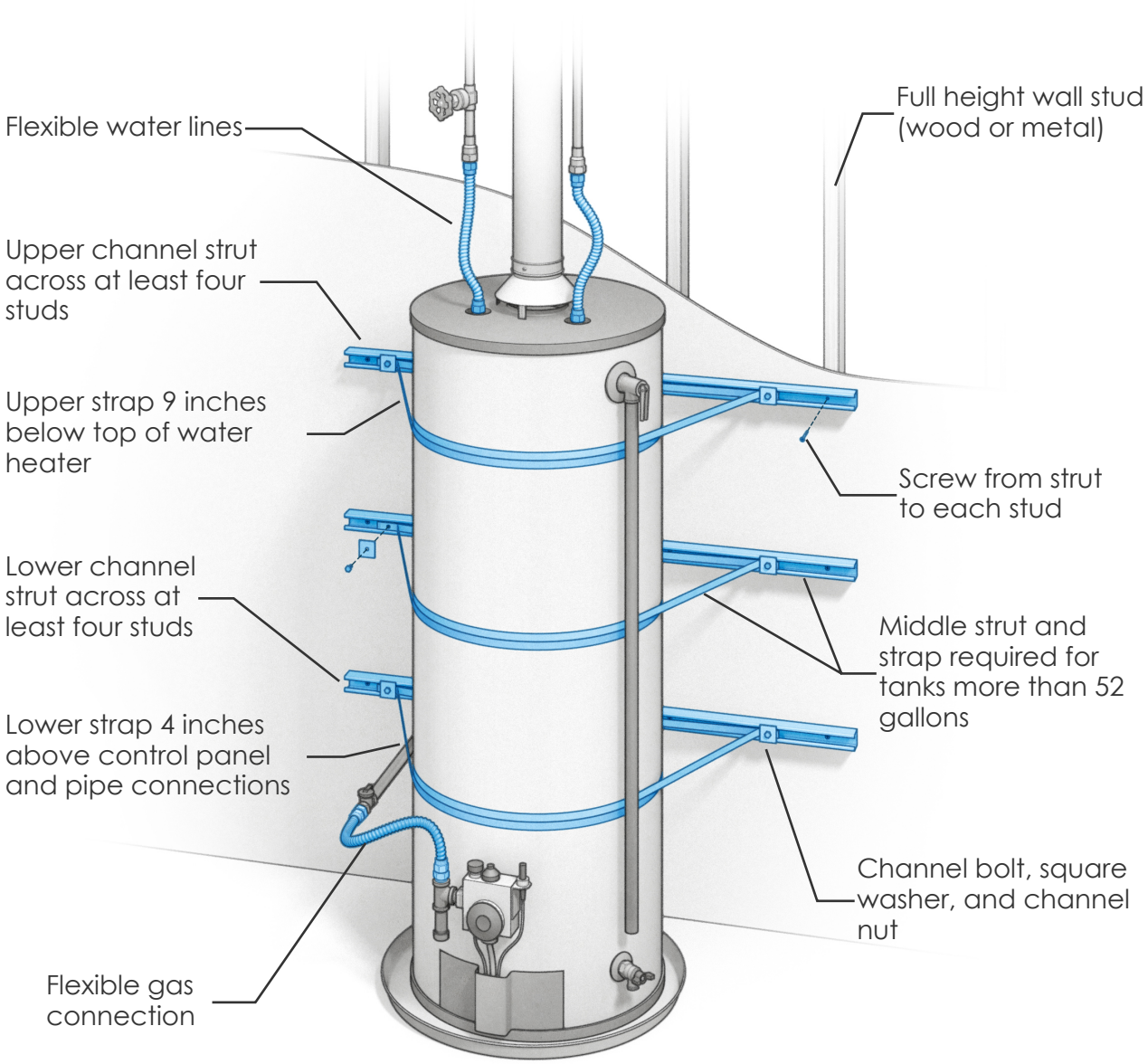


Pull down on installed rod with a weight of 200 pounds and confirm there is no discernable movement.

STEP 3: Repeat Step 1 and Step 2 to install rods every 5 feet along length of conduit.

STEP 4: Install conduit or cables through the conduit supports.

24 Water Heater



✓ Conditions of Use

- Full height wall studs spaced at 16 inches
- Tank capacity is 75 gallons or less
- Flexible connections to water and gas lines
- Water heater is not elevated on a platform

Material List

24 Continued

- 1⅝ inch by 1⅝ inch by 12 gauge channel struts
- ¼ inch diameter lag screws by 3 inches (wood studs) or ¼ inch diameter sheet metal screws by 1½ inch long (metal studs)
- ¾ inch by 22 gauge steel straps
- ⅜ inch diameter channel bolts and channel nuts
- 1⅝ inch square washers
- Metal angle spacers: 1½ inch tall by 3 inch long by ⅛ inch thick (depth per Step 8)

Installation

STEP 1: Locate the four nearest wall studs behind the water heater.

Verify wall studs are full height or fully braced.

STEP 2: Determine quantity of channel struts. Use two channel struts for 52 gallons tanks or smaller. Use three channel struts for tanks with a capacity of up to 75 gallons.

STEP 3: Determine height placement of channel struts. Locate the top strut 9 inches below the top of the tank. Locate the bottom strut approximately 4 inches above the control panel or any pipe connections. Where required, locate third strut approximately midway between the top and bottom struts.

STEP 4: Attach each channel strut to at least four wall studs.

At wood studs: Install ¼ inch diameter wood screws through back of channel strut into center of studs.

Verify screws are embedded at least 2 inches into wood stud.

At metal studs: Install ¼ inch sheet metal screws through back of channel strut into center of studs.

Verify screws are embedded into metal stud.

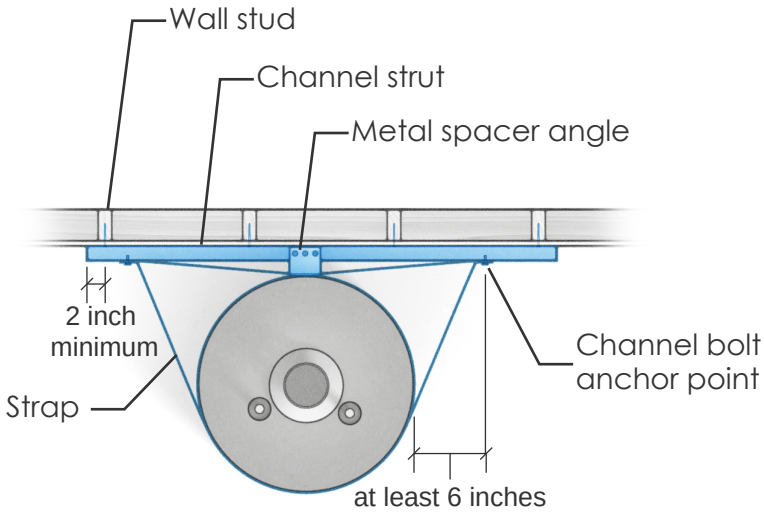
STEP 5: Place water heater. The gap between the back of tank and the wall should be at least 2½ inches and no more than 4 inches.

STEP 6 (see plan view next page): Determine location of channel bolt anchor point. The channel bolt shall be at least 6 inches from the outside of the tank. Measure the distance from the channel bolt around the circumference of the tank and back to the same channel bolt, then add 2 inches. This is the required length of metal strap. Cut two of these straps for each layer of channel strut (four total straps for up to 52 gallon tank; six total straps for up to 75 gallon tank).

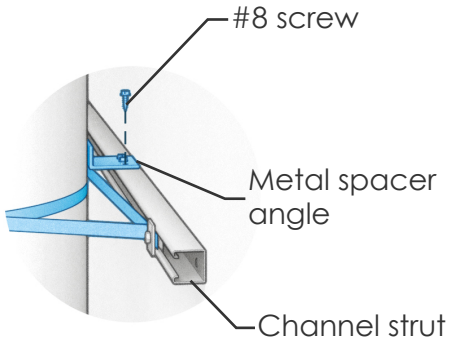
STEP 7: Install the straps. Wrap each strap around tank and tighten so that it is taut. Install a ⅜ inch diameter channel bolt, 1⅝ inch square washer, and channel nut at each anchor point location.

STEP 8 (see side view next page): Measure gap between tank and wall, then subtract up to ⅝ inches to get depth of metal spacer angle. Position angle on top of channel strut with vertical leg of angle tight to the tank. Screw horizontal leg of angle to top of channel strut with three #8 sheet metal screws.

Plan View of Water Heater



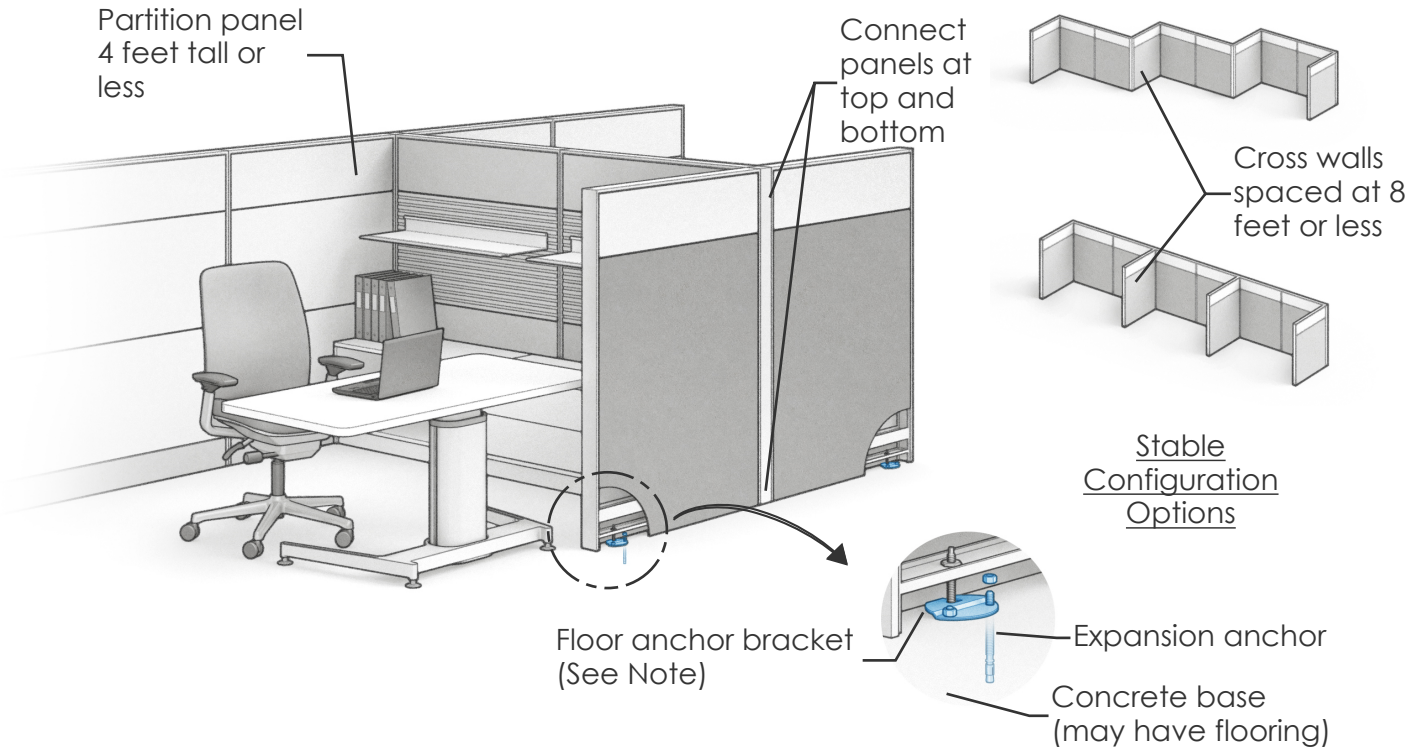
Side View at Metal Spacer



Notes:
As an alternative to the seismic bracing shown above, several manufactured systems are available (typically at local hardware or home improvement stores). These systems may be installed in accordance with the manufacturer's installation instructions, and subject to the Conditions of Use noted above.

If the water heater has an insulation blanket around the outside of the tank, it should be removed and reinstalled after the bracing system is completed.

25 Free-Standing Partitions (cubicals)



Material List

- Manufactured partition panels
- Fasteners by manufacturer for interconnecting individual panels
- Floor anchor brackets by manufacturer and ⅜ inch diameter expansion anchors (or sized as needed to fit predrilled holes in bracket). See Note.

Conditions of Use

- Height of partition is 4 feet or less
- Partition panels are arranged in a stable configuration such that there are cross walls every 8 feet maximum

Installation

STEP 1: Arrange partition panels in a stable configuration.

Verify cross walls are spaced at 8 feet or less.

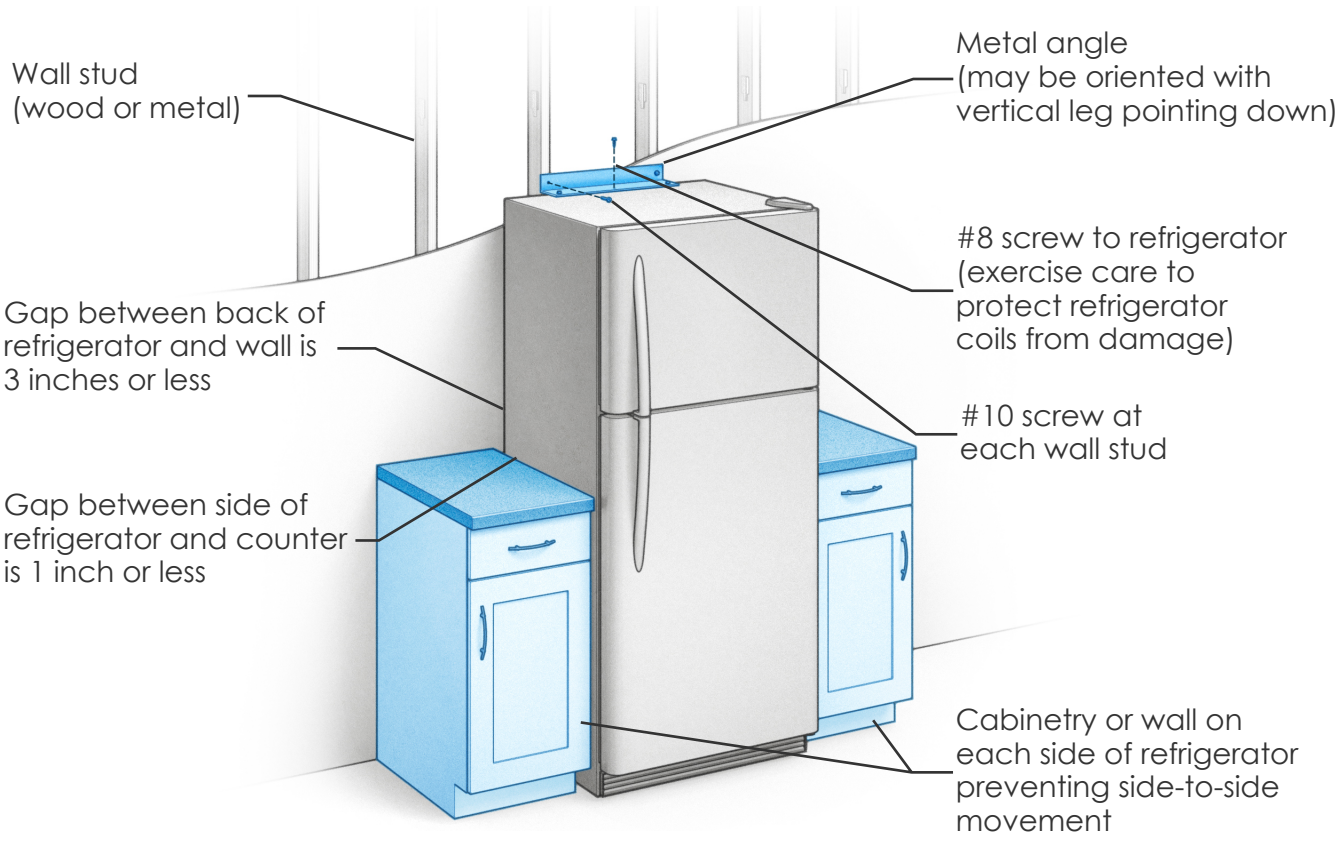
STEP 2: Connect individual panels to each other at top and bottom of each panel per manufacturer's installation instructions.

STEP 3: Identify anchorage locations so that partition is anchored to the floor every 8 feet or less and at ends of all cross walls.

STEP 4: At each anchorage location, install a floor anchor bracket with two ⅜ inch diameter expansion anchors with 1½ inch embedment into concrete floor. Follow expansion anchor product instructions, including those for testing and inspection.

Note: It is acceptable to skip Step 3 and Step 4 if the partition panels are not hard-wired into the building electrical system.

26 Refrigerator Between Cabinets



Material List

- Metal angle (2 inch tall by 4 inch wide by ⅛ inch thick, 18 inches long)
- #10 wood screw by 2½ inch long (wood studs) or #10 sheet metal screw by 1½ inch long (metal studs)
- #8 sheet metal screw

Conditions of Use

- Full height wall studs
- Weight including contents is 400 pounds or less
- Built-in cabinets or wall each side of refrigerator

Installation

STEP 1: Place refrigerator so that the gap between the back of the refrigerator and the wall is 3 inches or less.

STEP 2: Locate wall studs.

Verify wall studs are full height or fully braced.

STEP 3: Attach angle at top of refrigerator to at least two studs.

At wood studs: Install #10 wood screws through angle into each stud.

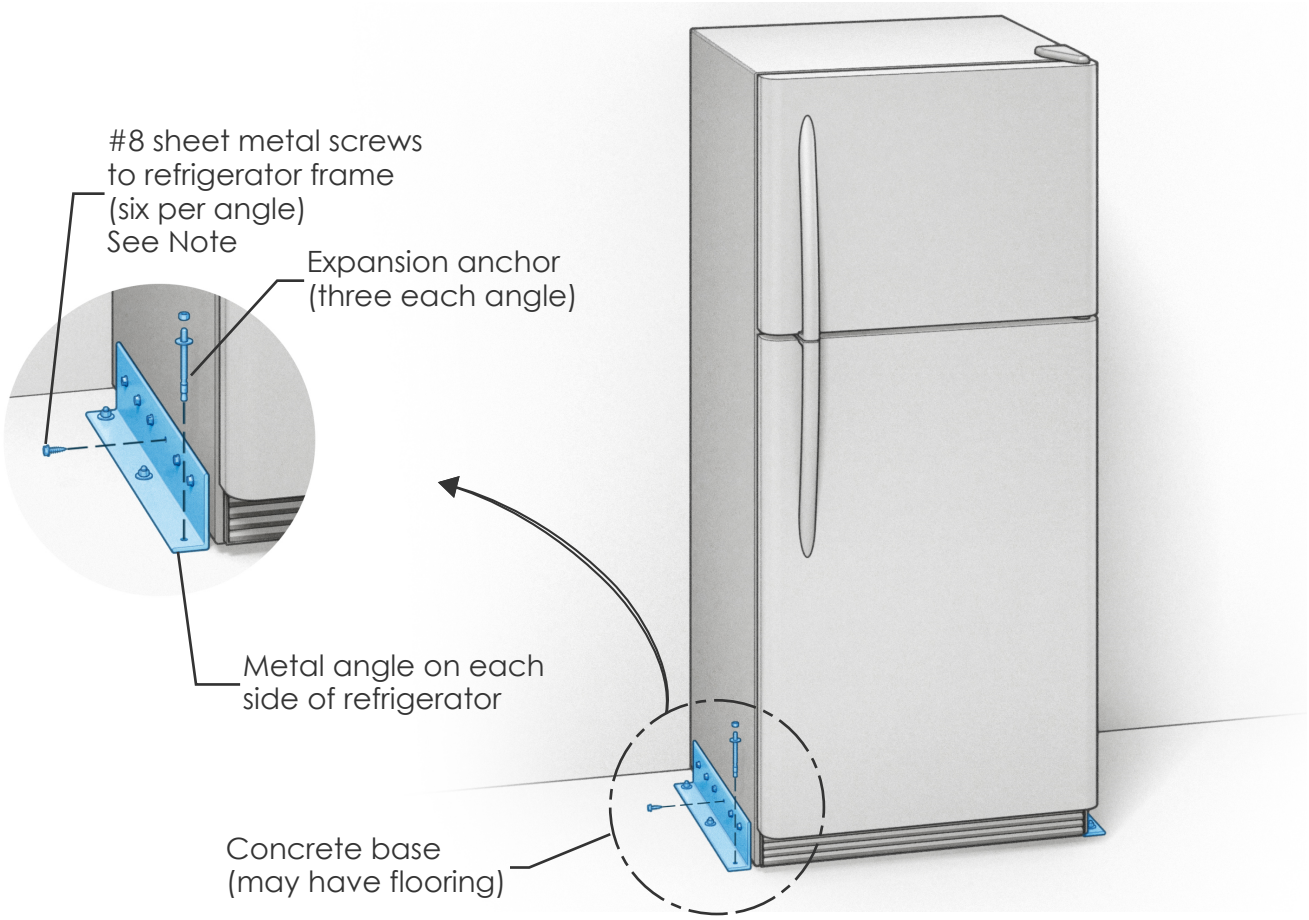
Verify screws are embedded at least 1¼ inches into wood stud.

At metal studs: Install #10 sheet metal screws through angle into each stud.

Verify screws are embedded into metal stud.

STEP 4: Attach angle to top of refrigerator with three #8 sheet metal screws spaced 8 inches apart. Exercise care to protect refrigerator coils from damage. Adjust screw locations as required.

27 Refrigerator (floor mount)



Material List

- Metal side angles (4 inch tall by 2 inch wide by ¼ inch thick, 20 inches long)
- #8 sheet metal screws
- ⅜ inch diameter expansion anchors

Conditions of Use

- Weight including contents is 400 pounds or less
- Flooring over 3¼ inches minimum concrete

Installation

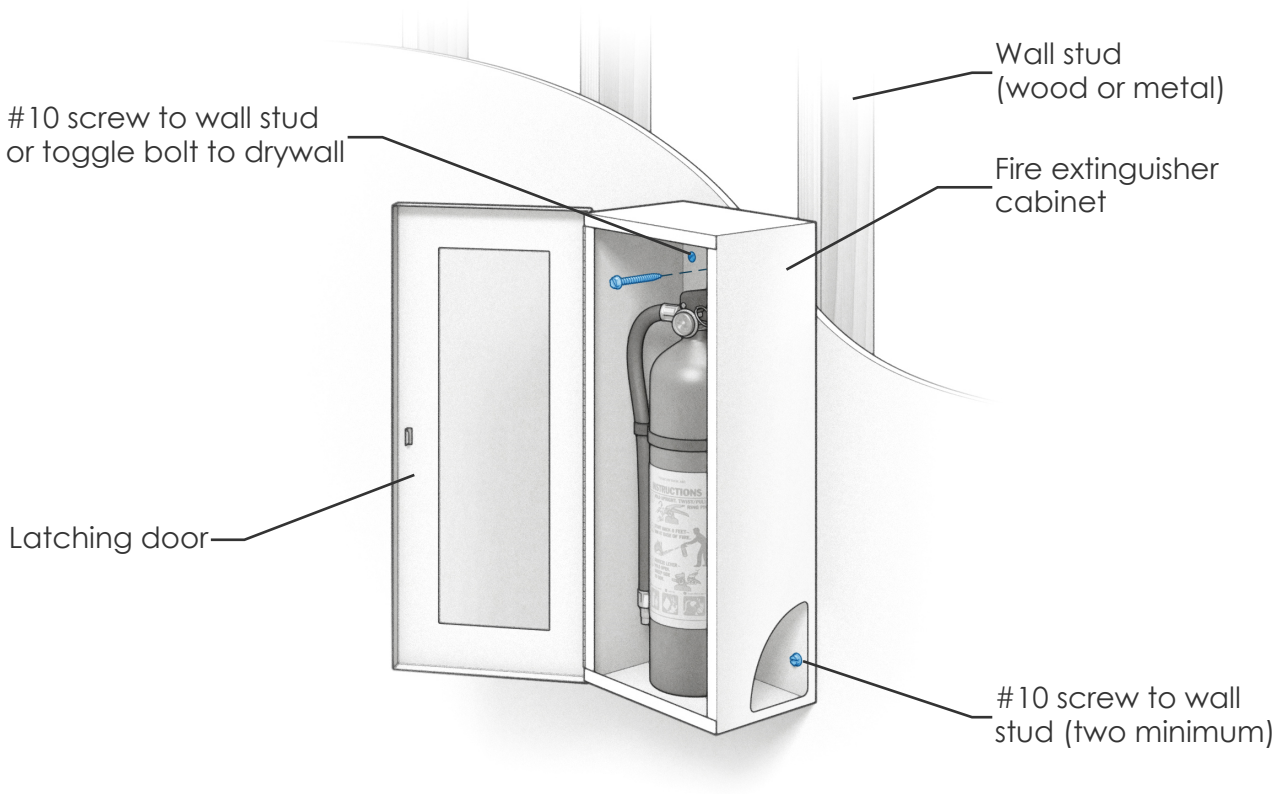
STEP 1: Place refrigerator in final position.

STEP 2: Attach each side angle to floor with ⅜ inch diameter expansion anchors with 1½ inch embedment spaced 9 inches apart into concrete floor. Follow expansion anchor product instructions, including those for testing and inspection.

STEP 3: Screw each side angle into refrigerator frame with #8 screws spaced at 3 inches apart (six screws per angle). See Note.

Note: Increase height of angle to up to 6 inches as needed to screw into refrigerator frame. Exercise care to protect refrigerator coils from damage. Adjust screw locations as required.

28 Fire Extinguisher (cabinet mount)



Material List

- Surface-mounted cabinet rated for weight of fire extinguisher with latching door
- #10 wood screw by 2½ inch long (wood studs) or #10 sheet metal screw by 1½ inch long (metal studs)
- Toggle bolts for mounting to gypsum board/drywall

Conditions of Use

- Weight of cabinet plus fire extinguisher is 20 pounds or less

Installation

STEP 1: Locate wall stud.

STEP 2: Attach one side of cabinet to wall stud with at least two screws.

At wood studs: Install #10 wood screws into center of stud.

Verify screws are embedded at least 1¼ inches into wood stud.

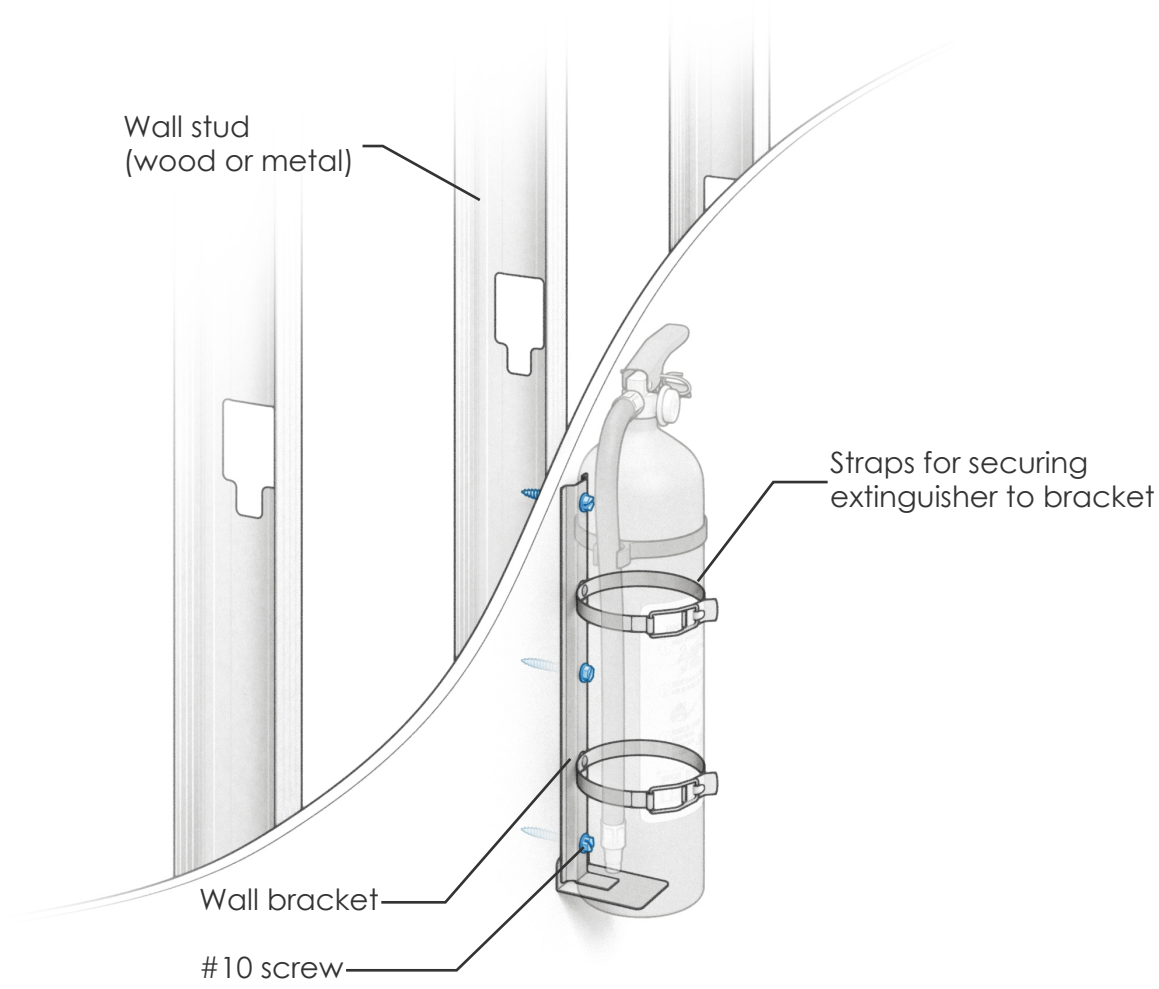
At metal studs: Install #10 sheet metal screws into studs.

Verify screws are embedded into metal stud.

STEP 3: If cabinet mounting holes on other side of cabinet align with a stud, repeat Step 2. If cabinet mounting holes do not align with a stud, install two toggle bolts through back of cabinet into drywall.

Verify door is latched.

29 Fire Extinguisher (bracket mount)



Material List

- Wall bracket with straps rated for weight of extinguisher
- #10 wood screw by 2 inch long (wood studs) or #10 sheet metal screw by 1½ inch long (metal studs)

Conditions of Use

- Weight of extinguisher is 20 pounds or less

Installation

STEP 1: Locate wall stud.

STEP 2: Attach bracket to wall stud.

At wood studs: Install at least two #10 wood screws through bracket into center of stud.

Verify screws are embedded at least 1¼ inches into wood stud.

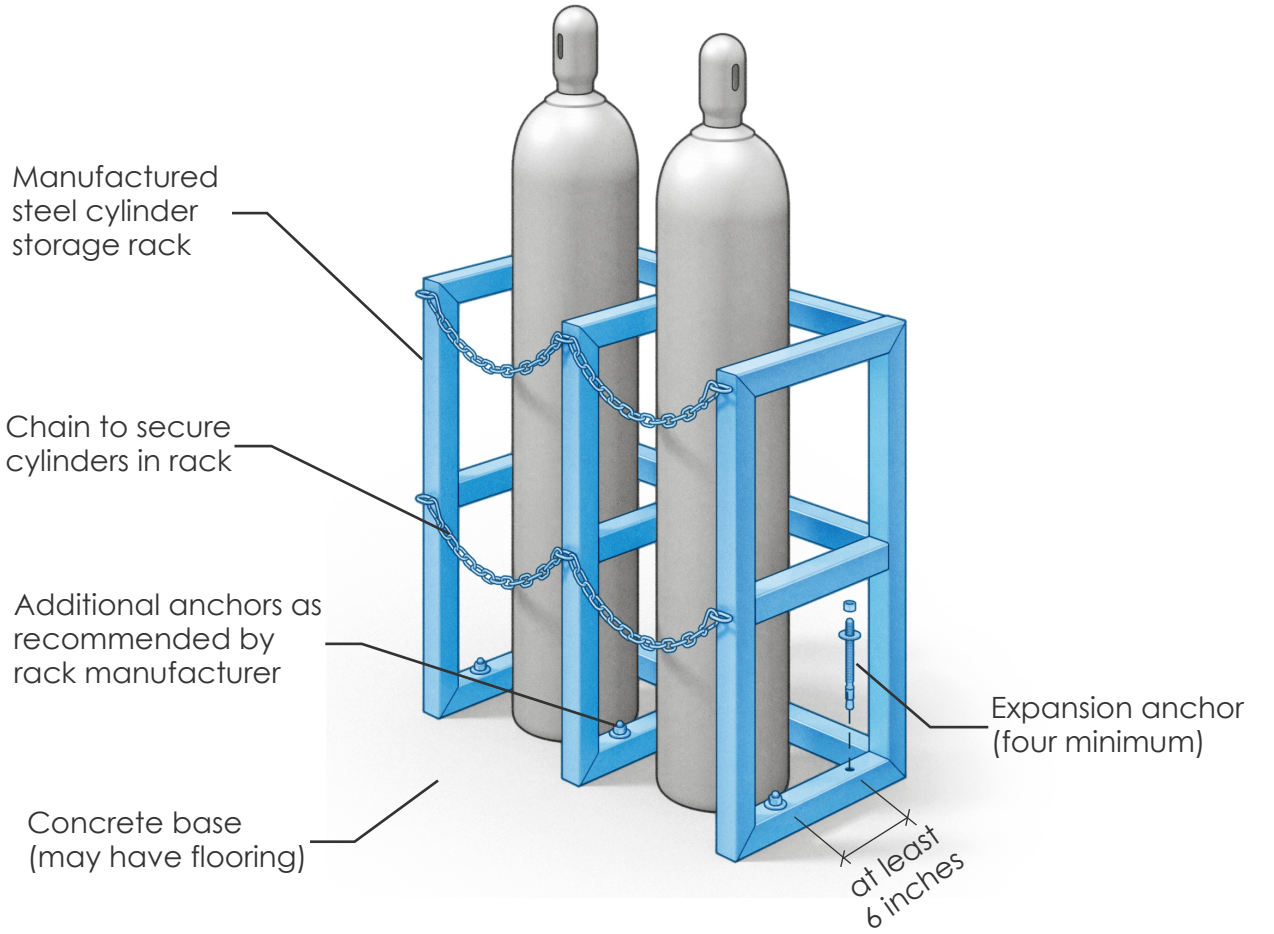
At metal studs: Install at least two #10 sheet metal screws through bracket into studs.

Verify screws are embedded into metal stud.

STEP 3: Place fire extinguisher on bracket.

STEP 4: Secure straps around fire extinguisher.

30 Gas Cylinders (floor mount)



Material List

- Manufactured steel cylinder storage rack with chains to secure cylinders and pre-drilled holes for anchors
- ⅜ inch diameter expansion anchors (Note: upsize anchors to ½ inch if needed to fit pre-drilled mounting holes)

Conditions of Use

- Weight of cylinders plus rack is 400 pounds or less
- Concrete beneath flooring is at least 4 inches thick

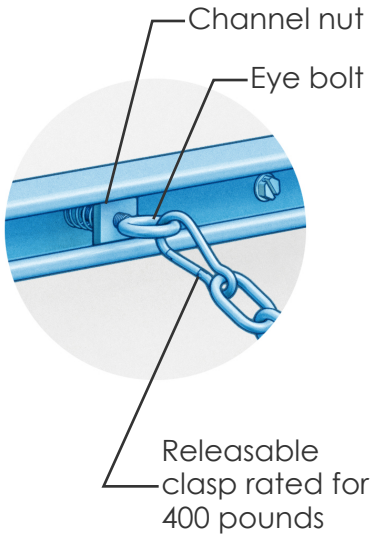
Installation

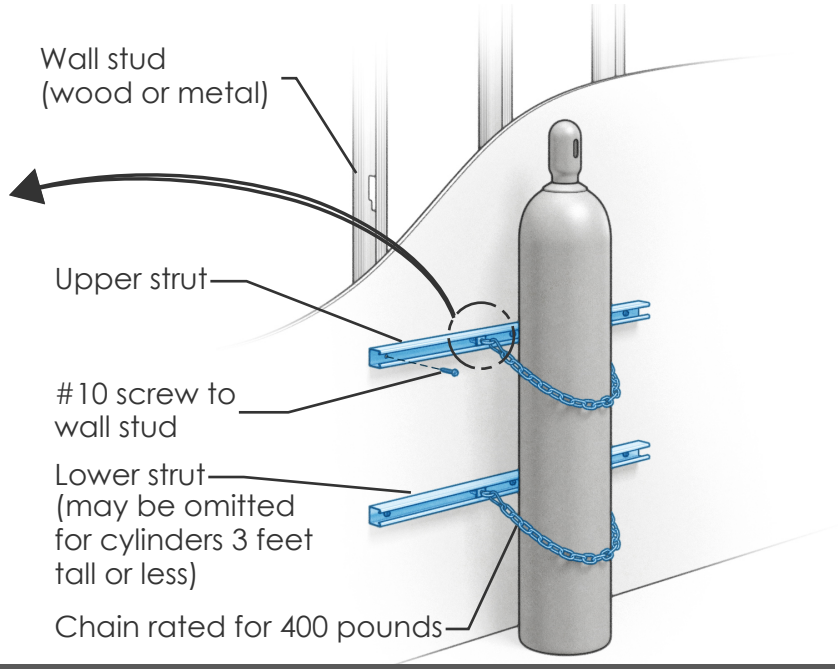
STEP 1: Attach rack to floor with minimum of four ⅜ inch diameter expansion anchors with 2 inch embedment into concrete. Follow expansion anchor product instructions, including those for testing and inspection. Follow manufacturer's instructions for additional anchors where required for larger racks.

STEP 2: Keep chains clasped to secure cylinders within rack.

Note: Engage a design professional for mitigation design if cylinders contain toxic, highly toxic, or explosive substances where the quantity of the material exceeds the threshold established by the California State Fire Marshal, or pose a threat to the public if released.

31 Gas Cylinders (wall mount)





Material List

- 1⅝ inch by 1⅝ inch by12 gauge thick by 3 foot long channel strut
- #10 wood screw by 2½ inch long (wood studs) or #10 sheet metal screw by 1½ inch long (metal studs)
- ¼ inch diameter eye bolts and nuts for channel strut
- Releasable clasps and chain both rated for 400 pounds

Conditions of Use

- Total weight of all cylinders is 400 pounds maximum

Installation

STEP 1: Determine strut placement. For cylinders 3 feet tall or shorter, provide single strut approximately 6 inches above mid-height. For cylinders taller than 3 feet, provide two struts. Locate lower strut at one third of the height and upper strut one foot below top of cylinder.

STEP 2: Locate wall studs.

STEP 3: Attach strut to three studs minimum.

At wood studs: Install wood screw through strut into center of each stud.

Verify screws are embedded at least 1¼ inches into wood stud.

At metal studs: Install sheet metal screw through strut into center of each stud.

Verify that screws are embedded into metal stud.

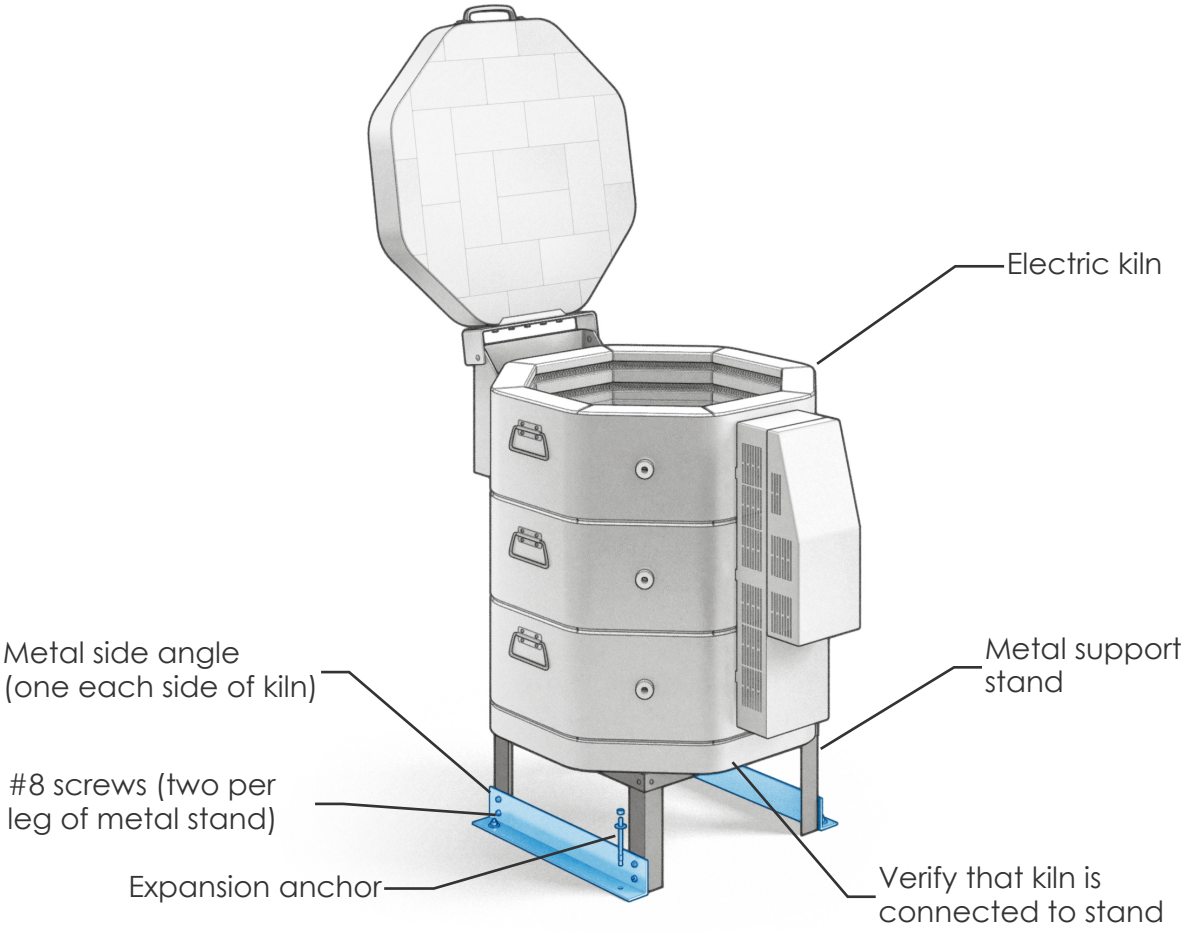
STEP 4: Install eye bolt with channel nut to strut on each side of cylinder.

STEP 5: Fit chain or wire snug around cylinder and clasp to eye bolt each end.

Note: Engage a design professional for mitigation design if cylinders contain toxic, highly toxic, or explosive substances where the quantity of the material exceeds the threshold established by the California State Fire Marshal, or pose a threat to the public if released.

Note: Multiple cylinders may be restrained side by side. Lengthen strut as needed and attach to each stud along length of strut. Provide separate chains for each cylinder.

32 Electric Kiln



Material List

- Metal side angles (3 inch tall by 2 inch wide by ⅛ inch thick, length to match distance from outside of leg to outside of leg)
- #8 sheet metal screws
- ⅜ inch diameter expansion anchors

Conditions of Use

- Kiln is securely fastened to metal support stand
- Flooring over 3¼ inch minimum concrete
- Kiln is 36 inches tall or less and 400 pounds or less

Installation

STEP 1: Measure distance from outside of stand leg to outside of stand leg to determine required length of angles.

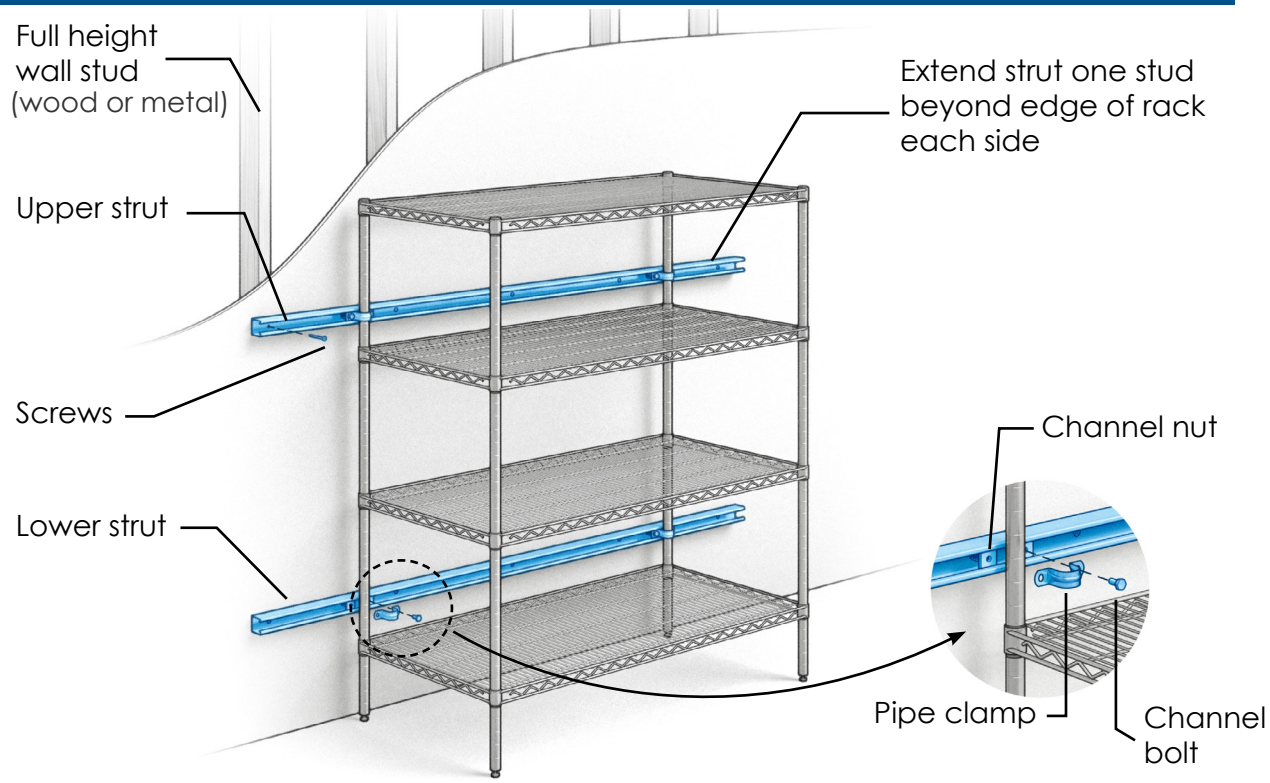
STEP 2: Place kiln in final position.

Verify that kiln is securely fastened to metal support stand. Follow manufacturer's instructions. Install seismic kit where available.

STEP 3: Attach each side angle to floor with two ⅜ inch diameter expansion anchors with 1½ inch embedment into concrete floor. Follow expansion anchor product instructions, including those for testing and inspection.

STEP 4: Screw side angles to stand with two #8 screws per leg (eight total).

33 Open Shelving Storage Rack



Material List

- 1⅝ inch by 1⅝ inch, 12 gauge thick channel strut
- #12 wood screw by 2½ inch long (wood studs) or #12 sheet metal screw by 1½ inch long (metal studs)
- Pipe clamps sized to fit rack legs and channel strut
- ¼ inch diameter channel bolts and nuts

Conditions of Use

- Full height wall studs
- Weight including contents is 400 pounds or less
- Height is 6 feet or less

Installation

STEP 1: Determine strut placement. Locate upper strut approximately 1 foot below top shelf. Locate lower strut approximately 1 foot above floor. Adjust lower strut as needed to avoid bottom shelf.

STEP 2: Locate wall studs.

Verify wall studs are full height or fully braced.

STEP 3: Attach strut to each stud.

At wood studs: Install wood screws through strut into center of stud.

Verify screws are embedded at least 1¼ inches into wood stud.

At metal studs: Install sheet metal screws through strut into studs.

Verify screws are embedded into metal stud.

STEP 4: Place rack tight against strut.

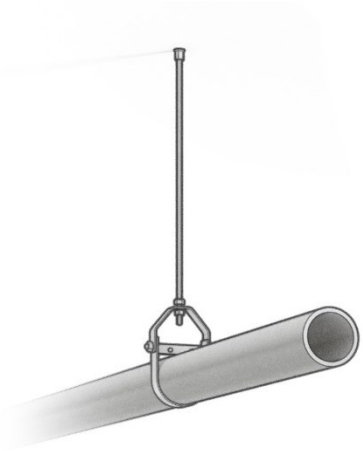
STEP 5: Place pipe clamp around rear rack leg and bolt pipe clamp to strut to with two channel bolts plus channel nuts (four pipe clamps total; eight channel bolts total).

Help Guide: Pipe and Conduit Bracing

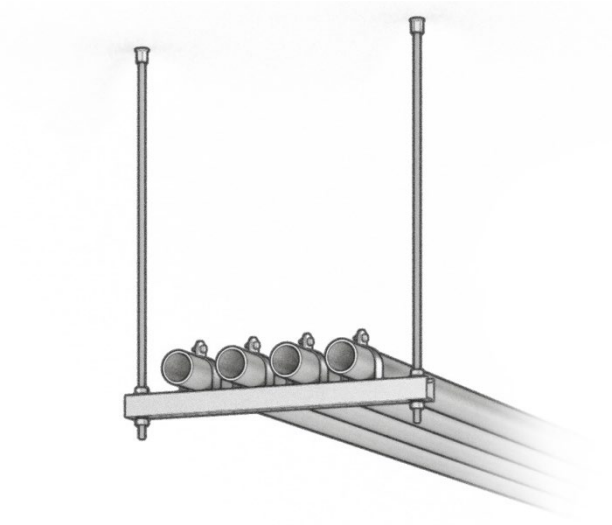
Pipes and electrical conduit deliver water and power throughout school buildings. They are often located above the ceiling and suspended from the floor or roof above. Seismic bracing prevents movement and protects the pipes and conduit to help keep schools functioning. The **School Earthquake Hazard Checklist: *Building Components and Equipment*** (Part B) includes pipes, fire sprinkler pipes, electrical cabling, and conduits. The surveyor is asked whether larger pipes and conduit are braced in transverse and longitudinal directions. This Help Guide describes how to determine if a pipe or conduit is already braced. Pipes and conduit are referred to below simply as "pipes."

Pipe Supports

Suspended pipes are hung from the floor or roof above either independently or as a group. In both cases, pipes are typically supported every 6 to 10 feet along the length of piping. Independently hung pipes are typically supported using a pipe clamp that fits around the pipe and a rod hanger that attaches to the structure above. Groups of pipes are typically supported with trapezes. In this case, each pipe is attached to a horizonal channel strut using a pipe clamp, and the strut is supported at each end with hangers that attach to the structure above. These hangers support the pipes but do not constitute seismic bracing.



Independently hung pipe

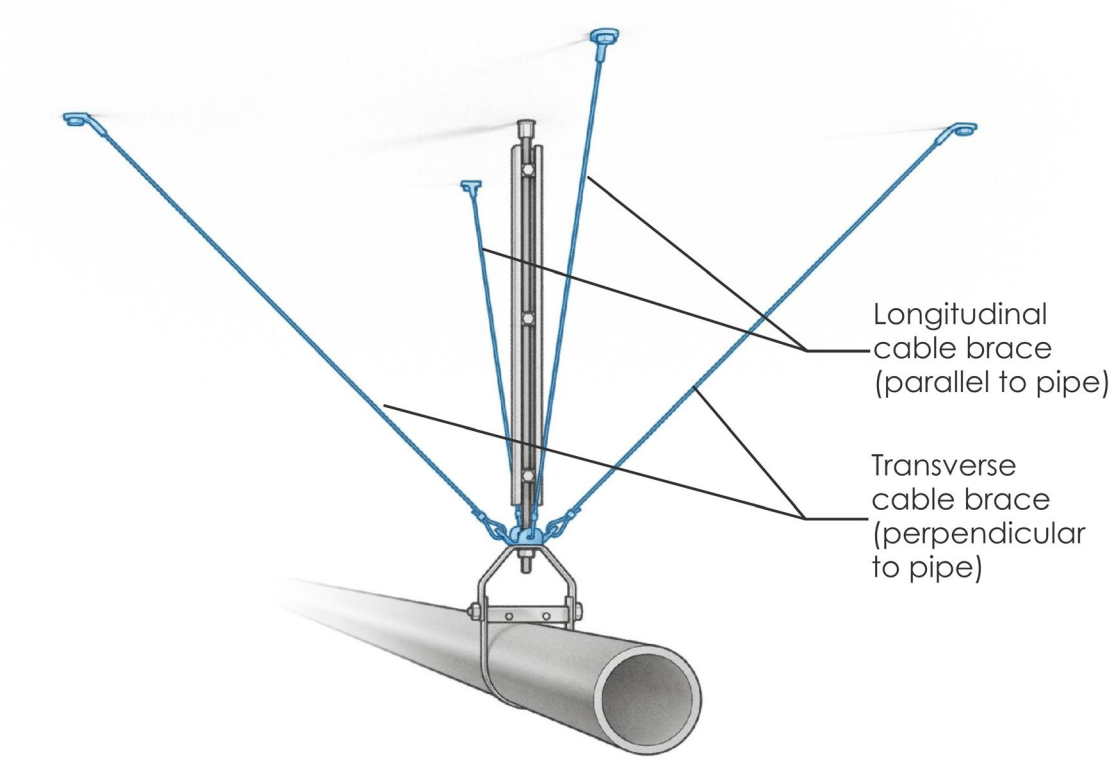


Trapeze-supported pipes

Typical Pipe Bracing

Braces are diagonal members that are attached to the pipe and structure to prevent the pipe from swinging. Pipe bracing may consist of cable braces, which are typically steel wires, or rigid braces, which are typically steel angles or channel strut.

Longitudinal braces prevent movement along the length of the pipe. Transverse braces prevent movement side-to-side.



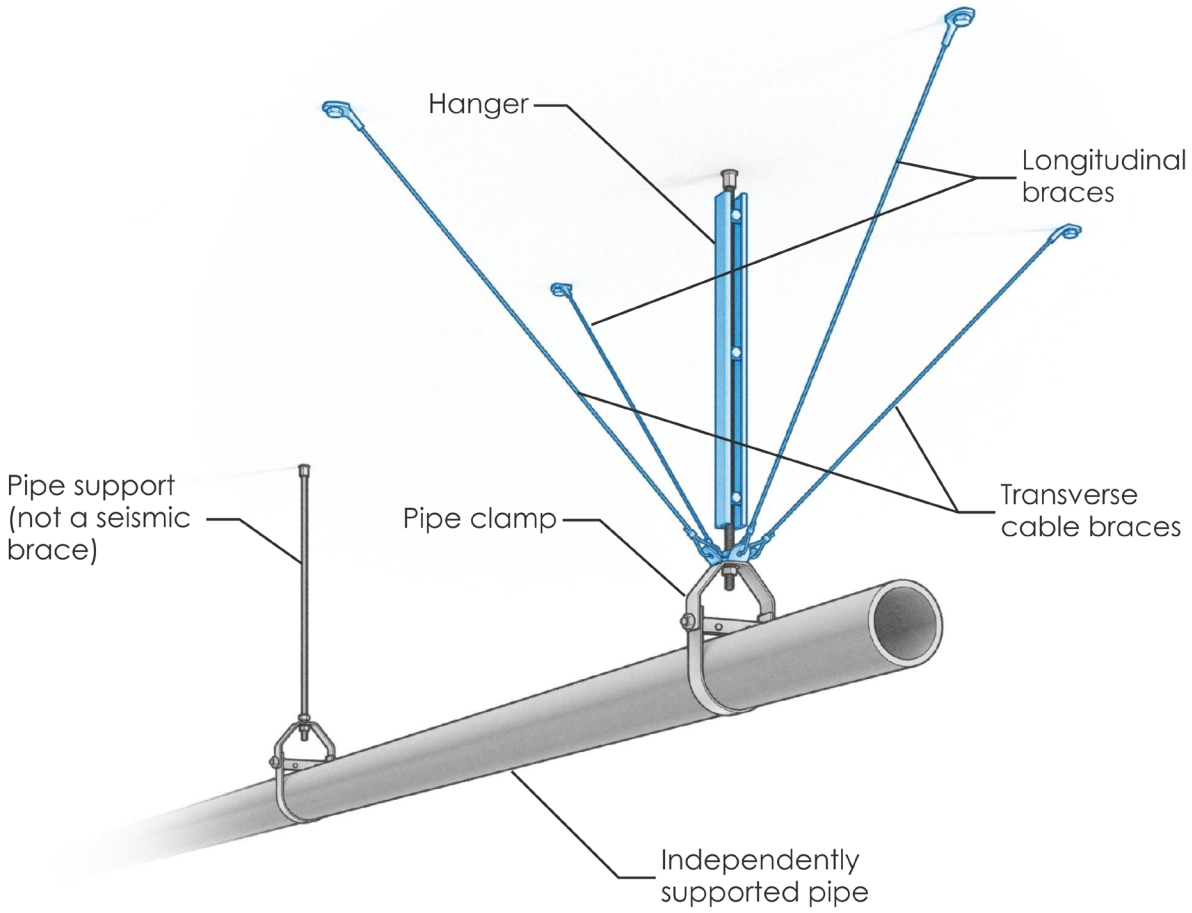
Longitudinal and transverse bracing

Longitudinal brace spacing is typically in the range of 20 feet to 80 feet. Transverse brace spacing is often half of the longitudinal brace spacing and is typically in the range of 10 feet to 40 feet. Longitudinal and transverse bracing can occur at the same location or at different locations along the length of the pipe.

For independently supported pipes, the braces may attach to the pipe clamp. For trapeze-supported pipes, the braces attach to the horizontal strut.

Bracing is not required for small pipes or where hangers are less than 12 inches long.

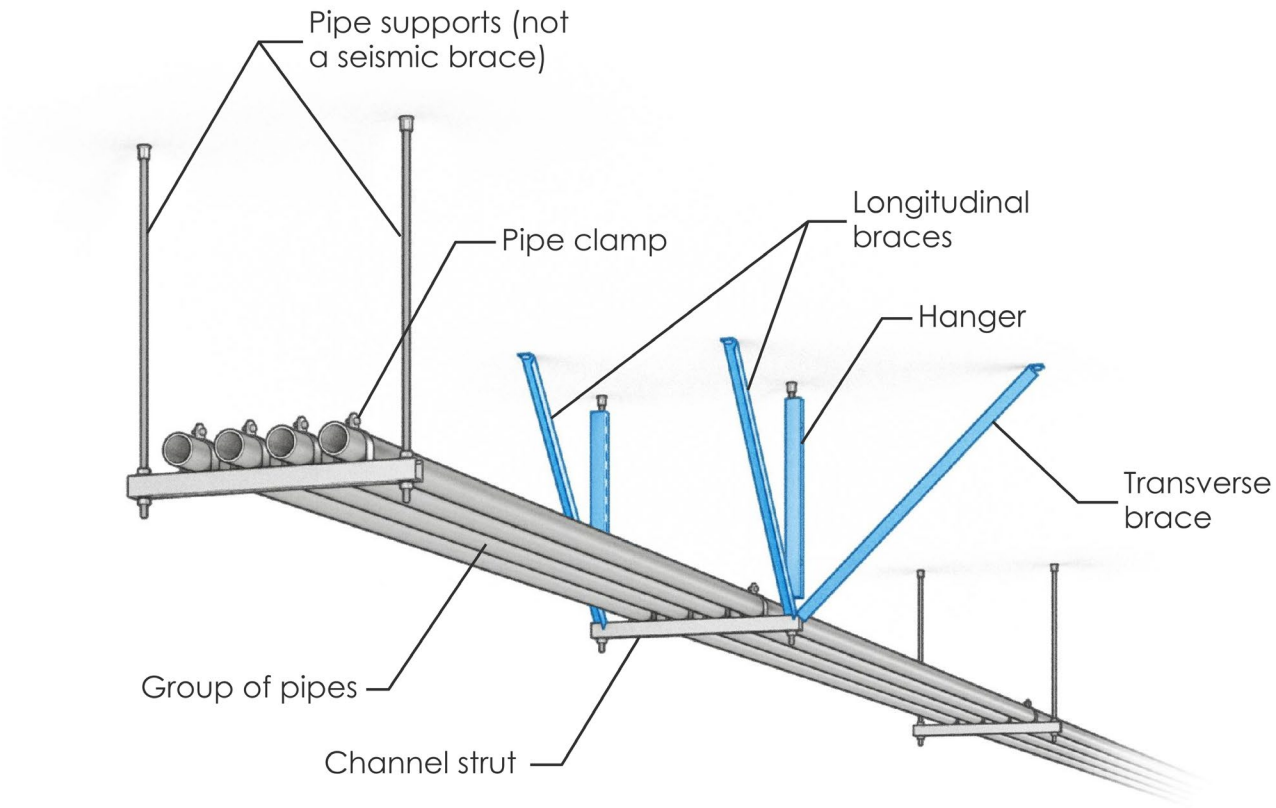
The image below shows an independently supported pipe with longitudinal and transverse cable bracing. The cable braces are required in pairs: two parallel to pipe for longitudinal bracing and two perpendicular to pipe for transverse bracing.



Independently supported pipe with cable bracing

Note: for independently supported pipes with rigid bracing, only one brace is required for either direction.

The image below shows a group of pipes supported on trapezes. At one trapeze, there are two rigid longitudinal braces and one rigid transverse brace.

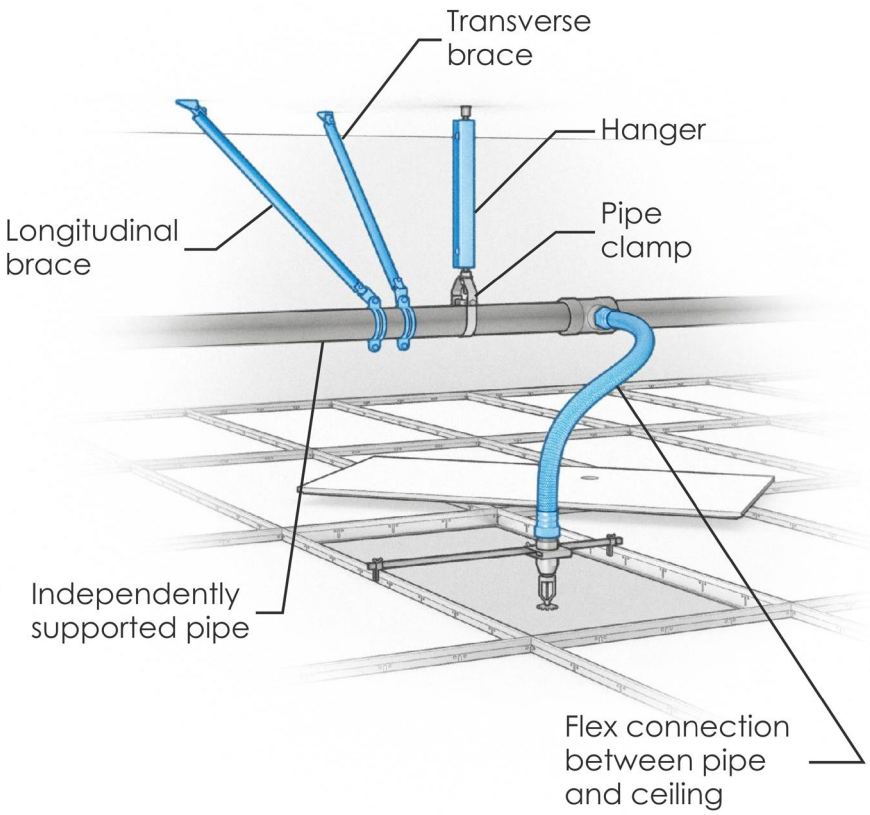


Group of pipes with rigid bracing

Fire Protection Pipe Bracing

Fire protection pipes convey water to fire sprinklers using high pressure. Failure of this piping can lead to quickly flooded classrooms and loss of fire protection. Bracing is required for pipes that are 2½ inches and larger in diameter and at the end of all pipe runs. Bracing for fire protection piping is not required where hangers are less than six inches long.

Braces are typically rigid steel pipes. Longitudinal braces are spaced at a maximum of 80 feet. Transverse braces are spaced at a maximum of 40 feet.



Fire protection piping

Surveying Pipe Bracing

In order to determine if piping is braced, it is necessary to look above the ceiling. If the ceiling is constructed with a suspended acoustic tile ceiling, a ceiling tile can be lifted to look above. In ceilings constructed with suspended gypsum wall board, there may be an access panel that can be opened to allow observation above the ceiling. There may also be rooms without ceilings where pipes are visible such as mechanical rooms.

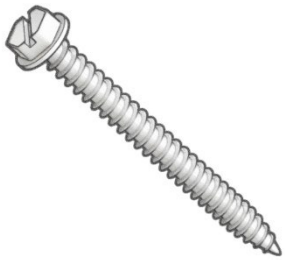
Once above ceiling, the surveyor looks for diagonal bracing. If several rooms are reviewed and no bracing is observed, the surveyor indicates "**Do not know** → Further evaluation required." An engineer can determine whether the pipes are adequately braced per the applicable building code.

Help Guide: Selecting the Right Fastener

Each **Detail** relies on fasteners to connect the equipment to the supporting wall, floor, or ceiling. For the installation to be successful, it is essential to use the right fastener. This Help Guide describes the various types of fasteners used in the **Details**.

Wood Screws

Where a component is attached to a wood stud wall, the **Details** call for wood screws. These are screws made of steel which have a sharp tip and may be partially or fully threaded. They come with a variety of heads, including hex heads or Phillips heads. Large diameter wood screws are also known as lag screws.



Fully threaded screw with hex head

Partially threaded screw with Philips head

When selecting a wood screw, the length must be sufficient to pass through the gypsum wall board (drywall) plus achieve the embedment called for in the detail. For example, if there are two layers of 5/8 inch wall board over the wood studs, and the detail calls for 1½ inch minimum embedment, the screw must be at least 2¾ inches long.

Before installing a wood screw, it is recommended to drill a pilot hole. This will ease installation of the screw and reduce splitting or cracking of the wood. To drill a pilot hole, first mark the location of the screw. Use a drill bit that matches the diameter of the screw shaft (the body of the screw not including the threads). Drill a hole the same depth as the length of your screw. Then install the screw.

Alternatively, there are self-drilling screws with special tips that can be installed without drilling a pilot hole. If using these, follow manufacturer's installation instructions.

Sheet Metal Screws

Where a component is attached to a metal stud wall, the **Details** call for sheet metal screws. These are also known as self-drilling screws or self-tapping screws. Steel screws typically have a hex head, but are also available with alternate heads. They have a drill bit tip that taps a hole without the need for predrilling.

When selecting a sheet metal screw, the length must be sufficient to pass through the gypsum wall board (drywall) plus penetrate the metal stud with at least three exposed threads. The details typically call for 1½ inch long sheet metal screws to accommodate up to two layers of 5/8 inch wall board over the metal studs. Where metal is directly attached to metal, the sheet metal screws may be shorter (about ¾ inch).

Sheet metal screw with hex head and drill bit tip

Concrete Anchors

Where a component is attached to concrete, the **Details** call for concrete expansion anchors. These are also known as wedge anchors. These are metal bolts with a special fitting at the end. They are installed in predrilled holes. When the nut is tightened, the fitting lifts and expands to grip the concrete.

Screw anchors are another type of concrete anchor. Where the **Details** call for expansion anchors, it is permissible to instead use screw anchors with the same diameter and embedment. Screw anchors are more easily removed in the future and have a lower profile (i.e., they stick up less).

Concrete expansion anchor

Concrete screw anchor

When relying concrete anchors, it is important to select an anchor that has an ICC-ES Report and is rated for seismic use in cracked concrete. Follow the manufacturer's requirements for installation and testing. It is expected that concrete anchors will be installed by an individual with experience in construction and access to specialty equipment.

Help Guide: Securing to Existing Stud Walls

The seismic restraint of many components requires connection to a wall that transfers earthquake forces to the building structure. Interior walls are typically constructed with metal or wood studs covered with drywall. It is essential that the wall itself is strong enough to deliver the earthquake forces to the structure. Consequently, some **Details** include instructions to ***Verify wall studs are full height or fully braced*** or ***Verify wall studs are 20 gauge minimum***. This Help Guide describes the construction of typical partition walls, explains how to determine if a partition is full height or fully braced, describes ways to determine the stud gauge, and provides guidance if a wall does not match the detail requirements.

Typical Stud Wall Construction

Most school buildings are constructed with partition walls that consist of vertical members called "studs" covered with wallboard. The studs are typically spaced at 16 inches on center (and are occasionally spaced up to 24 inches on center). The studs can be wood (typically 2x4, but sometimes larger) or metal C-shaped studs. The bottom of each stud connects to the floor with an anchored wood plate or a metal track.

Partition walls are either full height or partial height. Partial height walls can be unbraced or braced.

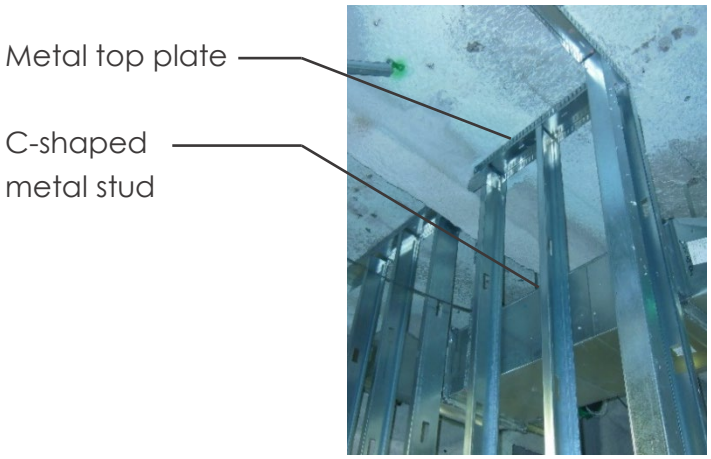
At full height walls, the top of each stud extends all the way to the floor or roof structure above. The studs are attached to metal track or wood top plate which is fastened to the structure.

At partial height walls, the studs terminate above the ceiling and do not extend to the floor or roof above. Partial height walls are considered fully braced when the top of each stud is connected to a continuous metal track or wood top plate, which is then braced to the floor or roof structure above. The braces are diagonal members that can be wood or metal C-shaped studs. The braces are typically spaced at four to eight feet.

Photos and three-dimensional views of full height walls and fully braced partial height walls are shown on the following pages.

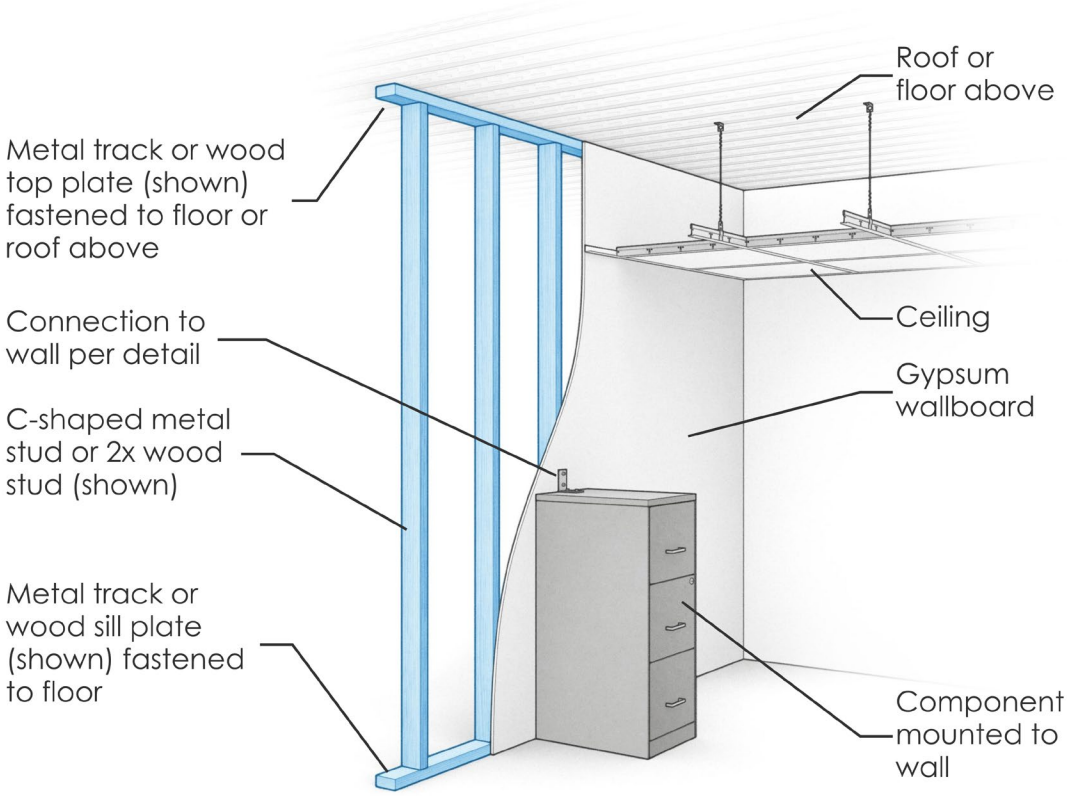
FULL HEIGHT PARTITION WALLS

The photograph below shows the top of a full height partition wall. This wall is framed with C-shaped metal studs spaced at 16 inches. The gypsum wallboard has not yet been installed.



Top of full height partition wall

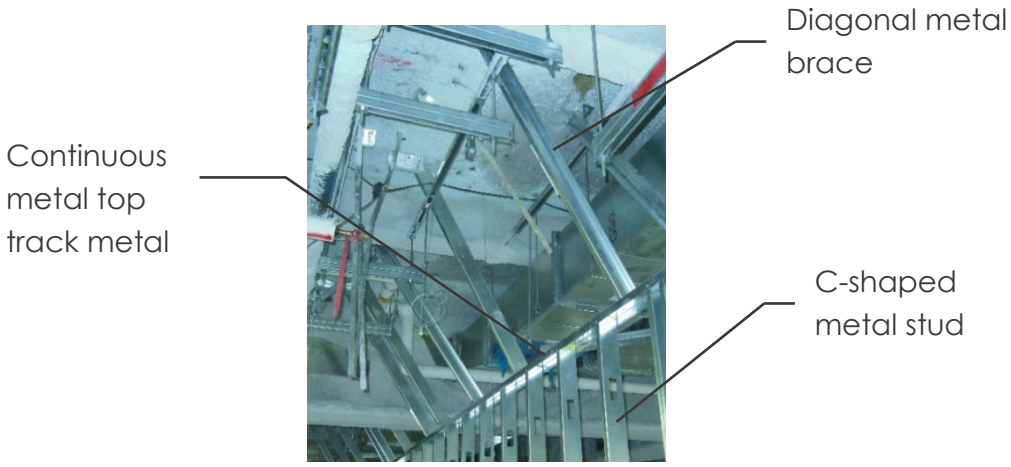
The graphic below shows an idealized full height partition wall. This wall is framed with 2x4 wood studs spaced at 16 inches. A nonstructural component is braced by it.



Typical full height partition wall

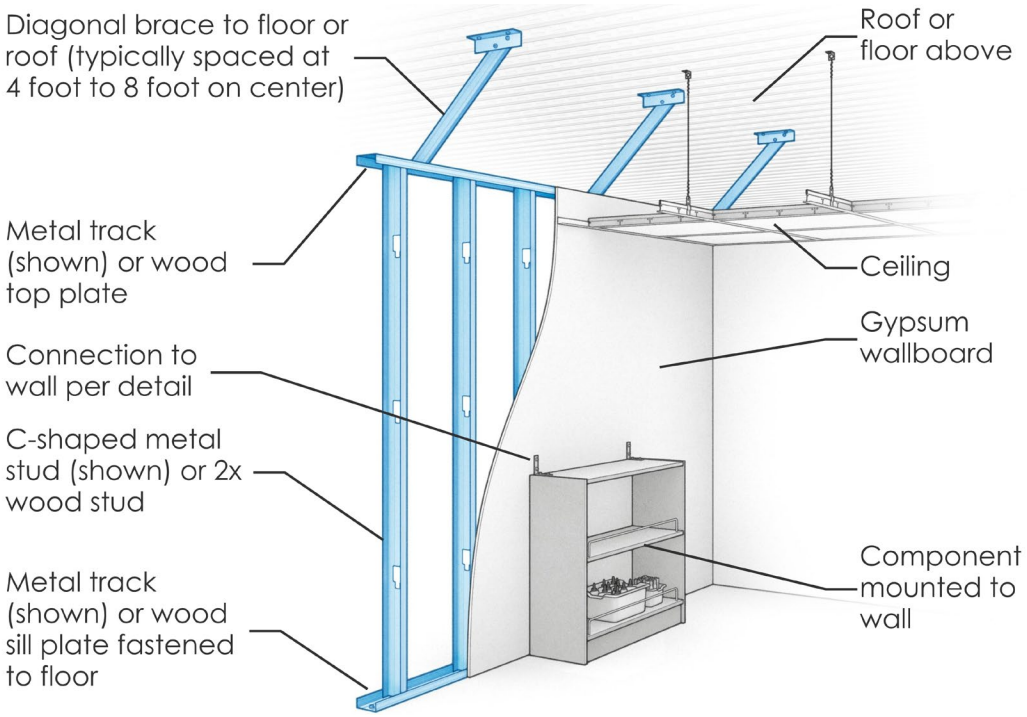
FULLY BRACED PARTIAL HEIGHT PARTITION WALLS

The photograph below shows the top of a fully braced partial height partition wall. This wall is framed with C-shaped metal studs that terminate at a continuous metal top track. The track is braced every four feet with a metal stud that is anchored to the floor or roof above. The gypsum wallboard has not yet been installed.



Top of fully braced partial height partition wall

The graphic below shows an idealized fully braced partial height partition wall. This wall is framed with c-shaped metal studs spaced at 16 inches and metal braces at four feet.



Fully braced partial height partition wall

How to Tell if a Stud Wall is Full Height or Fully Braced

In order to determine if a wall is full height or fully braced, it is necessary to look above the ceiling. If the ceiling is constructed with a suspended acoustic tile ceiling, a ceiling tile can be lifted to look above. In ceilings constructed with suspended gypsum wall board, there may be an access panel that can be opened to allow observation above the ceiling.

Once above the ceiling, the following questions can be answered: Do the studs continue all the way to the underside of the floor or roof above?

- If the answer is yes, for the purposes of seismic bracing of components included in this guide, the wall is considered full height.
- If the answer is no, is there diagonal bracing between the top of the wall studs and the underside of the floor or roof above?
    - If yes, the wall is considered "fully braced" for the purposes of seismic bracing of components included in this guide.

In some cases, the ceiling is fastened directly to the underside of the floor or roof framing above. In this situation, the studs will also have been installed with connections to the floor or roof above. These studs are considered full height for the purposes of seismic bracing of components included in this guide.

How to Tell if Studs are Wood or Metal

Facility staff involved in building maintenance may be sufficiently familiar with the building construction to know whether the walls are built with wood or metal studs. These individuals should be engaged at the outset and can provide guidance.

If there is no one available who is knowledgeable about the building construction, but building drawings are available, it is possible to review the drawings to determine whether the studs are wood or metal. A contractor or design professional can be consulted to review the drawings if it is unclear.

A strong magnet could be used to identify metal studs: If the magnet is attracted to the studs when moving along the wall surface, the studs are likely made of metal.

If there is space above the ceiling and the gypsum wallboard does not extend fully to the floor above, visual observation above the ceiling will indicate the type of stud.

If there is an area of the wall where it is visually acceptable to drill pilot holes, drilling through the gypsum wallboard or other finish into the stud may be informative. A wood stud will feel very different from a metal stud.

It is also possible to remove a small piece of wall finish to directly observe and identify the stud type. However, this generally is not required.

How to Determine the Gauge of a Metal Stud

The thickness of sheet metal is typically measured in gauge, where the higher the gauge number, the thinner the steel stud. Studs that are too thin may be insufficient for reliably bracing a nonstructural component. For example, a sheet metal screw fastened to a 25-gauge stud (0.02 inches thick) is generally not strong enough to brace most nonstructural components. For some components included in this guide, 20-gauge minimum studs (0.036 inches thick) are required. Studs that are colloquially referred to as "heavy studs" are 16 gauge (0.06 inches thick).

If a **Detail** requires confirming the minimum stud gauge, there are several possible ways to verify stud gauge, including the following:

EXISTING DOCUMENTATION

Original building drawings or renovation drawings may indicate the stud size and gauge used for construction. If drawings can be located, they could be examined to determine the stud gauge used. (Note: it is possible that in any given wall, the studs could be different from those indicated on the drawings. If, during installation there is reason to believe that the stud is thinner than specified (because of the ease with which screws are installed, for example), additional verification by one of the methods listed below is required.

STUD LABELS AND MEASURING

Stud manufacturers mark the studs for their size and gauge on each stud:

- **For exposed stud above ceiling:** When the wall is not a rated partition and gypsum wallboard does not extend to the floor or roof above on one or both sides, the stud label listing its gauge can be viewed and its size can be measured by gaining above-ceiling access.
- **For concealed stud above ceiling:** When gypsum wallboard covers both sides of a stud above the ceiling, an opening can be created in the wallboard allowing view

to the stud label and measurement of the stud size. The opening will need to be patched to restore acoustic and fire ratings.

- **For concealed stud below ceiling:** When gypsum wallboard covers both sides of a stud, and the stud does not extend above the ceiling or the above-ceiling area is not accessible, an opening can be created in the wallboard allowing view to the stud label and measurement of the stud. The opening will need to be patched to restore acoustic and fire ratings and to match existing finishes.
- Where the stud label is not visible, stud gauge can be measured using a Micrometer.

What to Do if the Wall is not Full Height or Fully Braced

There are two general strategies that can be used:

- Add bracing to the top of the wall to create a fully braced condition. This will involve adding diagonal bracing and connections and will generally require some construction experience to install.
- Use an alternate **Detail** that does not rely on the wall. This would typically require anchorage to the floor. If a floor-mounted option is not provided in this guide, engineering assistance may be required to develop an appropriate anchorage detail.

What to Do if the Wall is Made of a Different Material

If the wall is not a stud wall, but a concrete or fully grouted masonry wall, the instructions shown in this guide could be modified by installing concrete or masonry anchors approved for use in seismic applications in lieu of wood screws or sheet metal screws following manufacturer's instructions for anchor installation. If the masonry is hollow (i.e., not all cells in the blocks are grouted), engineering assistance is needed to develop an appropriate **Detail**.

Help Guide: Additional Actions and Resources for School Earthquake Safety

Quick Action Measures

Along with mitigating the nonstructural hazards identified in this guide, school safety and resilience can be improved using the quick action items listed below.

- Rearrange shelving so heavier items are on the bottom shelves and lighter items are on upper shelves.
- Relocate heavy full boxes from tall storage to below the height of occupants.
- Relocate tall and/or heavy furniture and equipment away from exits.
- Place furnishings over four feet tall, such as bookcases or file cabinets, in low occupancy areas such as a closet.
- Secure desktop equipment and displays that could fall and injure occupants
- Separate incompatible chemicals to prevent hazardous mixing.
- Move rarely used files or materials to an offsite storage facility.
- Discard items no longer serving a useful function.
- Backup important electronic files.

Additional Resources

This section provides additional resources for those interested in learning more about disaster preparedness in California, seismic protection of nonstructural components, and school earthquake safety.

DISASTER PREPAREDNESS RESOURCES

The physical mitigation strategies identified in this guide should be used in conjunction with other disaster preparedness activities, such as earthquake drills and exercising emergency management plans. Users can become more familiar by reviewing resources related to disaster preparedness listed below.

Great California ShakeOut: An annual earthquake drill conducted every third Thursday of October. Accessible here: shakeout.org/california

Earthquake Country Alliance: An organization with free resources related to earthquake hazard, preparedness, and mitigation. Accessible here: earthquakecountry.org

MyShake App: A free phone app the provides life-saving seconds by notifying you before shaking occurs. Accessible here: earthquake.ca.gov (and the app store)

Listos California: Website to sign up for alerts and to learn how to prepare for the next disaster. Accessible here: listoscalifornia.org

TECHNICAL RESOURCES

This guide draws on a variety of resources that can be reviewed for further information about school safety, earthquake hazards, behavior of nonstructural components, and seismic mitigation. Key resources are summarized below.

Relevant FEMA Publications

- FEMA E-74, *Reducing the Risks of Nonstructural Earthquake Damage – A Practical Guide*, published 2012, accessible here.
- FEMA P-1000, *Safer, Stronger, Smarter: A Guide to Improving School Natural Hazard Safety*, published 2017, accessible here.
- FEMA 395, *Earthquake Safety and Mitigation for Schools*, published 2003, accessible here.

National Earthquake Technical Assistance Program (NETAP) by FEMA

Interested users can learn more about reducing seismic risks in schools by participating in free trainings offered through NETAP:

- *Reducing Earthquake Risk in the Classroom and Beyond: Seismic Mitigation of* Nonstructural Hazards in Schools. This training by FEMA, intended for facility managers, K-12 school administrators, and teachers, teaches participants about the most common earthquake hazards in K-12 schools and empowers them to mitigate these issues.
- FEMA P-1000, *Safer, Stronger, Smarter: A Guide to Improving School Natural Hazard Safety*. This training provides guidance on school operations and physical protection of school facilities for natural disasters.
- FEMA E-74, *Reducing the Risks of Nonstructural Earthquake Damage*. This training describes sources of nonstructural earthquake damage and effective methods of reducing such damage.
- FEMA 395, *Earthquake Safety and Mitigation for Schools*. This training is for school officials, teachers, facility managers, and other stakeholders interested in reducing earthquake risks in local schools.

More information is available here: https://www.fema.gov/emergency-managers/risk-management/earthquake/training/netap

California Division of the State Architect (DSA)

DSA provides design and construction oversight for K-12 schools and community colleges in California. The DSA website provides Bulletins (BUs), Guidelines (GLs), and Interpretations of Regulations (IRs). These are created and updated by DSA and are intended to promote uniform statewide criteria relating to the design, construction, and inspection of public school, community college, and essential services building projects. These include information for nonstructural components, such as IR 25-2, which provides design and installation requirements for suspended ceilings in California schools. More information is available here: dgs.ca.gov/DSA

California Department of Health Care Access and Information (HCAI)

HCAI provides design and construction oversight for California hospitals and skilled nursing facilities. The HCAI website provides Office of Statewide Health Planning and Development (OSHPD) Preapproved Details (OPDs), which are preapproved standard architectural and engineering details. For example, OPD-0001 provides standard details for design of metal partition walls. More information is available here: hcai.ca.gov

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