6.4 Mechanical, Electrical, and Plumbing Components

6.4.7 Electrical and Communications Equipment

6.4.7.1 Control Panels, Motor Control Centers, and Switchgear

This category includes tall, narrow floor-mounted electrical items in sheet metal cabinets such as electrical control panels, motor control centers, switchgear, and substations.

Provisions

BUILDING CODE PROVISIONS

Electrical control panels, motor control centers, switchgear, and substations are designed using the provisions of ASCE/SEI 7-10, *Minimum Design Loads for Buildings and Other Structures*, (ASCE, 2010), Chapter 13. The principal objective is to prevent the components from sliding or toppling. These components may also be sensitive to building displacements if they are both anchored to the floor and braced to the floor above.

- ASCE/SEI 7-10 requires anchorage design for all equipment in Seismic Design Categories D, E, and F if the equipment weighs over 400 pounds. Lighter components may be exempt if the component Importance Factor $I_p = 1.0$.
- Items that are exempt from the anchorage design requirements must still be positively anchored to the structure. The anchorage need not be designed or detailed on the construction documents. Exempt items must also be provided with flexible connections between the equipment and associated raceways, bus ducts, or conduits if there is a potential for damaging differential movement between the equipment and connected components.
- Electrical component supports and their attachment to the component must be designed for the appropriate forces and displacements. Supports include braces, frames, skirts, legs, pedestals, and snubbers, as well as elements forged or cast as a part of the mechanical or electrical component. There are prescriptive requirements for reinforcing the cabinets around anchor points.
- The seismic design must consider the loads imposed on the components by attached utility or service lines that are attached to separate structures.
- Control panels, motor control centers, switchgear, and substations with slideout components must have a latching mechanism to hold the components in place.

- The design of the component cabinet must comply with the applicable National Electrical Manufacturers Association (NEMA) standards.
- If cutouts are made in the lower panels of the cabinet that were not made by the manufacturer, the effects of the cutouts on the strength of the cabinet should be specifically evaluated.
- Attachments for additional external items not provided by the manufacturer that weigh more than 100 lb should be evaluated.

RETROFIT STANDARD PROVISIONS

ASCE/SEI 41-06, *Seismic Rehabilitation of Existing Buildings*, (ASCE, 2007) classifies electrical equipment, including panel boards, motor control centers, and switch gear as force controlled. These components are subject to the provisions of the standard when the performance level is Immediate Occupancy. The requirements also apply when the performance level is Life Safety in high and moderate seismicity areas, and the equipment is over 6 feet in height and weighs more than 20 pounds. When applicable, electrical equipment meeting any of the following criteria must comply with the requirements of ASCE/SEI 41-06:

- The item weighs more than 400 pounds.
- The item is unanchored, weighs over 100 pounds and is subject to overturning. These items may be exempt if they have a factor of safety greater than 1.5 when design loads are applied.
- The item weighs over 20 pounds and is mounted over 4 feet above the floor.
- Building operation equipment.

Acceptance criteria for electrical equipment focus on providing adequate anchorage for seismic forces. Prescriptive anchorage and bracing provisions may be used for smaller equipment.

Typical Causes of Damage

- Overturning or sliding due to lack of anchorage or inadequate anchorage.
- Loss of function due to failure of internal components caused by inertial forces.
- Damaged electrical equipment may cause electrical hazards and fire hazards.

DAMAGE EXAMPLE

Figure 6.4.7.1-1 Overturned equipment in the 1985 magnitude-8 Mexico Earthquake, note absence of anchorage of equipment base to floor (Photo courtesy of Degenkolb Engineers).

Figure 6.4.7.1-2 Unanchored electrical cabinets overturned in a paper products plant during the 1999 magnitude-7.4 Izmit, Turkey earthquake (Photo courtesy of NISEE Izmit Collection, No. IZT-682, photograph by Halil Sezen).

Figure 6.4.7.1-3 Damage to unanchored electrical cabinets at power plant in Port-au-Prince in the 2010 magnitude-7 Haiti Earthquake (Photos courtesy of Eduardo Fierro, BFP Engineers).

Seismic Mitigation Considerations

- Working around electrical equipment can be extremely hazardous. Read the Electrical Danger Warning and Guidelines in Section 6.6.8 of this document before proceeding with any work.
- Many of these components can be supplied with shop welded brackets or predrilled holes for base or wall anchorage. For any new equipment, request items that can be supplied with seismic anchorage provisions by the manufacturer.
- When tall units are anchored to the floor, flexible connections between the equipment and raceways, bus ducts, or conduits that are braced to the level above will limit damage due to story drift.
- See Section 6.4.1.1 for additional base anchorage details. Refer to FEMA 413 *Installing Seismic Restraints for Electrical Equipment* (2004) for general information on seismic anchorage of electrical equipment.

MITIGATION EXAMPLES

Figure 6.4.7.1-9 Anchorage for electrical cabinets. Anchorage to wall at top of cabinets is also present but not visible (Photo courtesy of Maryann Phipps, Estructure).

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Figure 6.4.7.1-10 Detail of cabinet base anchorage (Photo courtesy of Maryann Phipps, Estructure).

MITIGATION DETAILS

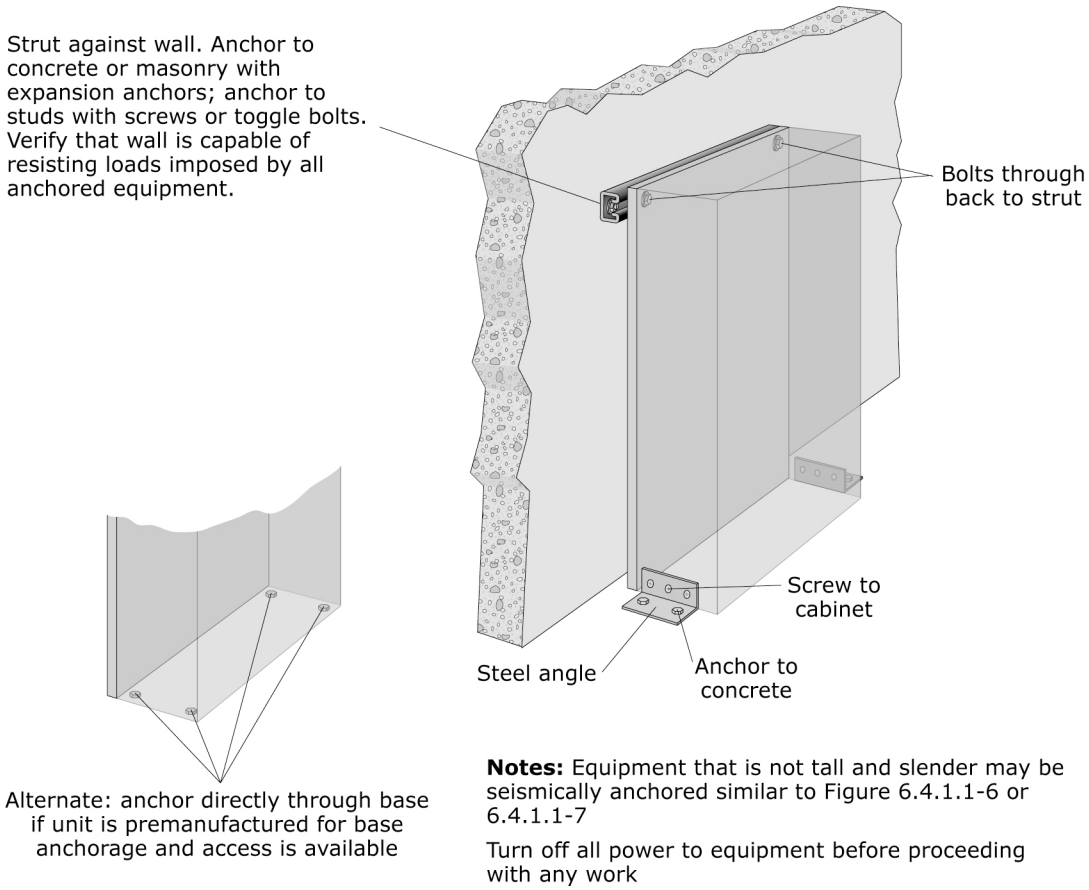
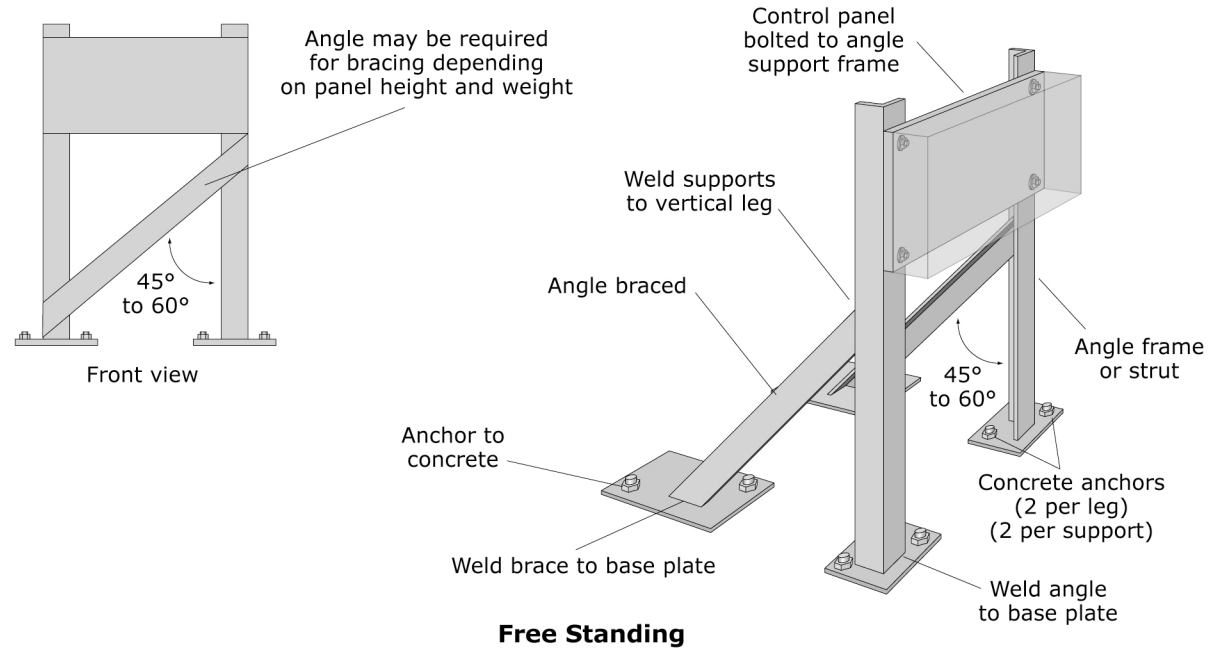


Figure 6.4.7.1-11 Electrical control panels, motor controls centers, or switchgear, (ER).



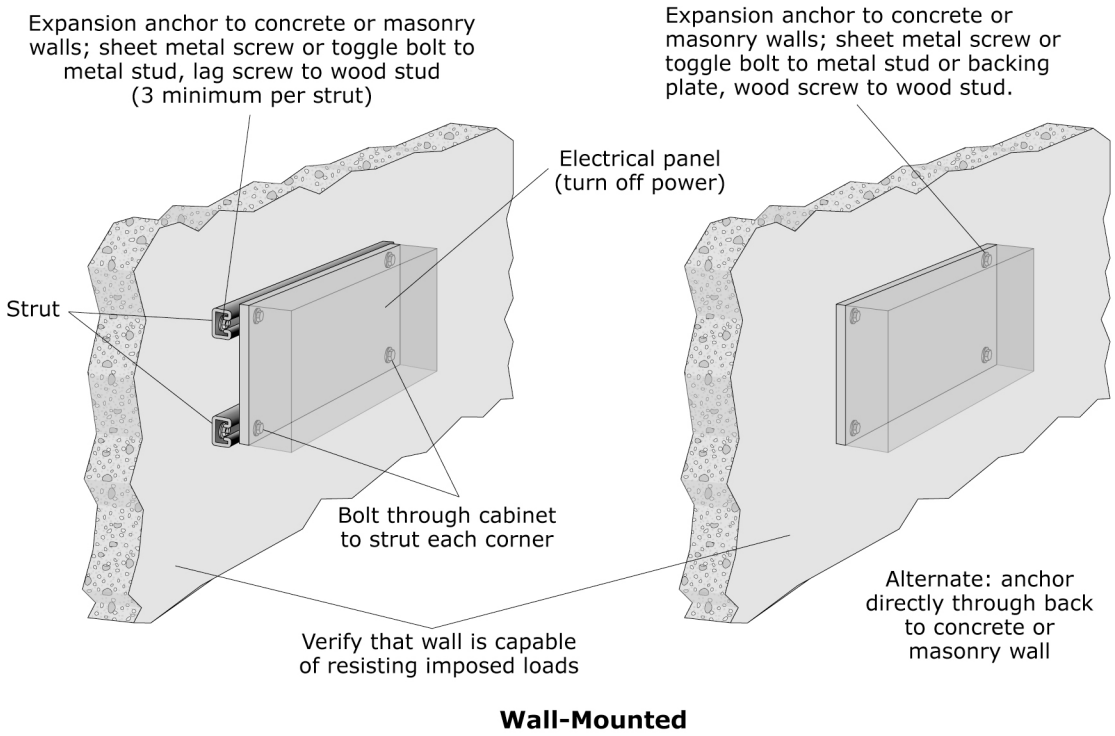


Figure 6.4.7.1-12 Free-standing and wall-mounted electrical control panels, motor controls centers, or switchgear (ER).