6.4 Mechanical, Electrical, and Plumbing Components

6.4.2 Storage Tanks and Water Heaters

6.4.2.3 Compressed Gas Cylinders

This category includes single or multiple gas cylinders. These may be attached to piping, anchored to carts for mobility, or stored for future use.

Provisions

BUILDING CODE PROVISIONS

Since compressed gas cylinders are generally not permanently attached to the building utilities, they are considered "temporary or moveable equipment" and are exempt from the requirements of ASCE/SEI 7-10, *Minimum Design Loads for Buildings and Other Structures*, (ASCE, 2010).

When gas cylinders are connected to building utilities, ASCE/SEI 7-10 Chapter 13 requires anchorage for cylinders in Seismic Design Categories D, E, and F weighing over 400 pounds. Lighter cylinders may be exempt if the component Importance Factor $I_p = 1.0$. Cylinders that are exempt from the anchorage requirement are still required to be restrained to prevent damage between the gas cylinder and associated pipes.

RETROFIT STANDARD PROVISIONS

ASCE/SEI 41-06, *Seismic Rehabilitation of Existing Buildings,* (ASCE, 2007) classifies compressed gas cylinders as hazardous materials storage. Anchorage of compressed gas cylinders requires compliance with the anchorage provisions of the standard when the performance level is Life Safety or higher. Prescriptive (non-engineered) anchorage approaches may be used.

Typical Causes of Damage

- Unanchored tanks may slide, overturn, and roll; connected piping may be damaged.
- Contents may be flammable or hazardous; leaking cylinders may be dangerous.
- Tank installations equipped with chains or straps are still susceptible to damage unless the chains or straps are properly secured around the tanks.

DAMAGE EXAMPLES

Figure 6.4.2.3-1 Unanchored tanks inside fenced enclosure in the 1994 magnitude-6.7 Northridge Earthquake (Photo courtesy of OSHPD).

Seismic Mitigation Considerations

- Wall restraint detail shown at top of Figure 6.4.2.3-8 is a non-engineered detail for tank storage; this detail does not provide sufficient restraint for tanks attached to piping.
- Engineered details with additional restraints are required for tanks attached to piping; see corral detail at bottom of Figure 6.4.2.3-7 or scheme shown in Figures 6.4.2.3-2 and 6.4.2.3-3.

MITIGATION EXAMPLES

Figure 6.4.2.3-2 Gas cylinder anchorage with attached gas lines undamaged in the 2001 magnitude-8.4 Peru Earthquake (Photo courtesy of Eduardo Fierro, BFP Engineers).

Figure 6.4.2.3-3 Detail of undamaged gas cylinder installation (Photo courtesy of Eduardo Fierro, BFP Engineers).

Figure 6.4.2.3-4 Wall-mounted cylinder restraints upgraded with stiffener plates following the 2001 Peru Earthquake(Photo courtesy of Eduardo Fierro, BFP Engineers).

Figure 6.4.2.3-5 Steel tube supports for mobile gas cylinder carts (Photo courtesy of Eduardo Fierro, BFP Engineers).

Figure 6.4.2.3-6 Detail of steel tube supports and chains (Photo courtesy of Eduardo Fierro, BFP Engineers).

Figure 6.4.2.3-7 Detail of enclosures for airgas tanks in a hospital; chains attached with quick release hooks (Photo courtesy of Maryann Phipps, Estructure).

MITIGATION DETAILS

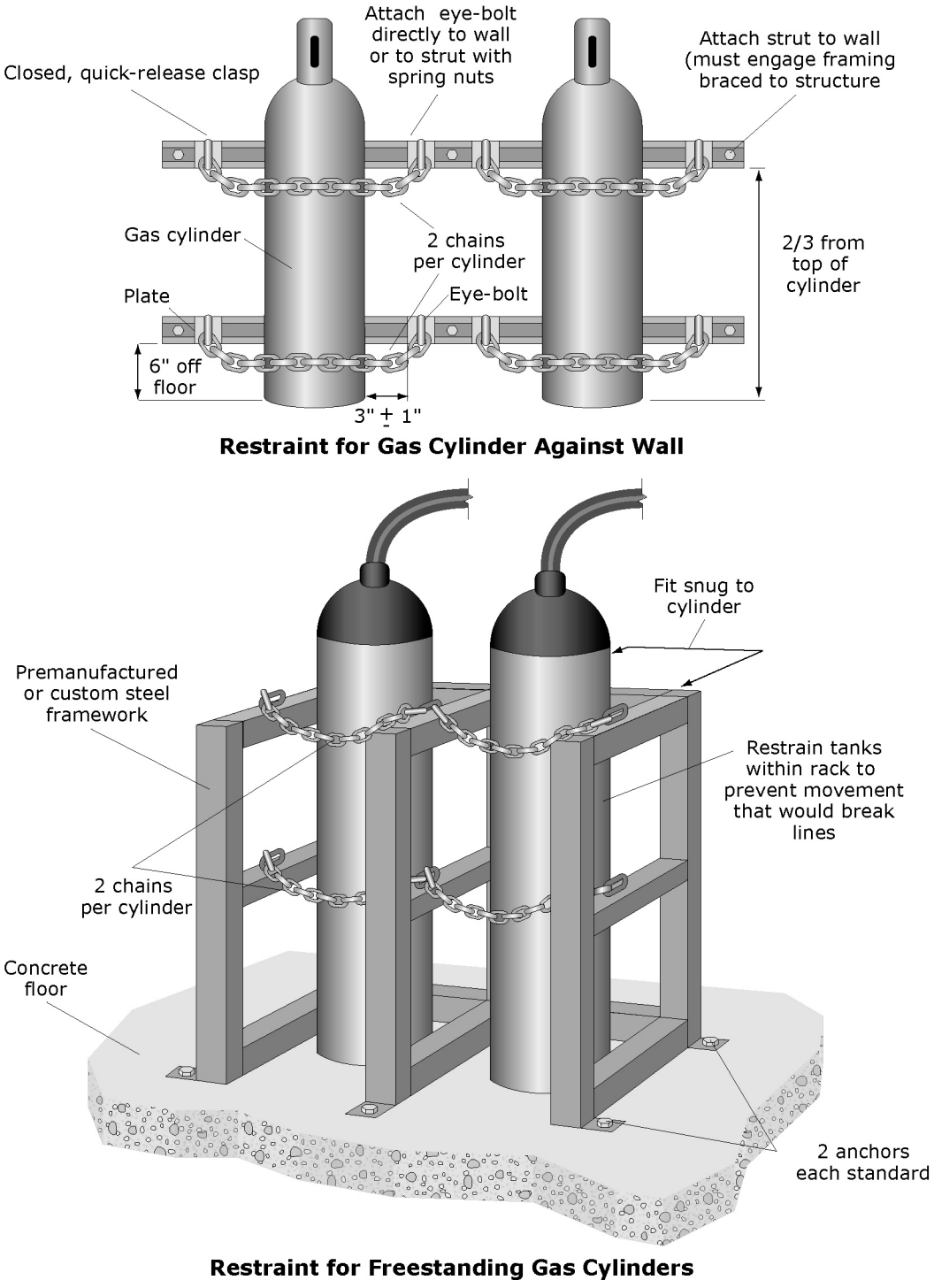

Figure 6.4.2.3-8 Compressed gas cylinders (ER).