

6.4 MECHANICAL, ELECTRICAL, AND PLUMBING COMPONENTS

6.4.3 PRESSURE PIPING

6.4.3.3 FLEXIBLE CONNECTIONS, EXPANSION JOINTS, AND SEISMIC SEPARATIONS

This category covers the flexible piping connections required to accommodate differential movement at seismic separations between buildings or between floors, at the interface between piping and equipment, or to accommodate thermal expansion.

TYPICAL CAUSES OF DAMAGE

- Differential movement between adjacent buildings or adjacent wings of buildings can cause damage to interconnected piping if relative movement has not been specifically accounted for. Differential movement between the fixed and base isolated portions of buildings can damage piping crossing the isolation plane. Failure to accommodate seismic displacements can rupture piping.
- Differential movement between anchored or restrained equipment and attached piping can cause damage to the equipment, the piping, or both.

Damage Examples

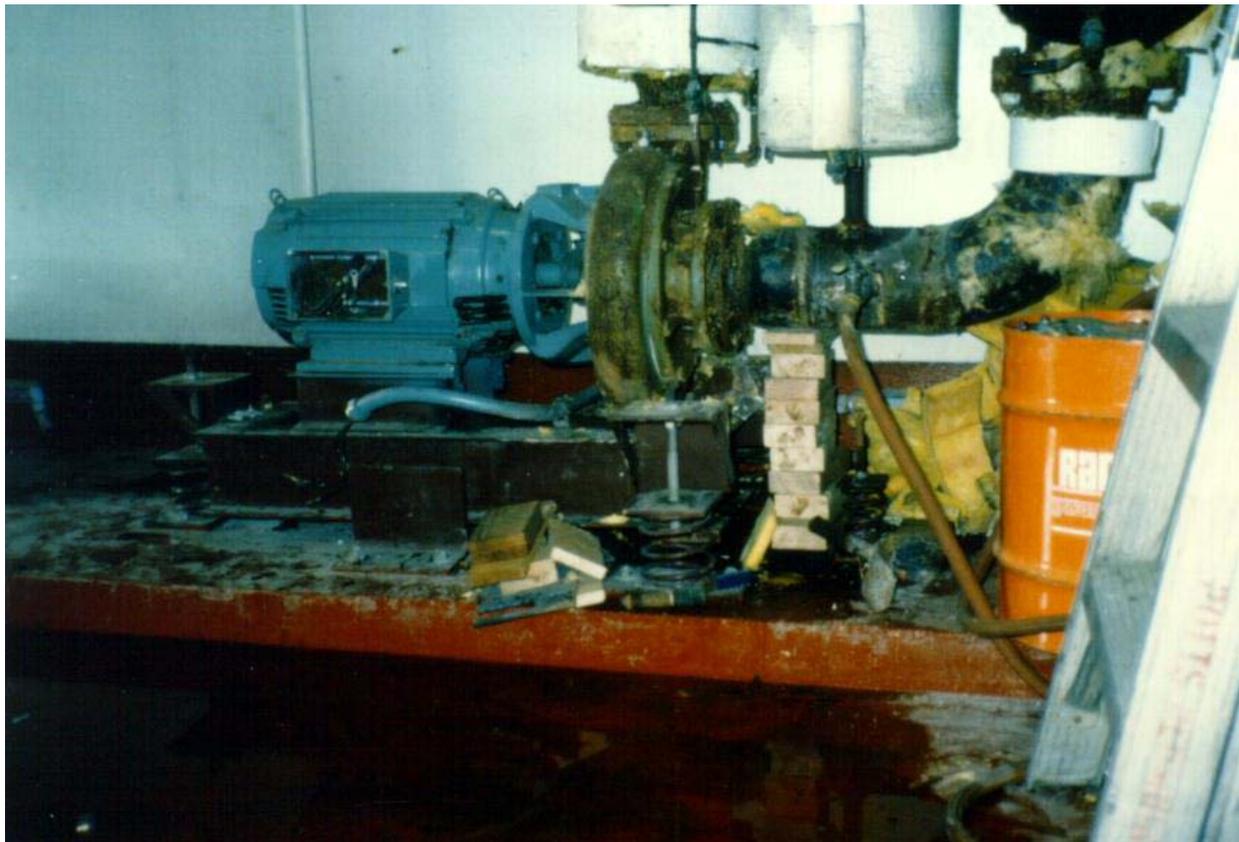


Figure 6.4.3.3-1 Failure at rigid connection to equipment on isolators without lateral restraint in the 1994 magnitude-6.7 Northridge Earthquake (Photo courtesy of Mason Industries).

SEISMIC MITIGATION CONSIDERATIONS

- Flexible couplings are needed to accommodate relative displacement in a pipeline. Locations that may require flexible couplings include connections between piping and anchored equipment, wall or slab penetrations, seismic joints between buildings, and seismic joints in base isolated buildings. Selection of a specific coupling detail will depend on the magnitude of the anticipated relative displacements, the diameter of the pipe, and the type of pipe and its location.
- Several different types of flexible connections are shown; details for other conditions including floor and roof penetrations can be found in FEMA 414 *Installing Seismic Restraints for Duct and Pipe* (2004). Many vendors supply specialized hardware to create articulated joints or flexible tubing for these applications.
- Connections must provide sufficient flexibility to accommodate the expected differential movement in all directions.
- It is generally good seismic resistant design practice to provide a flexible connection between piping and equipment.

Mitigation Examples

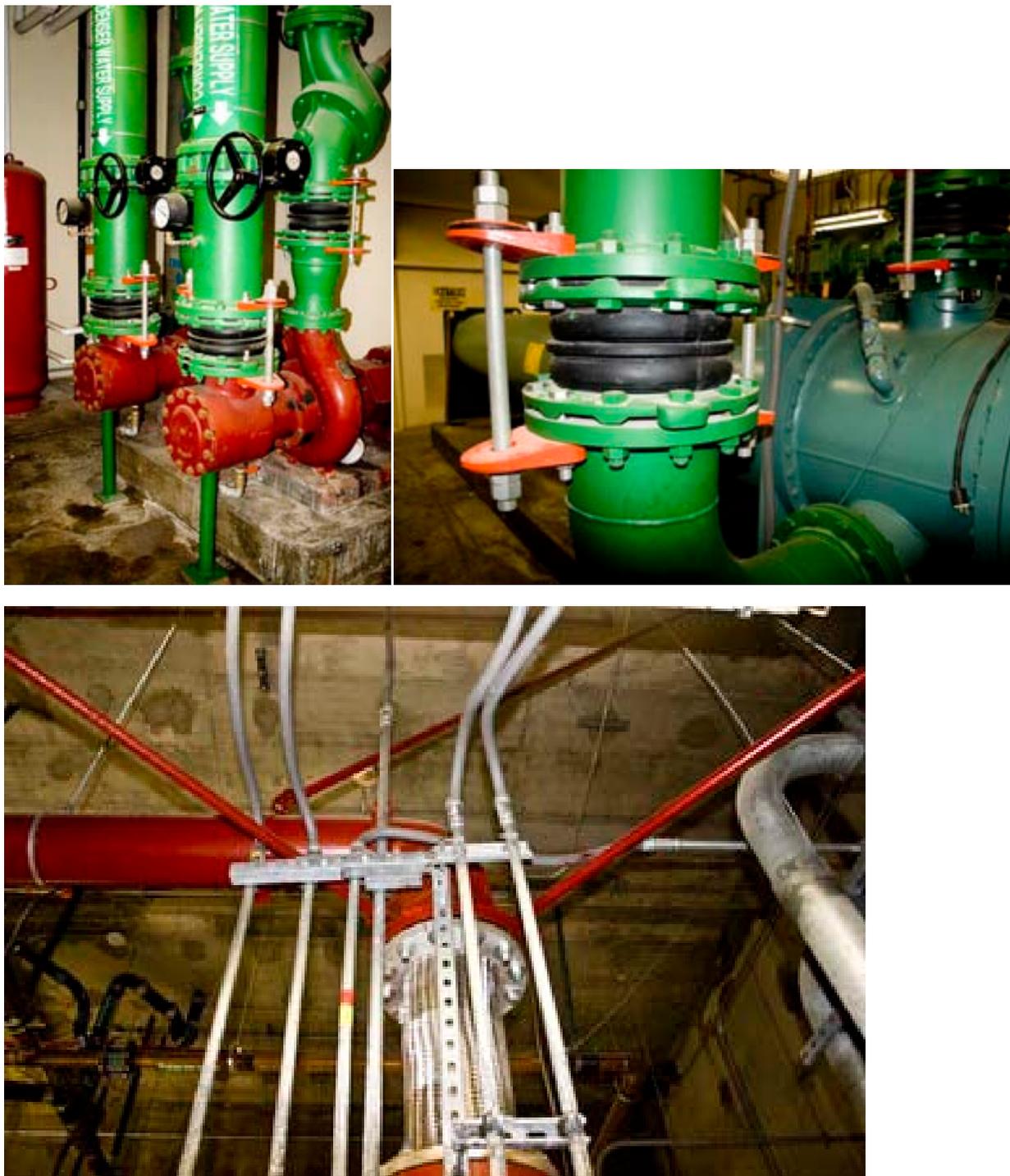


Figure 6.4.3.3-2 Examples of flexible couplings that performed well in the 2010 magnitude-7 Haiti Earthquake; the building suffered relatively minor damage (Photo courtesy of Tom Sawyer, Engineering News Record).

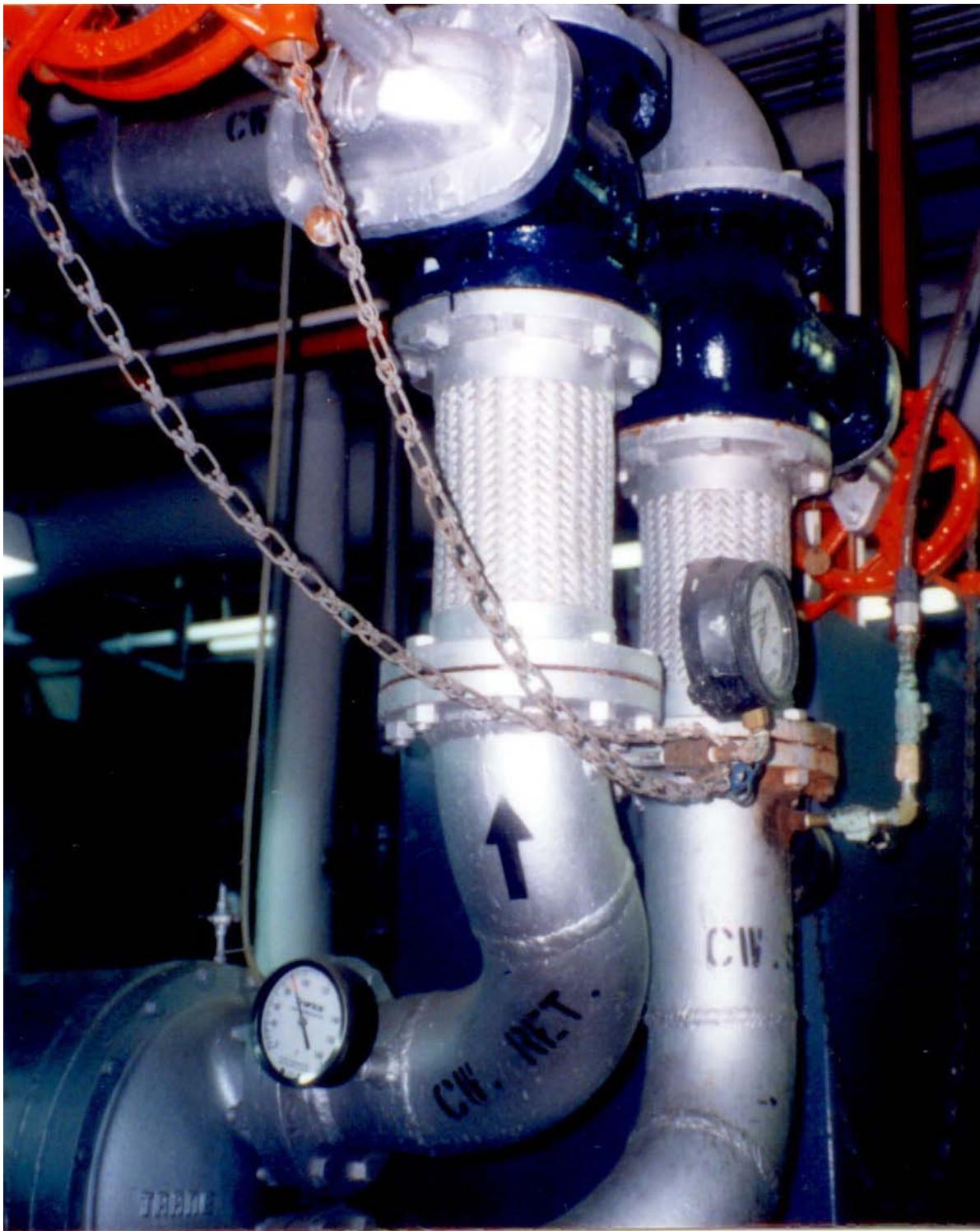


Figure 6.4.3.3-3 Flexible connection at pipe attachment to rigidly mounted tank (Photo courtesy of Wiss, Janney, Elstner, Associates).



Figure 6.4.3.3-4 Flexible pipe connections at rooftop expansion joint (Photo courtesy of Maryann Phipps, Estructure).

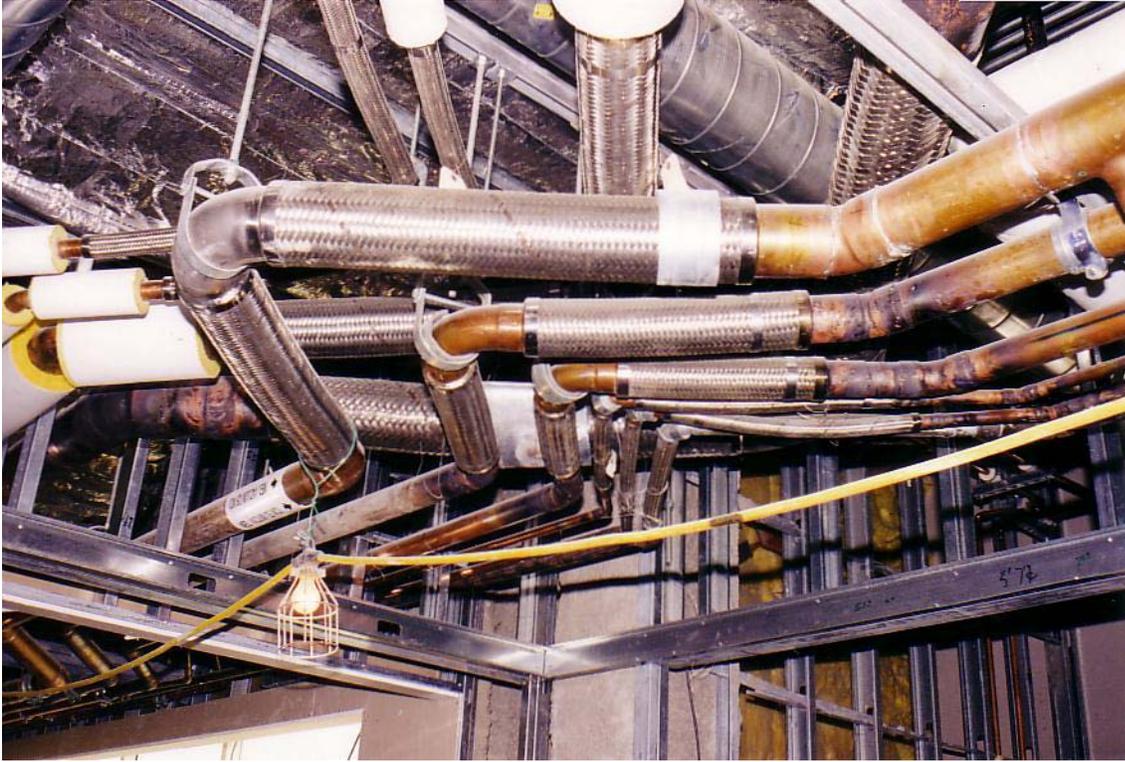


Figure 6.4.3.3-5 Flexible pipe connections at building separation (Photo courtesy of Mason Industries).

Mitigation Details

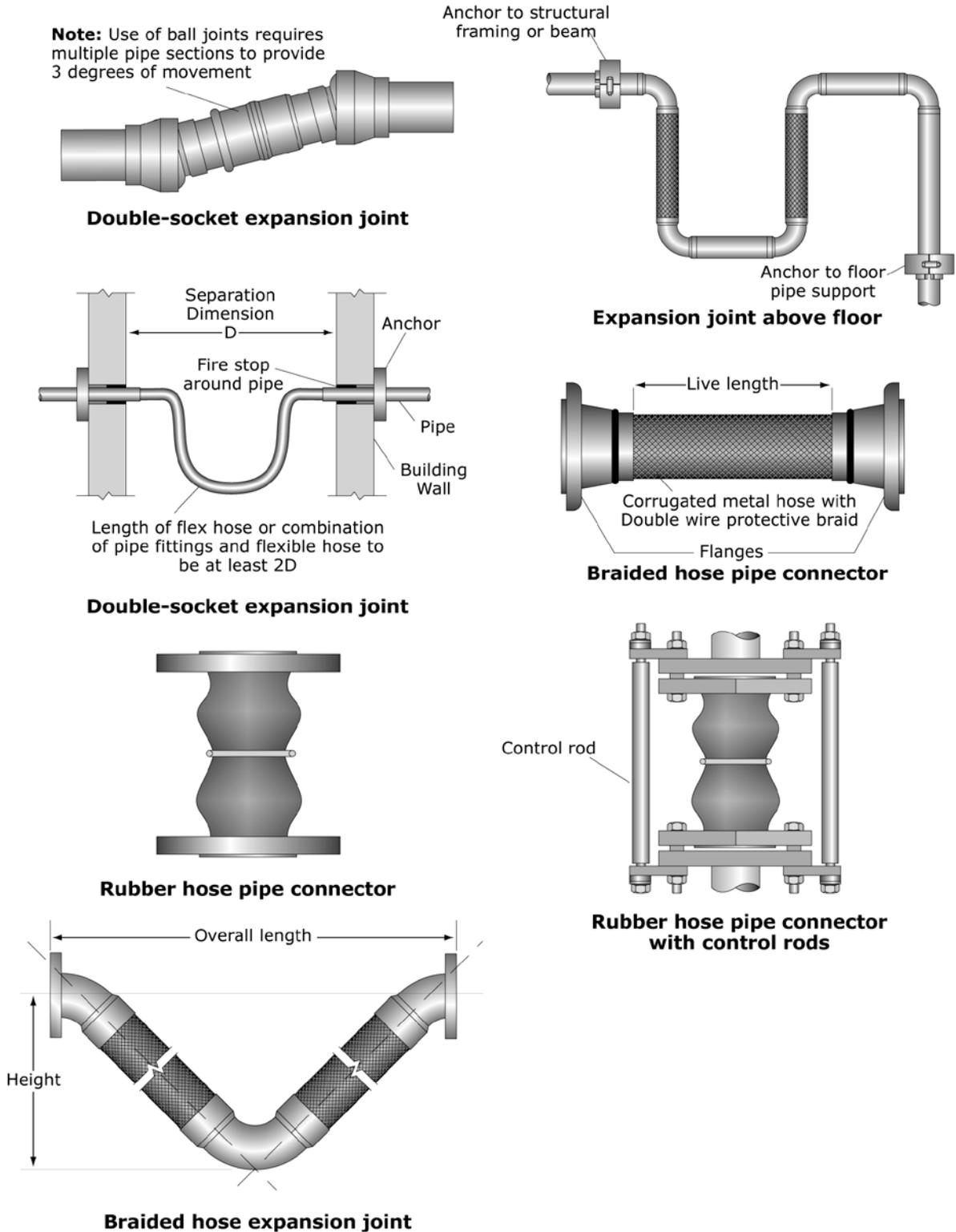


Figure 6.4.3.3-6 Flexible connections and expansion joints (ER).