6.4 MECHANICAL, ELECTRICAL, AND PLUMBING COMPONENTS

6.4.10 ELEVATORS AND ESCALATORS

6.4.10.1 HYDRAULIC ELEVATORS

Hydraulic elevators consist of relatively simple mechanical systems but failure of any of the component parts could disable the functionality of the entire system. These elevators are typically limited in height since they require a cylinder beneath the elevator equal to the height of the elevator cab's vertical travel.

TYPICAL CAUSES OF DAMAGE

- The primary components of the hydraulic elevator system are the elevator cab, cab guides, doors and door mechanism, piston, cylinder, fluid reservoir, hydraulic fluid, rotary pump, valve, solenoid switch, and electrical control panel. The system may be tied to a seismic switch or a smoke detector which would facilitate safe shutdown in the event of an earthquake or fire. Any of these components could be damaged if not properly restrained. Other possible failures are: misalignment of cab guides or cylinder, deformed door frames impeding the operation of doors, failure of door rails, leakage of hydraulic fluid, damaged pump.
- According to survey responses collected by the Division of Occupational Safety and Health Elevator, Tramway, and Ride unit, following the 1994 Northridge Earthquake 897 hydraulic elevators suffered damage such as leaks in underground feed lines, separated pipes, and failed gaskets and fittings. In addition, numerous guide rails were bent and several cars came out of rails. Tie downs on several oil tanks failed and hold-down bolts sheared and pulled out.
- In addition to property damage, passengers may become trapped in the cab following an earthquake and may need to await extraction by qualified elevator technicians.

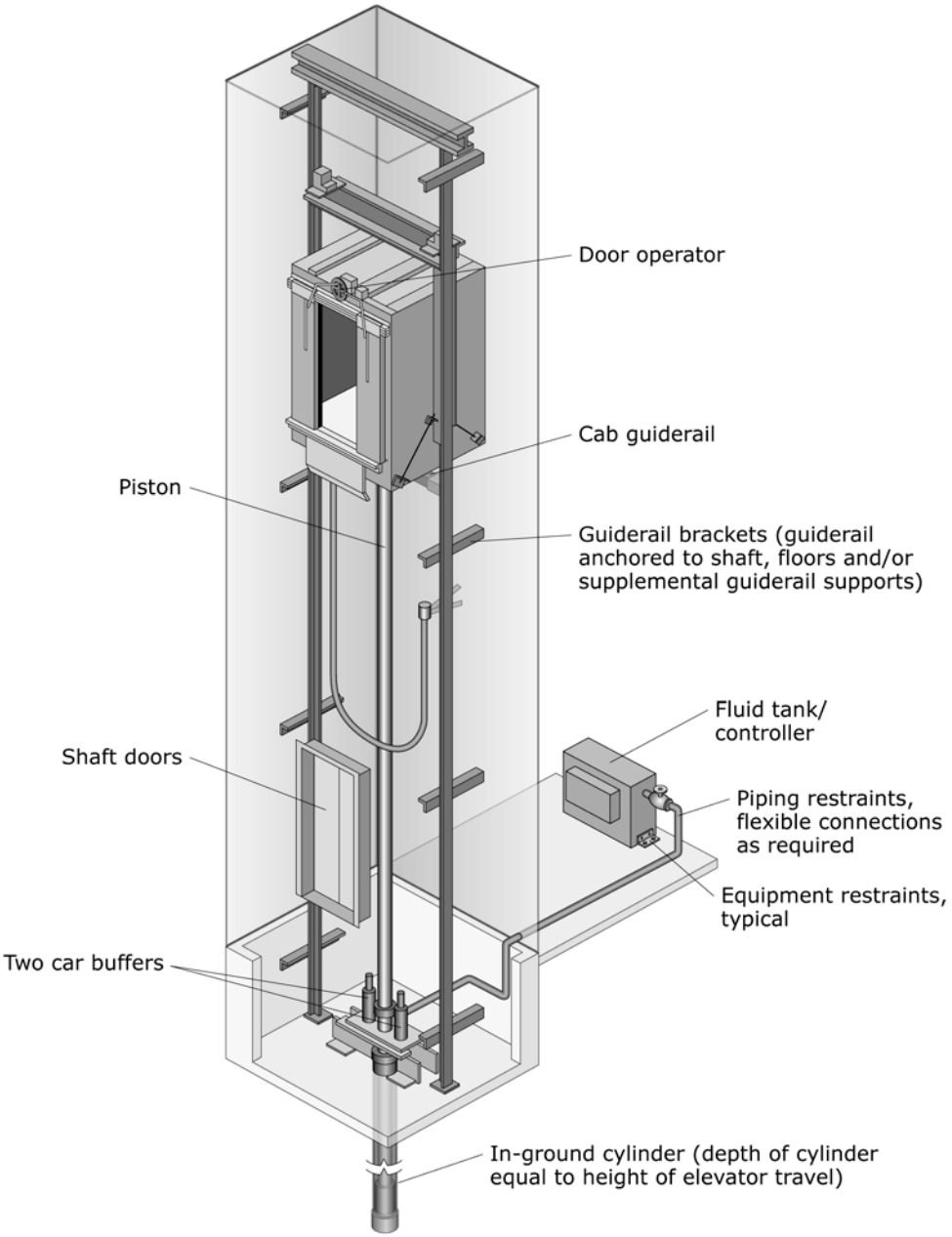
SEISMIC MITIGATION CONSIDERATIONS

- All components of the hydraulic system need to be restrained, anchored or detailed to accommodate movement to prevent damage in an earthquake. The system must be designed to accommodate the anticipated inter-story drift over the height of the elevator travel and the depth of the cylinder below. Components such as cab guides,

door frames, and cylinder supports must all be detailed to accommodate lateral deformations. All mechanical and electrical equipment, sensors, piping, tanks, valves, and guides need to be properly anchored or restrained.

- All elevators should be inspected by qualified elevator technicians following an earthquake. Elevators should have a seismic switch or safety features that allow for safe shutdown in an earthquake.
- Elevator safety is governed by the prescriptive requirements in ASME A17.1/CSA B44, *Safety Code for Elevators and Escalators* (ASME, 2007a) a document that is continually evolving to reflect new elevator technologies. In addition, ASME A17.7/B44.7, *Performance Based Code for Elevator Safety* (ASME, 2007b), is the next step in the evolution of elevator safety codes in the United States and Canada. Local or state jurisdictions may have other elevator requirements.
- The internet provides information regarding hydraulic elevators. A few websites are linked below:
    - The website http:science.howstuffworks.com/elevator1.htm describes the workings of hydraulic elevators and provides links to other resources
    - Jobsite safety in the elevator industry is discussed on http://safety.elevator-world.com/disaster.htm
    - The websites of the Elevator and Escalator Safety Foundation, http://eesf.org/, and major elevator suppliers such as The Otis Elevator Company and Schindler Elevators provide additional resources.
    - The National Elevator Industry, Inc. has other resources including a discussion of the performance based code for elevator safety (http://www.pbc-elevators.com/).

Mitigation Details



Notes: Provide lateral restraints for guiderails to resist design forces and accommodate anticipated interstory drift.

Elevators should be installed, maintained, inspected and repaired by qualified elevator technicians.

Inappropriate seismic restraints may compromise the safe operation of these systems.

Figure 6.4.10.1-1 Schematic view of hydraulic elevator (ER).