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*Water Systems**Pumps*

Water pumps (Figure 3.135) are common victims of earthquake forces, especially when motion restraints are not used in conjunction with vibration isolators and when flexible line connectors are not employed.

EQUIPMENT SEISMIC CATEGORY

- “B” support equipment

SEISMIC SPECIFICATION

- SDS-1.

SEISMIC QUALIFICATION APPROACH

- Design team judgment
 - Provide flexible supply lines.
- Equivalent static coefficient analysis.
 - Fixed anchorage.
- Dynamic analysis.
 - Vibration isolation, provide snubbers

REFERENCE FIGURE FOR INSTALLATION DETAILS

- 4-99

RELATIVE DEGREE OF DAMAGE OF INADEQUATELY PROTECTED EQUIPMENT

- Minor to moderate

MOST LIKELY TYPE OR CONSEQUENCE OF DAMAGE FOR INADEQUATELY PROTECTED EQUIPMENT

- Displaced pumps.

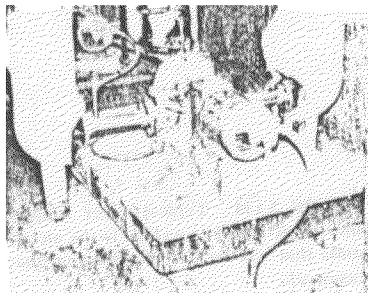


FIGURE 3.135 Chilled water pump with flexible connections. The pump is anchored to the inertia pad, which is supported by four unsecured vibration isolators. The lack of motion restraint and the unsecured vibration isolation are likely to result in pump failure during an earthquake.

- Inoperative pumps
- Severed supply lines
- Flooding potential
- Vibration isolation failure.
- General cleanup required.

REFERENCE FIGURE FOR EXAMPLE OF DAMAGED EQUIPMENT

- 3.178.

*Water Systems**Storage Tanks*

Above ground storage tanks (Figure 3.136) require base anchorage and flexible supply line connections to prevent possible flooding.

EQUIPMENT SEISMIC CATEGORY

- “B” support equipment.

SEISMIC SPECIFICATION

- SDS-1.

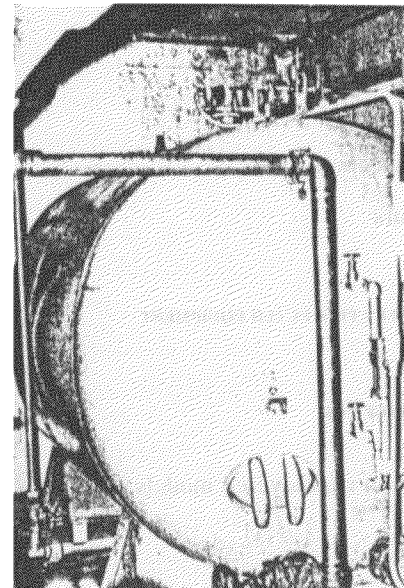


FIGURE 3.136 Large, uncoiled water storage tank without flexible connections.

SEISMIC QUALIFICATION APPROACH

- Equivalent static coefficient analysis
 - Tank anchorage
- Design team judgment.
 - Provide flexible supply line connections

REFERENCE FIGURES FOR INSTALLATION DETAILS

- 4.100, 4.101

RELATIVE DEGREE OF DAMAGE OF INADEQUATELY PROTECTED EQUIPMENT

- Minor to major.

MOST LIKELY TYPE OR CONSEQUENCE OF DAMAGE FOR INADEQUATELY PROTECTED EQUIPMENT

- Excessive tank displacement if unanchored.
- Ruptured supply lines
- Flooding potential

REFERENCE FIGURES FOR EXAMPLES OF DAMAGED EQUIPMENT

- 3.186, 3.187, 3.188, 3.189

*Water Systems**Water Heaters*

Hot water heaters (Figure 3.137) are usually tall, slender pieces of equipment that are highly susceptible to earthquake motions

EQUIPMENT SEISMIC CATEGORY

- “B” support equipment

SEISMIC SPECIFICATION

- SDS-1.

SEISMIC QUALIFICATION APPROACH

- Equivalent static coefficient analysis.
 - Base and top anchorage
- Design team judgment
 - Provide flexible connectors.

REFERENCE FIGURE FOR INSTALLATION DETAILS

- 4.101

RELATIVE DEGREE OF DAMAGE OF INADEQUATELY PROTECTED EQUIPMENT

- Minor to moderate.

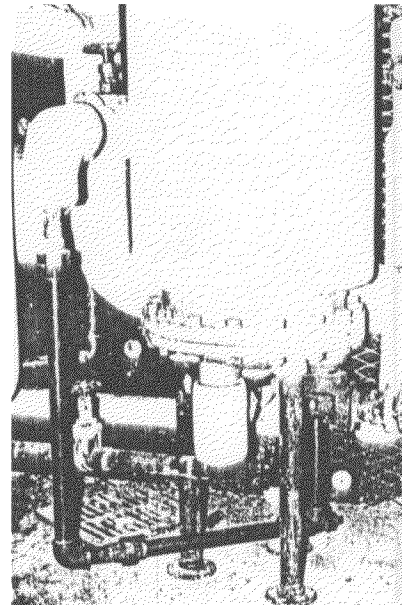


FIGURE 3.137. Hot water storage tank without base anchorage or flexible line connectors. Pipe legs are brittle and commonly fail during earthquakes

MOST LIKELY TYPE OR CONSEQUENCE OF DAMAGE FOR INADEQUATELY PROTECTED EQUIPMENT

- Broken pipe leg supports.
- Toppled tanks.
- Severed supply lines (gas and water).
 - Flooding potential
 - Fire potential.
- Secondary damage due to toppled tanks colliding with other equipment.
- Hot water system left inoperative.
- General cleanup required

REFERENCE FIGURES FOR EXAMPLES OF DAMAGED EQUIPMENT

- 3.186, 3.187, 3.188, 3.189.

*Water Systems**Water Softeners*

Water softeners (Figure 3.138) commonly have a geometry similar to that of hot water heaters and, consequently, similar stability problems.

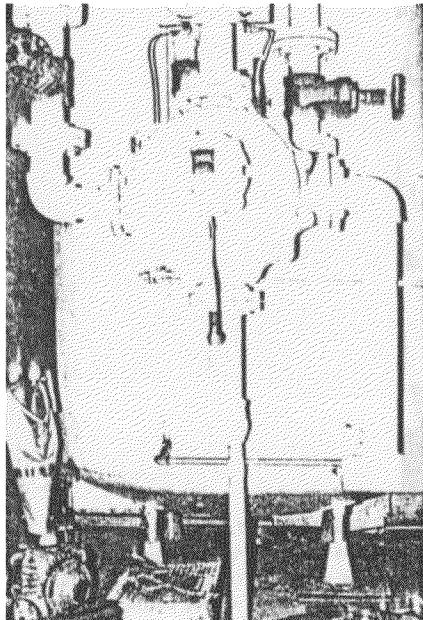


FIGURE 3.138 Water softener

EQUIPMENT SEISMIC CATEGORY

- "C" support equipment

SEISMIC SPECIFICATION

- SDS-2

SEISMIC QUALIFICATION APPROACH

- Equivalent static coefficient analysis.
 - Base and top anchorage
- Design team judgment
 - Provide flexible connections.

REFERENCE FIGURE FOR INSTALLATION DETAILS

- 4.101.

RELATIVE DEGREE OF DAMAGE OF INADEQUATELY PROTECTED EQUIPMENT

- Minor to moderate

MOST LIKELY TYPE OR CONSEQUENCE OF DAMAGE FOR INADEQUATELY PROTECTED EQUIPMENT

- Pipe leg failure.
- Toppled tanks.
- Severed supply lines with flooding potential
- General cleanup required.

REFERENCE FIGURES FOR EXAMPLES OF DAMAGED EQUIPMENT

- 3.186, 3.187, 3.188, 3.189.

Water Systems**Water Wells**

Water wells (Figure 3.139) require protection from other equipment to assure their operability. Collapsed casings and so forth are beyond the scope of this book with respect to well production.

EQUIPMENT SEISMIC CATEGORY

- "B" support equipment.

SEISMIC SPECIFICATION

- SDS-1.

SEISMIC QUALIFICATION APPROACH

- Design team judgment.
 - For surrounding equipment

RELATIVE DEGREE OF DAMAGE OF INADEQUATELY PROTECTED EQUIPMENT

- Minor to moderate.



FIGURE 3.139 Water well

MOST LIKELY TYPE OR CONSEQUENCE OF DAMAGE FOR INADEQUATELY PROTECTED EQUIPMENT

- Damage from unanchored adjacent equipment possible.
- Inoperative well.
- Flooding potential

Miscellaneous Equipment

The equipment items noted in this section are commonly found in nearly all facilities and do not easily fit into any of the described systems above.

Miscellaneous Equipment

Bookshelves

Bookshelves (Figure 3.140) are quite heavy when fully loaded and can present a cleanup problem if the books themselves are not restrained.

EQUIPMENT SEISMIC CATEGORY

- "E" miscellaneous equipment.

SEISMIC SPECIFICATION

- SDS-2

SEISMIC QUALIFICATION APPROACH

- Equivalent static coefficient analysis.
 - Base anchorage
 - Longitudinal "x" bracing.
 - Top bracing.
- Design team judgment
 - Provide shelf restrainers or tilted shelves.



FIGURE 3.140. These bookshelves have been anchored to the floor and have lateral bracing in the longitudinal direction. They lack top bracing and shelf parapeets.

REFERENCE FIGURES FOR INSTALLATION DETAILS

- 4.102, 4.103, 4.104.

RELATIVE DEGREE OF DAMAGE OF INADEQUATELY PROTECTED EQUIPMENT

- Minor.

MOST LIKELY TYPE OR CONSEQUENCE OF DAMAGE FOR INADEQUATELY PROTECTED EQUIPMENT

- Toppled shelves.
- Major cleanup required.

REFERENCE FIGURE FOR EXAMPLE OF DAMAGED EQUIPMENT

- 3.193.

Miscellaneous Equipment

Counters

Counters need adequate anchorage (Figure 3.141)

EQUIPMENT SEISMIC CATEGORY

- "E" miscellaneous equipment.

SEISMIC SPECIFICATION

- SDS-2.

SEISMIC QUALIFICATION APPROACH

- Equivalent static coefficient analysis.
 - Base anchorage.
- Design team judgment
 - Use positive latch doors
 - Use drawer stops.

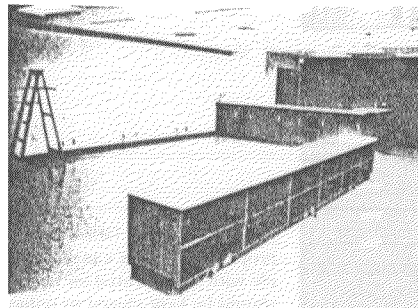


FIGURE 3.141. Anchorage must be provided for all counters whether they are located against a wall or out in the working spaces.

REFERENCE FOR INSTALLATION DETAILS

- Appendix 3.

RELATIVE DEGREE OF DAMAGE OF INADEQUATELY PROTECTED EQUIPMENT

- Minor.

MOST LIKELY TYPE OR CONSEQUENCE OF DAMAGE FOR INADEQUATELY PROTECTED EQUIPMENT

- Dislodged counters.
- Spilled items.
- General cleanup required

*Miscellaneous Equipment**Desks*

Sliding or toppling desks present both a cleanup problem as well as the potential for personnel injury (Figure 3.142).

EQUIPMENT SEISMIC CATEGORY

- "E" miscellaneous equipment

SEISMIC SPECIFICATION

- SDS-2.

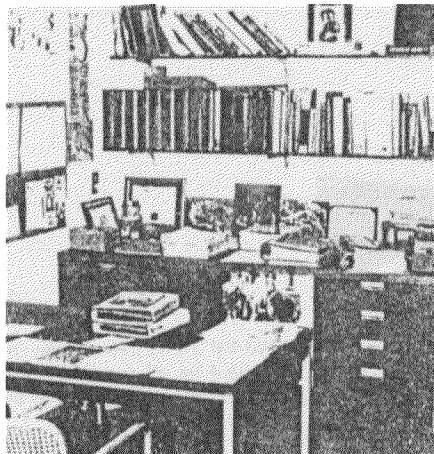


FIGURE 3.142 Office desks unless properly cared for can shift or even topple with the potential for injury. Drawers should be kept closed to reduce the toppling potential.

SEISMIC QUALIFICATION APPROACH

- Equivalent static coefficient analysis.
 - Base anchorage.

REFERENCE FIGURES FOR INSTALLATION DETAILS

- 4.105, 4.106, 4.107.

RELATIVE DEGREE OF DAMAGE OF INADEQUATELY PROTECTED EQUIPMENT

- Minor.

MOST LIKELY TYPE OR CONSEQUENCE OF DAMAGE FOR INADEQUATELY PROTECTED EQUIPMENT

- Dislodged desks.
- Toppled desks.
- Potential for personnel injury.
- General cleanup required.

REFERENCE FIGURE FOR EXAMPLE OF DAMAGED EQUIPMENT

- 3.197

*Miscellaneous Equipment**Filing Cabinets*

Filing cabinets (Figure 3.143) have been known to fall and block major exit ways in numerous facilities. The general cleanup and possibility of personnel injury should also be considered.

EQUIPMENT SEISMIC CATEGORY

- "E" miscellaneous equipment

SEISMIC SPECIFICATION

- SDS-2.

SEISMIC QUALIFICATION APPROACH

- Equivalent static coefficient analysis.
 - Base anchorage where possible.
- Design team judgment.
 - Provide top clips.
 - Provide top bracing.
 - Keep drawers at the bottom the fullest.
 - Keep drawers closed.
 - Purchase only filing cabinets with drawer locks.