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RELATIVE DEGREE OF DAMAGE FOR INADEQUATELY PROTECTED EQUIPMENT

- Minor to major

MOST LIKELY TYPE OR CONSEQUENCE OF DAMAGE FOR INADEQUATELY PROTECTED EQUIPMENT

- Severed pipe
- Flooding.
- Sanitation problems
- Steam escape

REFERENCE FIGURES FOR EXAMPLES OF DAMAGED EQUIPMENT

- 3.182, 3.183.

Piping Systems

Pipe Hangers, Vertical Pipe

Even where the pipe hanger (Figure 3.128) is set in the floor slab, the pipe itself must not be rigidly attached to the slab unless flexible connectors are supplied on either side of the slab.

EQUIPMENT SEISMIC CATEGORY

- Varies—Rupture can often affect critical equipment.

SEISMIC SPECIFICATION

- SDS-1 or SDS-2

SEISMIC QUALIFICATION APPROACH

- Design team judgment
- Dynamic analysis.
- Pipe flex computer programs are available.

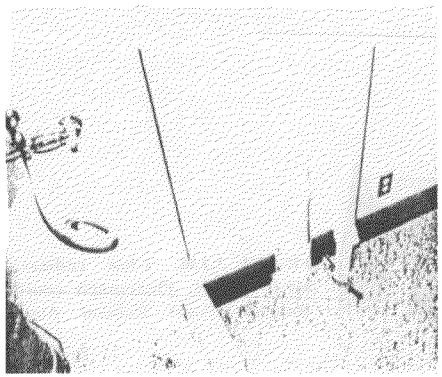

FIGURE 3.128. Vertical pipe hanger at floor level. Note the waste line bisecting the partition wall.

REFERENCE FIGURE FOR INSTALLATION DETAILS

- 4.91.

RELATIVE DEGREE OF DAMAGE FOR INADEQUATELY PROTECTED EQUIPMENT

- Minor to major.

MOST LIKELY TYPE OR CONSEQUENCE OF DAMAGE FOR INADEQUATELY PROTECTED EQUIPMENT

- Severed pipe.
- Flooding
- Sanitation problems.
- Steam escape.

Piping Systems

Pipe Racks

Pipe racks can be designed to allow for two or three controlled directions of motion. Shock loads must be considered at all pipe stops

EQUIPMENT SEISMIC CATEGORY

- Varies.

SEISMIC SPECIFICATION

- SDS-1 or SDS-2.

SEISMIC QUALIFICATION APPROACH

- Design team judgment.
- Dynamic analysis
- Pipe flex computer programs are available

RELATIVE DEGREE OF DAMAGE FOR INADEQUATELY PROTECTED EQUIPMENT

- Minor to major.

MOST LIKELY TYPE OR CONSEQUENCE OF DAMAGE FOR INADEQUATELY PROTECTED EQUIPMENT

- Severed pipe.
- Flooding
- Sanitation problems
- Steam escape.

REFERENCE FIGURES FOR EXAMPLES OF DAMAGED EQUIPMENT

- 3.180, 3.181.

Piping Systems

Tubing/Conduit

Tubing must be restrained for exceptionally long runs. It generally fairs well if flexible connections are provided at wall intersections, machinery interfaces, and so on (Figure 3.129).

EQUIPMENT SEISMIC CATEGORY

- Varies

SEISMIC SPECIFICATION

- SDS-1 or SDS-2.

SEISMIC QUALIFICATION APPROACH

- Design team judgment.
  - Provide flexible connectors
  - Provide support for long runs

REFERENCE FIGURES FOR INSTALLATION DETAILS

- 4.87, 4.88, 4.92

RELATIVE DEGREE OF DAMAGE FOR INADEQUATELY PROTECTED EQUIPMENT

- Minor to major.

MOST LIKELY TYPE OR CONSEQUENCE OF DAMAGE FOR INADEQUATELY PROTECTED EQUIPMENT

- Severed pipe.
- Flooding.
- Sanitation problems.
- Steam escape.

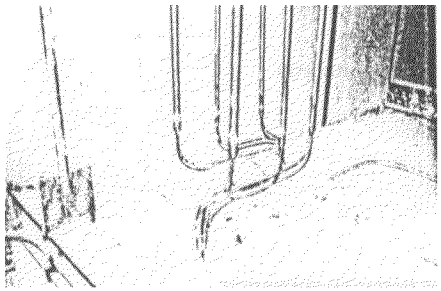

Figure 3.129. Flexible tubing at floor allows for movement without rupture.

Suspended Ceiling Systems

Suspended ceiling systems are not required for facility operation. Their failure does, however, present efficiency problems immediately after an earthquake. Those within a facility at the time of an earthquake may suffer undue "psychological stress" if ceiling panels begin to fall.

SYSTEM SEISMIC CATEGORY

- "E" miscellaneous system.

SYSTEM FOUND IN

- Business establishments.
- Communication centers
- Computing/data processing centers.
- Emergency operating centers.
- Fire stations.
- Government administration buildings.
- Hospitals.
- Police stations.
- Schools.

Suspended Ceiling Systems

T-Bar Ceiling

T-bar ceilings (Figure 3.130) are highly susceptible to earthquakes. Lay-in panels commonly fall as the T-bar frame deflects.

EQUIPMENT SEISMIC CATEGORY

- "E" miscellaneous equipment.

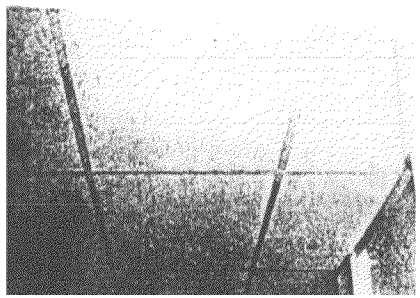

Figure 3.130. T-bar ceilings with lay-in panels. Photograph courtesy of Ruhnau-Evans-Rufman-Associates

SEISMIC SPECIFICATION

- SDS 2

SEISMIC QUALIFICATION APPROACH

- Equivalent static coefficient analysis
  - I bar frame
- Design team judgment
  - Specify compression posts and diagonal wiring

REFERENCE FIGURE FOR INSTALLATION DETAILS

- 4.98

RELATIVE DEGREE OF DAMAGE OF INADEQUATELY PROTECTED EQUIPMENT

- Minor

MOST LIKELY TYPE OR CONSEQUENCE OF DAMAGE FOR INADEQUATELY PROTECTED EQUIPMENT

- Dislodged lay-in panels.
- Cleanup of collapsed panels required
- Facility personnel unrest as panels fall. They may believe that the building is falling and panic

REFERENCE FIGURE FOR EXAMPLE OF DAMAGED EQUIPMENT

- 3.185.

Water Systems

Water systems include more than an occasional water pipe or sink. General performance in past earthquakes has been good. Qualification must be considered, however, to prevent pipe ruptures and subsequent flooding, which could prevent the operation of other systems.

SYSTEM SEISMIC CATEGORY

- "B" support equipment.

SYSTEM FOUND IN

- All building types

Water Systems

Boilers

Boilers for facility heating are typically large and earthquake consideration

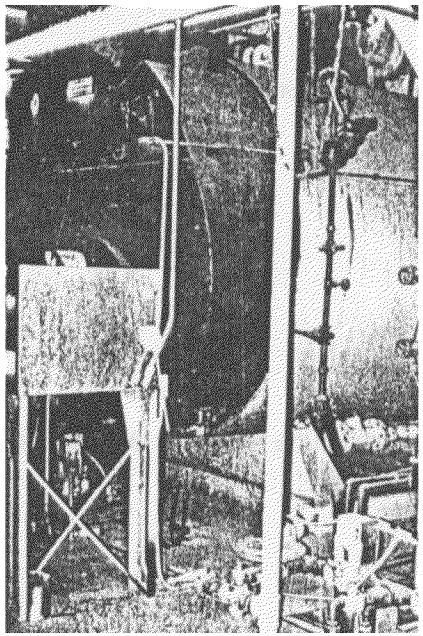

FIGURE 3.131. Large unsecured boiler

is generally not given (Figure 3.131). This equipment must receive adequate protection to remain operational.

EQUIPMENT SEISMIC CATEGORY

- "B" support equipment.

SEISMIC SPECIFICATION

- SDS-1.

SEISMIC QUALIFICATION APPROACH

- Equivalent static coefficient analysis.
  - Anchorage.
- Design team judgment
  - Use flexible connections on supply lines (water and gas)

REFERENCE FIGURE FOR INSTALLATION DETAILS

- 4.100.

RELATIVE DEGREE OF DAMAGE OF INADEQUATELY PROTECTED EQUIPMENT

- Minor to moderate

MOST LIKELY TYPE OR CONSEQUENCE OF DAMAGE FOR INADEQUATELY PROTECTED EQUIPMENT

- Dislodged boiler
  - Excessive movement possible if unanchored.
- Possibly inoperative boiler.
- Ruptured supply lines.
  - Flooding potential.
  - Fire potential.
- General cleanup required

Water Systems

Drinking Fountains, Freestanding

Freestanding water coolers (Figure 3.132) are the type most likely to cause damage (flooding) as a result of an earthquake.

EQUIPMENT SEISMIC CATEGORY

- "E" miscellaneous equipment

SEISMIC SPECIFICATION

- SDS-2.

SEISMIC QUALIFICATION APPROACH

- Equivalent static coefficient analysis.
  - Base anchorage.
- Design team judgment.
  - Provide flexible water lines to prevent rupture.
  - Use top bracing if possible

REFERENCE FIGURE FOR INSTALLATION DETAILS

- 4.35

RELATIVE DEGREE OF DAMAGE OF INADEQUATELY PROTECTED EQUIPMENT

- Minor to moderate.

MOST LIKELY TYPE OR CONSEQUENCE OF DAMAGE FOR INADEQUATELY PROTECTED EQUIPMENT

- Toppled drinking fountain.
- Broken water lines (flooding)
- General cleanup required

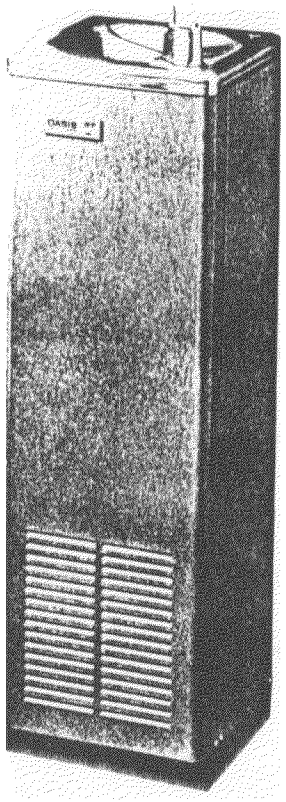

FIGURE 3.132. Freestanding water cooler. Photograph courtesy of Oasis Water Coolers.

Water Systems

Drinking Fountains, Wall-Hung

Wall-hung drinking fountains (Figure 3.133) have good performance records. Anchorage must be adequate especially for cantilevered models.

EQUIPMENT SEISMIC CATEGORY

- "E" miscellaneous equipment.

SEISMIC SPECIFICATION

- SDS-2.

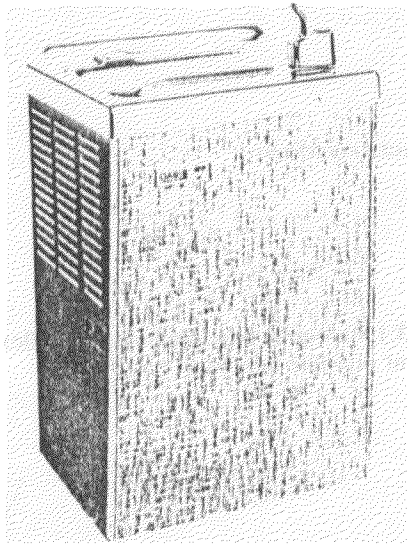

FIGURE 3.133. Wall hung water cooler. Photograph courtesy of Oasis Water Coolers.

SEISMIC QUALIFICATION APPROACH

- Equivalent static coefficient analysis.
  - For anchorage.
- Design team judgment.
  - Provide flexible supply line connection.

REFERENCE FIGURES FOR INSTALLATION DETAILS

- 4.102, 4.103

RELATIVE DEGREE OF DAMAGE OF INADEQUATELY PROTECTED EQUIPMENT

- Minor

MOST LIKELY TYPE OR CONSEQUENCE OF DAMAGE FOR INADEQUATELY PROTECTED EQUIPMENT

- Dislodged if inadequate anchorage on cantilevered models.
- Ruptured supply lines.
- Flooding potential
- General cleanup required

Water Systems

Hot and Cold Water Supply Lines

Most water supply lines (Figure 3.134) fair generally well during an earthquake

EQUIPMENT SEISMIC CATEGORY

- "B" support equipment

SEISMIC SPECIFICATION

- SDS-1.

SEISMIC QUALIFICATION APPROACH

- Design team judgment.
  - For small lines
- Equivalent static coefficient analysis
  - For larger line supports (2 inches and above) and braces.

REFERENCE FIGURE FOR INSTALLATION DETAILS

- 4.92.

RELATIVE DEGREE OF DAMAGE OF INADEQUATELY PROTECTED EQUIPMENT

- Minor to moderate.

MOST LIKELY TYPE OR CONSEQUENCE OF DAMAGE FOR INADEQUATELY PROTECTED EQUIPMENT

- System generally operative. Most frequent types of damage are minor leaks and broken supports.
- Potential for serious flooding should large lines rupture.
- General cleanup required

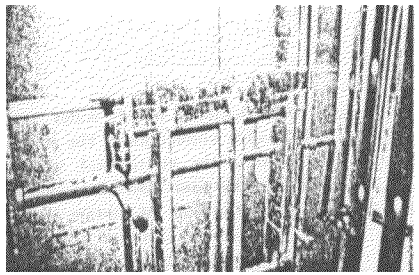

FIGURE 3.134. Typical water supply lines. Note the plate welded to the metal studs that will be used for hanging the casework.