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  - For dynamically sensitive subcomponents
- Dynamic analysis.
  - For frame integrity.
- Equivalent static coefficient analysis
  - For base and top anchorage.
  - Top bracing where possible.
- Design team judgment.
  - Use through bolts with nuts and lock washers and locate heavy, sensitive equipment toward the bottom of the rack.

REFERENCE FIGURES FOR INSTALLATION DETAILS

- 4.14, 4.15.

RELATIVE DEGREE OF DAMAGE OF INADEQUATELY PROTECTED EQUIPMENT

- Minor to major

MOST LIKELY TYPE OR CONSEQUENCE OF DAMAGE FOR INADEQUATELY PROTECTED EQUIPMENT

- Deformed racks
- Toppled racks.
- Racks can deflect enough to collide with other equipment.
- Failure of dynamically sensitive subcomponents
- System inoperability.
- General cleanup.

Communications Systems

INTERAC Operations

Volunteer communications operations within emergency operating centers are often neglected in the design phase (see Figure 3.27). They do, however, represent an important communication function that deserves consideration.

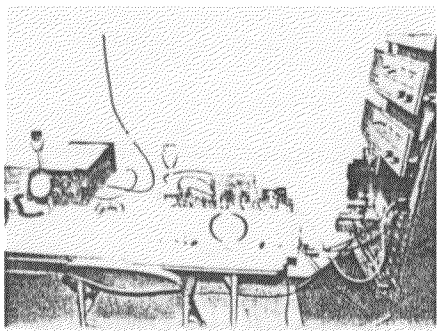

FIGURE 3.27. Leaving communication equipment loose atop unanchored tables as in this example will likely result in inoperative equipment.

EQUIPMENT SEISMIC CATEGORY

- "B" support equipment.

SEISMIC SPECIFICATION

- SDS-1

SEISMIC QUALIFICATION APPROACH

- Design team judgment.
  - Anchor tables
  - Restrain table top equipment.
  - Restrain adjacent equipment such as that shown in Figure 3.27.

REFERENCE FIGURES FOR INSTALLATION DETAILS

- 4.12, 4.13, 4.18, 4.19, 4.20, 4.21, 4.58, 4.61, 4.62, 4.63.

RELATIVE DEGREE OF DAMAGE OF INADEQUATELY PROTECTED EQUIPMENT

- Minor to moderate.

MOST LIKELY TYPE OR CONSEQUENCE OF DAMAGE FOR INADEQUATELY PROTECTED EQUIPMENT

- Overturned tables.
- Equipment falling off table top
- Inoperative equipment.
- General cleanup required.

Communications Systems

Storage, Ad Hoc

Unprotected ad hoc storage (Figure 3.28) adjacent to any expensive/sensitive equipment has the potential of damaging otherwise well protected equipment.

EQUIPMENT SEISMIC CATEGORY

- "E" miscellaneous equipment.

SEISMIC SPECIFICATION

- SDS-2.

SEISMIC QUALIFICATION APPROACH

- Equivalent static coefficient analysis
  - Shelf case anchorage.
- Design team judgment

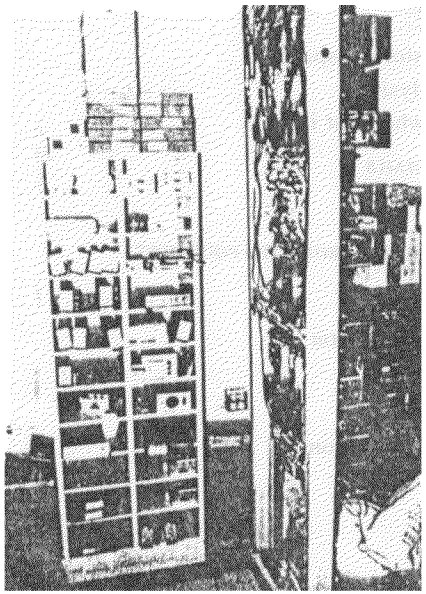

FIGURE 3.28. Ad hoc storage such as that shown here can easily topple and damage adjacent critical equipment.

- Do not store equipment where it can damage other equipment if at all possible.
- Use shelf restrainers to keep items on their shelves.

REFERENCE FIGURES FOR INSTALLATION DETAILS

- 4.53, 4.54, 4.55, 4.56, 4.73, 4.74, 4.76, 4.102, 4.103, 4.104, 4.108, 4.109.

RELATIVE DEGREE OF DAMAGE OF INADEQUATELY PROTECTED EQUIPMENT

- Minor to major.

MOST LIKELY TYPE OR CONSEQUENCE OF DAMAGE FOR INADEQUATELY PROTECTED EQUIPMENT

- Toppled shelves
- Spilled shelved items
- Potentially inoperable equipment.
- General cleanup required

REFERENCE FIGURE FOR EXAMPLE OF DAMAGED EQUIPMENT

- 3.198

Communications Systems

Teletypes

Hard copy communication equipment (Figure 3.29) such as teletypes generally requires base anchorage of the equipment frame and top bracing to prevent pounding against walls.

EQUIPMENT SEISMIC CATEGORY

- "B" support equipment

SEISMIC SPECIFICATION

- SDS-1

SEISMIC QUALIFICATION APPROACH

- Equivalent static coefficient analysis
  - Base anchorage
- Design team judgment.
  - Mount equipment far enough away from the adjacent wall to keep the equipment from pounding against it during strong motion or provide top bracing.

REFERENCE FIGURES FOR INSTALLATION DETAILS

- 4.16, 4.17, 4.58

RELATIVE DEGREE OF DAMAGE OF INADEQUATELY PROTECTED EQUIPMENT

- Minor to moderate.

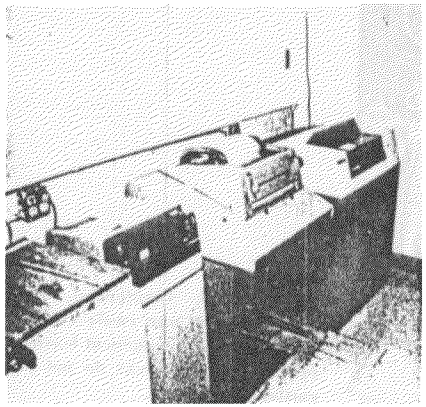

FIGURE 3.29. Teletype and other telecommunications equipment should always receive aseismic consideration. This example has not received any.

MOST LIKELY TYPE OR CONSEQUENCE OF DAMAGE FOR INADEQUATELY PROTECTED EQUIPMENT

- Toppling
  - Potentially inoperative equipment
- General cleanup required

Communications Systems

Test Equipment, Portable

Portable test equipment (Figure 3.30) presents a special hazard to stationary equipment (critical or support) and personnel if left unrestrained when not in use.

EQUIPMENT SEISMIC CATEGORY

- "D" support equipment.

SEISMIC SPECIFICATION

- SDS 2

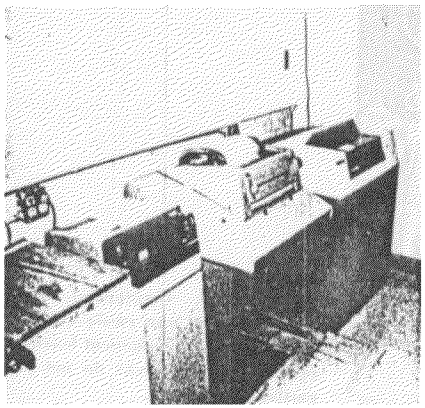

FIGURE 3.30. Unattended portable test equipment can easily collide with adjacent critical equipment leaving it inoperable. Wheel locks do not prevent earthquake damage

SEISMIC QUALIFICATION APPROACH

- Design team judgment
  - Provide for fixed protected storage space.
- Equivalent static coefficient analysis.
  - For restraining mechanism when not in use

REFERENCE FIGURES FOR INSTALLATION DETAILS

- 4.12, 4.13, 4.61, 4.62, 4.63, 4.68, 4.69

RELATIVE DEGREE OF DAMAGE OF INADEQUATELY PROTECTED EQUIPMENT

- Minor to major.

MOST LIKELY TYPE OR CONSEQUENCE OF DAMAGE FOR INADEQUATELY PROTECTED EQUIPMENT

- Toppled test equipment.
- Damage to fixed equipment from collision
- Potential personnel injury.
- Inoperable equipment.
- General cleanup required.

REFERENCE FIGURE FOR EXAMPLE OF DAMAGED EQUIPMENT

- 3.170.

Communications Systems

Wiring

Wiring and conduit should always be left with slack (Figure 3.31) to allow for differential movement

EQUIPMENT SEISMIC CATEGORY

- "A" critical equipment

SEISMIC SPECIFICATION

- SDS-1.

SEISMIC QUALIFICATION APPROACH

- Design team judgment
  - Specify slack in all wiring and conduit, especially at all building and equipment interfaces.

REFERENCE FIGURES FOR INSTALLATION DETAILS

- 4.9, 4.34.

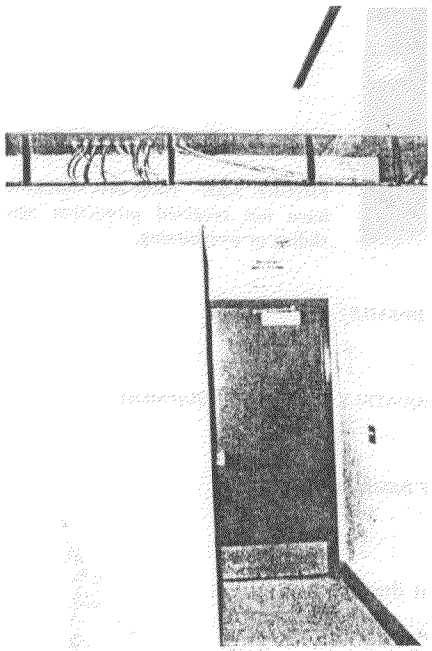

FIGURE 3.31 All wiring should be installed with slack. Shown here is wiring with proper slack, as well as wiring that has been pulled tight.

RELATIVE DEGREE OF DAMAGE OF INADEQUATELY PROTECTED EQUIPMENT

- Moderate to major.

MOST LIKELY TYPE OR CONSEQUENCE OF DAMAGE FOR INADEQUATELY PROTECTED EQUIPMENT

- Ripped wiring
  - Fire potential
- Potentially inoperative equipment

Data Processing Systems

Data processing systems are generally not needed for the continued operating capabilities of most facilities. The equipment is, however, quite expensive, difficult to repair, and time consuming to replace. Failure of seemingly minor equipment such as cooling systems can render the entire data processing center useless. For these reasons, it is necessary to adhere closely to qualification procedures.

SYSTEM SEISMIC CATEGORY

- "B" support system.

SYSTEM FOUND IN

- Business establishments.
- Computing/data processing centers.
- Government administration buildings.
- Schools.

Data Processing Systems

Cooling Equipment

Cooling capabilities are an absolute must for all computers. Cooling can be accomplished with refrigerated air or integral water systems (see Figure 3.32).

EQUIPMENT SEISMIC CATEGORY

- "A" critical equipment

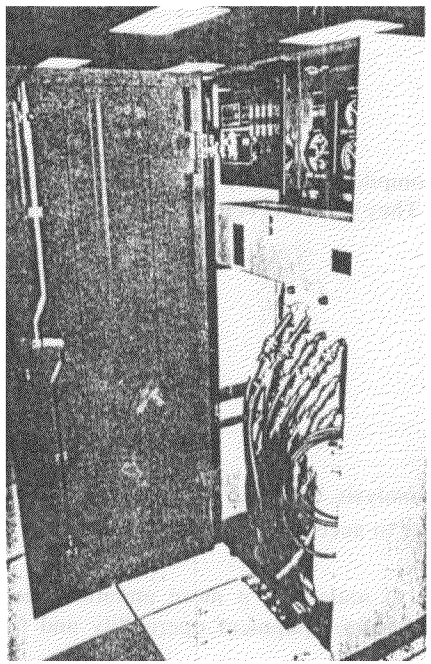

FIGURE 3.32. This computer cooling unit has been installed without base anchorage, which effectively jeopardizes the entire data processing system if it should fail.

SEISMIC SPECIFICATION

- SDS-1.

SEISMIC QUALIFICATION APPROACH

- Equivalent static coefficient analysis.
  - Base anchorage of all pumps, cooling towers, and sumps.
- Design team judgment.
  - Leave enough slack in all water lines to allow for movement
  - Use flexible hose where possible or flexible connectors

REFERENCE FIGURES FOR INSTALLATION DETAILS

- 4.9, 4.16, 4.17, 4.58, 4.88, 4.92, 4.93

RELATIVE DEGREE OF DAMAGE OF INADEQUATELY PROTECTED EQUIPMENT

- Minor to major.

MOST LIKELY TYPE OR CONSEQUENCE OF DAMAGE FOR INADEQUATELY PROTECTED EQUIPMENT

- Inoperable equipment
- Flooding if water supply lines should sever as a result of being installed without slack or flexible connections
- General cleanup required

Data Processing Systems

Disc Storage and Compilers

Disc storage (Figure 3.33) and compilers generally have wide footings and are thus likely to be fairly stable. They do, however, require base anchorage to prevent sliding.

EQUIPMENT SEISMIC CATEGORY

- "B" support equipment.

SEISMIC SPECIFICATION

- SDS-1.

SEISMIC QUALIFICATION APPROACH

- Equivalent static coefficient analysis.
  - Base anchorage of cabinet to access floor or subfloor.
- Seismic test/dynamic analysis.
  - Manufacturer may wish to undertake a more ambitious generic qualification program to assure equipment operability and frame/component integrity

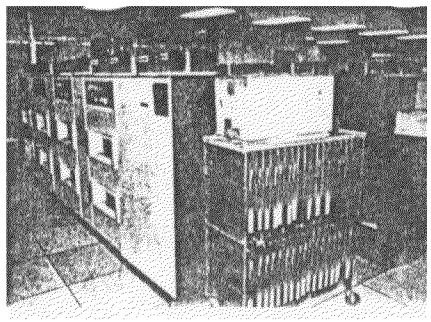

FIGURE 3.33. These disc storage units have not received protection against sliding or overturning.

REFERENCE FIGURES FOR INSTALLATION DETAILS

- 4.9, 4.14, 4.15, 4.34, 4.58.

RELATIVE DEGREE OF DAMAGE OF INADEQUATELY PROTECTED EQUIPMENT

- Minor to moderate.

MOST LIKELY TYPE OR CONSEQUENCE OF DAMAGE FOR INADEQUATELY PROTECTED EQUIPMENT

- Sliding cabinet.
- Possibly inoperable equipment due to torn wires.
- General cleanup required

Data Processing Systems

Interface, Input/Output

Input/output peripherals such as keyboards, line printers, and CRTs (Figure 3.34) need to be restrained from sliding and toppling.

EQUIPMENT SEISMIC CATEGORY

- "B" support equipment

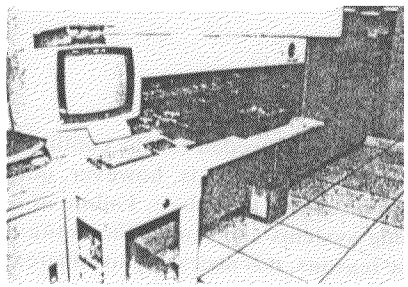

FIGURE 3.34. Input/output devices such as the CRT terminal shown here are typically left sitting atop tables without any earthquake protection