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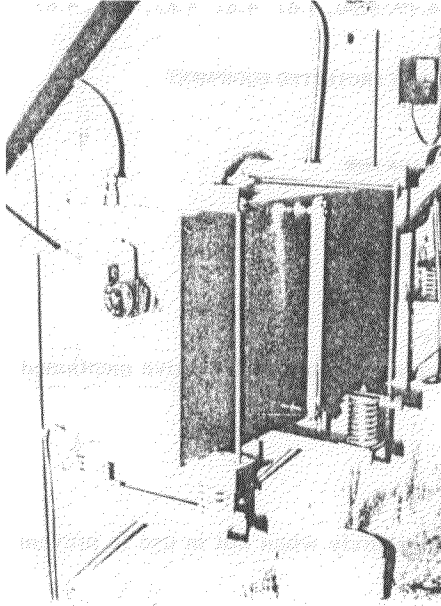


FIGURE 3.50. Small day tank showing vibration isolation without motion restraints and with flexible fuel lines.

#### REFERENCE FIGURES FOR INSTALLATION DETAILS

- 4.32, 4.33.

#### RELATIVE DEGREE OF DAMAGE OF INADEQUATELY PROTECTED EQUIPMENT

- None to minor.

#### MOST LIKELY TYPE OR CONSEQUENCE OF DAMAGE FOR INADEQUATELY PROTECTED EQUIPMENT

- If the day tank is dislodged, fuel may be spilled.
- Potential fire hazard from spilled fuel.
- If the day tank is dislodged, the emergency power supply may be left inoperative.

#### *Emergency Power Supply Systems*

##### *Fuel Supply Lines*

The major mode of failure for fuel supply lines is rupturing at rigid connections. Distribution metering boxes and fuel pumps should be fixed. All supply lines from the day tank to the emergency power generator should have

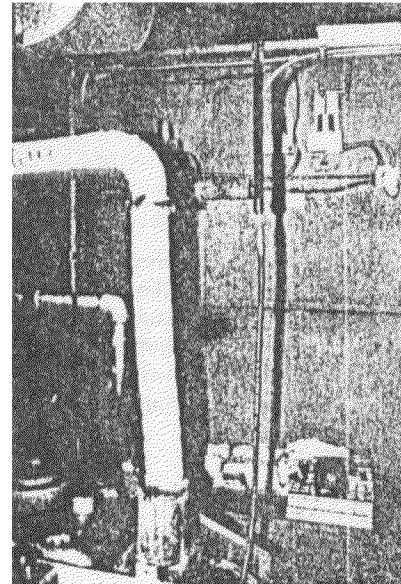


FIGURE 3.51. Flexible fuel lines should be used to assure generator operability. Rubber lines are used here.

flexible connections at every junction (Figure 3.51). Flexible connections (rubber, braided, or copper tubing) should have slack; that is, they should not be stretched tight for aesthetic reasons.

#### EQUIPMENT SEISMIC CATEGORY

- "A" critical equipment.

#### SEISMIC SPECIFICATION

- SDS-1.

#### SEISMIC QUALIFICATION APPROACH

- Design team judgment
  - Provide flexible connections with plenty of slack.

#### REFERENCE FIGURE FOR INSTALLATION DETAILS

- 4.36.

#### RELATIVE DEGREE OF DAMAGE OF INADEQUATELY PROTECTED EQUIPMENT

- None if flexible connections are used.
- Moderate to major if rigid connections are used.

**MOST LIKELY TYPE OR CONSEQUENCE OF DAMAGE FOR INADEQUATELY PROTECTED EQUIPMENT**

- Ruptured fuel line.
- Potential fire hazard from spilled fuel.
- The emergency power supply may be left inoperative if the fuel supply lines rupture.

*Emergency Power Supply Systems*

*Generator Set*

The generator set may be diesel, gasoline or turbine powered. The engine and generator are usually subjected to loads far in excess of the seismic loads during its normal operating conditions. They are usually attached to a skid and must be restrained either through fixed anchorage or snubbed vibration isolators. Moderate damage that may render the generator set inoperative is generally due to the failure of vibration isolation mountings that do not employ motion restraints (Figure 3.52).

**EQUIPMENT SEISMIC CATEGORY**

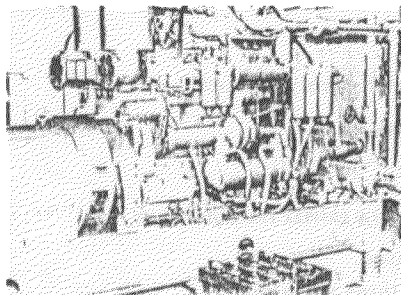
- "A" critical equipment.

**SEISMIC SPECIFICATION**

- SDS-1.

**SEISMIC QUALIFICATION APPROACH**

- Equivalent static coefficient analysis
  - Fixed anchorage
- Dynamic analysis.
  - Vibration isolation.
- Seismic test.
  - Manufacturers may consider generic programs for the entire system.



**FIGURE 3.52.** This emergency power supply has been installed without motion restraints for the vibration isolator. Note the batteries adjacent to the frame. They are likely to be damaged during an earthquake.

**REFERENCE FIGURES FOR INSTALLATION DETAILS**

- 4.37, 4.38, 4.39, 4.40, 4.41, 4.78, 4.79, 4.80, 4.81, 4.82, 4.83, 4.84, 4.85, 4.86

**RELATIVE DEGREE OF DAMAGE OF INADEQUATELY PROTECTED EQUIPMENT**

- Minor to major

**MOST LIKELY TYPE OR CONSEQUENCE OF DAMAGE FOR INADEQUATELY PROTECTED EQUIPMENT**

- Vibration isolation failure.
- Battery failure.
- Fuel line failure.
- Other peripheral equipment failure.
- Equipment may be left inoperative as a result of the above mentioned failures.

*Emergency Power Supply Systems*

*Generators, Portable*

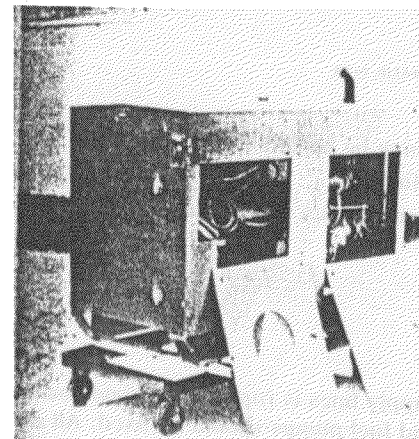
Portable generators should be stored securely when not in use to prevent damage (see Figure 3.53).

**EQUIPMENT SEISMIC CATEGORY**

- "A" critical equipment

**SEISMIC SPECIFICATION**

- SDS-1.



**FIGURE 3.53.** Portable generators should not be haphazardly stored on wheel carts as shown here. They should be securely stored to prevent toppling and so forth.

**SEISMIC QUALIFICATION APPROACH**

- Equivalent static coefficient analysis.
  - Of restrainers.
- Design team judgment.
  - Provide restraining system to keep this type of portable equipment stationary when not in use.

**REFERENCE FIGURE FOR INSTALLATION DETAILS**

- 4.69.

**RELATIVE DEGREE OF DAMAGE OF INADEQUATELY PROTECTED EQUIPMENT**

- Minor to major.

**MOST LIKELY TYPE OR CONSEQUENCE OF DAMAGE FOR INADEQUATELY PROTECTED EQUIPMENT**

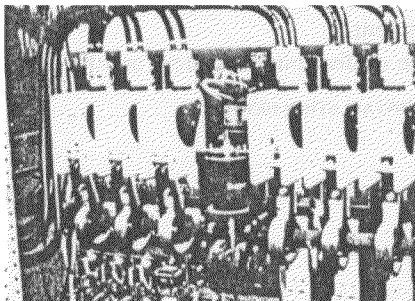
- Runaway equipment
- Collision with other equipment
- Topped equipment.
- Potentially inoperative generator.
- General cleanup required.

*Emergency Power Supply Systems**Power Transfer Panel*

Power transfer from the generator set to the building distribution network goes through the power transfer panel. This unit commonly contains switches and relays that are sensitive to dynamic motions, which could cause operational failures (see Figure 3.54).

**EQUIPMENT SEISMIC CATEGORY**

- "A" critical equipment.



**FIGURE 3.54.** Electric transfer panel with dynamically sensitive subcomponents require sophisticated qualification procedures

**SEISMIC SPECIFICATION**

- SDS-1.

**SEISMIC QUALIFICATION APPROACH**

- Seismic test
  - For both fixed and vibration isolation mounted panels. The latter is generally found in Civil Defense emergency operating centers only.
  - For panels with dynamically sensitive switches.
- Equivalent static coefficient analysis
  - For all other panels.

**REFERENCE FIGURES FOR INSTALLATION DETAILS**

- 4.34, 4.35.

**RELATIVE DEGREE OF DAMAGE OF INADEQUATELY PROTECTED EQUIPMENT**

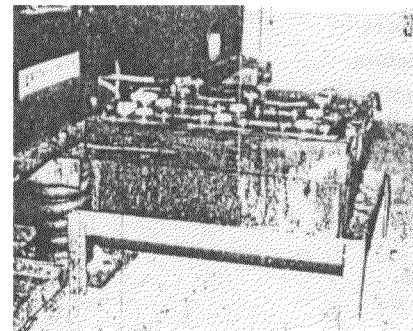
- Minor to moderate.

**MOST LIKELY TYPE OR CONSEQUENCE OF DAMAGE FOR INADEQUATELY PROTECTED EQUIPMENT**

- Operational failure of dynamically sensitive switches.
- Structural failure of panel is possible if vibration isolation is used without motion restraint.

*Emergency Power Supply Systems**Vibration Isolation*

Vibration isolators keep uncomfortable vibrations from being transmitted to the building during normal operation of reciprocating equipment. These isolators are, however, extremely sensitive to most earthquake motions (see Figure 3.55). Also see Motion Restraint Systems in this chapter.



**FIGURE 3.55.** Employment of vibration isolation always requires accompanying motion restraint equipment. This spring system does not have motion restraints and has been installed immediately adjacent to the starting batteries, which are likely to be damaged during strong motion

## EQUIPMENT SEISMIC CATEGORY

- "A" critical equipment.

## SEISMIC SPECIFICATION

- SDS-1.

## SEISMIC QUALIFICATION APPROACH

- Dynamic analysis.
  - By manufacturer.
- Seismic test
  - For dynamically sensitive equipment such as power transfer panel if vibration isolation units are used.

## REFERENCE FIGURES FOR INSTALLATION DETAILS

- 4.39, 4.40, 4.41, 4.78, 4.79, 4.80, 4.81, 4.82, 4.83, 4.84, 4.85, 4.86

## RELATIVE DEGREE OF DAMAGE OF INADEQUATELY PROTECTED EQUIPMENT

- Major.

## MOST LIKELY TYPE OR CONSEQUENCE OF DAMAGE FOR INADEQUATELY PROTECTED EQUIPMENT

- Resonance often occurs with major damage resulting.
- Inoperative emergency power supply system.

## REFERENCE FIGURE FOR EXAMPLE OF DAMAGED EQUIPMENT

- 3.173

## Fire Protection Systems

Fire protection systems are highly varied in their application and complexity. The following general types are available:

- Chemical suppression.
- Hand-held extinguishers.
- Smoke and gas detectors.
- Water distribution networks.

Earthquake protection of the various fire protection systems can clearly reduce potential earthquake losses.

## SYSTEM SEISMIC CATEGORY

- "A" critical system

## SYSTEM FOUND IN

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

*Fire Protection Systems**Chemical Fire Suppression Units*

These units usually contain the following elements:

- Chemical extinguisher tank
- Connection to distribution system.
- Distribution system.

The units are generally not susceptible to dynamic motions as long as they remain anchored and if flexible connections are provided at structural interfaces (Figure 3.56).

## EQUIPMENT SEISMIC CATEGORY

- "A" critical equipment.

## SEISMIC SPECIFICATION

- SDS-1.

## SEISMIC QUALIFICATION APPROACH

- Equivalent static coefficient analysis
  - For anchorage of chemical bottles.
- Design team judgment.
  - For anchorage of distribution system and flexible connections

## REFERENCE FIGURE FOR INSTALLATION DETAILS

- 4.43.

## RELATIVE DEGREE OF DAMAGE OF INADEQUATELY PROTECTED EQUIPMENT

- Minor to major.

- Inoperable fire protection system
- General cleamp required.

### Fire Protection Systems

#### Detectors, Smoke

Smoke detectors (Figure 3.58) are generally not susceptible to dynamic motions as long as they remain anchored and as long as they retain power.

#### EQUIPMENT SEISMIC CATEGORY

- "A" critical equipment.

#### SEISMIC SPECIFICATION

- SDS-1.

#### SEISMIC QUALIFICATION APPROACH

- Design team judgment.
  - Anchor components.

#### REFERENCE FIGURE FOR INSTALLATION DETAILS

- 4.46

#### RELATIVE DEGREE OF DAMAGE OF INADEQUATELY PROTECTED EQUIPMENT

- None to minor.

#### MOST LIKELY TYPE OR CONSEQUENCE OF DAMAGE FOR INADEQUATELY PROTECTED EQUIPMENT

- Even when inadequately supported, smoke detectors generally remain operational as long as power remains uninterrupted.



FIGURE 3.58. Ceiling installation of smoke detector

### Fire Protection Systems

#### Extinguishers, Hand-Held

These units (Figure 3.59) come in water and pressurized dry chemical models. They may be mounted directly to the wall or contained in a wall cabinet.

#### EQUIPMENT SEISMIC CATEGORY

- "A" critical equipment.

#### SEISMIC SPECIFICATION

- SDS-1.

#### SEISMIC QUALIFICATION APPROACH

- Design team judgment.
  - Provide positive latch doors and quick release holders.

#### REFERENCE FIGURES FOR INSTALLATION DETAILS

- 4.44, 4.45.

#### RELATIVE DEGREE OF DAMAGE OF INADEQUATELY PROTECTED EQUIPMENT

- Minor.

#### MOST LIKELY TYPE OR CONSEQUENCE OF DAMAGE FOR INADEQUATELY PROTECTED EQUIPMENT

- Extinguishers fall from wall hooks and cabinets
- Extinguishers may discharge their contents when they fall.

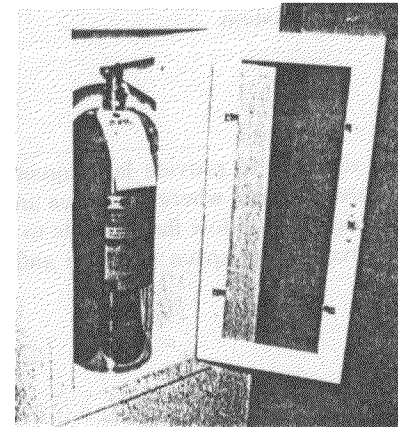


FIGURE 3.59. Hand-held extinguishers, whether mounted in a cabinet or wall hung, require brackets to keep them in place. This extinguisher is not anchored. The cabinet door does, however, have a positive latch, but it has a glass pane that may well break.