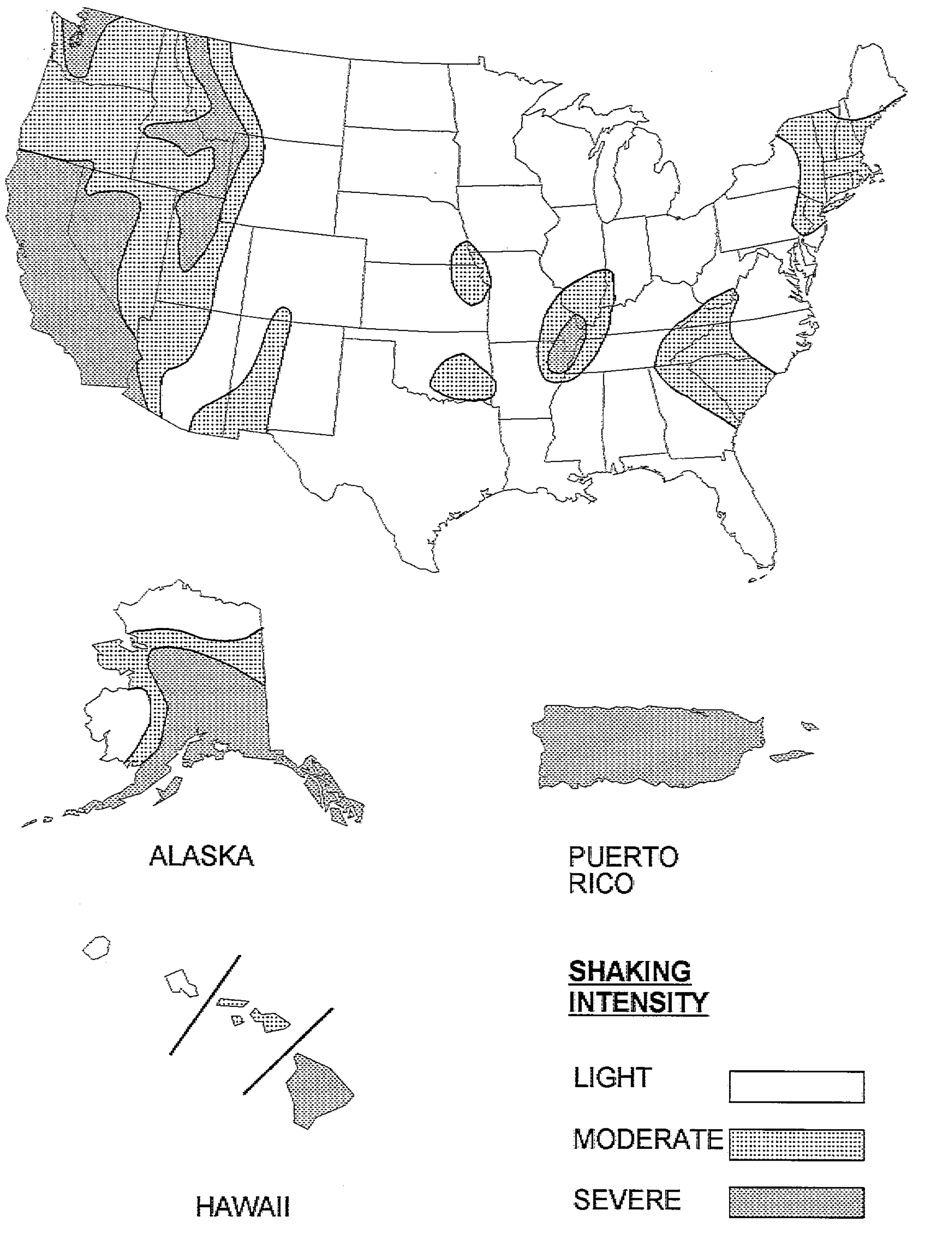


Note: There is approximately a 10% chance in 50 years that any given site will experience the shaking intensity shown. Map adapted from the following sources: 1991 NEHRP Recommended Provisions (primary source) and 1994 Uniform Building Code (basis for western states).

Figure 7 - Map of Probable Shaking Intensity for the United States

acceleration is often less than the maximum acceleration recorded during an earthquake. The three shaking intensity levels correspond approximately to the following EPA ranges:

- Light, less than 0.15g
- Moderate, between 0.15g and 0.3g
- Severe, greater than 0.3g

Several examples of earthquake motion recorded during the 1994 Northridge earthquake may help to put these acceleration ranges in perspective. The Northridge earthquake had a magnitude of 6.7. The magnitude of an earthquake is a measure of the amount of energy released by the fault rupture or ground shaking; it does not provide any information about the intensity of shaking at any particular location. During this earthquake, the intensity of ground shaking was severe in Northridge, near the earthquake epicenter. Several stations recorded ground motion with maximum accelerations in excess of 0.9g. Nevertheless, the majority of stations in downtown Los Angeles, at distances of approximately 30-40 kilometers from the epicenter, recorded moderate ground shaking--between 0.15g and 0.30g. Stations in Long Beach, approximately 60 kilometers from the epicenter, recorded light ground shaking--less than 0.15g [10]. EPA's from the Northridge earthquake records are lower than the maximum recorded accelerations indicated above, but the EPA's also show the same trend, that is, the shaking intensity became less severe as the distance from the epicenter increased. While few people outside California may need to worry about the intensity of shaking experienced in Northridge, many areas of the country may experience the moderate or light shaking that was felt in downtown Los Angeles and Long Beach during the Northridge earthquake.

One further note regarding shaking intensity will serve to illustrate what appears to be one of the most extreme cases to date of recorded earthquake shaking intensity. A peak horizontal acceleration of 1.7g was recorded at the roof level of the Los Angeles County Olive View Medical Center in Sylmar during the Northridge earthquake. The roof acceleration was 2.6 times higher than the ground acceleration (0.65g) measured near the building [11]. The horizontal forces on items at the roof level were 170% of their weight, if only for an instant. Although some roof-mounted items at the hospital were severely damaged, most of the anchored items performed well because they were designed using the special seismic requirements of the California Hospital Seismic Safety Act. While this is an extreme case, standard code provisions are not adequate to protect items in essential facilities from shaking of this intensity. Even the above-average requirements of special codes, such as California's Hospital Act, are being revised to include lessons from the Northridge earthquake.

3 NONSTRUCTURAL SURVEY PROCEDURES

What types of nonstructural components are present in a particular facility? How does the owner or manager know what the potential problems are? How will a specific nonstructural item perform in an earthquake, and what are the consequences of failure in terms of life safety, property loss, and interruption or loss of function? If the decision is made to upgrade a facility, which problems should be addressed first? This chapter includes guidelines that will help answer these questions.

TYPICAL NONSTRUCTURAL COMPONENTS

The nonstructural components listed in the tables and checklists provided in the appendixes are items that are most commonly found in commercial, multiple-unit residential, or public buildings. A complex facility such as a hospital, research laboratory, or industrial plant will contain many additional types of specialized equipment that are not addressed in this guide. The common components can be divided into three general categories as follows.

- **Building Utility Systems**
  These are typically built-in nonstructural components that form part of the building. Examples include mechanical and electrical equipment and distribution systems, piping and conduit, fire detection and suppression systems, elevators or escalators, HVAC systems, and roof-mounted solar panels.

- **Architectural Components**
  These are typically built-in nonstructural components that form part of the building. Examples include partitions and ceilings, windows, doors, lighting, interior or exterior ornamentation, exterior panels, veneer, and parapets.

- **Furniture and Contents**
  These are nonstructural components belonging to tenants or occupants. Examples include office, computer, and communications equipment; cabinets and shelving for record and supply storage; library stacks; kitchen and laundry facilities; furniture; movable partitions; lockers; and vending machines.

Not every conceivable item is included in these lists, so some judgment is needed to identify the critical items in a particular facility. In general, items that are taller, heavier, or important to operations, items that contain hazardous materials, and items that are more expensive should be included before items that are shorter, lighter, nonessential, inexpensive, and do not contain hazardous materials.

FACILITY SURVEY

As a first step, it may be useful to perform a survey of your facility to identify nonstructural components that may be vulnerable to earthquake damage. As noted earlier, consultant expertise may be advisable. Keep in mind three basic questions as each nonstructural item is considered:

- Would anyone get hurt by this item in an earthquake?
- Would a large property loss result?
- Would interruptions and outages be a serious problem?

For some items, the answers to these three questions may not be immediately obvious, since failure of an item may result in both direct damage and consequential damage. For example, if a fire sprinkler line breaks, this may cause minor damage to the sprinkler itself but result in major damage to architectural finishes and contents of the building. Even if the building did not sustain any other damage, the occupants may not be able to use the facility until the fire safety system is repaired. The potential direct and indirect property loss in this case is much greater than the repair cost for the sprinkler system. As another example, the battery rack used to start an emergency generator is generally located in a locked mechanical room and is unlikely to hurt anyone even if the rack and batteries all fall on the floor, resulting in a total loss for the battery rack. The direct life safety threat, that is, the threat of injury, is probably low, but if the emergency generator doesn't work, building occupants may be injured attempting to evacuate the building in the dark, or the lives of hospital patients on life-support systems may be jeopardized. Gas-fired residential water heaters rarely fall and hit anyone, but they have caused many postearthquake fires due to ruptured gas lines. In short, it is important not only to view each item as a discrete object that could tip or fall and hurt someone directly, but also to consider the consequences of failure.

A word of caution is in order regarding the field survey. When looking at mechanical equipment or office machines, it is sometimes easy to confuse a leveling bolt, which merely rests on the floor, with an anchor bolt, which is securely fastened to the floor. In the case of bookshelves in an office area, there may be hardware anchoring the shelving to the wall, but unless the hardware is secured to a solid wall or directly to a stud in a partition wall that is also braced, the anchorage may be ineffective in a strong earthquake. Anchor bolts that are ¼ inch in diameter may be adequate to restrain a light file cabinet but are probably too small to effectively restrain any large piece of mechanical equipment. Thus, if any braces or anchors are visible, it is important to consider whether they will be effective for the expected shaking intensity.

Survey Forms The field survey may be performed by using the forms and checklists in Appendixes A, B, and C. Appendix A contains a blank nonstructural inventory form that can be used to record field observations. The questions in the checklist provided in Appendix B will help identify vulnerable nonstructural items and potential hazards associated with each item. The questions on the checklist are all stated in such a way that a "no" answer is indicative of a potential problem. Items with potential problems should be listed on the nonstructural inventory form. The space provided for notes may be used to identify the type of problem observed, e.g., "unanchored," "unbraced," "bolts undersized," "bolts no good, missed stud," etc. Information regarding the existing vulnerability, upgrade costs, and priority may be added to the form later, after the initial field survey is complete. Appendix page A-3 illustrates a sample nonstructural inventory form.

During the initial survey, it may be helpful to create a list containing a large number of items. The initial list may be shortened later, perhaps by dropping low-priority items. At the initial stage, it is better to be conservative and overestimate vulnerabilities than to be too optimistic.

ASSESSMENT PROCEDURES

Following the initial field survey, additional information must be added to complete the nonstructural inventory form. Estimated risk ratings for many common items are listed in Appendix C. Upgrade costs for selected items are found with the details shown in Chapter 4.

Estimating the Shaking Intensity For the purposes of this nonstructural survey, the seismic risk, or shaking intensity, for a particular geographic location may be estimated by using the seismic maps shown in Figure 7. This figure shows the areas in the United States that are likely to experience light, moderate, or severe ground shaking during a future earthquake. Some of the areas that may experience severe shaking are California; the area near New Madrid, Missouri; the islands of Hawaii, Puerto Rico, and Guam (not shown); and portions of western Washington and southern Alaska. Locations such as southern Illinois, South Carolina, and much of New England may experience moderate shaking, although most of the Continental United States east of the Rockies will likely experience light shaking.

Shaking-intensity estimates based on the seismic risk maps in Figure 7 should be adequate for items situated at or near the ground in simple, nonessential facilities. For other situations, it may be advisable to choose the next higher shaking intensity or to seek the advice of professional consultants.

Estimating the earthquake forces on a particular item in a particular building can be a difficult technical problem. In order to perform engineering calculations, an engineer may have to consider one or more of the following factors: the proximity of the building site to an active fault, the soil conditions at the site, the flexibility of the building structure, the location of the item in the building, the flexibility of the floor framing or walls in the immediate vicinity of the item, the flexibility of the item, the weight and configuration of the item, the characteristics of any connection details between the item and the structure, the expected relative displacement between two connection points in adjacent stories or across a seismic gap, the function of the item, the function of the facility. One reason the use of professional consultants for complex facilities is recommended is that the seismic risk maps in Figure 7 do not take any of these additional factors into consideration. Clearly, the complexity and detail of engineering calculations should be commensurate with the complexity and importance of the facility and the item in question.

In addition, it may be appropriate to consider more than one earthquake scenario for a particular facility, since earthquakes of different magnitudes may occur at different average time intervals. For instance, a major earthquake with severe shaking might be likely to occur about once every 1000 years at a particular site, whereas the maps in Figure 7 are weighted toward more probable events and may show only moderate shaking for the site. While some installations may have to anticipate the most severe shaking, others may find it more economical to plan for a smaller, more frequent event.

Estimating Seismic Risk The risk ratings provided in Appendix C are based on a review of damage to nonstructural components in past earthquakes and the judgement of the authors and their advisory panel. Estimates of future earthquake damage to either the structural or nonstructural components of a building are only that -- estimates -- and should be used with discretion. The approximations provided in this guide are adequate for the purpose of making an initial determination of the seismic risk of the nonstructural components of a simple facility. For a facility that is more complex, or one where the potential risk is high, more detailed analyses should be performed by an in-house engineer or professional consultant.

The seismic risks for life safety, property loss, and loss of function have been rated simply as high, moderate, or low for different levels of shaking intensity. Appendix C contains more detailed notes concerning the definitions and assumptions used in assigning risk ratings. Stated briefly: Life Safety Risk is the risk of direct injury by the item; Property Loss Risk is the risk of incurring a repair or replacement cost as a result of damage to the item; Loss of Function Risk is the risk that the item will not function as a result of the damage incurred. The estimated risk ratings shown in Appendix C assume that the item is unbraced and unanchored and are intended for buildings with ordinary occupancies, not for essential facilities. The primary purpose of this information is to assist in assigning priority ratings, described below, and to help in identifying the most critical hazards.

Estimating Upgrade Costs Upgrade cost estimates are provided with selected details in Chapter 4. These unit cost estimates can be used to produce subtotals for each category itemized on the nonstructural inventory form, and then added together to estimate the total seismic upgrade cost for the entire facility. If a number of repetitive protective measures are to be installed in a large facility, the unit cost may be lowered.

The cost estimates can only be considered rough guides, since it is not possible to account for all the specific differences in construction conditions found in buildings or to allow for the variation in contractors' costs in changing construction market conditions and different regions of the country, or the difference between in-house labor versus outside contractor costs. The cost estimates cover labor and materials only and do not include any engineering or architectural services that may be required.

More detailed cost estimates should include the impact of any disruption that the installation of upgrade devices might necessitate, and any inconvenience associated with the daily use of the devices. For example, some of the upgrade measures described can be installed only when the building is not in normal use, and a scale factor might be needed to account for increased labor rates for work to be done during nonbusiness hours. The installation of straps or other removable restrainers for movable equipment implies that users will reattach the strap each time the anchored item is moved, perhaps resulting in an increase in the cost of operations in some facilities.

Detail Type Two types of upgrade details are presented in Chapter 4 of this guide and indicated in the lists presented in Appendix C. These two types of details are designated *Do-It-Yourself* and *Engineering Required* and are described in more detail in Chapter 4. The nonstructural inventory form includes space to indicate the detail number or detail type.

Priority Rating A simplified priority rating system might be used to indicate which items are more vulnerable to earthquake damage and to indicate those items whose failure is most likely to have serious consequences. All the items could be assigned a high, medium, or low priority, or each item or type of item could be ranked in order from highest to lowest. The highest priority might be assigned to those components where all three risk ratings are high. If loss of function is not a serious concern, the highest priority might be assigned to items where the life safety risk is high and the upgrade cost is lowest, since these hazards could be reduced most cost-effectively.

The assignment of priorities may vary widely for different types of facilities, and this guide merely provides some guidelines that can be used to establish a ranking system.

Cross-References Chapter 4 contains specific damage examples and anchorage details for a number of the listed items. For those items, cross-references are provided between the examples and the checklists in Appendixes B and C.

COMPARISON OF ALTERNATIVES

Separate lists might be prepared to compare relative cost estimates for different approaches. One list could describe a complete upgrade package covering all the vulnerable items identified in the survey, while another might consist of a minimally protective and less expensive package that addresses only the most critical problems. On the other hand, separate lists might be prepared considering different levels of shaking intensity. In this way, costs can be compared for two different levels of protection. The nonstructural inventory form provided in Appendix A can easily be reproduced with the use of spreadsheet or database software to facilitate the process of estimating upgrade costs, sorting in order of priority, comparing costs for different intensity levels, and so on.

General advice on the subject of where to draw the line between completeness and quality, on the one hand, and cost, on the other, is difficult to provide. It is better to focus on the most significant problems and address them effectively than to develop an all-inclusive list that is too extensive to implement. A two-phase approach may be desirable: Draw up a short list of the most critical items and address these first. After evaluating the success of the first phase, develop a second-phase program to address less critical items further down the list. The installation of seismic upgrade details is often easier than it might first appear. The important thing is to make a start and to do the first effort well.

4 NONSTRUCTURAL EXAMPLES: EARTHQUAKE DAMAGE AND UPGRADE DETAILS

This chapter includes specific examples of selected nonstructural items. In most cases, the example includes a photograph of earthquake damage that occurred to an unanchored or inadequately anchored item paired with a drawing of suggested upgrade details that can be used to reduce the seismic vulnerability of the item. Some of these are simple, generic details that can be installed by a handyman; these details are marked *Do-It-Yourself.* Others are schematic details that need to be developed by a design professional for a particular situation and in some instances will require installation by a specialty contractor; these details are marked *Engineering Required.* Enough examples have been provided to allow for an effective initial survey of most ordinary-occupancy buildings. The end of this chapter includes installation guidelines to accompany the *Do-It-Yourself* details.

NONSTRUCTURAL EXAMPLES

Photos of earthquake damage and suggested upgrade details are presented for a variety of common nonstructural items. While these examples do not cover every case, many items not included here would be damaged and/or upgraded in a manner similar to one that is shown. For example, the detail shown for an air compressor is applicable to many pieces of mechanical or HVAC equipment that are mounted on vibration isolation springs. Similarly, the wall and floor anchorage details shown for tall shelving or file cabinets are applicable to other items, such as storage cabinets or personnel lockers. The detail shown for a fire extinguisher could also be applied to a fire hose cabinet. Many types of desktop or countertop equipment found in offices, hospitals, or laboratories could be restrained by using the suggestions for desktop computers, although special detailing may be warranted for expensive equipment. Seismic protection schemes for newly installed items are often similar to the anchorage or restraint details shown.

The examples have been divided into three categories: utility systems that are part of the building; built-in architectural components; and furniture and contents, which are typically the property of the occupants or tenants rather than a permanent part of the building. The examples are listed in Figure 8.

Earthquake Damage The photographs presented here cover a variety of situations and have been taken over a 25-year period. Photographs from the 1971 San Fernando earthquake generally show damage to items that were not restrained, while some of the more recent photographs depict damage to items that appeared to be braced or anchored but whose bracing and anchoring details were apparently inadequate to resist the severity of the shaking.

Upgrade Details The examples presented in this chapter show representative details for protecting common items from earthquake damage. The two different types of details are described below.

- ***Do-It-Yourself*** These are simple, generic details for typical nonstructural items. Enough information is provided that a handyman can install them using common tools and readily available materials. Most of the examples for furniture and contents include simple details that are marked *Do-It-Yourself.* These details are applicable for many common items found in the home, office, or small business. At the end of this chapter are guidelines on the proper use and installation of these details.

- ***Engineering Required*** These are schematic details showing common solutions for the items in question. These sketches do not contain sufficient information for installation; they are provided primarily as an illustration of the required scope of work. The designation *Engineering Required* has been used for items where the self-help approach is most likely to be ineffective. The recommendation of this guide is that design professionals be retained to evaluate the vulnerability of these items and design appropriate anchorage or restraint details, particularly where safety is an issue. As stated earlier, this recommendation may apply to all items in specialized facilities such as hospitals and emergency operations or communications centers, where interruption or loss of function is unacceptable.

Recent experience has shown many instances where fire sprinkler and other water lines, HVAC equipment, emergency generators, water tanks, ceilings, parapets, glazing, and so on were damaged when subjected to severe shaking and failed to perform as expected. The lesson learned from this experience is that the protection of many items, particularly building utilities and architectural components in facilities that are expected to remain functional during and after a major earthquake, is a complex undertaking that should be addressed by engineers and architects with specific expertise in this area. As a result, most building utility systems and architectural components have been given the designation *Engineering Required.* Several of the items listed under furniture and contents have also been given this designation.

The upgrade details for these items are schematic only and are presented here with estimated installation costs, primarily for planning and/or budgeting purposes. Facilities personnel can use this information in conjunction with the survey forms and checklists included in this guide to estimate the scope of the work needed and obtain initial cost estimates for planning purposes.

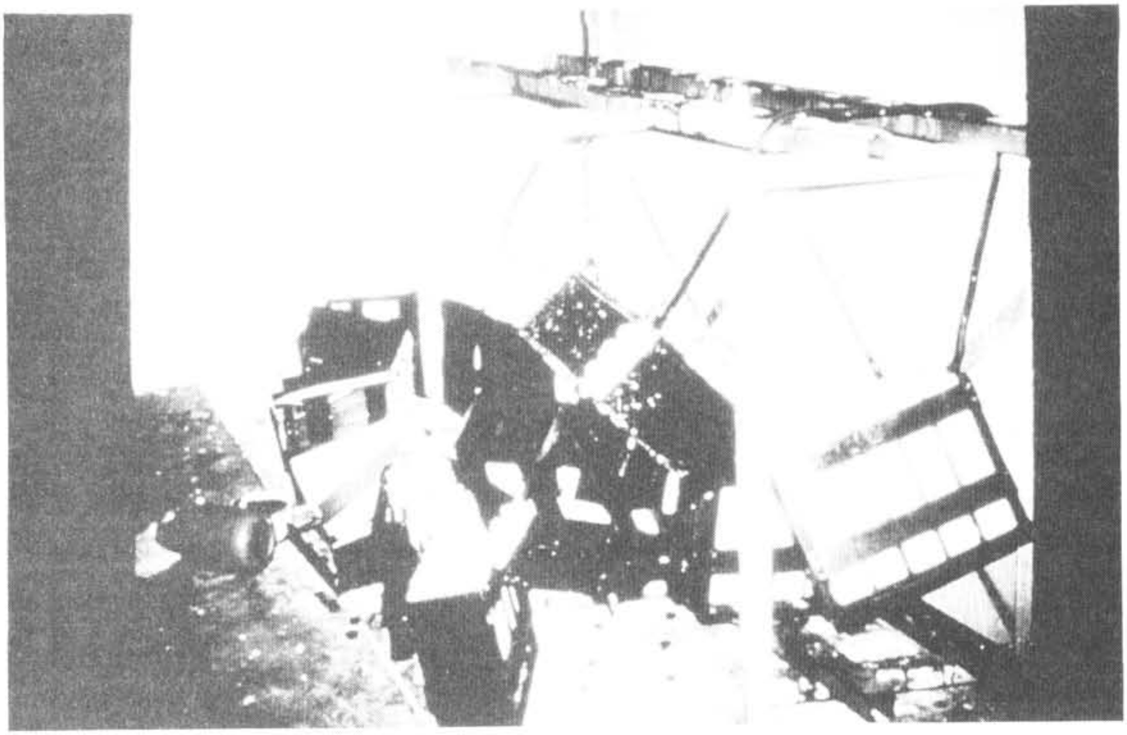
Upgrade Cost The cost estimates provided with the details in this chapter may be used as a rough guide for planning or budgeting purposes. The values are intended to cover the costs of materials and labor. They do not include any allowance for architectural or engineering fees, permits, special inspection, etc. These estimated costs represent a professional opinion based on information available at the time of publication in 1994. Actual construction costs may vary significantly, depending on the timing of construction, changes in conditions, the availability of materials, regional cost variations, and other factors.

Figure 8 : Nonstructural Examples

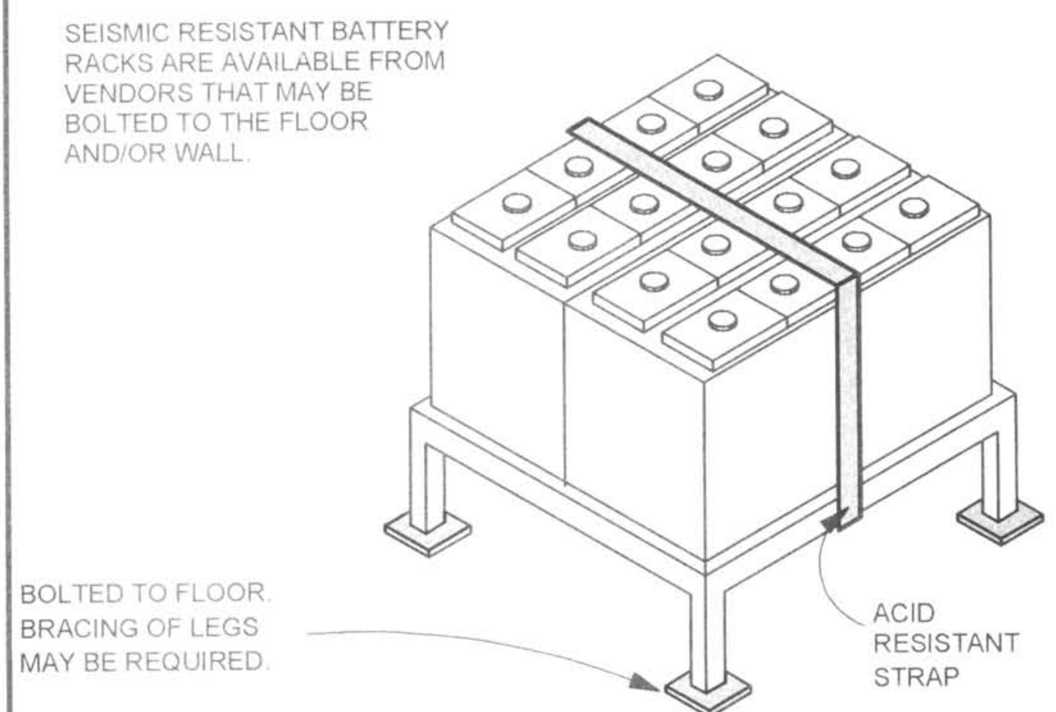
Detail	Nonstructural Item	Type of Detail	Page
U	**BUILDING UTILITY SYSTEMS**		
U2	Batteries and Battery Rack	Engineering Required	30
U3	Diesel Fuel Tank	Engineering Required	31
U8	Electrical Bus Ducts and Primary Cable System	Engineering Required	32
U10	Fire Extinguisher and Cabinet	Do-It-Yourself	33
U15	Propane Tank	Engineering Required	34
U19a	Water Heater: Corner Installation	Do-It-Yourself	35
U19b	Water Heater: Wall Installation	Do-It-Yourself	36
U21	Piping	Engineering Required	37
U29	Chiller	Engineering Required	38
U32	Air Compressor (or other HVAC Equipment)	Engineering Required	40
U35	Suspended Space Heater	Engineering Required	41
U36	HVAC Distribution Ducts	Engineering Required	42
U37	Air Diffuser	Do-It-Yourself	43
U38	Residential Chimney	Engineering Required	44
A	**ARCHITECTURAL ELEMENTS**		
A2a	Built-In Partial-Height Partitions	Engineering Required	45
A2b	Built-In Full-Height Partitions	Engineering Required	46
A3	Suspended T-Bar Ceilings	Engineering Required	47
A5a	Suspended Light Fixtures	Do-It-Yourself	48
A5b	Pendant Light Fixtures	Do-It-Yourself	49
A9	Stairways	Engineering Required	50
A12	Windows	Engineering Required	51
A15a	Unreinforced Brick Parapets	Engineering Required	52
A15b	Veneer	Engineering Required	53
A16	Freestanding Walls or Fences	Engineering Required	54
A21	Exterior Signs	Engineering Required	55

BATTERIES AND BATTERY RACK

ENGINEERING REQUIRED



Earthquake Damage: 1971, San Fernando, California
Photo Credit: John F. Meehan



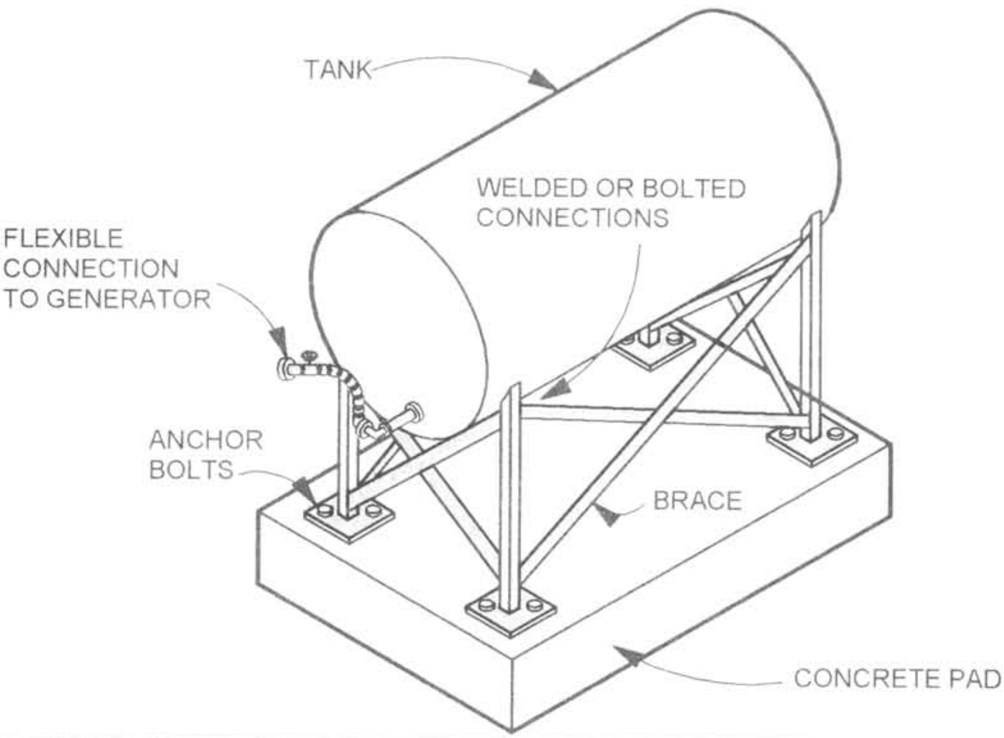
Schematic Upgrade Detail U2
Approximate Cost: $200

U2

DIESEL FUEL TANK

ENGINEERING REQUIRED

Unbraced Day Tank, Hospital, Puerto Rico
Photo Credit: Wiss, Janney, Elstner Associates, Inc.



Schematic Upgrade Detail U3
Approximate Cost: $500 - $1000

U3

ELECTRICAL BUS DUCTS AND PRIMARY CABLE SYSTEM

ENGINEERING REQUIRED

Unbraced Overhead Conduit and Pipes
Photo Credit: Wiss, Janney, Elstner Associates, Inc.

- ELECTRICAL BUS DUCTS AND CABLE LINES SHOULD BE ABLE TO ACCOMMODATE MOVEMENT AT LOCATIONS WHERE THEY CROSS SEISMIC JOINTS BETWEEN BUILDING WINGS. PROVIDE FLEXIBLE CONNECTIONS AT SEISMIC JOINTS.

- PROVIDE FLEXIBLE CONNECTIONS AT LOCATIONS WHERE DUCTS OR CABLE ARE ATTACHED TO RIGIDLY MOUNTED EQUIPMENT.

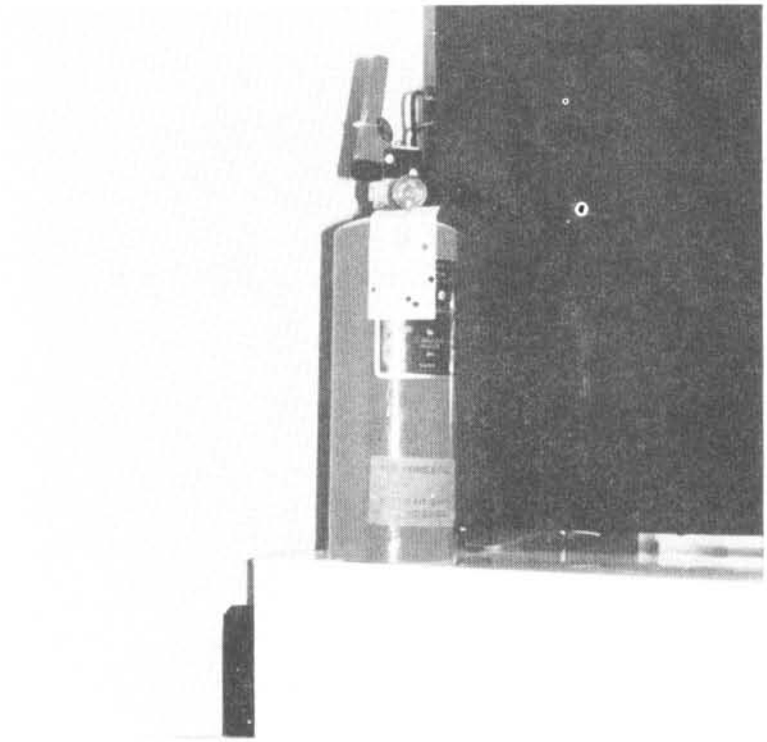
- DUCTS AND CABLE LINES SHOULD HAVE BOTH TRANSVERSE AND LONGITUDINAL SEISMIC BRACING SIMILAR TO THAT RECOMMENDED FOR PIPING. SEE PIPE BRACING DETAIL U21.

Schematic Upgrade Detail U8
Approximate Cost: $200 - $500 per brace

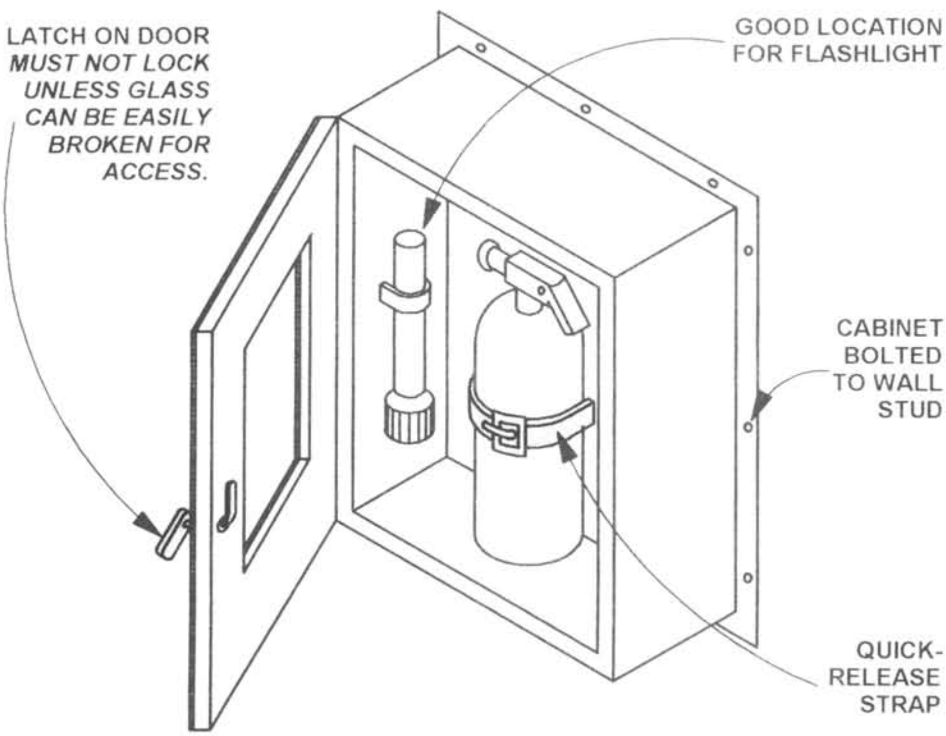
U8

FIRE EXTINGUISHER AND CABINET

DO-IT-YOURSELF



Unrestrained Extinguisher
Photo Credit: Wiss, Janney, Elstner Associates, Inc.

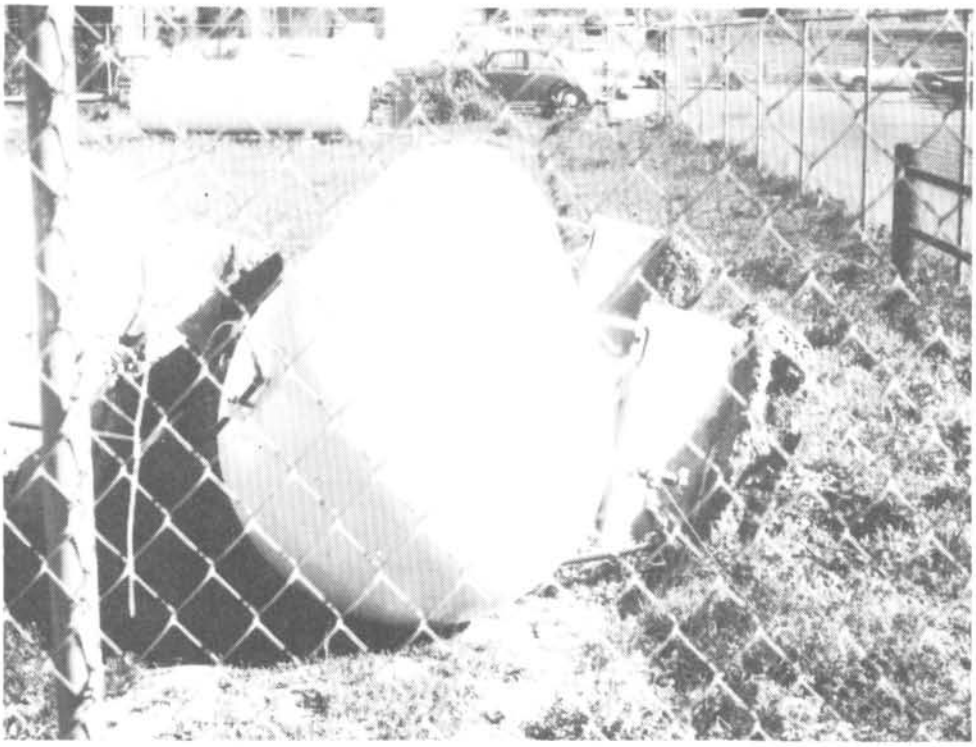


Upgrade Detail U10
Approximate Cost: $300

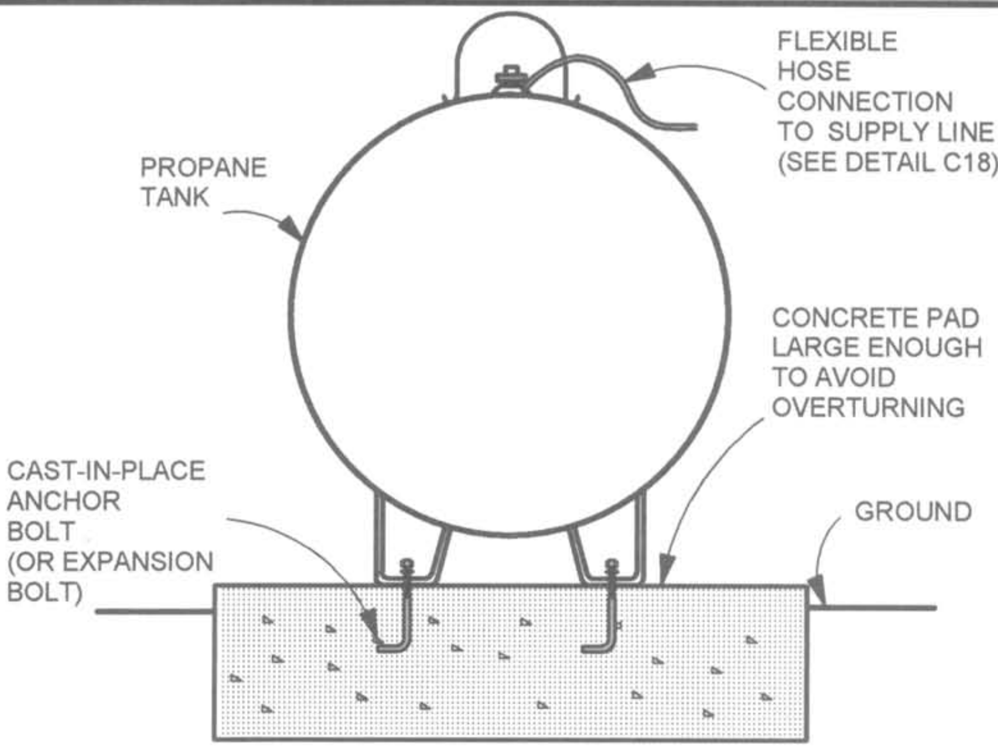
U10

PROPANE TANK

ENGINEERING REQUIRED



Earthquake Damage: 1971, San Fernando, California
Photo Credit: Scientific Service, Inc.

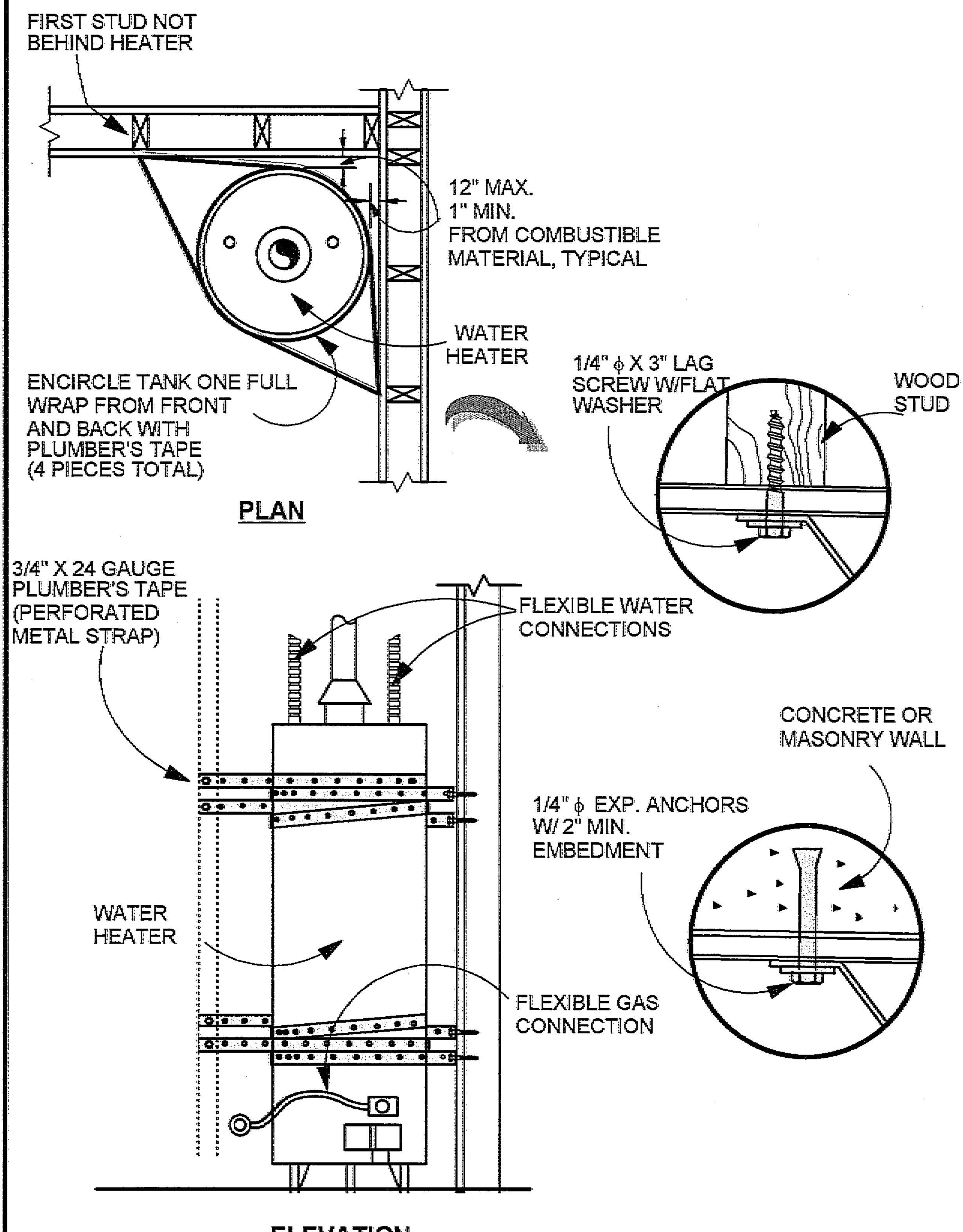


Schematic Upgrade Detail U15
Approximate Cost: $900

U15

WATER HEATER: CORNER INSTALLATION

DO-IT-YOURSELF

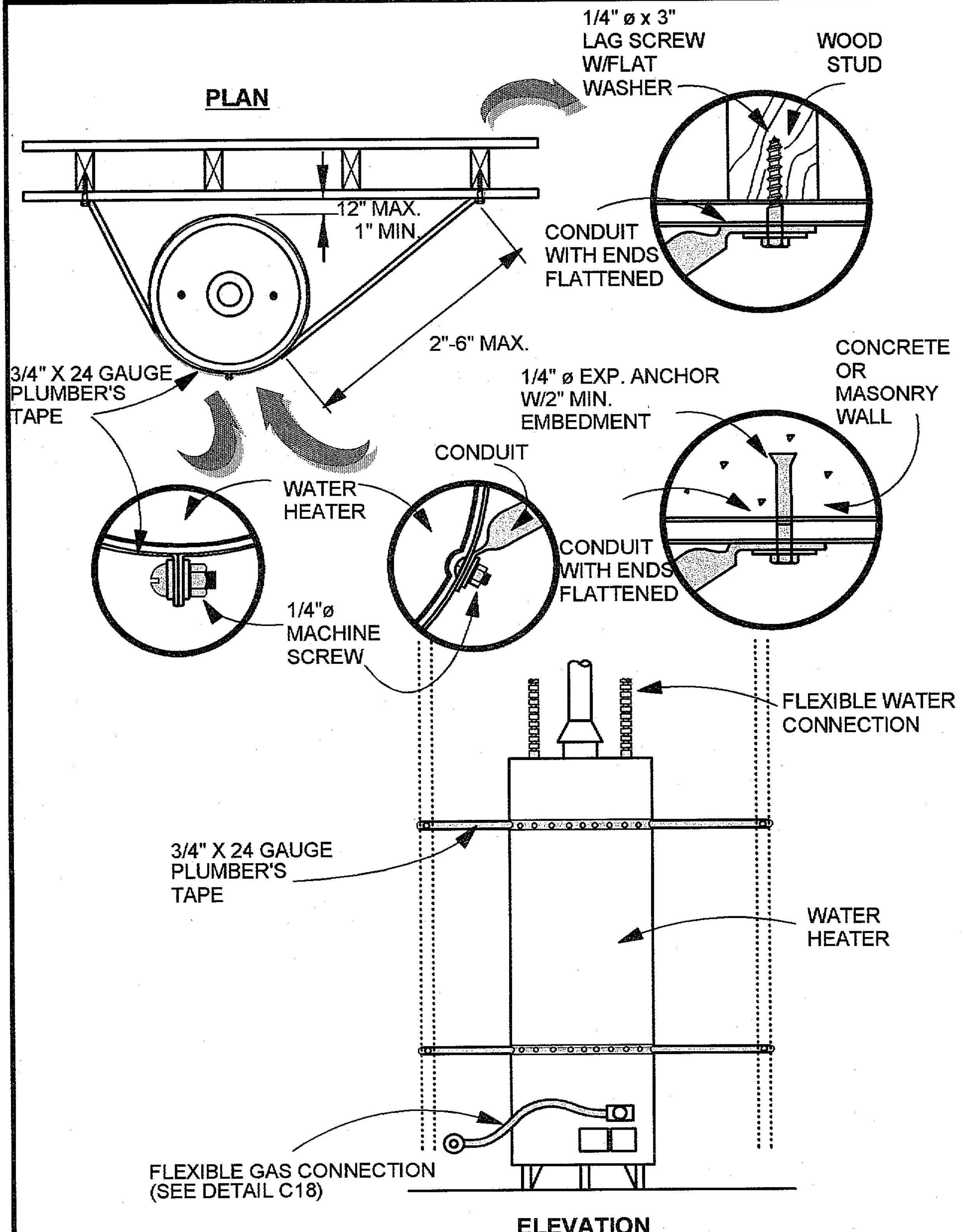


Upgrade Detail U19a
Approximate Cost: $80

U19a

WATER HEATER: WALL INSTALLATION

DO-IT-YOURSELF

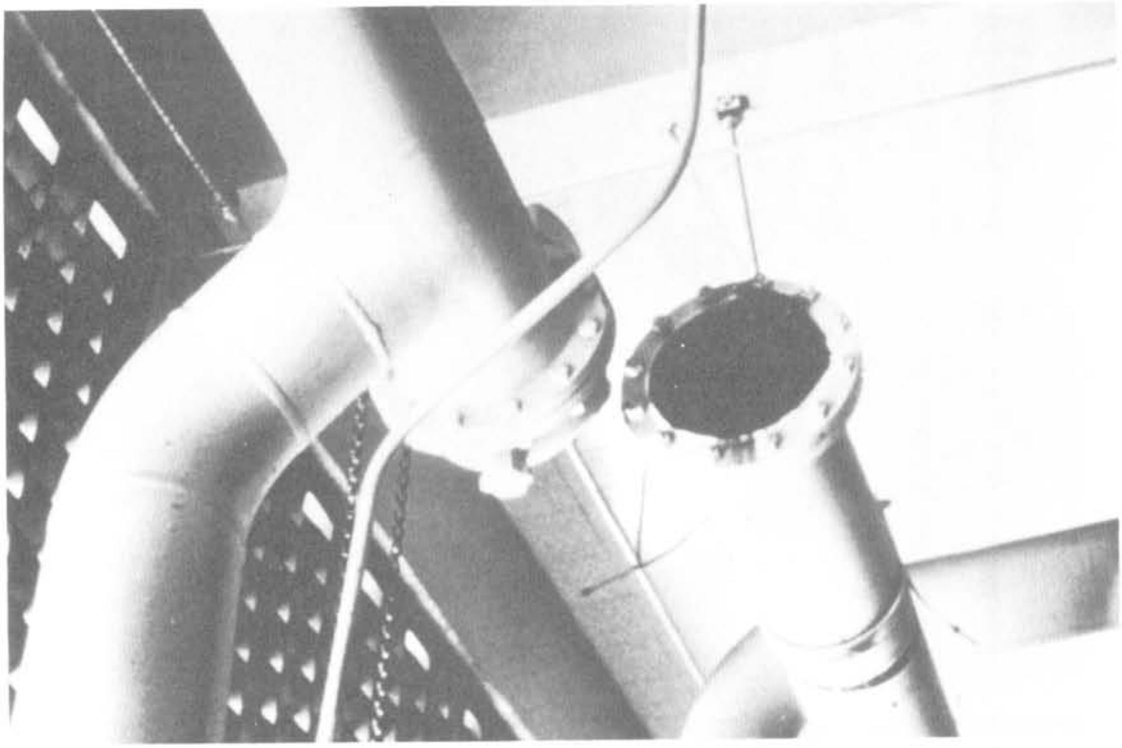


Upgrade Detail U19b
Approximate Cost: $200

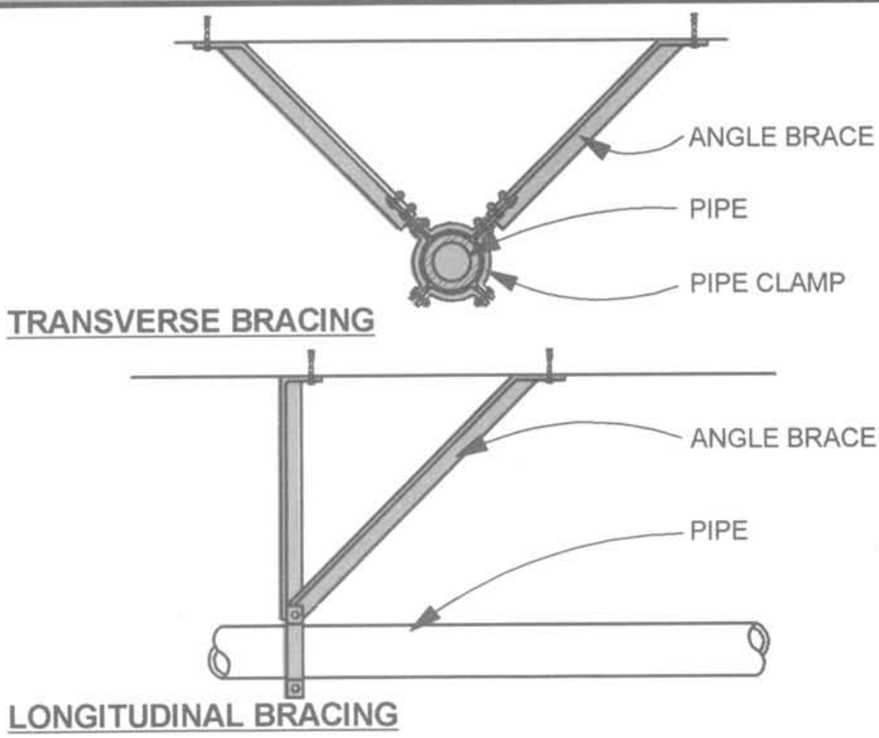
U19b

PIPING

ENGINEERING REQUIRED



Earthquake Damage: 1971, San Fernando, California
Photo Credit: John F. Meehan

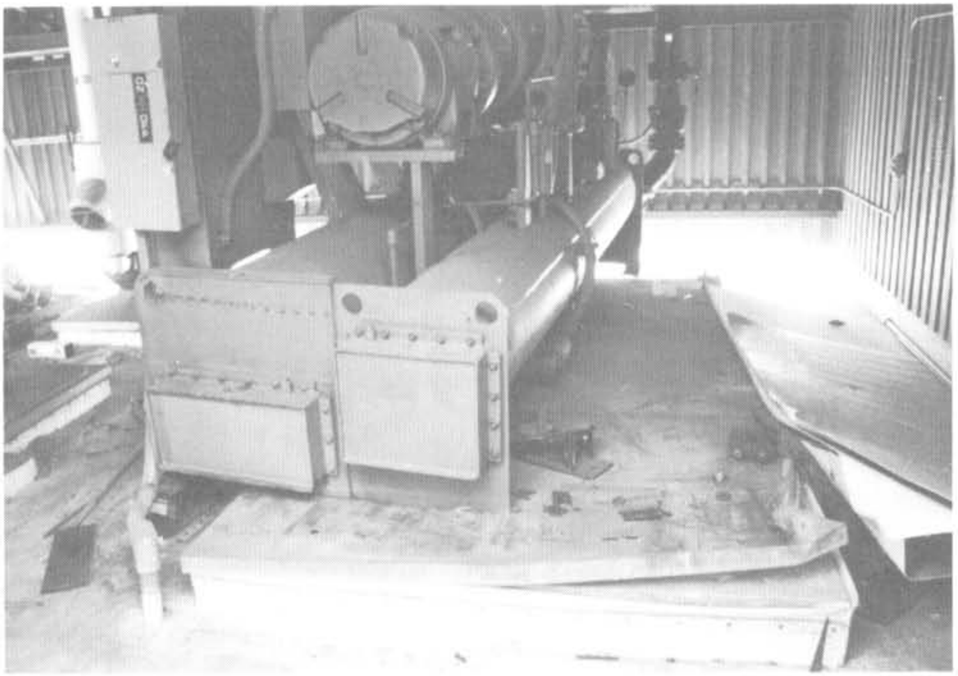


Schematic Upgrade Detail U21
Approximate Cost: $200 - $500 per brace

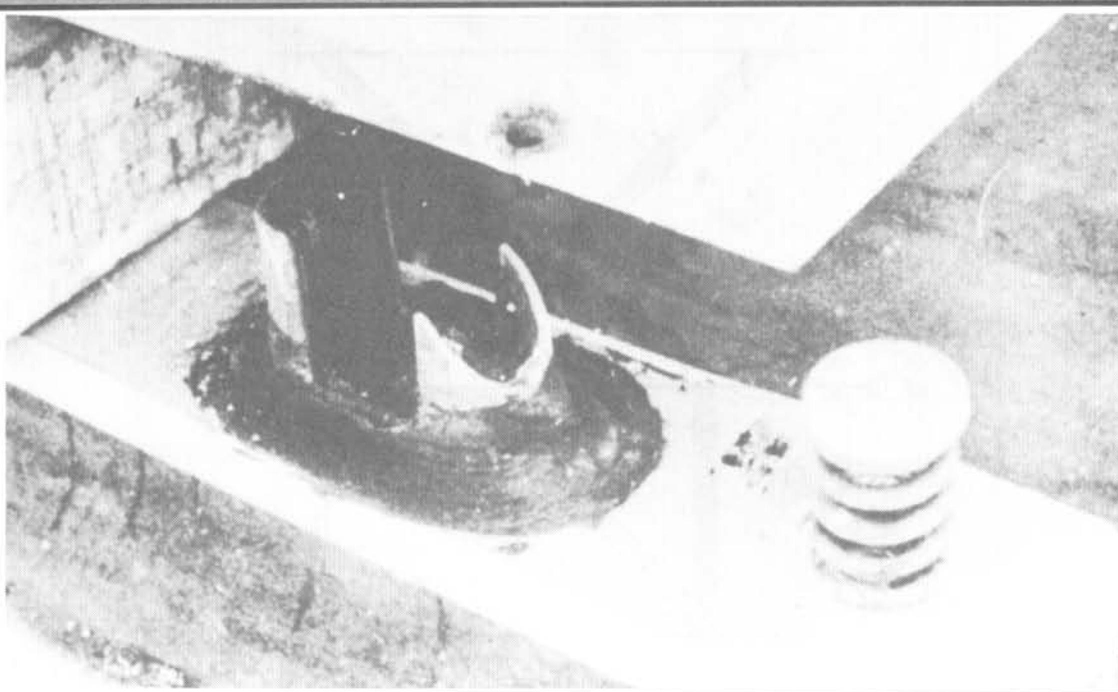
U21

CHILLER

ENGINEERING REQUIRED



Failed chiller mounts due to insufficient uplift resistance.
Earthquake Damage: 1994, Northridge, California
Photo Credit: Wiss, Janney, Elstner Associates, Inc.

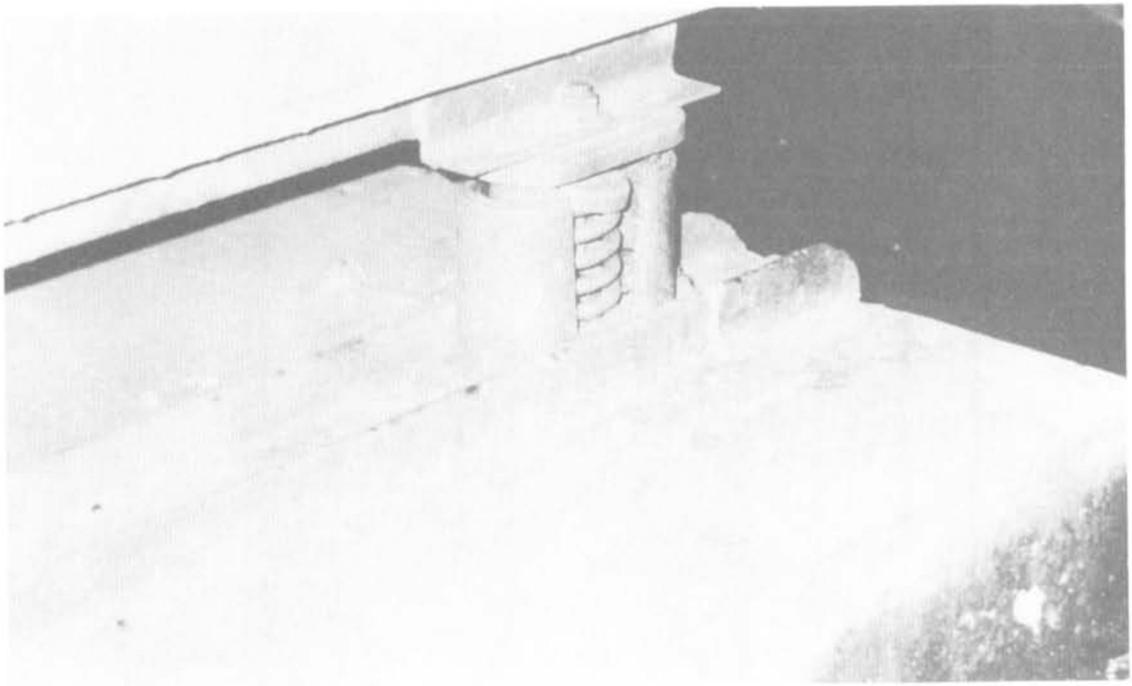


Failed chiller due mount due to insufficient shear resistance.
Earthquake Damage: 1980, Livermore, California
Photo Credit: William T. Holmes
Schematic Upgrade Detail: See Detail U32, Air Compressor

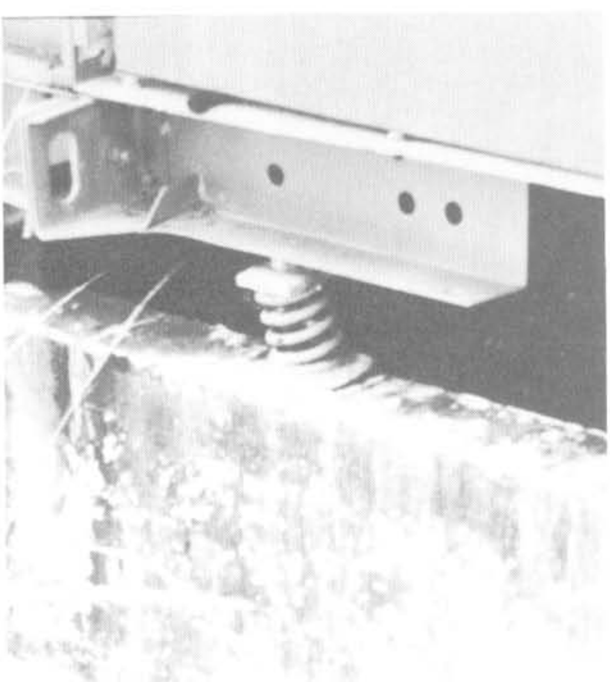
U29a

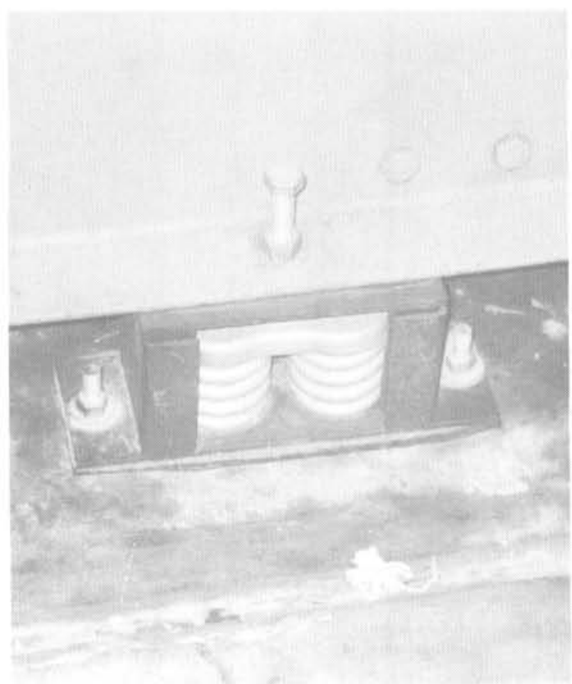
CHILLER

ENGINEERING REQUIRED



Chiller mount with no uplift resistance and insufficient shear resistance.
Photo Credit: Wiss, Janney, Elstner Associates, Inc.





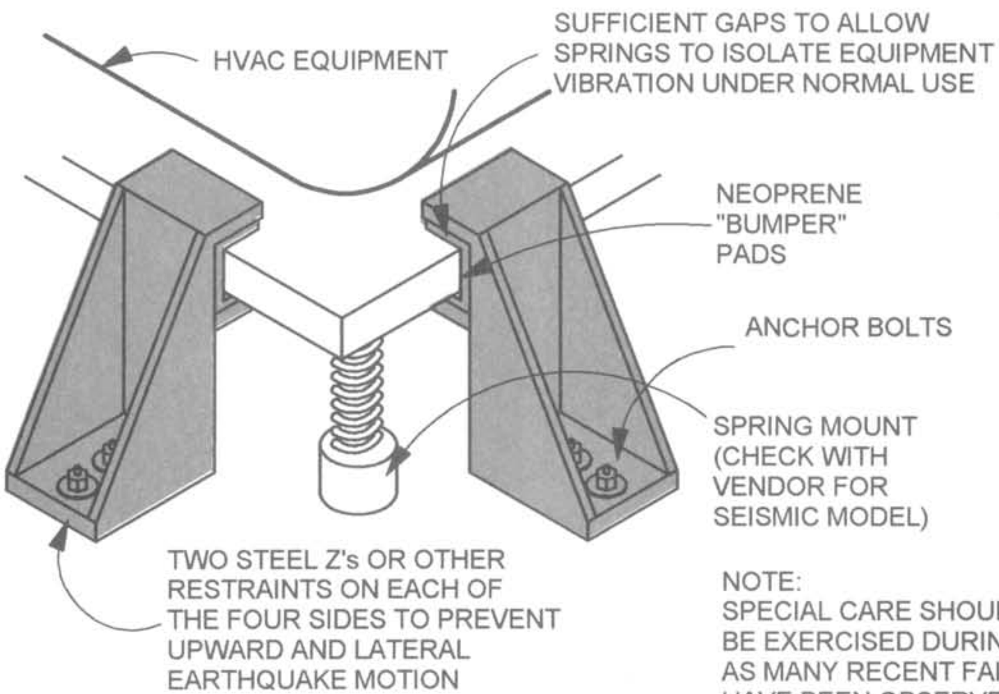
Chiller mount with no uplift resistance and insufficient or no shear resistance.
Photo Credit: Wiss, Janney, Elstner Associates, Inc.
Schematic Upgrade Detail: See Detail U32, Air Compressor

U29b

AIR COMPRESSOR (OR OTHER HVAC EQUIPMENT)

ENGINEERING REQUIRED

Earthquake Damage: 1994, Northridge, California
Photo Credit: Wiss, Janney, Elstner Associates, Inc.



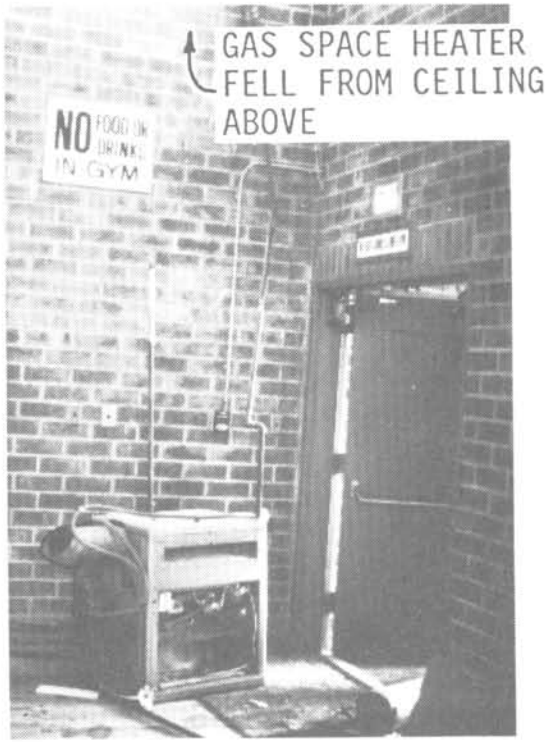
NOTE:
SPECIAL CARE SHOULD BE EXERCISED DURING DESIGN AS MANY RECENT FAILURES HAVE BEEN OBSERVED.

Schematic Upgrade Detail U32
Approximate Cost: Depends on individual case; $300 - $1,200

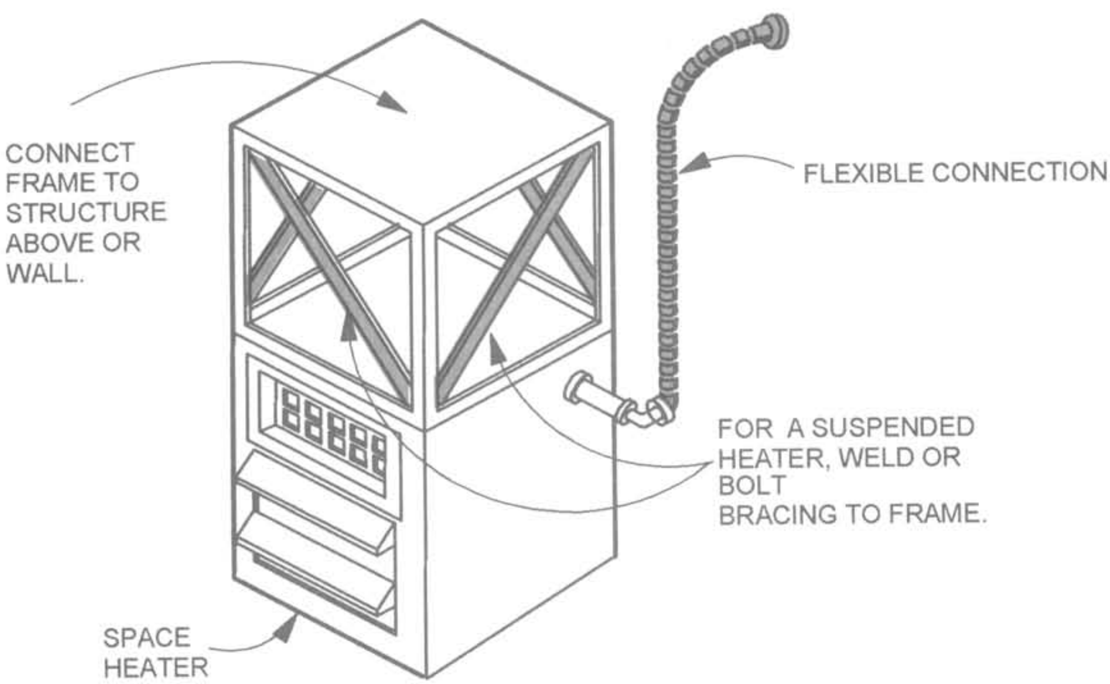
U32

SUSPENDED SPACE HEATER

ENGINEERING REQUIRED



Earthquake Damage: 1971, San Fernando, California
Photo Credit: C. Wilton, Scientific Service, Inc.



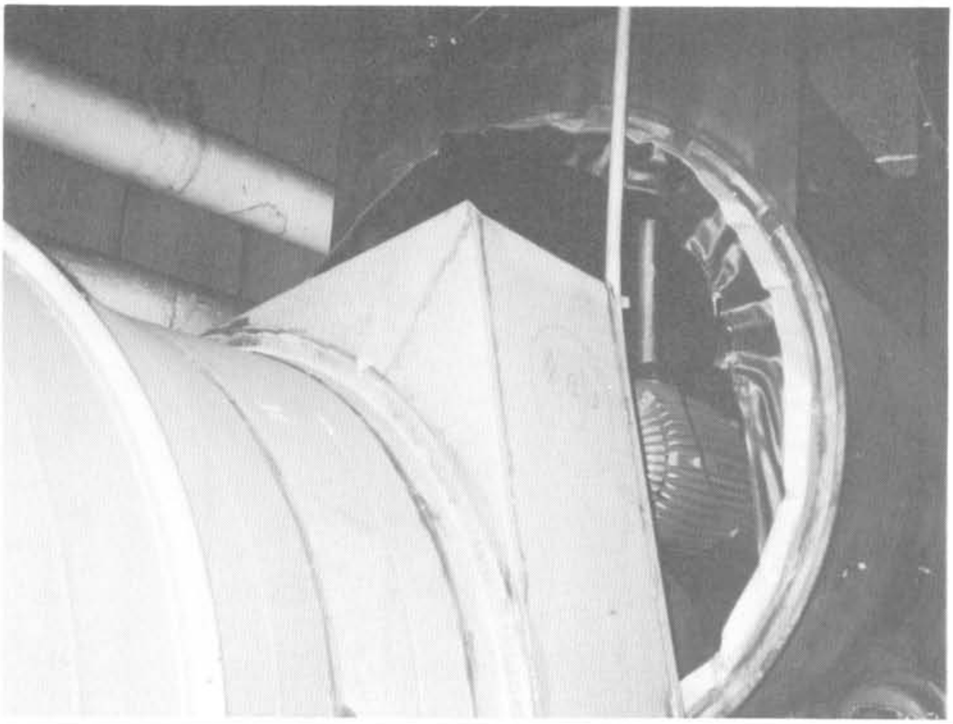
Schematic Upgrade Detail U35

Approximate Cost: $200

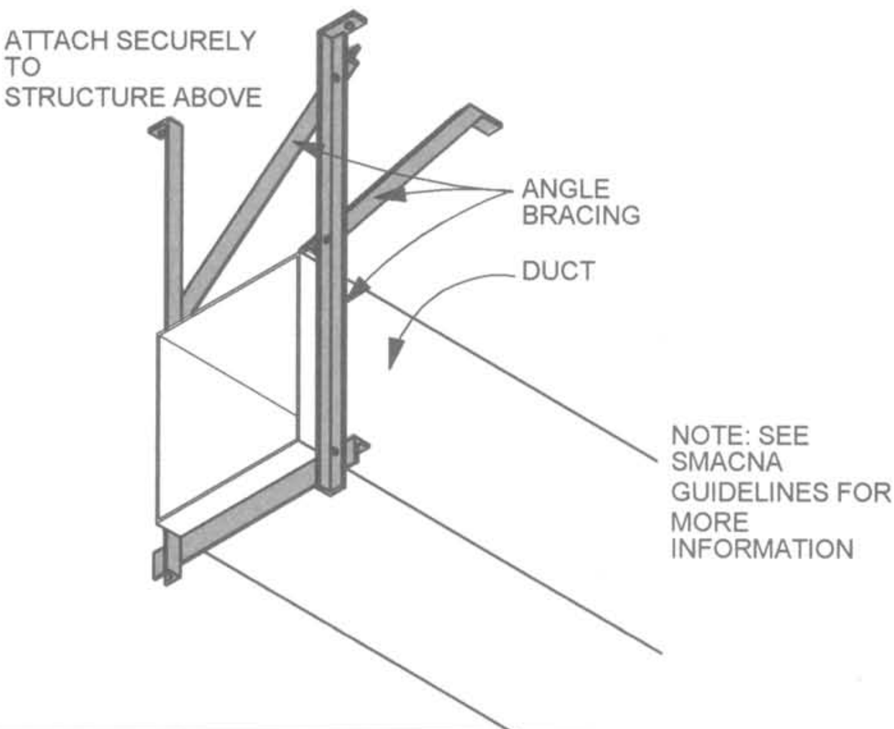
U35

HVAC DISTRIBUTION DUCTS

ENGINEERING REQUIRED



Sheet metal duct separated from fan unit.
Earthquake Damage: 1994, Northridge, California
Photo Credit: Wiss, Janney, Elstner Associates, Inc.



Schematic Upgrade Detail U36

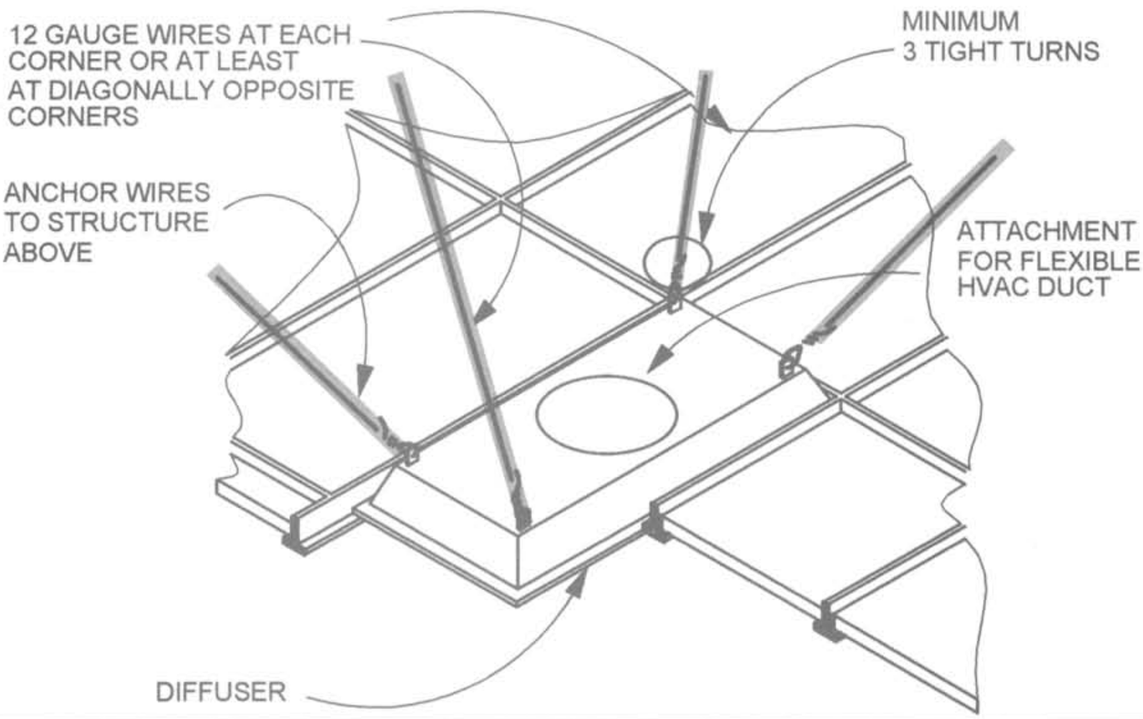
Approximate Cost: $200 - $500 per support

U36

AIR DIFFUSER

DO-IT-YOURSELF

Air diffusers fell to the floor.
Earthquake Damage: 1994, Northridge, California
Photo Credit: Wiss, Janney, Elstner Associates, Inc



Upgrade Detail U37

Approximate Cost: $50

U37