

# **Earthquake Preparedness and Mitigation Guidance for Oregon State Agency Offices and Warehouses**

Prepared by Oregon Emergency Management with the assistance of the Department of Corrections, the Liquor Control Commission, State Lottery, Department of Administrative Services, Department of Transportation, Building Codes Division, Archives Division, Parks and Recreation Department, and the Oregon Occupational Safety and Health Administration

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## **A. Introduction**

Oregon is considered a high-risk state for earthquakes. Oregon has experienced several earthquakes over magnitude 5 in the last 130 years (figure 1). The last earthquakes, that caused significant damage in Oregon, were in 1993: the 5.6 Scotts Mills and the 5.9/6.0 Klamath Falls. Damage can be both structural and non-structural. Structural damage includes building collapse and a house sliding off its foundation. Non-structural damage includes damage to office equipment such as computers and file cabinets, chimneys, parapets, light fixtures, storage tanks, etc. Often the most damage and casualties are the result of the movement of non-structural objects during the earthquake (figure 2). Therefore, it is important not only to prepare employees on what to do during an earthquake, but to secure items before the earthquake so they don't move.

This document focuses on 1) what to do during an earthquake in office and warehouse settings and 2) what to do before an earthquake that will reduce casualties and non-structural damage during the earthquake. The report is for guidance only and recommendations to create safe work environments are not requirements, except those building code and safety requirements that are specifically identified in the document.

## **B. During the earthquake**

### ***1. Drop, cover and hold***

When the earthquake shaking starts, people should drop, cover, and hold on, preferably under a table, desk, or something sturdy. If this is not an option move away from windows and objects that could fall or move to a safe interior wall, crouch, and cover your head with your arms. In a warehouse with steel racks that are bolted to the floor, get under the lowest and most stable shelf. In an office with systems furniture, drop under the work surface nearest the file cabinet. The work surface is attached to the cubicle wall and not actually held up by the file cabinet underneath (Figure 3). Dropping underneath the work surface near the file cabinet would offer the best protection in case the work surface does separate. The drop, cover, and hold drill is required for office workers in state and local government agencies (OAR 104-020-000, Appendix A).

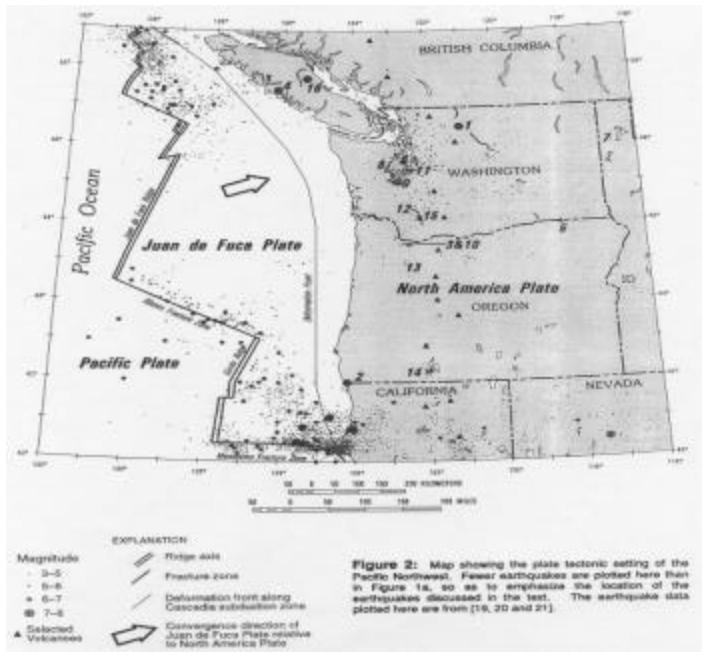


Figure 1. Earthquakes in Oregon between 1872 and 1994.

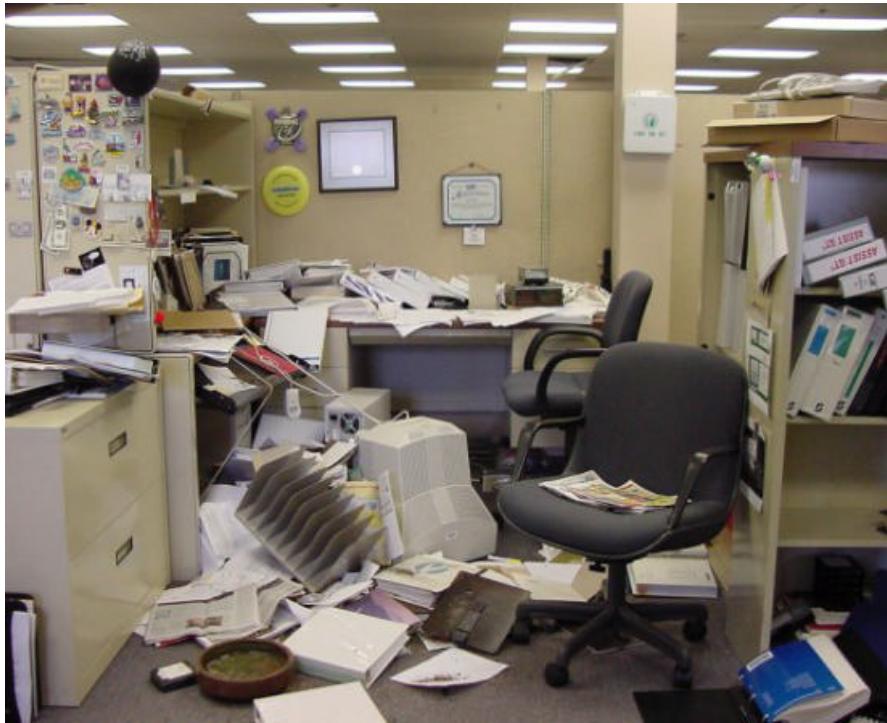


Figure 2. Office damage in Olympia during the 2001 Nisqually Earthquake.



Figure 3. Work surface with file cabinet underneath.

## ***2. Evacuation***

Evacuation may or may not be necessary once the shaking stops. An earthquake evacuation checklist, that assists with making evacuation decisions, is found in Appendix B.

## **C. Before the earthquake**

### ***1. Office mitigation***

Three systems furniture manufacturers, that supply state agencies (Hayworth, Herman Miller, and Steelcase), contend that their furniture performs well during earthquakes. There is also engineering evidence that systems furniture performs well during simulated earthquake shaking.

Although Herman Miller does not consider their products earthquake proof, their testing process guarantees a high degree of structural integrity. Properly installed Herman Miller Systems furniture had minimal or no product failure or damage based on evaluation of product performance during earthquakes by Herman Miller engineering/technical staff, customers, dealers, and sales personnel (Herman Miller, 1994). For example, during the 1989 Loma Prieta Earthquake, systems furniture installed at Apple Computer was still standing. Those who dove under a work surface were protected from falling light fixtures, ceilings, and unsecured objects. Herman Miller furniture also performed well during the 1994 Northridge earthquake. However, several wall-starts (fasteners) pulled away from the wall. The failure was to the wall or wall

fastener not to the furniture itself. The wall/fastener combinations appeared to be within guidelines, but Herman Miller reconsidered recommendations for attaching these products to walls. They now recommend additional fasteners and/or stronger fasteners than the expandable anchors typically used. For example, the C0483 fastener used by Milcare is one recommended fastener that has greater holding power than typical “star” or “toggler” hollow wall fasteners. On the other hand it is possible that wall-starts pulling away from the wall is actually a “preferred” failure by acting as a “fuse” to relieve stress on the system. This may prevent catastrophic system failures and/or severe product damage that may result from anchoring the product securely to the wall.

Herman Miller, Inc. maintains that the following areas are critical to insure adequate product performance during an earthquake:

*“Panel and partial-height wall support.* It is important to follow the guidelines to assure runs are supported at the appropriate interval and with the proper depth of support panel. In general, the support must be at least as deep as the deepest components to be hung on the panel. Wall hung lateral files must always have support panels that are at least 24” deep. Panels may require support returns on both sides of the panel, if both sides are to be loaded. Improperly supported panel may tip over in an earthquake

*Panel and partial-height wall run length.* The maximum distance between support panels is very important. In most cases, the maximum length between supports is 8 or 10’, depending on the panel type and loading. Distance between supports must never exceed 12’ and then only in runs without load-bearing components. Excessive or improper panel run length may cause extreme panel lean, damage, or tip over in an earthquake.

*Panel and partial-height wall loading.* Care should be taken not to exceed either the amount of load-bearing components that are hung on a system or the load capacity of individual components. Wherever possible, balance the load on both sides of the panel as long as proper support can be maintained. Overloading the system and/or individual components can cause system and/or component damage or system tip-over.

*Fasteners and hardware, etc.* Assure all fasteners are tight, glides are level and dislodgement devices are engaged and functioning. The use of work surface brackets, ganging plates and work surface support panels will help stabilize and strengthen panel systems. Improperly assembled products may disengage, tip over and/or sustain damage in an earthquake.

*Wall strips and wall starts (fasteners).* Wall construction and fasteners must meet minimum recommendations (typically 5/8” minimum drywall, 20 ga. Minimum steel or 2 by 4” wood studs, 24” on center maximum). Fasteners should be appropriate depending on whether attaching to the stud or to the wall between studs. Proper wall/fastener specifications and attachment will minimize product damage, wall damage and /or attachment from the wall

*Free standing lateral files.* Always have appropriate counterweights, either gang back-to-back or anchor to wall or floor. Unsecured or improperly weighted files may tip over and be damaged.”

Haworth also takes earthquakes into consideration when developing systems furniture. They accomplish this through layout restrictions and additional anchorage of the panels, lateral and vertical files storage cabinets and bookcases. They found that unanchored clusters of furniture, that were designed and laid out correctly, stayed together and just floated around. Furniture that was anchored to the floor performed well. Systems furniture manufacturers offer clips that keep the work surface from disconnecting from the cubicle wall, as well as fasteners that attach the walls to the floor (Appendix C).

In Seattle, Steelcase systems furniture performed well during the 2001 Nisqually Earthquake. The bolts all held and no repairs or improvements were necessary. The panel-mounted items in their systems furniture (storage bins, shelves, work surfaces) always come with a built-in, steel safety catch, which engages into the steel-slotted channel in the panel. The safety catches must be fully engaged to allow the maximum amount of safety during an earthquake. The panels also have a steel-welded frame that provides strong support for the panel-mounted items. According to Steelcase, their furniture meets strict California earthquake codes.

Three shake table tests of systems furniture were conducted in Canada. One study tested an L-shaped, freestanding modular office furniture system (60” x 72” in plan view) manufactured by Artmet, a western Canadian company (Filiatrault, 1991). The unit maintained its structural integrity during the shaking. Another test was on two commercially available single unit office workstations (Cheung, et. al., 1997). Effectiveness of fasteners on restraining office equipment such as computers and monitors were also investigated. Both workstations suffered no significant damage during the tests. However in the fifth earthquake (highest shaking), significant motion in the north-south direction was observed, which resulted in the strapped monitor falling off the desktop and minor separation of walls at the southwest edge of the workstation. Finally, Horyna, et al, 1998 conducted a test on systems furniture and contents. The systems furniture performed well, except for partial wall separation after one test. All secured objects (e.g. desktop computers) did not fall. It is assumed that the systems furniture was installed using manufacturers specifications, however the constructions and installation specifications for the Canadian furniture may or may not be different than the U.S manufactured systems furniture installed in Oregon state agency offices. Also there was no mention if the workstations were anchored to the shake table floor. However, during one shake table test the cubicle moved a few inches laterally during the test but did not fail, indicating that the cubicle had not been fastened to the shake table. Also note that only one cubicle was tested. In most offices there is a bank or farm of cubicles in which several cubicles are connected to one another.

A FEMA report (FEMA, 2001) on damage to the Transportation Building during the 2001 Nisqually earthquake in Washington reported no failure of systems furniture, although many unsecured file cabinets, partition walls, and computers did fall.

The contents of the office, whether the office has systems furniture or other designs, can also be secured. Velcro, quake mats, quake putty, and straps can be used for computers, other desktop equipment, and other potential moving objects in the office. Heavy objects can be moved from higher to lower shelves. If there are other office designs, bookshelves and file cabinets can be moved to other locations, so if they did fall the risk of injury is reduced. These fasteners are inexpensive and easy to install. Light fixtures and framed pictures can also be secured. Bookshelves and file cabinets can be bolted to walls. They could also be attached to each other creating a broad and stable base. This work would probably require the services of an experienced person. Another option is to move unsecured bookshelves and file cabinets to safer locations in the building as well as away from established evacuation routes.

Recommendations:

1. Language in the building codes addresses non-structural components (Appendix D). While furniture has no design requirements, it does need to be anchored properly. The manufacturer's specifications should be used for anchoring of furniture. Safety clips and wall/floor fasteners are available from the manufacturers. Safety clips, installed where the work surface is attached to the cubicle wall, are standard for systems furniture in Oregon state offices. It is recommended that safety clips be installed in all new systems furniture and added to all existing furniture if missing. Although securing systems furniture to the floor and wall is an option, there does not appear to be any evidence that systems furniture is unsafe during an earthquake if not secured to the floor or wall. In addition, there are potential problems associated with fastening to floors and walls. Systems furniture is portable. If reconfigured often, the life of the carpet below the furniture could decrease and aesthetics diminish: a problem for owners of leased facilities. If attached to the wall the furniture could be pulled from the wall if not attached properly. If systems furniture is moved periodically, the subsequent holes in the walls will require repair. Nevertheless, whatever fastener is used for systems furniture, the manufacturer's specifications should be followed, trained personnel should do the work, and the facilities manager should be contacted for prior approval.
2. A non-structural mitigation evaluation should be conducted (Appendix E)
3. Office contents should be secured and heavy objects moved from higher to lower shelves or to other less hazardous locations.
4. When designing workspaces take into consideration evacuation routes and what is placed along them. If unsecured bookcases or file cabinets are along identified evacuation routes move them to a safer location.
5. Non-structural mitigation should be added to new office construction budgets.

## **2. Warehouse mitigation**

Warehouse racks are required by code to be bolted to the floor (Figure 4, Appendix D). Free standing and bolted racks could be further secured with horizontal braces (figure 5). The aisles between racks with unsecured boxes and pallets on the shelves can be dangerous places during an earthquake (Figure 6).

If the lower shelf has been secured, the space below the shelf would be a safe place provided the racks are properly bolted to the floor. If space is at a premium, the shelf could be lowered to maximize storage space and still be large enough for a person to get under. In the section of the warehouse that is open with no racks, safe tables could be placed at convenient locations.

Following the 1994 Northridge earthquake, a major home improvement center suffered much damage in the form of collapsed racks and fallen shelf contents. After the earthquake, measures were taken to secure racks and their contents. The racks were bolted to the cement floor. They installed two levels of beams instead of one, which created less open space but more stability. They placed row spacers between racks to stabilize the racks. They used heavy-duty ( $4\frac{1}{2}$ ") doubler uprights (two columns welded together) for heavy loads and heavy-duty beams (5") for heavy palletized loads. Proper locking mechanism for beams include rifle bolt-action load locks and spring clips (Figure 7). They recommend load locks, because spring clips could disengage easily. If spring clips are used the beams should be bolted into the upright and the clips should be flush with the beam. Extension connections need to be bolted with at least four bolts and nuts. Removable barriers to movement of materials on shelves were installed, for example, removable vertical bars were installed to prevent lumber from falling into the aisles during an earthquake or when a forklift accidentally hit the rack. Boxes were shrink-wrapped on pallets. Thus, they were more likely to remain intact and on the shelf than if they were stacked without shrink-wrap.

At the Oregon Liquor Control Commission warehouse, shrink-wrapped or banded boxes five layers high were on pallets stacked three high on the floor, but were not placed in racks (figure 8). Although shrink-wrapped, the potential for tipping and falling is greater, because they are not in racks. Racks also limit the height that pallets can be stacked one on top of another.

Netting and wire or netted gates, that could easily open, are also available. The Oregon State Lottery placed netting on racks to prevent rack contents from falling on workers sitting at desks below (figure 9). The netting covers the sides and not the open working area of the rack. Depending on the contents on the rack shelf, one or more heavy-duty cables could be strung across the shelf and connected to the uprights with fasteners that could be easily uncoupled to allow quick access. Movable barriers, such as wire or netted gates, could be used for the working area of the rack. However, movable barriers could hinder warehouse operations during working hours.



Figure 4. Racks bolted to the floor at the Oregon Lottery warehouse.



Figure 5. Racks on the main floor of the Department of Corrections warehouse connected by horizontal braces as well as bolted to the floor.



Figure 6. Rack aisles and contents at the Oregon Lottery warehouse.



Figure 7. Spring clips on racks at the Oregon Liquor Control Commission warehouse.



Figure 8. Pallets stacked three high on floor at Oregon Liquor Control Commission.



Figure 9. Rack netting at the Oregon Lottery warehouse.

Recommendations:

1. Racks should be bolted to the floor following code requirements. When possible, adding row spacers would increase stability of racks.
2. The area below the lower shelf of a secured rack should be established as a safe zone during an earthquake.
3. Selected lower shelves should be secured as necessary to be designated as safe areas.
4. Safety tables should be placed in selected areas in the open part of the warehouse.
5. Loaded or partially loaded pallets should be shrink-wrapped. Full pallets should not be stacked on the floor more than one pallet high. Full pallets should be placed in properly secured racks.
6. When racks are moved they should be bolted to the floor again following code requirements.
7. Netting should be placed on the side of racks or on a non-working back where there is no existing barrier. Temporary barriers, such as wire or netted gates, should be installed on working racks. They could be closed after hours to protect inventory and closed during work hours if it does not significantly hinder warehouse operations.
8. If practical, allow only forklifts to enter the rack aisles. The worker should stay in the cage-protected forklift during an earthquake.

## **D. References**

Cheung, M.S., Foo, S.H.C., and White, W.A.S., 1998, Seismic Risk Reduction of Non-Structural Building Components, Proceedings, Sixth U.S. National Conference on Earthquake Engineering, Earthquake Engineering Research Institute, Oakland, California, 12p.

FEMA, 2001 Report on Damage to the Transportation Building during the Nisqually Earthquake, Washington State Department of Transportation.

Filiatrault, A., 1991. Seismic evaluation of modular office furniture system, *Earthquake Spectra*, 7, 4, pages 529-541.

Filiatrault, A., Christopoulos, C. and Stearns, C., 2001. Guidelines, Specifications, and Seismic Performance Characterization of Nonstructural Building Components and Equipment, Pacific Earthquake Engineering Research Center Report 2002/05, 102 p.

Horyna, T., Ventura, C.E., and Ventura, E., 1999. Shake table testing of functional and operational components of buildings. Technology Directorate National Capital Area Public Works and Government Services Canada Project 98-006.

Uniform Building Code, 1997, Section 1634 Non-building Structures and Chapter 22 Division X Steel Storage Racks

## **E. Appendices**

### **Appendix A**

#### **OREGON EMERGENCY MANAGEMENT CHAPTER 104 - DIVISION 20 EARTHQUAKE PREPAREDNESS DRILLS**

##### **104-020-000**

###### **Purpose**

The purpose of the rule is to provide guidance for state and local government agencies and employers with 250 or more full-time employees to conduct mandatory annual earthquake drills for employees located within office buildings.

##### **104-020-010**

###### **Definitions**

(1) "State and local agency" means a state or local government office, department, division, bureau, board, or commission that is assigned, renting, leasing, owning or controlling office space for carrying out its duties either in one or multiple locations. 'State or local agency' includes the legislative assembly (i.e. legislators) when in regular session.

(2) "Employers with 250 or more full-time employees" mean employers with 250 or more full time employees in Oregon, who are not state and local agencies.

(3) "Office Building" means a building whose primary function is office work. It does not include those non-office buildings whose primary function is manufacturing, assembly, warehouse, laboratory, maintenance, or other non-office situations.

(4) "Earthquake drill", as outlined in guidelines established by Oregon Emergency Management, means drop, cover, and hold or other protective action, if drop, cover and hold is not possible.

##### **104-020-020**

###### **Drill Requirements**

Those required to conduct the drill are certain office employees of state and local agencies and certain office employees of other employers who have 250 or more full-time employees.

###### **(1) State and local agencies**

- a. State and local agencies fall under the drill requirement regardless of the type (full and part time) and number of employees and number of works sites.
- b. All office employees are required to drill, except where there is a mix of office and non-office employees at a work site. If the office employees at a mixed work site are in the majority they are required to drill. If not, they are not required to drill. If an agency has more than one work site, each work site is evaluated separately according to this majority rule. A work site is defined as a site that has one street address, which may contain one or more buildings.

- (2) Employers with 250 or more full time employees
- a. Employers with 250 or more full time employees fall under the drill requirement regardless of the number of work sites. The 250 or more full-time employees include all full time employees.
  - b. All office employees (including both full and part time) are required to drill, except where there is a mix of office and non-office employees at a work site. If the office employees at the mixed work site are in the majority they are required to drill. If not, they are not required to drill. If an employer has more than one work site, each work site is evaluated separately according to this majority rule. A work site is defined as a site that has one street address, which may contain one or more buildings.

#### **104-020-030**

##### **Drill Guidelines**

(1) The earthquake drill shall be the drop, cover and hold, or if not possible, other protective action. Written information on pre-designated evacuation routes and procedures for exiting the building shall be made available to employees.

(2) Guidelines for the drill and evacuation procedures are posted on the web sites of Oregon Emergency Management (OEM) and the State Department of Geology and Mineral Industries (DOGAMI).

#### **104-020-040**

##### **Drill Records**

(1) Each state and local agency and employer with 250 or more full-time employees shall maintain a file that documents the date the earthquake drill was conducted. The file can be either maintained at one central location, for those agencies or employers that have multiple locations, or maintained at each location. If maintained at a central location, the record shall be kept in the office of the agency or company head. If maintained at each agency location, then the record shall be kept in the office of the manager at that site.

(2) For those agencies, companies and organizations that fit the drill criteria, drill waivers may be granted each year in exceptional circumstances and for good cause. Petitions must be submitted by the executive head of the state agency, local agency, company, or organization requesting the waiver to the Earthquake Program Coordinator, Oregon Emergency Management, P.O. Box 14370, Salem, OR 97309-5062.

Stat. Auth.: Chapter 366, Oregon Laws 2001

Stats. Implemented: Chapter 366, Oregon Laws 2001

## **Appendix B**

### Earthquake Evaluation

Is our building safe for occupancy after an earthquake?

State employees work in all kinds of buildings for all kinds of uses and in dozens of jurisdictions across the state. The earthquake risk varies across Oregon.

Furthermore, earthquakes come in many magnitudes, making it difficult to predict the amount of damage that may occur.

In a minor quake it may not be necessary to evacuate the building. On the other hand, if there is significant damage it is best to evacuate.

The EARTHQUAKE EVALUATION GUIDE can be used for two purposes:

- (1) After a quake the Site Emergency Coordinator (SEC), with input from top management and Evacuation Coordinators (ECs), must decide about evacuation. The SEC and ECs can use the guide to help decide whether it's safe or unsafe to remain inside.
- (2) If evacuation takes place and there are no facilities people on hand to check for safe re-entry, employees must decide for themselves, just as they would in their own homes.

Occupancy is likely safe if . . .

- a. the quake leaves little evidence of damage outside the building or across the neighborhood and town, and
- b. the basic inspection finds no or little evidence of damage to the building and its interior components.

A quake that causes noticeable damage within the building and surrounding area calls for more care.

We used the EVALUATION GUIDE and still are unsure the building is safe. Shall we call in professionals to inspect it?

Professionals understand structural damage issues. They include engineers, building inspectors, architects, contractors, or people with construction background that are familiar with building construction. Those who have been trained and registered by the Building Codes Division may also post a building as safe or unsafe to occupy. Those trained are called "Post Earthquake

Damage Inspectors" and they are trained to ATC 20 requirements for inspecting E/Q damaged buildings. Based on the tag these people attach to buildings, an immediate occupancy after the event may be allowed or not allowed by the local jurisdiction. Oregon Administrative Rules (OAR) for this certification is OAR 918-098-0600 through 0630.

Registered inspectors work with the local building official who coordinates the review of buildings in their jurisdiction, based on priority ranking. Hospitals and care facilities, police and fire stations, emergency centers, water and sewer plants and schools are at the top of the list.

Since it may be some time before you can obtain a professional inspection, you may not be able to wait. If there are no facilities people on hand, make a judgment call based on circumstances. Consider such things as whether there are landslides, large fissures, or movement in the surrounding ground. Per Evaluation Guide, what is the extent of damage to the building? What do local authorities on radio or TV say about damage to utilities, roads, and adjacent buildings in the area?

If your building appears to be unsafe, assume staying inside or re-entering is dangerous. There may be hidden damage to the structure, gas lines, electrical, water, sewer, or other building components. If there is damage, it may be worsened suddenly by an aftershock. If still unsure whether the building is safe to occupy, call in the professionals.

Instructions: Inspect your building for conditions listed below. Use the answers to help make your decision of whether the building is safe to occupy.

EARTHQUAKE EVALUATION GUIDE	YES	NO	MORE REVIEW NEEDED
Conditions 1-12 are critical life safety issues. If there is fire, pull alarm and evacuate. If response to any other item is YES, STOP and go report to your SEC or top manager and evaluate at once.			
1. Fire? If yes, pull the fire alarm!	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Smell natural gas or overturned LPG tanks?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Building collapsed, partially collapsed, or moved off its foundation?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Roof or floor framing separated from vertical supports or broken open?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. Arcing wires or equipment?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. Large diagonal or stepped cracking in unreinforced masonry walls?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. Collapsed, out of plumb, or tilted floors or walls?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. Collapsed suspended ceiling, lights or ducts?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9. Significant cracks in beams or supports?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10. Dislodged or buckled columns, support posts, or roof trusses?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
11. Danger from falling hazards from adjacent buildings that are damaged?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
12. Facades, windows, or parapets fallen from building or dislodged?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

EARTHQUAKE EVALUATION GUIDE Page 2	YES	NO	MORE REVIEW NEEDED
Continue inspection if answers to above are NO. Go through rest of the checklist. No condition below alone may be critical, but put together they are important in your evaluation decision. If your answer is NO for all, it is questionable that you need to evacuate.			
13. Water leaks?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
14. Chunks of fallen plaster or paint?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
15. Other fallen debris in building?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
16. Office furnishings have fallen or tipped over?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
17. Light fixtures have come loose?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
18. Office equipment damaged?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
19. Windows or mirrors have cracked?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
20. Wall cracks more than 1/4 of an inch wide?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
21. Cracks that extend clear through wall?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
22. "X" shaped cracks in exterior wall?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
23. Sudden loss of phone or power?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
24. Sticking doors?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

## Appendix C

### Seismic anchoring bracket for Haworth systems furniture

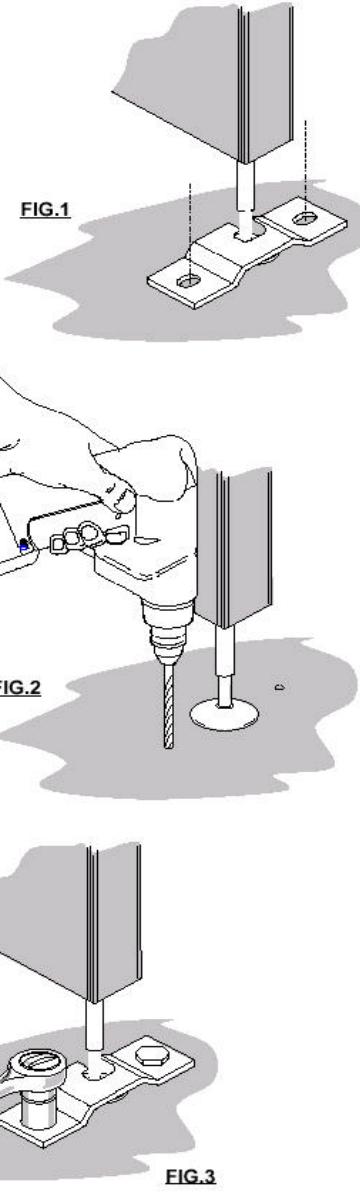
**ANCHOR PLATE**  
Installation Instructions

**Tools Required**  
Power Drill  
Ratchet Wrench

**NOTE:** The Haworth anchor plate is designed to be used with PLACES®, UniGroup®, and PREMISE® furniture systems. The anchor plate mounts to the floor with two (2) 5/8" diameter x 2-9/16" long anchor bolts, complying with the latest ICBO report No. 2895 installation specifications.

1. Before setting panels in place, extend the glide stem an additional 1/4" to provide clearance for the anchor plate.
2. Follow the appropriate PLACES, UniGroup or PREMISE panel installation procedures.
3. Determine location for anchor plates.  
**NOTE:** Local code may dictate cubicle configuration and anchor locations.
4. Slide anchor plate around glide stem and use holes in anchor plate as a template to mark floor for location of bolt holes (**Fig. 1**).
5. Remove the anchor plate from the glide stem and follow instructions from the anchor bolt manufacturer for drilling anchoring holes (**Fig. 2**).
6. Replace anchor plate and install anchor bolts (**Fig. 3**).
7. Repeat the above procedure for furniture configuration as required by the appropriate regulatory agency.

**OSHPD Approval**  
The California Office of Statewide Health Planning and Development (OSHPD) requires furniture systems in excess of 5' 9" tall to be anchored in an approved method. Contact your local Haworth Field Sales Engineer or Design Consultant for specific design and installation requirements and the OSHPD pre-approval documentation.



**FIG.1**

**FIG.2**

**FIG.3**

CUSTOMER SERVICE PHONE: 1-800-426-8562

<b>HAWORTH®</b>	E.C.O. No: 209-870	Page: 1 of 1	Part No: 7021-6883	Rev. B
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## **Appendix D**

### **Code requirements for non - structural elements**

Oregon statute ORS 455.020 provides that “... *DCBS to promulgate a state building code to govern the construction, reconstruction, alteration and repair of building and other structures ...*”. Since the statute does not provide authority for retroactive application of the code provisions to existing buildings, only the new work related to new construction, alterations, repairs etc. must conform to the building code requirements. Existing buildings and or structures could be required to be up-graded provided a determination is made by the authority having jurisdiction, that unsafe or dangerous conditions exist. In order for a jurisdiction to make that decision, local ordinances must be in place to allow them to make such a call. Oregon building codes do not provide that authority to the local jurisdiction.

Section 1632.1 of the 1998 Oregon Structural Specialty Code (OSSC) (based on 1997 Uniform Building Code) requires that “... *permanent nonstructural components and their attachments, and the attachments for permanent equipment supported by a structure shall be designed to resist the total design seismic forces prescribed ... Attachment for floor-or roof-mounted equipment weighing less than 400 pounds, and furniture need not be designed. Attachments shall include anchorage and required bracing. Friction resulting from gravity loads shall not be considered to provide resistance to seismic forces.*”

What this section means is that:

1. All non-structural components such as racks, sprinkler pipes, electrical raceways, plumbing pipes, tanks etc. are required to be anchored to resist the design seismic forces. The anchoring system is required to be designed.
2. Ceiling mounted equipment is required to have their anchorage systems designed.
3. Equipment that is less than 400 pounds in weight and when supported on the floor or roof need not have their anchorage system designed but they still need to be anchored. In such cases manufacturer installation instructions could be followed.
4. Furniture does not have any design requirements but still needs to be connected (anchored). The manufacturer's instructions could be used for anchoring of furniture.

Detailed design requirements are provided in Section 1634 of the 1998 OSSC.

In Oregon design may or may not be required to be performed by an Oregon licensed engineer or an architect depending upon if the structure and or work is exempt by the Oregon board of engineers and or architects. It is usually assumed that whenever the building code requires a design, a licensed engineer or architect's services would be required. OSSC Section 1632.5 Alternative Designs provides an alternate to this. It states “*Where an approved national standard or approved physical test data provide a basis for the earthquake – resistant design of a particular type of equipment or other non-structural component, such a standard or data maybe accepted as a basis for design of the item with the following limitations ...*”. Because of the language in this section, national standards, such as the Sheet Metal and Air Conditioning Contractor National Association, Inc.(SMACNA), have been allowed to be used as a substitute

for the design requirements for ducts installation and its anchorage. Similar standards are available for other non-structural components such as National Fire Protection Association (NFPA) standard for sprinkler pipes.

For STEEL RACKS, Division X in Chapter 22 provides the regulations for their design and construction. Section 2222.1 Scope, states that the “***building official may waive the design requirements for storage racks less than or equal to 8 feet in height.***” What this means is that although the racks 8 feet or less in height are not required to be designed, they still are required to be anchored as per section 1632 of the OSSC. Manufacturer’s instructions could be used for anchorage of the racks 8 feet or less in height. Section 2222 through 2229 of the OSSC provides detailed design requirements for steel storage racks.

## **Appendix E**

### **Non-Structural Earthquake Hazard Mitigation in the Office and Home**

#### Introduction

When the earthquake shaking starts, your first action should be to drop, cover, and hold. In other words, get under something sturdy, like a table or chair, and hold on. If this is not an option, move away from windows toward the interior of the room. However, when the shaking starts you won't be the only thing moving. Objects in and outside the building or home, such as light fixtures, lamps, computers, bookshelves, signs, chimneys, plus many others, will also be moving. They could be falling, toppling, sliding, rolling or even flying. These objects are considered the non-structural components of a building. Not only is there the potential for these objects to be damaged, but their movement can cause damage, injury or even loss of life. Often the most damage, injury and loss of life during an earthquake are the result of the movement of the non-structural components. Therefore, it is important to move quickly to protect yourself. Drop, cover, and hold looks easy on paper and even during practice, and practice almost makes perfect. However, when the shaking begins, it might not be as easy to protect yourself in a timely manner as you think.

Never fear. There is something that you can do. If objects are secured, either with bolts, velcro, straps, or other devices, then the urgency to drop, cover and hold is not as great, although still necessary. Damage, injury and loss of life from the earthquake would be greatly reduced if these objects were secured. In addition, evacuation, if necessary, will run smoother if there is less debris along the evacuation routes. Securing items is often inexpensive and easy to do. If securing is not an option, objects can be placed in a safer location, as long as its movement would not hinder evacuation. For example, heavy objects could be moved to lower shelves or a file cabinet could be moved away from a doorway.

Below you will find a checklist of objects typically found in offices and homes, complemented by diagrams illustrating how to secure them. The checklist is divided into different sections depending on the level of expertise required to inspect and secure the objects. Most people in an office and home would probably focus on the Equipment and Furnishings section.

By securing these objects and practicing the drop, cover and hold, you will go a long way in protecting yourself from the earthquake. Remember it is not if an earthquake will strike but when. Contact Earthquake Program Coordinator, State Office of Emergency Management, at 503-378-2911 for further information.

#### **Earthquake Non-Structural Hazard Checklist**

A. Inspecting and securing of objects, unless otherwise noted, can be made by office staff and homeowners.

1. \* indicates that inspection should be made by qualified staff or contractor
2. A/E indicates an architect or engineer should be consulted

B. Key to diagrams illustrating solutions are in parentheses. Solution diagrams are located at the end of the checklist.

C. **Bold** indicates a life safety hazard

D. If items can't be secured, they should be moved to a location where movement would not cause injury or be a barrier to evacuation.

**NOTE: Attaching objects to walls may require permission of the building owner and may require an inspection by a qualified individual if the wall is not load bearing.**

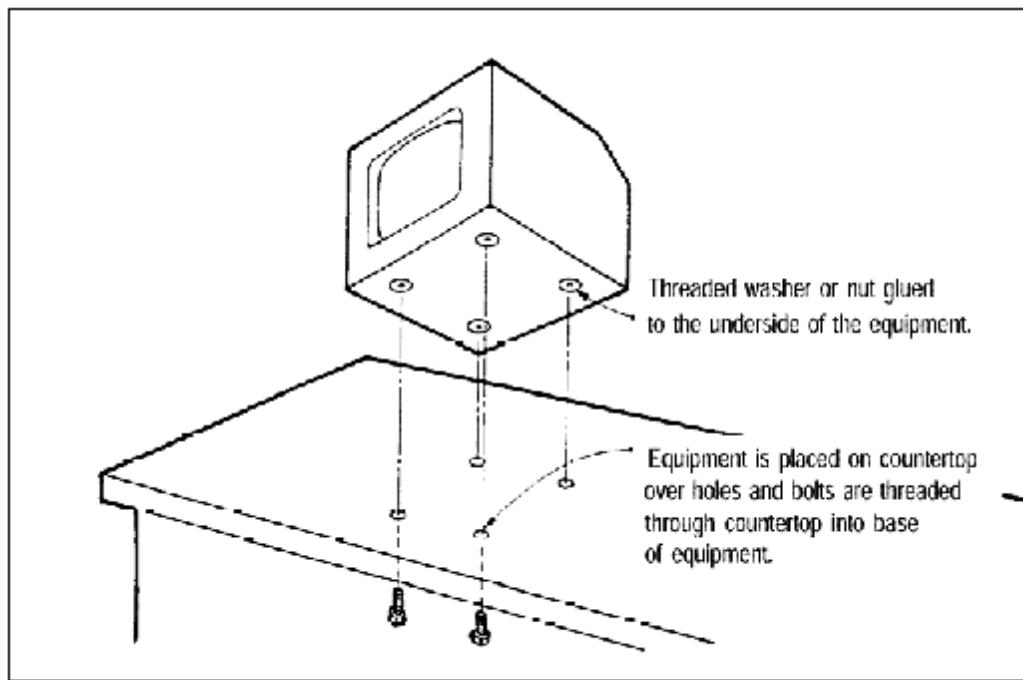
<u>Section EF (EQUIPMENT AND FURNISHINGS)</u>	yes	no
1. Are desk or table top computers, printers, etc. secured? (EF1 a or b)	9	9
2. Are the tops of 4-5 drawer file cabinets secured to wall or to each other? (EF2)	9	9
3. Do file cabinet drawers have latches? (Provide latches)	9	9
4. Are large and heavy office machines restrained and located where they will not slide a few inches, fall off counters, or block exits? (EF3a or b)	9	9
5. Are wall-mounted objects over 5 lbs connected to structural framing? (EF4)	9	9
<b>6. Are tall cabinets and bookshelves attached to the wall or to each other?</b> 9 (EF5)	9	9
7. Are desks or tables located such that they will not slide and block exits? (Move them)	9	9
<b>8. Are tall storage racks cross-braced in both directions or, for racks significantly taller than wide, are there large anchor bolts connected to the concrete slab?</b> (EF6)	9	9
9. Are heavy or sharp wall decorations securely mounted, with closed eye-hooks, for example? (EF4)	9	9
10. Are valuable, fragile art objects or trophies protected against tipping over, breaking glass, or sliding off shelves or pedestals? (EF7)	9	9

- 11. Are refrigerators, ranges, candy/soda machines restrained by built in cabinetry or attachments to floor or wall? 9 9**  
(EF2)
  
- 12. Is floor-supported freestanding shop equipment secured against overturning or sliding? 9 9**  
(EF8)

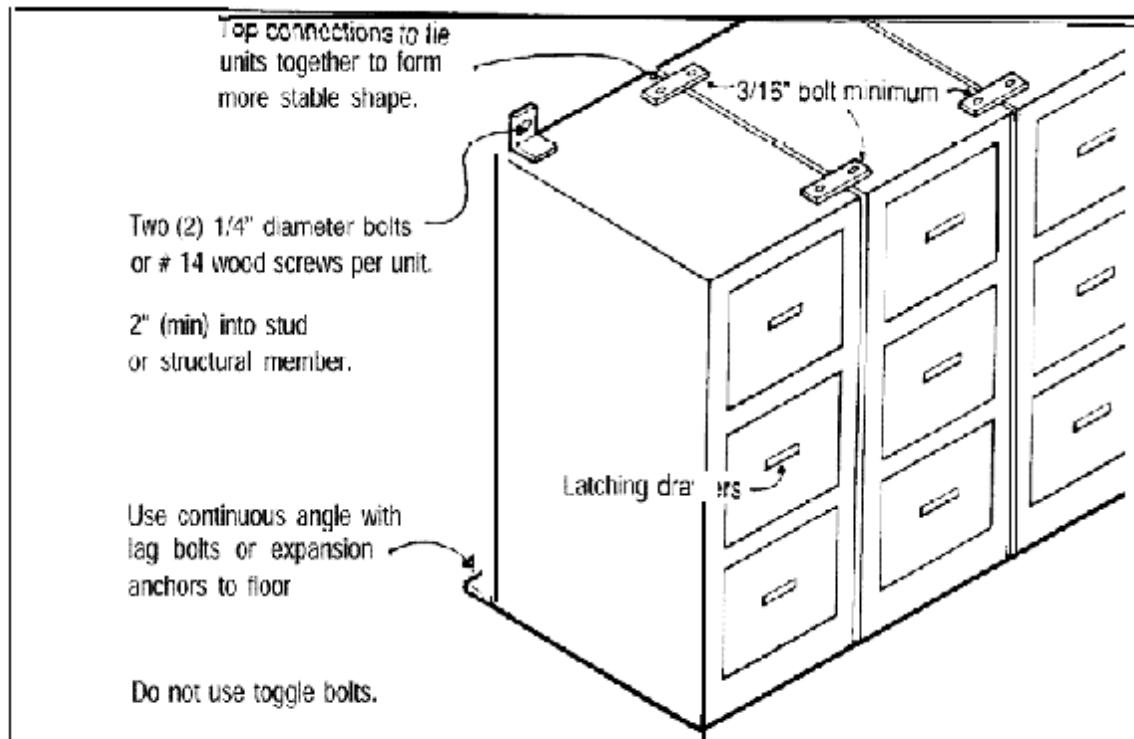
Section EF EQUIPMENT AND FURNISHINGS (cont.)

yes no

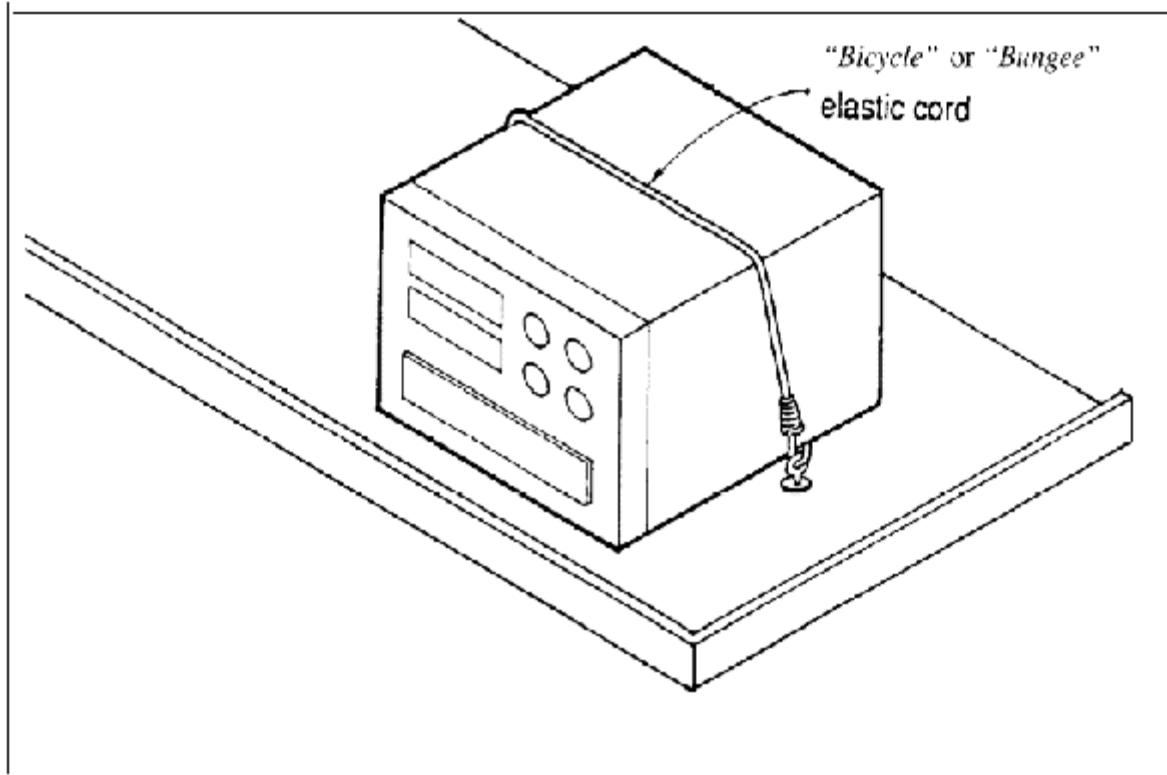
13. Are fire extinguishers securely mounted? **9 9**  
(EF9)
14. Are potted plants or heavy items on top of file cabinets or other high locations restrained? **9 9**  
(EF10)
15. Are display cases protected against overturning or sliding off tables? **9 9**  
(EF1)
16. Is freestanding equipment on wheels locked against rolling? **9 9**  
(lock wheels)
- 17. Have heavy objects been removed from the tops of shelves?** **9 9**  
**(remove the objects)**



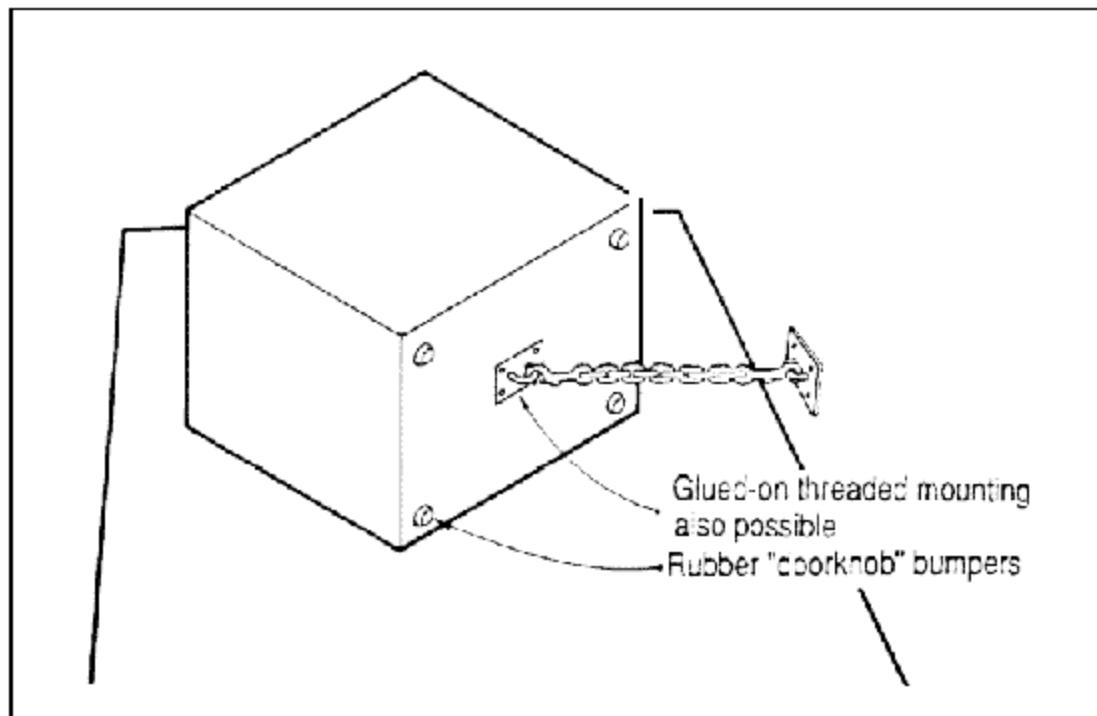
**EF1 (a) - FIXED ATTACHMENT OF EQUIPMENT TO COUNTERTOP**



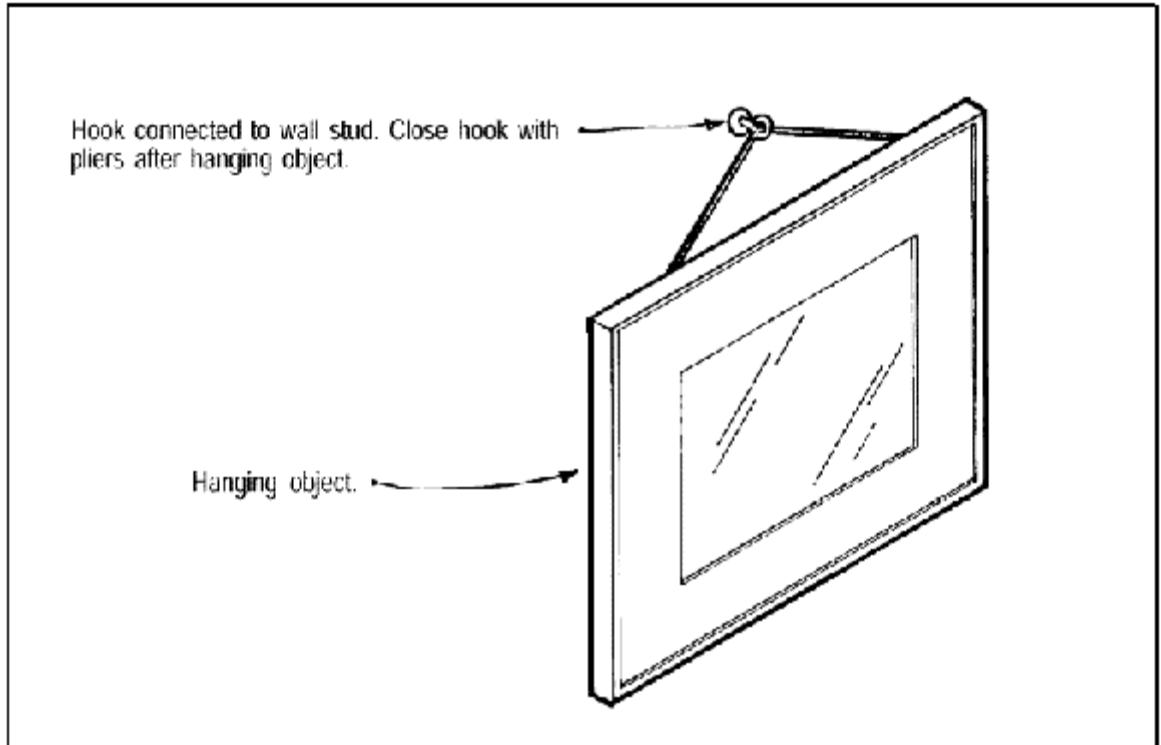
EF2 - CABINETS ATTACHED AT TOP, BOTTOM AND SIDES TO STRUCTURE



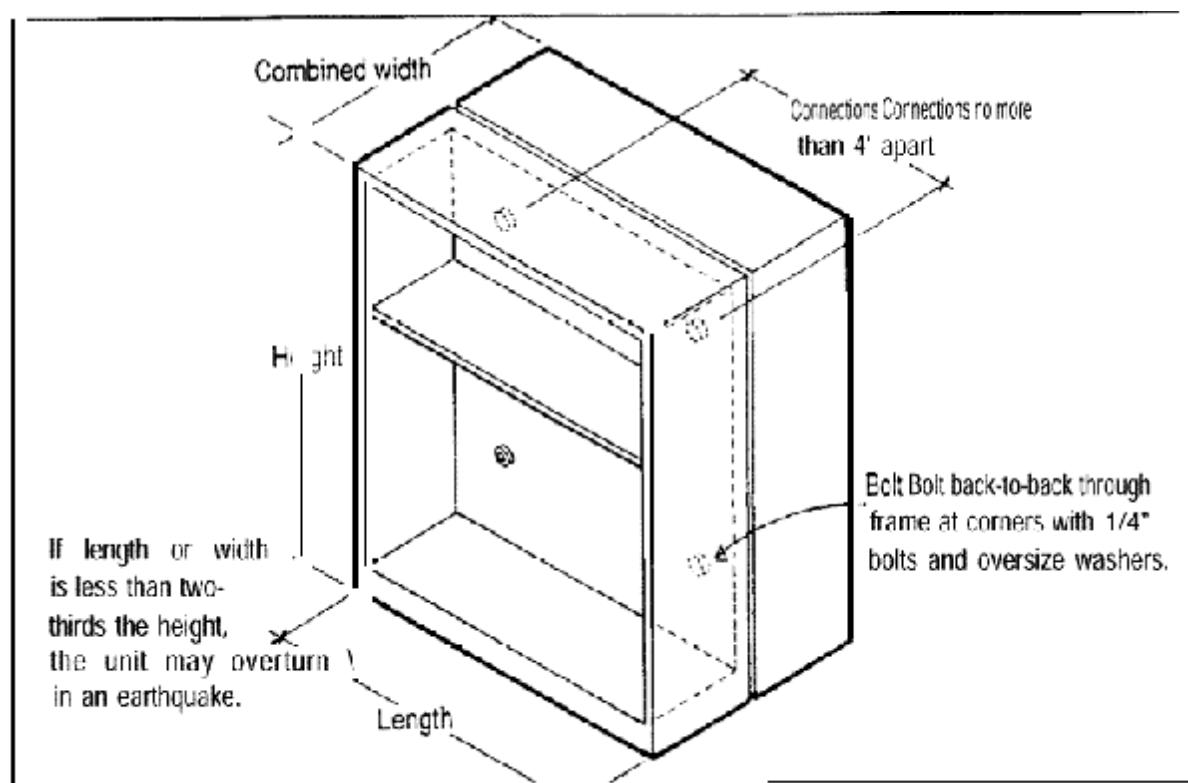
EF3(a) - TIE DOWN ATTACHMENT OF RADIO EQUIPMENT



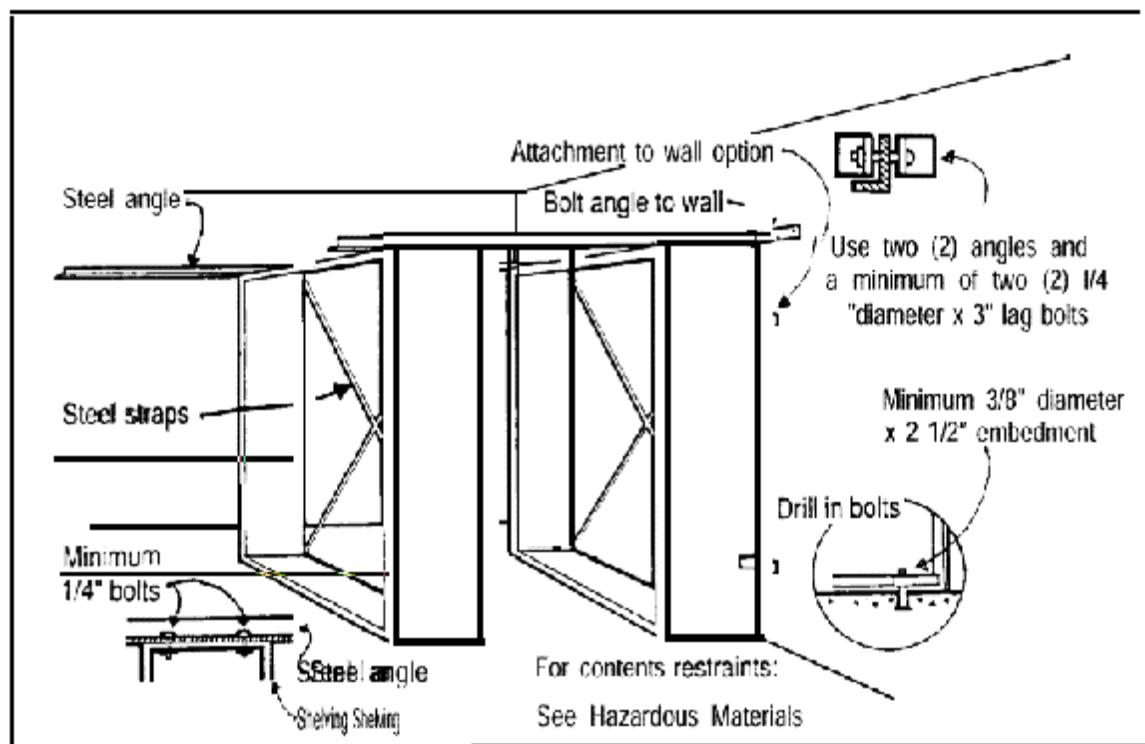
EF3(b) - DETACHABLE LEASH ATTACHMENT OF RADIO EQUIPMENT TO WALL



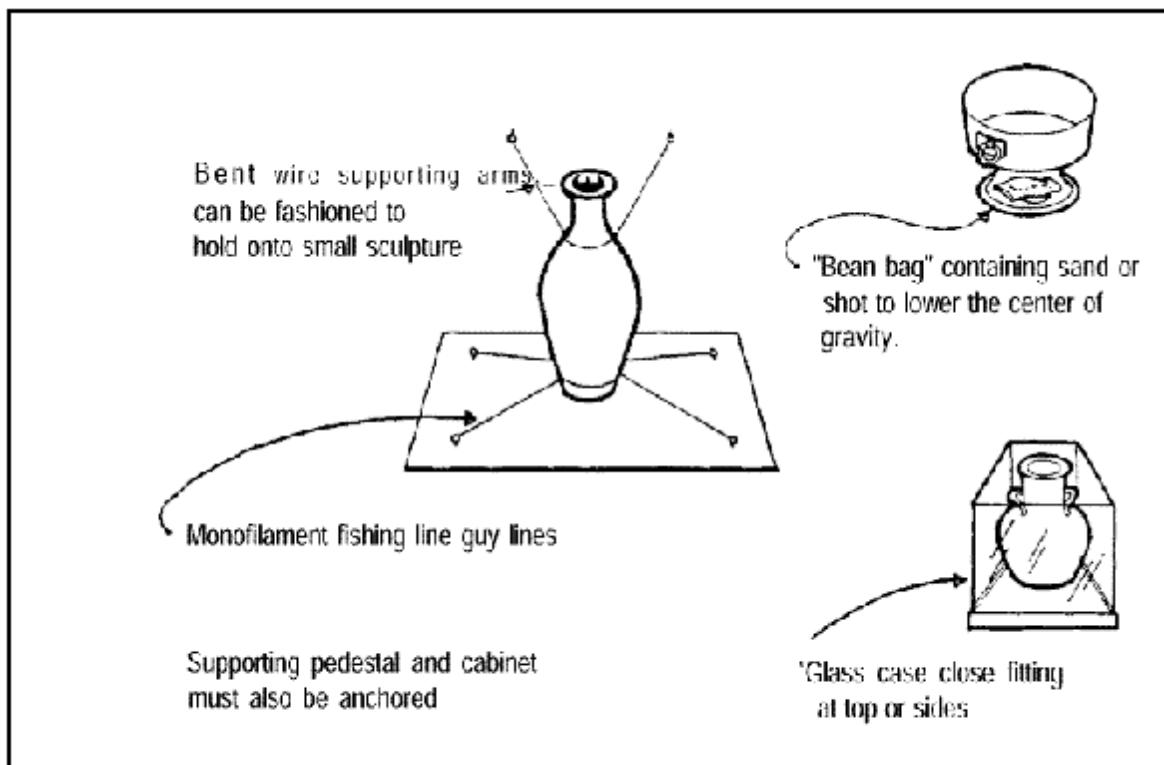
**EF4 - ATTACHMENT OF SHELVES AND PICTURE FRAMES TO WALLS**



**EF5 - BACK-TO-BACK Attachment OF BOOKCASES TO PREVENT OVERTURNING**



EF6 - BRACING OF LIBRARY SHELVING (STACKS)

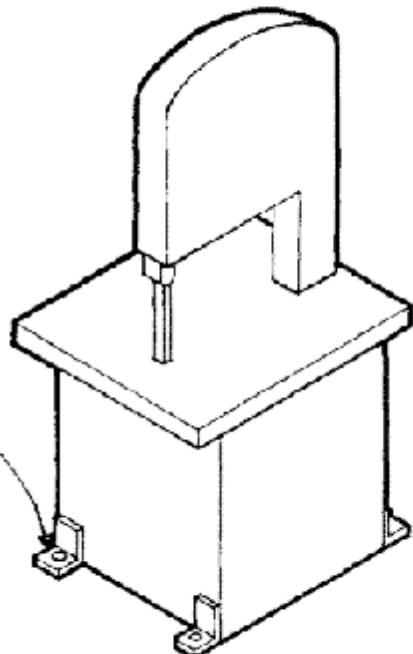


EF7 - BRACING OF FRAGILE DISPLAYS

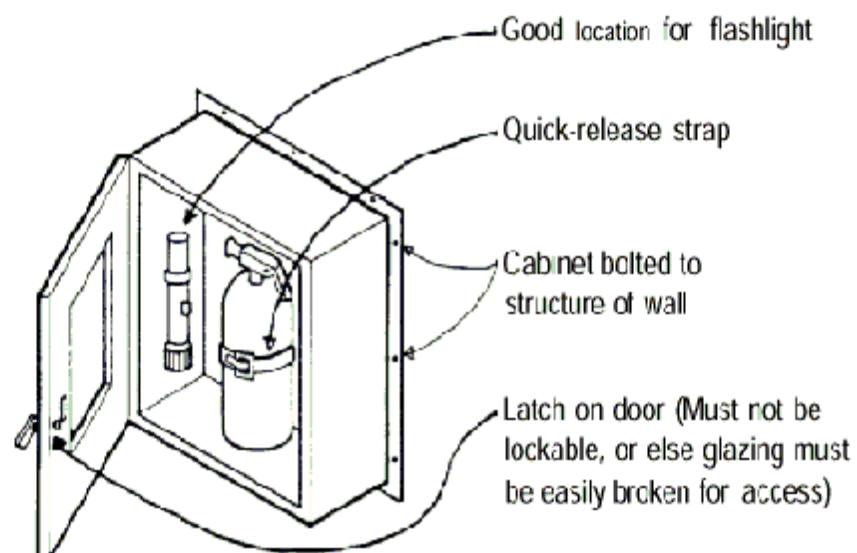
For objects under 1000 lbs.

For heavier equipment,  
seek an architect's or  
engineer's advice.

Minimum 1/2" wide x 3" embedment  
expansion anchors at each corner.  
Torque test to 30 foot- pounds.



#### EF8 - BOLTING OF SHOP EQUIPMENT TO FLOOR

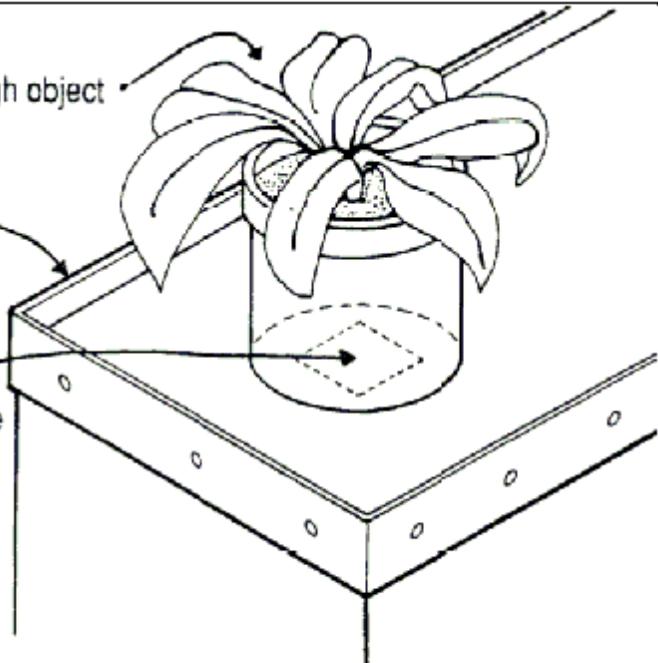


#### EF9 - ATTACHMENT OF FIRE EXTINGUISHER TO WALL

Potted plant or other heavy, high object

Guard rail alternative

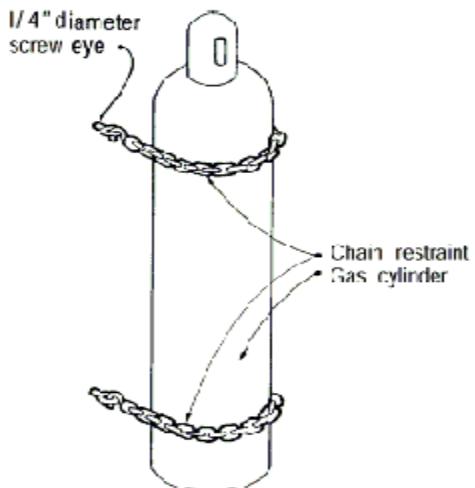
Large patches (4 x 5 sq. in.)  
of Velcro glued with appropriate  
adhesive to bottom of object  
and top of cabinet.



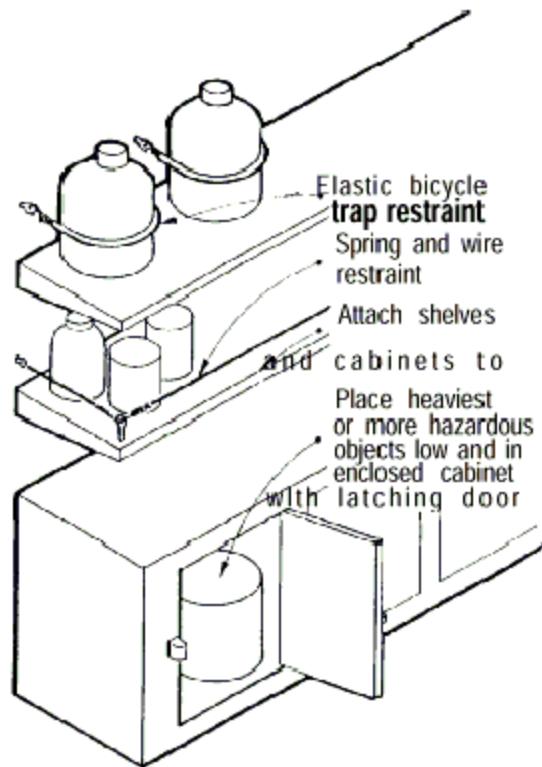
See separate chart for tall file cabinets

EF10 - GUARDRAILS TO CONTAIN FALLING OBJECTS

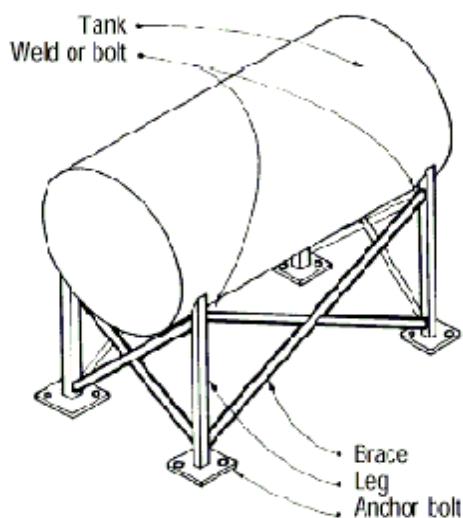
Section HM (HAZARDOUS MATERIALS)	yes	no
1. Are compressed gas cylinders secured top and bottom with a safety chain? (HM1)	9	9
2. <b>Are laboratory chemicals on shelves restrained?</b> (HM2)	9	9
3. <b>Are containers of hazardous materials stored on braced storage rack or tall stacks?</b> <b>(provide secured storage)</b>	9	9
4. <b>*Are gas tank legs anchored to a concrete footing or slab?</b> (HM3) [A/E]	9	9
5. <b>*Do gas pipes have flexible connections?</b> <b>(provide flexible connections)</b> [A/E]	9	9



**HM1-SAFETY CHAINS FOR BOTTLED HIGH PRESSURE GASES**

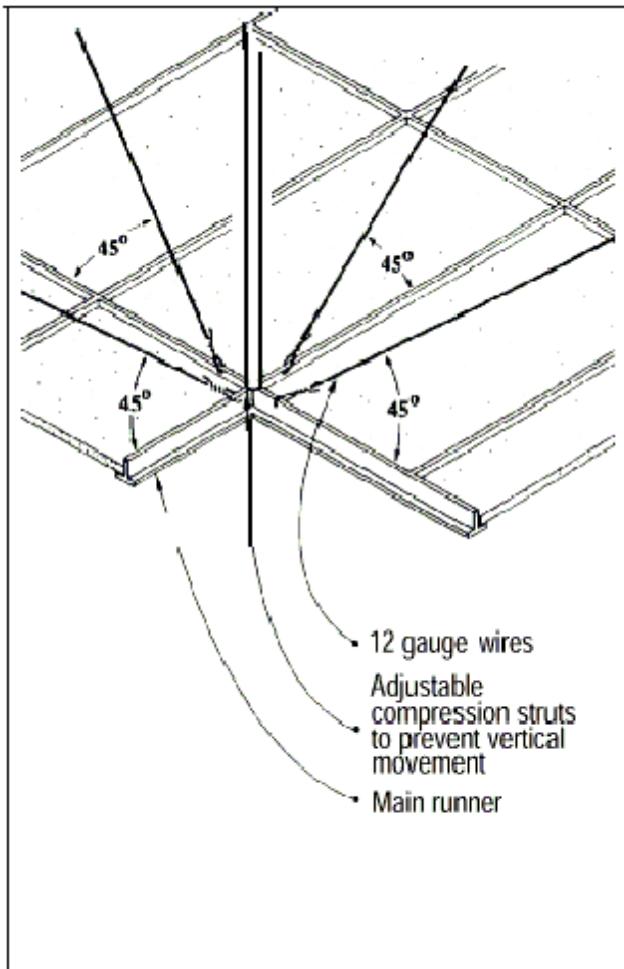


**HM2-SAFETY RESTRAINTS FOR CHEMICAL STORAGE**

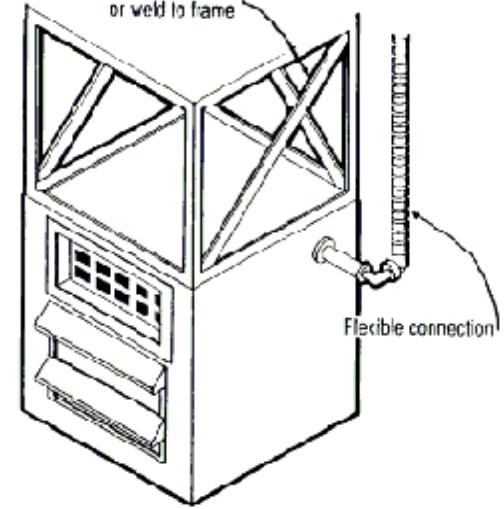


Section OE	<b>*(OVERHEAD ELEMENTS)</b>	yes	no
1.	<b>Do pendant mounted light fixtures or chandeliers have safety cables?</b> (OE4)	9	9
2.	<b>Will hanging light fixtures swing freely, not hitting each other if allowed to swing 45 degrees minimum?</b> (Fix or remove)	9	9
3.	Are sound system speakers or televisions in elevated locations anchored to structure? (secure them)	9	9
4.	Do hanging plants, mobiles, or displays have closed eye-hooks, and can they swing freely 45 degrees? (Secure objects in safe locations)	9	9
5.	Could chandeliers swing freely, not hitting each other, or windows, roof trusses, or walls? (immobilize or move chandeliers)	9	9
6.	Are air distribution grills or diffusers mounted? (provide anchorage)	9	9
7.	Do large metal air distribution ducts, especially those suspended a few feet, have diagonal bracing? (OE3)[A/E]	9	9
8.	<b>Does the suspended ceiling have diagonal bracing wires?</b> (OE1) [A/E]	9	9
9.	<b>Are the fluorescent light fixtures merely resting on the hung ceiling grid without another support?</b> (OE3) [A/E]	9	9
10.	Are decorative ceiling panels or latticework securely attached? (OE1)	9	9
11.	Will spotlights remain securely attached if shaken? (secure them)	9	9
12.	Are suspended space heaters, especially gas fired, braced and/or have flexible gas connections? (OE2) [A/E]	9	9

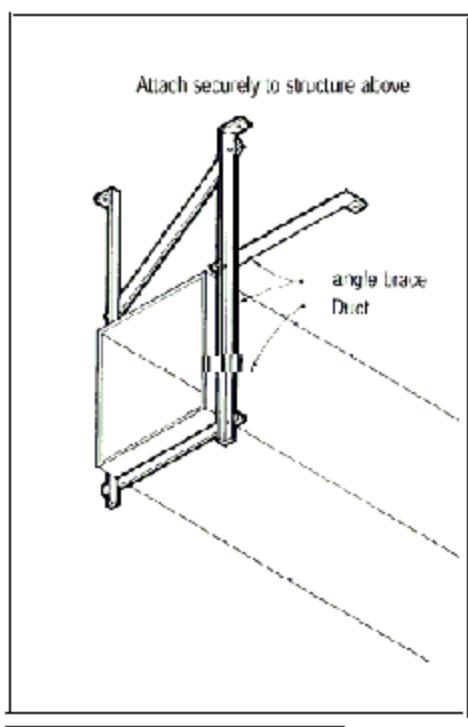
**OE1 - SEISMIC BRACING FOR SUSPENDED CEILINGS**



New tracing bolt or weld to frame

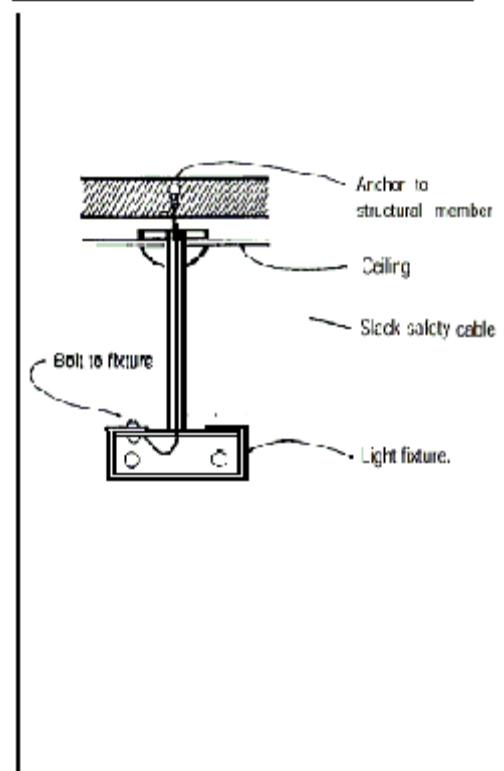


**OE2 - SEISMIC BRACING FOR SUSPENDED UNIT HEATERS**



**OE3 - SEISMIC BRACING FOR HVAC DUCT**

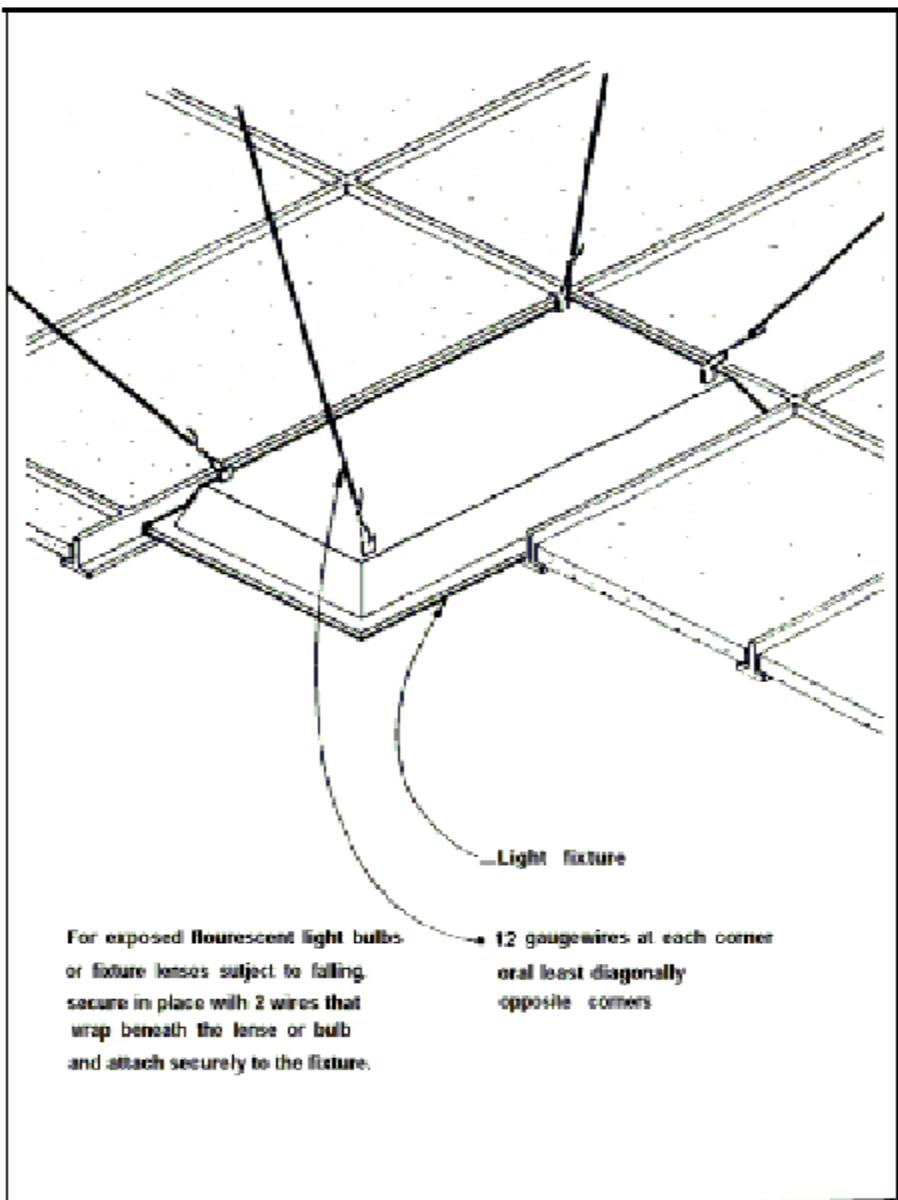
**OF4 - SAFETY WIRE FOR PENDANT LIGHT FIXTURE**



Section EE \*(ELECTRICAL EQUIPMENT)      yes      no

- |   |                 |
|---|-----------------|
| 1. Are fluorescent light bulbs and lenses fastened securely?<br>(EE1) | <b>9      9</b> |
| 2. Is essential communications equipment secured?<br>(secure it)      | <b>9      9</b> |

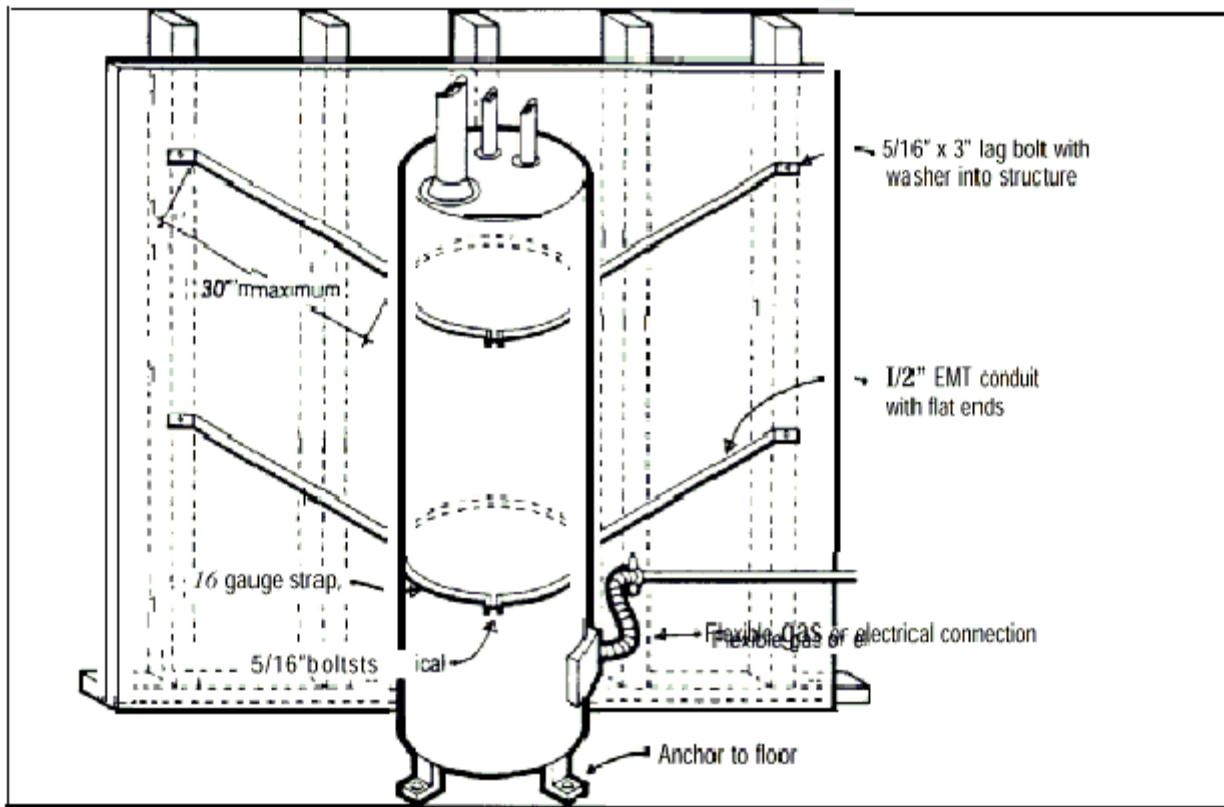
**EEI - SEISMIC SAFETY WIRES FOR LIGHT FIXTURES**



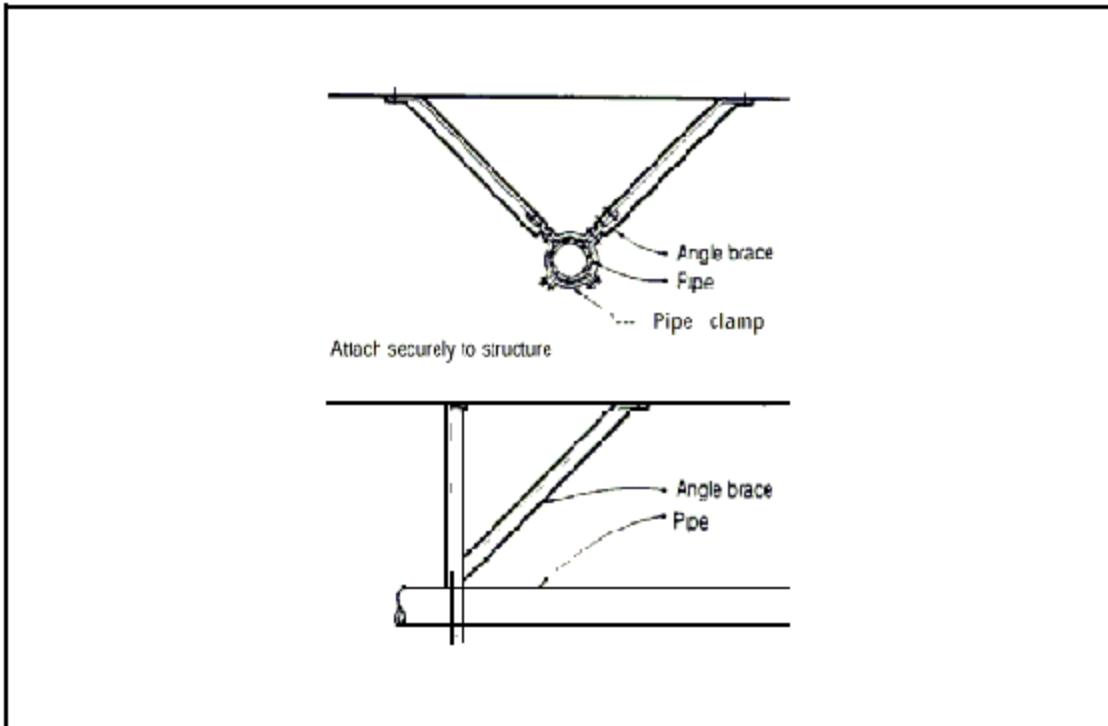
## Section ME \*(MECHANICAL EQUIPMENT)

yes      no

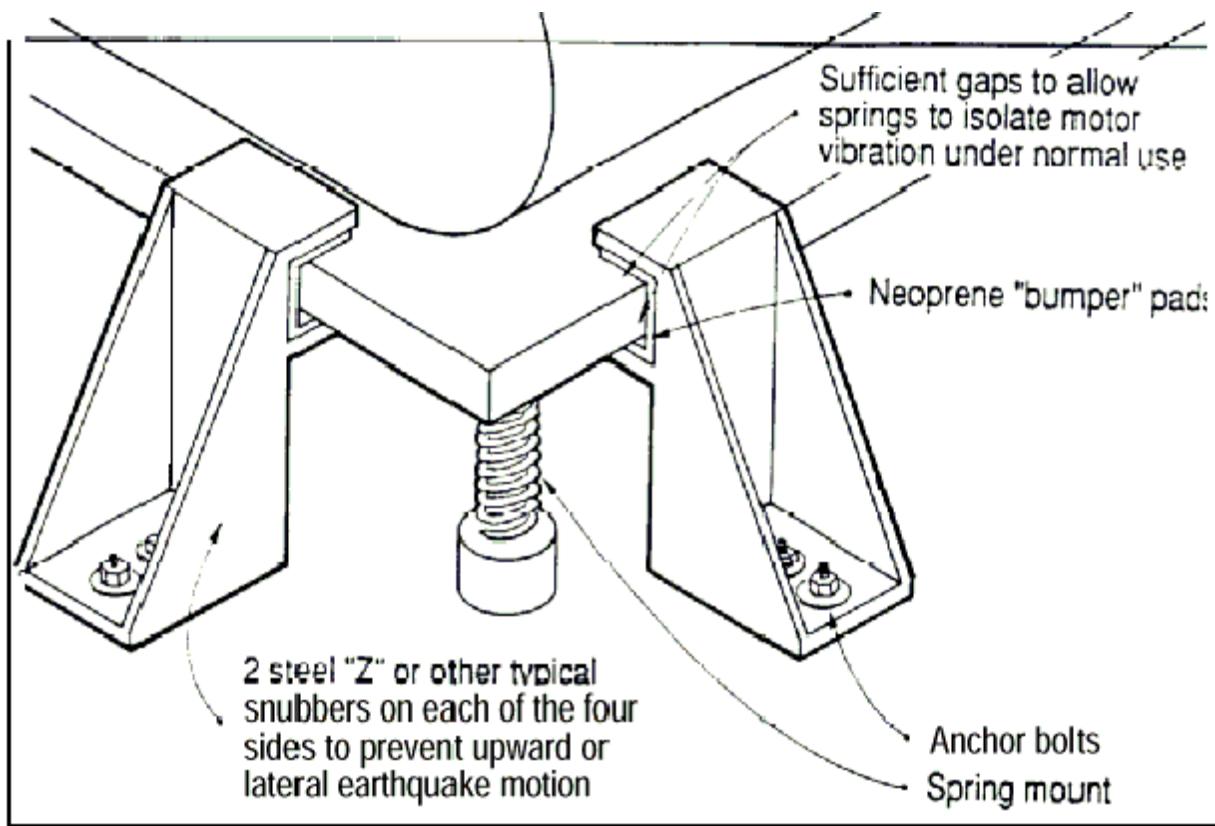
- |    |  |   |   |
|----|--|---|---|
| 1. | Are the water heaters restrained?<br>(ME1)   | 9 | 9 |
| 2. | Is the furnace or boiler restrained?<br>(EF8) [A/E]  | 9 | 9 |
| 3. | Are large diameter pipes braced or do pipes that cross expansion joints have accommodation for movement?<br>(ME2) [A/E]  | 9 | 9 |
| 4. | Are fans, chillers, pumps, or other heating- venting-air conditioning equipment-typically found in mechanical rooms-restrained or mounted correctly?<br>(ME3 a or b) [A/E] | 9 | 9 |
| 5. | Do the fire sprinkler risers have a v-brace to the wall, and do the large diameter sprinkler pipes have diagonal braces to the structure above?<br>(ME2) [A/E]             | 9 | 9 |



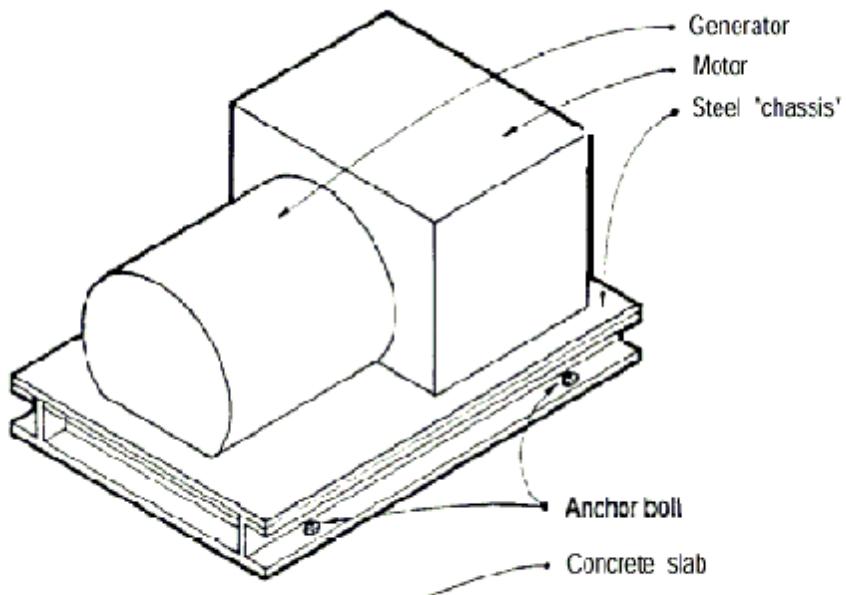
ME1 - SEISMIC BRACE SYSTEM FOR HOTWATER HEATERS



ME2 - SEISMIC BRACING OF PIPING 1



ME3(a)- SEISMIC SNUBBERS AND SPRING MOUNT FOR MECHANICAL EQUIPMENT

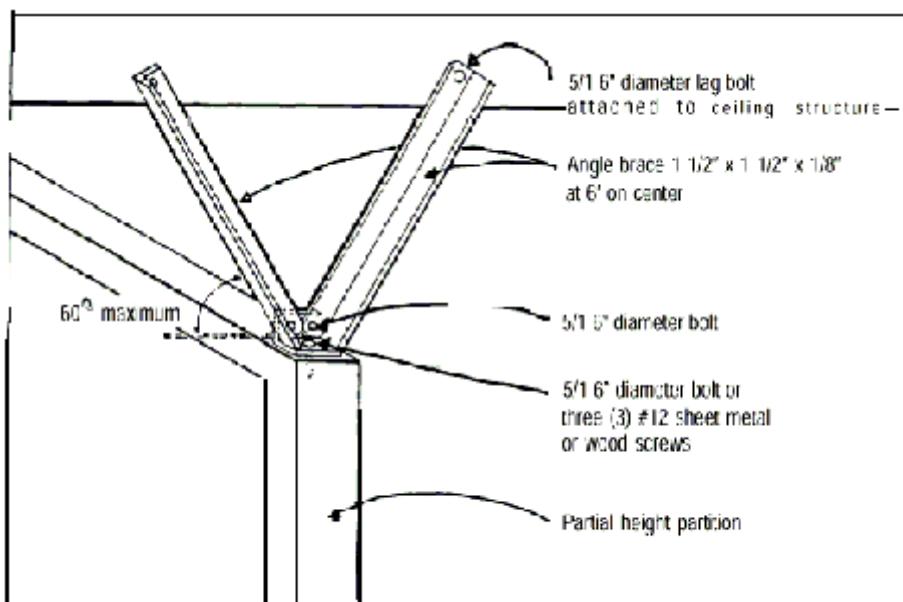
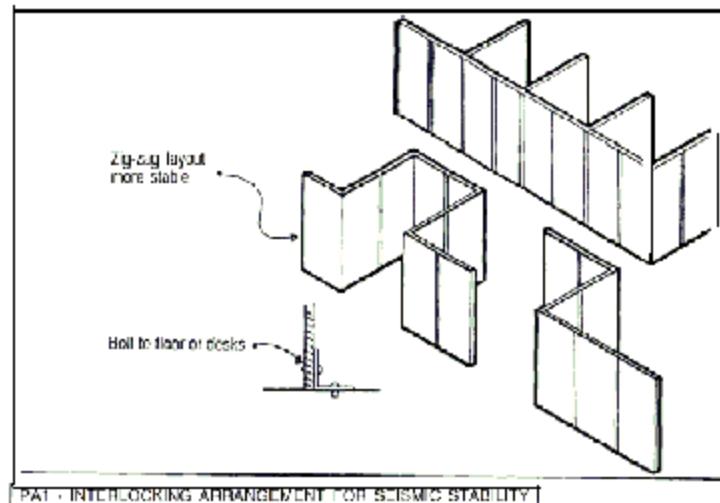


ME3(b) - ANCHOR BOLT AND CHASSIS SYSTEM FOR MECHANICAL EQUIPMENT

## Section PA \*(PARTITIONS)

yes      no

- |    |  |   |   |
|----|--|---|---|
| 1. | Are freestanding, movable, partial-height partitions-especially if supporting bookshelves-adequately braced?<br>(PA1)  | 9 | 9 |
| 2. | Are light-weight drywall partitions, that extend as high as the hung ceiling, braced or supported by the structure above, particularly if these partitions are used as lateral support for tall shelving or cabinets?<br>(PA3) [A/E] | 9 | 9 |
| 3. | Are the clear panels in partitions made of plastic or safety glass?<br>(Replace with shatter-proof materials or apply shatter-resistant film)  | 9 | 9 |



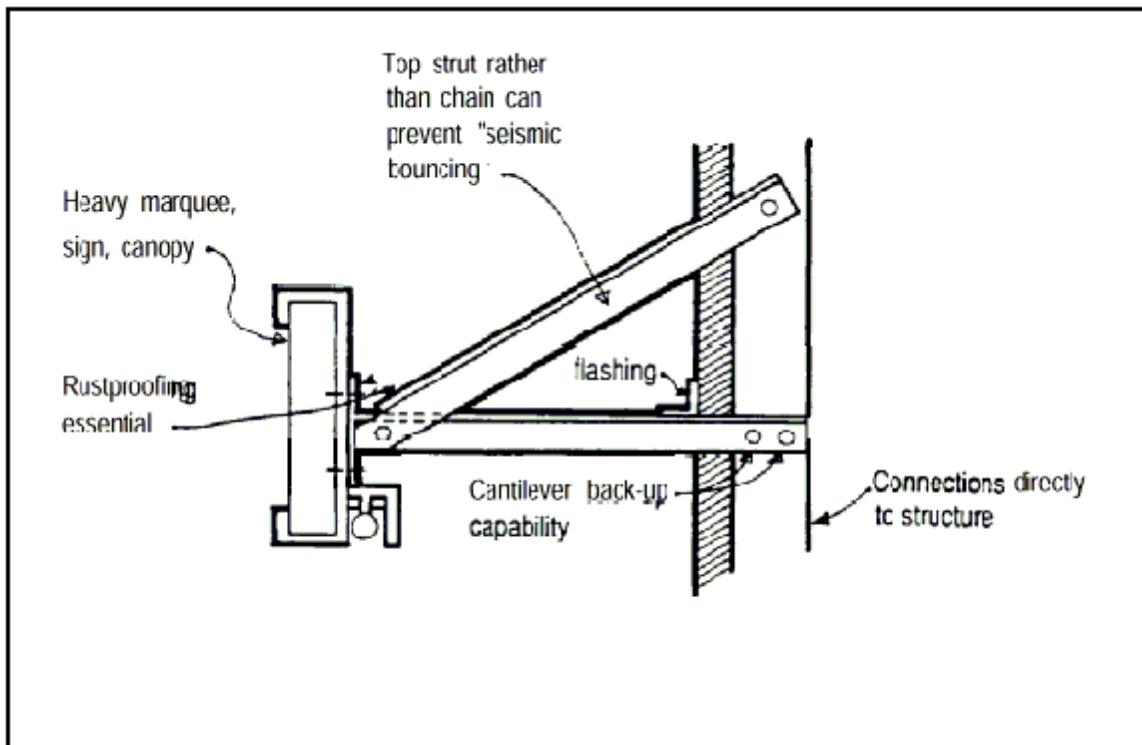
Section W \*(WINDOWS)      yes      no

- |   |          |          |
|---|----------|----------|
| 1. Are the large panes made of safety glass, and is it known if the mounting of the panes was designed by an architect/engineer to accommodate expected seismic distortion of the surrounding structure? (Apply shatter-resistant film) | <b>9</b> | <b>9</b> |
| 2. Are transoms (glass panes over doors) safety glass?<br>(Apply shatter-resistant film)  | <b>9</b> | <b>9</b> |

Section EE \*(EXTERIORS)

yes no

- |  |        |
|--|--------|
| 1. Are decorations or appendages adequately attached?<br>(E1) [A/E]  | 9    9 |
| 2. Are statuary or decorative objects anchored?<br>(E1) [A/E]  | 9    9 |
| 3. Are tall backboards or fences supported by pressure-treated wood posts<br>or galvanized metal posts?<br>(Provide anchorage to ground) | 9    9 |
| 4. If large trees are leaning or in poor health are they supported?<br>(Reinforce or remove)   | 9    9 |
| 5. Are signs adequately secured, especially if heavy?<br>(E1)  | 9    9 |



EI - BRACING OF CANTILEVERED MARQUEE OR SIGN