Appendix D

Check Lists
and
Visual Material
for
Vulnerability Surveys
(Earthquake)

Most of the illustrations referred to in the Check Lists were taken from
"Reducing the Risks of Nonstructural Earthquake Damage - a Practical Guide"
Federal Emergency Management Agency document FEMA 74 / September 1994

ITEM	YES	NO	SKETCH REF
Electricity			
Generator a Is the emergency generator adequately secured?			
Batteries a Are the batteries securely attached to the battery rack? b Is the rack cross-braced in both directions? c Does the battery rack have bolts secured to a concrete pad?			
Diesel Fuel Tank a Is the tank securely attached to the supports? b Are the tank supports cross-braced in both directions? c Is the bracing attached with anchor bolts secured to a concrete pad?			#31
Fuel Lines and Other Pipes a Are these lines and pipes attached with flexible connections? b Are they able to accommodate relative movement across joints?			#31
Transformers, Controls, Switchgear a Are these items properly attached to the floor or wall?			
Bus Ducts and Cables a Are these able to distort at their connections to equipment without rupture? b Are they able to accommodate relative movement across joints? c Are they laterally braced?			
Fire Fighting			
Smoke Detectors and Alarms a Are they properly mounted? b Are the control system and fire doors securely anchored?			
Fire Extinguishers and Hose-reel Cabinets a Are the cabinets securely mounted? b Are the extinguishers secured with quick-release straps?			#33

ITEM	YES	NO	SKETCH REF
Emergency Water Tank a Is it securely anchored to its supports? b Are the supports braced in both directions? c Are the supports or braces anchored to a concrete foundation?			
Propane Tanks			
The Tank a Is it securely anchored to its supports? b Are the supports braced in both directions? c Are the supports or braces anchored to a concrete foundation?			
Shut-off Valve a Does the system have an automatic, earthquake-triggered shut-off valve? b If manual, is a wrench stored close by?			
Supply Pipes a Are they able to accommodate relative movement across joints and at the tank? c Are they laterally braced?			
Plumbing			
Water Heaters and Boilers a Are they securely anchored to the floor or wall? b Does the gas line have a flexible connection to the heater or boiler to accommodate movement?			#36
Pumps a Are they anchored or are they mounted on vibration isolation springs with seismic lateral restraints?			
Hot and Cold-water Pipes and Wastewater Pipes a Are the pipes laterally braced at reasonable intervals? b Do they have flexible connections to boilers and tanks? c Can they accommodate movement across joints? d Are "free" pipe penetrations through walls large enough to for seismic movement? e Are they free of asbestos insulation (which can be broken in an earthquake)?			
Solar Panels a Are they securely anchored to the roof?			

ITEM	YES	NO	SKETCH REF
Elevators			
Cab a Is it properly attached to the guide rails?			
Cables, Counterweights, Rails a Are cables protected against misalignment during an earthquake? b Are counterweights properly attached to guide rails? c Are guide rails properly attached to the building structure?			
Motors and Control Cabinets a Are these anchored?			
Air Conditioning			
Chillers, Fans, Blowers, Filters, Air Compressors a Are they anchored or are they mounted on vibration isolation springs with seismic lateral restraints?			
Wall-mounted Units a Are they securely mounted?			
Ducts a Are they laterally braced? b Can they accommodate movement at locations where they cross separation joints?			
Diffusers a Are the grills anchored to the ducts or to the ceiling grid or to the wall? b Are hanging diffusers adequately supported?			
Non-structural Walls and Partitions			
Concrete Block, Brick, Clay Block a Are they reinforced vertically and/or horizontally? b Are they detailed to allow sliding at the top and movement at the sides? c Are they restrained at the top and the sides against falling?			#46
Stud-wall and Other Lightweight a Are partial-height partitions braced at their top edges? b If they support shelving or cabinets, are they securely attached to the structure of the building?			#45

ITEM	YES	NO	SKETCH REF
Ceilings and Lights			
Ceilings a Do the suspended ceilings have diagonal bracing wires? b For plaster ceilings is the wire mesh or wood lath securely attached to the structure above?			#47
Lighting a Do light fixtures (*eg* lay-in fluorescent fixtures) have supports independent of the ceiling grid? b Do pendant fixtures have safety restraints (*eg* cables) to limit sway? c Are emergency lights mounted to prevent them falling off shelf supports?			
Doors and Windows			
Doors a If exit doors are heavy metal fire doors that might jam in an earthquake, is there a crowbar or sledge hammer readily available to facilitate emergency opening? b Do automatic doors have manual overrides?			
Windows a Is it known whether the glazing has been designed to accommodate lateral movement? b Do large windows, door transoms and skylights have safety glass?			
Appendages and Sundries			
Parapets, Veneer and Decoration a Are parapets reinforced and braced? b Do veneers and decorative elements have positive anchorage to the building?			
Fences and Garden Walls a Is it known whether these were designed by the architect or engineer to resist lateral forces? b Are masonry walls reinforced vertically and rigidly fixed to their bases?			
Signs and Sculptures a Are signs adequately anchored? b Are heavy and/or tall sculptures anchored to prevent overturning?			
Clay and Concrete Roof Tiles a Are such tiles secured to the roof with individual fixings for each tile?			

ITEM	YES	NO	SKETCH REF
Movable Equipment			
Communications a Is radio equipment restrained from sliding off shelves? b Are telephones placed away from edges of desks and counters? c Are elevated loud speakers and CCTV anchored to the structure?			
Computers a Is vital computer information backed up regularly and stored off site? b Is heavy computer equipment with a height-to-width ratio greater than 2 anchored or braced? c Are desktop items prevented from sliding off tables? d Are access floors braced diagonally or do they have seismically-certified pedestals?			#57 #56
Storage of Records and Supplies a Are shelving units anchored to walls? b Are shelves fitted with edge restraints or cords to prevent items from falling? c Are heavier items located on the lower shelves? d Do filing cabinet drawers latch securely? e Are heavily-loaded racks braced in both directions? f Are fragile or valuable items restrained from tipping over? g Are chemical supplies secured or stored in "egg crate" containers?			#66 #63 #58
Hazardous Items a Are gas cylinders tightly secured with chains at top and bottom (or otherwise)? b Are the chains anchored to walls? c Are chemicals stored in accordance with manufacturers recommendations? d Are cabinets for hazardous materials given special attention with respect to anchoring?			#65
Furniture a Are heavy potted plants restrained from falling or located away from beds? b Are beds and tables and equipment with wheels provided with locks or other restraints to prevent them rolling unintentionally?			#56

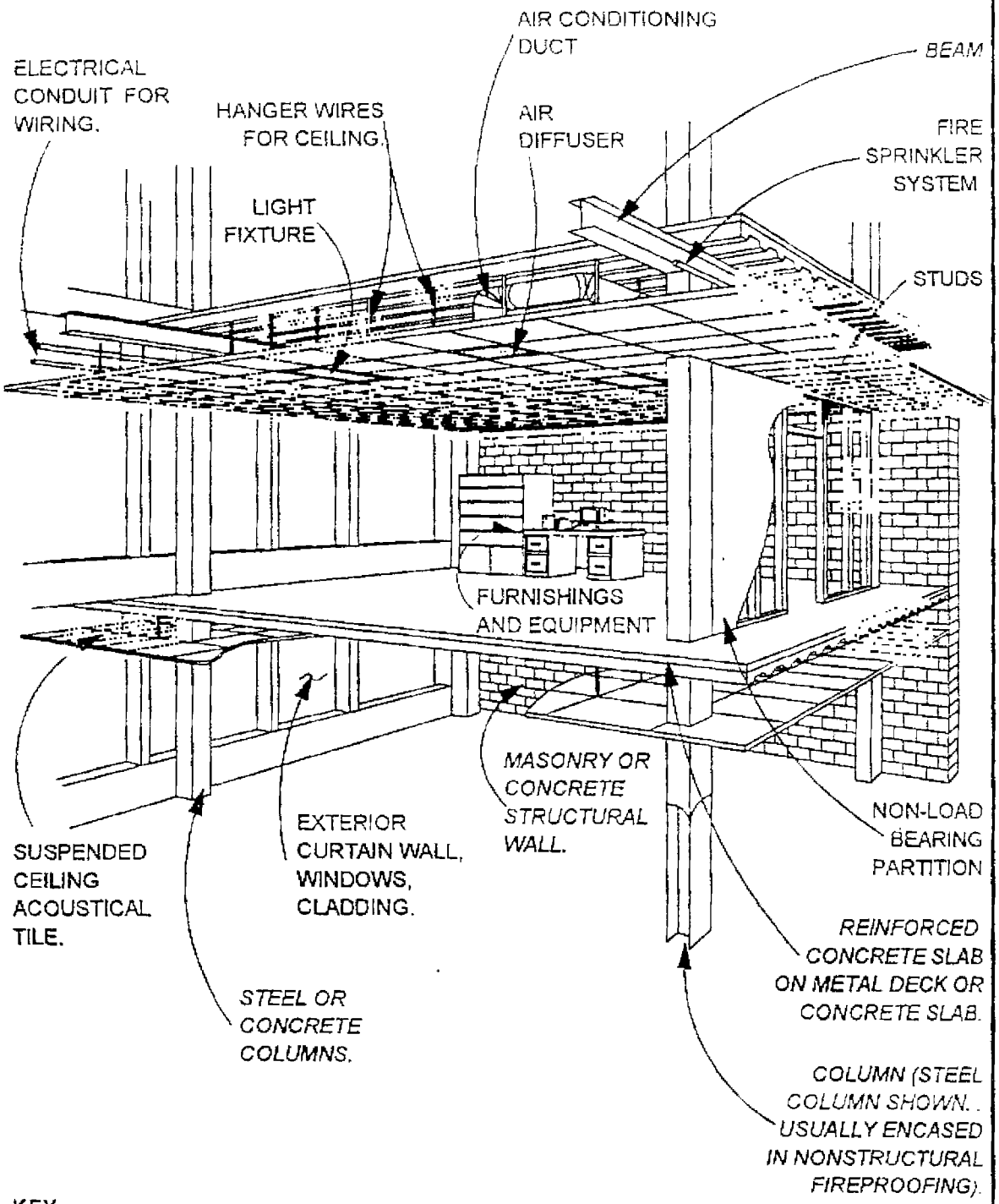
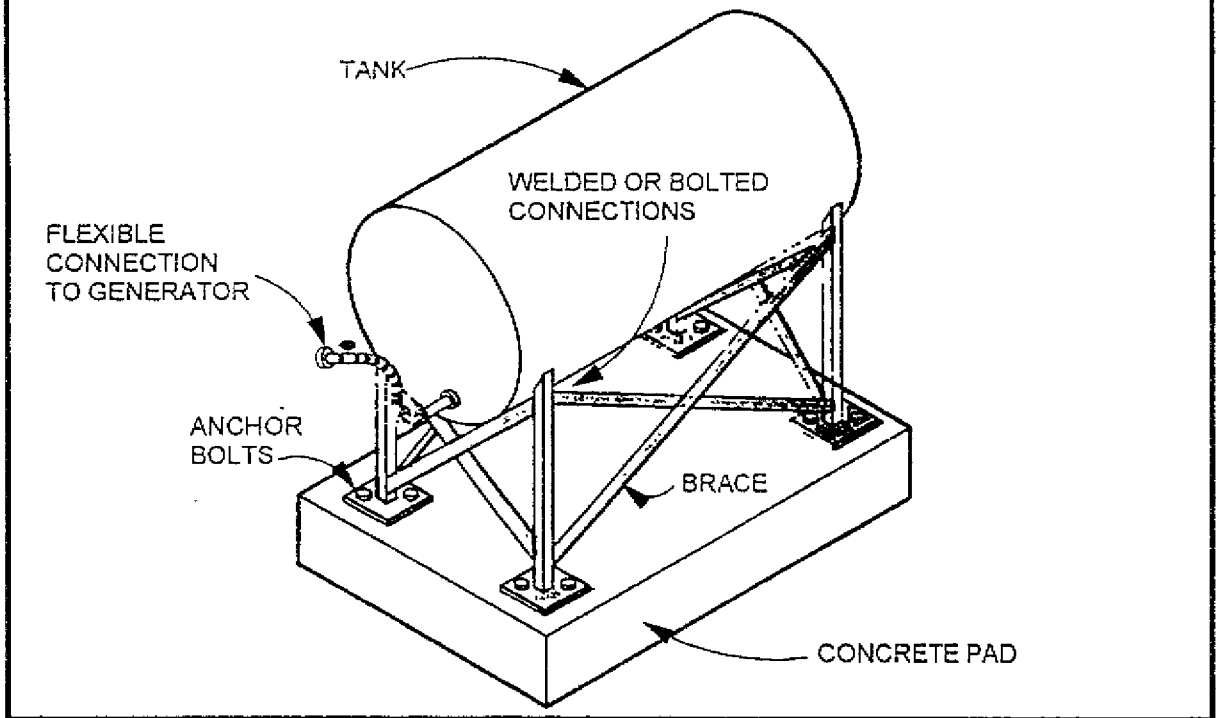


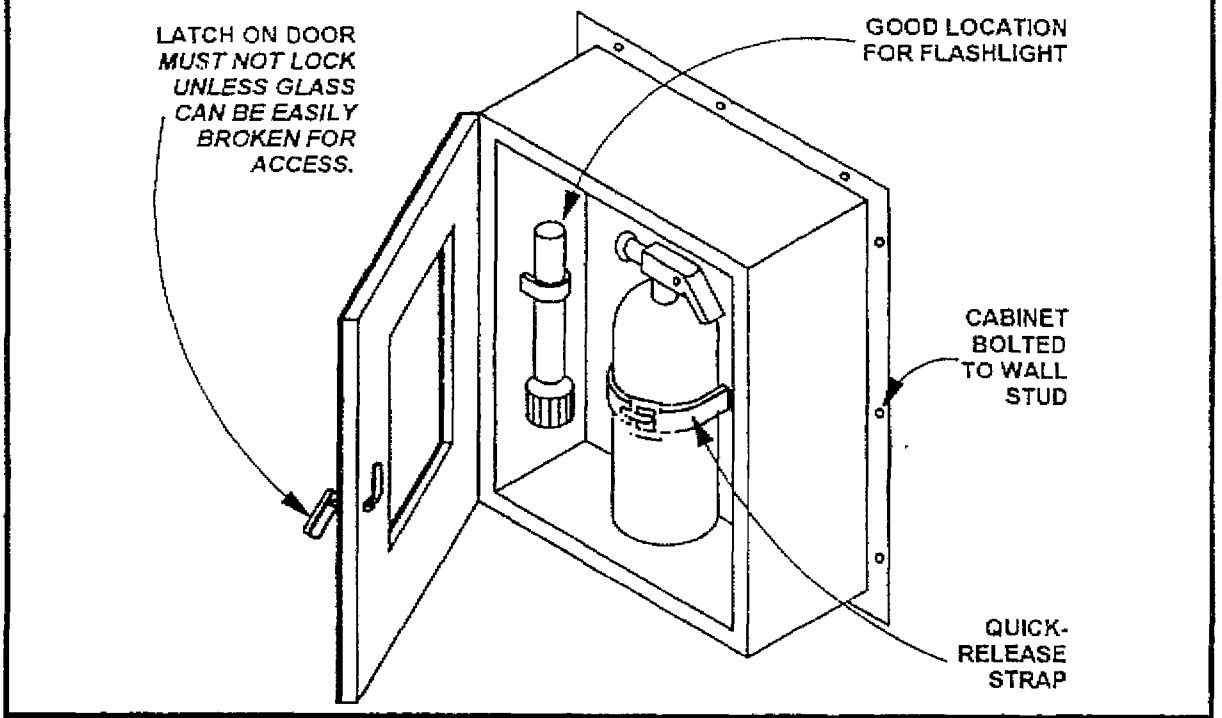
Figure 1. Nonstructural and Structural Components of a Typical Building

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



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

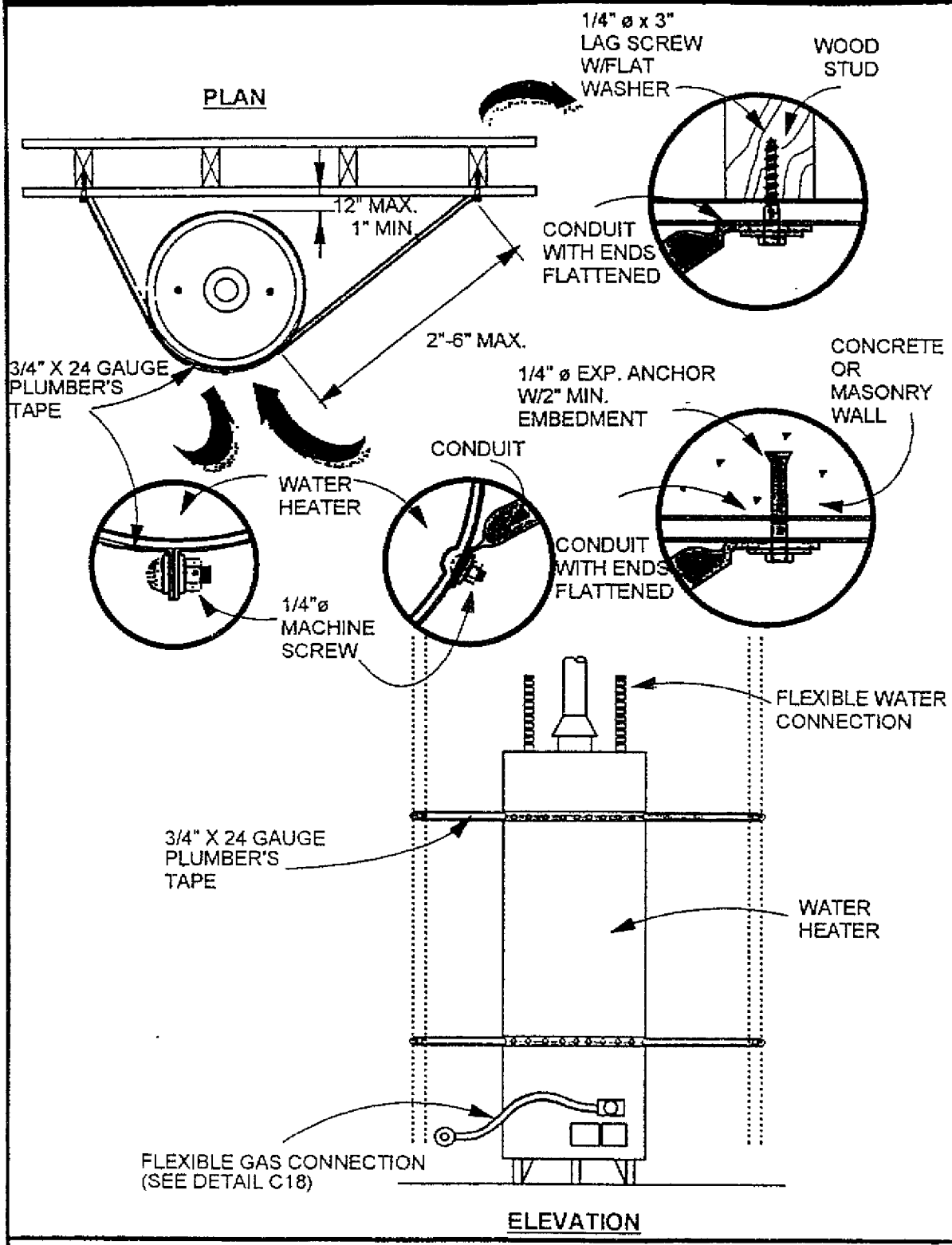
Extinguisher
Wiss, Janney, Elstner Associates, Inc.



Detail U10
Estimate Cost: $300
3/10

WATER HEATER: WALL INSTALLATION

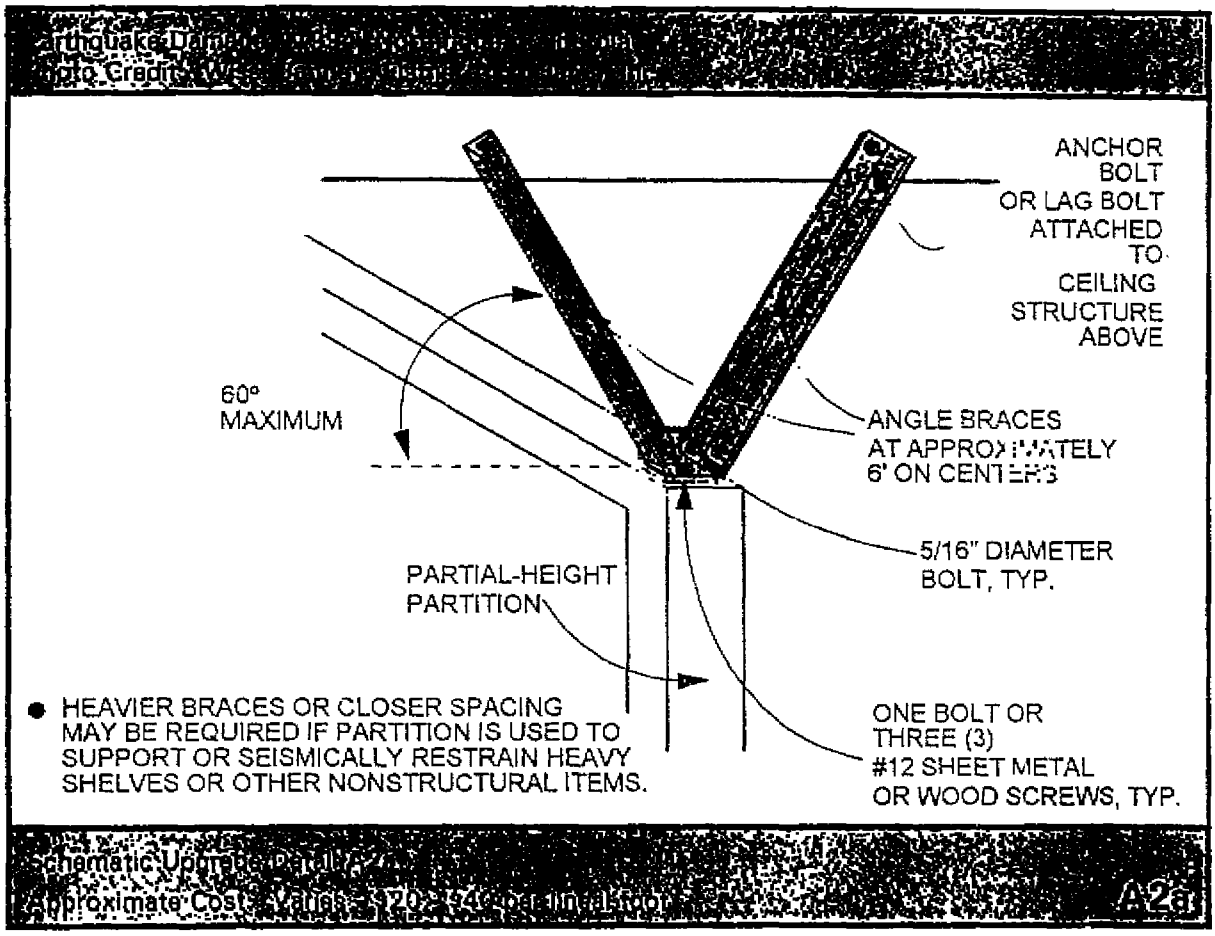
DO-IT-YOURSELF



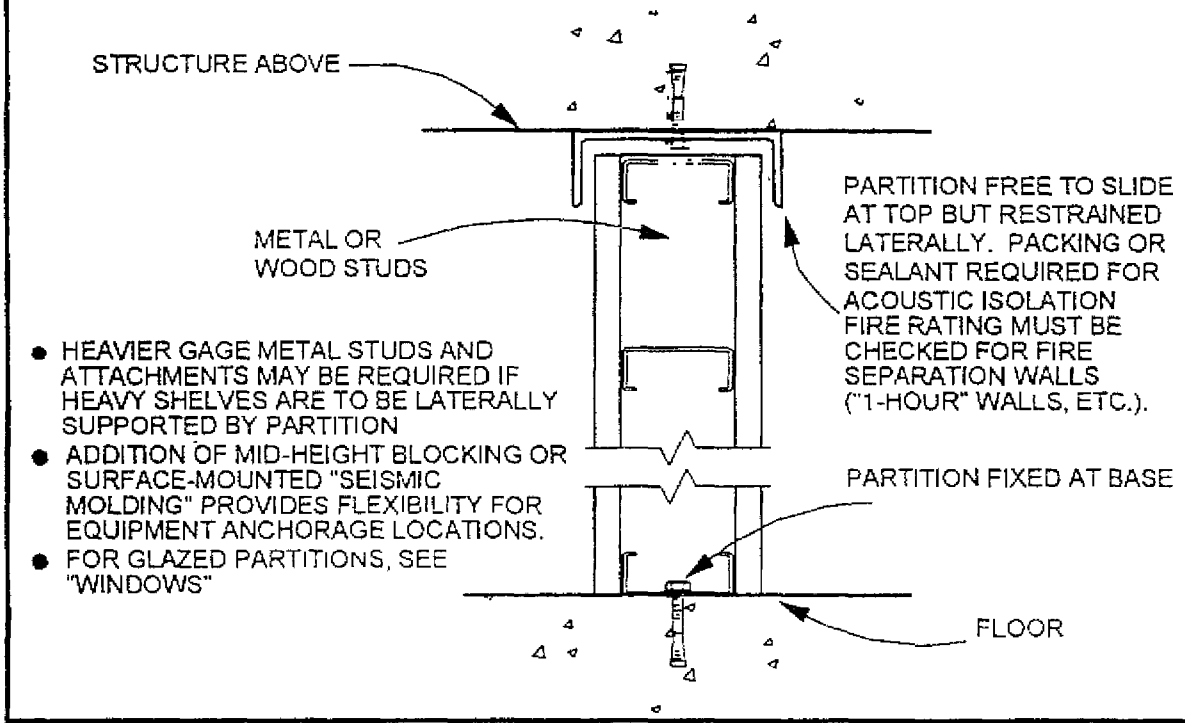
Upgrade Detail U19b

Approximate Cost: $200

U19b


ANCHOR BOLT OR LAG BOLT ATTACHED TO CEILING STRUCTURE ABOVE
60° MAXIMUM
ANGLE BRACES AT APPROXIMATELY 6' ON CENTERS
5/16" DIAMETER BOLT, TYP.
PARTIAL-HEIGHT PARTITION
ONE BOLT OR THREE (3) #12 SHEET METAL OR WOOD SCREWS, TYP.
• HEAVIER BRACES OR CLOSER SPACING MAY BE REQUIRED IF PARTITION IS USED TO SUPPORT OR SEISMICALLY RESTRAIN HEAVY SHELVES OR OTHER NONSTRUCTURAL ITEMS.
A2d

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

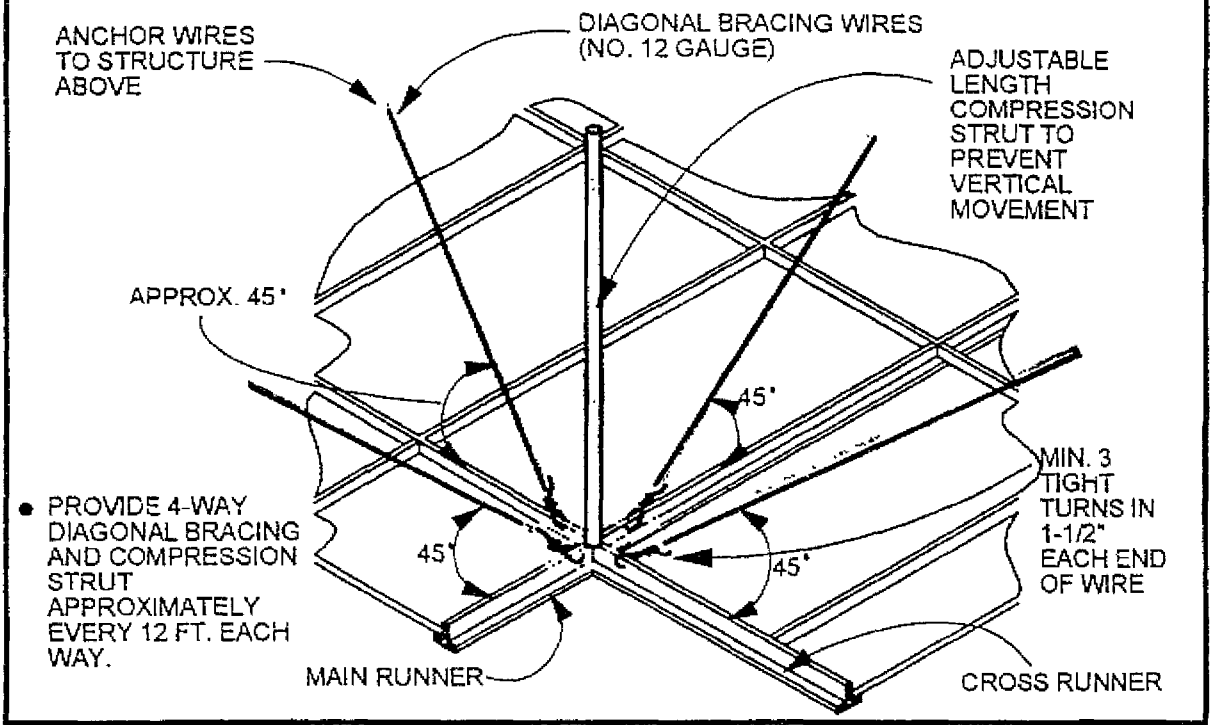


- HEAVIER GAGE METAL STUDS AND ATTACHMENTS MAY BE REQUIRED IF HEAVY SHELVES ARE TO BE LATERALLY SUPPORTED BY PARTITION
- ADDITION OF MID-HEIGHT BLOCKING OR SURFACE-MOUNTED "SEISMIC MOLDING" PROVIDES FLEXIBILITY FOR EQUIPMENT ANCHORAGE LOCATIONS.
- FOR GLAZED PARTITIONS, SEE "WINDOWS"

Schematic Upgrade Detail A2b
Approximate Cost: Varies, depending on design

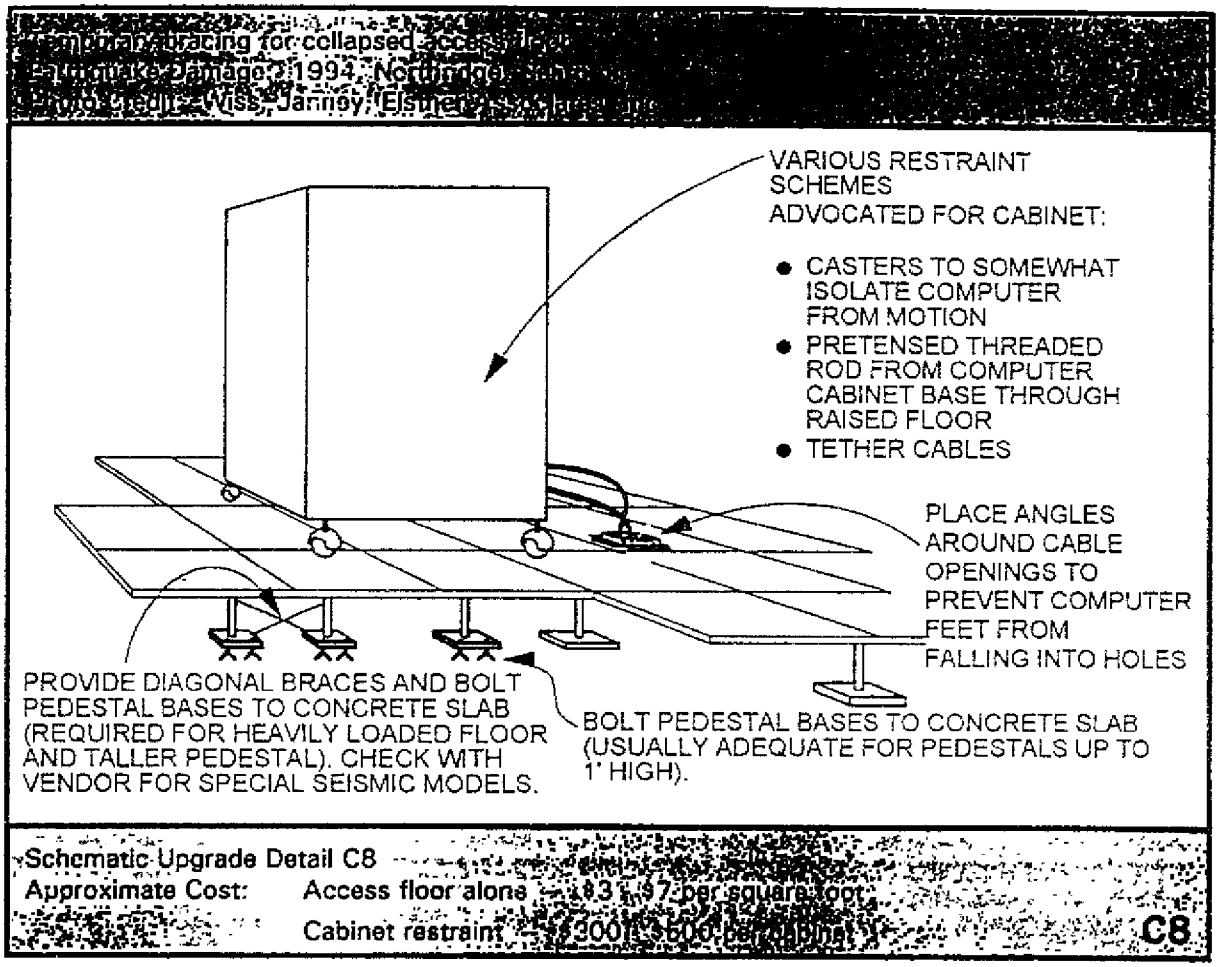
A2b

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

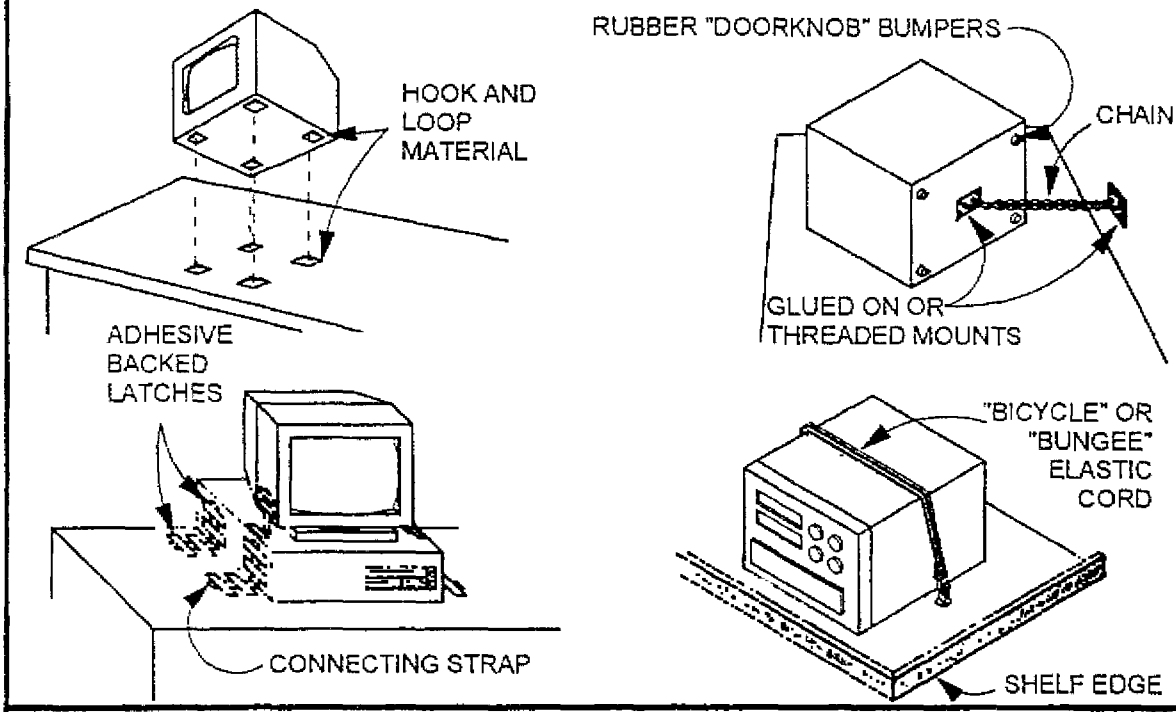


Schematic Upgrade Detail A3
Approximate Cost: $50 per brace

A3

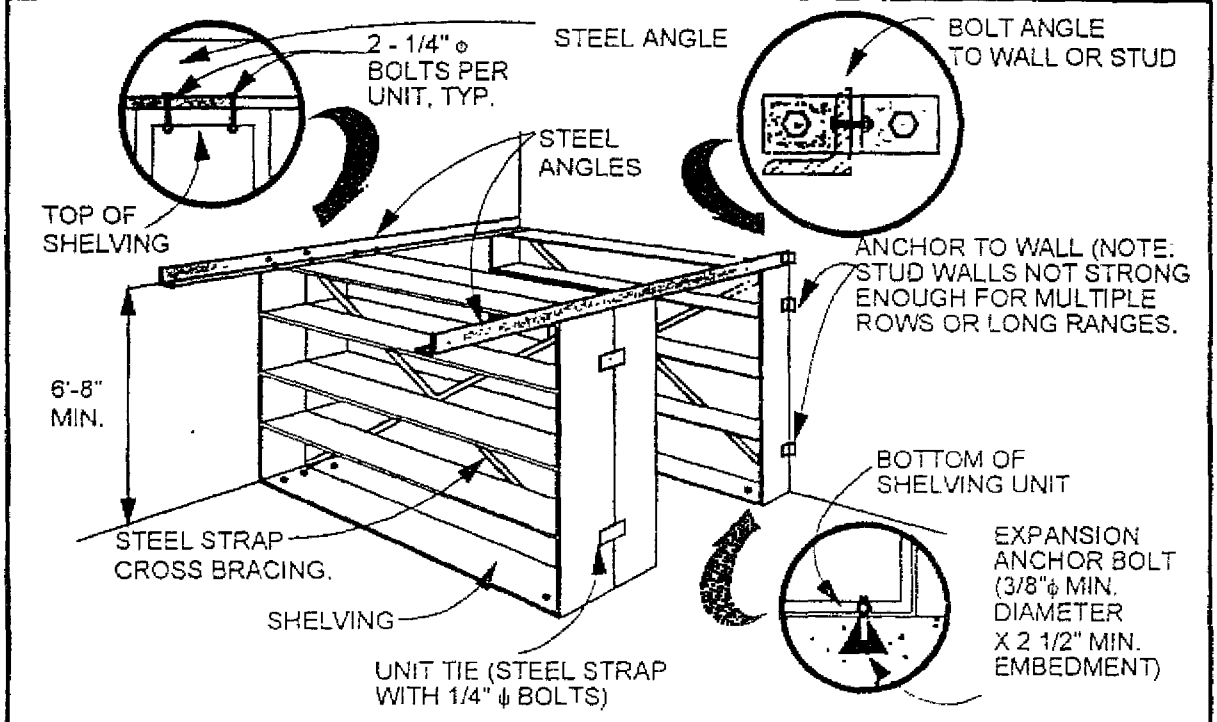

VARIOUS RESTRAINT SCHEMES ADVOCATED FOR CABINET:
• CASTERS TO SOMEWHAT ISOLATE COMPUTER FROM MOTION
• PRETENSED THREADED ROD FROM COMPUTER CABINET BASE THROUGH RAISED FLOOR
• TETHER CABLES
PLACE ANGLES AROUND CABLE OPENINGS TO PREVENT COMPUTER FEET FROM FALLING INTO HOLES
PROVIDE DIAGONAL BRACES AND BOLT PEDESTAL BASES TO CONCRETE SLAB (REQUIRED FOR HEAVILY LOADED FLOOR AND TALLER PEDESTAL). CHECK WITH VENDOR FOR SPECIAL SEISMIC MODELS.
BOLT PEDESTAL BASES TO CONCRETE SLAB (USUALLY ADEQUATE FOR PEDESTALS UP TO 1' HIGH).
Schematic Upgrade Detail C8
Approximate Cost:
Access floor alone
Cabinet restraint
C8

Unsecured computers may fall and suffer damage.
Photo Credit: Wiss, Janney, Elstner Associates, Inc.



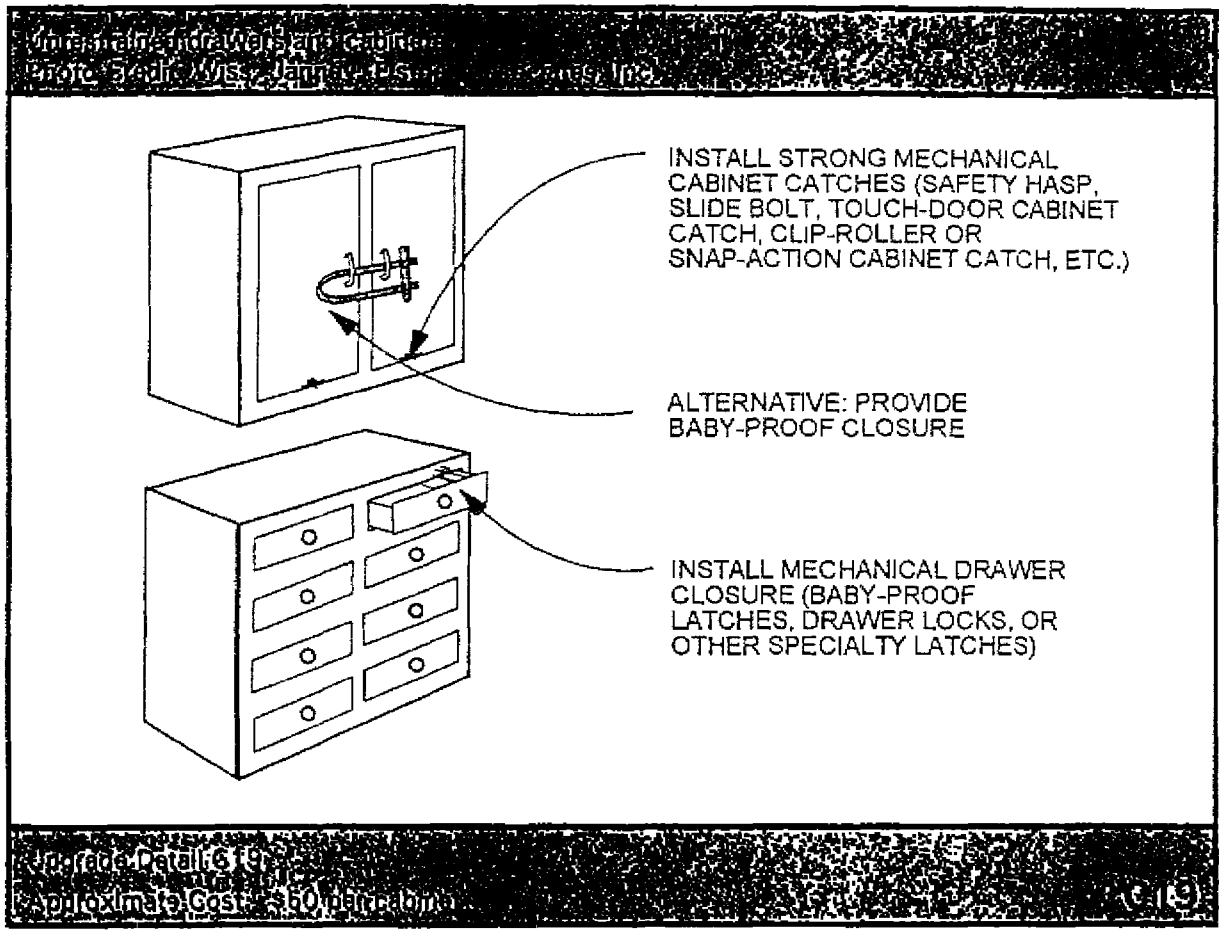
Upgrade Detail C10
Approximate Cost: $50 per computer

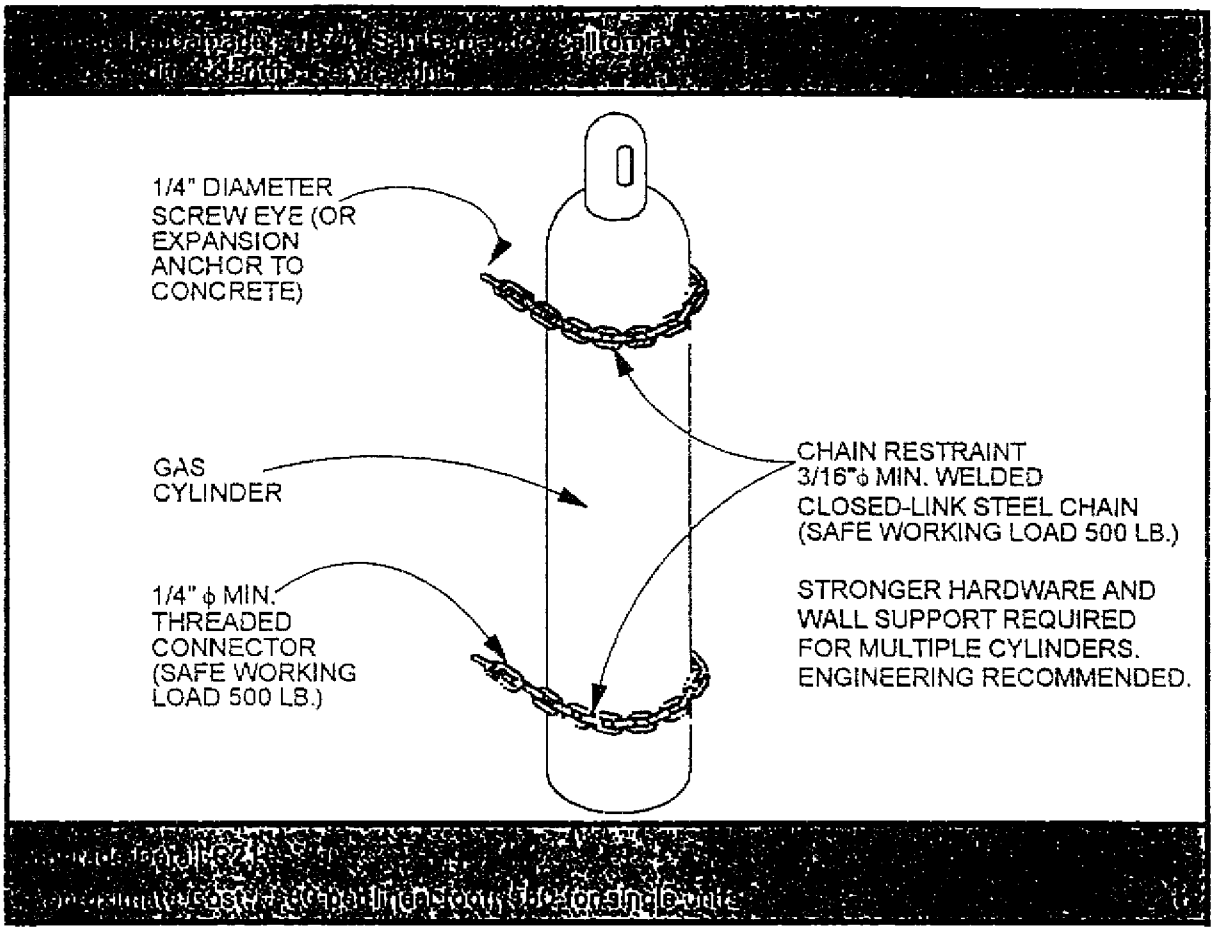
Earthquake Damage: 1972, Managua, Nicaragua
Photo Credit: John F. Meehan



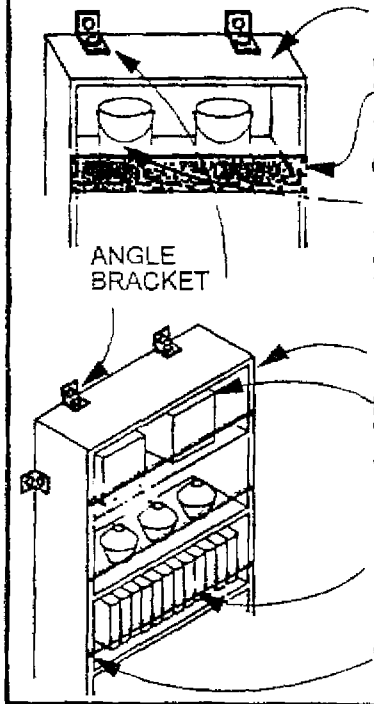
Schematic Upgrade Detail C12a
Approximate Cost: $20 per lineal foot of shelving

C12a


INSTALL STRONG MECHANICAL CABINET CATCHES (SAFETY HASP, SLIDE BOLT, TOUCH-DOOR CABINET CATCH, CLIP-ROLLER OR SNAP-ACTION CABINET CATCH, ETC.)
ALTERNATIVE: PROVIDE BABY-PROOF CLOSURE
INSTALL MECHANICAL DRAWER CLOSURE (BABY-PROOF LATCHES, DRAWER LOCKS, OR OTHER SPECIALTY LATCHES)


1/4" DIAMETER SCREW EYE (OR EXPANSION ANCHOR TO CONCRETE)
GAS CYLINDER
1/4" ϕ MIN. THREADED CONNECTOR (SAFE WORKING LOAD 500 LB.)
CHAIN RESTRAINT 3/16"ϕ MIN. WELDED CLOSED-LINK STEEL CHAIN (SAFE WORKING LOAD 500 LB.)
STRONGER HARDWARE AND WALL SUPPORT REQUIRED FOR MULTIPLE CYLINDERS. ENGINEERING RECOMMENDED.

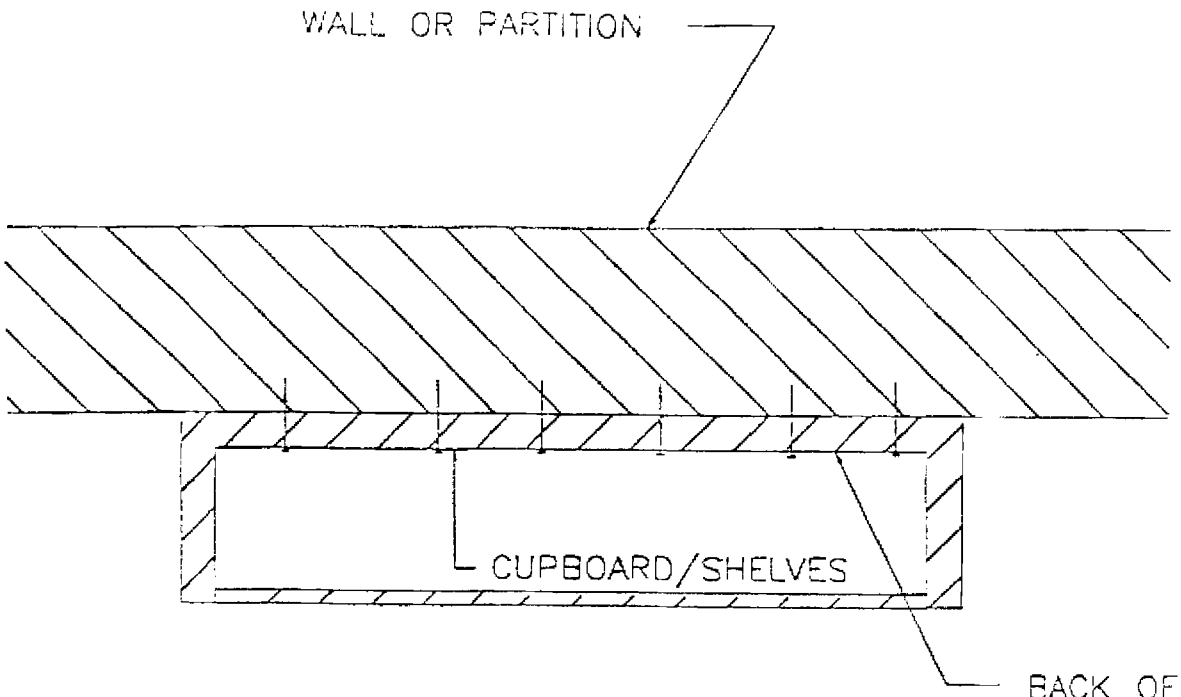
Typical laboratory chemical and physical supplies
Earthquake Damage, 1994, Northridge, California
Photo Credit: Roland Bethelman



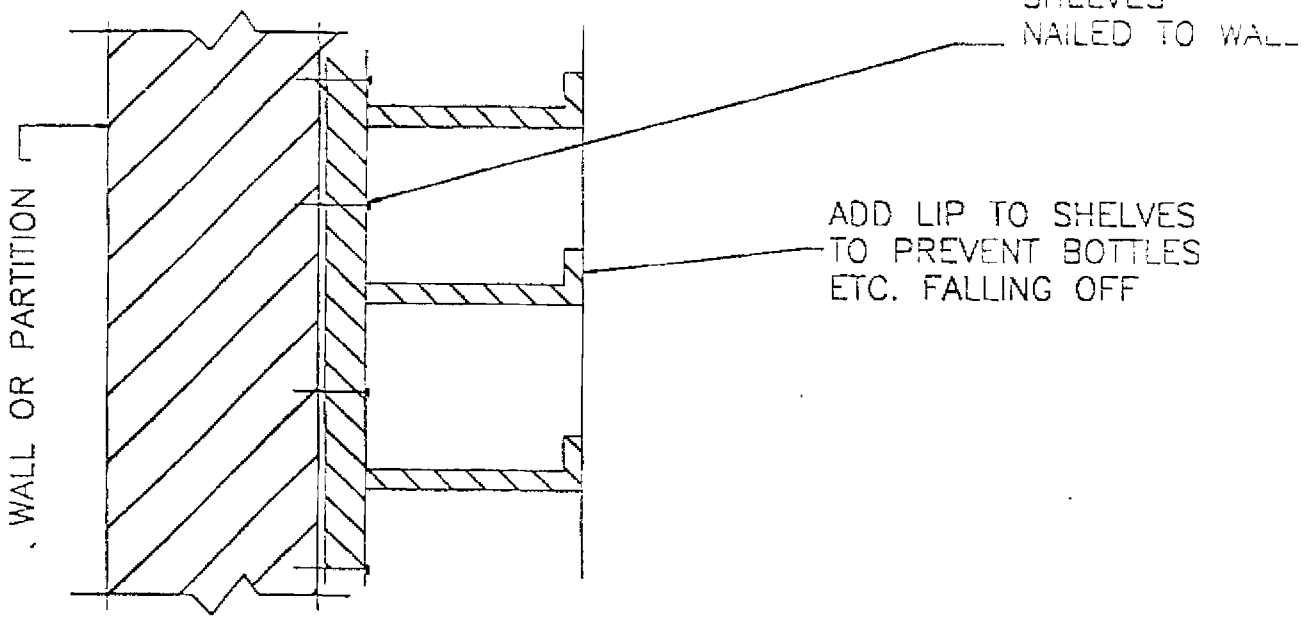
- ANCHOR STORAGE SHELVES
- PROVIDE SAFETY LIP OR SHELF EDGE
- PROVIDE MECHANICAL LATCHES FOR CABINETS AND DRAWERS
- STORE SMALL OR BREAKABLE ITEMS IN ORIGINAL PACKING OR EGGCRATE BOXES, NOT LOOSE ON SHELF OR IN DRAWER
- STORE INCOMPATIBLE MATERIALS AT A SAFE DISTANCE TO AVOID MIXING IF THE CONTAINERS FALL
- ORDER HAZARDOUS LAB CHEMICALS IN UNBREAKABLE PLASTIC BOTTLES OR IN GLASS BOTTLES WITH AN EXTERIOR PLASTIC SAFETY COATING

Schematic Upgrade Detail C22
Approximate Cost: Varies

C22



PLAN



PART ELEVATION

NOTES	The Queen Elisabeth Hospital Bridgetown, Barbados	SCALE: Not To Scale
1		DATE: Aug 98
	Cupboard/Shelves – Fixing Details	JOB No: CEP/20432
	CONSULTING ENGINEERS PARTNERSHIP LTD	SKETCH No: A