Earthquake Mitigation for Hospitals: Workshop

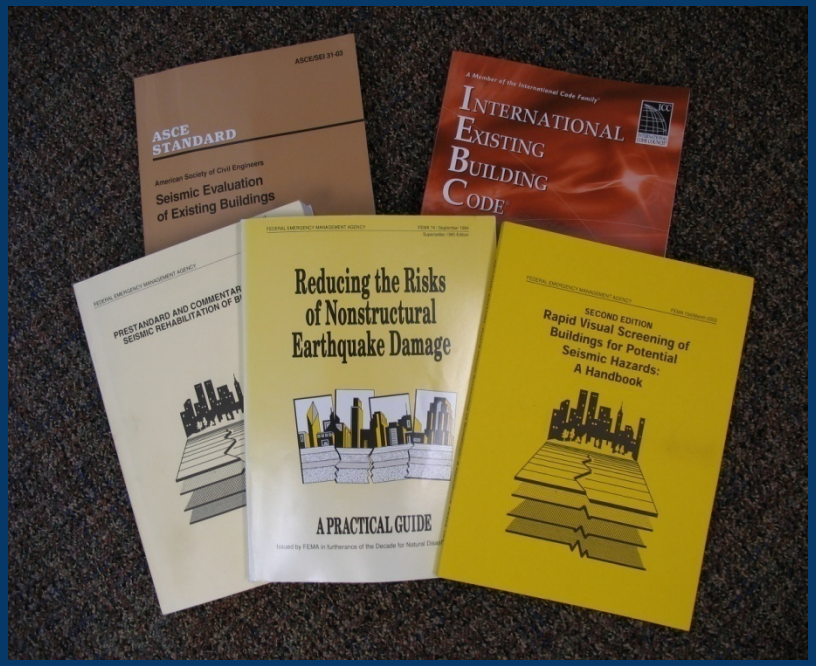
Part 9 – Nonstructural Equipment Mitigation

Nonstructural Mitigation Options

- Retrofit
- Replace
- Relocate
- Replicate (redundancy N+1/ provide a back-up)
- Plan for the consequences of failure

Nonstructural Resources

- FEMA 74 – Reducing the Risks of Nonstructural Earthquake Damage – A Practical Guide
- FEMA 154/155 – Rapid Visual Screening of Buildings for Potential Seismic Hazards
- ASCE/SEI 31-03 – Standard Seismic Evaluation of Existing Buildings
- ASCE 41-06 – Seismic Rehabilitation of Existing Buildings



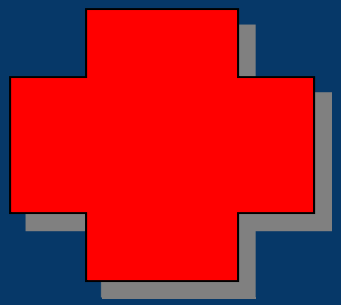
Nonstructural Resources

- FEMA 412: Installing Seismic Restraints for Mechanical Equipment
- FEMA 413: Installing Seismic Restraints for Electrical Equipment
- FEMA 414: Installing Seismic Restraints for Duct and Pipe

Nonstructural Mitigation

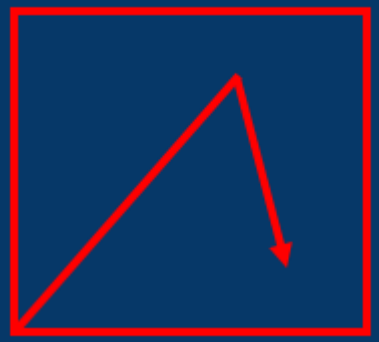
Nonstructural Mitigation

Step 1 – Risk Assessment



Life Safety

Property Loss



Functional Loss

Life Safety

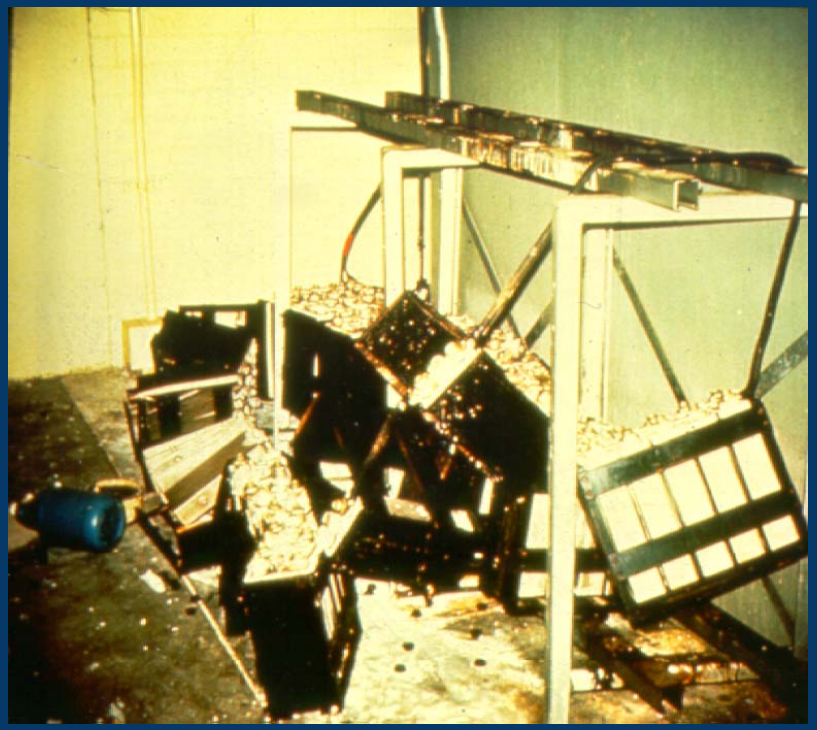
If item is damaged and inoperable will it:

- Become dislodged and hurt someone?
- Interrupt life support equipment?
- Harm patient's health?
- Prevent ability to perform emergency room services? Operating room services? Other critical care services?
- Require patients to be transferred?

Can it hurt someone?

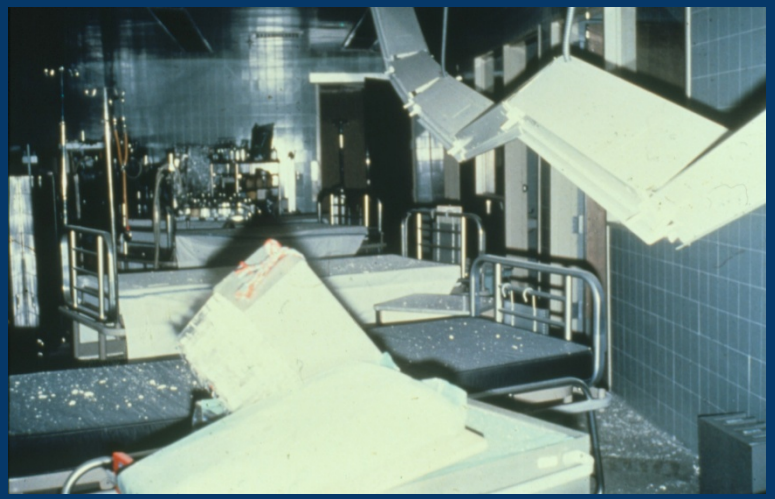
Can it hurt someone?

Can it interrupt life support?



Can it harm patient's health?

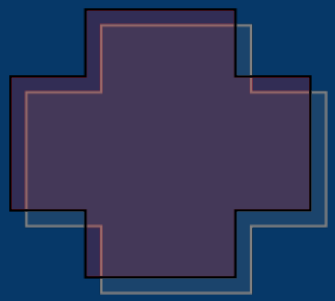
Prevent ability to provide critical care services?



Require evacuation?

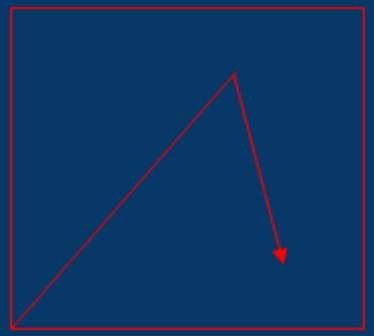
Nonstructural Mitigation

Step 1 – Risk Assessment



Life Safety

Property Loss



Functional Loss

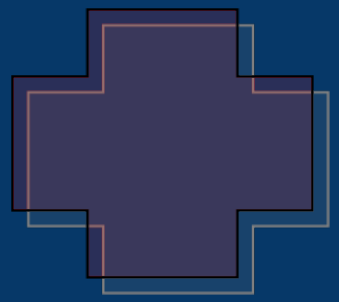
Property Loss

Repair or replacement of:

- Equipment
- Interior finishes
- Exterior cladding

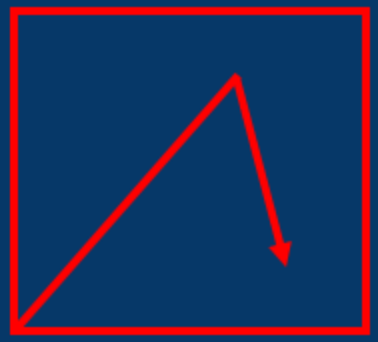
Nonstructural Mitigation

Step 1 – Risk Assessment



Life Safety

Property Loss



Functional Loss

Functional Loss

Nonstructural Mitigation Steps

1. Facility risk assessment:
   - Desk-top survey $
   - Rapid visual survey of the facility $$
   - Comprehensive facility risk assessment of building and nonstructural components $$$
2. Rank & prioritize risks
3. Develop a Mitigation Plan from the assessment findings and recommendations
4. Capitalize and begin to implement the Mitigation Plan

FEMA 74 nonstructural assessment

NONSTRUCTURAL INVENTORY SURVEY FORM

Building Name Corporate Headquarters Inspector Joe Engineer

Address 5555 Kingshighway Date April 19, 2007

City, State Zip Anywhere, USA

Room ID	Element Description	Quantity	Units	Restraint Detail	Retrofit Required Y/N	Comments
501	Administrative Offices:					
	Suspended Ceiling	1	144 sf	Detail ES-4	Y	Attach perimeter grid to (2) adj. walls.
	2x4 Fluorescent Lights	6	- - -	Detail ES-24	Y	Add safety wires to lights – One each opposite corner.
	Bookcases at exit	2	- - -		Y	Relocate bookcases from egress corridor, or anchor to adjacent wall studs per Detail ES-5.
502	Electrical Room:					
	Dry-Type Transformer	1	- - -	Detail ES-32	Y	Anchor unanchored transformer.
	Automatic Transfer Switch Panel	1	- - -	Detail ES-36	Y	
	Telecom/Network Racks	2	- - -		N	Rack bases are well anchored.
	Electric Bus Duct	1	- - -		N	Well braced top & bottom.

Sheet ____ of ____

Earthquake Hazard Mitigation for Nonstructural Elements Nonstructural Inventory Survey Form

Identifying Nonstructural Hazards

Identifying Nonstructural Hazards

- Nuclear medicine equipment
  - Suspended
  - Floor-mounted
- Ceilings
- Overhead lights
- Suspended piping

Identifying Nonstructural Hazards

- Ice Maker
- Med Stations
- Wall-mounted monitors
- Ceiling
- Overhead lights
- Suspended piping

Identifying Nonstructural Hazards

- Sterilizers
- Storage cabinets
- Mobile carts
- Casework
- Ceilings
- Overhead lights
- Suspended piping

Identifying Nonstructural Hazards

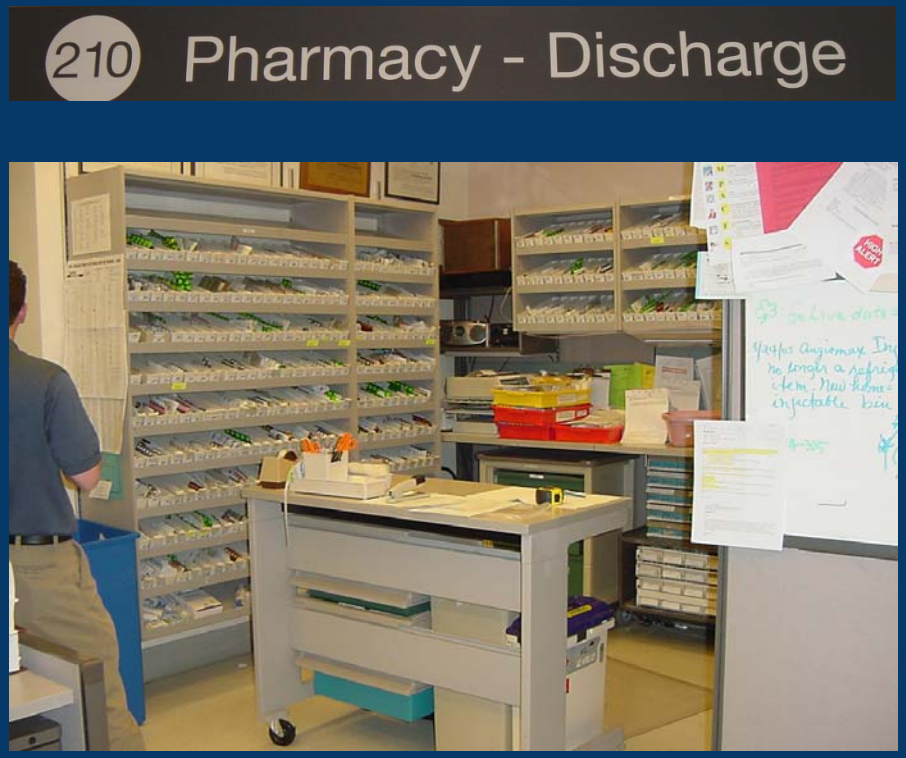
- Contents
- Storage racks
- Shelves
- Overhead lights
- Suspended piping

Identifying Nonstructural Hazards

- Refrigerators
- Analyzers
- Bench top equipment
- Storage cabinets
- Bookcases
- Ceilings
- Overhead lights
- Suspended piping

Identifying Nonstructural Hazards

- Cabinets
- Casework
- Ceiling
- Overhead lights
- Suspended piping



Identifying Nonstructural Hazards

- OR lights
- Equipment booms
- Film viewers
- Monitors
- Ceiling
- Suspended piping and HVAC

Operating Rooms

Identifying Nonstructural Hazards

- Monitors
- Headwall
- Casework
- Storage cabinets
- Televisions
- Ceiling
- Suspended piping

ICU

Identifying Nonstructural Hazards

Radiology

- Radiology equipment
- Casework
- Storage cabinets
- Ceiling
- Suspended piping

Identifying Nonstructural Hazards

- Boilers
- Chillers
- Tanks
- Cooling Towers
- Air handlers
- Exhaust fans
- Fan coils
- Piping
- Ductwork

Mechanical

Identifying Nonstructural Hazards

- Generators
- Motor control equipment
- Switchgear
- Transformers
- Panel boards
- Conduit
- Bus duct

Electrical

Identifying Nonstructural Hazards

- Continuous piping
- Continuous conduit
- Partitions

Building Separations

Identifying Nonstructural Hazards

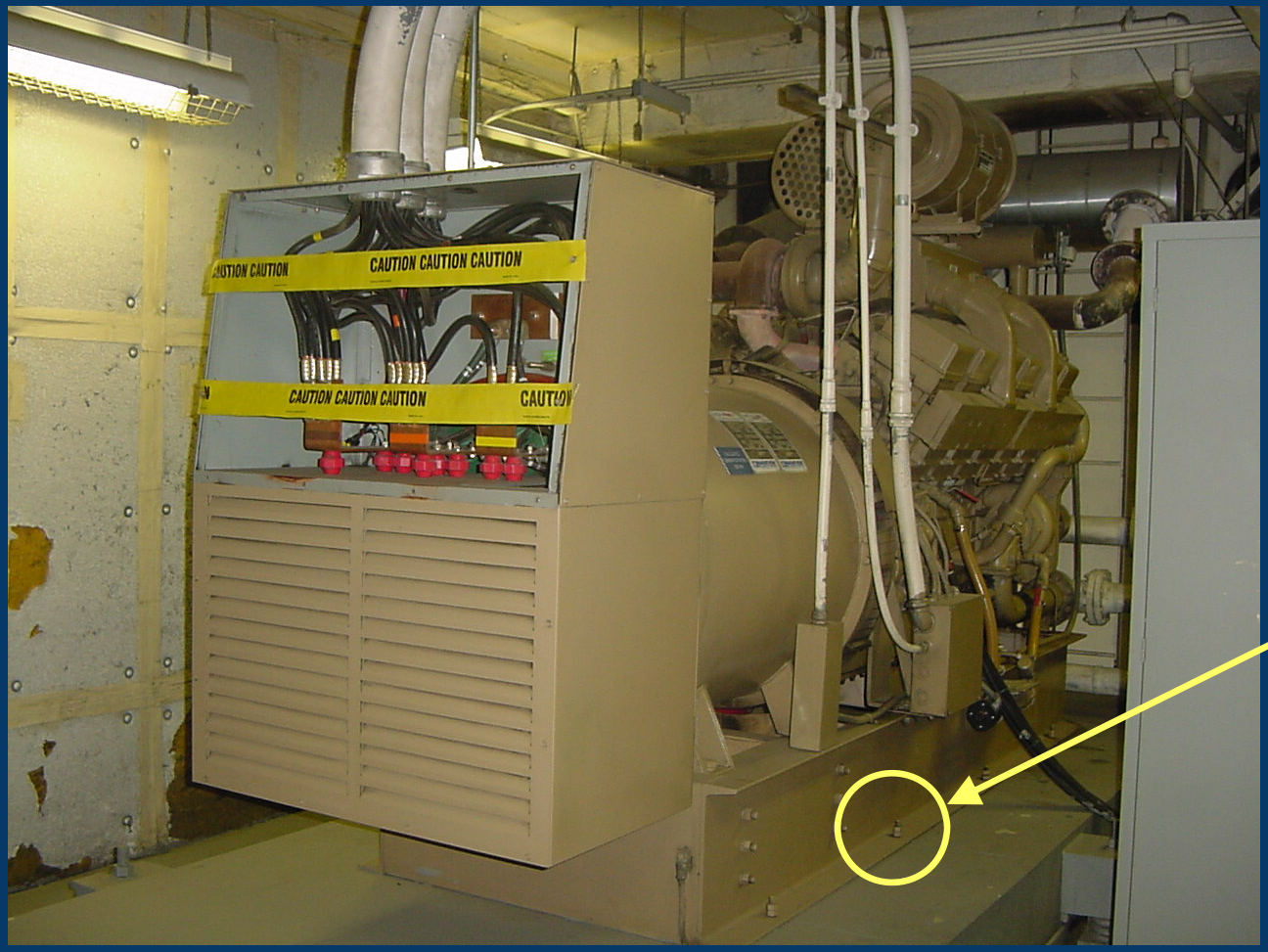
- Cladding
- Parapets
- Glazing
- Signs
- Canopies

Exterior

Mitigating Nonstructural Risks

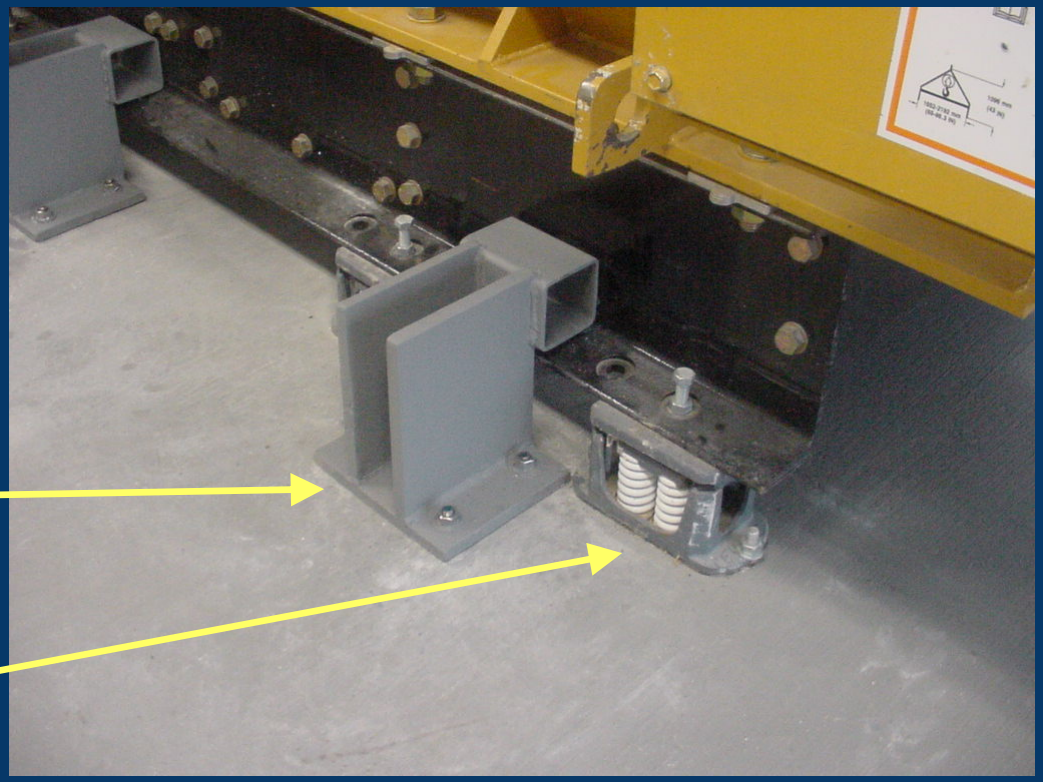
- Building utility systems
- Architectural elements
- Medical equipment
- Furniture and contents

Emergency Generator



Anchor Bolt

Emergency Generator



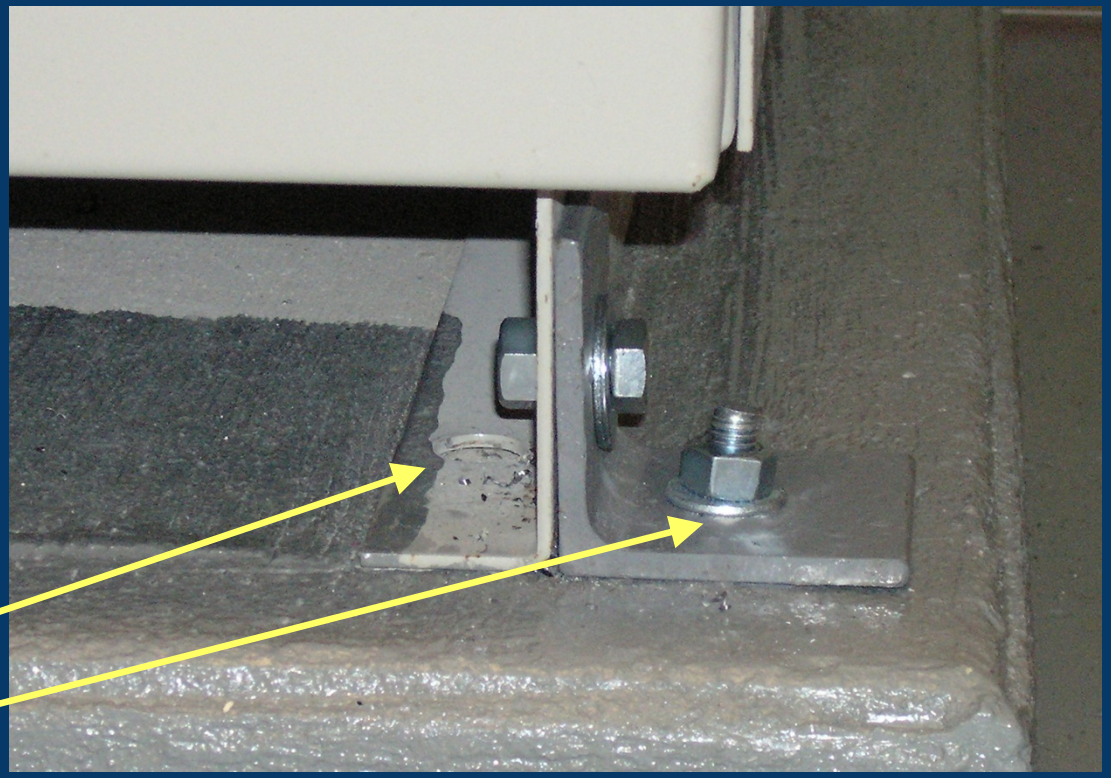
Seismic Strengthening

Non-seismic isolators

Emergency Generator

Seismic chain restraints

UPS Battery Cabinet



Missing anchor

Seismic retrofit

Packaged Chiller Unit

Seismic Strengthening

Non-seismic base isolators

Instrument Air Compressor

Base Strengthening

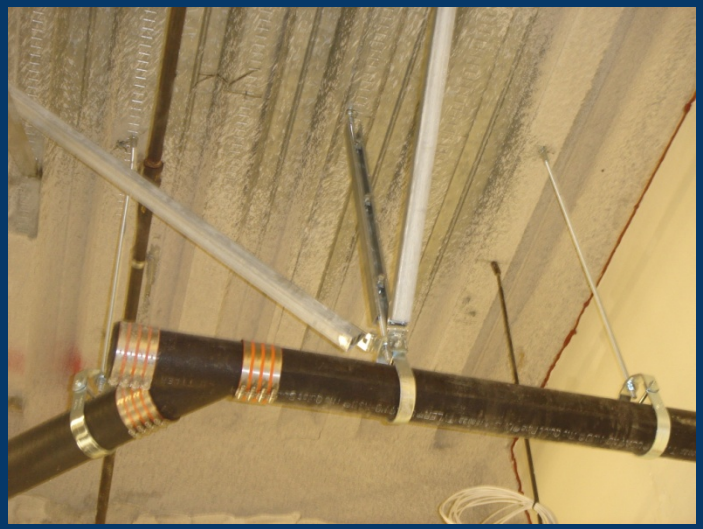
Fuel Oil Storage Tank

Additional Base Strengthening

Fuel Oil Day Tank

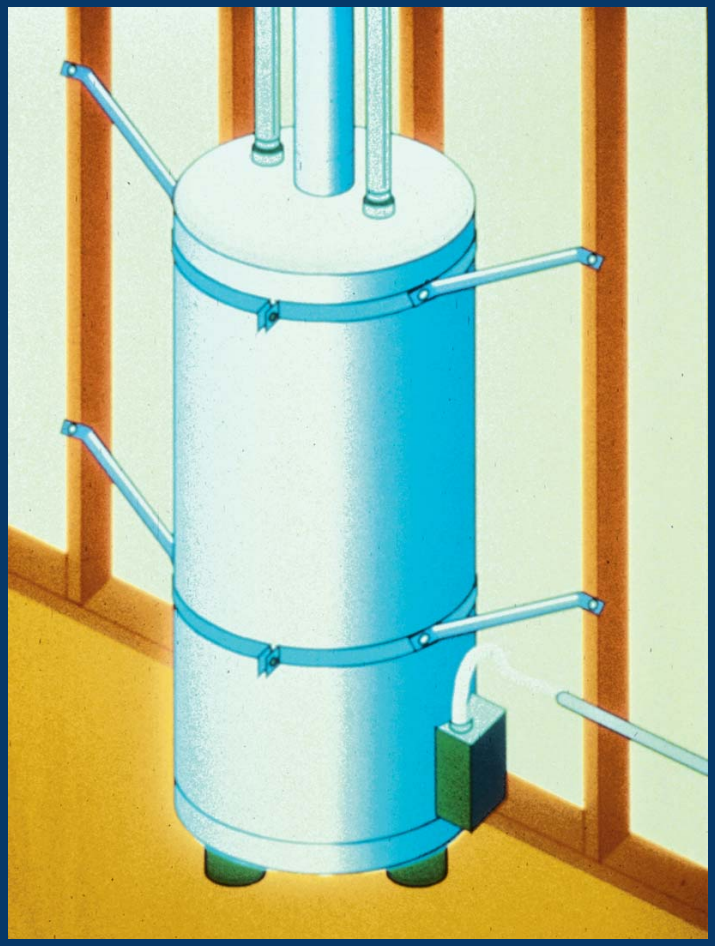
Marginal strengthening measure using seismic strap. Note large gap at wall and absence of base anchorage.

Suspended Piping



Suspended Conduit

Gas Hot Water Heaters



Architectural Elements

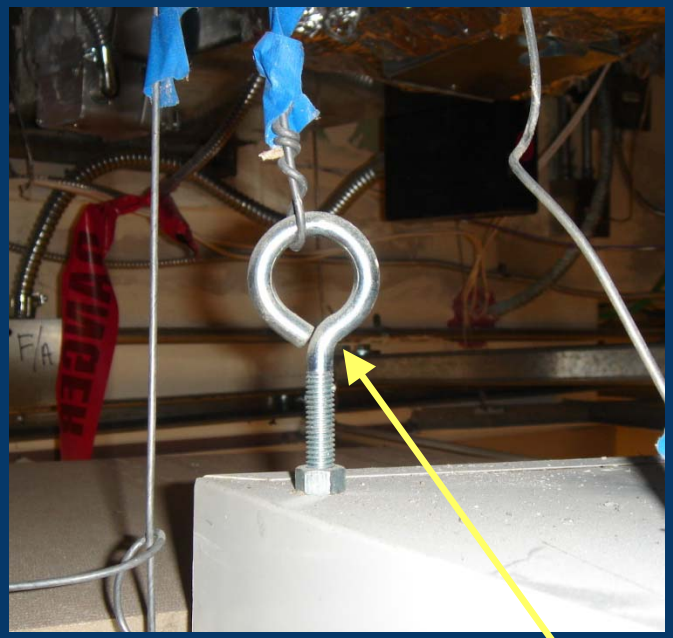
Parapet bracing

Ceilings

Compression post and splayed wire bracing

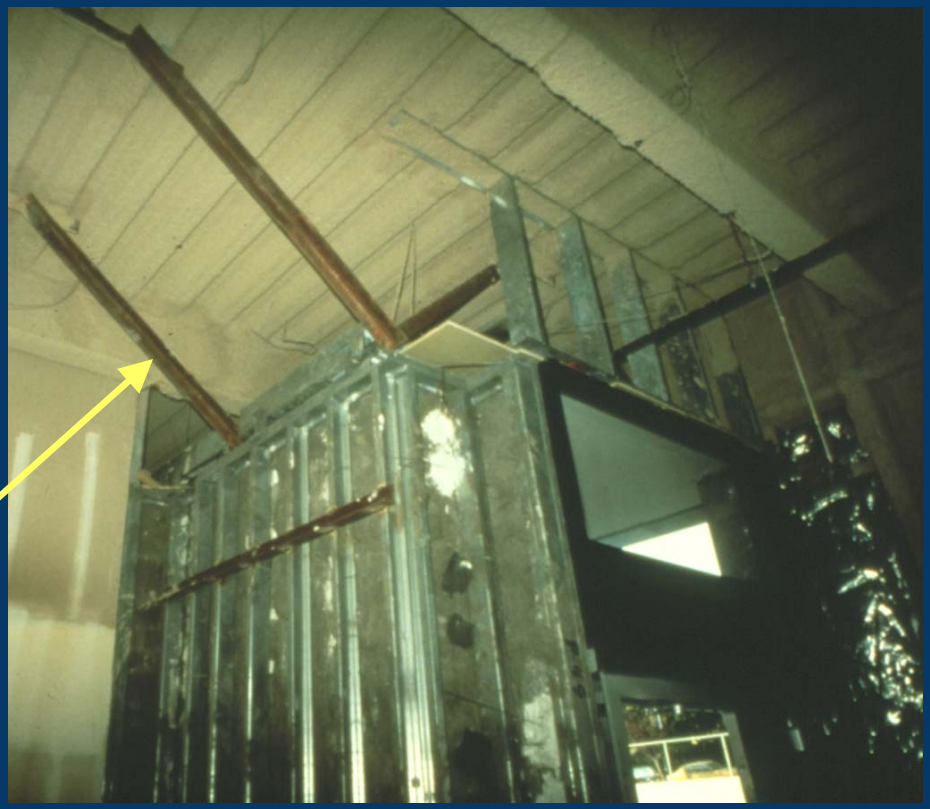
Proper grid attachment at walls

Lights



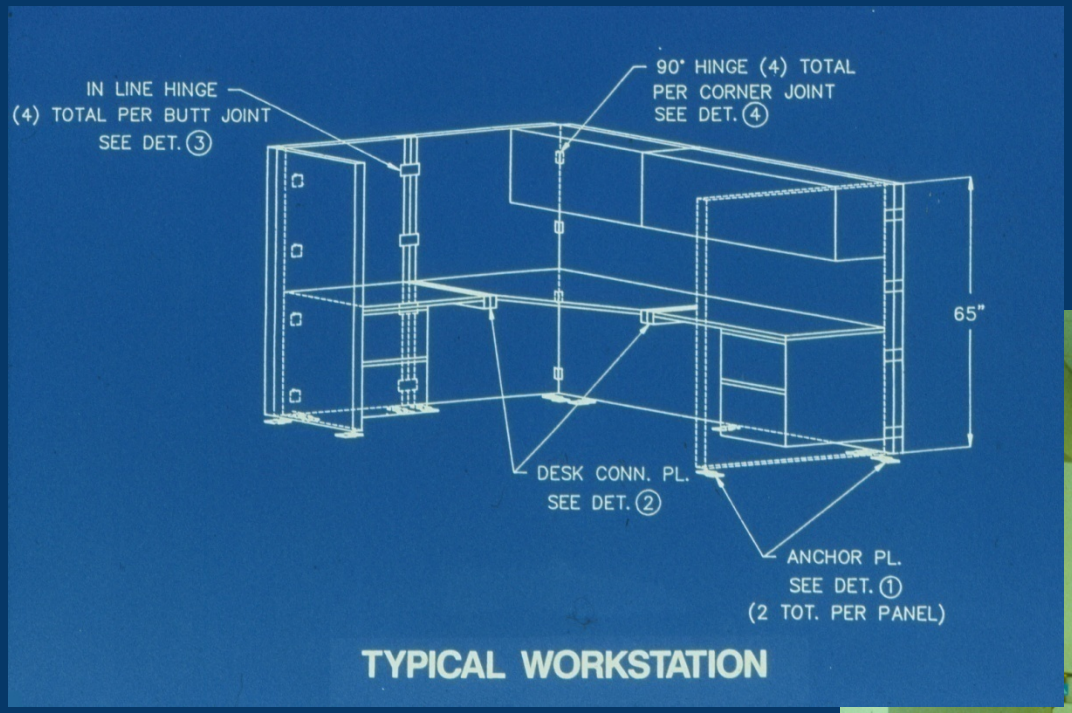
Independent support at two diagonally opposite corners

Partitions

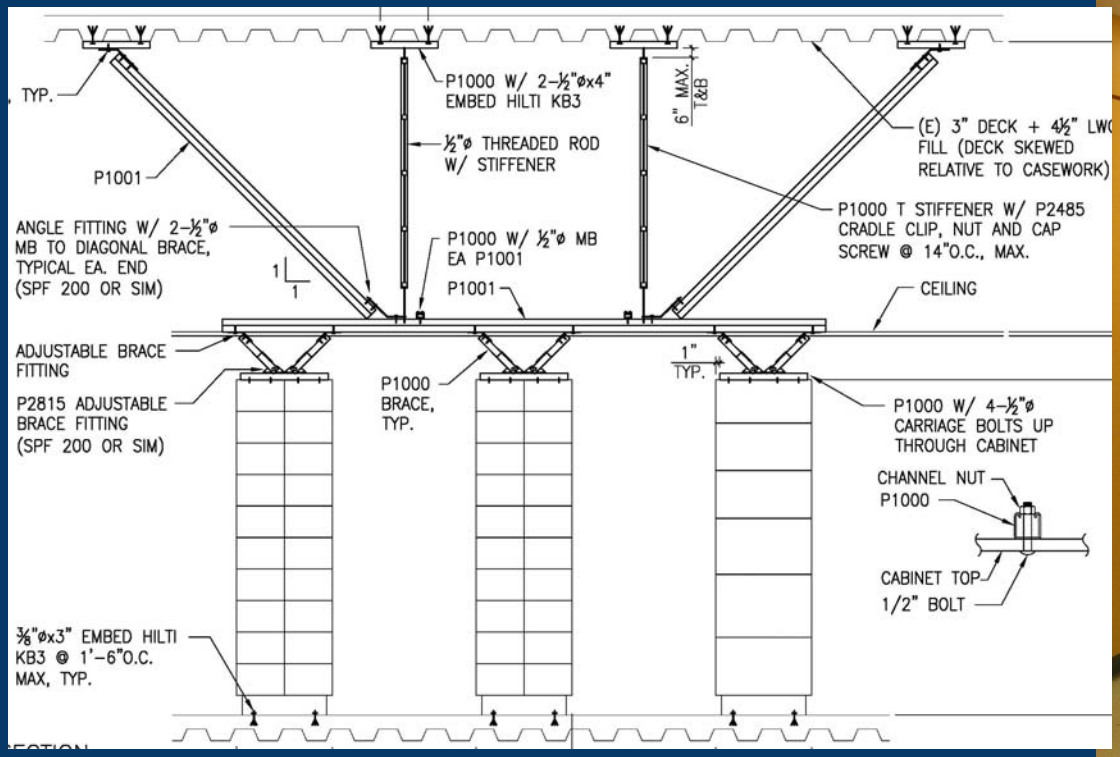


Added bracing at top of partial height studs

Demountable Partitions



Shelving


TYP.
P1001
ANGLE FITTING W/ 2-½"ø MB TO DIAGONAL BRACE, TYPICAL EA. END (SPF 200 OR SIM)
1
1
ADJUSTABLE BRACE FITTING
P2815 ADJUSTABLE BRACE FITTING (SPF 200 OR SIM)
⅜"øx3" EMBED HILTI KB3 @ 1'-6"O.C. MAX, TYP.
P1000 W/ 2-½"øx4" EMBED HILTI KB3
½"ø THREADED ROD W/ STIFFENER
P1000 W/ ½"ø MB EA P1001
P1001
P1000 BRACE, TYP.
6" MAX. T&B
1" TYP.
(E) 3" DECK + 4½" LWC FILL (DECK SKEWED RELATIVE TO CASEWORK)
P1000 T STIFFENER W/ P2485 CRADLE CLIP, NUT AND CAP SCREW @ 14"O.C., MAX.
CEILING
P1000 W/ 4-½"ø CARRIAGE BOLTS UP THROUGH CABINET
CHANNEL NUT P1000
CABINET TOP
1/2" BOLT

Cabinets

Refrigerators

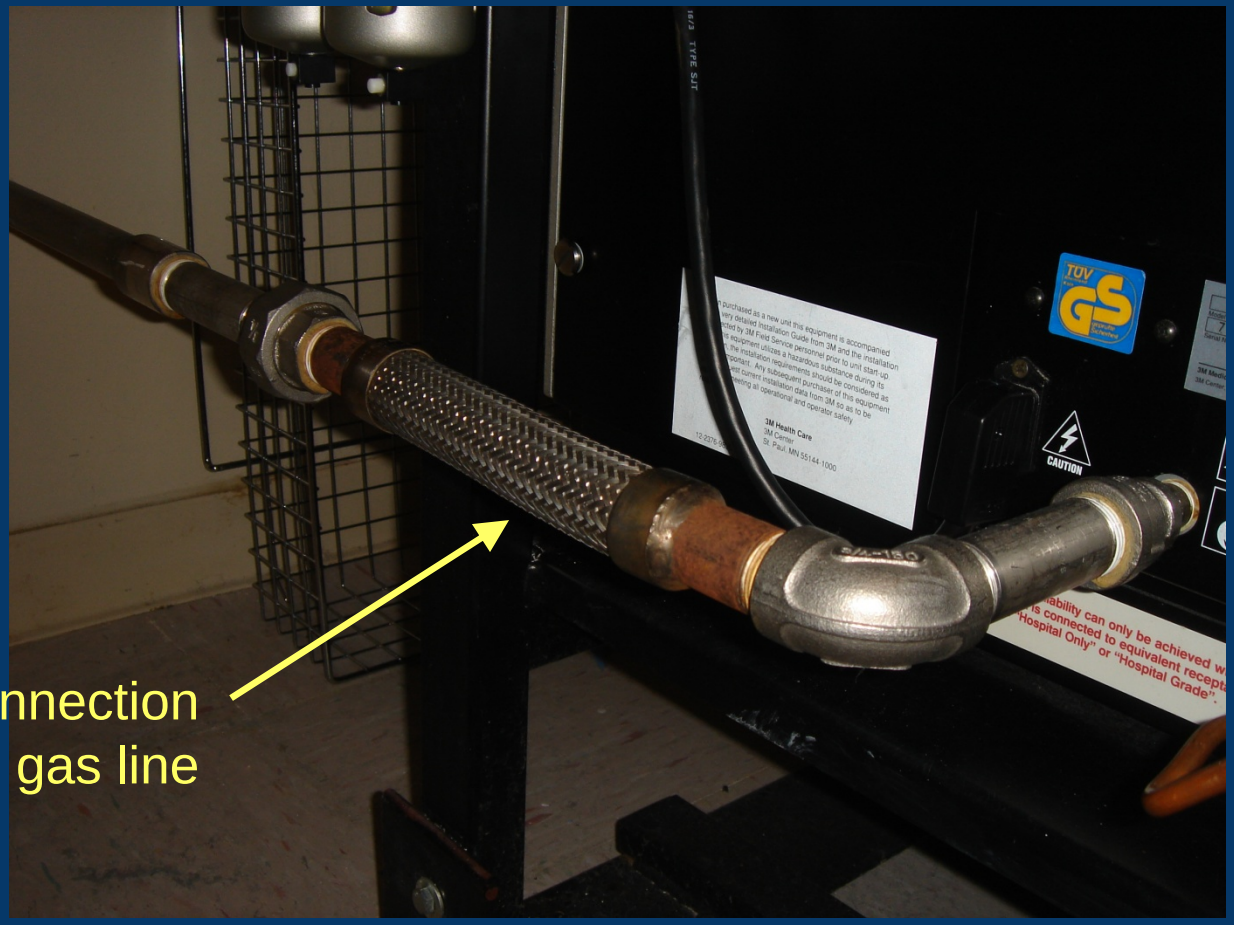
Operating Room Lights

Operating Room Lights

Mobile Carts

Sterilizer

Sterilizer



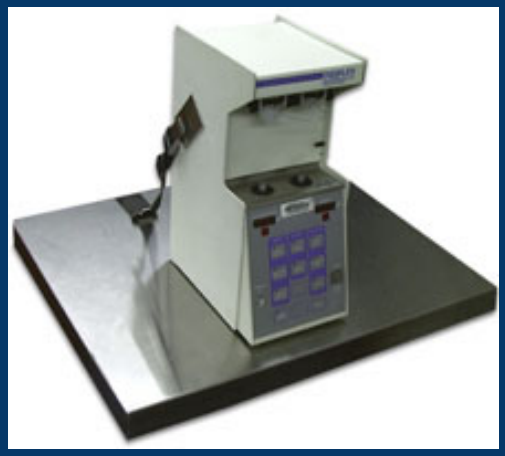
Flexible connection
in gas line

Televisions

Televisions

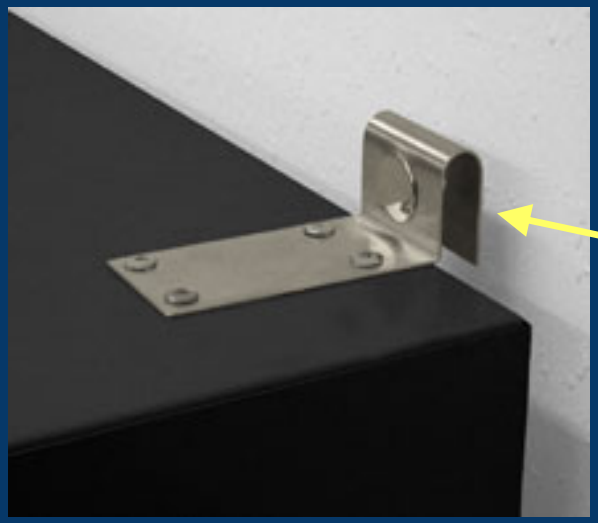
Televisions

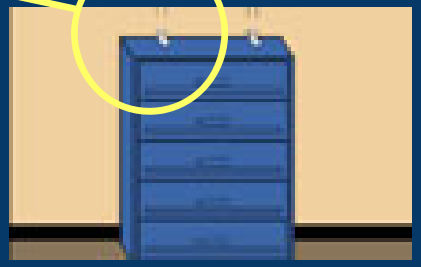
Bench, Rack, or Table-Top Restraints



Bench, Rack, or Table-Top Restraints

Furniture/Shelving Content Restraints

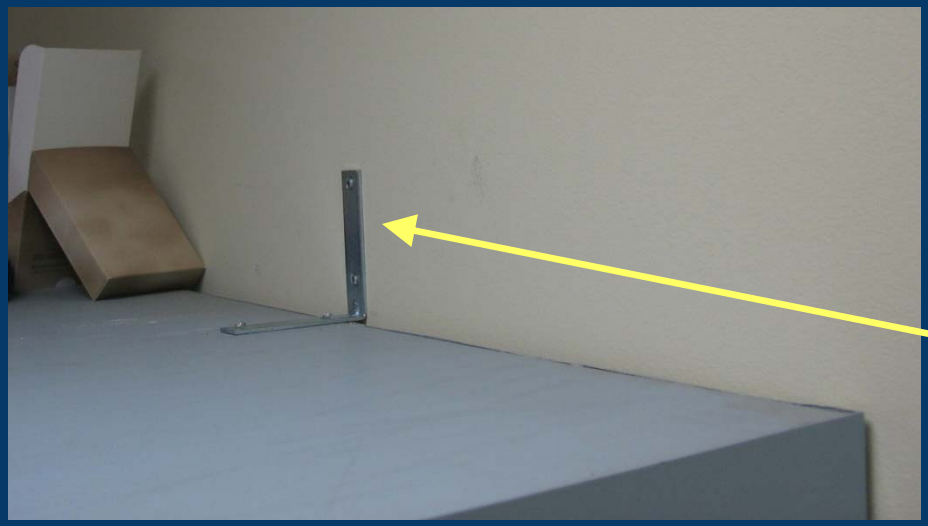




Small Equipment Base Anchorage

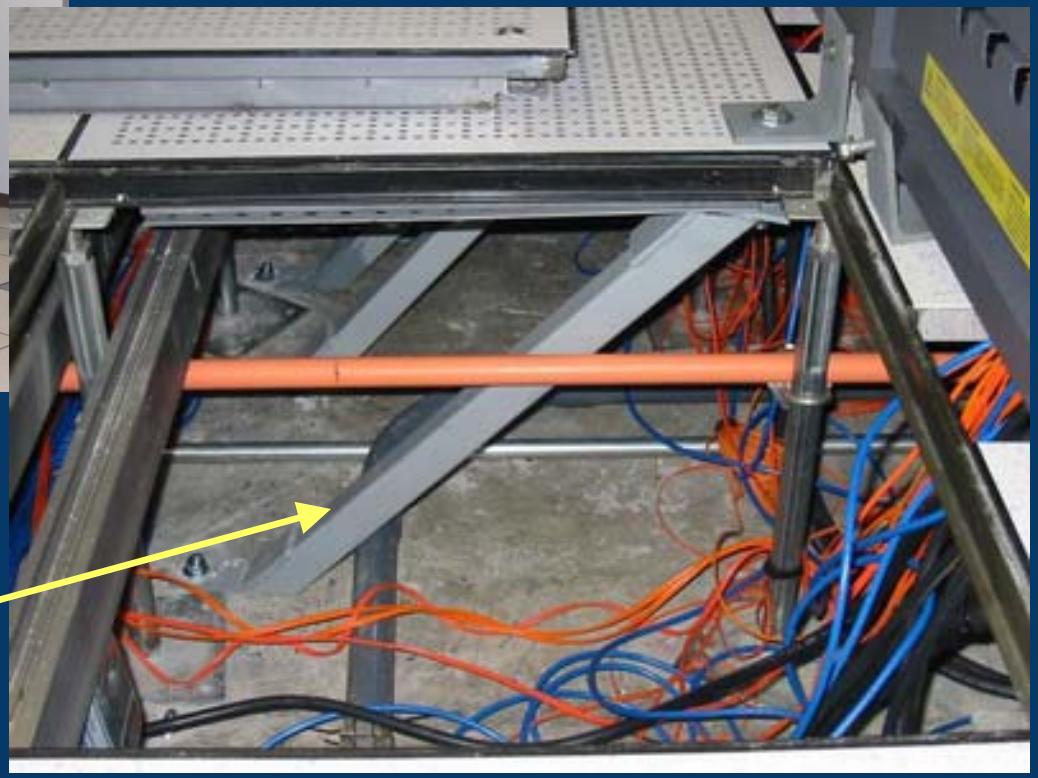
Shelving Part Container Restraints

Furniture Restraints



Typical Product Restraints

Computer Equipment



Raised floor bracing

Equipment Anchorage

Implementation

Biggest challenges of nonstructural mitigation in a hospital:

1. 24/7
2. No swing space
3. Infection control
4. Hazardous materials

Patient Care Areas

Patient Care Areas

Patient Care Areas

Best Long Term Strategy

New Construction:

Do it right the first time

Remodel:

Take care of problems when you have the chance