

Natural Hazards Risk

Understanding the impacts and the benefits of mitigation



2012 VOICES OF EXPERIENCE
When Infrastructure Fails

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Outline



- ▼ Natural Hazards
- ▼ Impact to Operations
- ▼ Risk Management
- ▼ Benefits of Mitigation
- ▼ Questions & Answers

Natural Hazards & Impact to Operations

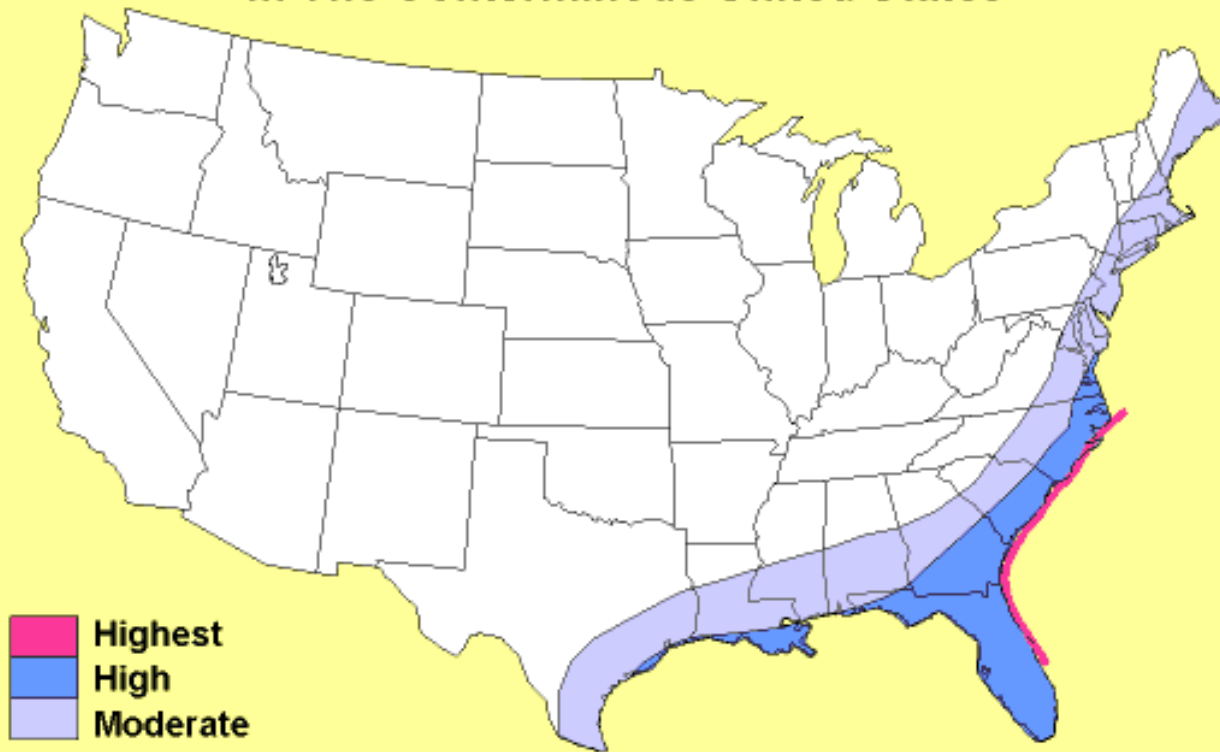




Hurricane Risk



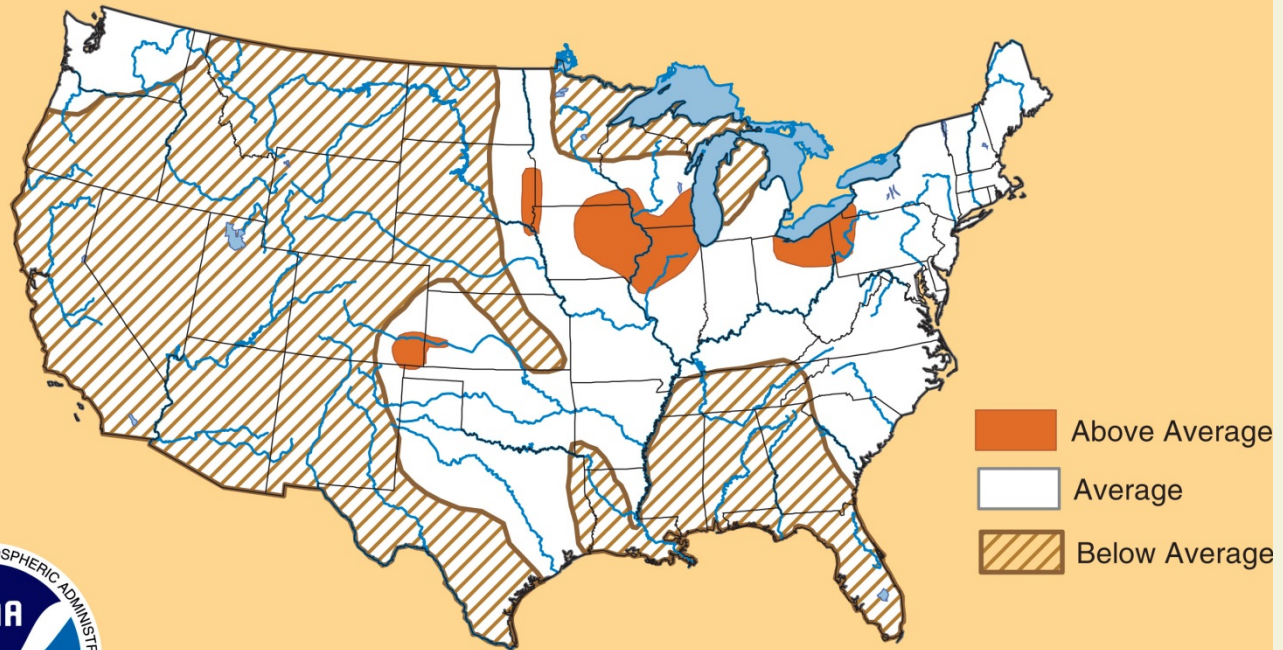
**Map Showing Hurricane Activity
In The Conterminous United States**



Flood Risk



Flood Risk (as of March 9, 2007)





Hurricane Opal – 1995
Charlotte Amalie Hospital
Records Storage.

(Ref. EQE International)



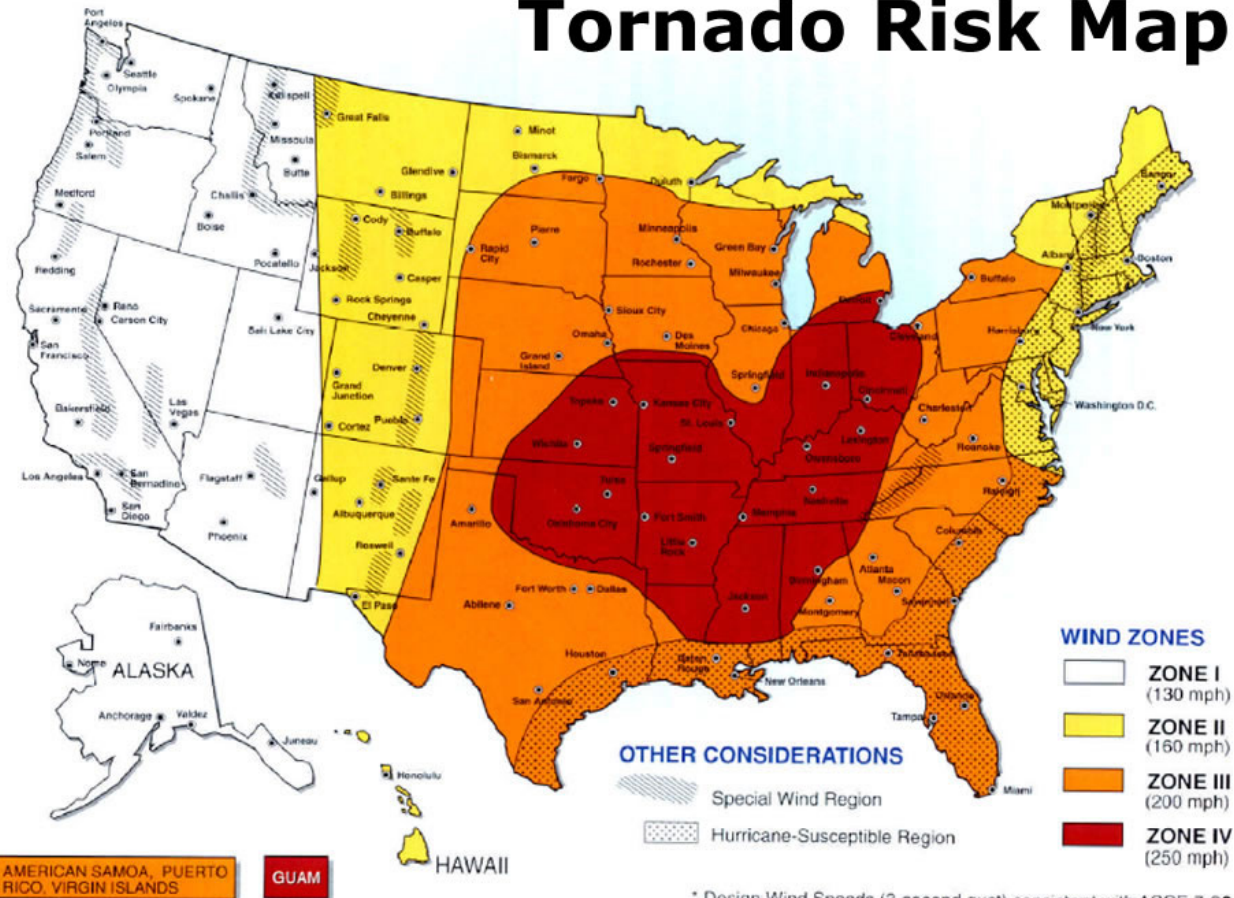
Hurricane Katrina – 2005
Garden Park Medical Center
Cladding & 6" of Flooding

(Ref. FEMA 549)

Tornado Risk



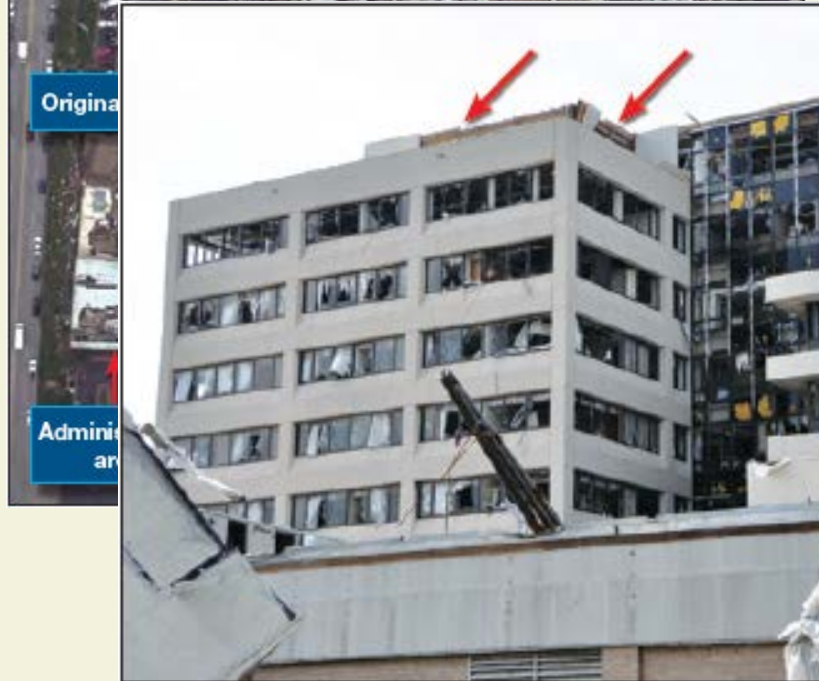
Tornado Risk Map



Joplin 2011 - St John's Regional Medical Center



(Ref. FEMA P-908)

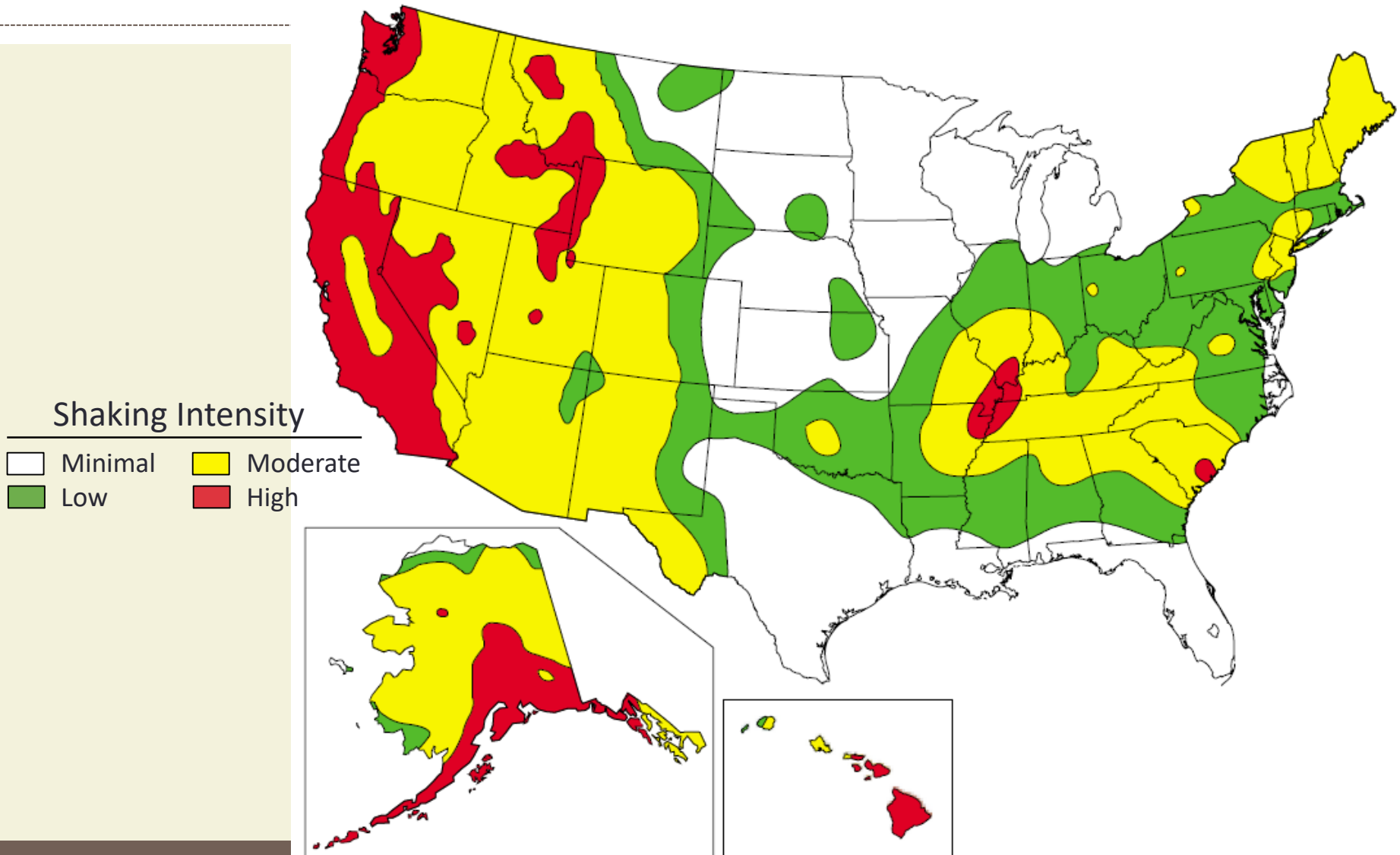


(Ref. FEMA P-908)



(Ref. Jeff Hower – MO
S.A.V.E.)

Earthquake Risk

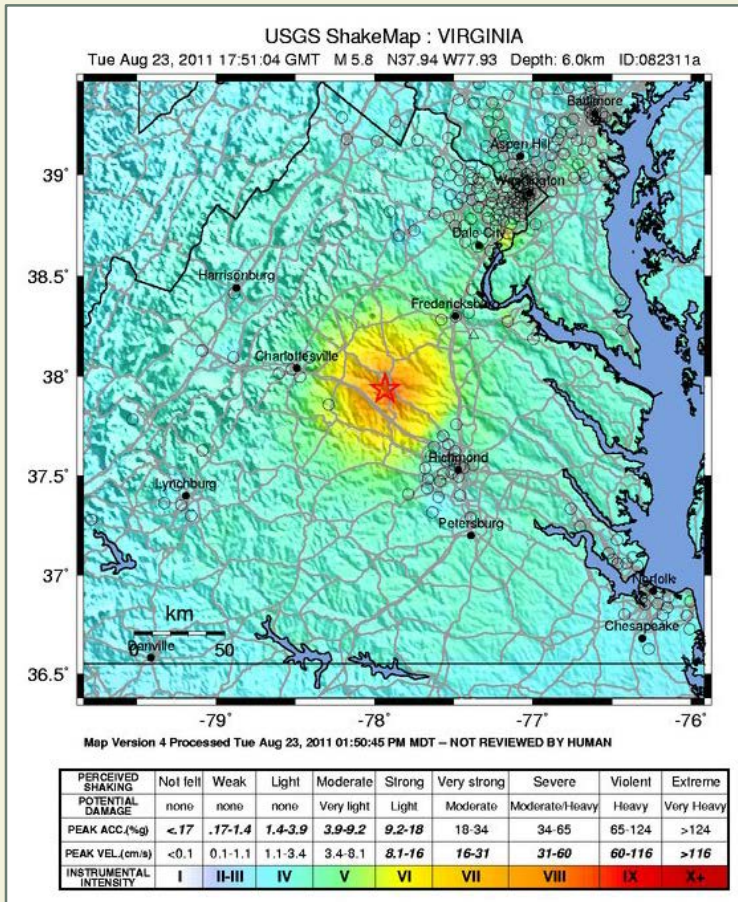


Earthquake Damage



▼ Mineral, VA: M5.8 (2011)

Even small EQs can be damaging



Mineral, VA Earthquake M5.8

Small magnitude event

Infrequent activity
regionally for moderate and
large events

No fatalities

Estimated losses \$200-\$300
million

Nonstructural damage to
Louisa County High School



Louisa County High School



Olive View Hospital - 1971



(Ref. FEMA P-767)

Damage to Finishes, Contents & Operations



(Ref. FEMA P-767)

Olive View Hospital - 1994



(Ref. FEMA P-767)

Damage to Finishes, Contents & Operations



(Ref. FEMA P-767)

Chile Earthquake 2010

Hospital Post-Earthquake Performance



(Ref. Mike Mahoney)

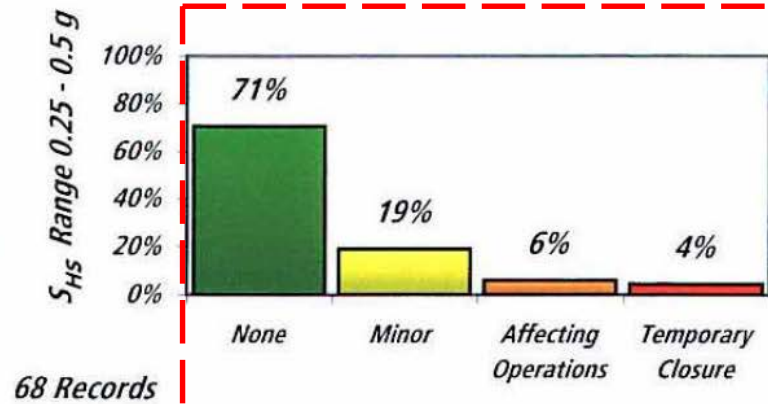
Earthquake Performance Expectations for Hospitals



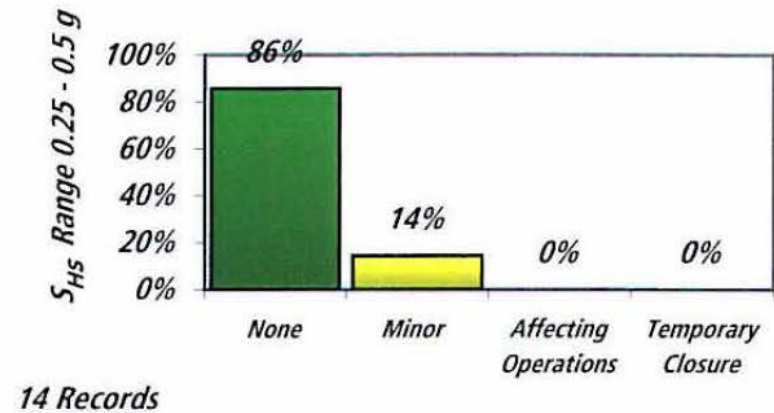
- ▼ Study by Holmes & Burkett, EERI 8th NCEE – California Hospital Earthquake Performance
- ▼ Primary purpose - identify levels of ground motion affecting operational performance of hospitals
- ▼ 218 Hospitals or data points that experienced earthquake ground shaking
- ▼ Pre-1973 Hospitals considered representative of hospitals outside of California to assess performance

Structural Damage

Damage to Pre-Act Buildings

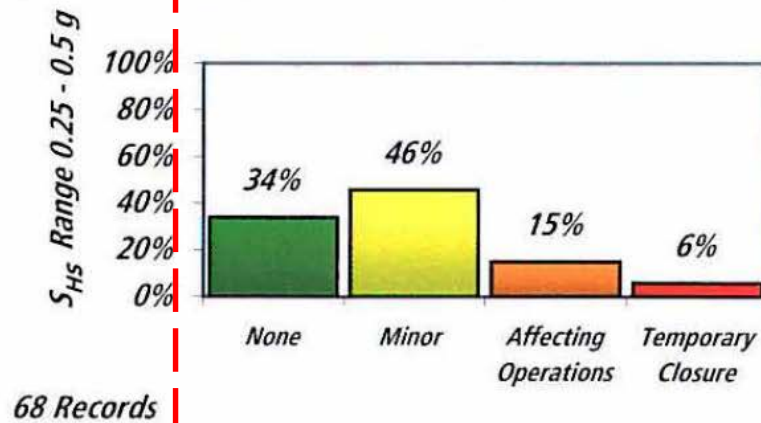


Damage to Post-Act Buildings

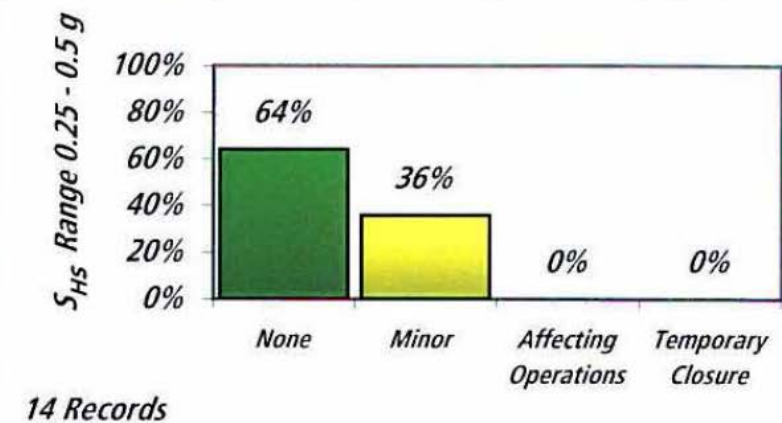


Nonstructural Damage

Damage to Pre-Act Buildings



Damage to Post-Act Buildings



Risk Management



Risk



- ▼ How many of you have Risk Management Departments?
- ▼ How many of you address natural hazards within your risk management departments?
- ▼ How many of you actually know what the risk is to your organization from natural hazards; i.e., has a comprehensive risk assessment been performed?

Risk to Natural Hazards



$$\text{RISK} = f(\text{HAZARD}, \text{VULNERABILITY})$$

*Risk is a function of both the potential hazard (seismic ground motion, flooding potential, extreme wind potential) and **vulnerability** (lack of seismic preparedness in structural and nonstructural systems)*

Potential Damage Risks



▼ Direct Damage:

- Physical asset damage
- Repair and restoration costs

▼ Indirect Damage:

- Loss of facility operations
- Loss of service to the community in the time of greatest need
- Loss of Good Will
- Patient evacuation/relocation
- Loss of life

Natural Hazard Damage Concerns



Life Safety – Paramount: Staff, Patients, Visitors

- Could anyone be hurt by this building or component in an earthquake?



Property Loss

- Could a large property loss result?



Functional Loss – Community Critical Care

- Could the loss of this building or component result in an outage, interruption or loss of use?

Risk Management Process



1. Facility risk assessment:

- Desk-top survey
- Rapid visual survey of the facility
- Comprehensive facility risk assessment of building and nonstructural components

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2. Rank & prioritize risks

3. Develop a Mitigation Plan from the assessment findings and recommendations

4. Capitalize and begin to implement the Mitigation Plan

***Remember – reducing risk cannot be achieved overnight.
Natural Hazard Mitigation is a long term process.***

Structural Components



- ▼ Structural components resist gravity loads, lateral loads (wind & earthquake), and other types of loads
- ▼ Structural components include:
 - Roof
 - Floors
 - Beams
 - Columns
 - Braces
 - Concrete / masonry walls (Load bearing only)
 - Foundation

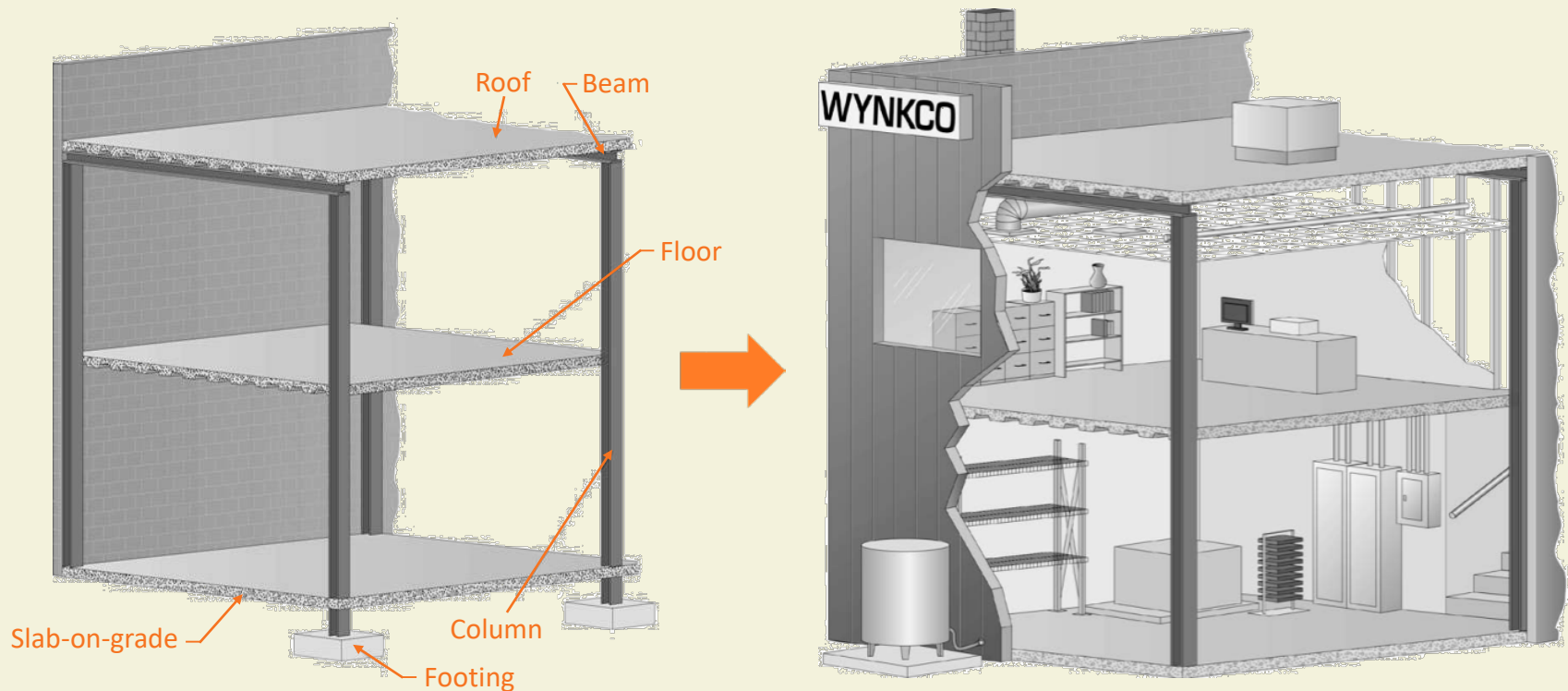


Ref. FEMA E-74

Nonstructural Components



- ▼ Nonstructural components include all portions of the facility that are not load-carrying / structural components



Ref. FEMA E-74

Structural & Nonstructural Components



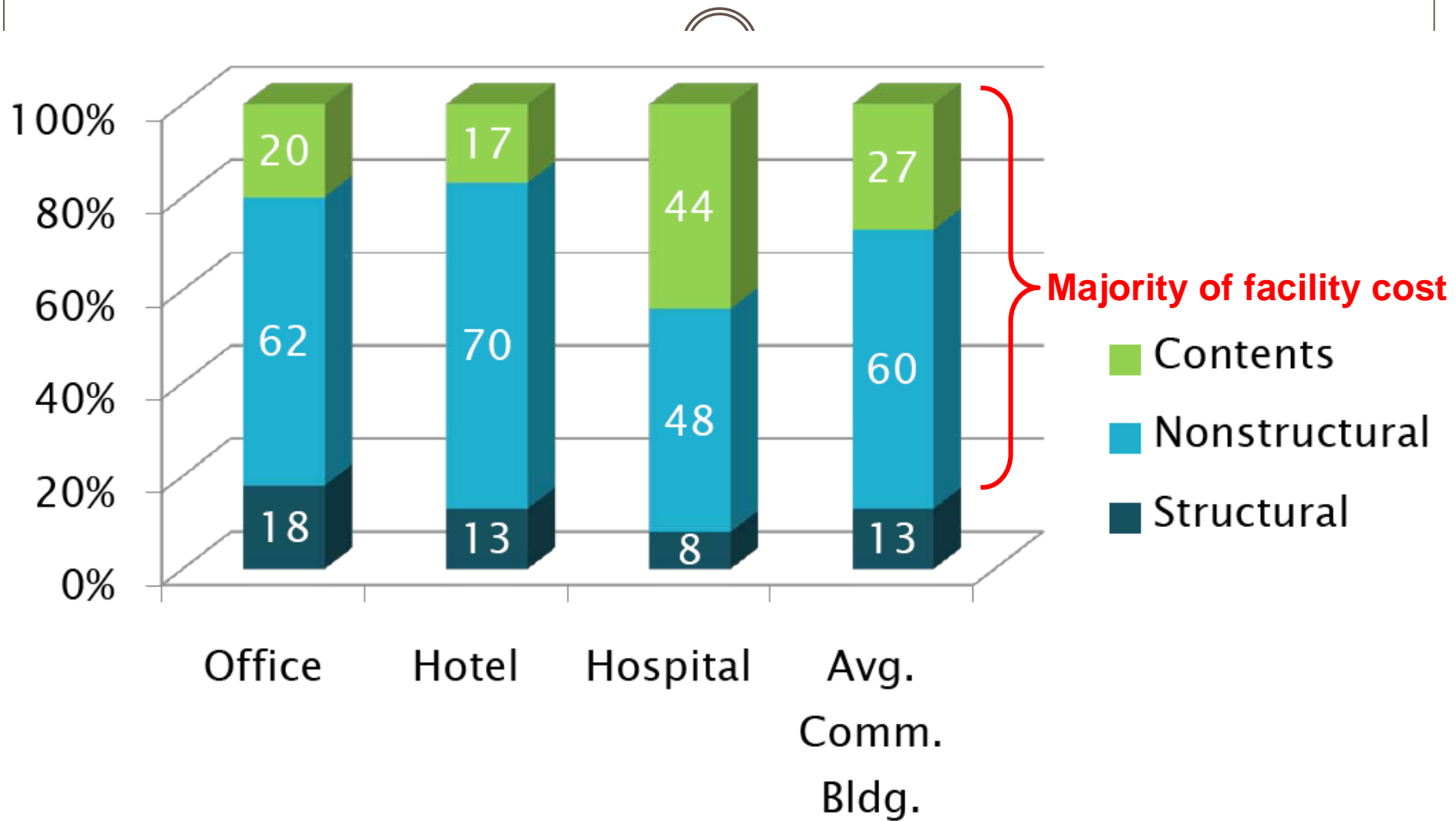
▼ Structural systems

- Designed by civil or structural engineer
- Structural elements are shown on the construction drawings including the seismic lateral force resisting systems
- Construction oversight to ensure bldg conforms to design drawings

▼ Nonstructural systems

- Specified by design team (architect, mechanical / electrical engineer, interior designer, IT engineer, fire protection engineer, etc.)
- Seismic design is via performance specifications TO BE IMPLEMENTED BY THE RESPECTIVE CONSTRUCTION TRADES
- Performance specifications provide limited guidance on seismic design for contractor implementation
- Little inspection or oversight to ensure proper installation

Where to begin?



Primary Contributors to Nonstructural Damage

1. Code Design Philosophy

Life safety performance

Nonstructural Design Importance Factor:

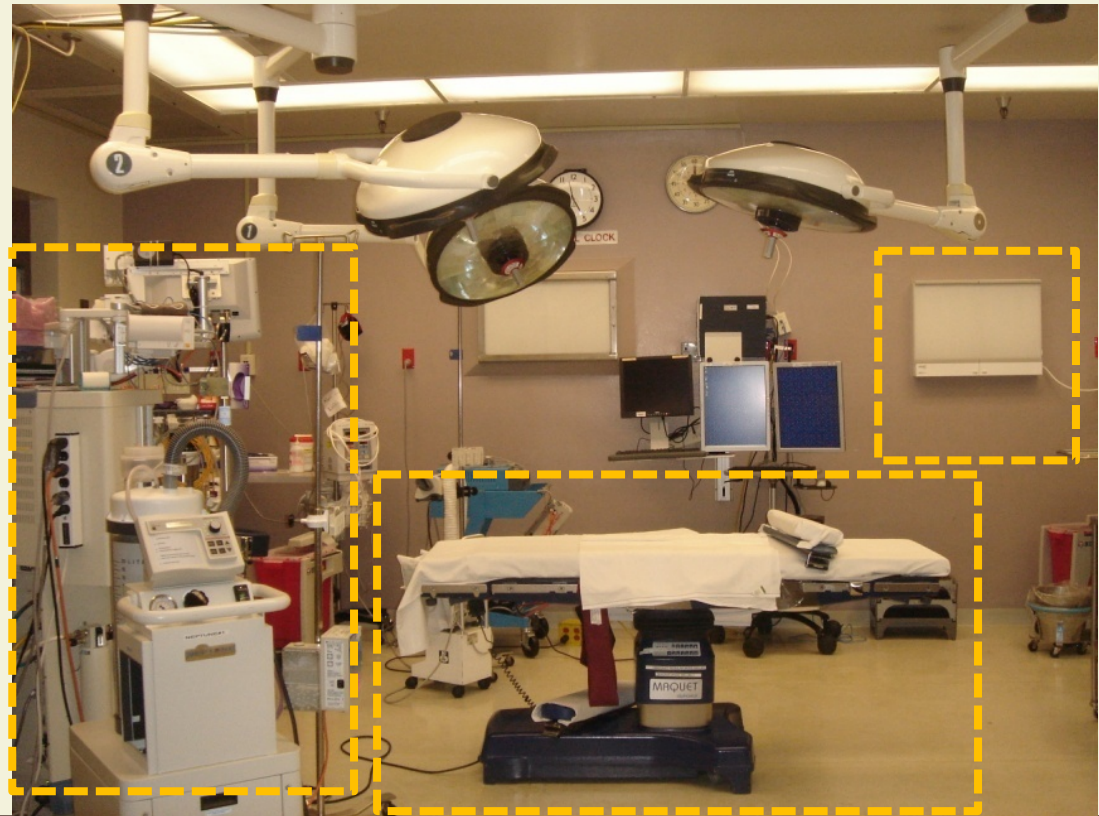
- Life safety system
- Contains or transports hazardous materials
- Required to operate/function following an earthquake event



Primary Contributors to Nonstructural Damage



1. Code Design Philosophy
2. Not all components governed by code
 - Screens/viewers
 - Portable or rolling equipment
 - Specimen / lab refrigerators
 - Critical lab bench equipment
 - Desks
 - Bookcases



Ref. FEMA P-767

Primary Contributors to Nonstructural Damage



1. Code Design Philosophy
2. Not all components governed by code
3. Design Professional Knowledge
of seismic design & responsibility

Knowledge & Responsibility?



- ▼ Engineers
 - Structural
 - Mechanical
 - Plumbing
 - Fire protection
 - Electrical
 - Telecom
- ▼ Architects
- ▼ Building Officials
- ▼ Owners



- ▼ General Contractor
- ▼ Subcontractors
 - Fire Protection
 - Cladding
 - Mechanical
 - Plumbing
 - Electrical
 - Drywall
 - Ceiling
 - Telecom
- ▼ Installers
- ▼ Equipment vendors
- ▼ Inspectors
- ▼ Tenants
- ▼ Facility Managers
- ▼ Office Manager

Responsibility?



Ref. FEMA E-74

Primary Contributors to Nonstructural Damage

1. Code Design Philosophy
2. Not all components governed by code
3. Design Professional Knowledge of seismic design & responsibility
4. Construction quality & enforcement



Nonstructural Component EQ Performance



Benefits of Mitigation



Benefits of Mitigation



1. Life-safety risks significantly reduced and controlled for staff, patients and visitors
2. Repair & recovery costs significantly reduced
3. Functionally available to serve the community in time of greatest need
4. Greatest cost-benefits achieved
 - FEMA – National Average: \$1 cost achieved \$4 benefit
5. Many mitigation measures are easily implemented by staff
6. Largest financial investment within your organization

AND

7. Life-safety risks are significantly reduced and controlled for staff, patients and visitors

Mitigation Options



- ▼ Do nothing – ignore the risk
- ▼ Accept the risk
- ▼ Modify emergency response & business recovery plans
- ▼ Adjust business operations:
 - Relocate critical functions to lower risk facilities
 - Locate non-critical functions to higher facilities
- ▼ Perform facility strengthening
- ▼ Perform nonstructural component strengthening and anchorage improvements
- ▼ Perform an incremental seismic rehabilitation program
- ▼ Combination of the above

Challenges to Hospital Mitigation



- ▼ Disruption to operations – 24/7 Operation
- ▼ No swing space
- ▼ Infection Control
- ▼ Temporary relocation of patients and patient care services
- ▼ Specialized areas
 - MRI, X-ray, etc.
 - Pharmacies
 - Bio Hazards
 - Records
- ▼ Hazardous Materials

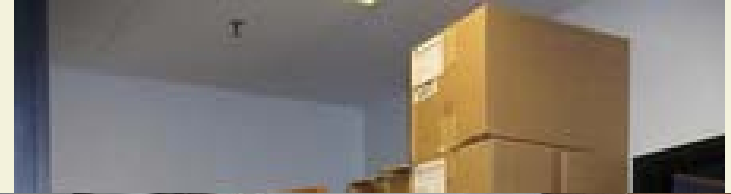


Ref. FEMA P-767

Mitigation Measures Straight Forward



- ▼ Implement good housekeeping measures
- ▼ Relocate contents to lower
 - Egress routes
- ▼ Restrain contents
- ▼ Install proper equipment anchorage



Mitigation Measures are Straight Forward



Seismic chain restraints? Do it correct the first time!

Mitigation Measures Straight Forward

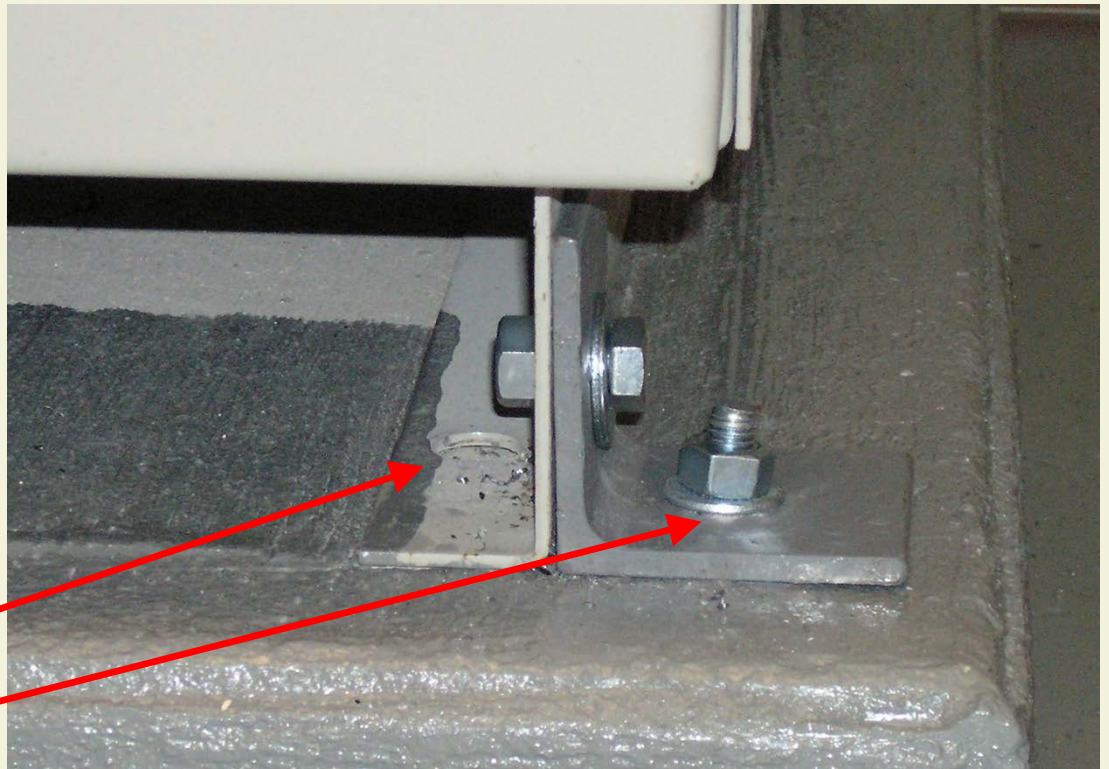


UPS - Emergency Battery Backup

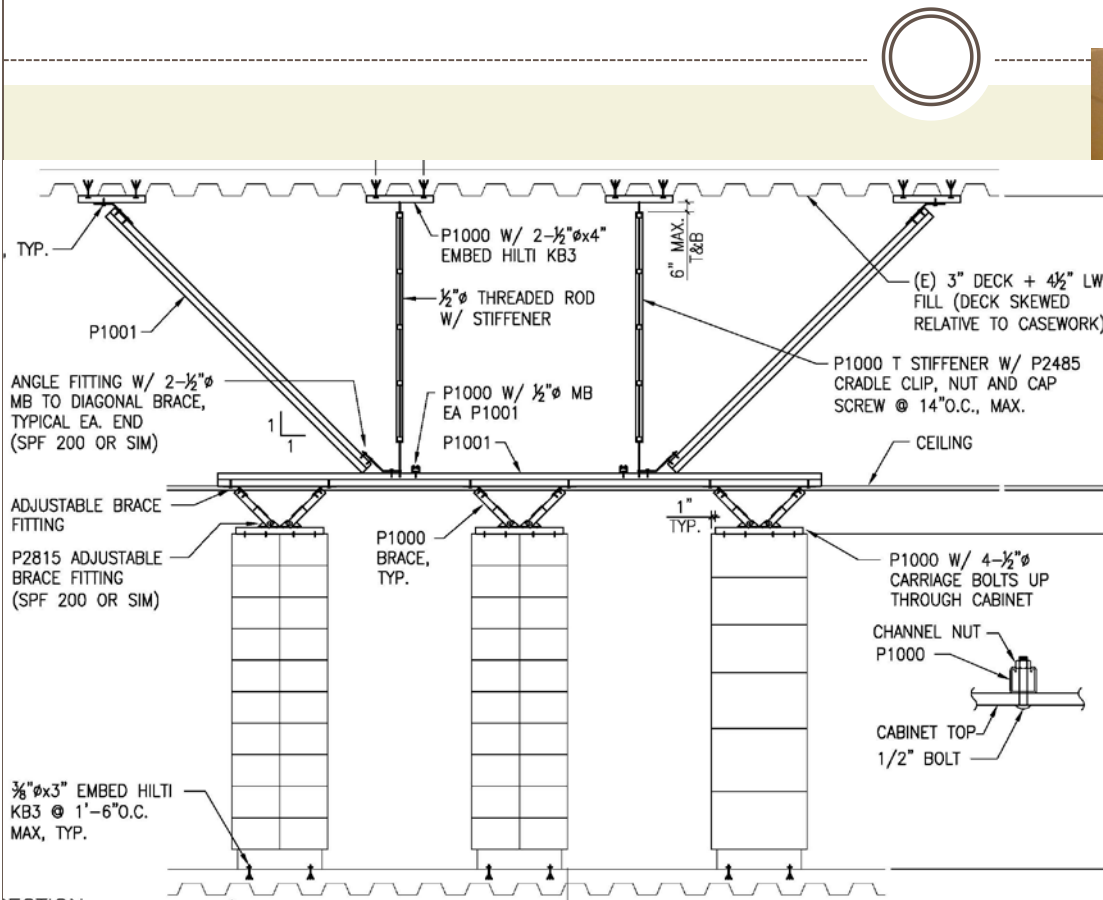


Missing anchor

Seismic retrofit



Shelving



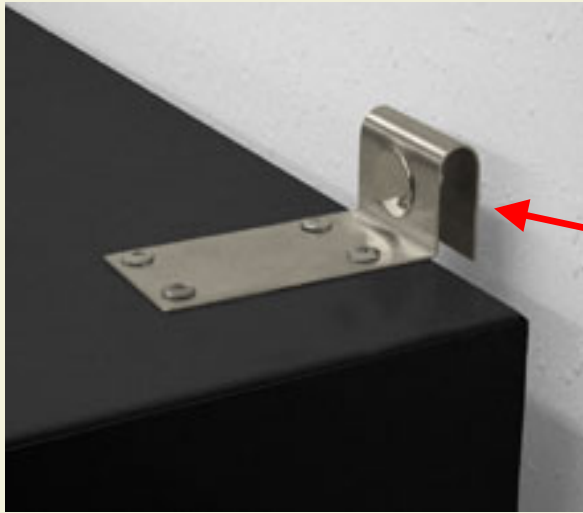
Ref. FEMA P-767

Refrigerators



Ref. FEMA P-767

Furniture/Shelving Content Restraints



Small Equipment
Base Anchorage

Shelving Part
Container Restraints



Ref. FEMA P-767

Benefits of Mitigation



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7. Life-safety risks are significantly reduced and controlled for staff, patients and visitors

Long-term Mitigation Strategies



- ▼ *Do it right the first time from today forward*
- ▼ *Long-term strategy:*
 - New Construction
 - Renovations & remodels
 - New equipment installations
 - Aging equipment replacement
 - Use planned facility outages & equipment maintenance activities as opportunities to effect seismic mitigation
- ▼ *Earthquake mitigation does not happen overnight*



Mitigation Resources



- ▼ FEMA 396: Incremental Seismic Rehabilitation of Hospitals
- ▼ FEMA 577: Design Guide for Improving Hospital Safety in Earthquakes, Floods, and High Winds: Providing Protection to People and Buildings
- ▼ FEMA E-74
<http://www.fema.gov/plan/prevent/earthquake/fema74/>
- ▼ FEMA 412 – Installing Seismic Restraints for Mechanical Equipment
- ▼ FEMA 413 – Installing Seismic Restraints for Electrical Equipment
- ▼ FEMA 414 –Installing Seismic Restraints for Duct & Pipe
- ▼ ASCE – Earthquake Protection of Building Equipment and Systems, by Gatscher, McGavin & Caldwell



Are Ready?



Questions?



**IF YOU HAVE ADDITIONAL QUESTIONS
PLEASE CONTACT ME AT:**

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