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Architecture | Engineering | Construction | Environmental

Solving complex problems for the built
environment



Earthquakes & Healthcare Facilities

Introduction



Healthcare Facilities
Management Society
of New Jersey

* 75TH Anniversary - ASHE Chapter - 75th Anniversary *

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Structural, MS, PE

Learning Objectives

U.S.A. Seismic Map

When to be Worried

Measuring Earthquakes

Data from NJ Earthquake 04.05.24

ATC 20-1 Rapid Assessment

Screening Buildings for Hazards

Rapid Visual Screening (RVS)

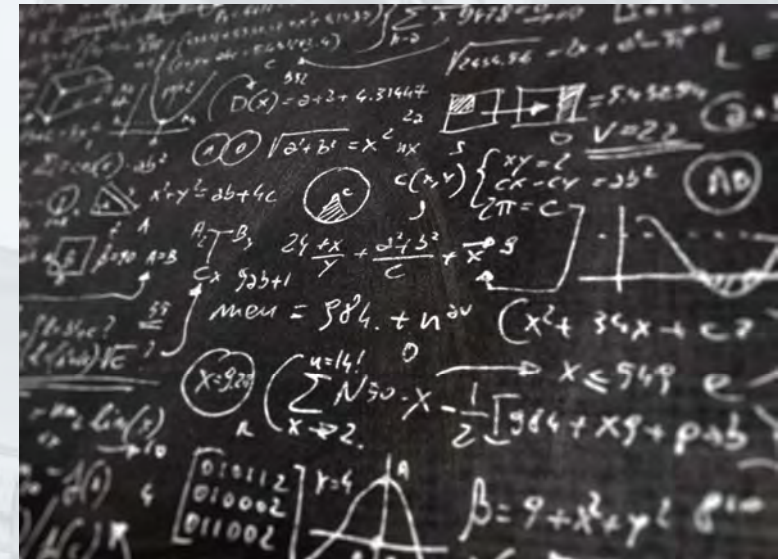
FEMA Building Type

Emergency Management

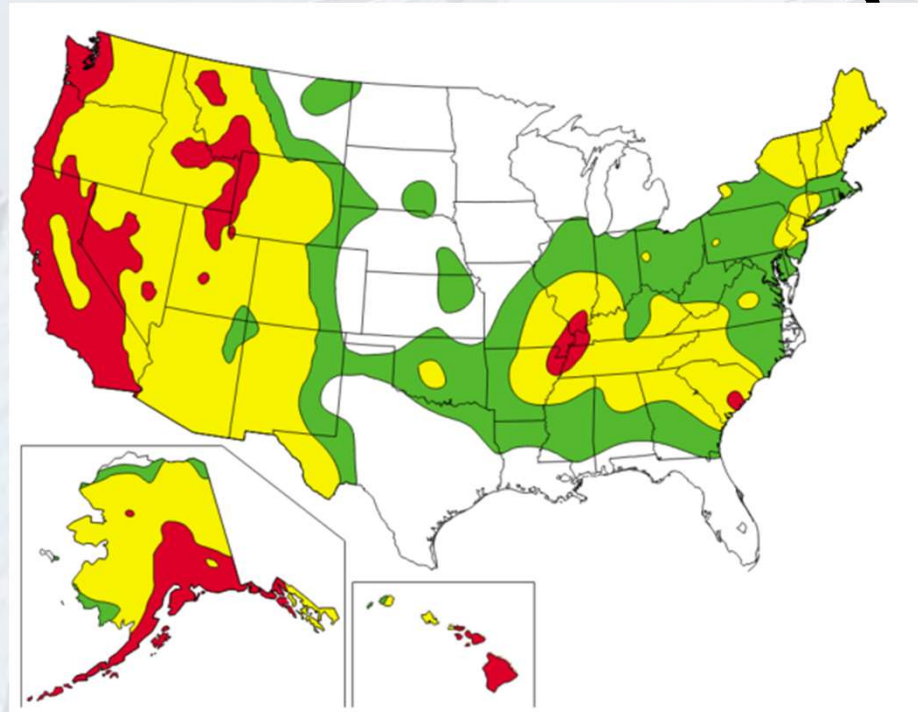
Bibliography

Learning Objectives

1. Inspection protocol for recent Earthquake in NJ
2. General information regarding earthquakes and hospital building structural design
3. Building type and earthquake performance
4. Seismic assessments that can be done for future events



U.S.A. Seismic Map



- Areas displayed in red are most likely to experience strong earthquakes, and white is least likely. New York and New Jersey fall in moderate.
- The construction of buildings play an important role in seismic safety.
- A 7.0 event would be devastating in NYC and would have minimal impact on San Francisco.

When to be Worried

- Media reports earthquake
- Get accurate data Latest Earthquake Data <https://earthquake.usgs.gov/earthquakes>
- Two standard measures of ground motion, MCE
- Probabilistic Maximum Considered Earthquake used in building codes
- Deterministic Maximum Credible Earthquake incorporated in the design of larger buildings, critical facilities, and civil infrastructure
- For New York & New Jersey, the largest historic Earthquakes had intensities of 5.2 & 5.8
- This will likely be reported in the media as a Richter scale
- Worry when there are reports of an earthquake approaching the MCE for your building (above 5.5)
- Always worry about your unreinforced masonry in facades, parapets, chimneys, etc.
- Always worry about falling hazards

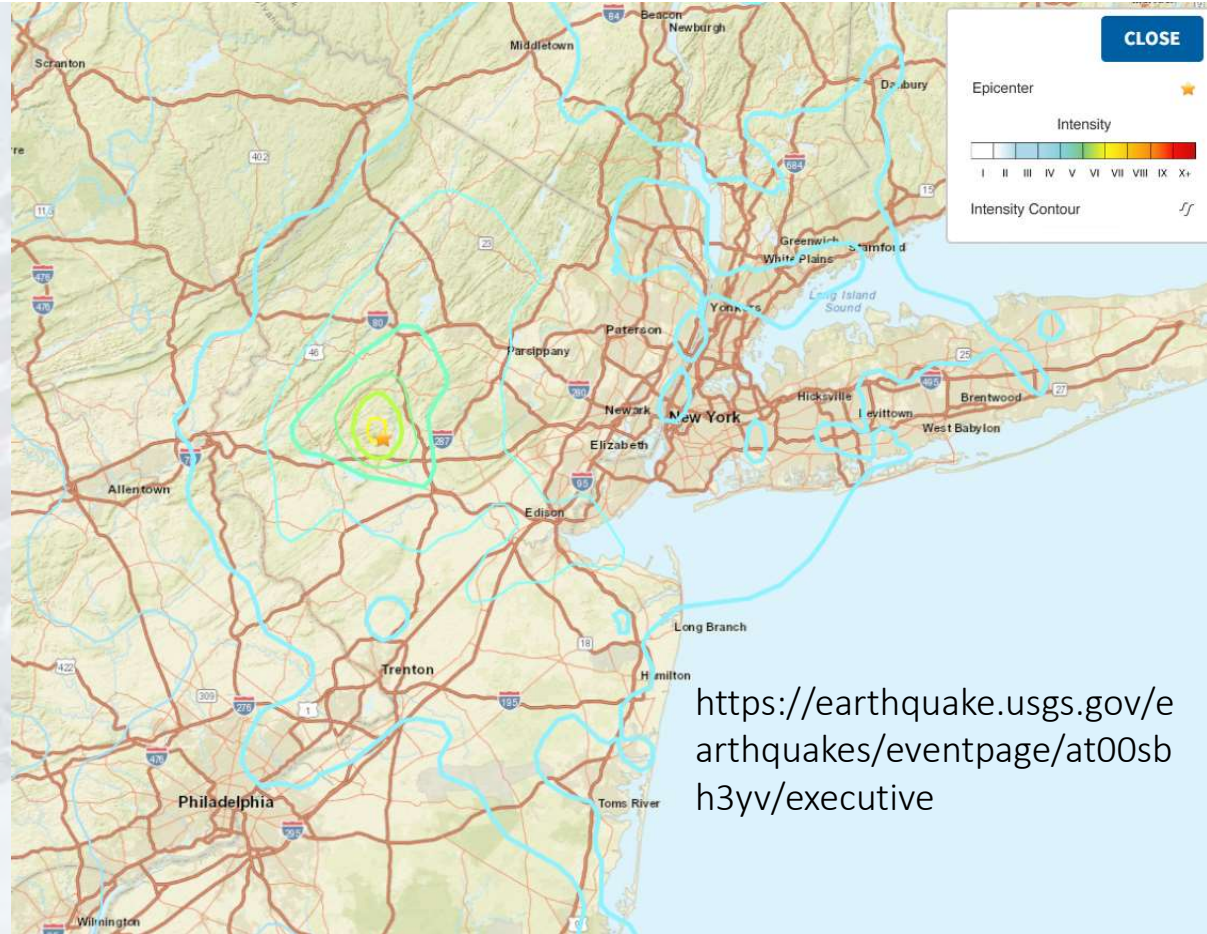
Measuring Earthquakes

- (USGS) Moment Magnitude Scale (M) {modern Richter} vs Modified Mercalli Intensity (MMI) scale
- The M scale measures the magnitude of the earthquake at its location, could be miles underground and 100s of miles away.
- MMI estimates the shaking intensity of an earthquake at a specific location. Buildings begin to get damaged at an intensity of VI.



NJ 04.05.24

- Location was Whitehouse Station, NJ
- 40.689°N 74.754°W 4.7km 4.8M
- Moment Magnitude Scale (Richter) 4.8
- MMI: Trenton 3.6
- Newark 3.6
- Epicenter 6.1
- Long Branch 3.5
- Elizabeth 4.3
- Central Park 3.4

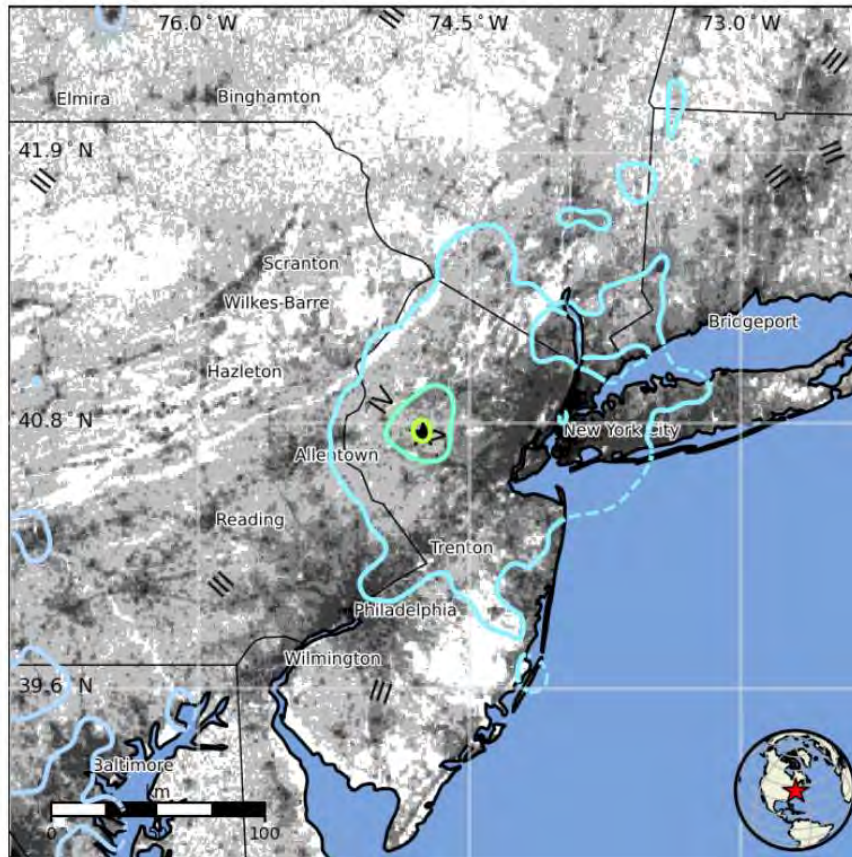


<https://earthquake.usgs.gov/earthquakes/eventpage/at00sbh3yv/executive>

United States Geological Survey (USGS):

<https://earthquake.usgs.gov/earthquakes/map/?extent=23.80545,-118.56445&extent=50.56928,-71.71875&map=false>

NJ 04.05.24



Population per ~1 sq. km. from LandScan

Population Exposure

Overall, the population in this region resides in structures that are resistant to earthquake shaking, though vulnerable structures exist. The predominant vulnerable building types are unreinforced brick masonry and reinforced masonry construction.

Show All Cities

Selected Cities Exposed

MMI	City	Population
VI	Califon	1 k
V	Long Valley	2 k
V	Chester	2 k
V	Lebanon	1 k
V	Bedminster	8 k
V	Glen Gardner	2 k
IV	Trenton	85 k
III	Hartford	125 k
II	Annapolis	38 k
II	Harrisburg	50 k

Applied Technology Council ATC 20

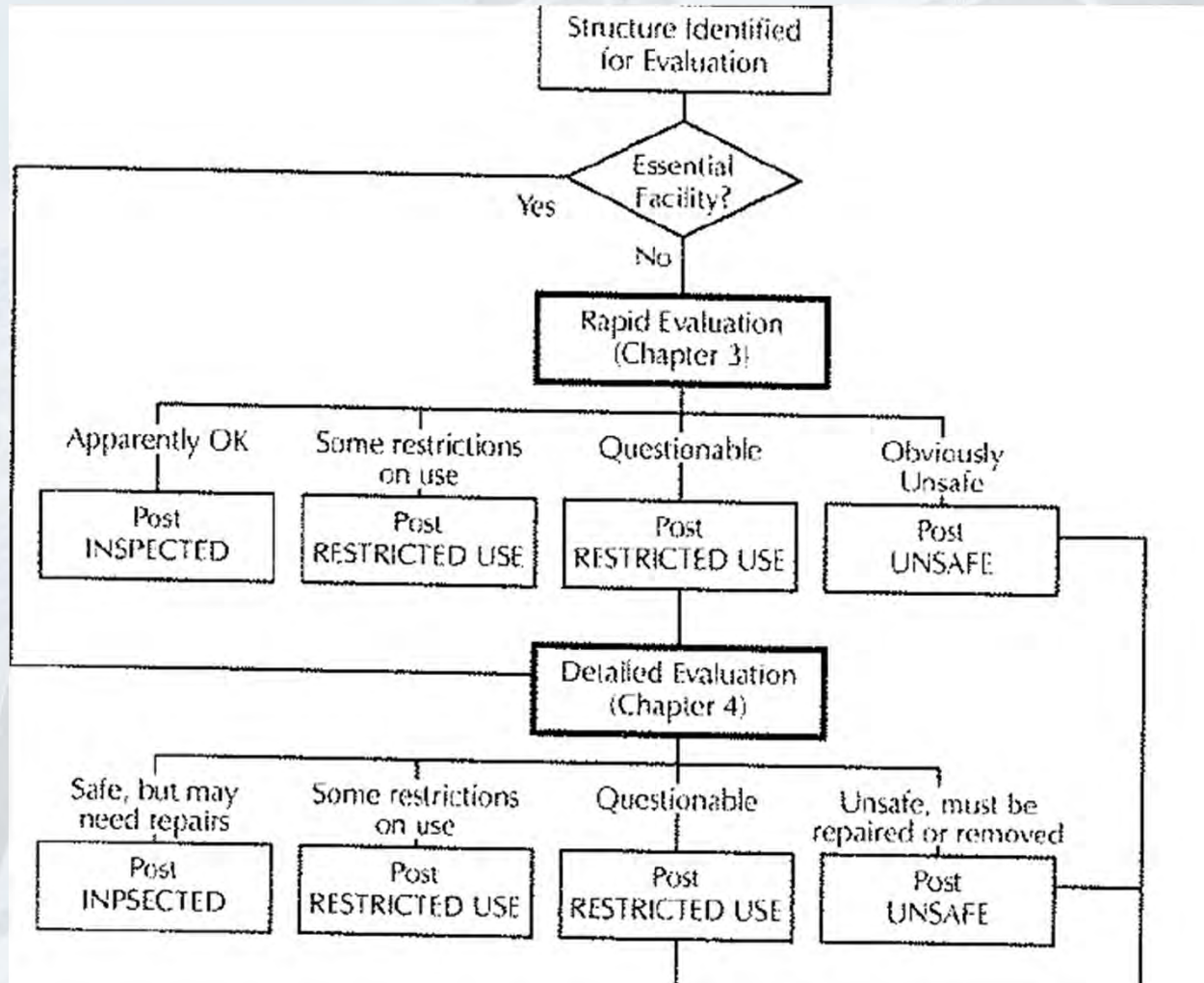
A Nonprofit Organization

www.atcouncil.org/atc-20

- Field Manual: Post earthquake Safety Evaluation of Buildings, 2nd Edition, 2005
- Developed for strong earthquakes but useful for major and minor damage
 - Rapid Evaluation. Rapid, cursory, immediate, about 30 minutes per building.
 - Detailed Evaluation. Thorough visual examination by a Structural Engineer.
 - Engineering Evaluation Further evaluation of questionable structures
- When to use. Any shaking? Develop your own program. If you can get your program down to 30 minutes per building, why not perform at any shaking? You are a critical facility!

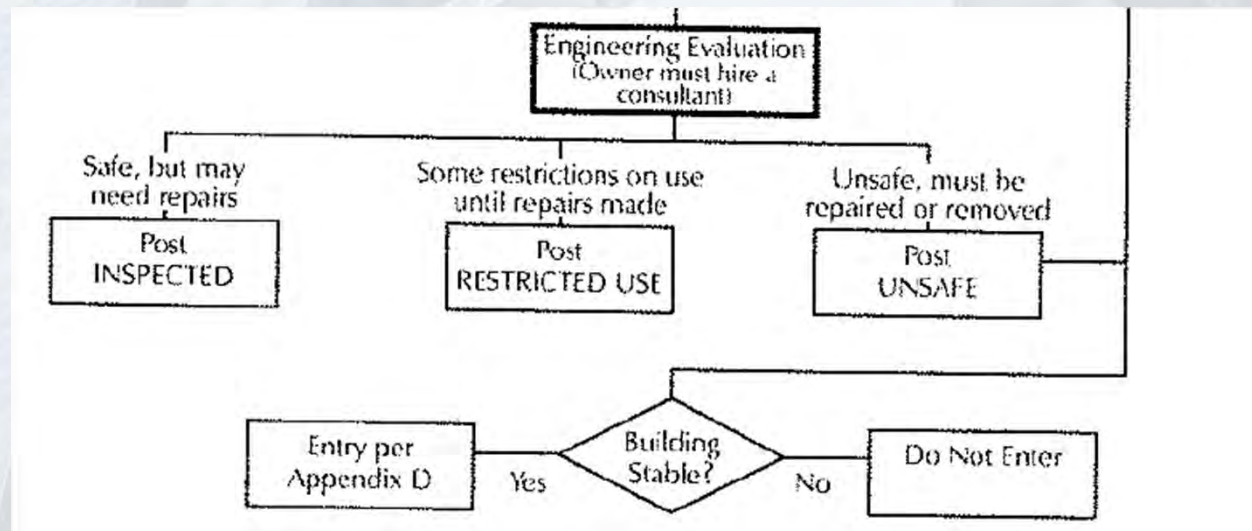
ATC 20 Flowchart

The following "ATC 20" information is available hard copy only. Please excuse any blurred or distorted images.



ATC 20 Flowchart

Flowchart Continued



ATC 20 Field Manual

Table 2-1. ATC-20 Building Evaluation Methods

Method	Suggested Personnel	Objective
Rapid Evaluation	Building inspectors Civil/Structural engineers Architects Disaster workers	Rapid assessment of building safety. Used to quickly post obviously unsafe and apparently safe structures and to identify necessary restrictions on building use.
Detailed Evaluation	Structural engineers ^{a,b}	Thorough visual evaluation of a building. Used to evaluate questionable buildings, to identify necessary restrictions on building use, or to identify the need for an Engineering Evaluation.
Engineering Evaluation	Structural engineering consultant ^c	Detailed engineering investigation of a damaged building for purposes of determining the extent of damage and/or how to stabilize and repair the building.

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Table 2-2. Building Safety-Evaluation Classifications

Posting Classification^a	Description^b
Inspected (Green)	No apparent hazard is found, although repairs may be required. The original seismic resistance is not significantly decreased. No restriction on use or occupancy.
Restricted Use (Yellow)	A hazardous condition exists (or is believed to exist) that requires restrictions on the occupancy or use of the structure. Entry and use are restricted as indicated on the placard^c.
Unsafe (Red)	Extreme structural or other hazard is present. There may be imminent risk of further damage or collapse from creep or aftershocks. Unsafe for occupancy or entry, except as authorized by the local building department^{c,d}.

Field Manual

Table 2-5. Examples of Posting and Barricading

Condition Present	Action
<i>Buildings</i>	
• Building in danger of collapse.	Post building Unsafe and barricade.
• Building in danger from collapse of adjacent structure.	Post building Unsafe and barricade.
• Building in danger from slope failure.	Post building Unsafe and barricade.
• Building structurally safe, but its use or entry are prevented by another hazard (e.g., ruptured gas line, toxic chemical spill).	Post building Unsafe or Restricted Use.
• Building appears to be of doubtful safety; Detailed Evaluation is recommended.	Post building Restricted Use with only brief entry permitted.
• One room is unsafe, but the remainder of the building is usable.	Post building Restricted Use with no use of unsafe room.
• Dwelling is undamaged, but chimney has fallen away.	Post dwelling Restricted Use with no use of fireplace permitted.
• Building has little damage, but back stairs are dangerous.	Post building Restricted Use with no use of damaged exit permitted. Barricade back stairs.
• Building has minor damage that does not create a hazard for occupancy.	Post building Inspected.

Table 2-5. Examples of Posting and Barricading (Continued)

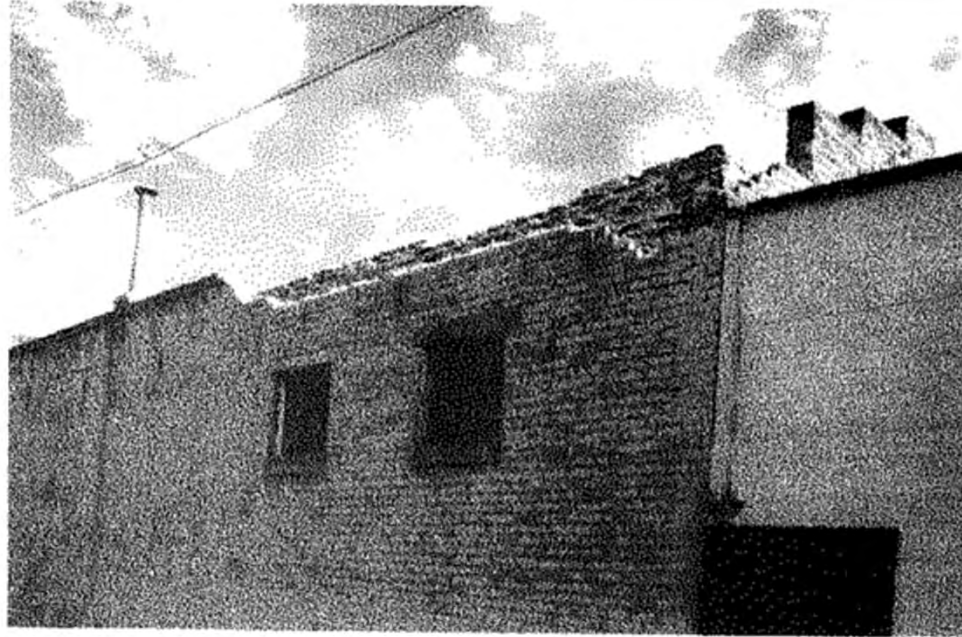
Condition Present	Action
<i>Equipment</i>	
• Elevators have been damaged.	Barricade elevator doors and switches. (If caution tape is unavailable, UNSAFE placards may also be used by placing them on elevator doors or switches.)
<i>Falling or Other Hazards</i>	
• Building has falling hazard present (e.g., damaged parapet, cracked window).	Barricade danger zone and/or post Restricted Use or Unsafe. (Placards may be placed on a perimeter barricade for this purpose.)
• Ruptured gas line, toxic chemical spill.	Barricade danger zone. Post building(s) Restricted Use with no use of endangered areas.
• Fallen power lines.	Barricade danger zone. Post buildings Restricted Use with no use of endangered areas.

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Table 3-1. Rapid Evaluation Criteria

Condition	Action ^a
1. Building has collapsed, partially collapsed, or moved off its foundation.	Post Unsafe.
2. Building or any story is significantly out of plumb (i.e., leaning).	Post Unsafe.
3. Obvious severe damage to primary structural members, severe racking of walls, or other signs of severe damage and distress present.	Post Unsafe.
4. Obvious parapet, chimney, or other falling hazard present.	Post Restricted Use and barricade the unsafe area.
5. Large fissures in ground, massive ground movement, or slope displacement is present.	Post Unsafe.
6. Other hazard present (e.g., toxic spill, asbestos contamination, broken gas line, fallen power line).	Post Unsafe and/or barricade unsafe area ^b

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**Condition 4: Obvious parapet or other falling hazard.
Post Restricted Use and barricade the unsafe area.**

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Table 3-2. Rapid Evaluation Inspection Procedure

1. Examine the entire outside of the structure.
2. Examine the ground and pavement in the general area of the structure for fissures, bulged ground, or signs of slope movement.
3. Enter a building when the structure cannot be viewed sufficiently from the outside and when there is a suspected or reported problem such as nonstructural distress (e.g., fallen ceiling or damaged partitions). See "Guidance on Entering a Building" (below). **Do not enter obviously unsafe structures.**
4. Evaluate the structure using the six criteria (Table 3-1). Complete the Rapid Evaluation form (Figure 3-2). Make sure that exitways are clear and usable. Doubtful buildings should be slated for a Detailed Evaluation. Record any restrictions placed on use of the structure on the Rapid Evaluation form.
5. Post the structure according to the results of the evaluation. Use one of the three placards INSPECTED, RESTRICTED USE, or UNSAFE). Indicate on the placard whether the inspection included only the "exterior" or the "exterior and interior" by checking the appropriate box. Post every entrance to a building classified as Restricted Use or Unsafe (except single-family dwellings).
6. Explain the significance of Restricted Use or Unsafe postings to building occupants, if they are available. Advise them to leave unsafe buildings immediately, but do not create panic. Unsafe areas must also be evacuated.

Rapid Evaluation Form



ATC-20 Rapid Evaluation Safety Assessment Form

Inspection

Inspector ID _____ Inspection date and time: _____ AM PM
 Affiliation: _____ Areas inspected: Exterior only Exterior and interior

Building Description

Building name: _____
 Address: _____
 Building contact/phone: _____
 Number of stories above ground: _____ below ground: _____
 Approx. "Footprint area" (square feet): _____
 Number of residential units: _____
 Number of residential units not habitable: _____

Type of Construction

Wood frame Concrete shear wall
 Steel frame Unreinforced masonry
 Tilt-up concrete Reinforced masonry
 Concrete frame Other: _____

Primary Occupancy

Dwelling Commercial Government
 Other residential Offices Historic
 Public assembly Industrial School
 Emergency services Other: _____

Evaluation

Investigate the building for the conditions below and check the appropriate column

Observed Conditions:	Minor/None	Moderate	Severe	Estimated Building Damage (excluding contents)
Collapse, partial collapse, or building off foundation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> None
Building or story leaning	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> 0-1%
Racking damage to walls, other structural damage	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> 1-10%
Chimney, parapet, or other falling hazard	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> 10-30%
Ground slope movement or cracking	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> 30-60%
Other (specify) _____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> 60-100%
				<input type="checkbox"/> 100%

Comments: _____

Rapid Evaluation Form

Posting
Choose a posting based on the evaluation and team judgment. Severe conditions endangering the overall building are grounds for an Unsafe posting. Localized Severe and overall Moderate conditions may allow a Restricted Use posting. Post INSPECTED placard at main entrance. Post RESTRICTED USE and UNSAFE placards at all entrances

INSPECTED (Green placard) **RESTRICTED USE** (Yellow placard) **UNSAFE** (Red placard)

Record any use and entry restrictions exactly as written on placard: _____

Further Actions Check the boxes below only if further actions are needed.

Barricades needed in the following areas: _____

Detailed Evaluation recommended: Structural Geotechnical Other: _____

Other recommendations: _____

Comments: _____

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STEP 4: Inspect for Nonstructural Hazards

- a. Inside the building, look for damage to nonstructural elements such as ceilings, partitions, light fixtures, roof-top tanks, and other appendages. If cladding damage suspected, inspect representative connections. See Chapter 12 for further guidance.

STEP 5: Inspect for Other Hazards

- a. If damage is present or suspected that would affect the safe operation of elevators, the elevators should not be restarted without inspection by a qualified person.

Detailed Evaluation Form

ATC-20 Detailed Evaluation Safety Assessment Form

Inspection
 Inspector ID: _____
 Affiliation: _____
 Inspection date and time: _____ AM PM

Final Posting
 from page 2
 Inspected
 Restricted Use
 Unsafe

Building Description

Building name: _____
 Address: _____
 Building contact/phone: _____
 Number of stories above ground: ____ below ground: ____
 Approx. "Footprint area" (square feet): _____
 Number of residential units: _____
 Number of residential units not habitable: _____

Type of Construction
 Wood frame
 Steel frame
 Tilt-up concrete
 Concrete frame
 Concrete shear wall
 Unreinforced masonry
 Reinforced masonry
 Other: _____

Primary Occupancy
 Dwelling
 Other residential
 Public assembly
 Emergency services
 Commercial
 Offices
 Industrial
 Other: _____
 Government
 Historic
 School

Evaluation
 Investigate the building for the conditions below and check the appropriate column. There is room on the second page for a sketch.

	Minor/None	Moderate	Severe	Comments
Overall hazards:				
Collapse or partial collapse	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Building or story leaning	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Other _____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Structural hazards:				
Foundations	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Roofs, floors (vertical loads)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Columns, pilasters, corbels	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Diaphragms, horizontal bracing	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Walls, vertical bracing	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Precast connections	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Other _____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Nonstructural hazards:				
Parapets, ornamentation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Cladding, glazing	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Ceilings, light fixtures	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Interior walls, partitions	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Elevators	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Stairs, exits	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Electric, gas	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Other _____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Geotechnical hazards:				
Slope failure, debris	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Ground movement, fissures	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Other _____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
General Comments: _____				

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6. Inspection and Posting of Masonry Structures

There are two kinds of masonry construction: unreinforced and reinforced. Unreinforced masonry (URM) structures, particularly bearing-wall structures, are one of the most hazardous forms of construction found in the United States. Many URM buildings have been retrofitted (e.g., parapets braced, wall-roof ties added), and this can reduce the general level of damage experienced. Reinforced masonry structures have performed much better; however, some reinforced masonry structures have construction similar to tilt-up buildings (see Chapter 7), and wall-roof and wall-floor separations can occur.

Many, if not most, unreinforced masonry structures, including adobe construction, have wood floors and roofs. Floors and walls are often not tied together for horizontal earthquake forces or, when tied together, they are only weakly connected. Due to their age, these structures may also have deteriorated mortar. Additionally, individual wythes of walls, particularly those without headers (bricks laid with the butt end on the exterior face of the wall), may not be connected except by mortar in tension, making the walls particularly prone to out-of-plane failures. Some walls may be covered by plaster or other materials, making identification more difficult. Various forms of damage to URM buildings are shown in Figure 6-1.

See Figure 6-2 for inspection points of unreinforced masonry bearing-wall buildings. (Note that concrete and steel-frame buildings with infill masonry walls are covered in Chapters 8 and 9, respectively.)

Inspect the building to determine if any of the principal safety concerns listed below exist. There may also be other hazards. For most



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- 2. Roof and Floor Framing
 - Roof or floor framing separation from vertical supports (Figure 6-3) Unsafe
 - Other failure or incipient failure of significant vertical load-carrying element or connection (Figure 6-4) Unsafe
- 3. Columns
 - Columns noticeably out of plumb Unsafe
 - Buckled or failed columns Unsafe
- 4. Unreinforced Masonry Walls
 - Noticeably out of plumb Unsafe
 - Diagonal, stepped (Figure 6-5), or other large cracking (Figure 6-6) Unsafe
 - Wythe separation and masonry spalling Restricted Use or Unsafe¹
 - Wall or pilaster cracking or spalling that jeopardizes vertical support of roof or floor framing (Figure 6-4) Unsafe
 - Cracked parapet (Figure 6-6) Restricted Use or Unsafe¹
- 5. Reinforced Masonry Walls
 - Major walls with 1/8-inch or larger diagonal (shear) cracks Restricted Use or Unsafe¹
 - Several failed piers at any one story (Figure 8-14) Unsafe
 - Walls with out-of-plane leaning Unsafe
 - Wall or pilaster cracking or spalling that jeopardizes vertical support of roof or floor framing Unsafe
 - Wall-roof separation Unsafe
- 6. Diaphragms
 - Bowed, broken or seriously damaged diaphragm Unsafe



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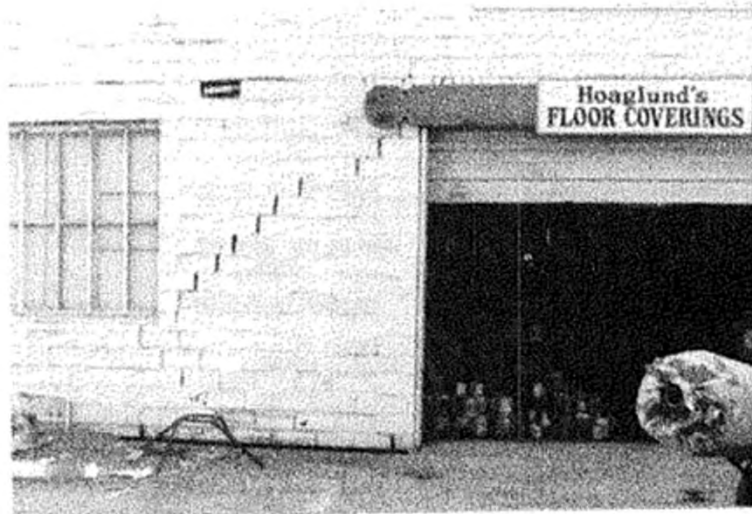


Figure 6-5 Unreinforced masonry wall with a stepped crack.



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12. Inspection and Posting of Nonstructural Hazards

In addition to the obvious life-safety concerns related to the stability of a building as a whole, damage to nonstructural elements can also create hazards. For example, a weakened parapet may fall in an aftershock, or a cracked gas line to a boiler may result in a postearthquake explosion and fire.

Inspect the building to determine if any of the common safety concerns listed below exist. Elevators and fire protection/detection equipment should be inspected by specialists. Refer to Appendix C for guidance whenever a spill or release of a hazardous or unknown material is encountered.

The posting recommendations given below are the recommended postings for the building or structure affected by the individual hazardous condition. Generally, nonstructural damage alone is not grounds for posting an entire building Unsafe. However, if the hazards are severe, life-threatening, and widespread, it may be necessary. It is recommended that the Restricted Use posting be used whenever possible, with restrictions placed either on entry into unsafe areas, or entry restricted to essential personnel and repair workers. For buildings with very minor nonstructural hazards, the Inspected placard, with appropriate barricading, may be used.

Condition	Posting ¹
1. Parapets, Ornamentation, and Appendages	
Partially dislodged masonry parapets	Restricted Use
Masonry parapets with cracking (no evidence of reinforcement)	Restricted Use

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Concrete parapets with major spalling or severe lean	Restricted Use
Ornamentation/cornices/signs/mansards with support distress or partial dislodgement	Restricted Use
Fallen or damaged veneer (Figure 12-1) or roof tile	Restricted Use
2. Canopies	
Partial collapse or lean of canopy (Figure 12-2).	Restricted Use
Failure or incipient failure of support for canopy, awning or marquee	Restricted Use
3. Cladding	
Falling hazard from damaged glazing	Restricted Use
Broken or damaged cladding (Figure 12-3).	Restricted Use
Walls with some fallen panels	Restricted Use
4. Ceilings and Light Fixtures	
Collapse, partial collapse, or incipient collapse of ceiling (Figure 12-4)	Restricted Use
Pendant fluorescent light fixtures with damaged stems	Restricted Use
Area with some fallen light fixtures (Figure 12-5) or possible falling hazard	Restricted Use
5. Interior Walls, Partitions, and Glazing	
Collapsed, partially collapsed, or severely cracked partitions (Figure 12-6).	Restricted Use
Cracked masonry or tile partitions (no evidence of reinforcement)	Restricted Use
Demountable partitions separated from supports	Restricted Use
Possible falling glass hazard.	Restricted Use



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6. Mechanical and Electrical Equipment

- Overturning or sliding of gas- and fuel-oil-fired equipment (Figure 12-7) Restricted Use²
- Gas or fuel line break or leak Restricted Use²
- Broken exhaust pipe. Restricted Use²
- Overhead piping and ducts with failed supports Restricted Use
- Other mechanical and electrical equipment falling hazard present Restricted Use

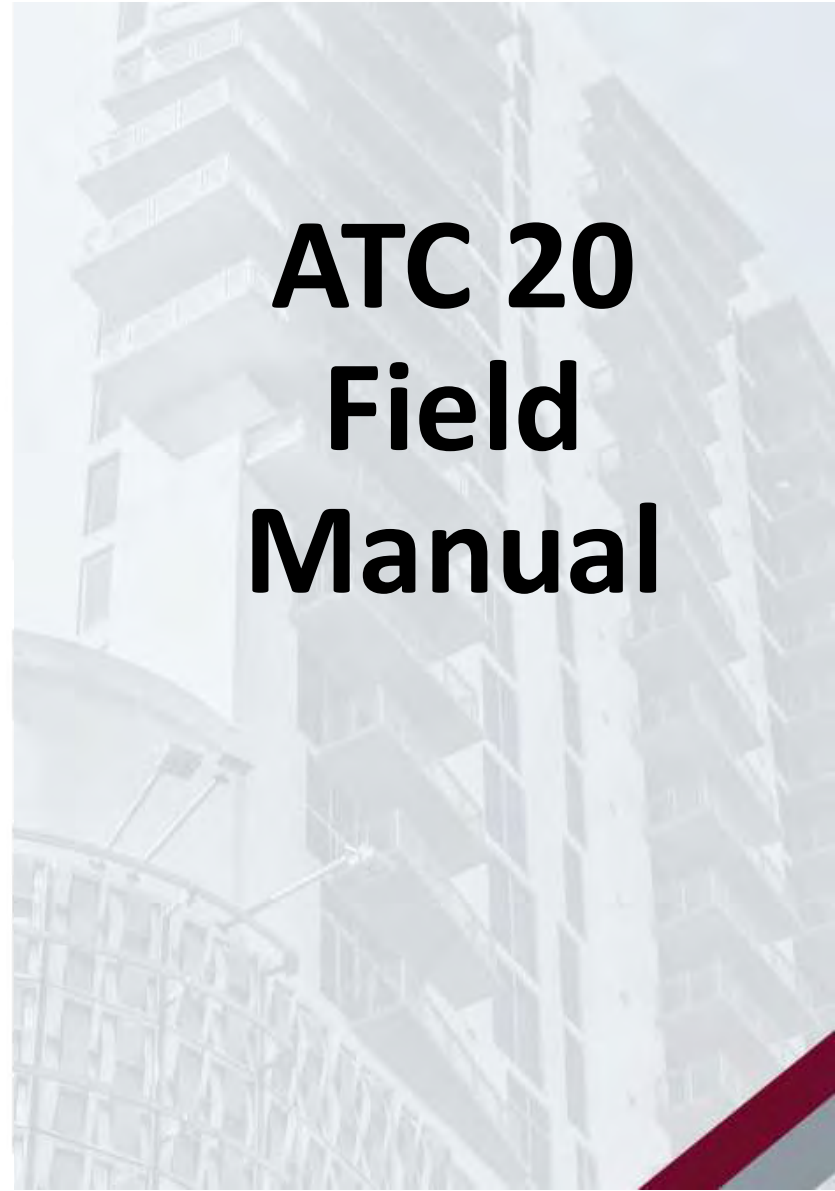
7. Elevators

Inspection points for traction elevators are shown in Figure 12-8. Passenger elevators in California with automatic operation and counterweights are provided with an earthquake protective device. Elevators posted Unsafe, including those with protective devices, should not be used.

- Suspected damage Unsafe
- Elevator with protective switch tripped Unsafe
- Counterweights out of guides Unsafe
- Damaged guiding member Unsafe
- Damaged guide rails or brackets. Unsafe
- Equipment anchorage failure Unsafe
- Cables out of sheaves Unsafe
- Door damage Unsafe

8. Other

- Spill of known or suspected dangerous materials Restricted Use¹



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- Leakage of unknown substance from tank, pressure vessel, or piping. Restricted Use¹
- Friable asbestos release Restricted Use or Unsafe¹
- Fire protection/detection equipment inoperable. Restricted Use
- Fallen electric lines. Restricted Use¹
- Unsafe condition at stairway, exitway, or inoperable exit door. Restricted Use³
- Raised access floor with collapse potential Restricted Use



Figure 12-1 Damaged brick veneer can be a falling hazard. Post Restricted Use and barricade unsafe area.

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ATC-20 Fixed Equipment Checklist

Building Description

Building name: _____
 Address: _____

Inspection

Inspector ID: _____
 Affiliation: _____
 Inspection date: _____
 Inspection time: _____ AM PM

Checklist

Overall hazards:	Equipment Damaged			Comments
	Minor/Negl	Moderate	Severe	
Main boilers	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
Chillers	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
Emergency generators	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
Fuel tanks	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
Battery racks	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
Fire pumps	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
On-site water storage	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
Communications equipment	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
Main transformers	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
Main electrical panels	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
Elevators (traction)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
Other fixed equipment	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
Special concerns for hospitals and other health care facilities				
Radiation equipment	<input type="checkbox"/>		<input type="checkbox"/>	_____
Toxic chemical storage	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
Liquid oxygen tanks	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
Other: _____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
_____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____

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Equipment Checklist

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Equipment Check

Table 13-1. Operability and Safety Considerations for Fixed Equipment

Item	Principal Concerns
Main boilers	Sliding, broken gas/fuel lines, broken exhaust lines, broken/bent steam and relief lines
Chillers	Sliding, loss of function, leaking refrigerant
Emergency generators	Failed vibration isolation mounts; sliding, broken fuel, cooling, signal, and power lines, leading to loss of function; broken exhaust lines
Fuel tanks	Sliding or overturning, leaks, broken fuel lines
Battery racks	Damaged rack, dislodged batteries, acid spill
Fire pumps	Anchorage failure, misalignment between pump and motor, broken piping
On-site water storage	Tank or vessel rupture, pipe break
Communications equipment	Sliding, overturning, or toppling, leading to loss of function
Main transformers	Sliding, oil leak, loss of function
Main electrical panels	Sliding or overturning, broken or damaged conduit or electrical bus
Elevators (traction)	Counterweights out of guide rails, cables out of sheaves, dislodged equipment
Other fixed equipment	Sliding or overturning, leading to loss of function (or damage to adjacent equipment)
Special Concerns for Hospitals and Other Health Care Facilities	
Radiation charges	Breach of containment, cobalt contamination
Toxics and chemicals	Spill, fumes in ventilation system
Liquid oxygen tanks	Sliding or overturning, leaks, broken lines

BEFORE Screening Buildings for Hazards

- Federal Emergency Management Agency (FEMA). Applied Technology Council (ATC)
- FEMA P-154 and P-155 a 2-part handbook “Rapid Visual Screening of Buildings for Potential Seismic Hazards”
- This program is for all buildings but is particularly beneficial for older buildings designed and constructed before the adoption of seismic design.
 - Handbook includes a scoring system for buildings.
 - Explains how to properly screen your building for safety during and after an event.
 - Rapid Visual Screening (RVS) Level 1 is designed for a broad audience.
 - Identifies when to consult with a Structural Engineer

<https://www.fema.gov/emergency-managers/risk-management/earthquake/training/fema-p-154>

Rapid Visual Screening (RVS)

- RVS uses a methodology-based “sidewalk survey” of a building and a data collection form.
- Some of the building details required to achieve a “Seismic Hazard Score” are :
 - Use
 - Size
 - Photographs
 - Sketches
 - Pertinent data related to seismic performance
- If a building score results as “Seismically Hazardous” a professional should be consulted.
- For critical facilities a professional should always be consulted

Rapid Visual Screening of Buildings for Potential Seismic Hazards
 FEMA P-154 Data Collection Form

**Level 1
HIGH Seismicity**

PHOTOGRAPH	Address: _____		Zip: _____			
	Other Identifiers: _____					
	Building Name: _____					
	Use: _____					
	Latitude: _____		Longitude: _____			
	Sj: _____		Si: _____			
	Screener(s): _____		Date/Time: _____			
	No. Stories: Above Grade: _____	Below Grade: _____	Year Built: _____ <input type="checkbox"/> EST			
	Total Floor Area (sq. ft.): _____		Code Year: _____			
	Additions: <input type="checkbox"/> None <input type="checkbox"/> Yes, Year(s) Built: _____					
Occupancy: Assembly	Commercial	Emer. Services	<input type="checkbox"/> Historic	<input type="checkbox"/> Shelter		
Industrial	Office	School	<input type="checkbox"/> Government			
Utility	Warehouse	Residential, #Units: _____				
Soil Type: <input type="checkbox"/> A	<input type="checkbox"/> B	<input type="checkbox"/> C	<input type="checkbox"/> D	<input type="checkbox"/> E	<input type="checkbox"/> F	DNK
Hard Rock	Avg Rock	Dense Soil	Stiff Soil	Soft Soil	Poor Soil	/DNK, assume Type D.

RVS Level 1 and 2

Level 1 Screenings are less intensive and preliminary. .

- Who can perform Level 1 Screenings:
Civil or structural Engineer, architect, design professional, building official, construction contractor, **facility manager**, firefighter, architectural or engineering student, or another individual with a general **familiarity or background in building design or construction.**
- Who can perform Level 2 Screenings:
Civil or structural engineer professional, architect, or graduate student with a background in seismic evaluation or design of buildings.

FEMA Building Type

- FEMA has broken down buildings into 17 categories known as “FEMA Building Types”
 - Each “FEMA Building Type” has its own ‘basic’ score for the seismicity region for RVS Level 1.
 - Other building characteristics to consider are **use**, pre-code buildings, height irregularities, soil type, large openings, hybrid structures etc.
- Light wood frame single- or multiple-family dwellings of one or more stories in height (W1)
 - Light wood frame multi-unit, multi-story residential buildings with plan areas on each floor of greater than 3,000 square feet (W1A)
 - Wood frame commercial and industrial buildings with a floor area larger than 5,000 square feet (W2)
 - Steel moment-resisting frame buildings (S1)
 - Braced steel frame buildings (S2)
 - Light metal buildings (S3)
 - Steel frame buildings with cast-in-place concrete shear walls (S4)
 - Steel frame buildings with unreinforced masonry infill walls (S5)
 - Concrete moment-resisting frame buildings (C1)
 - Concrete shear-wall buildings (C2)
 - Concrete frame buildings with unreinforced masonry infill walls (C3)
 - Tilt-up buildings (PC1)
 - Precast concrete frame buildings (PC2)
 - Reinforced masonry buildings with flexible floor and roof diaphragms (RM1)
 - Reinforced masonry buildings with rigid floor and roof diaphragms (RM2)
 - Unreinforced masonry bearing-wall buildings (URM)
 - Manufactured housing (MH)

Building Type Details

- Identifying your building type.
- Key Information:
 - Year constructed
 - Original building use
 - Height
 - Façade patterns
 - Unreinforced masonry components
 - Non-structural components

Brick buildings

Unreinforced masonry facades



Emergency Management Planning

- Emergency Management (EM) budgeting and planning for earthquakes.
- FEMA and NEHRP have EM information that can be found at:

<https://www.fema.gov/emergency-managers/risk-management/earthquake>

<https://nehrp.gov>



Bibliography & Pertinent Info

- FEMA 396 (December 2003), Risk Management Series, Incremental Seismic Rehabilitation of Hospital Buildings
 - FEMA P-154 (January 2015) Rapid Visual Screening of Potential Seismic Hazards: A Handbook 'Third Edition'
 - Additional FEMA P-154 information <https://www.fema.gov/emergency-managers/risk-management/earthquake/training/fema-p-154>
 - 04.05.2024 New Jersey Earthquake Data from United States Geological Survey <https://earthquake.usgs.gov/earthquakes/eventpage/at00sbh3yv/executive>
 - Latest Earthquake Data <https://earthquake.usgs.gov/earthquakes>
 - ATC-20-1 Applied Technology Council, Field Manual: Postearthquake Safety Evaluation of Buildings 'Second Edition'
 - Additional ATC-20 information www.atcouncil.org/atc-20
 - Additional EM information <https://nehrp.gov> or <https://www.fema.gov/emergency-managers/risk-management/earthquake>
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- American Society of Civil Engineers (ASCE)
 - ASCE 11 “Guideline for Structural Condition Assessments of Existing Buildings”
 - ASCE 31 Seismic evaluation of existing buildings
 - ASCE 41 Seismic rehabilitation of existing buildings

Questions?

