

## Conducting Building Assessments



Building assessment team, Montana  
Courtesy FEMA



## Objectives

- Describe the Environmental Health role in building assessments
- Discuss how disasters can impact buildings
- Identify exterior and interior building components
- Explain assessment preparation and process for buildings
- Identify building-related health hazards
- Exercise recovery and reoccupancy evaluations
- Identify preventative actions to improve building resiliency



## Role of Environmental Health

- Ensure buildings provide the occupants a healthful environment
- Prevent disease caused by impaired or contaminated buildings
- Provide information on building needs to protect occupants
- Conduct interventions needed to protect the public from impaired buildings
- Assist building officials identifying damaged structures that may cause physical injury



Building assessment, Texas  
Courtesy FEMA



## Role of Environmental Health- Building Environments

- On average, people spend 50% of the day in their homes
- On average, Americans spend about 90 percent or more of their time indoors
- Evolution of building codes in the United States
- Buildings have purpose and are designed to facilitate a specific function



Living and kitchen area, Iowa



Office space, Connecticut



Pictures courtesy FEMA



## Role of Environmental Health- Healthy Homes Principles

Seven principles, keep it:

- **Dry**
- **Clean**
- **Ventilated**
- **Contaminant-Free**
- **Safe**
- **Pest-free**
- **Maintained**



- Understand the connection between building damage and health impacts
- Training and credentialing available through National Center for Healthy Housing(NCHH), CDC and HUD Healthy Homes



## Role of Environmental Health – Safety



Clean up with PPE, North Carolina



Owner of destroyed home, North Carolina

- Safety of team
- Situational awareness
- Knowledge of building contents and hazards
- Right of entry and legal authority
- Scope of Assessment – typically a limited, visual inspection
- What PPE is needed
- Demeanor and mindset of building owners
- Communication/contact needs



Pictures courtesy FEMA



## Role of Environmental Health – Safety (continued)

### Urban Search and Rescue (US&R) Markings

- Structure triage, assessment and marking system to communicate structure/building hazards
- For safety, Practitioners need to know what markings mean
- Practitioners need to research what unique markings may be used in their community



Structure marking, Tennessee



Structure marking, Florida



Pictures courtesy FEMA

## Role of Environmental Health – After Major Disasters

### Assessment Response



Aerial view of Area of Impact(AI), Montana



Urban Search and Rescue, Texas



- FEMA Incident Management Assistance Teams(IMATs) conduct rapid overview of damage
- Individual response groups such as Urban Search and Rescue (USAR) teams, Army Corps of Engineers and National Guard respond and further triage needs
- Specialized teams, e.g. Strike, Task force
- Consider teams that might be involved with Catastrophic events
- Consider teams that might be involved with non national events(state and local teams)

Pictures courtesy FEMA



## Role of Environmental Health – Community Recovery

### Where do Building Assessments fit in?

- Broad damage assessment occurs (EH working in multi discipline teams)
- Sheltering
- More detailed assessment begins
- Interim Housing provided(permitting needed)
- Structures repaired and rebuilt
- Monitoring (follow up inspections)



Shelter, North Carolina



Temporary housing, North Dakota

Note: Building assessments are NOT a replacement for insurance adjustors



Pictures courtesy FEMA



## Role of Environmental Health – Community Recovery

### Where does Environmental Health fit in?

- Building, emergency management and safety officials are the normal building assessment team leads
- Environmental Practitioners utilized in a cross discipline team
- Practitioners can integrate into building assessment teams
- Integration may lead to additional funding for Environmental Health



Interior assessment, North Carolina



Building assessment, Florida



Pictures courtesy FEMA



## Role of Environmental Health – Key Partners

- Emergency Management
- Emergency Operation Command (EOC)
- Public works and wastewater utilities
- Emergency Support Functions (ESF)
- Building owners and building support services (maintenance)
- Local code enforcement/building dept.
- Builders and the Construction Industry
- CDC, Healthy Homes, HUD, EPA and Small Business Administration
- Insurance Companies
- Land grant Colleges and Universities
- Home Inspection Industry and Realtors



Partners compare assessment reports, Illinois  
Courtesy FEMA



## Role of Environmental Health – Activity

### What can you bring to the table for building assessments?

- Environmental Practitioners have broad knowledge backgrounds and working experience
- Practitioners may work in multiple programmatic areas; onsite systems, group care facility inspections, drinking water etc.

**Take 5 minutes and write down your own individual knowledge and working experience that you feel could contribute to a disaster building assessment team in your community. Share any disaster building assessment response experience you may have. Be prepared to share with the group.**



## Disaster Impacts on Buildings – Numerous Causes

### Natural Disasters

Hurricanes, blizzards, landslides, tornadoes, earthquakes, volcanic eruptions, heat waves, floods, lighting strikes, hail storms, wild fires, sinkholes, snow melt, avalanches and severe storms



Tornado damaged school, Alabama



Landslide, California



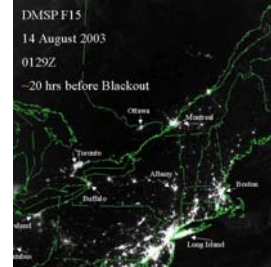
Pictures courtesy FEMA



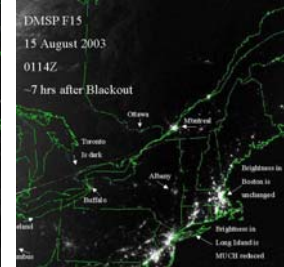
## Disaster Impacts on Buildings – Numerous Causes

### Technological/Manmade Disasters

Terrorist attacks, fires, explosions, biological or chemical contamination, cyber attacks, nuclear attacks and critical infrastructure disruption



Pictures courtesy NOAA



## Building Components - Exterior

### Building envelope

- Roof covering
- Exterior walls
- Windows
- Doors

### Envelope protects us from:

- Hot or cold air
- Moisture
- Precipitation (snow and rain)
- Insects and rodents
- Wind
- Sun
- Dust



Hospital in Montana, Courtesy FEMA



Residential home in Mississippi, Courtesy FEMA



## Building Components – Exterior (continued)

### Utility Infrastructure

- Electrical service connection
- Potable water supply
- Liquid waste disposal
- Gas service connection
- Heating, Ventilation and Air Conditioning(HVAC)



Air conditioner, Courtesy CPSC



Open septic tanks, Courtesy CDC



## Building Components - Interior



House cross section, Courtesy CDC NCEH

### Furnishing

- Mattresses
- Couches
- Office desks
- Tables

### Finishing

- Carpet
- Laminate flooring
- Sheetrock
- Paint
- Wood panels



## Building Components – Interior (continued)



Interior Assessment, Connecticut, Courtesy FEMA

### Appliances

- Refrigerators
- Stoves/ovens
- Hot water heaters
- Dish washers
- Clothes washer
- Clothes dryers
- Microwaves

### Function Specific

- Autoclaves
- Commercial kitchen equipment
- Network servers
- Medical support machinery





## Disaster Impacts on Buildings - Affects

### Function affected

- Compromised structural integrity
- No protection from the open environment



Hurricane removes access and egress, North Carolina  
Courtesy FEMA



Foundation damage after landslide, California  
Courtesy FEMA

### Unsafe access/egress to structure

- Access eroded away
- Blocked access
- Overhanging structural concern(trees)



## Disaster Impacts on Buildings – Affects (continued)



Visible mold after flood, Tennessee  
Courtesy FEMA



Checking mailboxes for anthrax, Courtesy CDC

### Possible acute and chronic exposure health risks

- Indoor air concerns – mold
- Sewage flooding or backup
- Chemical contamination
- Nuclear contamination
- Biological terrorist attacks



## Disaster Impacts on Buildings – Affects (continued)

### Critical utility services reduced or eliminated

- No potable water supply
  - Private well
  - Public water
- Gas supply interruption
- Power loss



Potable water supply disruption, Louisiana  
Courtesy FEMA



Storm surge removes onsite wastewater system  
Courtesy CDC

- Lack of liquid waste disposal
  - Onsite system
  - Public sewer
- Heating Ventilation and Air Conditioning (HVAC)



## Disaster Impacts on Buildings – Affects (continued)

### Damaged or destroyed



Destroyed house due to flooding, Wisconsin  
Courtesy FEMA



- Long-term utility costs
  - No area to repair the onsite wastewater system, nearest sewer system located miles away
- Building repair may exceed the value of the building
- Property may be eroded away or now unsuitable for building foundation



## Building Assessment – Preparation

### Equipment needed



### Standard EH survey tools

- Flashlight
- Camera
- Binoculars
- PPE

### Specialized tools

- Multi gas meter
- Moisture meter
- GPS for GIS mapping
- Lead and asbestos test kits
- Water pressure gauge
- Voltage tic meter(non contact)

### Critical tools

- Practitioner senses
- Practitioner training



## Building Assessment Preparation

### Access, permission and authority



Building assessment, Florida  
Courtesy FEMA

### Before we conduct our assessment

- ICS forms, form 202
  - Mission/task number
  - Operational period
  - Assessment/task scope
  - Health and safety Plan(HASP)
- Right of entry and enforcement capacity
- Building owner awareness of assessment
- Permitting agencies that need to be advised



## Building Assessments Preparation

### Documentation preparation

Before going into the field determine what information is available

- Impact areas (earthquake, flood, chemical release, tornado)
- Means of liquid waste disposal in the area
- Means of drinking water supply
- Street maps (signs removed)
- Aerial pre and post disaster
- Pre-disaster risk assessment
- Geo-coded data



Street map, New Jersey, Courtesy FEMA



Path of EF-2 tornado, Courtesy NOAA



## Building Assessments Preparation

### Documentation preparation (continued)

Many Property Appraiser websites can provide:

- Current owner
- Age of structure(s)
- Floor plans (great for documentation)
- Parcel boundaries
- Exterior and interior wall material



## Building Assessment Preparation

### Documentation forms



Building assessment, California

- Forms should be adapted to meet mission needs
- Forms should document the type and use of building
- Broad estimations of damage (<50% or >50%) (functional or nonfunctional)



Tracking building assessment pictures, New York

- Routine inspection forms not needed for initial disaster building assessment
- Photographs need accurate tracking and labeling



Pictures courtesy FEMA



## Building Assessment Preparation

### Documentation forms (continued)

- Form flow needs to facilitate an effective, comprehensive and efficient assessment
- Liquid waste disposal - sewer or an onsite system
- Potable water – onsite well or public water supply
- Use floor plan sketches
- Property site plans for quick documentation



Fire damaged well water pump at child care center, Texas  
Courtesy FEMA



## Building Assessment Preparation

### Documentation forms (continued)



Inspector receiving real-time data in the field, New Orleans  
Courtesy FEMA

- Tablets and laptops
- Can quickly fill out assessment forms
- Quick integration of photographs into assessment reports
- Real-time updates from and to the field
- Several Home Inspector programs as guides and possible tools



## Building Assessment Preparation - Activity

### Documentation forms

Review the example building assessment forms in your student manual. Pick one form to critique based off your assigned disaster event.

- Group A - Snow storm event
- Group B - Earthquake
- Group C - Wildfire
- Group D - Tornado

What would you change or add to the form? Consider potential component damage and associated hazards created by the type event.

Working in small groups, take 10 minutes and write down your ideas for building assessment forms. Be prepared to share your ideas with the group.



## Building Assessment Process(exterior)

### Exterior Assessment Pattern



Flooding waterline elevation mark, Montana

- Building assessments should start with the exterior
- Note exterior damage that will be symptomatic of interior damage
- Evaluate what can be seen at a distance
- Circle the structure in one direction then circle in the opposite direction



Picture courtesy FEMA



## Building Assessment Process(exterior)

### Utility infrastructure

Limited, visual inspection of utility infrastructure components

- Electrical – shock hazard?
- Gas – any apparent leaks?



Gas meter, Florida, Courtesy CDC



Service mast, New York  
Courtesy FEMA



HVAC assessment at a school, Oklahoma  
Courtesy FEMA

- Heating Ventilation and Air Conditioning (HVAC) – is HVAC needed for occupancy?



## Building Assessment Process(exterior)

### Utility infrastructure - Potable water supply



Private well, Chickasaw Nation  
Courtesy USGS

- Private well
- Damage to casing
  - Loss of pressure
- Municipal supply
- Under a boil water notice
  - Service line damage



Spinning register



Water pressure gauge, Florida



Water meter, Florida



## Building Assessment Process(exterior)

### Utility infrastructure - Wastewater

Is there sewage on the ground?

Onsite system(septic)

- Displaced tank or drainfield
- Saturated soil conditions
- Drainfield treatment area erosion

Sanitary sewer

- Connection component damage
- Backflow into building



Eroded onsite system, Florida  
Courtesy CDC



## Building Assessment Process(exterior)

### Foundation

- Foundation damage, a safety concern for responders and occupants
- Are exterior walls vertical and straight?
- Check for cracks in masonry slabs
- Look at individual piers for elevated structures
- Take photographs of damage and use an item for scale
- May need further onsite evaluation by an engineer



Flood water dislodges foundation, Arkansas  
Courtesy FEMA

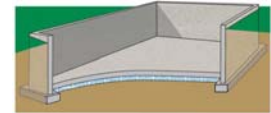


## Building Assessment Process(exterior)

### Foundation types



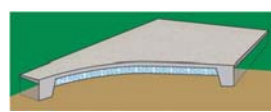
Continuous wall with slab



Basement



Crawlspace



Slab on grade



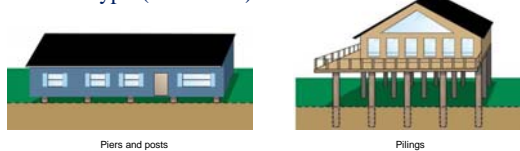
Foundation graphics, Courtesy FEMA





## Building Assessment Process(exterio

### Foundation types(Continued)



- Is the structure safe for an interior assessment?
- Do visual cracks appear in foundations that indicate a need for evaluation by an engineer
- Describe the damage, type of foundation and take photographs of your concerns
- Safety first, avoid dangerous areas



Foundation graphics, Courtesy FEMA



## Building Assessment Process(exterio

### Roof Covering and Sheathing

- Safety, roof damage can be an exterior symptom of interior structural concerns
- Roof damage leads to water intrusion
- Water intrusion leads to indoor air issues
- Indoor air issues are a public health concern



Shingles/roof covering  
Courtesy National Park Service



Cutting vent holes for roof, Texas  
Courtesy FEMA

Note: Quick mitigation of damaged roofs

- How can we prevent further damage with compromised roofs? – FEMA's BLUE ROOF
- Immediate steps to limit indoor air issues – Increase air movement with fans and dehumidifiers



## Building Assessment Process(exterio

### Windows and doors



Damaged windows at an elementary school, Kansas  
Courtesy FEMA

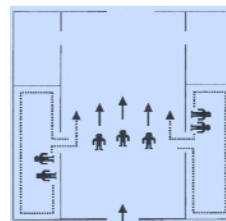
- Damaged windows and screen coverings cause loss of vector control
- Compromised vector control can lead to entrance of rodent and insects that can transmit disease
- Window and frames can give signs of possible structural damage
- Will doors open and shut easily?



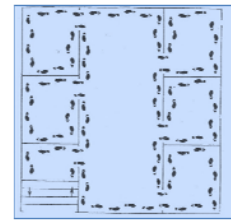
## Building Assessment Process(interior

### Interior Assessment Patterns

- Go right, stay right (AKA hug a wall)
- Line walk through
- Looking high to low then low to high



Line walk through



Go right, stay right / Hug a wall



Foundation graphics  
Courtesy Center for Domestic Preparedness (CDP)



## Building Assessment Process(interior

### Flooring

#### Flooring conditions

- Flooring buckled, shifted or cracked
- Flooring absorbent or non absorbent
- Subflooring saturation
- Indication of foundation issues

#### Public Health Concerns

- Potentially hazardous materials, i.e. asbestos flooring tiles
- Slip, trip and fall hazards
- Saturated, absorbent materials lead to indoor air issues



Damaged flooring in a home, North Carolina  
Courtesy FEMA



## Building Assessment Process

### Walls and Ceilings



Checking ceiling in a hospital, Hawaii



Earthquake damage, California

- Wall cracks normally occur around door and window frames
- Water stain may be visible on ceiling or wall materials
- Ceiling building material may contain asbestos
- Wall paint may contain lead, damage creates flakes
- Physical damage can expose asbestos and other hazardous building materials



Pictures courtesy FEMA



## Building related Health Hazards

### A 3-step evaluation process

1. Chemical, physical or biological hazard present in the building?
2. Does a pathway exist to transport the hazard to the occupant?
3. If so, can the exposure be quantified (time/dose)?



Biological concern (mold), Tennessee  
Courtesy FEMA



## Building related Health Hazards (continued)

### Indoor Air Concerns (mold)

- Most common biological concern after disaster events
- A visual walkthrough will give you all the information you need
- Look for mold growth and water damage
- Find moisture source(s) and eliminate them



Mold growth on kitchen cabinets, Tennessee



Manufactured home wall, Tennessee



Wall, Tennessee



Pictures courtesy FEMA



## Building related Health Hazards (continued)

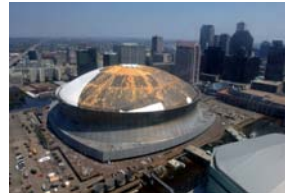
### Structural concerns

Apparent structural damage that could endanger occupants

- Foundation shifting or settling – break in waste disposal lines
- Roof truss or support damage- possible water intrusion (mold)
- Load bearing walls damaged or cracked – cracks in potable waterlines



Foundation shifting after tornadoes, Montana



Roof damage at Superdome, New Orleans



Pictures courtesy FEMA



## Building related Health Hazards (continued)

### Disaster introduced contaminants in buildings

There are a variety of hazards that could negatively affect health

- Wastewater, fire ash, soot and smoke; anaerobic muck, river silt and mud; heating oil and other substances can enter structures
- Some situations may be actual hazards and some may be falsely perceived by the public- Practitioners will need to find answers



Mud/silt build up after flooding, Louisiana



Oil contamination, Virginia



Smoke, soot and ash, Colorado



Pictures courtesy FEMA



## Building related Health Hazards (continued)

### Contaminants in buildings

- Consider chemicals and hazardous materials stored in buildings
- What do people keep under their kitchen sink or in the garage
- What type waste is stored in buildings such as hospitals – need applicable MSDS sheets before entry into the structure
- Unique chemical contamination concerns –NIOSH pocket guide



Hazardous household waste, Alabama  
Courtesy FEMA



Courtesy OSHA



Courtesy CDC



## Building related Health Hazards (continued)

### When buildings are repaired or demolished

What hazards can be created from disturbed building material

- Asbestos shingles, siding and insulation
- Lead paint on interior and exterior of building
- Need for evaluations before building repair or demolition
- Most jurisdictions require special permits for asbestos and lead



Team check s for asbestos, Louisiana  
Courtesy FEMA



Asbestos  
Courtesy EPA



Lead Paint  
Courtesy EPA





## Building related Health Hazards (continued) Communication and legal considerations



- Posting placards on assessed buildings can clearly communicate identified hazards
- Identify legal right of entry in your jurisdiction
- Consider legal liability and immunity of classifying conditions
- Identify legal authority to post assessed buildings



Placards utilized by Safety Assessment Program (SAP)  
California



## Recovery and Reoccupancy – Considerations

After we identify potential building hazards

**How do we recover and when can we reoccupy the building?**

**What balance needs to be made considering:**

- **Disaster needs**
- **Building function impact**
- **Occupant specific risk assessment**



## Recovery and Reoccupancy – 4 Step Evaluation Process Measured response process to potential hazards

1. **Public health hazard exists *now* or *in future*?**
2. **Does hazard or remediation impact building use?**
3. **Disaster need considerations**
4. **Use Recommendations**



## Recovery and Reoccupancy – Activity

Working in small groups over 15 minutes, evaluate assigned disaster scenarios. Utilizing your combined Environmental Health knowledge and experience, make recovery and reoccupancy recommendations. Use the 4 step evaluation process and base your recommendations considering disaster needs, building function impact and occupant specific risk assessment.

Pick a person in your group to brief out your scenario and recommendations



## Recovery and Reoccupancy – 4 Step Evaluation Process Group 1– Heavy snow melt floods a residential home

1. **Public health hazard exists *now* or *in future*?**
2. **Does hazard or remediation impact building use?**
3. **Disaster need considerations**
4. **Use Recommendations**



Carpet and padding removal, North Dakota  
Courtesy FEMA



## Recovery and Reoccupancy- 4 step evaluation activity Group 2- Earthquake damaged elementary school

1. **Public health hazard exists *now* or *in future*?**
2. **Does hazard or remediation impact building use?**
3. **Disaster need considerations**
4. **Use Recommendations**



Asbestos dust in an Elementary School, California  
Courtesy FEMA



### Recovery and Reoccupancy- 4 step evaluation activity Group 3- Regional wide blackout and a Nursing home

1. Public health hazard exists *now* or *in future*?
2. Does hazard or remediation impact building use?
3. Disaster need considerations
4. Use Recommendations



Hospital on generator power, Guam



Pictures courtesy FEMA



### Recovery and Reoccupancy – 4 step evaluation activity Group 4- Compromised river levee floods residential homes

1. Public health hazard exists *now* or *in future*?
2. Does hazard or remediation impact building use?
3. Disaster need considerations
4. Use Recommendations



Resident salvaging items, New Orleans



Resident staying near their homes, New Orleans



Pictures courtesy FEMA



### Recovery and Reoccupancy- When we cannot reoccupy



Unsafe structure posted, North Carolina  
Courtesy FEMA

- Determine who can legally condemn a structure
- How are building owners notified
- Who can clear a structure for use
- Consider single causes and combination of possible health hazards
- Need to find alternate shelters for occupants



### Recovery and Reoccupancy – Mold Remediation

- Remove mold growth
  - Porous surfaces? Dispose and replace
  - Impervious surfaces? Clean and disinfect
- Should you sample for mold?
  - Typically not indicated for emergency response



Moldy drywall removal, Montana



Wallboard replacement, Montana



Pictures courtesy FEMA



### Recovery and Reoccupancy – Mold Remediation PSAs



Mold cleanup information, Tennessee  
Courtesy FEMA

Example topics to be covered on mold remediation PSAs

- Mold basics
- Mold cleanup and guidelines
- What to wear when cleaning moldy areas
- Moisture and mold prevention and control tips
- Hidden mold



Picture of dehumidifiers and mold information  
Courtesy EPA



### Improving Building Resiliency – Strengthening Buildings Keeping structures intact prevents further damage



Hurricane clips, Florida



Earthquake straps, California

- Prevents flying or collapsing debris
- Protects interior from water and wind damage

- Easy installation at time of construction or normal repair
- Protects interior appliances
- Possible savings in building insurance



Pictures courtesy FEMA



## Improving Building Resiliency – Readiness

Some disaster events may give us warning



Flooding property protection, North Dakota  
Courtesy FEMA



WIPP used to protect power plant, IA  
Courtesy Hydrological Solutions, Inc.



Merchant protects business, Louisiana  
Courtesy FEMA



## Improving Building Resiliency –Preventative Construction

Building structures that can better withstand future events



HVAC protection, North Carolina

Less building damage leads to less hazards  
Past events give indication of flood or surge levels, raise foundation elevation  
Flood damage resistant materials  
Consider Environmental Health involvement with community planning

Can elevate interior appliances

- Ovens, washers, dryers and HVAC

What utility companies have done

- Underground power



Raising house above flood marks, Louisiana



Pictures courtesy FEMA

