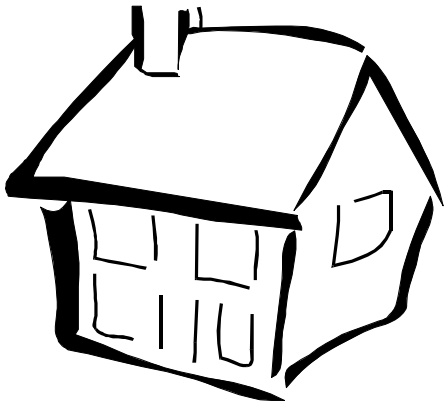
MITIGATION FOR HOMEOWNERS



INDEPENDENT STUDY

Federal Emergency Management Agency
Emergency Management Institute

CONTENTS

FOREWORD

The Federal Emergency Management (FEMA) is responsible for implementing programs and assistance under the Robert T. Stafford Disaster Relief and Emergency Assistance Act (P.L. 100-107) including provisions for hazard mitigation. Training in how to perform mitigation tasks is essential in reducing the ever-escalating costs of, and losses from, disasters. FEMA provides training and education in emergency management through the National Emergency Training Center located in Emmitsburg, Maryland. The institutions that conduct the training program, the Emergency Management Institute (EMI) and the National Fire Academy (NFA), share the facilities at Emmitsburg. Both the NFA and EMI offer courses, workshops, seminars and conferences on the main campus, and across the United States through funding of State training programs.

Independent Study Program

The Independent Study Program is delivered through EMI and consists of a series of self-paced courses. The courses are suitable for both the general public and persons who have local government responsibilities for emergency management.

The following courses are available:

IS-1: Emergency Program Manager: An Orientation to the Position
IS-2: Emergency Preparedness, USA
IS-3: Radiological Emergency Management
IS-5: Hazardous Materials: A Citizen's Orientation
IS-7: A Citizen's Guide to Disaster Assistance

The following courses are audience-specific:

IS-8: Building for the Earthquakes of Tomorrow: Complying with Executive Order 12699
IS-9: Managing Floodplain Development Through the National Flood Insurance Program
IS-10: Animals in Disaster, Module A, Awareness and Preparedness
IS-11: Animals in Disaster, Module B, Community Planning
IS-12: Introduction to Property Acquisition for Local Communities
IS-120: An Orientation to Community Disaster Exercises
IS-195: Basic Incident Command
IS-234 Community Hurricane Preparedness
IS-275: The Emergency Operations Center's (EOC) Role in Community Preparedness, Response, and Recovery Operations
IS-279: Retrofitting Flood-Prone Residential Buildings
IS-288: The Role of Voluntary Agencies in Emergency Management
IS-301: Radiological Emergency Response
IS-330: Refresher Course for Radiological Monitors
IS-346: Orientation to Hazardous Materials for Medical Personnel

IS-393: Introduction to Mitigation
ERT 534 (Course on Terrorism)

Individual and group enrollments are available for all courses. There is no charge for enrollment. Individual enrollments should be submitted on FEMA Form L-173 to:

FEMA Independent Study Program
Emergency Management Institute
16825 S. Seton Avenue
Emmitsburg, Maryland 21727

Requests for group enrollment (five or more participants) may be made by letter or on FEMA Form 21, Application for Group Enrollment, to the same address. Individuals who score 75% or better on the mail-in exam are issued a certificate of completion by EMI.

Enrollment in FEMA independent study courses may be accomplished electronically via the FEMA Home Page at http://www.fema.gov. Independent study courses open to the general public may also be completed on-line through the same Internet address.

One semester hour of college credit may be obtained for each successfully completed course. For information regarding application for academic credit and fees, contact the independent study office at EMI, 1-800-238-3358.

COURSE REFERENCES

The following publications were used in the development of this course and will serve as useful mitigation references.

- American Red Cross, *Preparing Your Home for a Hurricane*, 1995
- American Red Cross/Federal Emergency Management Agency, *Against the Wind: Protecting Your Home from Hurricane Wind Damage,* FEMA 247
- American Red Cross Videotapes, *Before the Wind Blows, Winds of Destruction, Home Preparedness for Hurricane*
- National Flood Insurance Program Videos: *Best Build I: Constructing a Sound Coastal Home, Best Build II: Building Near Rivers, Constructing in a Riverine Floodplain*
- Disaster Field Training Organization, *Hazard Mitigation Program*, Draft, January 1997
- Earthquake Preparedness Center of Expertise, Family Preparedness, U.S. Army Corp of Engineers.
- *Earthquake Readiness, The Complete Preparedness Guide Expanded and Updated*, Virginia Kimball, used by written permission.
- Federal Emergency Management Agency, *Elevated Residential Structures, FEMA 54, 1984*
- FEMA 83, Seismic Considerations for Communities at Risk, 1995
- FEMA-114 *Retrofitting Flood-Prone Residential Structures*, 1986
- FEMA-234 *Repairing Your Flooded Home*, 1992
- FEMA-312, *Homeowner's Guide to Retrofitting*, June 1998.
- FEMA 320-*Taking Shelter from the Storm: Building a Safe Room Inside Your House*.
- FEMA, *Mitigation How To Series*, FEMA Website: www.fema.gov
- FEMA, *National Mitigation Strategy Partnerships for Building Safer Communities,* 1995
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- FEMA, Protecting Your Home From Flood Damage, 1996
- FEMA, *Protecting Your Home from Flooding*, 1994
- FEMA, *Recovery Times*, Issue 2, 1996
- FEMA, *Robert T. Stafford Disaster Relief and Emergency Assistance Act and Miscellaneous Directives of PL 100-707.*
- FEMA, *USFA-Protecting Your Family from Fires*, FA 130, February 1993
- FEMA: Project Impact Guidebook-Assessment 1998
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- National Oceanic and Atmospheric Administration, National Climatic Data Center, Research Customer Service Group, Asheville, NC, June 1998
- Institute for Business and Home Safety, *Is Your Home Protected from Hurricane Disaster*, 1997
- U.S. Fire Administration, Fire and Safety Prevention Information, March 1998
- U.S. Fire Administration, *Fire Stops With You* Fact Sheets, March 1998
- USFA Website: www.usfa.gov

ADDITIONAL REFERENCES

- Federal Emergency Management Agency, *A Focus Group on Attitudes Toward Mitigation Among Homeowners, Small Businesses and Community Leaders*, November 1966.
- Federal Emergency Management Agency, *Protecting Floodplain Resources*, 1996.
- FEMA, L-105 Safety Tips for Hurricanes
- FEMA, L-107 Hurricane-Floods: Safety Tips for Coastal and Inland Flooding (Brochure)
- FEMA, L-212 Hurricane-Action Guidelines for Senior Citizens
- FEMA, L-213 Hurricane-Action Guidelines for School Children
- FIA-2, A*nswers to Questions about the National Flood Insurance Program*, November 1997
- *On Shaky Ground: Living With Earthquakes on the North Coast*, Humboldt Earthquake Education Center, Humboldt State University, Arcata, California
- Texas Tech University, Wind Engineering Research Center web site: http://www.wind.ttu.edu/inshelter/inshelte.htm

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INTRODUCTION

Over the last several years, the number of natural disasters, and costs associated with them, have risen astronomically in the United States. Up until now, mitigation has not been a term that is widely used, or even known, by most homeowners. As a result, homeowners may rely mainly on the Federal Government to meet their needs after every disaster. This course is intended to provide individual citizens with an awareness of the natural hazards that affect them and their communities and the mitigation practices available to them to help reduce their degree of vulnerability. It provides the homeowner with non-technical mitigation techniques for the home, both pre-disaster (preventive) and post-disaster (corrective) that will reduce disaster costs and the impacts of natural hazards.

At the end of the course, you should be able to:

- Explain the rationale for mitigation.
- Identify the natural hazards which affect your community and to which you are most vulnerable.
- Identify what potential risks could affect your home during disasters.
- Determine which mitigation actions you should undertake to reduce the risk of potential damage to your family, home and property from disaster.

Course Overview

The course contains five instructional units, a pretest, and a final examination. The five units to *Mitigation for Homeowners* are outlined below.

Unit One: Disaster Readiness: Mitigate Now/Save Later
The unit begins with descriptions of disasters that have happened, a discussion about the high costs to recover from these events, and plans in place to reduce the costs associated with disaster. Hazard mitigation is defined and successful home projects are briefly described to inform the participants of the benefits of mitigating hazards.

The concepts of hazard identification, probability of occurrence, severity, effect on the home and community, and vulnerability are described and discussed.

Unit Two: Reducing Risks from Flooding
Unit Two provides examples of the various mitigation steps that will protect the home and its contents from flooding. The unit is divided into measures that are low costs and those that are more complex and more expensive or used in more severe circumstances. The unit will also give the advantages and disadvantages of the more costly measures. Detailed information is given on

flood insurance and an entire section has been given to myths and facts associated with the National Flood Insurance Program.

Unit Three: Reducing Risks from Wind Damage
Unit Three includes sources of wind-related loss of life and property, examples of hurricane and tornado damage, and areas most susceptible to wind occurrences. The unit is divided into four categories, depicting four areas of the home that should be checked for wind protection and lists the steps to take to prevent or lessen damage. The unit also introduces FEMA Publication 320, *Taking Shelter from the Storm: Building a Safe Room Inside Your Home*, and ordering information to request the drawing plans.

Unit Four: Preparing Your Home for an Earthquake
The unit begins by listing earthquake protection changes the homeowners can make themselves that do not require professional contractors. Following each example is a "Tips" section or easy reminders that will make the job go more smoothly. The unit also alerts the participants to structural jobs that may require building permits. At the end of the unit is a checklist for an earthquake hazard hunt which the homeowner conducts in the home, listing the mitigation practice and the date it was accomplished. Activities include listing things to do during and after an earthquake and right now to prepare for an earthquake.

Unit Five: Protecting Your Home from Fire
The unit includes simple protection measures to protect the home from fire, including wildfires and fires that start in the home. It is divided into categories of fires from particular sources and lists ways to mitigate each of them. It also gives precautionary tips each homeowner should be aware of and how to maintain fire-safe property.

HOW TO COMPLETE THE COURSE

This course should be studied carefully at your own pace. The course contains information you need to become familiar with mitigation procedures for your home and community. Some sections deal with hazards that do not threaten you because of where you live. However, because you may face such hazards if you move or travel, you should study all sections. In these materials you will face decisions to make that will apply to your situation as well as to situations that you may someday find yourself facing.

The **pretest** at the beginning of the course is designed to find out how much you already know about mitigating your home against natural hazards. The questions are either "true-false' or multiple choice. Answer the pretest questions without looking ahead to the course materials. An answer key is provided so you can pay special attention to discussions in the text about missed questions.

Do not rush through the course in one sitting. Take a break at the end of each unit and give yourself time to think about what you have learned.

At the end of each unit, you will find a section called "**Unit Review"** with questions that test your mastery of the material in each of the units. You score the review tests yourself and determine which pages to review for each question that you answer incorrectly. An answer key is also provided for each unit quiz.

A **glossary** is located after the final unit containing definitions of terms related to mitigation. Use the glossary as you complete the units of instruction.

Answers to the Pretest and Unit Review include the correct responses to those sections.

The **Final Exam,** located at the end of the text, will test the knowledge and skills you have gained from the course. The exam consists of 50 multiple choice and true-false questions. An answer sheet is provided along with mailing instructions for having the exam graded and the certificate awarded.

PRETEST

(Answers on page A-1)

1. When a disaster occurs, a Disaster Resistant Community:

   a) has limited interruption of public services such as water, sewage, utilities, etc.
   b) experiences minimal loss of life.
   c) resumes business operations in a timely manner
   d) All of the above.

2. Mitigation involves actions such as:

   a) evacuating an elementary school that is threatened by flooding.
   b) developing a preparedness plan.
   c) relocating a structure out of the floodplain.
   d) recovering from a disaster and helping citizens return to normal life.

3. Where can you find information on how people and structures will be damaged in a disaster?

   a) your Homeowners Association
   b) the local emergency management office
   c) your insurance company
   d) the library

4. One way to fireproof my property is:

   a) To remove dead wood, debris and low tree branches from around my house.
   b) To install a smoke detector.
   c) To develop an evacuation plan.
   d) To purchase fire insurance.

5. Which of the following statements about tornadoes is true?

   a) Tornadoes occur when wind speeds reach 45 miles per hour.
   b) Tornado season is usually March through April.
   c) If you aren't sure whether your house is at risk from tornadoes, you should check with the previous owners.
   d) An example of tornado protection for your home is to locate the nearest shelter.

6. What is a good mitigation activity if you live in a floodprone area?

   a) Elevate or relocate a water heater to at least 12 feet above flood level.
   b) Cover the main breaker or fuse box with plastic sheeting.
   c) Reinforce all doors.
   d) Install shutters on all windows.

7. Which of the following is ***not*** an example of a mitigation measure you can take to lessen the potential danger from an earthquake?

   a) Anchor large pieces of furniture.
   b) Stabilize framed wall pictures and mirrors.
   c) Secure your water heater.
   d) Label containers of flammable and poisonous substances.

8. What is an important mitigation measure against wildland fires in or around your house?

   a) Consider how you can help neighbors with special needs.
   b) Select materials and plants that can contain fire rather than fuel it.
   c) Let grass grow freely, but keep it watered.
   d) Lock doors before evacuating.

9. Which area of the U.S. might be in the greatest danger from a hurricane?

   a) Atlantic Coast
   b) Pacific Coast
   c) Gulf of Mexico
   d) a & c above

10. What should a homeowner do to mitigate against the effects of a hurricane?

    a) Install hurricane straps.
    b) Stay inside your house away from windows.
    c) Build a shelter inside the basement.
    d) Stockpile food and water.

11. When considering a house's vulnerability to earthquakes, what three things should you evaluate?

    a) location, the year it was built, and the landscape
    b) location, structure, and arrangement of interior furnishings
    c) roof, soil, and size of chimney

12. If you experience a strong earthquake that lasts a long time, you should…

    a) call your relatives to make sure they are safe.
    b) immediately run to the nearest exit.
    c) stay put until authorities issue an *all clear*.
    d) turn the power off.

13. Name three alarm systems used in a residence for fire protection.

    a. smoke detectors, fire extinguishers, security systems
    b. residential sprinklers, burglar alarms, 2-way radios
    c. heat-sensitive blinking lights, smoke detectors, commercial sprinklers
    d. smoke detectors, residential sprinklers, fire alarms

14. Another important mitigation step that will protect the home and family during a wildfire is:

    a) installing a swimming pool
    b) replacing flammable roofing with fire-resistant materials.
    c) removing all draperies from the windows.
    d) mowing the lawn

15. When living in a hurricane zone, why should you brace your garage doors?

    a) The pressure outside by a hurricane will cause a home with unsupported garage doors to collapse.
    b) The local building codes require that all garage doors be supported.
    c) Garage doors built to today's standards are safe and need not be braced.
    d) To ensure the safety of your vehicles.

16. In determining the safety of your home for earthquakes, first be sure you have a good strong:

    a) roof
    b) porch and deck
    c) foundation
    d) garage

17. What can you do to prevent a structural fire?

    a) Immediately report the fire to the fire department.
    b) Install smoke detectors and residential sprinklers.
    c) Have escape route plans in place.
    d) Tell family members where to meet in case of a fire.

18. If you decide to move your house out of a floodplain, what is the first construction step?

    a) move your furniture to storage
    b) locate a new building site
    c) check the transportation route
    d) disconnect utilities

19. You should test smoke detectors in your home…

    a. once a year
    b. monthly
    c. when you set your clocks back
    d. when the time changes to daylight savings time

20. During an earthquake, the greatest danger is…

    a) falling objects and collapsing structures
    b) heavily used roads
    c) bridges
    d) brick homes

Unit 1

Disaster Readiness: Mitigate Now/Save Later

Objectives: At the end of this unit, participants will be able to:

1. *Define mitigation.*
2. *Cite examples of the high cost of disasters.*
3. *Specify and describe the variety and frequency of hazards that exist in their area.*
4. *Describe characteristics of a disaster resistant community.*

INTRODUCTION

You've purchased a home. You move in and all is right with the world when you realize that your home and family are susceptible to disasters, those acts of nature that could destroy all that you worked so hard for. You ask yourself these questions: Could flooding destroy our home and its contents? If a hurricane or tornado strikes, are we protected? And what about fires? What can I do now that will possibly save lives and thousands of dollars later, after a disaster hits? The answers to these questions and more will be addressed in this course on mitigation techniques for homeowners.

This unit explains what mitigation is and why it should be a part of the plan to save lives and reduce costs associated with disaster. It describes disaster resistant communities and shows examples of home projects that will benefit you, the homeowner, in mitigating hazards associated with your community.

WHAT IS MITIGATION?

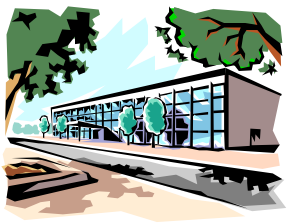
Mitigation is the cornerstone of emergency management. It is the ongoing effort to lessen the impact disasters have on people and property. Mitigation involves keeping homes away from floodplains, engineering bridges to withstand earthquakes, creating and enforcing effective building codes to protect property from hurricanes -- and more.

Mitigation is defined as "**sustained action taken to reduce or eliminate long-term risk to people and property from hazards and their effects**." It describes the ongoing effort at the Federal, State, local, and individual levels to lessen the impact of disasters upon our families, homes, communities and economy.

By applying mitigation practices, our society can ensure that fewer Americans and their communities become victims of natural disasters. For example, mitigation measures

- can be applied to strengthen your home, so that your family and belongings are better protected from floods, earthquakes, hurricanes, and other natural hazards.
- can be utilized to help business and industry avoid damages to their facilities and remain operational in the face of catastrophe.
- can be used to strengthen hospitals, fire stations, and other critical service facilities so that they can remain operational or reopen more quickly after an event.
- can help reduce disaster losses and suffering so that there is less demand for money and resources in the aftermath.

In practice, mitigation can take many forms. It can involve actions such as:



- ! Promoting sound land use planning based on known hazards
- ! Buying flood insurance to protect your belongings
- Relocating or elevating structures out of the floodplains
- Securing shelves and water heaters to nearby walls
- Having hurricane straps installed to more securely attach a structure's roof to its walls and foundation
- Developing, adopting, and enforcing effective building codes and standards

- Engineering roads and bridges to withstand earthquakes
- Using fire-retardant materials in new construction
- Developing and implementing a plan in your business or community to reduce your susceptibility to hazards

In simpler terms, mitigation is important and necessary:

- ✓ To protect people and structures
- ✓ To reduce the costs of disaster response
- ✓ To help reduce the Federal debt

Additionally, mitigation means less:

- ✓ loss of life
- ✓ property damage
- ✓ insurance premiums
- ✓ disruption to the community

REDUCING LOSS OF LIFE AND INJURIES

A total of over 1,100 deaths resulted from natural hazards events between 1989 and 1994. The potential for much larger numbers of deaths has been reduced in some instances through the determined efforts of society and in other instances by sheer good fortune.

REDUCING ECONOMIC COSTS

Economic costs take many forms, including costs to repair public infrastructure and privately owned buildings, loss of revenue or earnings and agricultural and industrial productivity, disruption of local communities, and tax dollars spent on disaster response and recovery.

Between 1989 and 1994, the United States suffered an unprecedented number of large-scale natural disasters, including flooding, a massive winter storm on the east coast, earthquakes, hurricanes, wildfires, and volcanic eruptions. During this period the President declared a total of 291 disasters. Federal assistance available to stricken individuals and communities cost the U.S. Treasury over $34 billion. Seven of these disasters, among the 10 most costly in American history, caused over 370 deaths and losses of over $85 billion.

A few examples of some very expensive weather-related disasters in the U.S. with extremely high numbers of lives lost are listed below:

- **Hurricane Andrew,** August 1992. Category 4 hurricane hits Florida and Louisiana; approximately $27.0 billion damage/costs; 58 deaths.

- **Midwest Flooding,** Summer 1993. Central U.S.; approximately $21.0 billion damage/costs; 48 deaths.

- **Hurricane Fran,** September 1996. Category 3 hurricane strikes North Carolina and Virginia; over $5.0 billion damage/costs; 37 deaths.

- **Northern Plains Flooding,** April-May 1997. Severe flooding in the Dakotas and Minnesota due to heavy spring snowmelt; approximately $2.0 billion damage/costs; 11 deaths.

- **Southeast Severe Weather,** Winter-Spring 1998. Tornadoes and flooding related to El Niño in southeastern states; approximately $1.0 billion damage/costs; at least 132 deaths.

In nearly every location across the country, homeowners are at risk from a variety of hazards, including floods; earthquakes; high winds from tornadoes, hurricanes, and severe winter storms; and wildfires. Because most of these hazards only occur periodically, however, many homeowners don't even realize the danger they face.

Nearly every location in every State is at risk. Flooding is by far the most prevalent, occurring to some degree in every State in the nation. Forty-one States have a moderate or higher earthquake hazard. Wildfires can occur anywhere that fuel exists and weather conditions are right. In addition, damaging high winds have caused destruction across the nation, particularly in coastal areas. Given the hazards that are out there, homeowners need to take action to protect themselves and their property.

Fortunately, homeowners can reduce their risk through cost-effective mitigation measures. Ideally, these measures should be considered before your home is built. For example, potential homeowners should consider carefully the risks they would face by moving to certain high-hazard areas before making the decision to buy or build. Also, when building your home, close attention should be paid to how your home is being constructed. Risks posed by all types of natural hazards (including floods, earthquakes, hurricanes, or wildfire) may be reduced substantially by paying attention to building codes and by incorporating mitigation measures into the structure.

If you have an existing home, however, all hope is not lost. There are also many steps that you can take to better protect yourself from future losses. Buildings subject to earthquakes or high winds may be strengthened to make them more resistant to a variety of hazards. In addition, simple steps can be taken within your home to make your property less susceptible to damages if a disaster occurs.

This course will introduce ways to protect yourself and your home from losses due to winds, floods, earthquakes and fires.

HAZARD IDENTIFICATION AND VULNERABILITY ANALYSIS

Before implementing mitigation measures, homeowners must be aware of those hazards which, if they occur, could harm your community. This is the purpose of hazard identification and vulnerability.

Everyone knows that natural disasters pose some threat to people, homes, businesses, and communities. We know that severe winds can damage the roofs on our houses and that heavy rains can flood our basements. We usually are aware of the natural disaster history in our communities. We know whether there have been floods, earthquakes, tornadoes, hurricanes, or wildfires. This is where **past history** comes into play. If you have had floods, tornadoes or forest fires before, these disasters could happen again. The risk may be higher than in communities which have not had these disasters. You may know about the history of disasters in your community from personal experience. If not, you may learn about them from oral histories, libraries, local newspaper records, or emergency management office records.

Weather patterns are another factor to consider when you determine the dangers to your community from natural disasters. If the weather that affects your community brings regular events like snow, rain or heat, the chances of weather-related emergencies may be high.

Geographical characteristics should be considered because if you live near an ocean, a river, a fault line, or mountains, related natural hazards could affect you. Learn the geography in your area and the associated hazards.

Floods, hurricanes, earthquakes, tornadoes, and wildfires are the most frequently occurring natural hazards. Some of these events can cause related or secondary hazard problems. For example, floods can cause mudslides, earthquakes can cause landslides, and wildfires (because they destroy plants) can make hillsides prone to landslide or mudslide.

Defining the extent to which natural hazards threaten your community is **hazard identification**. Hazard identification determines which areas of your community are affected by disasters, how likely it is that the disaster may occur, and how intense the disaster might be.

Areas of concern include:

- How often the hazard is likely to occur
- How severe
- Where it is likely to occur

- How large an area it will affect
- Who will be affected
- How long it will last
- How fast it is likely to occur
- The time of year it is likely to occur
- How much warning time there is

Next, identifying how people, properties and structures will be damaged by the disastrous event is a **vulnerability analysis**. If people or their homes and other structures can be damaged by a hazard's impact, they are vulnerable.

Natural hazards invariably "seek out" the weakest part of buildings or systems. Strong winds will find the portion of the roof not properly nailed down. Ground motions will find the weak building connectors--structural damage, or worse, building failure, will result. The water treatment plant in the floodplain will stop functioning, and businesses throughout the community will be forced to close until water is restored. Finding the weak points in systems--identifying building types that are vulnerable to damage and anticipating the loss in high risk areas--helps you make decisions later about the expenses associated with reducing the potential for disaster.

Your local emergency manager regularly conducts vulnerability analyses for your community. You can contact your local emergency management office for the results of these analyses.

In summary, hazard identification deals with causes of potential emergencies or disasters. Vulnerability analysis deals with what is most likely to happen to people and property in those disasters. Both these elements are important in determining which mitigation measures are needed for your home.

DISASTER RESISTANT COMMUNITIES

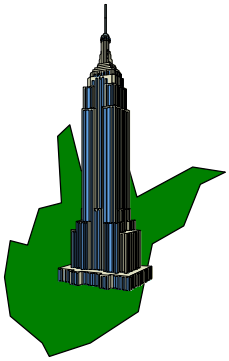
The Federal Emergency Management Agency (FEMA) has launched a national effort to change the way America deals with disasters by shifting the focus of emergency management from responding to disasters to taking actions in advance of disasters that reduce potential damage. Breaking the disaster-rebuild-disaster cycle in the United States is FEMA's top priority. To that end, *Project Impact* was developed to challenge the country to undertake actions that protect families, businesses and communities by reducing the effects of natural hazards. It included the selection of seven pilot communities that demonstrate the benefits of hazard mitigation through a partnership approach and an outreach effort to businesses and communities to become disaster resistant. FEMA's goal is to eventually have at least one disaster-resistant community in each state.

Experience has shown again and again that lives can be saved, damage to property can be reduced significantly, and economic recovery can be accelerated by consistently building safer and stronger buildings, strengthening existing infrastructures, enforcing building codes, and making the proper preparations BEFORE a disaster occurs.

As part of the federal government's commitment to the President's Volunteer Summit, FEMA developed Spring Break '98, a *Project Impact* initiative, providing the nation's youth an opportunity to give back to their community. The Spring Break project, a collaboration between FEMA and the Corporation for National Service, was started when students and volunteers donated their spring break time to help make communities more disaster resistant. Following are a few of the communities that took part in Spring Break '98.

- *Students in the **San Francisco Bay**, **California**, area spent their Spring Break helping to make homes more resistant to damage from earthquakes and other disasters. They made non-structural retrofits to Oakland homes occupied by low-income seniors and people with disabilities. The students, along with community volunteers and AmeriCorp members, visited 150 housing units and implemented mitigation measures including installing more than 1300 cabinet safety latches, 250 locks for heavy electronic equipment such as televisions and stereos, and securing over 100 refrigerators to make sure that in an earthquake, they would not fall and block exits or cause injuries.*

- *In **Wilmington, North Carolina**, 250 student volunteers from the University of North Carolina at Wilmington spent the day checking and repairing safety devices and installing smoke detectors in the homes of elderly citizens.*



- *In **Tucker and Randolph (West Virginia)** counties, AmeriCorp volunteers worked with students from West Virginia University and Davis-Elkins College to map the longitude and latitude of structures at risk of flooding.*

- *In **Deerfield Beach, Florida**, volunteers from AmeriCorp, Deerfield Beach High School, local Home Depot stores and Southeast Metal Inc., a local business, installed storm shutters on the houses of five single family, low to moderate income homeowners. Southeast Metal donated the accordion shutters (a $12,000 value).*

With the help of these volunteers, and efforts in other Project Impact communities, these areas have become models for other cities to see how everyone can get involved to make the nation more disaster resistant.

The seven pilot communities identified for Project Impact are Allegany County, MD; Deerfield Beach, Florida; Oakland, California; Pascagoula, Mississippi; Seattle, Washington; Tucker and Randolph Counties, West Virginia; and Wilmington, North Carolina.

Unit Review

Circle the correct response. Answers may be found on page A1.

1. An example of economic costs stemming from a major disaster can be in the form of:

   a) Funeral costs for disaster-related deaths.
   b) Relocating a structure out of the floodplain.
   c) Strengthening partnerships among government and private sector.

2. Mitigation is defined as:

   a) rebuilding after a disaster strikes.
   b) search and rescue, mass care, medical services, and bringing damaged services and systems back on line after a disaster.
   c) ensuring that people are ready for a disaster and will respond to it effectively.
   d) sustained action taken to reduce or eliminate long-term risk to people and property from hazards and their effects.

3. Determining which areas of your community are affected by disaster, how likely it is that the disaster may occur and how intense the disaster might be is:

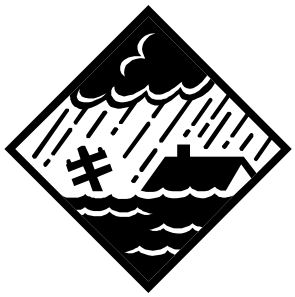
   a) Hazard Identification
   b) Mitigation
   c) Vulnerability Analysis

4. Which of the following natural hazards is most prevalent in the U.S.?

   a) High winds (hurricanes and tornadoes)
   b) Flooding
   c) Technological hazards such as explosions
   d) Droughts

5. Under Project Impact, a disaster resistant community:

   a) takes actions that prepare and protect its residents from natural disasters BEFORE they happen.
   b) is the partnership approach between businesses and the community to break the disaster-rebuild-disaster cycle.
   c) was first established in seven locations throughout the U.S. and plans are in place to have at least one in every State.
   d) All of the above.



Unit 2

Reducing Risks from Flooding

Objectives: At the end of this unit, participants will be able to:

1. *List and describe low-cost mitigation steps the homeowner can take to protect the home from flooding.*
2. *Define floodproofing.*
3. *List three things an insurance policy purchased through the National Flood Insurance Program covers.*
4. *Identify six measures that reduce risks from flooding in severe cases.*

INTRODUCTION

Out of all the natural hazards that occur in the U.S., flooding occurs most often; at least 90% of disasters in the U.S. are floods. Most of the flooding that occurs in the U.S. is either **riverine** or **ocean** flooding, although flooding also occurs around lakes and ponds and in isolated areas where storm drainage systems are not adequate.

Riverine flooding, as its name implies, occurs when rivers and streams overflow their banks. Riverine floodwaters can move quite rapidly, as in a flash flood, or very slowly, as they often do where the land is gently sloping or flat. The primary causes of riverine flooding are rainfall and melting snow (and sometimes a combination of both).

Ocean flooding, which is caused by storm surge and wave action, affects primarily coastal areas, especially those along the beachfront, but it can also affect

areas around bays, and it can back up along rivers and streams that empty into bays. Ocean flooding is most dangerous, and causes the most severe damage, where large waves are driven inland by wind. These wind-driven waves occur primarily along the open coast, where they can destroy houses, wash away protective dunes, and erode the soil, often so much that the ground surface is lowered several feet. But they can also move inland where the land is flat and there are no large dunes or other obstacles to break them. In these areas the level of damage can rival that along the open coast.

If you have experienced flooding in your home, or if there's a chance you might, **now is the best time to think about floodproofing your home**. You can do many things now that will protect your property in the future.

Many floodproofing measures are quite simple, cost effective, and easy to put in place. By floodproofing, you can make the next flood easier on you and your wallet. If you aren't sure whether your house is at risk from flooding, check with your local floodplain manager, building official, city engineer, or planning and zoning administrator. They can tell you whether you are in a flood hazard area. Also, they usually can tell you how to protect yourself and your house and property from flooding.

Steps You Can Take…

There is a wide range of flood protection measures for buildings that can eliminate or reduce the risk of future flood damage. In severe cases, a building can be relocated out the floodplain area or elevated above the projected flood levels. In less severe cases, which we will focus on first, there are a number of relatively inexpensive flood mitigation techniques that can be used to protect specific elements of a building.

Before we begin with the protection measures, definitions to some terms you will see repeatedly throughout this section are listed below:

One-hundred-year flood—This term is simply a convenient way to express probability. For example, the flood that has a 1-percent probability (1 in 100) of being equaled or exceeded in any year is referred to as the 100-year flood. It should not be interpreted to mean a flood that happens exactly once every 100 years. Nor does it imply that once a 100-year flood occurs, there is little risk of another 100-year flood occurring in the near future. To the contrary, changes in climatic conditions, such as those caused by El Niño, often result in "clusters" of floods that occur over relatively short times at the same location.

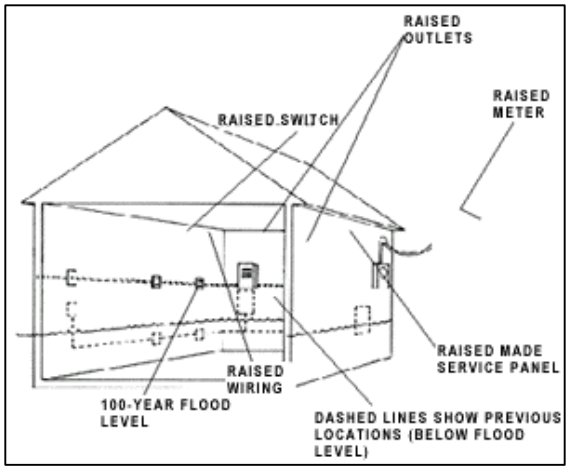
For most homeowners, the value of these terms is that they indicate relative frequencies and sizes. On the average, over a long period, a 100-year flood is expected to occur less often than a 50-year flood and more often than a 500-year flood. The 100-year flood is particularly important for homeowners because it is the basis of the National Flood Insurance Program (NFIP) rates and regulatory floodplain requirements. *(See NFIP, #8, page 2-7.)* In the NFIP, the 100-year flood is referred to as the *"**base flood**"* and the 100-year flood elevation as the ***"base flood elevation" or BFE***.

This unit provides examples of the range of flood loss reduction techniques that are available. The following are low-cost mitigation measures you can take to protect yourself, your home, and your property from losses:

1. ***Move valuables and appliances out of the basement of your home or business if it is prone to flooding.*** By doing so, you increase the chance that your belongings will be safe and sound when a flood event occurs. Relocate washer and dryer to a floor with at least a 12-inch safety margin above the base flood elevation or BFE to protect them from flooding.

   Should you decide to elevate your washer and dryer, do so on a concrete blocks or a wooden platform (pressure-treated lumber) supported by concrete blocks to at least a 12-foot safety margin above the BFE, or the highest known flood level. Make certain that washers and dryers are secure and will not vibrate off the blocks or platform during use. A 1- or 2-foot waterproof floodwall around appliances will protect them from shallow flooding.

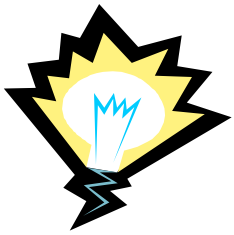
2. ***Elevate or relocate the main breaker or fuse box and the utility meters above the anticipated flood level in your home or business, so that floodwater won't damage your utilities***.



   Electrical system components, including service panels (fuse and circuit breaker boxes), meters, switches, and outlets, are easily damaged by flood water. If they are inundated for even short periods, they will probably have to be replaced. Another serious problem is the potential for fires caused by short circuits in flooded systems. Raising electrical system components helps you avoid those problems. Also, having an undamaged, operating electrical system after a flood will help you clean up, make repairs, and return to your home with fewer delays.

The surest way to protect your valuable electrical system is to keep it from getting wet. All outlets, switches, light sockets and junction boxes, as well as the main breaker or fuse box and electric motors, should be out of danger of getting wet. Make sure each circuit is labeled so you know which circuit controls which outlet and switch.

Elevate electric panel to a recommended minimum 12-foot safety margin above the base flood elevation or the highest known flood level if you are outside of any known flood zone. All components of the electrical system, including the wiring, should be raised at least 1 foot above the 100-year flood level. In an existing house, this work will require the removal of some interior wall sheathing (drywall, for example). If you are repairing a flood-damaged house or building a new house, elevating the electrical system will be easier.



It's a good idea to run wires overhead. If a wire has to run into the zones that could get wet it is best to use a wire rated for underground use. No wire should end in the flood zone and all junctions should be in approved junction boxes. If a wire has to terminate below the 100-year flood level it should be specially marked in the panel box and turned off at the time of a flood warning.

Note:

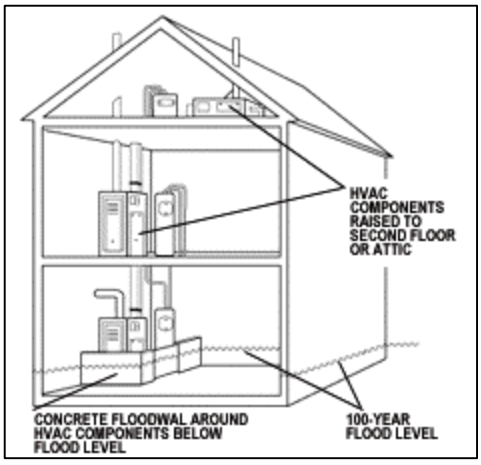
- All relevant permits must be obtained before work begins, and all work must conform to state and local building codes.
- Electrical system modifications must be done by a licensed contractor, who will ensure that the work is done correctly and according to all applicable codes. This is important for your safety.
- Your contractor should check with the local power company about the maximum height that the electric meter can be raised.
- If your house is equipped with an old-style fuse box or low-amperage service, you may want to consider upgrading to a modern circuit breaker system and higher-amperage service, especially if you have large appliances or other electrical equipment that draws a lot of power.

Raising the electrical service panel, meter, and all of the outlets, switches, and wiring in a 1,000-square-foot, single-floor house will cost about $1,500 to $2,000. If this work is performed during the repair of a damaged house or construction of a new house, the cost may be much lower.

3. ***Elevate electric baseboard heaters.*** If your 100-year-flood elevation is 12 inches or less above your floor level, you can protect your electric baseboard heater system by elevating it above the floodwaters. Use

waterproof wall construction techniques for the wall area below the baseboard units.

4. ***Elevate or relocate a water heater or heating plant.*** Heating, ventilating, and cooling (HVAC) equipment, such as a furnace or hot water heater, can be damaged extensively if it is inundated by floodwaters. The amount of damage will depend partly on the depth of flooding and the amount of time the equipment remains under water. Often, the damage is so great that the only solution is replacement.



In floodprone houses, a good way to protect HVAC equipment is to move it from the basement or lower level of the house to an upper floor or even to the attic. When relocating or raising the water heater, be sure it will be at least 12 feet above the 100-year flood level. Consult your local building department for details. A water heater can be put anywhere near a hot water pipe.

A less desirable method is to leave the equipment where it is and build a concrete or masonry block floodwall around it. Both of these methods require the skills of a professional contractor. Relocation can involve plumbing and electrical changes, and floodwalls must be adequately designed and constructed so that they are strong enough and high enough to provide the necessary level of protection.

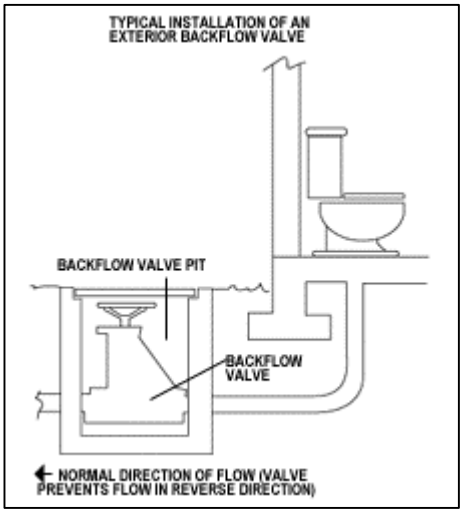
If the existing ductwork for your furnace is below the 100-year flood level (e.g. inside a slab or crawlspace beneath the home) it should be relocated so that it distributes heat from above and runs free and clear of floodwaters. Your local building department can help you determine your 100-year flood level. An updraft furnace located in a basement can be replaced with a downdraft furnace on a floor above the flood protection level. If you are replacing your furnace, ask your supplier for information on a downdraft system.

Note:

- Changes to the plumbing, electrical system, and ventilating ductwork in your house must be done by a licensed contractor, who will ensure that the work is done correctly and according to all applicable codes. This is important for your safety.
- If you are having your existing furnace or hot water heater repaired or replaced, consider having it relocated at the same time. It will probably be cheaper to combine these projects than to carry them out at different times.
- Similarly, if you have decided to raise your HVAC equipment, consider upgrading to a more energy-efficient unit at the same time. Upgrading can not only save you money on your heating and cooling bills, it may also make you eligible for a rebate from your utility companies.
- If you decide to protect your HVAC equipment with a floodwall, remember that you will need enough space in the enclosed area for system repairs and routine maintenance. Also, depending on its height, the wall may have to be equipped with an opening that provides access to the enclosed area. Any opening will have to be equipped with a gate that can be closed to prevent flood waters from entering.

Having your furnace and hot water heater moved to a higher floor or to the attic will cost about $ 1,500. The cost of a floodwall will depend partly on its height and length. A 3-foot-high wall with a perimeter length of 35 feet would cost about $1,000.

5. ***Elevate an air conditioning compressor or heat pump.*** To protect an air conditioning compressor or heat pump, elevate it to at least a 12-foot safety margin above the 100-year flood level on a base of masonry, concrete, or pressure treated lumber. Keep service lines above the 100-year flood level. If your new air conditioner or heat pump will be outside, install it on a platform above your flood protection level.



6. ***Install sewer backflow valves.*** In some floodprone areas, flooding can cause sewage from sanitary sewer lines to back up into houses through drainpipes. These backups not only cause damage that is difficult to repair but also create health hazards.

A good way to protect your house from sewage backups is to install backflow valves, which are designed to block drainpipes temporarily and prevent flow into the house. Backflow valves are available in a variety of designs that range from the simple to the complex. The figure shows a gate valve, one of the more complex designs. It provides a

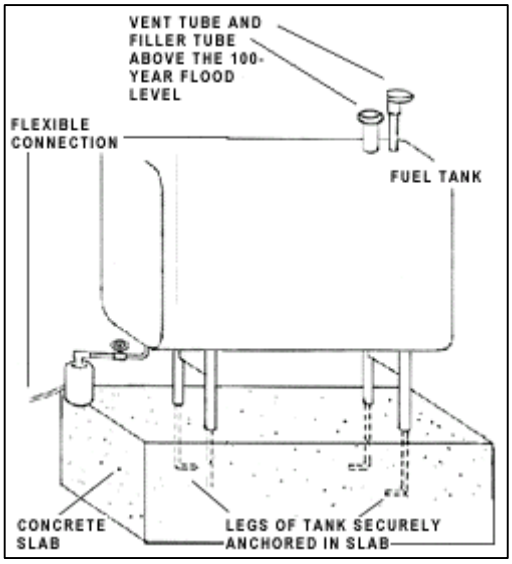
strong seal, but must be operated by hand. So the effectiveness of a gate valve will depend on how much warning you have of impending flooding. Among the simpler valves are flap or check valves, which open to allow flow out of the house but close when the flow reverses. These valves operate automatically but do not provide as strong a seal as a gate valve.

NOTE:

- Changes to the plumbing in your house must be done by a licensed plumber or contractor, who will ensure that the work is done correctly and according to all applicable codes. This is important for your safety.
- Some valves incorporate the advantages of both flap and gate valves into a single design. Your plumber or contractor can advise you on the relative advantages and disadvantages of the various types of backflow valves.
- Valves should be installed on all pipes that leave the house or that are connected to equipment that is below the potential flood level. So valves may be needed on washing machine drain lines, laundry sinks, fuel oil lines, rain downspouts, and sump pumps, as well as sewer/septic connections.
- If you have a sump pump, it may be connected to underground drain lines, which may be difficult to seal off.

Having a plumber or contractor install one backflow valve will cost you about $525 for a combined gate/flap valve or about $375 for a flap valve. These figures include the cost of excavation and back-filling.

7. ***Anchor a fuel tank***. Unanchored fuel tanks can be easily moved by flood waters; they can tip over or float. Escaping fuel may result in spills and fires. These tanks pose serious threats not only to you, your family, and your house, but also to public safety and the environment. An unanchored tank outside your house can be driven into your walls, and it can be swept downstream, where it can damage other houses. When an unanchored tank in your basement is moved by flood waters, the supply line can tear free and your basement can be contaminated by oil. Even a buried tank can be pushed to the surface by the buoyant effect of soil saturated by water.



To prevent this, anchor your fuel tank. One way to anchor a tank is to attach it to a large concrete slab whose weight is great enough to resist the force of flood waters. This method can be used for all tanks, both inside and outside your house. You can also anchor an outside tank by running straps over it and attaching them to ground anchors. Use non-corrosive metal structural supports and

fasteners or pressure treated wood structural supports and fasteners or pressure treated wood structural supports. The type of anchorage will vary depending on the size of the tank and the structure it is being attached to. Keep the fuel tank topped off to increase the tank's weight and reduce its tendency to float.

Anchoring a 1,000-gallon fuel tank to a concrete base will cost you about $300 to $500. Using straps and ground anchors will cost about $300.

NOTE:

- If you prefer not to do this work yourself, you can have a handyman or contractor anchor your tank.
- Check with the fuel tank manufacturer for recommendation on anchoring.
- Be sure all work done conforms to state and local building codes.
- For rented tanks, check with the fuel supplier before making any modifications to the tank.
- Extend all filling and ventilation tubes above the 100-year flood level so that flood waters cannot enter the tank.

8. ***Buy flood insurance to cover the value of your home and its contents.*** Not only will insurance give you greater peace of mind, but it will also greatly speed your recovery if a flood occurs.

   Even if you have floodproofed your house, you still need insurance to protect you from unexpected events, such as a flood that rises higher than your flood protection level. If you have insurance, find out whether you have the right kinds of coverage, and whether you have adequate coverage. Homeowners' policies do not cover damage caused by floods, so you will need to purchase a separate policy under the **National Flood Insurance Program (NFIP)**, the federal government's principal administrative mechanism for reducing flood damage. Established by Congress in 1968, the NFIP is administered by the Federal Emergency Management Agency (FEMA). The NFIP insures buildings and their contents in flood-prone areas where conventional insurance had, prior to the NFIP, been generally unavailable.

   An NFIP policy covers:

   - ✓ Damage to your building or contents caused by a general condition of surface water flooding (up to the amount of your coverage)

- ✓ Costs for moving and storing your contents for up to 45 days (up to the amount of the minimum deductible)

- ✓ Expenses for removing debris left by the flood.

An NFIP policy does ***not*** cover:

- ✓ Damage caused by high groundwater, sewer backup, subsurface flows, wind-driven rain, or local drainage problems that are not considered a "general condition of flooding"

- ✓ Property located outside an insurable building, including fences, outdoor swimming pools, driveways, docks, floodwalls, crops in the field, and landscaping

- ✓ Vehicles, trailers on wheels, and boats

- ✓ Paneling, carpeting, furniture, and contents in the finished portion of a basement or underneath an elevated building

- ✓ Animals

- ✓ Money, valuable papers, and land values

- ✓ Living expenses and lost income

The NFIP provides federally backed insurance coverage for any building in a community that is participating in the program. Almost every type of walled and roofed building can be insured. It does not matter whether the building is in or out of the floodplain. A mobile (manufactured) home affixed to a permanent site and properly anchored can also be insured. You can get coverage on the building as well as for contents.

Types of Coverage:

- Building Coverage. Insurance can be purchased for the building, including walls, floors, insulation, wall-to-wall carpeting, furnace, and other items permanently attached to the structure. (Permanent items include anything that would not fall out if you were to turn the building upside down.) Up to 10 percent of the policy value for building coverage may apply to a detached garage or carport on the same lot.

  If you buy insurance for 80 percent or more of the replacement value of your house, you will be reimbursed for the replacement value of damage to your house—no depreciation will apply. If your coverage is for less than 80

percent, you will be reimbursed for the actual cash value of the damage—replacement value minus depreciation.

- Contents Coverage. Contents coverage insures your personal property. Renters as well as owners may purchase contents coverage. Although you can get contents coverage without having a building that can be insured under the NFIP. Contents coverage will pay some of the costs of moving and storing contents in a safe place when a flood threatens.

- Basements. Building coverage is recommended to cover walls, floor, furnace, and other structural components of a basement. However, the NFIP does not cover finished portions of a basement (carpets, wallboard) or its contents. Damage to the basement foundation is a major problem during floods, so this coverage can be very important even though it does not cover the finished portions (carpets, wallpaper) of basements. Some private companies sell coverage for water damage caused by sewer backup or sump pump failure—items that are not covered by the NFIP.

NFIP flood insurance is sold through private insurance agents and companies. All policies offer identical coverage and rates. Newer or substantially improved houses are charged flood insurance rates according to their elevation in relation to the expected flood level. Older houses, which are "grandfathered" in, qualify for a flat, subsidized rate. Houses outside floodplains that are identified on Flood Insurance Rate Maps (FIRMS) often pay lower rates. You can check your property's location on a FIRM at your building department or ask an insurance agent.

A few private insurance companies sell their own flood insurance policies, although the coverage and rates are different from the NFIP's. Some mobile home insurance covers flood losses. Unlike the NFIP, private insurance varies from company to company, so check around to compare their coverage and rates.

If you are located in a floodplain shown on a Flood Insurance Rate Map, you must buy flood insurance coverage as a condition of having a mortgage or home improvement loan from a federally regulated lender or as a condition for getting federal disaster assistance. In some cases, private insurance will satisfy this requirement, but generally the lender or disaster assistance agency will ask you to get an NFIP policy.

Flood Insurance Facts

Myth: My standard homeowners' insurance will cover me if my house is damaged or destroyed in a flood.

FACT: Homeowners' insurance does not cover flood damage. Federal flood insurance, purchased through your insurance agent or company, is the only guaranteed flood insurance coverage available for your home.

Myth: Federal disaster aid, available during and after a flood, will reimburse me for losses. Therefore, I don't need to buy flood insurance for my home and belongings.

FACT: Federal Emergency Management Agency disaster aid is only available during Presidentially declared disasters. Federal aid may often be in the form of an SBA loan that you must pay back with interest. Flood insurance policies pay claims whether or not a disaster is declared.

Myth: I live outside the floodplain, so I don't need to buy flood insurance.

FACT: More than 25 percent of the National Flood Insurance Program's (NFIP) claims are for structures outside identified flood plains. Floods can occur anywhere. An area that is near a levee or a dam is at risk of levee or dam breakage. People who face even moderate flood risks should get insurance, which can be purchased for as little as $80 per year.

Myth: I can't buy flood insurance because my home has been flooded previously.

FACT: If your community is participating in the NFIP, it doesn't matter that your home has been flooded before. You may still buy flood insurance.

Myth: If people don't want to purchase flood insurance, it's their own business. It doesn't really affect me.

FACT: When people do not buy flood insurance, you pay more for federal and state disaster relief. Flood insurance is one of the best ways to keep disaster relief costs down for all taxpayers.

Myth: Flood insurance is only available for homeowners.

FACT: Flood insurance is available to protect homes, condominiums and nonresidential buildings including farm and commercial structures in participating communities. Contents coverage also is available, so coverage is available to renters as well.

Myth: If they predict a flood in the near future, it's too late for me to purchase insurance.

FACT: You can purchase flood insurance anytime in a participating community. However, there is a 30-day waiting period after you have applied and paid the premium before the policy is in effect. The policy will not, however, cover a loss in progress.

DON'T WAIT!

Buy flood insurance protection before the next flood is threatening. Call your insurance agent for information on rates and coverage.

For Flood Insurance Information Call 1-800-427-4661

MORE STEPS TO REDUCE FLOOD DAMAGE

You may need to decide if you will be better off living in a different location, away from areas that flood. Ask your building official about government agencies that sometimes purchase property for open space or flood protection in areas that flood—you may qualify.

If you are sure that you will repair or rebuild your house in the floodprone area, choose the mitigation measures that are best for your home or property. Each homeowner's situation needs to be looked at individually.

There are 6 basic mitigation steps or types of floodproofing described below. **Please note: These measures will be for more severe cases and will be more costly.**

1. Elevation

One of the most common retrofitting methods is elevating a house to a required or desired Flood Protection Elevation (FPE). When a house is properly elevated, the living area will be above all but the most severe floods (such as the 500-year flood). Most types of houses can be raised so that the lowest floor is above the FPE, including wood frame, brick, slab-on-grade, crawlspace, or homes with basements. This is an extremely reliable flood proofing method and requires little human intervention to prepare for a flood event.

If you had foundation damage from a flood, you may need to raise the house to repair it. It will be easier and cheaper to elevate the house at that time. Several elevation techniques are available. In general, they involve (1) lifting the house and building a new, or extending the existing, foundation below it or (2) leaving the house in place and either building an elevated floor within the house or adding a new upper story.

An elevated building will need a new foundation. The contractor will jack up the house and set it on a temporary framework call cribbing while the new foundation is built underneath. The foundations of an elevated building may be columns, piers, pilings, or raised foundation walls. The elevated building will usually look better and have added protection if fill dirt is placed around the new foundation. But check with your building department before adding fill dirt. It may not be allowed in all areas of your community.

The floor elevation height should be set at a recommended safety margin above the 100-year-flood level. Some buildings may be elevated over 9 feet above their existing floor levels. In such an extreme case the new lower level would probably be used as a garage. In all cases, a new entry stair and front porch is built to meet the new height. Elevating a home requires use of

professional plumbers/electricians, house movers, contractors, and structural engineers to help you design your new foundation and obtain a permit from your building department. Because the new foundation will be in the floodwaters, it is extremely important that it be structurally designed to withstand lateral (sideways) forces such as fast flowing currents and the impact of water-borne debris.

Basic Steps in Elevating a Building:

- Have appropriate professionals disconnect all utilities.
- Hire a professional house mover to disconnect your house from the existing foundation, jack it up to the new height and provide a temporary foundation.
- Have the utilities temporarily reconnected so the house is livable while foundation work is done.
- Build a temporary access stair to meet the new height.
- Build a new, permanent foundation.
- Have the house mover lower the house onto the new foundation and connect the anchor bolts.
- Have the utilities permanently reconnected.
- Build a new, permanent access stair and landing.

There are other variations of this technique. Also, there are numerous contractors throughout the United States who are qualified to undertake elevating your house above the flood level. Elevation or relocation are the only reasonable ways to protect your home if it is subject to coastal flooding or to deep flooding (flooding more than 6 feet deep). Elevation and relocation are also the most dependable measures for floodproofing your home.

Case Study - Winter Floods 1997

Herb and Lark Lozoff and their children of Forestville, California, lost everything when floods in 1995 swept through their home. The most painful loss was the destruction of personal family items, including irreplaceable photographs. The recovery was long, and the family vowed to do whatever was necessary to ensure it didn't happen again. With the help of their community, the Lozoff's elevated their house above the flood level and strengthened it against earthquakes. It didn't take long for their efforts to pay off -- the floods of December and January surged into their yard and ground-level garage. But their house stayed safe and dry above the roaring waters. Herb Lozoff said: "We had 7 feet of water in the house in '95. We raised it up almost 11 feet and didn't get a drop of water in the house. This was a little bit less than the flood of '95, a few feet less. But it wasn't even close. We were a good 5 feet above the highest water."

Lark Lozoff said, "It was just the best thing we ever did. Paying that price one time, you can get the house up and it won't happen again."

ADVANTAGES AND DISADVANTAGES OF ELEVATION

ADVANTAGES	DISADVANTAGES
▪ Elevation to or above the BFE allows a substantially damaged or substantially improved house to be brought into compliance with your community's floodplain management ordinance or law. ▪ Elevation reduces the flood risk to the house and its contents. ▪ Except where a lower floor is used for storage, elevation eliminates the need to move vulnerable contents to areas above the water level during flooding. ▪ Elevation often reduces flood insurance premiums. ▪ Elevation techniques are well known, and qualified contractors are often readily available. ▪ Elevation does not require the additional land that may be needed for the construction of floodwalls or levees. ▪ Elevation reduces the physical, financial, and emotional strain that accompanies floods.	▪ Cost may be prohibitive. ▪ The appearance of the house may be adversely affected. ▪ Access to the house must not be occupied during a flood. ▪ The house must not be occupied during a flood. ▪ Unless special measures are taken, elevation is not appropriate in areas with high velocity flows, waves, fast-moving ice or debris, or erosion. ▪ Additional costs are likely if the house must be brought into compliance with current code requirements for plumbing, electrical, and energy systems. ▪ Potential wind and earthquake loads must be considered.

Table 2.1

2. Relocation

Moving a building out of the flood-prone area is the surest way to protect it from flood damage. Most houses and smaller commercial buildings in good condition can be moved, and it is usually no problem to find contractors experienced in moving buildings. You will have to purchase a new lot unless your present lot is large and has a good spot on higher ground for your house. Relocation and elevation are the only reasonable choices for protecting a house that is subject to deep flooding (flooding more than 6 feet deep) or to coastal flooding.

To relocate a building, it is detached from the original foundation, placed on a heavy-duty truck bed, transported to the new site and set on a conventional foundation. The house is installed on the new foundation and all utility lines are connected. Relocation is particularly appropriate in areas where the flood hazard is severe, such as where flood conditions are characterized by one or more of the following:

- Deep water
- Short warning time
- High flow velocity
- Long duration
- High rates of rise and fall
- Wave action
- High debris potential

Relocation is also appropriate for homeowners who want to be free of worries about damage from future floods that may exceed a selected FPE.

Unless there is a hidden structural defect, most homes and small commercial buildings in good structural condition can be moved with no more damage than occasional slight cracks in the plaster or wallboard joints. Single story frame houses over a crawlspace or basement are easiest to relocate. Multi-story, slab-on-grade, and brick buildings can also be moved.

Moving a house is a complex operation that requires a professional house mover. Although similar to *elevation*, relocation requires additional steps that usually make it more expensive. Before you choose a house mover, obtain bids from several companies and contractors. Before choosing the lowest bid be certain the contractor or mover has the experience and resources to complete the project at the quoted price. Be certain that they have liability insurance to cover the move.

Construction Steps Involved in Building Relocation

- Locate a new building site.
- Check the transportation route to the new location. Is it clear and adequate to move the house?
- On the building site, construct a new perimeter and interior foundation that coordinates with the existing house.
- Install new utilities to stubbed-in locations in the foundation. Disconnect, elevate and move the house to the new location.
- Lower and anchor the building onto the new foundation.
- Connect the new utilities.

Let's take a look at the advantages and disadvantages of relocating a building.

ADVANTAGES AND DISADVANTAGES OF RELOCATION

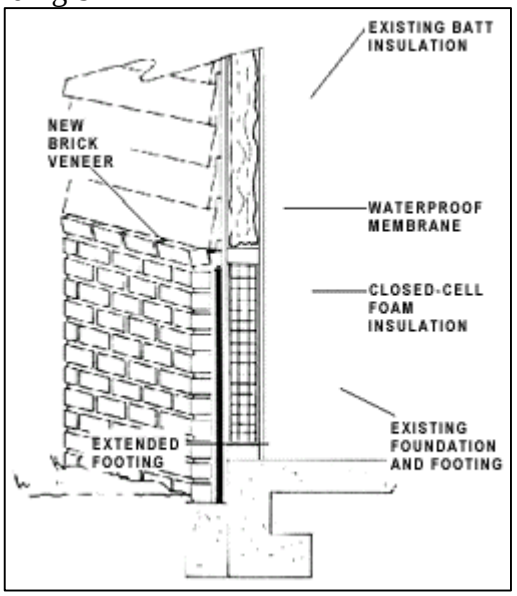
ADVANTAGES	DISADVANTAGES
▪ Relocation allows a substantially damaged or substantially improved house to be brought into compliance with your community's floodplain management ordinance or law. ▪ Relocation significantly reduces flood risk to the house and its contents. ▪ Relocation can either eliminate the need to purchase flood insurance or reduce the amount of the premium. ▪ Relocation techniques are well known, and qualified contractors are often readily available. ▪ Relocation reduces the physical, financial, and emotional strain that accompanies flood events.	▪ Cost may be prohibitive. ▪ A new site (preferably outside the flood hazard area) must be located and purchased. ▪ Disposition of the flood-prone lot must be addressed. ▪ Additional costs are likely if the house must be brought into compliance with current code requirements for plumbing, electrical, and energy systems.

Table 2.2

3. *Floodwalls*

Floodwalls, berms, and levees all work to keep floodwaters from reaching your house. They are built to at least the height of the flood protection level in your area. Floodwalls are usually made of concrete. Berms are simply small levees, usually built from fill dirt.

Floodwalls, berms, and levees can either surround the building (ring levee) or connect to high ground. They can also be built up against a building's foundation walls. A sump and pump will be needed to pump out water that seeps under the walls. Floodwalls, levees or berms may not be allowed in your area if they could create a drainage problem on your neighbor's property. Check with your building department before you build.



Floodwalls of all types work best in places where flooding is less than 3 feet deep. If floodwaters near your house develop swift currents, earthen levees and berms cannot be used—they may wash away. Floodwalls and berms may not be appropriate for homes with basements.

- An **exterior floodwall** can protect a window well or stair against low level flash flooding. Walls should be supported by and securely tied to a footing so that they will not be undercut by scouring. It is important to understand the flood situation you are working with and your soil conditions in order to properly evaluate if a floodwall is the right solution for you. Floodwalls are not effective when the ground becomes saturated.

  Construct a watertight masonry floodwall around the perimeter of the opening. The wall should not exceed 3 feet in height and must be constructed of properly reinforced poured concrete or sufficient masonry units to prevent failure under the flood conditions. Install proper footing and anchor to existing walls. Install a watertight, spring-loaded steel access door and watertight gaskets on sides and bottom of frame at any necessary opening. Be sure all work conforms to State and local building codes.

- An **interior floodwall** can be built to accommodate low levels of flooding. The wall must enclose the utilities and be built 1 foot above the 100-year flood elevation. The wall must be constructed of either concrete blocks or poured concrete and reinforced with steel rods in order to be able to resist the pressure of the floodwaters. It is important to anchor the new wall into the existing basement wall and floor so that it is not pushed around by the floodwaters. For best protection, do not install gates that open **into** the enclosure.

Even in areas where floodwaters are less than 2 feet deep, a house can be severely damaged if water reaches the interior. The damage to walls and floors can be expensive to repair, and the house may be uninhabitable while repairs are underway.

To protect a house from shallow flooding, add a **waterproof veneer** to the exterior walls sealing all openings, including doors, to prevent the entry of water. As shown in the figure, the veneer can consist of a layer of brick backed by a waterproof membrane. Before the veneer is applied, the siding is removed and replaced with exterior grade plywood sheathing. If necessary, the existing foundation footing is extended to support the brick. Also, because the wall will be exposed to flood water, changes are made to the interior walls as well so that they will resist moisture damage. In the area below the flood level, standard batt insulation is replaced with washable closed-cell foam insulation, and any wood blocking added inside the wall cavity is made of exterior grade lumber.

Tips
Keep these points in mind when you have a waterproof veneer added to the exterior walls of your house:

- Adding a waterproof veneer is appropriate in areas where the flood depth is less than 2 feet. When flood depths exceed 2 feet, the pressure on waterproofed walls increases greatly, usually beyond the strength of the walls. If greater flood depths are expected, consult with a licensed civil or structural engineer before using this method.
- Changes to the foundation of your house must be done by a licensed contractor, who will ensure that the work is done correctly and according to all applicable codes. This is important for your safety.
- If your house is being remodeled or repaired, consider having the veneer added as part of the remodeling or repair work. It will probably be cheaper to combine these projects than to carry them out separately.
- If your house has brick walls, you can still use this method. The new brick veneer and waterproof membrane are added over the existing brick.
- If your house is flooded by groundwater entering through the floor, this method will not be effective.

Estimated Cost. If you have a contractor add a waterproof brick veneer to your house, you can expect to pay about $10 per square foot of exterior wall. For example, a 3-foot-high brick veneer on a house measuring 60 feet by 30 feet would cover about 540 square feet and would cost about $5,400. This figure does not include the cost of sealing doors and other openings or extending the foundation.

The advantages and disadvantages of adding levees and floodwalls are listed on the next page.

ADVANTAGES AND DISADVANTAGES OF LEVEES AND FLOODWALLS

ADVANTAGES	DISADVANTAGES
▪ The house and the area around it will be protected from inundation, and no significant changes to the house will be required. ▪ Floodwaters cannot reach the house or other structures in the protected area and therefore will not cause damage through inundation, hydrodynamic pressure, erosion, scour, or debris impact. ▪ Building levees and floodwalls is usually less expensive than elevating or relocating a house. ▪ The house can be occupied during construction of levees and floodwalls. ▪ Levees and floodwalls reduce the flood risk to the house and its contents. ▪ Levees and floodwalls reduce the physical, financial, and emotional strain that accompanies flood events.	▪ Levees and floodwalls may not be used to bring a substantially damaged or substantially improved house into compliance with your community's floodplain management ordinance or law. ▪ Cost may be prohibitive. ▪ Periodic maintenance is required. ▪ Human intervention and adequate warning time are required to close any openings in a levee or floodwall. ▪ If a levee or floodwall fails or is overtopped by floodwaters, the effect on the house will be the same as if there were no protection at all. ▪ An interior drainage system must be provided. ▪ Local drainage can be affected, possibly creating or worsening flood problems for others. ▪ The house must not be occupied during a flood. ▪ Access to the house may be restricted. ▪ Levees and floodwalls do not reduce flood insurance rates. ▪ Floodplain management requirements may make levees and floodwalls violations of codes and/or regulations. ▪ A large area may be required for construction, especially for levees. ▪ Hydrostatic pressure on below-ground portions of a house may still be a problem, so levees and floodwalls are not good retrofitting methods for houses with basements.

Table 2.3

4. Dry floodproofing

Dry floodproofing means sealing a building to keep floodwaters out. All areas below the flood protection level are made watertight. Walls are coated with plastic or rubberized sheeting or special waterproofing compounds. Openings such as doors, windows, sewer lines, and vents are closed permanently, or they are temporarily sealed with removable shields or sandbags.

Dry floodproofing can only be done if the walls of your house are strong enough to hold back the floodwaters without collapsing. For this reason, dry floodproofing is not recommended if your flood protection level is more than 2 or 3 feet above ground level. Dry floodproofing is generally *not* appropriate for houses with basements or crawl spaces. Successful dry floodproofing involves the following:

- sealing the exterior walls of the house
- covering openings below the flood level
- protecting the interior of the house from seepage
- protecting service equipment (utility systems, heating and cooling systems and large appliances) outside the house

5. Wet floodproofing

Wet floodproofing means modifying a building so that floodwaters will cause only minimal damage to the building and contents. Building materials below the flood protection level are replaced with materials that are resistant to water. Floodwaters are allowed into the building to counteract the pressure of the water on the outside of the walls.

You should furnish areas that have been wetproofed with light, portable furniture that can be easily and quickly moved before a flood. Objects that are difficult to move quickly, such as furnaces, water heaters, appliances, and bookcases, are either put permanently on platforms or reinstalled upstairs.

Wet floodproofing has one advantage over the other four floodproofing types: even the smallest efforts will significantly reduce flood damage the next time. Simply moving furniture and electrical appliances out of areas that will flood can save thousands of dollars. If you decide not to use one of the other four floodproofing measures described above, you should use wet floodproofing measures as you repair and rebuild.

Successful wet floodproofing involves the following:

- ensuring that flood waters enter and exit the house
- ensuring that flood waters inside the house rise and fall at the same rate as flood waters outside
- protecting the areas of the house that are below the flood level from damage caused by contact with flood waters
- protecting service equipment inside and outside the house
- relocating any materials stored below the Flood Protection Level (FPE)

6. *Demolition*

Demolition is another mitigation method that can be practical and effective. Demolition is used in the following instances:

- If a floodprone house has been severely damaged because of flooding or any other cause.
- If an undamaged house, deteriorated over time, is not worth retrofitting with any of the other methods described in this chapter.

If you choose the demolition method, you will tear down your damaged house and either rebuild properly on the same property or move outside the floodplain. It involves disconnecting and capping utility lines at the damaged house, tearing the house down, removing debris and otherwise restoring the old site and building or buying a new house. The most important considerations involve how badly your house has been damaged and your options for building or buying a new house.

Basic Steps in Demolition of Buildings:

- Have utility company turn off all services to the house.
- Have demolition contractor disconnect the utility lines. If you do not plan to rebuild on the same site, the contractor will cap the lines permanently or remove them according to utility company requirements.
- Have environmental hazards, such as asbestos, abated in accordance with Federal, state and local requirements.

- Demolition contractor will push down the house with bulldozer and then dispose of resulting debris.
- Have old site restored including demolishing or removing the house and any pavement (driveway or patio), grading areas disturbed by the demolition, and stabilizing the site with grass.
- Have aboveground and underground tanks drained or removed, or anchored to resist flotation.
- Utilizing the services of a qualified geotechnical or environmental engineering firm, have soil tested around an underground tank to determine whether leakage has occurred.
- Have contaminated soil cleaned if there has been leakage from the tank.

ADVANTAGES AND DISADVANTAGES OF DEMOLITIONS

▪ Demolition greatly reduces or eliminates the potential for damage from floods, earthquakes, high winds and other hazards. ▪ Tearing down a house is an easy process. ▪ If a disaster has caused extensive damage to the interior and exterior of your house or left it structurally unsound, tearing it down and starting over may be easier than making all of the necessary repairs. ▪ Demolition techniques are well known, and qualified contractors are often readily available. ▪ Demolition reduces the physical, financial, and emotional strain that accompanies flood and other hazard events.	▪ Demolition is disruptive to occupants. ▪ Cost may be prohibitive. ▪ You will need to purchase a house elsewhere or rebuild somewhere on the existing property. ▪ If you are not rebuilding on the old site, the site must be restored to the requirements of local regulations. ▪ Old property inside the regulatory floodplain may be difficult to sell because of restrictions on its use.

Table 2.4

Permit. You or your design professional or contractor must check with local officials regarding permitting requirements for the necessary work. All permits for demolition, including disconnecting and capping utilities and disposing of debris; new construction; and restoration of the old site should be obtained before the demolition process begins.

BUILDING PERMIT

Once you've determined the repairs and floodproofing measures you are going to take, local codes generally require that you get a building permit. Before you make repairs or alterations to your home or property, make sure your plans are reviewed and OK'ed by your building department. You may also need to get the OK of your homeowners' association or mortgage holder before you make repairs or alterations to your home or property.

If you are just replacing items such as carpeting or wallboard, you will probably not need a permit—but should check with your local building department before you proceed. You will usually have to get a permit for electrical work and repairs of structural damage, such as broken walls.

Most local and state building codes require that a building that is substantially damaged be treated as a new building. A new residential building must be so that its lowest floor is at or above the flood protection level. In other words, if your house is substantially damaged, you will have no choice but to elevate or relocate your house in order to meet local building codes.

Failure to follow the local building code can result in an order to stop reconstruction, a fine, higher flood insurance rates, denial of flood insurance, or all of the above.

Before you begin the work, make sure you'll do it right.
Contact you local building official!!

Unit Review

Circle the correct response. Answers may be found on page A1.

1. The reason for purchasing flood insurance under the National Flood Insurance Program (NFIP) is:
   a) An NFIP policy covers damage to paneling, carpeting and furniture in a basement.
   b) NFIP policies are sold through private insurance agents and companies.
   c) NFIP policy covers damage to your home or contents caused by surface water flooding, something homeowners' insurance policies do not cover.
   d) An NFIP policy covers water damage caused by sewer back-up or sump pump failure.

2. What can you do about wires that terminate below the 100-year flood level?
   a) Make sure the wire is specially marked in the panel box and turned off at the time of a flood warning.
   b) Leave it where it is and repair the damages after the flood event.
   c) Have a qualified electrician move all wiring well above the 100-year flood level, out of danger of getting wet.
   d) No wires end in the flood zone.

3. Washers and dryers:
   a) can be used immediately following a flood whether or not they got wet.
   b) should never be elevated because they may vibrate off of blocks during use.
   c) can be relocated to a floor with at least a 12-inch safety margin above the base flood elevation to protect them from flooding.
   d) are designed to withstand floodwaters and are therefore not affected during a flood.

4. The ***surest*** way to protect a building from flood damage is to:
   a) Close all windows and doors as soon as you receive the flood warning.
   b) Construct a floodwall or levee around the building.
   c) Move the building out of the flood-prone area.
   d) Elevate the home above the base flood elevation level.

5. Circle the statement below that is true:
   a) Dry floodproofing can be done only if you have a basement or crawl space.
   b) In wet floodproofing, floodwaters are allowed into the building to counteract the pressure of the water on the outside of the walls.
   c) Building permits are usually not necessary if you have written plans for altering your home or property.
   d) If your house is flooded by ground water entering through the floor, adding a waterproof veneer will help.

Unit 3

Reducing Risks From Winds

Objectives: At the end of this unit, participants will be able to:

1. *Describe the steps the homeowner can take to reduce vulnerability to high winds, tornadoes, and hurricanes.*
2. *Identify the four areas of the home that should be checked first for weakness before a hurricane or tornado strikes.*
3. *List three non-structural pre-hurricane/tornado mitigation tips that will reduce damage to the home.*

INTRODUCTION

Wind is a major source of fatalities and property losses in the United States. From 1981 to 1990, insured losses from wind damage totaled $23 billion. Two main sources of wind-related loss of life and property damage are ***tornadoes*** and ***hurricanes***.

Hurricanes

One of the most dramatic, damaging, and potentially deadly events that occur in this country is a hurricane. If you live in a Gulf, or Atlantic coastal state, you are in a hurricane zone. Few communities within this zone remain untouched by the killer storms that occur from June 1 through November 30.

Hurricanes are products of the tropical ocean and atmosphere. Powered by heat from the sea, they are steered erratically by the easterly trade winds and the temperate westerly winds, as well as by their own energy. As they move ashore, they bring with them a storm surge of ocean water along the coastline, high winds, tornadoes, and both torrential rains and flooding. Each year on average, ten tropical storms develop over the Atlantic Ocean, Caribbean Sea, or Gulf of Mexico. About six of these will strengthen enough to become hurricanes. Many of these remain over the ocean with little or no impact on the continental United States. However, about five hurricanes strike the United States coastline every 3 years. Of these five, two will be major hurricanes measuring a category 3 or higher (defined as having winds above 111 miles per hour) on the Saffir-Simpson

Scale. These storms can end up costing our nation millions, if not billions, of dollars in damages.

The **Saffir-Simpson** Scale breaks them into the following categories according to wind speeds:

Category 1: 74 - 95 miles per hour
Category 2: 96 – 110 mph
Category 3: 111 – 130 mph
Category 4: 131 – 155 mph
Category 5: greater than 155 mph

Category One and Two hurricanes usually pose minor damage to stable building structures, but can do major damage to mobile homes, vegetation and piers. These categories cause flooding in some coastal areas.

Category Three hurricanes cause some structural damage to small residences and utility buildings. Mobile homes are destroyed. Flooding near the coast destroys smaller structures with larger structures damaged by floating debris. Terrain continuously lower than 5 feet above sea level may be flooded inland 8 miles or more.

Category Four and Five hurricanes are the most deadly and destructive. Both can create roof failure and building collapse.

During a hurricane, homes, businesses, public buildings, and infrastructure may be damaged or destroyed by high winds and high waves. Debris can break windows and doors, allowing high winds and rain inside the home. Roads and bridges can be washed away by flash flooding, or can be blocked by debris. In extreme storms (such as Hurricane Andrew), the force of the wind alone can cause tremendous devastation, as trees and power lines topple and weak elements of homes and buildings fail. And these losses are not limited to the coastline -- they can extend hundreds of miles inland, under the right conditions. In September of 1989, Hurricane Hugo battered Charlotte, North Carolina, (175 miles inland) with gusts of winds 100 mph, downing trees and power lines and causing massive disruption.

Fortunately, there are a variety of measures that can be taken -- both at the individual and community levels -- to reduce your vulnerability to hurricane hazards. Simple construction measures, such as the use of storm shutters over exposed glass, and the addition of hurricane straps to hold the roof of a structure to its walls and foundation, have proven highly effective in lowering damages when hurricanes strike. In addition, more complex mitigation measures can be

pursued to further reduce a property's susceptibility. For example, coastal homes and businesses can be elevated to permit coastal storm surge to pass under living and working spaces. Communities can further reduce their vulnerability to hurricanes through the adoption and enforcement of wind- and flood-resistant building codes. Sound land-use planning can also ensure that structures are not built in the highest hazard areas.

Tornadoes

Although tornadoes occur in many parts of the world, these destructive forces of nature are found most frequently in the United States east of the Rocky Mountains during the spring and summer months. Tornado season is usually March through April, although tornadoes can occur at any time of year. In the southern states, peak tornado occurrence is in March through May, while peak months in the northern states are during the summer. They tend to occur in the afternoons and evenings.

In an average year, 800 tornadoes are reported nationwide, resulting in 80 deaths and over 1,500 injuries. A **tornado** is defined as a violently rotating column of air extending from a thunderstorm to the ground. Tornadoes strike with incredible velocity. The most violent tornadoes are capable of tremendous destruction and wind speeds can approach 300 miles per hour. Damage paths can be in excess of one mile wide and 50 miles long. Once a tornado in Broken Bow, Oklahoma, carried a motel sign 30 miles and dropped it in Arkansas. As the wind intensifies, shingles begin to lift and trees are uprooted. Unprotected doors give way and the wind is inside the house, pushing the structure from within. Poorly attached window coverings give way, and as pressure builds, the garage door fails, allowing the full force of the wind inside. Among other things the wind can rip off sheathing (decking) and destroy gable end walls. Over-hanging eaves and rakes, extended awnings, open porches, and other features that tend to trap air beneath them are particularly susceptible to damage. Wind-borne debris can break windows and damage roof coverings and walls. In fact, these powerful forces can literally lift the roof right off the house. And all this happens in a matter of seconds. Tornadoes are classified using the Fujita Scale below.

Fujita Tornado Intensity Scale

Category F-0: 40 – 72 miles per hour. Gale tornado, light damage. Some damage to chimneys; break branches off trees; push over shallow-rooted trees; damage to sign boards.

Category F-1: 73 – 112 mph. Moderate tornado; moderate damage. Peel surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off roads.

Category F-2: 113 – 157 mph. Significant tornado; considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light-object missiles generated.

Category F-3: 158 – 206 mph. Severe tornado; severe damage. Roofs and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted; heavy cars lifted off ground and thrown.

Category F-4: 207 – 260 mph. Devastating tornado; devastating damage. Well-constructed houses leveled; structure with weak foundation blown off some distance; cars thrown and large missiles generated.

Category F-5: 261 – 318 mph. Incredible tornado; incredible damage. Strong frame houses lifted off foundations and carried considerable distance to disintegrate; automobile-sized missiles fly through the air in excess of 100 yards; trees debarked; incredible phenomena will occur.

Watches versus Warnings

Many people confuse the meaning of a tornado ‘watch” and tornado “warning” issued by the National Weather Service. Here’s the difference:

Watch: tornadoes are possible in your area; remain alert for approaching storms.

Warning: A tornado has been sighted or indicated by weather radar. If a tornado warning is issued for your area and the sky becomes threatening, move to your pre-designated place of safety.

EXAMPLES OF MITIGATION TECHNIQUES

Hurricanes and tornadoes both have in common very high winds and the associated damage. Once a tornado or hurricane strikes, there is little to do to prevent damage; however, there are steps you can take ahead of time to protect lives and property. If you aren't sure whether your house is at risk from hurricanes or tornadoes, check with your local building official, city engineer, or

planning and zoning administrator. They can tell you whether you are in an area where these high-wind events occur. Also, they usually can tell you how to protect yourself and your house and property.

In this unit, we will explore the steps you can take to reduce risks to your home during high winds, tornadoes and hurricanes. After Hurricane Andrew, a team of experts examined homes that had failed and ones that had survived. They found four areas that should be checked for weakness—

- the roof,
- windows,
- doors, and
- if you have one, garage door.

We will discuss some steps here that you can take to help make your home stronger before the next windstorm strikes.

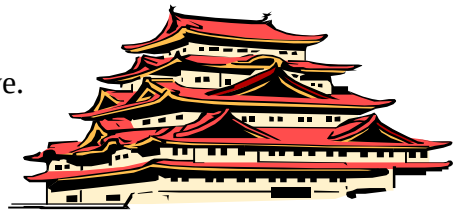
While these projects, if done correctly, can make your home safer during a hurricane, they are no guarantee that your home won't be damaged or even destroyed. If you are told by authorities to evacuate, do so immediately, even if you have taken these precautions.

Hurricane and tornado protection can involve a variety of changes to your house and property -- changes that can vary in complexity and cost. You may be able to make some types of changes yourself. But complicated or large-scale changes and those that affect the structure of your house or its electrical wiring and plumbing should be carried out only by a professional contractor licensed to work in your state, county, or city. The examples of hurricane and tornado protection listed below are things that skilled homeowners can probably do on their own.

ROOF STRUCTURES

During a windstorm, the force of the wind pushes against the outside of your home. That force is passed along from your roof to the exterior walls and finally to the foundation. Homes can be damaged or destroyed when the energy from the wind is not properly transferred to the ground.

Does your home have a gabled roof?



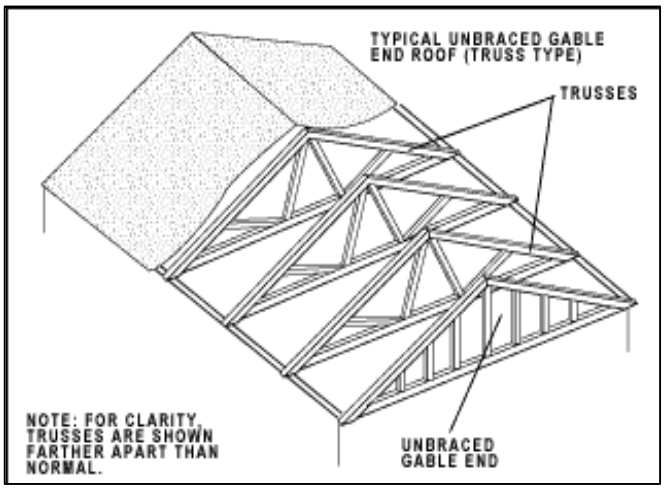
The first thing you should do is determine what type of roof you have. Homes with gabled roofs are more likely to suffer damage during a hurricane. A gabled roof looks like an A on the ends, with the outside wall going to the top of the roof. The end wall of a home with a gabled roof takes a beating during a hurricane, and those that are not properly braced can collapse, causing major damage to the roof.

1. ***Inspect roof's bracing.*** In most homes, gabled roofs are built using manufactured trusses. Sheets of roof sheathing, often plywood, are fastened to the trusses with nails or staples, and roofing material is fastened to the sheathing. In many cases, the only thing holding the trusses in place is the plywood on top. This may not be enough to hold the roof in place during a hurricane. Installing additional truss bracing makes your roof's truss system much stronger.

   To inspect your roof's bracing, go into the attic. While working in your attic, you should wear clothing that covers your skin, work gloves, a hat, eye protection, and a dust mask. If your attic does not have a floor, be careful to walk on the wood joists, or install boards wide enough to walk on as you work. Notice how the plywood is attached to the truss system. If most of the large nails or staples coming through the sheathing have missed the trusses, consider having the sheathing properly installed.

2. ***Install Truss bracing***. In gabled roofs, truss bracing usually consists of 2x4s that run the length of the roof. If you do not have truss bracing, it should be installed. You can do this yourself or hire a professional. Install 2x4s the length of your roof, overlapping the ends of the 2x4s across two trusses. Braces should be installed 18 inches from the ridge, in the center span, and at the base, with 8 to 10 feet between the braces. Use two 3-inch, 14-gauge wood screws or two 16d (16 penny) galvanized common nails at each truss. Because space in attics is generally limited, screws may be easier to install.

3. ***Brace gable end roof framing***. Another example of hurricane and tornado protection is adding bracing to gable end roof framing. This is something that only a licensed contractor should do.



Gable end roofs are more susceptible to damage by high winds than hip roofs or flat roofs. The gable end presents a large obstacle to the wind and receives its full force. If the framing of the gable end and the rest of the roof are not adequately braced to resist the wind, the roof can fail. Roof failures, especially in unbraced gable roofs, are a common cause of major damage to houses and their contents in high winds.

If your house has a gable roof, you should check to see whether the roof framing is braced. Some gable end roofs are truss roofs, but some are constructed with rafters rather than trusses. Both types should be braced. If you are

unsure whether your gable end roof is adequately braced, check with your local building department. After inspecting your roof framing, a building official can tell you whether bracing is required and if so, how it should be added.

Gable end bracing consists of 2x4s placed in an "X" pattern from the top center of the gable to the bottom center brace of the fourth truss, and from the bottom center of the gable center to the top center brace of the fourth truss. Use two 3-inch, 14-gauge wood screws or two 16d (16 penny) galvanized common nails to attach the 2x4s to the gable and each of the four trusses.

Tips

Keep these points in mind if you have bracing added to a gable end roof:

- Bracing can be added fairly easily, but you should have a contractor perform the work to make sure that the bracing is properly designed and attached.

- If you have a building official inspect your roof framing, ask about other changes you may be able to make to your house to protect it from high winds.

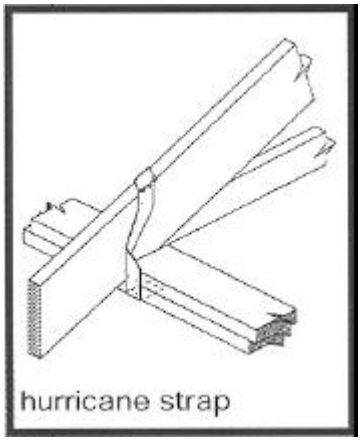
Estimated Cost. If you hire a contractor to brace a gable end roof, you can expect to pay about $75 for each gable end. This figure is for a gable end about 30 feet long. Bracing longer gable ends may be slightly more expensive.

4. ***Install hurricane straps in your home or business to better secure the roof to the walls and foundation***. This will reduce the risk of losing your roof to high winds. There are many types of roof design. Regardless of your type of roof, hurricane straps are designed to help hold your roof to the walls. While you are in the attic, inspect for hurricane straps of galvanized metal.

   To install straps or hurricane clips, remove the roof sheathing around the perimeter of the roof to reveal the top of the wall. You may also need to remove the soffit (the horizontal underside of an eave) and exterior cladding to reveal the top 12 to 18 inches of the wall. In addition, if the exterior cladding is brick veneer, you may need to remove small sections of brick as needed.

   If your roof has trusses, make sure you tie them to the wall by either anchoring to the top plate and then the top plate to the wall stud, or strapping the truss directly to the wall stud. You can anchor the roof to the top of the wall of wood or masonry homes with straps or connectors.

Hurricane straps may be difficult for homeowners to install. You may need to call a professional to retrofit your home with hurricane straps. Check with you local government building officials to see if hurricane straps are required in your area.



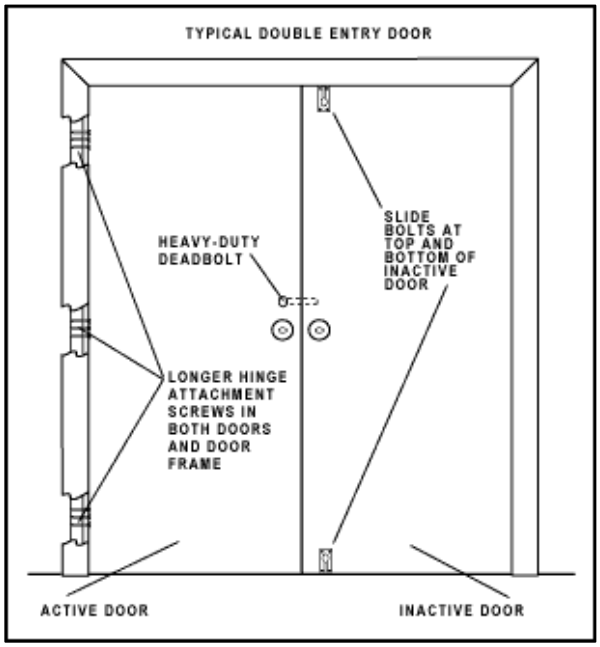
EXTERIOR DOORS AND WINDOWS

The exterior walls, doors and windows are the protective shell of your home. If your home's protective shell is broken, high winds can enter and put pressure on your roof and walls, causing damage. You can protect your home by strengthening the doors and windows.

A common misunderstanding is that windows should be left open to equalize and stabilize pressure on our home. **The truth is that if hurricane winds enter any opening, damage is much more likely to occur due to increased internal pressure on walls and roofs supports. MAKE SURE ALL WINDOWS, DOORS AND OPENINGS ARE COMPLETELY COVERED AND BRACED.**

REINFORCE DOUBLE ENTRY DOORS.

Your home has either double or single entry doors. If they are solid wood or hollow metal they probably can resist wind pressures and hurricane debris. However, if you are not sure whether they are strong enough, take these precautions:



- Most double doors have an active and an inactive or fixed door. Check to see how the fixed door is secured at the top and bottom. Install head and foot bolts on the inactive door of double entry doors.

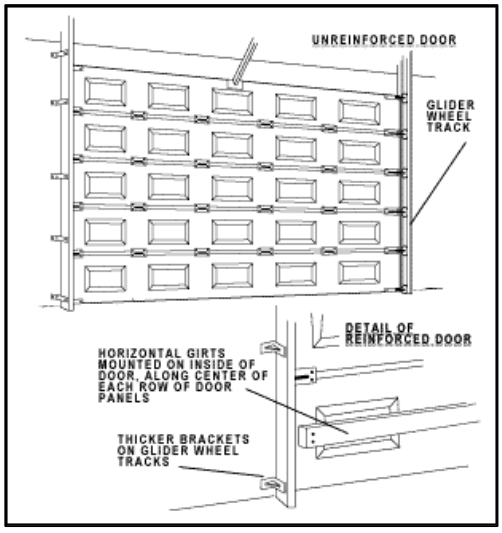
- Make sure your doors have at least three hinges and a dead bolt security lock which has a minimum 1-inch bolt throw length.

- Since double entry doors fail when their surface bolts break at the header trim or threshold, check the connections at both places. Be sure the surface bolt extends into the door header and through the threshold into the subfloor.

Some door manufacturers provide reinforcing bolt kits made specifically for their doors. Check with your local building supplies retailer to find out what type of bolt system will work for your door. The door bolt materials should cost from $10 to $40, depending on the type and finish. Doors with windows will need additional protection from flying debris.

REINFORCE OR REPLACE GARAGE DOORS

High winds from hurricanes and tornadoes can damage garage doors or even blow them in. If wind enters a garage it can cause dangerous and expensive structural damage. Reinforcing your garage door helps you protect not only your garage but its contents as well.



Because of their width, doublewide (two-car) garage doors can pose a problem during hurricanes because they are so large that they wobble as the high winds

blow. Unless you have a tested hurricane resistant door, the wind may force it out of the roller track -- especially if the track is lightweight or some anchor bolts are not in place. This occurs because the door deflects too much under excessive wind pressure and fails. When garage doors fail, high winds can enter your home through the garage and blow out doors, windows, walls, and even the roof.

There are many steel, aluminum and wood bracing products on the market specifically made to withstand hurricane winds. If your garage door is not well-supported, you may want to investigate those products for future usage.

To secure your garage door:

- **Check with your local government building official to see if there are code requirements for garage doors in your area.** Certain parts of the country have building codes requiring garage doors to withstand high winds.

- Some garage doors can be strengthened with retrofit kits. **Check with your local building supplier or garage door retailer to see if a retrofit kit is available for your garage door.** You can expect to pay from $75 to $150 to retrofit your garage door.

You should probably reinforce your doublewide garage door at its weakest points. This involves installing horizontal and/or vertical bracing onto each panel, using wood or light gauge metal girts bolted to the door, added across the back of the door. This horizontal (or vertical) bracing can be part of a kit from the garage door manufacturer. You may also need heavier hinges and stronger center supports and end supports for your door. However, if your existing door is old or damaged, you might want to replace it with a stronger door and tracks. Even if you decide to buy a new door, reinforcing it is still a good idea. Hardware and home supply stores, as well as companies that specialize in overhead door sales and installation, can advise you about stronger doors and track systems.

To strengthen the glider wheel tracks, first check the track on your garage door. With both hands, grab a section of each track and see if it is loose or if it can be twisted. If so, a stronger track can be installed. Make sure that it is anchored to the 2x4s inside the wall with heavy wood bolts or properly attached to masonry with expansion bolts.

If you decide to retrofit your garage door with a kit that allows you to operate the door after it is installed, make sure the door is balanced by lowering it about halfway and letting go. If the door goes up or down, the springs will need adjusting. *Note: Since the springs are dangerous, only a professional should adjust them.*

If you are unable to retrofit your garage door with a kit *specifically designed for your door*, you can purchase garage door retrofit kits to withstand hurricane winds at your local building supply store. Also, check to see if the supplier can do the installation.

Tips

Keep these points in mind when you reinforce or replace your garage doors:

- Reinforcing an existing garage door is something you may be able to do yourself if you have the necessary skills and tools, or you can hire a contractor to do the work. The necessary materials, including metal brackets and wood boards for girts can usually be found at a lumber yard, hardware store, or home supply store.

- Single-car garage doors usually resist wind forces better than two-car garage doors.

- Don't wait until a hurricane warning is issued to reinforce your garage door; you probably won't have time.

- Installing a new garage door is more than a one-person job and is not the type of work that most homeowners who lack the necessary skills and equipment would want to undertake. If you buy a new door, you may want to either have the seller install it or hire a contractor.

- If you are buying a new door, get one without windows. Unless covered, glass is easily broken by high winds and windblown debris. Again, one reason for protecting your garage door is to prevent wind from entering the garage.

Estimated Cost. If you are unable to retrofit your door, you can purchase specially reinforced garage doors designed to withstand winds of up to 120 miles per hour. These doors can cost from $400 to $450 (excluding labor) and should be installed by a professional. If you hire a contractor to reinforce an existing two-car garage door, you can expect to pay about $300. The cost of replacing a door, including installation, can vary greatly depending on the size and type of door.

STORM SHUTTERS

INSTALL WINDOW/PATIO DOOR SHUTTERS

Installing impact-resistant shutters over all exposed windows and other glass surfaces is one of the easiest and most effective ways to protect your home in windstorms. You should cover all windows, French doors, sliding glass doors, and skylights. Not only do they protect doors and windows from wind-borne objects, but they can reduce damage caused by sudden pressure changes when a window or door is broken. There are many types of manufactured shutters. Check with your local building supplies retailer. If you install manufactured shutters, follow the manufacturer's instructions carefully.

Before installing shutters, check with your local building official to find out if a building permit is required. It is important that you have your shutters ready now, and that you mark and store them so they can be easily installed during a hurricane watch.

The easiest designs are those that simply cover the opening with a structural panel such as plywood. Plywood shutters that you make yourself, if installed properly, can offer a high level of protection from flying debris during a hurricane. In past hurricanes, many homeowners upon returning have noticed their temporary plywood shutters blown off because they were not adequately fastened. If you have a wood-frame house, use adequate fasteners to attach panels over the openings when a hurricane approaches. If your home is made with concrete blocks, however, you will have to install anchoring devices well in advance.

Steps to Installing Shutters

1. Measure each window and each door that has glass, and add 8 inches to both the height and width to provide a 4-inch overlap on each side of the window or door. Sheets of plywood are generally 4x8 feet. Tell your local building supply retailer the size and number of openings you need to cover to determine how many sheets to buy.

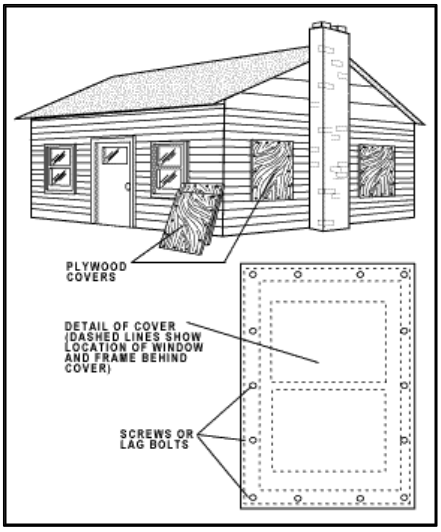
2. To install plywood shutters you will need bolts, wood or masonry anchors, large washers, and 5/8-inch exterior-grade plywood. For windows 3 feet by 4 feet or smaller installed on a wood frame house, use ¼- inch lag bolts and plastic-coated permanent anchors. The lag bolts should penetrate the wall and frame surrounding the window at least 1¾ inches.

   For larger windows, use 3/8-inch lag bolts that penetrate the wall and frame surrounding the window at least 2½ inches. For windows 3 feet by 4 feet or smaller installed on a masonry house, use ¼-inch expansion bolts and

galvanized permanent expansion anchors. The expansion bolt should penetrate the wall at least 1½ inches. For larger windows, use 3/8-inch expansion bolts that penetrate the wall at least 1½ inches. The tools you will need are a circular or hand saw, a drill with the appropriately sized bits, a hammer, and a wrench to fit the bolts. To be safe, use eye protection and work gloves.

3. Cut the plywood to the measurements for each opening. Drill holes 2½ inches from the outside edge of the plywood at each corner and at 12-inch intervals. Drill four holes in the center area of the plywood to relieve pressure during a hurricane.

4. Place the plywood over the opening and mark each hole position on the outside wall. Drill holes with the appropriate size and type of bit for the anchors. Install the anchors, the plywood, and the bolts to make sure they fit properly. On wood-frame houses, make sure that the anchors are secured into the solid wood that frames the door or window and not into the siding or trim. Mark each shutter so you will know where it is to be installed and store them and the bolts in an accessible place.



If the opening is larger than one sheet of plywood, you will need to make shutters with 2x4 bracing. This bracing can be two 2x4s at the middle and bottom of the two sheets of plywood, evenly spaced, with the 2-inch side attached to the inside of the storm shutter. Attach the 2x4s to the outside of the storm shutter with 2-inch, 10-gauge wood screws before installing the shutter.

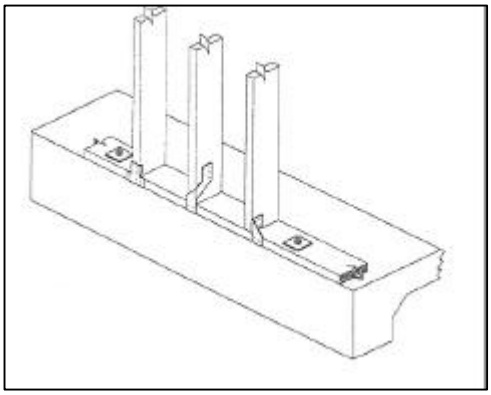
If your residence has permanent shutters, evaluate their effectiveness. Manufacturers are responsible for testing their shutters up to the standard necessary to resist wind forces and wind-borne debris. Some shutters are very flexible, especially those that roll up.

If struck by a rigid piece of debris, shutters may bend and break the window. To determine whether your shutter can resist this impact, gently lean against it and see if it yields. You can also inspect your shutters to see if they are properly attached to the house and will not fly off during a storm by inspecting the shutter connectors for obvious excessive wear or missing connectors. Ask the shutter manufacturer for proper installation criteria.

WALLS

REINFORCE WALL TO FOUNDATION CONNECTION

To complete your home strengthening process, make sure the exterior walls are anchored to the foundation. Although this is not as critical as some of the other tasks listed here, an inadequate connection between the wall and foundation could weaken your entire home. This is especially true if you live in a one-story home with large roof truss spans and a low-sloped roof.



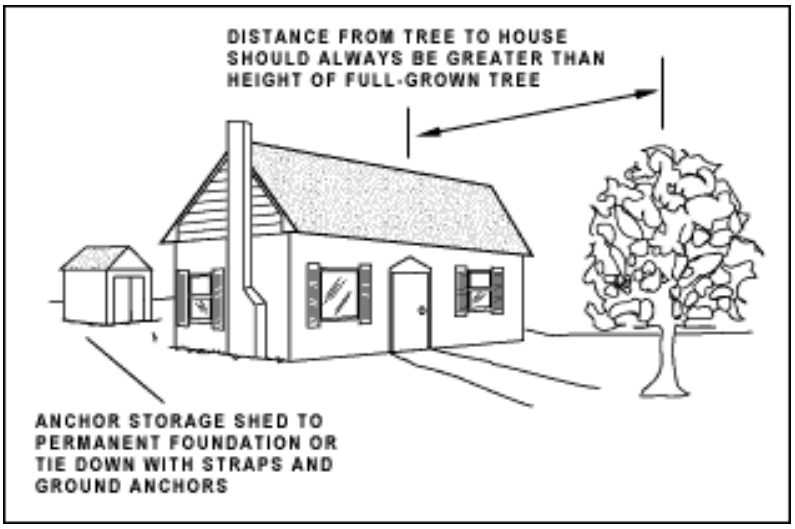
Make sure the wall studs are adequately connected to the sill plate, which sits directly on top of the foundation wall. Metal clips are available at your building supply store for this task. Then drill holes through the existing sill plate into the concrete foundation to install anchor bolts. Place the holes as close to the center of the sill plate as possible using epoxy anchors which you can find at your local building supply store.

An engineer should determine the minimum bolt spacing for the force analysis of the shear and uplift loads. But placing 5/8-inch diameter anchor bolts no more than 6 feet apart, with an anchor bolt at the end of each wall, provides an extra measure of safety for your home. Unfortunately, if you have a concrete masonry block home, verifying that the exterior wall is connected to the foundation is extremely difficult. In that case, the best method to make sure that all required reinforcing is present and installed correctly is to inspect for it while the home is being built.

AREAS AROUND YOUR HOUSE

REMOVE TREES AND POTENTIAL WINDBORNE MISSILES

If the area immediately surrounding your house contains trees, outbuildings, trashcans, yard debris, or other materials that can be moved by the wind, your house will be more likely to be damaged during a hurricane or tornado. The wind can topple trees onto your house and can pick up smaller objects and drive them through windows and glass doors.



You should ensure that all trees are far enough away from your house that they can't fall on it. So the distance between your house and any nearby tree should always be greater than the height the tree will reach when it is fully grown. All storage sheds and other outbuildings should be securely anchored, either to a permanent foundation or with straps and ground anchors. Smaller objects, such as trash cans, barbecue grills, and outdoor furniture should also be anchored or, if you have adequate warning, moved indoors. You should also clear away any debris, such as fallen tree branches.

Tips

Keep these points in mind when you remove trees and potential windborne missiles from around your house:

- Removing large trees near your house can be extremely dangerous, for both you and your house, and therefore is a job for a skilled contractor.
- The straps and ground anchors used for manufactured homes also can be used to anchor outbuildings, especially small garden sheds, which are usually not placed on a permanent foundation.
- You can secure outdoor furniture and barbecue grills by bolting them to decks or patios or by attaching them to ground anchors with cables or chains. Also, with adequate warning, these can be moved indoors.
- You can secure trash cans with cables or chains attached to ground anchors or to wood posts firmly embedded in the ground. Trash can lids should be tied to cans with cables or chains.

Estimated Cost. If you hire a contractor to remove a large tree, you can expect to pay about $300 to $500. Having a contractor anchor a storage shed with straps and ground anchors will cost about $100 to $200.

PRE-HURRICANE/TORNADO MITIGATION TIPS

- ❖ Gather outdoor furniture, garbage cans, potential debris, etc., and move them inside. Encourage your neighbors to do the same.

- ❖ Replace gravel/rock-landscaping material with shredded bark.

- ❖ When landscaping your home, use plant life that is native to hurricane areas, and more likely to stay rooted through winds and rains.

- ❖ Keep trees and shrubbery trimmed. Cut weak branches and trees that could fall or bump against the house. When trimming, try to create a channel through the foliage to the center of the tree to allow for airflow. Keep climbing roses and vines trimmed back. Do not attempt to do your trimming after a watch has been announced as trash pick will be delayed.

- ❖ Screened porches and other similar areas are usually first to suffer damage, so make sure the porch is properly attached. (*The industry has no standards yet for adequate performance of porch screens in hurricane winds.)*

- ❖ Reinforce the double-entry doors with heavy-duty foot and head bolts, and use a security dead bolt lock with 1-inch minimum bolt throw length.

- ❖ Reinforce the double garage door and tracks.

- ❖ If you find that the roof sheathing is not adequately attached:

  - use adhesive to attach the sheathing to the rafters

  - use extra 8d (8 penny nails or #8 screws) if you need to reroof

- ❖ Brace the gable end walls and roof trusses.

- ❖ Purchase materials to secure your home (plywood, shutters, plastic sheeting, nails, etc.). Cut and label plywood to fit all windows and sliding glass doors.

SHELTERS FOR PROTECTION

The mitigation techniques provided in this unit are all good measures to help reduce damage to property caused by extreme winds. We realize that even with these measures implemented, the risks to life and property still remain. However, there is something you can do to reduce the number of lives lost. Residents of tornado- and hurricane-prone areas can now build a "safe room" or in-residence shelter that can protect against deadly tornadoes and hurricanes.

What is a Safe Room?

A safe room, or in-residence shelter, is a small windowless room, such as a closet or bathroom, readily accessible from all parts of the house, designed to provide occupant protection from tornadoes and hurricanes. Its purpose is threefold:

- To save lives,
- reduce injuries, and
- relieve anxiety.

The safe room is applicable to both existing residences and newly constructed homes. Included with this course is a publication, "***Taking Shelter from the Storm: Building a Safe Room Inside Your House***," which outlines a room shelter design, including construction plans, materials and construction cost estimates.

The publication was developed by FEMA in collaboration with Texas Tech University's Wind Engineering Research Center, Lubbock, Texas. Research shows that inspections done on homes in more than 90 towns and cities struck by tornadoes revealed that, in most cases, small rooms in the central portion of the house remained standing even when the house was severely damaged or completely destroyed. This led to the concept that these interior rooms could be economically reinforced to provide a high degree of occupant protection. A shelter built according to the plans can provide protection against winds of up to 250 miles per hour and projectiles traveling at 100 miles per hour. The estimated cost ranges from $2,000 - $6,000.

Read through the attached publication. If you live in an area vulnerable to tornadoes and hurricanes, we urge you to strongly consider constructing a safe room in your home. Remember: mitigate now – before the next windstorm – to save lives later.

Unit Review

Circle the correct response. Answers may be found on page A1.

1. What can happen during a hurricane or tornado if your garage doors fail?
   a) The car will be blown away.
   b) High winds can enter your home through the garage and blow out doors, windows, walls, and even the roof.
   c) Flying debris such as trees, lawn furniture, etc., can land in your garage.
   d) Animals may use the garage as shelter from the windstorm.

2. Name one example of hurricane and tornado protection associated with the roof of the house.
   a) Add bracing to gable end roof framing.
   b) Determine what type of roof you have.
   c) Inspect roof's bracing in the attic of the house.
   d) Reinforce windows and doors.

3. The best time to do hurricane mitigation such as reinforcing the garage door or anchoring the walls to the foundation is:
   a) When the hurricane warning is issued.
   b) When the wind reaches 80 mph.
   c) Now.
   d) Anytime during hurricane season.

4. In getting your home ready for a hurricane, if your residence has permanent shutters…
   a) no further work is necessary.
   b) they have already been tested for wind resistance.
   c) evaluate their effectiveness and replace if necessary.
   d) they will not fly off during a storm.

5. Which of the following is ***not*** a pre-hurricane/tornado tip?
   a) Make sure a screened porch is properly attached.
   b) Reinforce the double-entry doors.
   c) Gather outdoor furniture, garbage cans, potential debris, etc., and move them inside.
   d) Open all windows and doors so the wind won't blow them in.

6. The National Weather Service issues this when the storm is possible in your area. You should remain alert for approaching storms. This is the time to remind family members where the safest places within your home are located, and listen to the radio or television for further developments. What is it?
   a) Tornado sighting
   b) Tornado warning
   c) Tornado watch
   d) Thunderstorm forecast

Unit 4

Preparing Your Home for an Earthquake

Objectives: At the end of this unit, participants will be able to:

1. *Identify the most common causes of earthquake-related casualties.*
2. *List five examples of non-structural earthquake protection changes you can make around the home.*
3. *Differentiate between earthquake modifications homeowners can make themselves and those that need a licensed contractor.*
4. *Identify professionals to contact in determining what earthquake changes to make to your home.*
5. *Discuss the need for mitigation projects in non-traditional seismic risk areas.*

INTRODUCTION

An ***earthquake*** is a sudden, rapid shaking of the Earth caused by the breaking and shifting of rock beneath the Earth's surface. This shaking can cause buildings and bridges to collapse; disrupt gas, electric, and phone service; and sometimes trigger landslides, avalanches, flash floods, fires, and huge, destructive ocean waves (called tsunamis).

Earthquakes have long been feared as one of nature's most terrifying phenomena. Early in human history, the sudden shaking of the earth and the death and destruction that resulted were seen as mysterious and uncontrollable. In 1969, the

theory of *plate tectonics* removed the mystery by explaining the origin of earthquakes and showing that they must be accepted as a natural environmental process. (*See page G5 for information on the plate tectonics theory.*)

DANGER ZONES

Earthquakes occur most frequently west of the Rocky Mountains, although historically the most violent earthquakes have occurred in the central United States. **Please note that all 50 states and all U.S. territories are vulnerable to earthquakes.** Forty-one states or territories are at moderate to high risk. Major earthquake risk zones are in these areas:

- the West
- the central Mississippi Valley
- New England
- South Carolina
- Hawaii
- Puerto Rico
- the Virgin Islands

Buildings with foundations resting on unconsolidated landfill, old waterways, or other unstable soil are most at risk. Buildings or trailers and manufactured homes not tied to a reinforced foundation anchored to the ground are also at risk since they can be shaken off their mountings during an earthquake. Earthquakes can occur at anytime of the year.

Did You Know…?

- ✓ Many people think of California as "Earthquake Country," but the state with the most major earthquakes is Alaska. The granddaddy of earthquakes was along the New Madrid Fault in Missouri where a 3-month-long series of quakes in 1811-1812 included three quakes larger than a magnitude of 8. These quakes were felt over 2 million square miles, as far away as Boston. There were few casualties because the country was sparsely settled.

- ✓ The Richter Scale was developed by Charles F. Richter in 1935. It is a logarithmic measurement of the amount of energy released by an earthquake. Earthquakes with a magnitude of at least 4.5 are strong enough to be recorded by sensitive seismographs all over the world. In the United States several thousand shocks of varying sizes occur annually. An important aspect of earthquakes that most people do not realize is that above magnitude 6.7, the shaking does not get any stronger as the earthquake size increases (for observers within 100 miles of the epicenter). The shaking just lasts longer.

CAUSES OF EARTHQUAKE-RELATED CASUALTIES

During an earthquake, the actual movement of the ground is seldom the direct cause of death or injury. Earthquake-related casualties are commonly caused by:

(1) partial or total building collapse;
(2) flying glass from broken windows and skylights;
(3) overturned bookcases, fixtures, and other large furniture and appliances;
(4) fires from broken chimneys and broken gas lines;
(5) fallen power lines; and
(6) an inappropriate or drastic human reaction caused by fear.

What You Can Do *Before* An Earthquake…

EVALUATE THE BUILDING

When selecting a home, most people don't consider evaluating its vulnerability to earthquakes, but we should. There are certain locations and types of buildings that should be avoided altogether. And there are others in which improvements can be made to upgrade earthquake safety. People who rent or lease their homes may not be able or willing to undertake any structural modifications, but the arrangement of interior furnishings can do much to reduce hazards. Information about a particular building's dangers may help you avoid injury during and after an earthquake. If, for example, you know that one exit may be dangerous after an earthquake, you can use another.

Location. Obvious areas to avoid or be very careful about include fault zones, unstable soils, which might experience liquefaction or uneven settling, slide-prone hillsides, and spillways of dams, reservoirs, and storage tanks. Consult a geologist or soils engineer for a thorough evaluation of the geology, or take a look at a geologic map of the area. These maps are often available at the local library or by request from the U.S. Geological Survey.

Whenever you select a home, take a good look at the surrounding area in as many ways as possible. Look around for significant cracks in the earth, streets, retaining walls and driveways. Be aware of the type of industrial facilities, if any, nearby, as well as railroad tracks, freeways, and highways.

Structural characteristics. For earthquake resistance, unreinforced masonry is the most hazardous type of construction, and single story wood frame is the best. Other structural elements to consider are, first, that the frame of the building is connected to the foundation; secondly, that design does not operate *against* earthquake safety. Large expanses of glass may weaken the structure, and complicated architecture involving many exterior corners and wings may reduce the building's ability to flex as a unit. Lateral bracing or shear walls are now

recommended. Garages that serve as foundations for rooms above them may need additional bracing for earthquake resistance. Heavy roofing materials, such as clay tile, may weaken the structure, and may fall off during ground shaking. Slender stilts for vertical support may not perform well under stress. Chimneys installed before 1960 may not be properly reinforced and tied to the building. Be especially careful about very tall chimneys, which could fall in the direction of an exit.

Non-Structural Preparation

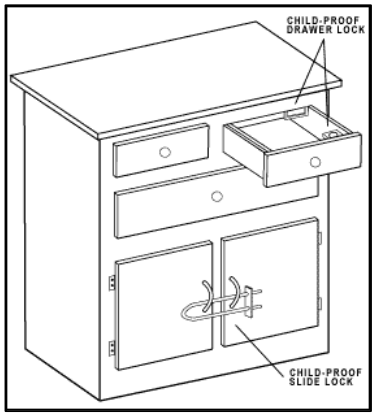
If you aren't sure whether your house is at risk from earthquakes, before investing, check with your local building official, city engineer, or planning and zoning administrator. They can tell you whether you are in an earthquake hazard area. The inspector will also evaluate the earthquake safety of the building by looking at its location and structural characteristics, and make recommendations for any necessary improvements to protect yourself and your house and property from earthquakes.

Earthquake protection can involve a variety of changes to your house and property -- changes that can vary in complexity and cost. You may be able to make some types of changes yourself. But complicated or large-scale changes and those that affect the structure of your house or its electrical wiring and plumbing should be carried out only by a professional contractor licensed to work in your state, county, or city.

Preparing Every Room

The Kitchen.

During an earthquake, shattering glass, spattering chemicals, and falling objects (light fixtures, hanging utensils, and objects sliding off counters, shelves and cupboards) can injure you or members of your family. The following measures will help you prepare your kitchen for an earthquake.



1. Install latches on cabinet doors and drawers so that they will remain closed during an earthquake.

One way to prevent the accidental opening of drawers and cabinet doors is to install latches such as barrel bolts, safety hasps, and childproof locks. Most hardware and home supply stores stock a variety of latches. Catches designed for use in campers are ideal, because they will not open if the cupboard is tilted or shaken. Heavy objects inside your cupboards can lean or fall against the inside of your cabinet doors, and the latches must be strong enough to withstand this pushing. The "passive" latches, which automatically lock when the door is closed, would be best for

families with people who might forget to latch the door. The "child-proof" guards for cupboard doors can also serve as earthquake guards, and these are not visible from the outside. The relatively simple and inexpensive precaution of installing earthquake catches can save you hundreds of dollars, while preventing serious injuries.

Tips
Keep these points in mind when you install latches on drawers and cabinet doors:

- Do not rely on magnetic or pinch-grip catches to hold cabinet doors closed, especially on overhead cabinets and any cabinets that contain heavy, breakable, or dangerous items.

- Install latches according to the manufacturer's directions. For example, use all of the hardware provided with the latch and do not substitute undersized screws or bolts for those provided.

2. **Store heaviest items on lower shelves of lower cabinets**. Heavy things may break through a cupboard door, but they probably won't hurt anyone if they are at floor level. Don't store heavy and light objects together. Heavy things can tip or slide over and crush lighter objects.

3. **Put guard rails or "fences" on open shelves so that items can't slide off.** If you want to display fragile things on open shelves, silicon adhesive, or pressure-sensitive, industrial strength Velcro® tape, called "Quake Tape®," or the related Quake Grip® products can be used. Florists' clay is no longer recommended because it deteriorates with age.

   For special situations, you may devise your own earthquake safety system. For example, if you want to display your collection of mugs, you might use narrow shelves with a lip and a guardrail made of piano wire or strong fishing line, and separate the mugs by a wooden backboard with indentations for each mug. Or you might install pegs over which each mug could be placed upside down, or "tracks" on the shelf for the base of each mug to slide between. Racks can be purchased or made and after the rack is secured to the shelf, display objects can be placed in the rack.

4. **Pack breakables for storage**. Delicate crystal, stemware, and china are safest when packed as for moving or shipping: wrapped and packed in a sturdy box and stored on the lower shelf of a cupboard with a secure door. For more accessibility, use racks inside cupboards, anchored to the shelf. Some department stores sell soft quilted caddies with individual compartments for plates, cups and saucers, or stemware. These will offer

good protection so long as you prevent the whole package from sliding onto the floor.

5. **Secure wall and ceiling fixtures**. Attach light fixtures, clocks, and hanging plants and kitchen utensils to wall studs. These vertical supports, usually 2 x 4s, are spaced 16" apart, inside the walls. Locate one by tapping the wall and listening for a solid rather than a hollow sound. Then measure along the wall to locate the others. Hanging fixtures should be secured to the ceiling joists (the studs in the ceiling) or even better, to a 2 x 4 or other board fastened to the ceiling joists. Fixtures screwed to the plaster, wallboard, or paneling, are more likely to fall, and could take some of the wall or ceiling with them.

6. **When possible, do not store heavy, breakable, or dangerous items (such as insecticides, solvents, and bleach) in overhead cabinets.** (See *Storing Toxic Substances* below.) Storage at floor level in secured cabinets is best. There are plastic caddies for cleaning supplies, which can be used for storing products so that they won't tip over. Dishwasher detergent, drain cleaners, oven cleaners, lighter fluid, and ammonia are some of the most dangerous chemicals. Periodically discard dangerous products you don't often use.

7. **Store extra keys on cup hooks so that you can find them in a hurry.**

8. **Install stoves and other gas appliances with flexible gas lines.**

9. **Block heavy appliances on wheels with doorstops, or remove or lock their wheels to prevent them from rolling.** Cabinetry around a built-in refrigerator will prevent it from moving any direction except forward.

Storing Toxic Substances
▪ **Keep only those chemicals you need on hand. Dispose of old or unwanted chemicals by taking them to an appropriate recycling center.**
▪ **Store ammonia and bleach in different locations. If these liquids mix, they create toxic fumes.**
▪ **Place pesticides, gasoline, paint thinners, etc., on the floor, on a low shelf, or in a locked cabinet that is securely fastened to the wall.**
▪ **If placed on a shelf, install a guardrail to prevent the bottles or containers from slipping off the shelf and breaking or spilling onto the floor.**
▪ **Close lids tightly on all containers.**
▪ **Store gasoline in vapor-proof containers.**

Estimated Cost. The cost of adding latches will depend on the type you decide to buy and the number of drawers and cabinet doors you want to secure. Most latches will cost between $2 and $5. So, for example, if you do the work yourself, the cost of adding latches to all the cabinets and drawers in a medium-sized kitchen could range from about $60 to about $100. If you hire a contractor or handyman to install latches, you will have to pay for time as well as materials.

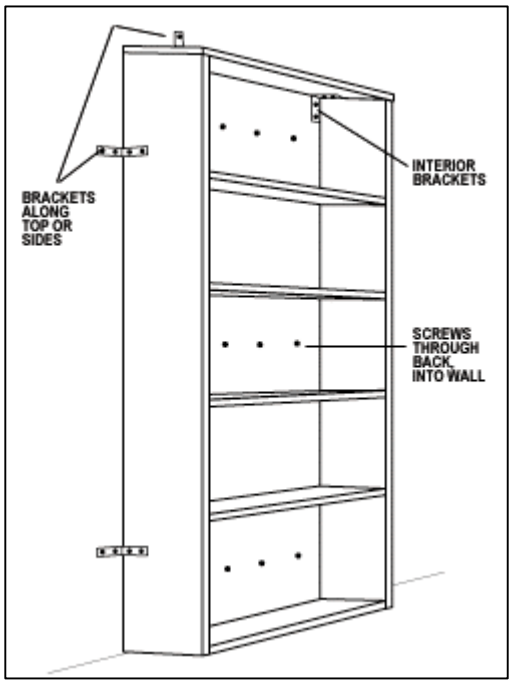
The Bedroom.

In preparing a bedroom for an earthquake, there are three main goals: to prevent objects from falling on the bed, causing injuries; to keep the escape route clear; and to keep needed equipment accessible, (i.e., flashlight, your glasses, your shoes to protect your feet from broken glass, your bathrobe, and, if needed, a few days supply of essential medication.)

1. **Anchor large pieces of furniture, such as armoires, freestanding closets, dressers, display cases, bookcases and file cabinets, so that they will remain upright during an earthquake. This is something that you can probably do on your own.**

   During an earthquake, large pieces of furniture such as tall bookcases and file cabinets can fall on you or members of your family. Toppled furniture can also block exits and prevent you from escaping. Anchoring furniture so that it remains upright not only helps prevent injuries but also helps protect both the furniture and its contents.

   You can anchor large pieces of furniture in several ways. Either bolt directly through the back of the furniture into the wall studs or use steel angle brackets. Fallen furnishings could block your escape route, besides causing injury and damage.



Tips
Keep these points in mind when you anchor large pieces of furniture:

- Make sure that all anchoring screws penetrate not just the wall but the studs behind it as well. Screws embedded only in drywall or plaster will pull out. Regardless of the anchoring method you use, the screws should be long enough to extend at least 2 inches into the wall and studs.

- Before anchoring a bookcase with screws through its back, make sure the back is sturdy enough and that it is securely attached to the sides, top, and bottom. Some bookcases have backs made of very thin materials that are held in place with only small screws or staples that can easily pull out. Those bookcases should be anchored with brackets.

- If you have two or more bookcases or file cabinets that sit next to each other, consider connecting them to one another as well as to the wall. They will be even more stable if you do.

- If possible, move all bookcases, file cabinets, and other large pieces of furniture away from exits so that if they do fall, they won't prevent you from escaping.

- To prevent the contents of your bookcases from falling out, you can install a thin metal or plastic rod, a wood dowel, or even an elastic band across the front of each shelf.

Check the upper shelves of your closets for heavy items, which might slide off. Store your heavy items on the floor or low shelves. Lighter items such as pillows and blankets can be safely stored up high. Cupboards should be closed with earthquake latches.

Estimated Cost. The cost of anchoring a bookcase or file cabinet will depend on its width. In general, if you do the work yourself, you can expect the cost to be approximately $5 per foot. So, for example, anchoring a 3-foot-wide bookcase will cost you about $15. This amount covers only the hardware you will have to buy and excludes the cost of any tools you use and the value of your time. If you hire a contractor or handyman to do the work, you will have to pay for time as well as materials.

The Bathroom.

The primary danger in the bathroom during an earthquake is broken glass. Mirrors, toiletries, and medicines can fall and break. More and more personal care products are packaged in plastic now, but liquid medicines, perfume, cologne, and after-shave lotion are sometimes supplied in glass containers. Because you can be cut by broken glass, it is a good idea to follow these guidelines in the bathroom:

- Select products in unbreakable containers, when possible. Use only unbreakable containers in the shower and bathtub.

- Secure the door on your medicine cabinet with a childproof latch.

- Keep only towels and other lightweight and shatterproof items on open shelves, unless they are well secured.

- Store cleaning supplies on the bottom shelf of a low cabinet, closed with an earthquake-proof latch.

- Old shower doors and tub enclosures may be made of regular glass, which could break into sharp, dangerous pieces. Replace these old doors with the newer shower doors and tub enclosures made of *tempered* glass, which shatters into lots of small harmless pieces, or sticky, unbreakable plastic.

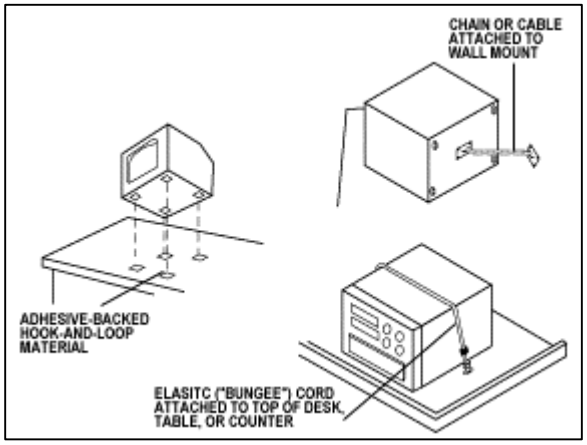
The Living Room, Den, and Dining Room.

1. Restrain personal computers and other small desktop appliances. This is something that you can probably do on your own.

The tremors caused by even minor earthquakes can easily move personal computer systems, stereo systems, television sets, VCRs and other small appliances that typically sit on desks, tables, and countertops. If they fall, they can be damaged beyond repair.

You can protect desktop computers and other small appliances by restraining them in a variety of ways. Some methods, such as using hook-and-loop material (Velcro for example), require no tools. Others, which include using chain, cables, or elastic cord ("bungee" cords for example), will usually require simple hand tools.

Lamps often tip over during an earthquake, because of their high center of gravity. Once they begin to tip or wobble with the action of the earthquake, they often fall over. Select lamps with broad bases and low centers of gravity, and place them on sturdy tables. Vases, art objects, and other small items should not be placed near the edges of tables and can be secured as described.



Tips

Keep these points in mind when you restrain desktop computers and appliances:

- Make sure that the desk or table the appliance sits on is not so light that it can be easily over-turned. If it is, and you can't move the appliance to another location, consider anchoring the desk or table to the floor or wall.

- You can anchor the ends of chains, cables, or elastic cords to either the wall or the surface of the desk, table, or counter using eye-hooks, rings, screws and washers, or other types of mounts.

- If you want to use a wall-anchored chain, cable, or cord, attach it to a closed eye-hook screwed into the wall or to a wall mount (such as a ring or plate) attached with screws. Make sure the eye-hook or screws are long enough to penetrate not just the wall but the studs behind it as well.

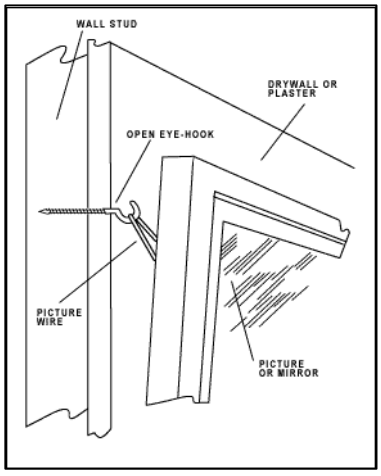
Estimated Cost. Restraining a single desktop computer or appliance with one of the methods described will cost you about $2 to $10, depending on the amount of hardware required. Using hook-and-loop material will be the cheapest method. Using chain or cable will be the most expensive method but may be necessary for heavy items.

2. **Bolt bookcases, entertainment centers, china cabinets, grandfather clocks, and other tall furniture to the studs of the wall behind them by bolting directly through the back of the furniture or by using 3-inch steel angle brackets with two bolts into the furniture, and two bolts into the studs.**

   Plumber's tape (perforated steel) can also be used for certain situations. Remember to use oversized steel hardware so that the connection will be strong. Freestanding bookshelves should be bolted to the floor and to ceiling joists or overhead steel bracing. Adjustable shelves, the boards which rest on wall brackets, can be stabilized with clips or wire to connect the board to the bracket.

   Bookcases that are anchored or braced at the top are less likely to sway enough to empty onto the floor, but a wire or wooden fence should be added to each shelf of books for protection.

3. Stabilize framed pictures and mirrors so that they will remain in place during an earthquake. This is something that many homeowners can probably do themselves.



During an earthquake, framed pictures and mirrors that are not securely attached to walls can easily fall. Large pictures and mirrors can cause injuries when they fall, and the broken glass that often results increases the potential for injury.

One way to mount framed pictures and mirrors securely is to use long-shanked, open eye-hooks instead of traditional picture hangers. The eye-hooks must be long enough to penetrate the wall stud as well as the drywall or plaster. Eye-hooks used in this way are much less likely to pull out of the wall than picture hooks installed with nails that penetrate only the drywall or plaster. Also, an alternative to running wire across the back of the picture or mirror is to use closed eye-hooks securely screwed into the back of the frame.

Tips

Keep these points in mind when you hang framed pictures or mirrors:

- The number of eye-hooks you need for a picture or mirror will depend on its size and weight. Large pictures and mirrors will be more stable when mounted on two hooks rather than one.

- Make sure that eye-hooks penetrate not just the wall but the studs behind it as well. Eye-hooks embedded only in drywall or plaster are likely to pull out. To be embedded deeply enough, eye-hooks should be at least 12 inches long.

- Regardless of whether you use picture wire or closed eye-hooks on the back of the picture or mirror, make sure the hooks, screws, or other types of mounting hardware are securely attached to the frame. Also, make sure the hardware is strong enough to support the weight of the frame, and that the object is secured to the studs of the wall.

- If possible, don't hang large pictures or mirrors in places where they are more likely to fall on someone, such as over beds, chairs, or couches.

Estimated Cost. The cost of mounting a picture or mirror with eye-hooks will depend on its size and weight. In general, for a large picture or mirror that requires two eye-hooks, you can expect the cost to be approximately $3 to $5.

This amount covers only the hardware you will have to buy, not any tools you use or the value of your time. If you hire a contractor or handyman to do the work, you will have to pay for time as well as materials.

4. **Securely attach chandeliers and other hanging objects to the ceiling joists or to a strong board attached to the top of the joists**.

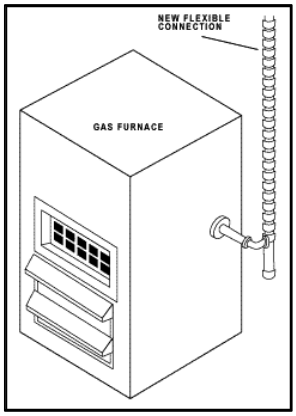
The Laundry Room, Utility Room, Garage, and Workshop.

1. Secure your water heater.

With its high center of gravity, the home appliance most vulnerable to earthquake damage is the standard water heater. Although modern water heaters have been designed to be a bit more steady than the early models, these large water-filled cylinders are still likely to "walk" or even tip during an earthquake. If this happens, the utility lines may be disconnected, causing gas or water leakage, or electrical shorts, fires, or explosions. And if it does tip over, you could lose one of your best sources of water for the period following the earthquake. Here's how to prevent the water heater from moving or tipping over:

- Wrap steel plumber's tape around the entire heater at least twice. Then secure the tape to two different wall studs with big 2-inch or longer lag screws. For added security, place blocking between the heater and the wall to prevent movement. Install a plywood "shelf" behind the heater, cut to fit the water heater's circular shape, or a 2 x 4 or similar board behind the heater to prevent it from tipping.

2. Install flexible gas and water connectors. This is something that only a licensed contractor should do**.**



The figure shows a flexible connection pipe installed on 2 gas furnaces.

Because most gas and water lines are rigid, they can be torn from their connection points during an earthquake. The results could include not only serious damage to your house but also injury to you and members of your family. A broken gas line is especially serious because of the potential for a fire or even an explosion.

One way to prevent broken gas and water lines is to have flexible connection pipes installed between appliances and their supply lines. *The figure shows a flexible connection installed on a gas furnace*. The same method can be used for other appliances, such as a hot water heater, clothes dryer, or stove. A licensed contractor can usually do this for you easily.

3. **Have a plumber drain the heater every year, or learn how to do it yourself.** The water in the tank can then be used to drink in an emergency.

Tips

Keep these points in mind when you have flexible connections installed:

- Changes to the gas lines and plumbing in your house must be done by a licensed contractor, who will ensure that the work is done correctly and according to all applicable codes. This is important for your safety.

- A flexible connection will help protect against a small amount of movement but is not designed to function when the appliance it is connected to moves extensively or falls. So you should also consider anchoring the appliance to the floor or wall.

Estimated Cost. Having a flexible connection installed on a furnace or other large appliance will cost you about $75.

4. **Carefully store flammable, poisonous, and explosive substances.** This may prevent injury, fire, and other damage. Store the following in unbreakable, clearly identified containers in low cupboards with earthquake-proof latches**:** paint, gasoline, paint thinner, bleach, ammonia, pesticides, herbicides and other dangerous products. Volatile substances—gasoline, paint, or lacquer thinner, etc.—should not be stored in a room with a pilot light. They should be stored in a well-ventilated room equipped with a fire extinguisher. In workshops and work areas, install fences or doors on open shelves. If you keep lumber or firewood, stack it in a sturdy crib no higher than waist level.

The Windows.

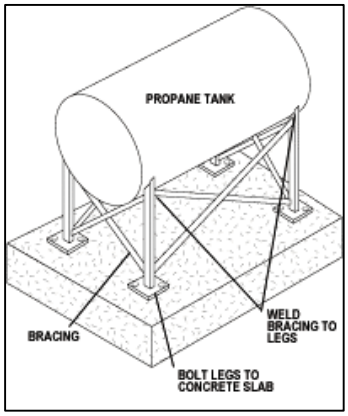
Large windows, particularly next to exits and beds or other places where people spend a lot of time, can be dangerous if they break during an earthquake. There are two options:

- tempered glass, which breaks into tiny rounded pieces, or
- shatter-resistant film, a plastic film applied to glass.

The film is less expensive than replacing the glass, but it must be installed by an expert. The shatter-resistant film is similar to the film that may tint windows or make them reflective, but the plastic and the adhesive is stronger so that if the window breaks, the plastic holds the pieces together.

Earthquake Protection for Other Items in the Home.

1. Anchor and brace propane tanks and gas cylinders. These are things that skilled homeowners can probably do on their own.



During earthquakes, propane tanks can break free of their supporting legs. When a tank falls, there is always a danger of a fire or an explosion. Even when a tank remains on its legs, its supply line can be ruptured. Escaping gas can then cause a fire. Similar problems can occur with smaller, compressed gas cylinders, which are often stored inside a house or garage.

One way to prevent damage to propane tanks and compressed gas cylinders is to anchor and brace them securely. The figure shows how the legs of a propane tank can be braced and anchored. Using a flexible connection on the supply line will help reduce the likelihood of a leak. Compressed gas cylinders, because they have to be periodically replaced, cannot be permanently anchored. But you can use chains to attach them to a wall so that they will remain upright.

Tips

Keep these points in mind when you anchor and brace propane tanks or compressed gas cylinders:

- Before you alter your propane tank in any way, make sure that the tank is your property and not rented from the propane supplier. Before welding new bracing to the tank legs, you must remove the gas from the tank. You should also check with your propane supplier to find out whether additional precautions are necessary.

- Clear the area around the propane tank to ensure that there are no tall or heavy objects that could fall on the tank or rupture the supply line.

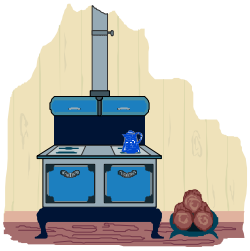
- Keep a wrench near the shutoff valve and make sure the members of your family know how to turn off the supply line if they smell a gas leak. On larger tanks, such as farm tanks, consider installing a seismic shutoff valve that will automatically turn off the gas during an earthquake.

- Provide a flexible connection between the propane tank and the supply line and where the supply line enters the house. But keep in mind that adding a flexible connection to a propane tank line should be done by a licensed contractor, who will ensure that the work is done correctly and according to all applicable codes. This is important for your safety.

- To attach a compressed gas cylinder to a wall, use two lengths of chain around the cylinder -- one just below the top of the cylinder and one just above the bottom. The chains should be attached to eye hooks that are screwed into the wall. In wood-frame walls, the eye hooks must be long enough to penetrate not just the wall but the studs behind it as well. In concrete or masonry block walls, the eye hooks should be installed with expansion anchors or molly bolts.

Estimated Cost. Bracing and anchoring a propane tank will cost about $250. Having flexible connections installed on the tank and at the house will cost about $75. Attaching one gas cylinder to the wall will cost about $50.

For more information on how to use these tips or for configurations other than the ones discussed above, consult your stove or propane vendor, local office of emergency services and/or local fire department.



2. Secure wood burning stoves to wall or floor studs. Make sure you have a fire extinguisher close at hand.

Freestanding wood burning stoves pose an additional risk in an earthquake. Heavy objects such as stoves are actually more likely to move during strong ground shaking than lighter objects. Fire codes leave the stoves unsupported on all four sides and vulnerable to sliding or overturning in an earthquake. If the stove were to tip and/or separate from the stovepipe, cinders or sparks might easily cause a fire in the home.

In order to reduce the potential fire hazard following an earthquake, the stove should be anchored to the floor and stovepipe sections secured. It is important that the seismic anchors or braces do not conduct heat from the stove. Although there are many types of stoves in use, the following recommendations can be used for common installations:

- Stoves resting on brick hearth can be anchored using bricks and mortar.
- Mobile home approved units come with pre-drilled holes in the pedestals or legs and can be safely anchored to the underlying floor framing.
- Those resting on concrete slab-on-grade can be anchored directly to the concrete.
- Stovepipe should be anchored to the flue exit and each of the stovepipe segments should be secured together.

Structural Preparation

Determining the Safety of Your Home

Next to loss of life, the loss of your home will be the greatest catastrophe to occur in an earthquake. Engineers learn more about how to build and reinforce existing buildings after every earthquake. Even though your home was built to seismic specifications several years ago, there may be things you can do now to strengthen it. If you had retrofitting done several years ago, you should check current standards and update the work.

Most people are safe at home if they live in a well-braced wood-frame building of one or two stories. These buildings are unlikely to collapse completely during earthquakes. Common damage in these structures is light cracking of interior walls or cracking of brick.

Older wooden structures can fail at or near ground level if not adequately bolted to the foundation, or if the pier-and-post foundation or short cripple walls (often found between the foundation and the first floor) are not adequately braced. Your local community planning or building inspection office has information on adding foundation bolts and bracing cripple walls. *(See section #1 below.)* Correcting these problems will drastically reduce earthquake risk in older homes.

Mobile Homes. Special considerations are needed for mobile homes and modular buildings not attached to permanent foundations. These structures can slide off their foundation if not properly secured to resist horizontal motion.

Special earthquake stabilizing devices for mobile homes are available. Check with earthquake retrofit specialists in your area. These devices have proved to be effective in preventing or minimizing damage in several recent earthquakes.

Structural engineers advise that four precautions will improve the earthquake readiness of a mobile home:

1. Keep the axle, wheels, and inflated tires on the unit.
2. Reduce interior hazards in the same way as for conventional housing.
3. Install an earthquake safety device to keep the unit from falling off its supports.
4. Install an automatic gas shutoff valve.

****

It is difficult to make suggestions which will be applicable to every situation. The best thing to do is to read this material, acquaint yourself with your building, and consult with a licensed engineer or contractor who specializes in earthquake retrofitting. Retrofitting costs vary a great deal depending on what needs to be done. However, the expense of retrofitting is nothing compared to repairing or replacing your house. One estimate is that the cost of picking up a house and setting it back on its foundation will be 23 times greater than the cost of preventative retrofitting!

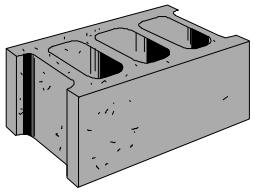
The most important things you can do to mitigate the effects of an earthquake are:

1) to maintain your home and ensure its structural integrity by having regular inspections for pests and decay, and

2) to improve the building's resistance to earthquake damage by keeping the retrofitting up with seismic standards.

Following are earthquake protection steps to be applied to the foundation of your home and to the chimney.

Foundation

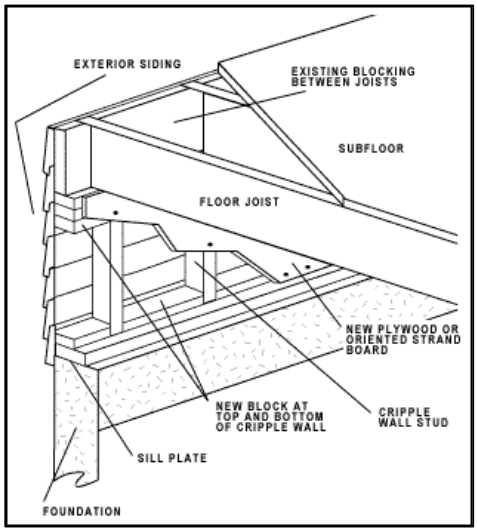


- Be sure that you have good strong foundation.
- Check to see that the mudsill is not rotted.
- The house should be securely fastened to the foundation with expansion bolts. If your home was built before 1950, it probably does not have bolts securing the wood structure to the concrete foundation. There should be a bolt at each end of a section of mudsill and one every 4 feet in between.

1. Brace Cripple Walls.

For a house built on a cripple wall foundation, brace the cripple wall to increase structural stability and reduce earthquake damage. This is something that skilled homeowners can probably do on their own, provided they obtain any necessary permits.

A cripple wall is a short wall that rests on the foundation and supports the floor and exterior walls. Even if a foundation is bolted, it is possible for the house to collapse in this area if the connection is not made between the mudsill, studs and the plate. A shear wall braces the connection between the mudsill, studs and plate.



If the cripple wall is not braced, it can shift during an earthquake. When this occurs, there is a greater likelihood that your house will be severely damaged and that you and members of your family will be injured.

If your house is built on cripple walls, **bracing the cripple walls** is one way to increase its stability and reduce earthquake damage. In this method, horizontal blocking that consists of 2 x 4-inch boards is added between the vertical studs at the top and bottom of the cripple wall and, if necessary, at other locations between the studs. New vertical studs can also be added if necessary. *Plywood or oriented strand board is then nailed to the interior face of the cripple wall. Also, nails are added through the existing blocking between floor joists to ensure that the floor is securely attached to the cripple wall.

***Note:**

- Plywood panels (5/8 inch) are nailed with 10d common nails every 4 inches around the horizontal members and every 6 inches down the studs.

- The shear wall panels should be installed around the perimeter of the house. They are most needed at the corners – 8 feet from each corner in a one-story house, 16 feet in each direction in a two-story house.

Tips
Keep these points in mind when you brace cripple walls:

- Check with your local building officials to see whether you need a permit to do this work.

- Before adding any bracing, check to see whether the sill plate below the cripple wall is bolted or otherwise anchored to the top of the foundation.

If it is not, you should consider having bolts or anchors added. Any anchoring of the sill plate should be done before you add bracing. For more information, refer to section number 2 below on *Bolting Sill Plates to Foundation.*

Estimated Cost. Bracing a 2-foot-high cripple wall will cost you about $1.50 per linear foot of wall. For example, a house measuring 60 feet by 30 feet will have a perimeter of 180 feet. So the cost for that house would be about $270. This figure covers only the materials you will have to buy and excludes the cost of any tools you use, building permit fees, and the value of your time. This figure also excludes the cost of having a contractor anchor your sill plates. Also, bracing higher cripple walls may require more lumber and therefore may be more expensive.

2. Bolt the Sill Plates to Foundation.

Bolting the sill plates of your house to its foundation will increase structural stability. This is something that only a licensed contractor should do.

The sill plate of a house rests directly on top of the foundation. (This figure shows the sill plate for a house built on a cripple wall and crawl space foundation, a type of construction that is especially susceptible to earthquake damage.) If the sill plate is not securely anchored, an earthquake can cause it to shift on the foundation. When this occurs, there is a greater potential for severe damage as well as injury to you and members of your family.

To increase the stability of your house and reduce earthquake damage, have the sill plate bolted or otherwise anchored to the foundation. In the method shown in the figure, bolts long enough to pass through the sill plate and penetrate several inches into the foundation are installed every few feet along the base of the exterior walls. This method is not limited to cripple wall construction; it can also be used for a house built on a basement or slab-on-grade foundation or on another type of crawl space foundation.

Tips
Keep these points in mind when you have the sill plates bolted to the foundation:

- Modifications to the foundation of your house must be done by a licensed contractor, who will ensure that the work is done correctly and according to all applicable codes. This is important for your safety.

- Bolts are usually installed no more than 6 feet apart. The work involved is likely to be extensive and may require that portions of the walls or floor be cut away temporarily.

- Your contractor may be able to recommend an alternative anchoring method based on other approved fasteners or connectors that can be installed with fewer changes to your house and less work.

- If your house is built on cripple walls, you should consider bracing them after the sill plates are bolted. For more information, refer to the section number 1 above titled *Brace Cripple Walls*.

Estimated Cost. Having a contractor bolt the sill plates to the foundation will cost you about $50 to $75 per bolt, depending on the type of foundation you have. For example, a house measuring 60 feet by 30 feet, will have a perimeter of 180 feet and would therefore require a minimum of 30 bolts (if the bolts are placed no more than 6 feet apart). So the cost for that house would be about $1,500 to $2,250.

Chimney

- Reinforce the ceiling surrounding the chimney with ¾-inch plywood nailed to ceiling joists.

- Do not brace the chimney to the roof. Rods connecting the chimney to the roof cause the chimney to fall through the ceiling as a unit which is far more damaging than if the chimney merely cracks and falls in pieces.

- Be sure to have the chimney checked, and repaired if needed, before using it after an earthquake.

You may need to do additional structural work to protect your house such as blocking between the joists, using additional hold-downs on corners of the building, etc. Please consult with a structural engineer for specifics on your home.

Who to Contact *Before* An Earthquake Strikes…

If you have earthquake damage, NOW is the time to strengthen your home correctly. If your home escaped damage, NOW is the time to evaluate your home and install strengthening measures -- before you forget, and before the next earthquake. Contact a licensed professional about making the necessary changes to your home or office. Contact your local building department to modify details to fit local building codes.

How do you locate professionals to advise you on the resistance of your building to earthquake shaking? Who should perform the needed construction?

Civil and Structural Engineers Architects	☞are trained to provide information about structures.
Geologists Foundation Engineers Geotechnical Engineers	☞are trained and licensed to evaluate soil conditions and recommend appropriate action.
A Contractor	☞ has to implement the detailed plans and specifications prepared by an architect or engineer.

A good place to start is to call a professional organization and ask about the types of work that might be required; how to select an engineer, geologist, or architect; and a list of members in your area. Contact several firms or individuals to determine whether they do the types of work you need. Make sure the firm has the necessary licenses and has experience in strengthening structures to resist earthquake shaking. Recognize the quality of the advice given and the work performed, as well as the price you pay, may depend on the care you take in making your selection.

Become informed. Even if you do not understand the technical details, ask enough questions to understand the concepts and relative importance of the issues involved. You have a right to understand what needs to be done and why.

State and federal agencies do not inspect individual buildings. Your local building department may be willing to inspect your building, but they are not authorized to recommend actions to be taken.

WHAT TO DO IN THE HOME *AFTER* AN EARTHQUAKE:

1. **Check for injuries.** Do not move a seriously injured person unless they are in immediate danger of further injuries.

2. **Check for hazards.**
   - *Fire or fire hazards.*
   - *Gas leaks.* Shut off the main gas valve only if a leak is suspected or identified by the odor of natural gas. Wait for the gas company to turn it back on once the damage is repaired.
   - *Damaged electrical wiring.* Shut off power at the control box.

- *Downed or damaged utility lines.* Stay away from downed lines, even if power appears to be off.
- *Fallen objects in closets and cupboards.* Displaced objects may fall when you open the door.
- *Downed or damaged chimneys.* Approach chimneys with caution. They may be weakened and could topple during an aftershock.
- *Your telephone.* Make sure each phone is on its receiver. Telephones off the hook tie up the telephone network unnecessarily.

3. **Clean up.** Potentially harmful materials and/or medicines may have spilled.

4. **Anticipate tsunamis.** Pronounced soo-náh-mee, they are strong ocean waves generated from earthquakes. If you live along the coast, be alert for news of tsunami warnings issued by the federal government's Tsunami Warning Center. *If an earthquake is centered nearby, there will not be time to issue a warning.* If you experience a strong earthquake that lasts a very long time, move to higher ground or go to the upper floors of a building as soon as you are able and stay there until the authorities issue an *all clear*.

5. **Expect aftershocks.** Most of these are smaller than the main earthquake. Some may be large enough to do additional damage to weakened structures.

What To Do *Right Now* To Prepare:

PROTECT YOURSELF

1. **Practice *drop, cover, and hold* drills at home with your family and at work.**
   Injuries and deaths during earthquakes are caused by falling objects and collapsing structures. Show children safe areas to drop and cover. Practice counting how many seconds your *test earthquake* lasts. This will help you keep calm when a real earthquake strikes.

2. **Develop an earthquake plan.**
   If an earthquake hits during the day, family members may be separated for hours or even days. Your local chapter of the American Red Cross can help you develop a plan at home, at work, and in your neighborhood. A family plan should include:

   - A safe place where your family can reunite after the earthquake. Transportation may be disrupted. Select alternate meeting places near work or schools.

- Designation of an out-of-the-area telephone contact. Completing local telephone calls may be difficult. It will probably be easier to telephone someone out of the earthquake area. Select a relative or friend to act as a clearing house for information about your family. All family members should call this contact to report their condition and location. Make sure family members carry this number with them at all times. Other friends and relatives should know this number too.

- Discuss the plan with all family members. Discuss with children what will happen to them if an earthquake occurs while they are at school.

3. **Know the following:**

    - What to do during and after an earthquake. *(Resources for this information are listed on page 4 of this manual.)*

    - The safest places in your home. They should be away from heavy furniture or appliances, wood stoves, fireplaces, and large panes of glass, pictures, or mirrors.

    - Where your gas, electric, and water main shutoffs are and how to turn each off. Now is the time to buy a special wrench that fits your gas turnoff valve and to fasten it next to the valve. Remember, turn off the utilities only if you suspect the lines are damaged, if you smell gas, or if you are instructed to do so. *If you turn the gas off, you must contact your utility company to turn it back on.*

    - How to fight fires, rescue people trapped under debris, provide first aid, find help for dire emergencies, and assist others, especially the fragile elderly or disabled. Ask your local American Red Cross office or County Mental Health Department for more information.

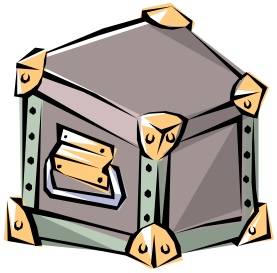
    - The policy of your local school concerning release of children after an earthquake. Arrange with neighbors to watch out for your family and property in case you are not home.

4. **Store emergency supplies.**

    - After a major earthquake, medical aid, transportation, water, electricity, and communication may be unavailable or severely restricted for days or weeks. Be prepared to take care of yourself,

your family, and your neighbors for at least three days -- longer if you live in a remote area.

- At home, at work, and in your car, store



a flashlight
batteries
an A-B-C-rated fire extinguisher
a battery-operated radio and extra batteries
a first-aid kit and manual
at least one gallon of water per person per day
emergency food
warm clothes
sturdy shoes
gloves
essential medicines

- Make sure emergency supplies are located in a safe and readily available place.

- Make sure everyone in your family knows where these supplies are and how to use them.

- Take a course in first aid from your local chapter of the American Red Cross.

- Include pets in your planning. Plan for their food and water supplies for at least three days.

- Make arrangements with a neighbor to care for your pet in the event you are unable to get home.

5. **Find Out More.**

- Look at the first aid and survival guide in the introductory pages of your telephone book.

- Go to your local library. Ask the librarian for reference materials listed in this manual.

- Ask your city or county Office of Emergency Services or your local American Red Cross for pamphlets on preparedness and survival. Invite a speaker to talk to your club or organization about earthquake preparedness.

Earthquake Insurance

As we have seen in this unit, earthquakes can do a great deal of damage to your home and personal possessions and, at its worst, financially devastate a family. Aside from being physically prepared for the earthquake, homeowners should also be financially prepared. One way to be financially prepared for an earthquake is to purchase earthquake insurance. Be aware that earthquake insurance, like flood insurance, is not covered under a standard homeowners policy. You may have to add a special rider to protect your home from damage caused by an earthquake.

The vast majority of people don't buy earthquake insurance. Some believe that if a disastrous earthquake strikes, the area would probably be declared a federal disaster area making them eligible for federal disaster benefits. However, in most cases, disaster relief comes in the form of low-interest loans.

To help you decide whether or not you need earthquake insurance, consider the following:

- What is the likelihood of an earthquake occurring in your area?
- Is your home close to an active fault?
- What is the nature of the ground or soil under your home? *(You're at higher risk if the soil is sandy or loose or if you live on a fill area.)*
- Is your home a single-story, two-story, or multi-level?
- Are the walls and foundations properly braced?
- Is your home of wood-frame construction, stone or brick? *(Bricks or rocks covering the outside of a building are usually not covered unless you pay a higher premium.)*
- How old is your home? Older homes are at higher risks for damages.

Should you decide to purchase earthquake insurance, remember that you should buy enough to cover the costs of totally rebuilding your home. The amount of insurance you buy should be based on replacement and reconstruction costs, not the fair market value of your property or possessions. The earthquake rider usually comes with a deductible, ranging from 10 to 20 percent of the amount covered. This means that a policy covering a house for $100,000 and contents for $25,000 with a 10 percent deductible, requires the policyholder to pay the first 10,000 of damage to the house and the first 2,500 of damage to contents. Your premiums will depend on where you live (premiums vary according to proximity to fault lines), the type of home you have (wood or brick), and of course the amount of the deductible. Talk to your insurance agent about your coverage.

Tips
Keep these points in mind when purchasing insurance:

- Keep your insurance up-to-date: Review your homeowners policy on an annual basis. Check to make sure you have coverage to rebuild your home if it is completely destroyed. Check with local contractors to get an idea of rebuilding costs.

- Inventory your home. Write down serial numbers and take photographs or videotapes. It may be difficult to remember everything in your home after disaster strikes.

- Store documents safely. Keep copies of both your policy and your home's inventory in a safe deposit box or with out-of-town family or friends. If this is not possible, storing documents in a fireproof box in your home may be the best alternative.

Earthquake Hazard Hunt

Below is a list of mitigation practices to accomplish in your home before an earthquake occurs. The task is listed, along with space to record the date you complete each task.

1. Check your water heater. Securely fasten to the wall studs with screws and plumber's tape.

   DATE TO DO _____

2. Identify top-heavy, freestanding furniture that could topple in an earthquake, such as bookcases and China cabinets.

   Secure to wall. **DATE TO DO _____**

3. Identify heavy or breakable objects on high shelves or in cabinets.

   Securely fasten or move. **DATE TO DO _____**

4. Identify electronic equipment (stereos, computers, etc.) and appliances (microwave, toasters, etc.) that might slide off their cabinets.

   Secure with industrial strength Velcro or provide a restraining edge on the cabinet or shelf.
   DATE TO DO _____

2. Identify hanging plants, especially those in heavy baskets, and hanging lights that are near windows.

   Secure, move or fasten down.
   DATE TO DO _____

3. Identify mirrors, heavily framed pictures, etc., that are placed over beds, couches, and chairs.

   Relocate or securely mount them.
   DATE TO DO _____

4. Identify appliances that could move enough to rupture gas or electrical connection.

   Securely fasten these objects.
   DATE TO DO _____

5. Check appliances and the water heater to make sure they are connected to the fuel source with flexible lines.

   Install flexible connectors on gas appliances and the water heater.
   DATE TO DO _____

6. Identify latches on kitchen and bathroom cabinets that will not hold the door closed during heavy shaking.

   Install more secure latches or hooks.
   DATE TO DO _____

7. Inspect the foundation of our house. If you house is not securely bolted, and shear walled, contact a resource person.

   DATE TO DO _____

8. Check your chimney and roof for loose tiles and bricks.

   If there is work to do, contact a resource person.
   DATE TO DO _____

9. Identify poisons, toxins, or solvents in breakable containers that are located in high or dangerous locations.

   Dispose of and/or rearrange.
   DATE TO DO _____

Unit Review

Circle the correct response. Answers may be found on page _____.

1. One way to increase the stability of your house and reduce earthquake damage is to:
   a) install latches on windows and doors.
   b) bolt or anchor the sill plate to the foundation of the house.
   c) not hang pictures on the wall over the bed or sofa.
   d) move the house from its present location.

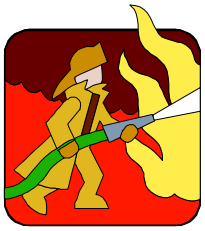
2. The best way to prevent damage to personal computers and other small appliances during an earthquake is to:
   a) make sure they sit on a heavy desk or table.
   b) make sure PC's and small appliances are turned off during an earthquake.
   c) restrain them with Velcro or bungee cords.
   d) store the appliances on the floor of the closet.

3. A house built on a cripple wall foundation means:
   a) The house is inexpensive, but sturdy.
   b) The house will likely not be damaged during an earthquake.
   c) You will pay thousands of dollars to prepare the house for an earthquake.
   d) The house is built on a short wall that rests on the foundation and supports the floor and exterior walls.

4. Which of the following is ***not*** a reason to install latches on cabinet doors and drawers before an earthquake?
   a) Stored materials (e.g., insecticides, solvents, and bleach) can spill out and damage floors and floor coverings.
   b) Objects can fall from overhead cabinets and injure you or members of your family.
   c) You want to keep clean-up to a minimum following the earthquake event and picking up items off the floor will be extra work.
   d) Latches can be easily installed and removed.

5. A broken gas line during an earthquake is serious because of the potential for a fire or explosion. How do you prevent broken gas and water lines during an earthquake?
   a) Install flexible connection pipes between appliances and their supply lines.
   b) Anchor the appliances to the floor or wall before the earthquake.
   c) Disconnect gas and water lines.
   d) Have a contractor inspect the gas and water lines before an earthquake.

6. As discussed in this unit, which of the following should ***not*** be braced in trying to prevent earthquake damage?
   a) Roof
   b) Ceiling
   c) Cripple Wall
   d) Chimney



Unit 5

Protecting Your Home from Fires

Objectives: At the end of this unit, participants will be able to:

1. *Name three types of alarm systems that protect your home and family from fires.*
2. *Describe four ways to create fire-safe landscaping in wildland-urban interface.*
3. *List two mitigation measures that reduce the homeowner's susceptibility to wildfires.*
4. *Describe five fire safety precautions in preventing electrical fires.*
5. *Describe four precautionary measures homeowners should take during the holiday season.*
6. *Explain why older Americans are at a greater risk of fire mishaps than the rest of the population.*

INTRODUCTION

Every day Americans experience the tragedy of fire. Each year more than 4,500 Americans die in fires and more than 30,000 are injured. The tragedy is that fires kill more Americans than all natural disasters combined. Fortunately, unlike other disasters, most fire losses can be prevented through effective public education and awareness initiatives.

In areas known as wildland-urban interface, the risk of fire destroying homes and property greatly increases. More people are making their homes in woodland settings – in or near forests, rural areas or remote mountain sites. There, homeowners enjoy the beauty of the environment but face the very real danger of wildfire. The wildland-urban (also known as rural-urban) interface is the area where homes and structures meet the natural environment of forests and wildlands.

Whether simple cabins, mobile homes, or large expensive developments -- many are constructed in the wakes of past fires and in the path of future fires. In areas where wildfires have occurred naturally for centuries, homes and gardens now add fuels that can accelerate the spread of fire. When wildfires occur today in these areas, limited resources often force fire fighters to choose between attacking the fire or defending the home.

There are time-tested ways to prevent a fire. It's not a question of luck. It's a matter of planning ahead.

If you aren't sure whether your house is at risk from wildfires, check with your local fire marshall, building official, city engineer, or planning and zoning administrator. They can tell you whether you are in a wildfire hazard area. Also, they usually can tell you how to protect yourself and your house and property from wildfires.

Fire protection can involve a variety of changes to your house and property -- changes that can vary in complexity and cost. You may be able to make some types of changes yourself. But complicated or large-scale changes and those that affect the structure of your house or its electrical wiring and plumbing should be carried out only by a professional contractor licensed to work in your state, county, or city.

If you live in the wildland-urban interface, you must increase your role to protect lives and property in your community beyond the city limits. Before we address the things you can do to increase your protection from wildfires, let's take a look at some important facts about rural living:

- Once a fire starts outdoors in a rural area, it is often hard to control. Wildland firefighters are trained to protect natural resources, not homes and buildings.

- Many homes are located far from fire stations. The result is longer emergency response times. Within a matter of minutes, an entire home may be destroyed by fire.

- Limited water supply in rural areas can make fire suppression difficult.

- Homes may be secluded and surrounded by woods, dense brush, and combustible vegetation that fuel fires.

PROTECTING YOUR HOME FROM WILDFIRES

This section includes mitigation steps that will protect your home and family during a wildfire or help to prevent a fire.

1. **Replace flammable roofing with fire-resistant materials**. Some roofing materials, including asphalt shingles and especially wood shakes, are less resistant to fire than others. When wildfires and brush fires spread to houses, it is often because burning branches, leaves, and other debris buoyed by the heated air and carried by the wind fall on roofs. If the roof of your house is covered with wood or asphalt shingles, you should consider replacing them with fire-resistant materials like stone, brick and metal to protect your home.

   As shown in the figure, you can replace your existing roofing materials with slate, terra cotta or other types of tile, or standing-seam metal roofing. Replacing roofing materials is difficult and dangerous work. Unless you are skilled in roofing and have all the necessary tools and equipment, you will probably want to hire a roofing contractor to do the work. Also a roofing contractor can advise you on the relative advantages and disadvantages of various fire-resistant roofing materials.

Tips

Keep these points in mind if you plan to have your existing roofing materials replaced:

- Tile, metal, and slate are more expensive roofing materials, but if you need to replace your roofing anyway, it may be worthwhile to pay a little more for the added protection these materials provide.

- Slate and tile can be much heavier than asphalt shingles or wood shingles. If you are considering switching to one of these heavier coverings, your roofing contractor should determine whether the framing of your roof is strong enough to support them.

- If you live in an area where snow loads are a problem, consider switching to a modern standing-seam metal roof, which will usually shed snow efficiently.

Estimated Cost. If you hire a contractor to replace your existing roof covering, you can expect to pay about $4 per square foot of roof area for tile or metal roofing and about $7 per square foot of roof area for slate. For example, a house measuring 60 feet by 30 feet will have about 1,800 square feet of roof area. So for this house, tile or metal roofing would cost about $7,200 and slate would cost about $12,600.

2. **Remove vegetation and combustible materials**. If the area immediately surrounding your house contains trees, shrubs, and other vegetation; yard debris; or other materials that burn easily, your house will be at an increased risk of damage during wildfires and forest fires. These combustible materials provide a path by which fire from nearby areas can reach your house. Reduce excess leaves, plant parts and low-hanging branches.

   You should clear the area around your house. Shrubs, brush, woodpiles, and combustible debris should be removed within a radius of 30 feet. The distance between your house and any nearby tree should always be greater than the height of the mature tree or at least 10 feet. Similarly, any outbuildings, such as storage sheds, should be at least as far away as their height.

Tips

Keep these points in mind when you remove vegetation and other combustible materials from around your house:

- Removing large trees near your house can be very dangerous, for both you and your house, and is therefore a job for a skilled contractor.

- Rather than plant shrubs near your house, consider landscaping alternatives such as creating a rock garden.

Estimated Cost. If you hire a contractor to remove a large tree, you can expect to pay about $300 to $500. The charge for removing smaller trees and shrubs will be less.

TIPS FOR FIREPROOFING YOUR PROPERTY

- Keep lawns trimmed, leaves raked, and the roof and rain-gutters free from debris such as dead limbs and leaves.

- Beyond 30 feet, remove dead wood, debris and low tree branches. Stack firewood at least 30 feet away from your home.

- Store flammable materials, liquids and solvents in metal containers outside the home at least 30 feet away from structures and wooden fences.

- Post home address signs that are clearly visible from the road.

- Provide emergency vehicle access with properly constructed driveways and roadways, at least 12 feet wide with adequate turnaround space.

- ❖ Make sure water sources, such as hydrants and ponds, are accessible to the fire department.

- ❖ Burning yard waste is a fire hazard. Check with your local fire department on a non-emergency number for fire permit requirements and restricted burning times.

FIRE-SAFE LANDSCAPING

Wildland fires destroy hundreds of homes and acres of land every year across the country. Fire-safe landscaping is an effective tool that creates an area of defensible space between your home and flammable vegetation that protects against devastating fires. This section gives specific details on fire-safe landscaping, including landscape design, pruning, maintenance and water management, in areas known as the wildland-urban interface.

LANDSCAPE DESIGN

Firewise designs incorporate the needs of relatively public and formal front yards and more private and personal backyards, the structure, and surrounding properties. Often firewise techniques such as subtle adjustments in plant selection and placement can improve fire safety and meet the needs of the homeowner and the requirements of the environment.

Listed below are nine fire-safe landscaping tips:

1. **Create a defensible space perimeter** by thinning trees and brush within 30 feet around your home.

   During the 1993 raging Malibu fires, a number of homes were saved as a result of the owners' careful pruning and landscaping techniques that protected their homes. In a fire situation, the dead trees and shrubs surrounding your home act as fuel for fire. Removing flammable vegetation reduces the threat of fire. Follow these basic rules to create defensible space that works:

   - Remove all dead plants, trees and shrubs from the site.
   - Reduce excess leaves, plant parts and low-hanging branches.
   - Replace dense flammable plants with fire-resistant plants.

The choice of plants, spacing, and maintenance are crucial elements in any defensible space landscaping plan.

2. Landscape your property with **fire-resistant plants and vegetation** to prevent fire from spreading quickly.

- Check your local nursery or county extension service for advice on fire resistant plants that are suited for your environment.
- There are no "fire-proof" plants. Select high moisture plants that grow close to the ground and have a low sap or resin content.
- Choose plant species that resist ignition such as rockrose, iceplant, and aloe.
- Fire-resistant shrubs include hedging roses, bush honeysuckles, currant, cotoneaster, sumac, and shrub apples.
- Plant hardwood, maple, poplar and cherry trees that are less flammable than pine, fir, and other conifers.

3. Eliminate small trees and plants growing under trees. They allow ground fires to jump into tree crowns.

4. Space trees 30 feet apart and prune to a height of 8 to 10 feet.

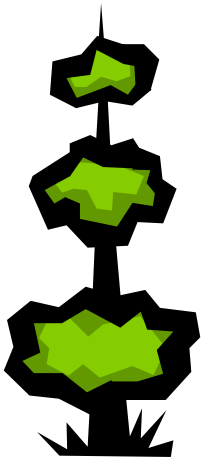
5. Place shrubs at least 20 feet from any structures and prune regularly.

6. Plant the most drought-tolerant vegetation within 3 feet of your home and adjacent to structures to prevent ignition.

7. Provide at least 10 to 15-foot separation between islands of shrubs and plant groups to effectively break-up continuity of vegetation.

8. Create fire-safe zones with stone walls, patios, swimming pools, decks, and roadways.

9. Use rock, mulch, flowerbeds and gardens as ground cover for bare spaces and as effective firebreaks.



PRUNING

Maintain a well-pruned and watered landscape to serve as a green belt and protection against fire. As trees grow, careful pruning preserves their appearance, structural integrity, and functional values. But pruning also maintains its ability to resist fire. Pruning tree branches at least 6-10 feet from the ground helps to interrupt the fire's path.

Pruning cuts should be clean and smooth, avoiding flush cuts and stubs. A well-pruned tree heals quickly while poor pruning results in scarring and possible disease. No more than one-third of a tree's live foliage should be removed at one time to avoid stress.

Young, vigorous trees can withstand more severe pruning than older, weaker trees. Remove dead and diseased branches from trees. This reduces the potential for fire spreading into the crown. Shrubs should be well spaced to break up the fire ladder and keep the vegetation density low. Except for formal clipped or sheared shrubs, shrubs should be maintained by thinning, maintaining size, and removing excess leaf litter.

Vines and ground covers can build up heavy underbrush of dead leaves and branches, which should be removed to lessen fuel for fire. Remove or mow dry grasses, weeds and underbrush.

Mulch over bare soil can provide many benefits while adding little fire risk. Even in healthy landscapes, the buildup of leaf litter and other debris can give fires a chance to start under porches and decks and on roofs.

MAINTENANCE AND FIRE SAFETY

Landscapes that are easy to maintain are more desirable than highly complex arrangements that may be neglected. Over time, plants grow and spread; mulches dry out; leaves and pine needles accumulate. All contribute to the fuels which can accelerate a wildfire. Proper maintenance improves the appearance of plants and helps protect your home from wildfire.

Fire needs fuel -- something to burn, like grass, trees, or the homes nestled among them. To an interface fire, homes and other structures become merely fuel. Fires start easily and burn rapidly in light fuels like dry grasses. These, in turn, provide a path to larger fuels like trees. Once at the base of a tree, fire can move into low branches and climb to the top, or crown. This arrangement, known as ladder fuels, provides a path along which to grow and spread.

Interrupting a potential fire's path is a primary concern in maintaining the property and the landscape. A firewise landscape is a healthy landscape - one whose plants are durable, fire resistant, compatible with the fire terrain and climate and well-maintained.

WATER MANAGEMENT

When plants dry out, they become more flammable. Proper watering is, therefore, essential. The results of over-watering and under-watering can be the same -- damaged plants and increased flammable litter.

Irrigation systems -- whether drip or spray-- play an important role in maintaining the health of plants, shrubs and trees. If an irrigation system is not working effectively, vegetation may become stressed and dry, providing wildfire a way to spread to other vegetation. Familiarity with the system, along with routine inspection and maintenance is necessary to keep the landscape in top condition.

SOURCES OF HOME FIRE PROTECTION

There are three types of alarm systems which can be used in the home. You can decide which ones provide the level of assurance you need in protecting your family and home from fire. The following are described below in detail:

- **Smoke detectors**
- **Residential sprinklers**
- **Fire alarms**

SMOKE DETECTORS

Why should my home have smoke detectors*?*

In the event of a fire, a smoke detector can save your life and those of your loved ones. A working smoke detector can double your chances of survival. They are the single most important means of preventing house and apartment fire fatalities by providing an early warning signal -- so you and your family can escape. Smoke detectors are one of the best safety features you can buy and install to protect.

The smoke detectors currently in place have saved thousands of lives, but several problems exist. First, 12% of homes without detectors have more than half of the fires; second, it is estimated that a third of the detectors in place are not working, often due to failure to replace a worn out battery; and third, many homes do not have as many smoke detectors as are needed to protect the occupants properly.

Where would I get smoke detectors?

Many hardware, home supply or general merchandise stores carry smoke detectors. If you are unsure where to buy one in your community, call your local fire department (on a non-emergency telephone number) and they will provide you with some suggestions. Some fire departments offer smoke detectors for little or no cost.

What kind of smoke detector should I get?

There are two types of home smoke detectors:

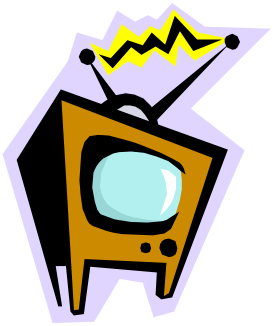
① the ion type
② the photoelectric type

The ion type reacts faster to open flaming fires and is usually the least expensive. The photoelectric type reacts to smoldering fires and is less likely to react to cooking. Both types provide good protection and can be used without worry. If you need more than one detector, you might get one of each.

Okay, how many do I need and where do I put them?

The primary job of your smoke detector is to protect you from fires while you are asleep. Thus, your smoke detector should be located between any sleeping persons and the rest of the house -- outside bedrooms or sleeping areas. But tests conducted in the 1970's clearly showed that this may not be enough.

In multi-story homes, fires on a floor level without a smoke detector can grow to dangerous conditions before sufficient smoke can rise in a stairway to set off a detector on the upper floor. Based on this observation, most codes require that additional smoke detectors be located on each floor level of the home, including the basement.



Many fatal fires begin late at night or in the early morning. A closed door provides protection from smoke on the other side, but will also prevent smoke from reaching a smoke detector. This is particularly a problem in bedrooms. If you sleep with your bedroom door closed, you should add a smoke detector in the bedroom; particularly if you smoke in the bedroom or there is a TV, air conditioner, or other major appliance in the bedroom that might start a fire. If you sleep with the bedroom door open, the detector in the hall outside will detect a fire in the bedroom or elsewhere. For extra safety, install smoke detectors both inside and outside sleeping areas.

There are a few places where a smoke detector should not be placed. These include kitchens and garages (cooking fumes and car exhaust are likely to set them off) and unheated attics and crawl spaces (where it can get too cold or hot for the electronics to work properly). Fires beginning in these areas are generally detected by the other smoke detectors in enough time to escape safely. If a detector is desired in these spaces, heat detectors are available which can be used. But remember that the smoke detectors are the primary safety devices in any home protection scheme.

Are smoke detectors hard to install?

Not a bit. In most cases, all you will need is a screwdriver. Many brands are self-adhesive and will automatically stick to the wall or ceiling where they are placed. However, be sure to follow the directions from the manufacturer because each brand is different. If you are uncomfortable standing on a ladder, ask a relative or friend for help. Some fire departments will actually install a smoke detector in your home for you. Call your local fire department (again, on a non-emergency number) if you have problems installing a smoke detector.

How should they be installed?

Since smoke and many deadly gases rise, installing your smoke detectors at the proper level will provide you with the earliest warning possible. Always follow the manufacturer's installation instructions.

Smoke detectors are normally installed on the ceiling or high on the wall, with the top of the detector not closer than 4 inches nor further than 12 inches from the ceiling. Detectors should be no closer than 3 feet from supply registers of forced air heating systems (that might blow on the detector preventing it from seeing smoke) and no closer than 3 feet from the door to a kitchen or a bathroom containing a shower (steam can set the detector off when the door is opened).

If a detector is mounted on an exterior wall or a ceiling below an unheated attic that is poorly insulated (the surface gets noticeably cold in the winter and warm in the summer); the temperature difference can prevent smoke from getting to the detector. Placing the detector on an inside wall avoids the problem. In desert climates where evaporative coolers are being used, mount smoke detectors on walls 12 inches below the ceiling because the coolers add moisture which can cause the smoke to drop.

Older adults may have difficulty reaching detectors on ceilings to change batteries. If house-powered detectors are impractical, wall mounting 12 inches down should be considered.

How do I keep my smoke detector working?

Smoke detectors are very easy to take care of. There are two steps to remember:

① **Simply replace the batteries at least once a year.** Most operate on a battery (usually 9-volt) which should be replaced at least once a year. When the battery needs changing, the smoke detector will begin to "chirp" every 20 seconds or so, which will persist for a month. This is most likely to start in the middle of the night when the temperature in the house drops) so that you have to get up and remove the battery so you can sleep. To prevent this nuisance you should pick a special day and give your detectors new batteries each year on that day. *Tip*: Pick a holiday or your birthday. Some fire safety organizations promote "change your clocks, change your batteries" when the change is made back from daylight savings time each fall. Always make sure that you use the right battery -- the required battery type is marked on the detector near where the battery goes.

Some smoke detectors now on the market come with a 10-year battery. These detectors are designed to be replaced as a whole unit, thus avoiding the need for battery replacement.

② **Keep them clean**. Dust and debris can interfere with their operation, so vacuum over and around your smoke detector regularly.

Smoke detectors installed in a new home will be operated from the household electrical power and do not need replacement. These types all have a "power on" light to tell you that the detector has power. Fires do not generally affect the power until they get very large, so it is rare that such detectors fail to work due to a loss of power. However, if there were a power failure due to the weather (i.e., thunderstorms, ice storms, etc.), then the smoke detector would not have power in case there is a fire. Smoke detectors are available which run on house power but also have a battery in case the main power fails. Since the battery is not normally in use, such backup batteries will last about 6 years before they need replacing (the detector will "chirp" like the battery-powered ones).

Will I be able to hear my detectors?

The ultimate test for smoke detectors is their ability to wake you when you're asleep. This generally means that the nearest detector to the bedroom can be no further away than in the next room with the intervening door open.

House-powered detectors can be connected together (with a wire) so that when one detector activates, all interconnected detectors go off. Many detectors in new homes have this feature. It means any detector in the home can awaken you in your bedroom if the nearest detector is loud enough to do so.

For homes with battery-powered detectors, there are models that contain a radio transmitter which will activate a receiver that can be placed in the bedroom. An advantage of this type is that, when you go on vacation, you can give the receiver to a neighbor who could call the fire department if a fire starts. Of course, these are a lot more expensive than the simple smoke detectors.

All battery-powered and most house-powered smoke detectors use a high pitched electronic horn which is difficult for some people to hear. Test detectors before installation to make sure that all members of the household can hear them clearly.

People with hearing impairments can get smoke detectors with bright, flashing lights or vibrating signals. To awaken you, the light needs to be over the head of the bed and should be rated at least 110 candela. Such bright lights must be powered from house power, so if it is battery operated, it is probably not bright enough to use in the bedroom.

What if the alarm goes off while I'm cooking?

Then it's doing its job. Smoke detectors are highly reliable but can sometimes be fooled by cooking or steam. Do not disable your smoke detector if it alarms due to cooking or other non-fire causes. You may not remember to put the batteries back in the detector after cooking. Instead, clear the air by waving a towel near the detector, leaving the batteries in place. The detector may need to be moved a few feet to a new position where it is not in the way of cooking vapors or steam.

Another non-fire cause could be that it has insects in it, so you should take it down and vacuum it out. If it continues to "act up," simply replace it with a new detector (they are too inexpensive to fool with).

How long will my smoke detector last?

About 8 to 10 years, after which they should be replaced, even if they seem to be working. Like most electrical devices, smoke detectors wear out. You may want to write the purchase date with a marker on the inside of your unit. That way, you'll know when to replace it. Always follow the manufacturer's instructions for replacement.

Even though prices of today's smoke detectors are many times lower than you might have paid some years ago, the detectors themselves are generally more reliable. Thus, it is usually not worth keeping an old detector rather than buying a replacement.

What about testing and maintenance?

Smoke detectors should be tested at least once a month. All smoke detectors have a test button which you push to check out the entire detector, including its sensitivity (how much smoke it takes to set it off). If the testing mechanism does not work properly, the detector should be replaced immediately. Never use open flame devices to test a detector.

Older adults and the physically impaired may have problems reaching their detectors to test them. There is one brand of smoke detector on which the test feature can be activated by shining a flashlight on it. Another brand has an automatic test which activates at the same time and day, once a week. These models can be used where proper testing might not otherwise be done.

Smoke detectors need no maintenance other than changing batteries (in those that have batteries) and an occasional vacuuming of dust or cobwebs. Every smoke detector comes with a homeowner booklet which describes how to use and take care of that particular detector. You should read that booklet and keep it in a safe place for future reference.

Anything else I should know?

Reminder: Some smoke detectors are considered to be "hard wired." This means they are connected to the household electrical system and may not have battery backup. It is important to test every smoke detector **monthly**. And always use new batteries when replacing old ones.

RESIDENTIAL SPRINKLERS

Why should I consider a home sprinkler system?

Fire sprinklers have been used to protect commercial buildings for more than 100 years. More recently, a new type of sprinkler system has been developed for residences which offers an unprecedented level of fire safety for both lives and property.

Sprinklers are affordable--they can increase property value and lower insurance rates. New technology will allow sprinklers to be connected directly to your standard home plumbing system. Individual sprinkler heads are only activated where fire strikes. Consider a home sprinkler system whenever renovating, buying or building a house. Contact your local fire department if you need more information.

How much do residential sprinklers cost?

The cost of a sprinkler system is about $1.50 per square foot in a new home (for a 1000-square foot home this is $1500). In an existing home they range from $2.50 to $5.00 per square foot, depending on how difficult it is to run the pipes. This assumes the availability of adequate and reliable water supply.

How do residential sprinklers differ from commercial sprinklers?

The sprinklers that you have come to expect in hotels, offices, and other commercial buildings are there primarily to protect property and to protect people who are not in the immediate vicinity of the fire's point of origin. Sprinklers work by limiting the size and impact of the fire to a small area. Sprinklers in commercial buildings use larger quantities of water because fires in these types of buildings can involve large fuel loads.

Sprinklers used in the home are a special type referred to as residential sprinklers. These sprinklers use a fast acting element to allow the sprinkler to activate when the fire is still in its very early stages of development. No matter what type of building sprinklers are in, inadvertent operation of the sprinkler system is extremely unlikely. Smaller fuel loads coupled with activation when the fire is smaller allow these sprinklers to require much less water, so much so that the typical home's domestic water system is usually sufficient for such systems.

Why are sprinklers so powerful?

The primary reason is that as soon as it activates, the sprinkler sprays water on the burning object and puts out or controls the fire. In fact, the sprinkler system not only stops the growth of the fire, it also acts directly on the potentially deadly effect of the fire, for example, by lowering the air temperature.

This means that a combination of sprinklers and smoke detectors can save most potential victims of home fires. The principal exceptions are victims of clothing fires, explosions, or flash fires. For some potential victims, there is no substitute for prevention.

What about water damage?

Unlike fires you often see on TV and in the movies, in a real fire, only one or two sprinklers near a fire activate and discharge water. Residential sprinklers discharge water at a low rate, so your home will not be flooded. (Flooding is not a danger with sprinklers in commercial buildings either.) After the fire is out, the supply valve can be simply shut off -- *but never do this yourself*. Always call the fire department and let the professionals determine when it is safe to shut off the water.

Do you need smoke detectors too?

YES! When home fire sprinklers are used with working smoke detectors, your chances of surviving a fire are greatly increased. Smoke detectors will tend to react first, providing extra time to escape. In some fires, sufficient smoke can be released to impair judgment or even threaten persons with pre-existing medical problems before enough heat is released to set off the sprinkler. Also, smoke detectors provide early warning of fires that may start out of range of the sprinklers, such as within a wall space. Therefore, it is important that smoke detectors be installed in all of the places discussed earlier in this section.

FIRE ALARM SYSTEMS

What is a fire alarm system?

A home fire alarm system is usually part of a total security system providing burglary protection in addition to fire protection. Such a system supervises doors and windows and spaces within the home for break-in and may also provide monitoring services by dialing your telephone to report a fire or intrusion to a security office, where it will be reported to your local police or fire department.

Due to their relatively high cost, these systems are generally found only in larger homes. The system can cost $1000 or more to install, with 24-hour monitoring service adding $15 to $20 per month.

Components of the system

These systems consist of a central control panel to which smoke and heat detectors are connected, along with bells or horns that are activated when the system triggers an alarm. Other sensors associated with the burglary functions connect to doors and windows or monitor rooms for motion or body heat. The control panel operates from house power but also usually contains an emergency battery which can operate the system for about 24 hours during a power outage.

The basic requirements for the number and location of detectors are exactly the same as with the self-contained detectors discussed previously. The difference is that a fire alarm system gives you more flexibility to locate additional detectors and additional bells or horns (or flashing lights, should a person in the household be hearing impaired).

Fire alarm systems that provide remote monitoring services can also be used to provide medical alert services. Here, a person with health problems who lives alone carries a radio transmitter that can trigger the system in case they need assistance. Signals received at the monitoring station are identified by type (fire, burglary, medical alert) so that the proper response can be made.

Why have a residential fire alarm system?

The primary advantage of a home fire alarm system is increased reliability and the ability to place detectors and bells exactly where needed. However, the reason most people have them is that they wanted a burglar alarm system and the cost of adding fire alarm features to a residential burglary system is relatively small.

Another advantage is that they are the only way to obtain remote monitoring services. This becomes important in cases where family members may not be capable of escaping from a fire without assistance. For example, if you have an older or physically impaired person in your home and a fire started when no one was home to assist that person, detectors alone might not be enough to assure their safety.

A feature of most monitoring services is the ability to keep special information on the residence which comes up on a computer screen whenever an alarm is received from that home. Thus, if there is a disabled person in the home who needs special assistance, this fact will be known to the operator and can be passed along to the fire department when they are called.

FIRES THAT START IN THE HOME

Many Americans believe that "fires only happen to other people – not to me and not in my home." Yet over 70 percent of fire deaths occur in residences, most often claiming the lives of the young, the elderly and the disadvantaged. Now, let's take a look at mitigation tips for residential fires.

1. **Alter security bars in your home**. Security bars may help keep your family safe from intruders, but they can also trap you in a deadly fire! By following the steps below you reduce the chances of security bars being a danger during a fire.

   - *Use quick release devices on barred windows and doors*. Windows and doors with security bars should have quick release devices to allow them to be opened immediately in an emergency. These devices operate from inside and allow the bars to be opened for emergency escape without compromising the security of your home. The quick release devices should be easy to open without the use of a key, detailed knowledge or great physical effort. Release devices vary by region and manufacturer. Contact your local fire department on a non-emergency number for approved release devices available in your area.

   - *Retrofit current security bars*. Security bars on windows and locked doors prevent escape from fire and also impede firefighters' rescue attempts. If the security bars in your home are permanently fixed or do not have quick release devices, they should be retrofitted with release devices.

   - *Be aware of security bar issues when practicing fire escape routes.* Know and practice fire escape plans monthly, and use them to identify and correct obstructions of windows and doors needed for escape from a deadly fire. Make sure that windows are not stuck, screens can be taken out quickly and that security bars can be properly opened.

     It is important that everyone in the family understands and practices how to properly operate locked or barred windows and doors. Windows should open easily and be wide enough to allow escape, and locked or barred doors should operate quickly and easily. The best escape plans have two ways to get out of each room. If the primary exit is blocked by fire or smoke, you will need a second way out. A secondary route might be a window onto an adjacent roof or an Underwriter's Laboratory (UL) approved collapsible ladder for escape from upper story windows.

3. **Cover all exterior vents, attics and eaves with metal mesh screens no larger than 6 millimeters**.

4. **Install multipane windows, tempered safety glass or fireproof shutters to protect large windows from radiant heat**.

5. **Use fire-resistant draperies for added window protection**.

PROTECTION FOR HEATING SOURCES

More than one-third of Americans uses fireplaces, wood stoves and other fuel-fired appliances as primary heat sources in their home. Unfortunately, many people are unaware of the fire risks when heating with wood and solid fuels.

Heating fire account for 36% of residential home fires in rural areas every year. Often these are due to creosote buildup in chimneys and stovepipes. All home heating systems require maintenance to function safely and efficiently.

Fireplaces and Wood Stoves

- Have your chimney or wood stove inspected and cleaned annually by a certified chimney specialist.
- Carefully follow the manufacturer's installation and maintenance instructions for a wood stove.
- Look for solid construction, such as plate steel or cast iron metal.
- Check for cracks and inspect legs, hinges, and door seals for smooth joints and seams.
- Clear the area around the hearth of debris, decorations and flammable materials.
- Always use a metal mesh screen with fireplaces. Leave glass doors open while burning a fire.
- Install stovepipe thermometers to help monitor flue temperatures.
- Keep air inlets on wood stoves open, and never restrict air supply to fireplaces. Otherwise you may cause creosote buildup that could lead to a chimney fire.
- Use fire-resistant materials on walls around wood stoves.
- Never use flammable liquids to start a fire.

- Use only seasoned hardwood. Soft, moist wood accelerates creosote buildup.
- Build small fires that burn completely and produce less smoke.
- Never burn cardboard boxes, trash or debris in your fireplace or wood stove.
- When building a fire, place logs at the rear of the fireplace on an adequate supporting grate.
- Never leave a fire in the fireplace unattended. Extinguish the fire before going to bed or leaving the house.
- Soak hot ashes in water and place them in a metal container outside your home.

Electric Space Heaters

- Buy only heaters with the UL safety listing.
- Check to make sure it has a thermostat control mechanism, and will switch off automatically if the heater falls over.
- Don't dry clothes or store objects on top of your heater; heaters are not dryers or tables.
- Space heaters need space; keep combustibles at least 3 feet away from each heater.
- Always unplug your electric space heater when not in use.

Kerosene Heaters

- Buy only UL approved heaters and check with your local fire department on the legality of kerosene heaters in your community.
- Never fill your heater with gasoline or camp stove fuel; both flair-up easily. Only use crystal clear, K-1 kerosene. Never overfill any portable heater.
- Use the kerosene heater in a well-ventilated room.

PREVENTING ELECTRICAL FIRES

Electrical fires in our homes claim the lives of 200 Americans each year and injure 1,500 more. Some of these fires are caused by electrical system failures and appliance defects, but many more are caused by the misuse and poor maintenance of electrical appliances, incorrectly installed wiring, and overloaded circuits and extension cords.

December is the most dangerous month for electrical fires. Fire deaths are highest in winter months which call for more indoor activities and increases in lighting, heating, and appliance use. Most electrical wiring fires start in the bedroom.

Safety Precautions in Preventing Electrical Fires

- When using appliances, follow the manufacturer's safety precautions. Overheating, unusual smells, shorts, sparks and sputters are all warning signs that appliances need to be shut off, then replaced or repaired. Have an electrician check the wiring in your house. Unplug appliances when not in use.

- ***Routinely check*** your electrical appliances and wiring.

- Never overload extension cords or wall sockets. Do not place cords and wires under rugs, over nails or in high traffic areas. Immediately shut off, then professionally replace, light switches that are hot to the touch and lights that flicker. Use safety closures to "child-proof" electrical outlets.

- Frayed wires can cause fires. Replace all worn, old, or damaged appliance cords immediately.

- Keep electrical appliances away from wet floors and counters; pay special care to electrical appliances in the bathroom and kitchen.

- When buying electrical appliances, look for products which meet the UL standard for safety.

- Don't allow children to play with or around electrical appliances like space heaters, irons and hair dryers.

- Do not trap electric cords against walls where heat can build up.

- Keep clothes, bedding, curtains and other potentially combustible items at least 3 feet from all heaters.

- Only use lab-approved electric blankets and warmers. Check to make sure the cords are not frayed.

- If an appliance has a three-prong plug, use it only in a three-slot outlet. Never force it to fit into a two-slot outlet or extension cord.

- Check your electrical tools regularly for signs of wear. If the cords are frayed or cracked, replace them. Replace any tool if it causes even small electrical shocks, overheats, shorts out or gives off smoke or sparks.

- Replace mattresses made before the 1973 Federal Mattress Flammability Standard. Mattresses made since then are required by law to be safer.

PREVENTING FIRES DURING THE HOLIDAY SEASON

Each year fires associated with the holiday season injure 1,200 individuals and cause over $25 million in damage.

1. **Holiday trees**. Special fire safety precautions need to be taken when keeping a live tree in the house. A burning tree can rapidly fill a room with fire and deadly gases.

   - *Selecting a tree*. Needles on fresh trees should be green and hard to pull back from the branches, and the needle should not break if the tree has been freshly cut. The trunk should be sticky to the touch. Old trees can be identified by bouncing the tree trunk on the ground. If many needles fall off, the tree has been cut too long, has probably dried out, and is a fire hazard.

   - *Caring for your tree*. Do not place your tree close to a heat source, including a fireplace or heat vent. The heat will dry out the tree, causing it to be more easily ignited by heat, flame or sparks. Be careful not to drop or flick cigarette ashes near a tree. Do not put your live tree up too early or leave it up for longer than two weeks. Keep the tree stand filled with water at all times.

   - *Disposing of your tree*. Never put tree branches or needles in a fireplace or woodburning stove. When the tree becomes dry, discard it promptly. The best way to dispose of your tree is by taking it to a recycling center or having it hauled away by a community pick-up service.

2. **Holiday lights**.

   - *Maintain your holiday lights*. Inspect holiday lights each year for frayed wires, bare spots, gaps in the insulation, broken or cracked sockets and excessive kinking or wear before putting them up. Use only lighting listed by an approved testing laboratory.

   - *Do not overload electrical outlets*. Do not link more than three light strands, unless the directions indicate it is safe. Connect strings of light to an extension cord before plugging the cord into the outlet. Make sure to periodically check the wires—they should not be warm to the touch.

   - *Do not leave holiday lights unattended*.

3. **Holiday decorations**.

   - *Use only nonflammable decorations*. All decorations should be nonflammable or flame-retardant and placed away from heat vents.

   - *Never put wrapping paper in a fireplace*. It can throw off dangerous sparks and produce a chemical buildup in the home that could cause an explosion.

   - *Artificial holiday trees*. If you are using a metallic or artificial tree, make sure it is flame retardant.

4. **Candle Care**.

   - *Avoid using lit candles*. If you do use them, make sure they are in stable holders and place them where they cannot be easily knocked down. Never leave the house with candles burning.

   - *Never put lit candles on a tree*. Do not go near a holiday tree with an open flame—candles, lighters or matches.

   - *Have working smoke alarms*. As in every season, have working smoke alarms installed on every level of your home, test them monthly and keep them clean and equipped with fresh batteries at all times. Know when and how to call for help. And remember to practice your home escape plan.

PRECAUTIONARY MEASURES FOR OLDER AMERICANS

Every year more than 1,000 Americans over age 65 die in fires. People over the age of 80 die in fires at a rate three times higher than the rest of the population. Many of these fatalities occur where there is no working smoke detector. However, the following are a number of precautionary steps older Americans can take to dramatically reduce their chances of becoming a fire casualty.

1. ***Kitchen Fires***. Cooking accidents are the leading cause of fire related injuries for older Americans. The kitchen is one of the most active and potentially dangerous rooms in the home. Most kitchen fires occur because food is left unattended on the stove or in the oven.

    - If you must leave the kitchen while cooking, turn off the burners and take a spoon or potholder with you to remind you to return to the kitchen.

    - Never cook with loose, dangling sleeves. Robes and other loose-fitting garments can ignite easily.

    - Grease is extremely flammable; keep all cooking surfaces clean. Heat cooking oils gradually and use extra caution when deep-frying. If a fire breaks out in a pan, put a lid on the pan. **Never throw water on a grease fire**.

    - Turn pot handles toward the side of the range, and always use a potholder when reaching for handles.

    - Never use a range or stove to heat your home.

2. ***Space Heaters***. Heating equipment is responsible for a big share of fires in seniors' homes. Extra caution should be used with alternate heaters such as wood stoves or electric space heaters. Too often the heaters become a fire hazard, particularly when newspapers and other combustibles are nearby.

    - Buy only UL-approved heaters. Check your heaters often to make sure they are in good condition.

    - Burning fuel can produce deadly fumes; only use them in well-ventilated areas. Use only the manufacturer's recommended fuel for each heater.

    - Do not use electric space heaters in the bathroom or around other wet areas.

- Do not dry or store objects on top of your heater. Keep combustibles away from heat sources.

3. ***Wiring***. Faulty wiring is another major cause of fires affecting the elderly. Older homes can have serious wiring problems, ranging from old appliances with bad wiring to overloaded sockets.

   - Regularly inspect your extension cords for fraying, exposed wires or loose plugs. They are not intended for use as permanent wiring. Unplug them when not in use.

   - If you need to plug in two or three appliances, do not use a simple extension cord. It's better to get a UL-approved unit that has built-in circuit breakers.

   - Never run electric cords or extensions under rugs or in high traffic areas.

4. ***Smoking***. The unsafe use of smoking materials is the leading cause of fire deaths among older Americans.

   - Don't leave smoking materials unattended.

   - Don't put ashtrays on arms of sofas or chairs where they can be easily knocked over.

   - Use safety ashtrays with wide lips.

   - Empty all ashtrays into the toilet or a metal container every night before going to bed.

   - Never smoke in bed. Burning sheets and blankets may create a fire from which escape may be impossible.

Finally, having a working smoke detector dramatically increases your chances of surviving a fire. And remember to practice a home escape plan frequently with your family.

Unit Review

Circle the correct response. Answers may be found on page A1.

1. A good protection measure against wildfires mentioned in this unit is _____.
   a) planting shrubbery that will stop the spread of fire.
   b) altering security bars on windows and doors so they don't trap you in a fire.
   c) building you home close to a fire station to decrease emergency response time.

2. A combination of residential sprinklers and smoke detectors can save most potential victims of home fires except victims of:
   a) clothing fires
   b) explosions
   c) flash floods
   d) all of the above.

3. Which of the following is NOT considered fuel to an interface fire?
   a) leaves and pine needles
   b) rock garden
   c) trees and grass
   d) houses

4. One reason fires start more easily during the holiday season is:
   a) Children are usually careless when disposing of gift boxes and wrapping paper.
   b) Sometimes holiday trees are placed too close to heating sources such as a fireplace or vent and are easily ignited by the heat.
   c) Because of kitchen accidents which occur more often due to the amount of cooking done during the holidays.

5. What is the **leading** cause of fire related injuries for older Americans?
   a) space heaters
   b) smoking
   c) kitchen fires
   d) candles usage

6. An effective tool that creates defensible space between your home and flammable vegetation to protect against fires is known as _____.
   a) fire-safe landscaping
   b) fire walls
   c) swimming pools

7. Which of the home heating sources below should homeowners take **extra** precaution in operating?
   a) stove
   b) electric space heater
   c) electric blanket

GLOSSARY TERMS

100-Year Flood Level - The elevation of the maximum flood level with a one-percent chance of occurring within any given year. "A" zones, designated as Special Flood Hazard Areas (SFHAs) are at risk of flooding during the 100-year flood.

– B –

Backflow Valve – Designed to block drainpipes temporarily and prevent flow into the house. Also called the "check valve," which allows water to flow in one direction (out of the house), but automatically closes when the direction of flow is reversed.

Base Flood - Flood that has a one percent probability of being equaled or exceeded in any given year. Also known as the 100-year flood.

Base Flood Elevation (BFE) - Elevation of the 100-year flood. This elevation is the basis of the insurance and floodplain management requirements of the National Flood Insurance Program.

Berm - Small levees, usually built from fill dirt.

– C –

Cladding - A layer of some metal or alloy bonded to another metal.

Coastal Flooding - The inundation of land areas along the oceanic coast that is caused by sea waters over and above normal tidal action. Such flooding can originate from the ocean front, back bays, sound, etc.

Crawlspace - Type of foundation in which the lowest floor of a house is suspended above the ground on continuous foundation walls.

Cripple Wall - A short wall that rests on the foundation and supports the floor and exterior walls of a structure.

Creosote - A black oily liquid with a pungent odor used as a wood preservative.

– D –

Debris - Materials (broken bits and pieces of wood, stone, glass, etc.) carried by wind or floodwaters, including objects of various sizes.

Disaster – Any natural catastrophe or, regardless of cause, any fire, flood, or explosion in any part of the United States which, in the determination of the President, causes damage of sufficient severity and magnitude to warrant major disaster assistance to supplement the efforts

and available resources of States, local governments and disaster relief organizations in alleviating the damage, loss, hardship, or suffering caused thereby.

Disaster Resistant Community – A community-based initiative that seeks to reduce vulnerability to natural hazards for the entire designated area through mitigation actions. This approach requires cooperation between individuals and the business sectors of a community to implement effective mitigation strategies.

A disaster resistant community is one that experiences minimal loss of life as a result of disaster, has limited interruption of public services, can resume business operations in a timely manner following a disaster, and returns to pre-disaster conditions in a timely, orderly manner.

Dowel - A short cylinder of wood, metal, etc., usually fitted into corresponding holes in two pieces to fasten them together.

Downdraft - A sudden descent of a stream of cool air from a lot, often causing windshear.

Downdraft Furnace - A furnace with a downward air current.

Dry Floodproofing - Protecting a building by sealing its exterior walls to prevent the entry of flood waters.

– E –

Earthquake – A sudden, rapid shaking, sometimes violent, of the Earth caused by the breaking and shifting of rock beneath the Earth's surface.

Elevation - In retrofitting, the process of raising a house or other building so that it is above the height of a given flood.

El Niño – the phenomenon of a warm current replacing normally cool waters off the coast of Peru. Coastal winds usually push away surface water and the water is replaced by cold, nutrient-rich water from deep in the ocean, which supports abundant sea life.

El Niño shifts the normal storm tracks of the U.S. farther north, producing a warmer than average winter in the Northwest and a wetter than average winter in the Southeast.

Emergency – Any hurricane, tornado, storm, flood, high water, wind-driven water, tidal wave, tsunami, earthquake, volcanic eruption, landslide, mudslide, snowstorm, drought, fire, explosion, or other catastrophe in any part of the United States which requires federal emergency assistance to supplement State and local efforts to save lives and protect property, public health and safety, or to avert or lessen the threat of disaster.

Epicenter – The area of the Earth's surface directly above the place of origin, or focus, of an earthquake.

Epoxy - Blended with other chemicals to form strong, hard chemically resistant substances used as adhesives, enamel coatings, etc.

Erosion - Process by which flood waters lower the ground surface in an area by removing upper layers of soil.

– F –

Federal Emergency Management Agency (FEMA) – Independent agency of the federal government, founded in 1979, reporting to the President. FEMA's mission is to reduce loss of life and property and protect our nation's critical infrastructure from all types of hazards through a comprehensive, risk-based, emergency management program of mitigation, preparedness, response and recovery. FEMA administers the National Flood Insurance Program.

Fill – Material such as soil, gravel, or stone which is dumped in an area to increase the ground elevation. Fill is usually placed in layers and each layer compacted.

Flash Flood - Flood that rises very quickly, occurring suddenly, within a short time (from minutes to less than 6 hours), and usually is characterized by high flow velocities. Flash floods often result from intense rainfall over a small area, usually in areas of steep terrain.

Flood - Under the National Flood Insurance Program (NFIP), a partial or complete inundation of normally dry land areas from 1) the overland flow of a lake, river, stream, ditch, etc.; 2) the unusual and rapid accumulation or runoff of surface waters; and 3) mudflows or the sudden collapse of shoreline land.

Flood Elevation - Height of flood waters above an elevation datum plane.

Flood Insurance Rate Maps (FIRMS) - The official map of a community prepared by FEMA, showing base flood elevations along with the special hazard areas and the risk premium zones.

Floodplain - Any area susceptible to inundation by water from any source.

Floodproofing - Using materials and practices that will prevent or minimize flood damage in the future.

Flood Protection Elevation (FPE) – Elevation of the highest flood that a retrofitting method is intended to protect against.

Floodwall - Flood barrier constructed of manmade materials, such as concrete or masonry.

Floodway - The channel of a river and the adjacent overbank areas reserved to carry base flood discharge without raising the BFE more than a designated amount

Fujita Tornado Scale - Usually referred to as the F-Scale, it classifies tornadoes based on the damage caused. It assigns categories as F-0 through F-5. It was developed by Dr. Theodore Fujita.

– H –

Hasp - Hinged metal fastening for a door, window, lid, etc., especially a metal piece that fits over a staple and is held in place by a pin or padlock.

Hazard Identification - A review of hazards, and of locations and conditions associated with hazards in a particular area; being aware of those hazards which, if they occur, could harm your community.

Human Intervention - Any action that a person must take to enable a flood protection measure to function as intended. This action must be taken every time flooding threatens.

Hurricane - A severe tropical disturbance in the North Atlantic Ocean, Caribbean Sea, or Gulf of Mexico that achieves a sustained wind force of a least 74 miles per hour.

Hurricane Straps – Usually galvanized metal, designed to help hold your roof to the walls, reducing the risk of losing your roof to high winds.

Hydrodynamic Force - Force extended by moving water.

Hydrostatic Force - Force exerted by water at rest, including lateral pressure on walls and uplift (buoyancy) on floors.

– J –

Joists - Any of the parallel planks or beams that hold up the planks of a floor or the ceiling.

– L –

Levee - Flood barrier constructed of compacted soil.

– M –

Mitigation – Sustained actions taken to reduce or eliminate long-term risk to people and property from hazards and their effects.

Mudflows - Sometimes called debris flows, are rivers of rock, Earth, and debris saturated with water. They develop when water accumulates rapidly in the ground, so that the Earth becomes a flowing river of mud (called a *slurry*).

– N –

National Flood Insurance Program (NFIP) – Provides the availability of flood insurance in exchange for the adoption and enforcement of a minimum local floodplain management ordinance. The ordinance regulates new and substantially damaged or improved development in identified flood hazard areas.

– O –

Ocean Flooding – Flooding caused by storm surge and wave action and affects primarily coastal areas, especially those along the beachfront.

– P –

Plate Tectonics - from the Greek tektonicos for "builder." According to this theory, the Earth's surface is made up of about ten large plates and a number of small ones that fit together like a jigsaw puzzle. Each plate is composed of the Earth's crust and the top portion of the mantle, for a total thickness of about 100 miles.

Plates are constantly moving, though slowly. For example, North American plates are said to be moving 7 centimeters or 3 inches farther apart each year. This is approximately the growth rate of your fingernails. Where plates meet, rock accumulates strain. When the stress exceeds the strength of the rock, the rock ruptures -- or breaks--along a pre-existing or new fracture plain known as a fault. When the rock ruptures, it causes the Earth to tremble. This happens about 800,000 times a year. Usually faint tremors go unnoticed, but on occasion "the big one" for a region reminds us of the dynamic forces of our restless planet.

Preparedness – Activities to ensure that people are ready for disaster and respond to it effectively. Preparedness requires figuring out what will be done if essential services break down, developing a plan for contingencies, and practicing the plan.

Project Impact – A new project introduced by FEMA as a result of the increasing number and severity of disasters over the last decade to reduce the damage resulting from hurricanes, tornadoes, severe storms, floods, and fires. It helps communities protect themselves from the effects of natural disasters by taking actions to reduce disruption and loss.

– R –

Relocation - In retrofitting, the process of moving a house or other building to a new location outside the flood hazard area.

Reinforcement – Inclusion of steel bars in concrete members and structures to increase their strength.

Retrofitting - Making changes to an existing house or other building to protect it from flooding or other hazards.

Richter Scale - a measure of the amplitude of seismic waves. The scale is logarithmic, which means that an Earthquake that measures 7 on the Richter Scale has ground motion 10 times as large as one with a measurement of 6. Earthquakes of 6 or more are considered major. Extremely strong Earthquakes have magnitudes of 8 or more.

Riverine Flooding - Occurs when a river or stream flows over its banks and causes considerable inundation of nearby land and roads. Riverine flooding is a longer-term event that may last a week or more.

– S –

Saffir-Simpson Scale - A disaster-potential scale used by the National Oceanic and Atmosphere Administration's hurricane forecasters. The scale assigns storms to five categories. All hurricanes are dangerous but some are more so than others. The scale was designed to make comparisons easier and to make the predicted hazards of approaching hurricanes clearer to emergency forces.

Scour - Process by which floodwaters remove soil around objects that obstruct flow, such as the foundation walls of a house.

Sealant – In retrofitting, a waterproofing material or substance used to prevent the infiltration of floodwaters.

Seismic - Of, subject to, or caused by an Earthquake or an Earth vibration.

Seismic Event - The abrupt release of energy in the Earth's crust (the solid, rocky part of the Earth) causing an Earth vibration or Earthquake.

Seismograph - Used by scientists to record the changing intensity of the vibrations of an Earthquake.

Service Equipment - In retrofitting, the utility systems, heating and cooling systems, and large appliances in a house.

Sill Plate – A heavy, horizontal timber or line of masonry supporting a house wall, which sits directly on top of the foundation wall.

Slab-on-grade - Type of foundation in which the lowest floor of the house is formed by a concrete slab that sits directly on the ground. The slab may be supported by independent footings or integral grade beams.

Soffit – The horizontal underside of an eave.

Special Flood Hazard Area (SFHA) – Portion of the floodplain subject to inundation of the base flood, designated Zone A, AE, A1-A30, AH, AO, V, V1-V30, or M on a flood insurance rate map.

Storm Surge – Rise in the level of the ocean that results from the decrease in atmospheric pressure associated with hurricanes and other storms

Subgrade – Below the level of the ground surface.

Sump Pump - Device used to remove water from seepage or rainfall that collects in areas protected by a levee, floodwall, or dry floodproofing. In addition, a sump pump is often part of a standard house drainage system that removes water that collects below a basement slab floor.

– T –

Tornado - The most violent storms on Earth, with estimated wind speeds of 250 mph or more. At tornado is a violently rotating column of air extending between a cloud (often a thunderstorm loud) and the ground. The spinning motion of a tornado is almost always counterclockwise.

Thunderstorms, nicknamed "twisters, develop in warm, most air in advance of eastward-moving fronts. A **funnel cloud** is a similar column of air that is not in contact with the ground. A **water spout** is a tornado that is over water. When either a funnel cloud or a water spout come in contact with the ground, they become, by definition, a tornado.

Truss – A rigid framework of beams, girders, struts, bars, etc., for supporting a roof, bridge, etc.

Tsunami – (pronounced soo-náh-mee) A series of ocean waves of extremely long length, generated by disturbances from Earthquakes, underwater volcanic eruptions, or landslides occurring below or near the ocean floor.

– V –

Veneer – Nonstructural, decorative, exterior layer of brick, stone, or concrete block added to the walls of a building, sealing all openings, including doors, to prevent the entry of water.

Vulnerability Analysis – Identifying how people, properties and structures will be damaged by the disastrous event.

– W –

Wave - A usually small cyclonic center in the early state of development. Waves usually move along a cold front. Also referred to as a wave cyclone.

Wet Floodproofing - Protecting a building by allowing flood waters to enter so that internal and external hydrostatic pressures are equalized. Usually only enclosed areas used for parking, storage, or building access are wet floodproofed.

Wildland-Urban Interface – The area where homes and structures meet the natural environment of forests and wildlands.

Wind - Air in motion parallel to the surface of the ground.

Windshear - A sudden variation in the vector of wind flow that is especially dangerous to aircraft during takeoff and landing.

ANSWERS TO PRETEST AND UNIT REVIEW

Number	Pretest	Unit One	Unit Two	Unit Three	Unit Four	Unit Five
1	D	B	C	B	B	A
2	C	D	C	A	C	A
3	B	C	C	C	D	B
4	A	B	C	C	C	B
5	B	D	B	D	A	C
6	A			C	D	A
7	D					B
8	B					
9	D					
10	A					
11	B					
12	C					
13	D					
14	B					
15	A					
16	C					
17	B					
18	B					
19	B					
20	A					

FINAL EXAMINATION

Directions. Carefully read each question and all of the possible answers before you mark your answers on the answer sheet provided. There is only one correct answer for each test item. Using a soft lead (#2) pencil, record the best answer for each of the following questions. When you have answered all the questions, prepare the answer sheet as directed and mail to the address provided. Your examination will be evaluated and the results returned to you as quickly as possible.

1. How can you make a gabled roof more resistant to hurricane winds?
   a) Check the attic for wood sheathing.
   b) Install hurricane straps.
   c) Keep trusses in place.
   d) Use nails and staples to attach plywood.

2. What is meant by ***dry floodproofing*** your home?
   a) Protecting service equipment inside and outside your home.
   b) Permanently closing all doors that lead to the outside.
   c) Sealing a building's windows and doors to keep floodwaters out.
   d) Modifying a building so that floodwaters will cause minimal damage to the building and its contents.

3. A 100-year flood means:
   a) The flood occurs exactly once every 100 years.
   b) Once the flood occurs, there is little risk of another 100-year flood occurring in the near future.
   c) Hundreds of floods happening at one time.
   d) The flood has a 1 percent probability (1 in 100) of being equaled or exceeded in any year.

4. A good way to protect your home from sewer backups during a flood is:
   a) Install backflow valves on all pipes that leave the house.
   b) Buy flood insurance.
   c) Turn off all water pipes.

5. The National Flood Insurance Program (NFIP) provides federally backed insurance coverage for your building in a participating community including walls, floors, wall-to-wall carpet, and furnace. Name another item included in the building coverage:
   a) storage shed
   b) swimming pool
   c) insulation
   d) driveway

6. One of the advantages of elevating a home in floodprone areas is:
   a) Elevating doesn't cost very much.
   b) There is no need to move vulnerable contents to a higher level during flooding.
   c) There is no need to evacuate during the flooding event.
   d) You don't need professionals to accomplish it.

7. Hurricane season as established by the National Weather Service is:
   a) June 1 through November 30
   b) February through April
   c) March through April
   d) June 1 through September 30

8. With regard to relocating a house that is subject to deep flooding, which statement is true?
   a) Only small one-story homes and commercial buildings with less than 4 rooms can be relocated.
   b) Once a house has been relocated outside the flood hazard area, flood insurance is still needed.
   c) The local government locates the new site for residents.
   d) Moving a house is a complex operation that requires a professional house mover.

9. Which is a good measure in preparing your kitchen for an earthquake?
   a) Attach hanging plants and kitchen utensils to wall studs.
   b) Put guard rails on open shelves so items can't slide off
   c) Keep delicate crystal, china and stemware in cabinets.
   d) All of the above.
   e) a & b above.

10. Why is it necessary to secure your water heater if you live in an earthquake zone?
    a) If it walks, it could cause gas or water leakage, or electrical shocks, fires or explosions.
    b) It is the most vulnerable appliance to earthquake damage.
    c) You could be without water after an earthquake.
    d) All of the above.

11. One way to protect a home from damage in a windstorm is to install _____ over all large windows and doors.
    a) safety film
    b) plastic sheeting
    c) impact-resistant plywood shutters
    d) masking or other strong tape

12. What is the best type of house roofing material to use in wildfire protection?
    a) Asphalt shingles
    b) Tile
    c) Slate
    d) Wood shakes
    e) b & c above.

13. A house in Mississippi was flooded several times. During the largest flood, the water reached as high as 2 feet above the first floor. The owners realized they needed to make changes to their home to protect it from flooding in the future. This process is called:
    a) Retrofitting
    b) Rehabilitating
    c) Stabilizing
    d) Construction technology

14. The first thing you should do in taking steps to reduce risk to your home in the event of a wind hazard is:
    a) Replace all windows with shatter-proof glass.
    b) Strengthen doors.
    c) Determine what type of roof you have.
    d) Evacuate

15. Most of the flooding that occurs in the U.S. is _____.
    a) flash flooding.
    b) either riverine or ocean flooding.
    c) coastal.
    d) lake.

16. When do tornadoes usually occur?
    a) mornings
    b) evenings
    c) afternoons and evenings
    d) after midnight

17. The elevation of the highest flood that a retrofitting method is intended to protect is:
    a) Base flood elevation
    b) 100-year flood
    c) 500-year flood
    d) Flood Protection Elevation

18. According to the text, what areas in the U.S. that are vulnerable to earthquakes?
    a) South Carolina and California
    b) California and Alaska
    c) All 50 states
    d) The Mississippi Valley and the West

19. The amount of damage to your furnace or hot water heater during flooding will depend on what two factors?
    a) Where you live and the location of the equipment.
    b) Depth of the flooding and the amount of time the equipment remains under water.
    c) When your house was built and the type of soil it sits on.
    d) How energy-efficient and how old the units are.

20. Installing flexible gas and water connection pipes between your appliances and their supply lines should be done by:
    a) you, the homeowner.
    b) a plumber.
    c) a licensed contractor.
    d) the people who sold you the appliance.

21. What is the best way to protect your heating, ventilation and cooling (HVAC) equipment from flooding?
    a) Build a concrete or masonry block floodwall around it.
    b) Set it on concrete blocks.
    c) Move it from the basement or lower level of the house to an upper floor or attic.
    d) Place it outside.

22. When a tornado has been sighted or indicated by weather radar, a(n) _____ is issued.
    a) tornado watch
    b) Emergency Alert System (EAS)
    c) tornado warning
    d) tornado threat

23. What should you do with a large amoire in your bedroom to prevent it from toppling over during an earthquake?
    a) Make sure it is positioned away from the bed.
    b) Make sure it is positioned away from the exit so it won't block your escape if it falls.
    c) Bolt the furniture into the wall studs or use angle brackets.
    d) There is nothing you can do for large furniture before an earthquake.

24. What dangers other than tornadoes often accompany thunderstorms?
    a) flash floods
    b) lightening
    c) large hail
    d) all of the above

25. Which home appliance below is most vulnerable to earthquake damage?
    a) washer
    b) air compressor
    c) fuel tank
    d) water heater

26. Which of the following improvements for hurricane protection that you can do yourself costs less than $300?
    a) Install hurricane clips/straps
    b) Gather outdoor furniture, garbage cans, potential debris, etc., and move them inside.
    c) Cover all large windows and patio doors with storm shutters made of plywood.
    d) Replace roof covering.

27. Weak tornadoes that form over warm water are called _____.
    a) thunderstorms
    b) waterspouts
    c) damaging straight-line winds
    d) hurricanes

28. The electrical device used with a levee or floodwall to remove floodwaters from the protected area faster than water enters is called a _____.
    a) drain
    b) generator
    c) wall opening
    d) sump pump

29. Removing shrubs and other landscaping away from the sides of your home or deck is a good mitigation measure against what hazard event?
    a) hurricane
    b) flooding
    c) wildfire
    d) earthquake

30. In past hurricanes, many homeowners returning home noticed their temporary plywood shutters blew off. Why?
    a) Plywood is not impact-resistant or strong enough.
    b) They were not adequately fastened.
    c) They were not tested beforehand.

31. For hazard identification in your community, consider which of the following:
    a) how long disaster events last
    b) past history of disasters
    c) vulnerability analysis
    d) both a & b

32. Which precaution will improve earthquake readiness in a mobile home?
    a) Use more bracing than conventional homes.
    b) Keep the axle, wheels, and inflated tires on the unit.
    c) Use heavy roofing materials.
    d) Place the unit on gravel or pavement.

33. In deciding whether to purchase earthquake insurance, one question you should ask is….
    a) Do I have the money for premiums?
    b) Is my house new?
    c) Is my house wood-frame or brick?
    d) Are the contents of my home worth insuring?

34. Mitigation:
    a) is the cornerstone of emergency management.
    b) reduces the chance of an emergency happening.
    c) lessens the impact disasters have on people and property.
    d) all of the above

35. A community-based initiative that seeks to reduce vulnerability to natural hazards for the entire designated area through mitigation actions is know as:
    a) The National Flood Insurance Program
    b) The Federal Emergency Management Agency
    c) A Disaster Resistant Community
    d) An Emergency

36. ***True or False***. During an earthquake, the actual movement of the ground is the cause of death 90% of the time.

    a) True
    b) False

37. ***True or False***. Homeowner's insurance does not cover flood damage.

    a) True
    b) False

38. Flood insurance is only available for homeowners.

    a) True
    b) False

39. If you live outside the floodplain, there is no need to purchase flood insurance.

    a) True
    b) False

Who to contact? Match the professional below with what they are trained to do in advising you on earthquake protection for your home. Please note: one profession may match more than one title.

40. _____ Architects
41. _____ Contractors
42. _____ Civil/Structural Engineers
43. _____ Geologists
44. _____ Foundation Engineers

a) Are trained and licensed to evaluate soil conditions and recommend appropriate action.
b) Have to implement the detailed plans and specifications prepared by an architect and engineer.
c) Are trained to provide information about structures.

Match the following methods of flood mitigation:

45. _____ Levee
46. _____ Wet Floodproofing
47. _____ Floodwalls
48. _____ Elevation
49. _____ Demolition
50. _____ Relocation

a) Moving your house out of the flood hazard area to higher ground where it will not be exposed to flooding.

b) Engineered structure usually built of concrete, masonry, or a combination of both.

c) Tearing down your damaged house and either rebuilding properly on the same property or buying or building a house elsewhere.

d) Flood protection barrier -- typically a compacted earthen structure.

e) Allowing floodwaters to enter uninhabited portions of your house which will cause only minimal damage to the building and its contents.

f) Raising your house so that the lowest floor is above the flood level.