Unit 1

Course Introduction

INTRODUCTION

On the morning of September 2, 1886, the people of Charleston, South Carolina, awoke to a devastating scene. For a day and a half, their city had been racked by a series of disastrous earthquakes. Most inhabitants of the city were camped out in tents in parks and open places, afraid to return to what remained of their homes. The streets were cluttered with rubble from the 102 buildings destroyed. Ninety percent of the city lay in ruins. Seventy people were dead, and doctors had been working around the clock to tend to the thousands of injured. People as far away as New York, Chicago, Boston, and St. Louis also had felt the tremors and wondered if they might be next.

If President Grover Cleveland had signed Executive Order 12699, "Seismic Safety of Federal and Federally Assisted or Regulated New Building Construction," at that time, there would be very little need for this course. People throughout the United States would only have to look at the pictures in their newspapers and remember the tremors. They would have been clamoring to know, "How do I protect my family, my home, and my business?"

Unfortunately, Executive Order 12699 was not signed by President Cleveland in 1886. It was signed by President George Bush in 1990 and became effective only in February 1993. More than 100 years have gone by since the Charlestonians witnessed the devastation of their city. No one remembers the earthquakes, and no one remembers the tremors experienced in cities throughout the eastern part of the country. However, the hazard has not gone away. The geologic stresses and strains in this region continue to build, waiting for their release—an earthquake. Scientists have not had much success with predicting earthquakes, but they are fond of saying, "The farther away you are from the last earthquake, the closer you are to the next." Even though 100 years have gone by without a repeat of the 1886 disaster, it does not mean that we are out of the woods; it means we are just that much closer to the next damaging earthquake.

We cannot escape the threat of an earthquake, but we can mitigate the damage caused by earthquakes. That is the purpose of Executive Order 12699: to prepare our communities by

using building codes that ensure structures that are built to withstand an earthquake with reduced risk of injury or loss of life and devastation to the built environment.

Concern over the potential for earthquakes, the safety of people, and the security of infrastructure and property gave rise to Executive Order 12699. This course presents the intent of the Executive Order in detail and discuss how your community can protect itself. Topics covered in each unit are summarized later in this unit. Unit 1 answers the following questions:

- What is the history of earthquakes in the United States?
- How can your community be protected?
- What is the purpose of this course?
- For whom is this course designed?
- How should I proceed through the course?
- What will be covered in this course?

WHAT IS THE HISTORY OF EARTHQUAKES IN THE UNITED STATES?

Although we associate earthquakes with the western United States—especially California—the fact is that all 50 States are vulnerable. Take a look at the map in Figure 1-1. It shows the earthquake hazard across the country. What is the highest hazard in your State?

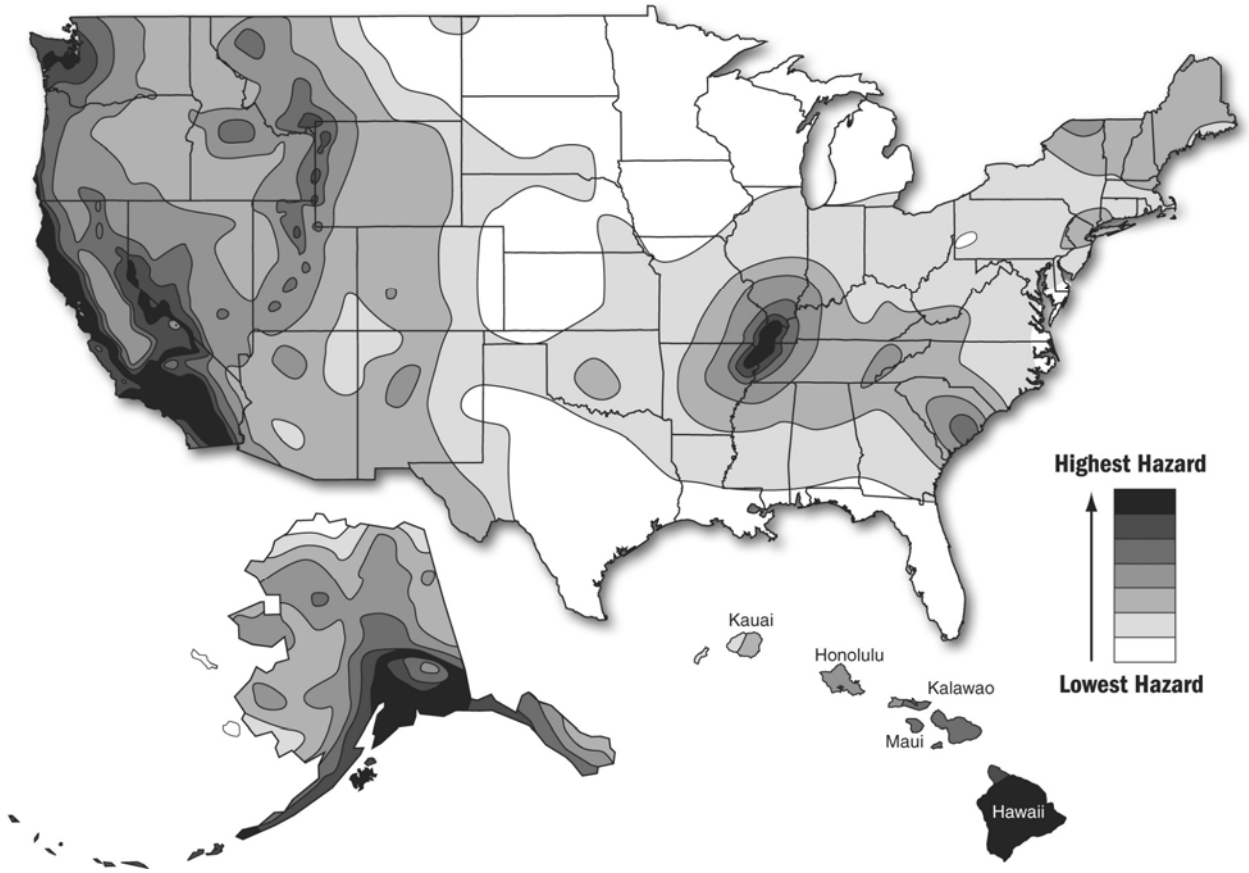

Figure 1-1 *Source: U.S. Geological Survey.*

Was the hazard in your State higher or lower than you thought? Did you realize that there is a high potential for earthquake activity in Illinois, Kentucky, Tennessee, Missouri, and Arkansas? Everyone has heard about the great earthquake that struck San Francisco in 1906. Few people realize that earthquakes of equal magnitude occurred near the New Madrid seismic zone of the central United States in 1811 and 1812. (New Madrid is a town in southern Missouri.) The damage done by these earthquakes resulted in fewer deaths and less damage to the built environment (buildings, transportation lines and structures, communications lines, and utilities) than the San Francisco earthquake. This is because there were fewer people and buildings there in 1811 and 1812, but imagine what a similar earthquake might do today. Cities like Memphis and, to a lesser extent, Little Rock and St.

Louis, most likely would experience significant damage. Traffic on the Mississippi River would be disrupted. Bridges, highways, railroads, and communications networks that did not exist in 1811 and 1812 could be badly damaged or destroyed.

The earthquakes around the New Madrid area happened a long time ago. Many of the areas where the earthquakes occurred do not appear to be seismically active today. The lack of recent earthquake, or seismic, activity does not mean that an area is safe from earthquakes. In fact, some scientists believe that a lack of recent seismic activity—especially in a region that once was seismically active—could indicate a higher likelihood of an earthquake occurrence. The earthquake hazard for the central United States has probably not changed since 1812. What has changed is the risk to the communities in this area. These terms, hazard and risk, are sometimes used interchangeably. In fact, they have very different meanings. There are many types of hazards—earthquakes, floods, volcanoes, and many others. Hazards exist because of some natural phenomena. For earthquakes, a hazard exists because of the structure of the rocks below the surface of the earth. A hazard has the potential to cause the loss of life, personal injury, and damage. So when we say the earthquake hazard for an area has not changed, it means that the potential for an earthquake to occur has not changed.

Risk, on the other hand, refers to the potential exposure of persons and the built environment (buildings, transportation lines and structures, communications lines, and utilities) to loss of life, personal injury, and damage as a result of an earthquake. Seismic hazard is high in some areas of the West, such as in Montana, but the seismic risk is much lower than in the central United States because the population and built environment is much smaller. The risk in the central United States has increased dramatically since 1812 with the growth of major cities, highways, and utilities while the hazard has stayed the same. When almost 200 years go by without any substantial earthquake activity, it is easy for a community to put the hazard out of their minds. Unfortunately, this also makes it easy to ignore the need to reduce seismic risk in local communities.

This course will help you evaluate and take steps to reduce the risk, or mitigate, earthquake damage occurring in your community. You will need to look at both the seismic hazard and risk for your community. You can’t change your community’s seismic hazard, but you can change its seismic risk. The time to act is now, before a major seismic event causes a devastating loss of life and structural damage. Making sure that new construction in your community is seismically resistant will help reduce the risk to your community in the future.

Figure 1-2 (page 1-6) lists some of the major earthquakes that have occurred in the central and eastern United States, Mexico, and Canada since 1700 and their magnitudes. (For a complete list of major earthquakes that have occurred in the United States, Mexico, and Canada between 1700 and 2004, see Appendix A.) We have grown accustomed to earthquakes occurring in California and some western states, but it is rare to see a list that features other areas of the United States.

Year	Date	Time[1]	Place	Magnitude[2]
1700	January 26	NA[3]	Cascadia subduction zone	~9
1811	December 16	08:00	New Madrid, MO	~8.1
1812	January 23	15:00	New Madrid, MO	~7.8
1812	February 7	09:45	New Madrid, MO	~8
1857	January 9	16:24	Fort Tejon, CA	~7.9
1868	April 3	02:25	Hilea, southeast Hawaii, HI	~7.9
1886	August 31	02:51	Charleston, SC	~7.3
1895	October 31	11:08	Charleston, MO	~6.6
1906	April 18	13:12	San Francisco, CA	7.8
1918	October 11	14:14	Puerto Rico	7.5
1929	November 18	20:32	Grand Banks, Nova Scotia, Canada	7.3
1938	November 10	20:18	Shumagin Islands, AK	8.2
1940	May 19	04:36	Imperial Valley, CA	7.1
1946	April 1	12:28	Unimak Island, AK	8.1
1949	August 22	04:01	Queen Charlotte Island, British Columbia, Canada	8.1
1952	July 21	11:52	Kern County, CA	7.3
1954	December 16	11:07	Fairview Peak, NV	7.1
1959	August 18	06:37	Hebgen Lake, MT	7.3
1964	March 28	03:36	Prince William Sound, AK	9.2
1965	February 4	05:01	Rat Island, AK	8.7
1975	November 29	14:47	South flank of Kilauea, HI	7.2
1983	May 2	23:42	Coalinga, CA	6.4
1985	September 19	13:17	Michoacan, Mexico	8.0
1994	January 17	12:30	Northridge, CA	6.7
2001	February 28	18:54	Olympia, WA	6.8
2002	April 20	10:50	Au Sable Forks, NY	5.2
2003	December 22	19:15	San Simeon, CA	6.6

[1]Greenwich Mean Time (GMT) *Source: U.S. Geological Survey.*

[2]Earthquake magnitude as measured on the Richter Scale, which quantifies the ground motion and energy released at the source of the earthquake. Information about measuring earthquakes with the Richter Scale and the Modified Mercalli Intensity Scale is found in Unit 3.

[3]Not Available

Figure 1-2

What do you think the effects of these earthquakes in terms of loss of life and property damage might be today?

HOW CAN YOUR COMMUNITY BE PROTECTED?

From looking at the seismic hazard map and the historical information on earthquakes in Figures 1-1 and 1-3, we have learned about the general earthquake hazard in various geographic areas. What can be done to protect a community from earthquake damage? However inevitable or unpredictable earthquakes may seem, there are numerous things that can be done to prepare for an earthquake and reduce loss of life and damage to the built environment, which includes buildings, transportation lines and structures, communications lines, and utilities. Design and construction of seismically resistant buildings can reduce risk to communities. One of the key purposes behind Executive Order 12699 is to get the Federal Government and State and local communities to respond to the earthquake hazard by taking steps that will save lives and reduce property damage in the event of a major earthquake.

Post-disaster studies (studies done on the effects of a disaster) have shown that community investment in mitigation pays direct dividends. What do we mean by mitigation? Mitigation is a set of actions, resulting in permanent improvements, taken to reduce risk of injury and loss of life due to damage to structures during a natural disaster. Mitigation is generally achieved through the effective use of building codes, land-use planning, and public awareness.

An analysis published in May 1994, by the National Institutes of Standards and Technology (NIST), showed that seismic engineering techniques do reduce damage to buildings. It said that after the San Fernando, California, earthquake in 1971, during which several hospitals and other structures collapsed or were irreparably damaged, the Uniform Building Code (UBC) section on seismic engineering was made more stringent. The report further stated that no hospitals built to the post 1971 UBC standard were seriously damaged during the Northridge earthquake in 1994. In fact, the report stated that damage to hospitals built after 1971 was almost non-existent. The report found similarly improved performance among other structures, including single-family homes that were built to the post-1971 UBC standard.

Reducing damage to a community's buildings not only saves lives, it can save the community. Reconstruction or replacement of damaged or destroyed buildings is very expensive. Federal assistance programs to repair or replace public buildings often are eligible for reimbursement of a significant portion of expenditures. This program does not

pay for the costs which are, or could have been, covered by private insurance. Even with maximum reimbursement allowed, affected communities bear large financial responsibilities to repair or replace public buildings.

The additional cost of seismic resistant construction for a new building is considerably less than the cost for retrofitting an existing building. A 1985 Building Seismic Safety Commission study found that the average increase in total costs to be 0.7% for low-rise residential, 3.3% for high-rise residential, 1.3% for office, 0.5% for industrial, and 1.7% for commercial. (Reducing Earthquake Hazards in the Central United States, Seismic Building Codes; University of Illinois) Many communities that have suffered serious damage from disasters have found that, even with insurance and Federal assistance, the costs of repairing and rebuilding all damaged buildings may be prohibitive. Five years after the 1989 Loma Prieta earthquake, small cities such as Watsonville and Santa Cruz, California, are still struggling with the costs of financing their reconstruction efforts.

How can communities get started? We know that mitigation measures such as adoption of building codes, zoning ordinances, and land-use practices are needed to prevent or reduce actual damage from earthquakes. We also know that awareness and education are key factors in effective mitigation as well. This course and your compliance with Executive Order 12699 are vital steps toward adopting and implementing effective mitigation practices in your community.

WHAT IS THE PURPOSE OF THIS COURSE?

Purpose

Since the Earthquake Hazards Reduction Act was passed in 1977 to establish a program to help communities reduce losses from earthquakes, many actions have been taken to improve seismic safety in the United States. A strong federally mandated effort is Executive Order 12699, “Seismic Safety of Federally Assisted or Regulated New Building Construction,” signed by President George Bush in January 1990. This Order requires all *new* Federal, federally assisted, and federally regulated buildings to be appropriately “seismic resistant.”

Because the scope of Executive Order 12699 is so far-reaching—covering everything from single-family dwellings, public buildings, schools, and hospitals to large Federal complexes across the nation—a course is needed to provide the tools, information, and planning guidance for the people whom the Executive Order affects. This course provides individuals

with the information they need to comply with Executive Order 12699.

Goals and Objectives

At the conclusion of this course, you will be able to:

- Describe the intent and implications of Executive Order 12699, the advantages of compliance, and the consequences of noncompliance;
- Describe how it will affect the built environment;
- Describe the theory and practice of Executive Order 12699, hazard mitigation, and the rationale for including seismic provisions in building codes;
- Compare the Executive Order's standards and local codes to determine substantive differences and deficiencies in local codes; and
- Develop a plan of action for achieving compliance if local codes do not comply with Executive Order 12699.

FOR WHOM IS THIS COURSE DESIGNED?

This course is designed for individuals who may be involved in the implementation of Executive Order 12699. The following list shows many, but not all, of those who could benefit from this course:

- Government personnel
    - State and local decisionmakers,
    - Elected and appointed officials,
    - Building code officials,
    - Zoning and land-use officials,
    - Planning and building commission officials,
    - Public works officials,
    - Construction permitting officials,
    - Building inspectors, and
    - Federal officials.
- Others

- Engineers, architects, and construction industry representatives,
- Students in construction technology, engineering, and related fields,
- Lenders, and
- Private industry representatives.

HOW SHOULD I PROCEED THROUGH THE COURSE?

Read and study each section, then complete the Unit Review. You don't have to go through the course sequentially, but each unit assumes that you have covered all the information in previous units. If a term has been defined in a previous section, it will not be defined again. However, if you feel you are already knowledgeable about certain topics, you can jump around.

Each unit ends with a Unit Review. These reviews are designed to help you check your comprehension of the information presented in the units. Questions have been designed to review the information and to give you a chance to explore certain concepts further. You may find it useful to start a section by going through the Unit Review. This will help you focus on unfamiliar information. If you are already familiar with the information in any of the units, use the Unit Reviews to check your knowledge before you move on. The Unit Reviews also will prepare you for the final exam you must pass to receive credit for this course.

WHAT WILL BE COVERED IN THE COURSE?

This course is made up of seven units, each of which is described briefly below:

Unit 1: Course Introduction

This unit introduces you to the course, its objectives and goals, and the history of earthquakes in the United States.

Unit 2: Executive Order 12699

This unit introduces and explains the intent of Executive Order 12699.

Unit 3: Earthquake Causes and Characteristics

This unit presents the current theories on causes of earthquakes and discusses earthquake characteristics.

Unit 4: Earthquake Effects

This unit examines an earthquake's primary effects on the natural and built environments. Secondary consequences to communities also will be explored.

Unit 5: Protecting Your Community

This unit discusses the importance of mitigation practices and helps you to establish a seismic safety program tailored to your community's needs.

Unit 6: Evaluating Your Community's Safety

This unit will help you evaluate your community's susceptibility to loss of life and property damage due to earthquakes.

Unit 7: Conclusions

This unit reviews and summarizes key points made throughout the course.

UNIT 1 - SUMMARY

Unit 1 introduced us to the history of earthquakes in the United States, the purpose of this course, and the topics to be covered. In this unit, we answered the following questions:

- What is the history of earthquakes in the United States?
- How can your community be protected?
- What is the purpose of this course?
- For whom is this course designed?
- How should I proceed through the course?
- What will be covered in the course?

Unit 1

Course Introduction

Unit Review

Directions: For each question, circle the letter of the correct response and check your answers with the Answer Guide at the end of the unit.

1. The set of actions, resulting in permanent improvements, taken to reduce risk of injury and loss of life due to damage to structures during a natural disaster is referred to as:

   a. mitigation
   b. determent
   c. zoning
   d. land-use practices

2. To provide responsible individuals with the information they need to comply with Executive Order 12699 is:

   a. the purpose of the Earthquake Hazard Reduction Act.
   b. the purpose of this course.
   c. the responsibility of all Federal officials.
   d. the responsibility of lenders.

3. Which statement below is ***not*** an objective of this course?

   a. To describe the intent and implications of Executive Order 12699, the advantages of compliance, and the consequences of noncompliance.
   b. To evaluate national model building codes.
   c. To develop a plan of action to achieve compliance if local codes do not comply with the order.
   d. To describe how the order will affect the built environment.

4. Which activity cannot be defined as mitigation?

   a. Earthquake prediction
   b. Seismic education and awareness
   c. Adoption of building codes
   d. Land-use planning

5. This course has been designed for:

   a. only selected Federal officials.
   b. only Federal and State officials.
   c. only State and local decisionmakers.
   d. a variety of State, local, and Federal Government officials, as well as lenders and other private industry representatives.

6. What is the seismic hazard level of New York?

   a. Very low
   b. Very high
   c. Moderate
   d. High

7. The potential damage to the built environment (buildings, transportation lines and structures, communications lines, and utilities) due to an earthquake is referred to as seismic _____.

   a. hazard
   b. risk
   c. load
   d. affect

8. The earthquake hazards for Yellowstone National Park and Los Angeles are about the same. Which area has a higher risk?

   a. Yellowstone National Park
   b. Los Angeles

Unit 1

Course Introduction

Unit Review - Answer Guide

1. The set of actions, resulting in permanent improvements, taken to reduce risk of injury and loss of life due to damage to structures during a natural disaster is referred to as:

   a. mitigation
   Reference: p. 1-7

2. To provide responsible individuals with the information they need to comply with Executive Order 12699 is _____.

   b. the purpose of this course
   Reference: p. 1-9

3. Which statement below is ***not*** an objective of this course?

   b. To evaluate national model building codes.
   Reference: p. 1-9

4. Which activity cannot be defined as mitigation?

   a. Earthquake prediction.
   Reference: p. 1-7

5. This course has been designed for:

   d. a variety of State, local, and Federal Government officials, as well as lenders and other private industry representatives.
   Reference: p. 1-9

6. What is the seismic hazard level of New York?

   c. Moderate
   Reference: p. 1-3

7. The potential damage to the built environment (buildings, transportation lines and structures, communications lines, and utilities) due to an earthquake is referred to as seismic _____.

   b. risk
   Reference: p. 1-4

8. The earthquake hazards for Yellowstone National Park and Los Angeles are about the same. Which area has a higher risk?

   b. Los Angeles
   Reference: p. 1-3