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(Brief Description)

Donald G. Eagling

November 1980

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Brief Description

SEISMIC SAFETY GUIDE

A Practical Reference for a Comprehensive
Earthquake Safety Program

Donald G. Eagling

This work was supported by the U. S. Department of Energy
under Contract W-7405-ENG-48

Brief Description

SEISMIC SAFETY GUIDE

A Practical Reference for a Comprehensive
Earthquake Safety Program

Donald G. Eagling

This document will provide Managers of DOE facilities with a practical guide for administering a comprehensive earthquake safety program. Many believe that such a guide is badly needed. Often the approach for reviewing existing facilities is so overly sophisticated that the actual abatement of obvious deficiencies is delayed, costly and often legalistic rather than objective. As well, it is observed that buildings are still generally being constructed today without the benefit of a seismic plan check, a simple process that has proved so effective in actual experience with earthquakes in California.

Significantly, structural engineers who have observed and studied damaged buildings in the aftermath of earthquakes are generally able to diagnose hazardous deficiencies in existing buildings rather easily and efficiently. It is seldom necessary to carry out elaborate analyses to evaluate the seismic resistance of structures. The process of review does not have to be expensive or complex. Most often the problems found in construction and design are simply a failure to implement what has been known and observed about earthquake engineering for many years.

The concept of this "Guide" is to provide clear practical advice about earthquake safety and engineering to Managers of DOE facilities so that they can get the job done without falling into common pitfalls and prolonged diagnosis. It provides the Manager with basic guidelines and methodology, but it is not intended as a textbook nor as a substitute for the use of a competent consultant.

The "Guide" is comprehensive with respect to earthquakes covering natural hazards, site planning, evaluation and rehabilitation of existing buildings, design of new facilities, operational safety, emergency planning, special considerations related to shielding blocks, non-structural elements, lifelines, fire protection and emergency facilities. Management of risk and liabilities are also covered. Nuclear facilities per se are not dealt with specifically. The principles covered in the "Guide" apply generally, but the design and construction of such facilities are subject to special regulations and legal controls.

Each section of the "Guide" was written by a professional with solid design and field experience in his subject. Comment and advice from the Operator-Manager's point of view is also provided in the foreword to each section to bridge the gap between earthquake engineering and operational reality.

A brief description of the contents of the "Guide" follows:

SEISMIC SAFETY GUIDE

Compiled and Edited by
Donald G. Eagling
Plant Manager
Lawrence Berkeley Laboratory
Engineering Technical Services Division

Consultant Authors

Jack R. Benjamin
Jack R. Benjamin and
Associates, Inc.

John J. Earle
Shapiro, Okino, Horn
and Associates

Harold M. Engle, Jr.
Engle and Engle
Structural Engineers

Stephen R. Korbay
and
Lyle E. Lewis
Harding-Lawson
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Roland L. Sharpe
Engineering Decision
Analysis Co., Inc.

James L. Stratta
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SEISMIC SAFETY GUIDE

CONTENTS

1. INTRODUCTION - Donald G. Eagling
The background for and purpose of the Seismic Safety Guide.
2. THE OPERATOR-MANAGER'S ROLE IN EARTHQUAKE SAFETY - Donald G. Eagling
The elements of a comprehensive earthquake safety program. How to manage it, find good consultants and avoid common pitfalls. Discretionary policies, due process and design criteria not covered by Code.
3. EARTHQUAKE DAMAGE - James L. Stratta, Consulting Engineer
Foreword by Donald G. Eagling
The "earthquake chaser's" point of view, typical failures and problems in the aftermath of damaging earthquakes. Effects on buildings, tanks, utilities, lifelines and other structures.
4. SITE USE PLANNING FOR EARTHQUAKE SAFETY - Stephen R. Korbay and Lyle E. Lewis, Harding-Lawson Associates
Foreword by Donald G. Eagling
An assessment of site related hazards, faults, groundshaking, slides, subsidence, liquefaction and tsunamis. Practical considerations in site use planning.
5. DESIGN OF NEW FACILITIES FOR EARTHQUAKE SAFETY - Roland L. Sharpe, Engineering Decision Analysis Company, Inc.
Foreword by Donald G. Eagling
Analysis and design of new buildings and facilities for earthquake safety including non-structural elements and lifelines. Principles

and practical guidelines for earthquake resistant design; recommended details, references and plan check procedures. The use and limitations of dynamic analysis for special situations.

6. EVALUATION OF EXISTING BUILDINGS FOR EARTHQUAKE SAFETY - Harold M. Engle, Jr., Engle and Engle Structural Engineers

Foreword by Donald G. Eagling

Methodology for surveying existing buildings and facilities for earthquake related hazards; common problems related to type of construction and historical performance.

7. REHABILITATION OF BUILDINGS FOR EARTHQUAKE SAFETY - John J. Earle, Shapiro, Okino, Hom and Associates

Foreword by Donald G. Eagling

The analysis and design of rehabilitation projects for earthquake safety. Typical problem construction and methods for abatement of hazards. Design principles and criteria for corrective measures.

8. EVALUATION OF OPERATIONS AND BUILDING CONTENTS FOR EARTHQUAKE SAFETY - James L. Stratta, Consulting Engineer

Foreword by Donald G. Eagling

Seismic hazards related to operations, occupancy, building contents and personnel safety. Inspection techniques and procedures to mitigate potential for damage and personal injury.

9. EMERGENCY PLANNING FOR EARTHQUAKE SAFETY - Donald G. Eagling

Use of the scenario technique to develop a realistic model for the aftermath of a damaging earthquake. Preparing emergency plans,

organizations, facilities and operations to handle the emergency recovery situation.

10. RISK MANAGEMENT PLANNING FOR EARTHQUAKE SAFETY - Jack R. Benjamin, Jack R. Benjamin and Associates, Inc., Consulting Engineers

Foreword by Donald G. Eagling

Techniques for dealing with the probabilistic nature of earthquakes.

Relating hazards, mitigation costs and probability to management decisions.

11. DESIGN OF CONCRETE SHIELDING BLOCKS FOR EARTHQUAKE SAFETY - John J. Earle Shapiro, Okino, Hom and Associates

Foreword by Donald G. Eagling

Review of seismic problems related to shielding blocks; how unanchored blocks may act in a strong earthquake. Suggested design criteria and solutions for restraining block assemblies.

12. MODEL CODE SERVICES - International Conference of Building Officials (ICBO)

Foreword by Donald G. Eagling

Description of the services available to the DOE Operator-Manager through Class A Membership in the International Conference of Building Officials, publishers of the Uniform Building Code; membership qualifications, functional and legal relationship of the ICBO to the "Building Official."

Biographical Sketches of Authors

Jack R. Benjamin, Ph.D., Civil Engineer
Structural Engineer

Dr. Benjamin is a leader in the application of probabilistic methods and decision theory in civil engineering. He is Professor Emeritus of Civil Engineering at Stanford University. Dr. Benjamin is author of the book Statically Indeterminate Structures, one of the McGraw-Hill Engineering Series, and is co-author of the book Probability, Statistics, and Decision for Civil Engineers, the standard text and reference on probabilistic methods in civil engineering.

Much of his work has dealt with extreme and unusual (high-hazard) loading conditions, the development of rational, probability-based design criteria, and safety analyses using decision, event, and fault tree techniques. In addition, he has had extensive structural engineering experience for more than 30 years, both as a consultant and in his own design practice. A registered engineer in California, Dr. Benjamin is chairman of the board of Jack R. Benjamin and Associates, Inc., Consulting Engineers, Palo Alto, California.

John J. Earle, Civil Engineer
Structural Engineer

Mr. Earle has extensive structural analysis and design experience and is widely active in seismic code and educational work. He was the principal contact and project engineer for all work on the structural analysis and design of the earthquake-resisting systems incorporated into existing buildings, radiation shielding blocks, and other facilities and equipment at Lawrence Berkeley Laboratory. Much of his work includes seismic design of schools, laboratories and other facilities.

He currently is chairman both of the Structural Technical Group and the Professional Development Committee of the American Society of Civil Engineers. He also is chairman of the Continuing Education Committee of the Structural Engineers Association of Northern California. He has organized several seminars on seismic code and design.

Mr. Earle is a Registered Civil and Structural Engineer in California, working on the staff of Shapiro, Okino, Horn and Associates, Engineers, San Francisco, California, which was founded for the practice of structural engineering by Daniel Shapiro in 1965.

H. M. Engle, Jr., Civil Engineer
Structural Engineer
H. M. Engle, Sr., Civil Engineer
(1898 - 1977) Structural Engineer

Engle & Engle were the lead structural engineers of the seismic safety program at Lawrence Berkeley Laboratory. In addition they have played a principal role in the many aspects of writing and producing this publication.

Mr. Engle, Sr.'s 58-year career in civil and structural engineering included 19 years on the Field Act Advisory Board to the State Architect (California) for the design of public school buildings. Additionally, he was the Consulting Structural engineer for the Pacific Fire Rating Bureau and Factory Insurance Association, responsible for review of seismic risks. He also developed procedures for rating buildings for earthquake insurance rates. A charter member of the Earthquake Engineering Research Institute, Consulting Engineers Association of California, and the Structural Engineers Association of Northern California, he was also a member of the American Society of Civil Engineers and the Seismological Society of America. Mr. Engle was the author of numerous publications and, throughout his career, gave more than 100 talks on earthquakes and earthquake-resistant structural design before various technical societies and service clubs.

H. M. Engle, Jr., a University of Southern California graduate, has had 18 years in the Engle & Engle partnership and is now sole technical partner in the firm. He is a member of the Structural Engineers Association of Northern California, the Earthquake Engineering Research Institute, and the Consulting Engineers Association of California. To his work in the field of seismic analysis and design, Mr. Engle has brought a thoroughly professional methodology for surveying existing buildings and facilities for earthquake-related hazards. Engle & Engle is located in San Rafael, California.

Lyle E. Lewis, Civil Engineer
Agricultural Engineer

Mr. Lewis has been consulting in soil mechanics, instrumentation, and all phases of laboratory testing of soils for the past 18 years, with extensive experience in dams and tailings piles in the Western United States. He also has considerable experience with solid waste disposal sites and projects, landslide repair and dredging technology. He is a Registered Civil Engineer in California and an Associate Engineer in the firm of Harding-Lawson Associates, Novato, California.

Stephen R. Korbay, Geologist, Engineering Geologist

Mr. Korbay has extensive experience in geologic investigations for earthfill dams, subdivisions, nuclear power plants, pipeline and transmission line routes, and geothermal steam well sites. He has performed geologic hazards assessments and is experienced in geologic and hydrologic studies for environmental impact reports. He has conducted water resource evaluations and construction materials searches at numerous sites in California, Nevada, Texas and Guam. He has special expertise in geologic/seismic investigations for hospitals and schools. He is a Registered Geologist and a Certified Engineering Geologist in California, and an Associate Geologist with Harding-Lawson Associates, Novato, California.

Roland L. Sharpe, Civil Engineer
Structural Engineer

A leading authority in the field of seismic safety, Mr. Sharpe has 33 years' experience in structural and earthquake engineering design. He was the project director for the National Science Foundation/National Bureau of Standards project to develop comprehensive seismic design recommendations which can be adapted by jurisdictions throughout the United States. He was also a principal consultant to the United States Atomic Energy Commission on the seismic safety of nuclear power plants, and he directed and administered planning, criteria determination and structural engineering design for the Stanford Linear Accelerator.

Mr. Sharpe has authored numerous publications and engineering analyses and research reports on: recommendations concerning the behaviour of structural systems under dynamic loading; recommendations for shape of earthquake response spectra; seismic design of structures; and on the need for seismic design of mechanical and electrical equipment.

He is active in a number of professional organizations and has served the Structural Engineers Association of California on the board of directors and currently as chairman of the American Society of Civil Engineers Committee on Dynamic Effects. He also served on the board of directors of the Earthquake Engineering Research Institute. He is chairman of the board and senior consultant of Engineering Decision Analysis Company, Inc., Palo Alto, California and Frankfurt, W. Germany.

James L. Stratta, Civil Engineer
Structural Engineer

Mr. Stratta has been a consulting civil and structural engineer since his graduation from the University of California at Berkeley in 1943. In 1952 he joined a partnership for architecture and engineering, with special emphasis on seismic analysis and design. He began his private consulting practice in 1978.

Mr. Stratta served in 1962 as president of the Structural Engineers Association of Northern California, and in 1967 as president of the Consulting Engineers Association of California. He was a director of the American Consulting Engineers Council, Earthquake Engineering Research Institute in 1968. He is a fellow of both the American Society of Civil Engineers, and the American Consulting Engineers Council. He has taken part in world-wide earthquake conferences and surveyed numerous quake sites. James L. Stratta Associates is located in Menlo Park, California.

Mr. Stratta has co-authored reports on the following seismic events:

- | | |
|-------------|--|
| 1964 | Anchorage, Alaska Earthquake. |
| 1970 & 1974 | Peru Earthquakes. |
| 1971 | Interaction of Infill Walls and Concrete
Frames During Earthquakes. |
| 1976 | Rotation of Footings Due to Surface Waves. |
| 1977 | Mindanao, Philippines Earthquakes. |
| 1979 | Friuli Earthquake, Italy 1976. |

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