ASCE Manuals and Reports on Engineering Practice No. 96

Guide to Improved Earthquake Performance of Electric Power Systems

ASCE

AMERICAN SOCIETY OF CIVIL ENGINEERS

ASCE Manuals and Reports on Engineering Practice No. 96

Guide to Improved Earthquake Performance of Electric Power Systems

Prepared by
Electric Power and Communications Committee
Technical Council on Lifeline Earthquake Engineering

Edited by
Anshel J. Schiff

Published by
ASCE American Society of Civil Engineers
1801 Alexander Bell Drive
Reston, Virginia 20191-4400

Abstract: The Manual documents methods to improve the earthquake response of electric power systems. A review of the Manual should raise the awareness and understanding of the vulnerabilities of power system facilities and equipment. The emphasis is on power system elements that have been damaged by earthquakes, primarily high-voltage substation equipment. Power-generating stations, transmission and distribution lines, substations, system communications and control, and ancillary facilities and functions are also discussed. A detailed review of earthquake damage to power facilities and suggestions to improve their performance are presented. The Manual suggests an overall approach to an earthquake mitigation program. Postearthquake emergency response procedures to reduce the disruption from damaged facilities are also discussed. The Manual demonstrates that improved installation practices and other mitigation measures, particularly for new construction and during refurbishment, that are cost-effective in any region with a history of significant earthquakes can be implemented to improve earthquake performance.

Library of Congress Cataloging-in-Publication Data

American Society of Civil Engineers. Electric Power and Communications Committee.
Guide to improved earthquake performance of electric power systems / prepared by Electric Power and Communications Committee, Technical Council on Lifeline Earthquake Engineering.
p. cm.—(ASCE manuals and reports on engineering practice ; no. 96)
Includes bibliographical references and index.
ISBN 0-7844-0414-3
1. Electric power systems—Earthquake effects. 2. Lifeline earthquake engineering. I. Title. II . Series.
TK1005.A633 1999
621.31'21—dc21 99-20666
CIP

Library of Congress Catalog Card No: 99-20666
ISBN 0-7844-0414-3
Manufactured in the United States of America

MANUALS AND REPORTS ON ENGINEERING PRACTICE

(As developed by the ASCE Technical Procedures Committee, July 1930, and revised March 1935, February 1962, and April 1982)

A manual or report in this series consists of an orderly presentation of facts on a particular subject, supplemented by an analysis of limitations and applications of these facts. It contains information useful to the average engineer in his everyday work, rather than the findings that may be useful only occasionally or rarely. It is not in any sense a "standard," however; nor is it so elementary or so conclusive as to provide a "rule of thumb" for non-engineers.

Furthermore, material in this series, in distinction from a paper (which expressed only one person's observations or opinions), is the work of a committee or group selected to assemble and express informaton on a specific topic. As often as practicable the committee is under the direction of one or more of the Technical Divisions and Councils, and the product evolved has been subjected to review by the Executive Committee of the Division or Council. As a step in the process of this review, proposed manuscripts are often brought before the members of the Technical Divisions and Councils for comment, which may serve as the basis for improvement. When published, each work shows the names of the committees by which it was compiled and indicates clearly the several processes through which it has passed in review, in order that its merit may be definitely understood.

In February 1962 (and revised in April 1982) the Board of Direction voted to establish:

> A series entitled "Manuals and Reports on Engineering Practice," to include the Manuals published and authorized to date, future Manuals of Professional Practice, and Reports on Engineering Practice. All such Manual or Report material of the Society would have been refereed in a manner approved by the Board Committee on Publications and would be bound, with applicable discussion, in books similar to past Manuals. Numbering would be consecutive and would be a continuation of present Manual numbers. In some cases of reports of joint committees, bypassing of Journal publications may be authorized.

MANUALS AND REPORTS OF ENGINEERING PRACTICE

No.	Title
13	Filtering Materials for Sewage Treatment Plants
14	Accommodation of Utility Plant Within the Rights-of-Way of Urban Streets and Highways
34	Definitions of Surveying and Associated Terms
35	A List of Translations of Foreign Literature on Hydraulics
37	Design and Construction of Sanitary and Storm Sewers
40	Ground Water Management
41	Plastic Design in Steel: A Guide and Commentary
45	Consulting Engineering: A Guide for the Engagement of Engineering Services
46	Pipeline Route Selection for Rural and Cross-Country Pipelines
47	Selected Abstracts on Structural Applications of Plastics
49	Urban Planning Guide
50	Planning and Design Guidelines for Small Craft Harbors
51	Survey of Current Structural Research
52	Guide for the Design of Steel Transmission Towers
53	Criteria for Maintenance of Multilane Highways
54	Sedimentation Engineering
55	Guide to Employment Conditions for Civil Engineers
57	Management, Operation and Maintenance of Irrigation and Drainage Systems
59	Computer Pricing Practices
60	Gravity Sanitary Sewer Design and Construction
62	Existing Sewer Evaluation and Rehabilitation
63	Structural Plastics Design Manual
64	Manual on Engineering Surveying
65	Construction Cost Control
66	Structural Plastics Selection Manual
67	Wind Tunnel Studies of Buildings and Structures
68	Aeration: A Wastewater Treatment Process
69	Sulfide in Wastewater Collection and Treatment Systems
70	Evapotranspiration and Irrigation Water Requirements
71	Agricultural Salinity Assessment and Management
72	Design of Steel Transmission Pole Structures
73	Quality in the Constructed Project: A Guide for Owners, Designers, and Constructors
74	Guidelines for Electrical Transmission Line Structural Loading
75	Right-of-Way Surveying
76	Design of Municipal Wastewater Treatment Plants
77	Design and Construction of Urban Stormwater Management Systems
78	Structural Fire Protection
79	Steel Penstocks
80	Ship Channel Design
81	Guidelines for Cloud Seeding to Augment Precipitation
82	Odor Control in Wastewater Treatment Plants
83	Environmental Site Investigation
84	Mechanical Connections in Wood Structures
85	Quality of Ground Water
86	Operation and Maintenance of Ground Water Facilities
87	Urban Runoff Quality Manual
88	Management of Water Treatment Plant Residuals
89	Pipeline Crossings
90	Guide to Structural Optimization
91	Design of Guyed Electrical Transmission Structures
92	Manhole Inspection and Rehabilitation
93	Crane Safety on Construction Sites
94	Inland Navigation: Locks, Dams, and Channels
95	Urban Subsurface Drainage
96	Guide to Improved Earthquake Performance of Electric Power Systems
97	Hydraulic Modeling: Concepts and Practice

TABLE OF CONTENTS