



**US Army Corps
of Engineers**

Hydrologic Engineering Center

Emergency Planning for Dams

**Bibliography and Abstracts of Selected
Publications**

January 1982

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14. ABSTRACT This document is designed to assist Corps and other planners by providing a bibliography and abstracts of selected publications relevant to emergency planning for dams and development of flood evacuation plans. This document is supplemented by RD-13, "Flood Emergency Plans: Guidelines for Corps Dams", June 1980.					
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Emergency Planning for Dams

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RD-17

Foreword

As part of its dam safety program, the Corps is committed to development of emergency plans for Corps dams. The Hydrologic Engineering Center has been given responsibility for development of the necessary planning guidance.

This document is designed to assist Corps and other planners by providing a bibliography and abstracts of selected publications relevant to emergency planning for dams and development of flood evacuation plans. It supplements the document "Flood Emergency Plans: Guidelines for Corps Dams" (RD-13) which was issued by the Director of Civil Works on 30 June 1980.

Mr. H. James Owen, Principal of Flood Loss Reduction Associates, prepared this document pursuant to contract DACW05-80-C-0101 with the Hydrologic Engineering Center. Mr. Bill S. Eichert was the Director of HEC during its preparation. Mr. Arlen Feldman of HEC was the Principal-In-Charge.

Emergency Planning for Dams Bibliography and Abstracts of Selected Publications

Introduction

Background

Extensive care is taken by the Corps in design, construction and operation of dams. As a result, the Corps record for dam safety is considered excellent. Nevertheless, dam failures in the United States in recent years have focused much attention on dam safety, resulting in a requirement for all Federal agencies to review practices affecting the safety and integrity of Federal dams.

As part of the Corps Dam Safety Assurance Program, the office of the Chief of Engineers has directed the preparation of emergency plans for all Corps dams. District offices have also been directed to offer assistance in evacuation planning to local government officials in areas potentially affected by emergencies at Corps dams. Areas potentially affected include downstream areas and lands constituting the reservoir area that would be inundated by spillway design flood.

The Hydrologic Engineering Center has been assigned responsibility for preparation of technical guidance for the required planning. The first major item, "Flood Emergency Plans: Guidelines for Corps Dam" (RD-13), was issued by the Director of Civil Works on 30 June 1980. An appendix to the guidelines entitled "Preparation and Publication of Inundation Maps for Flood Emergency Plans" was issued shortly thereafter. An example emergency plan for Blue Marsh Dam near Reading, Pennsylvania, is being prepared and is expected to be distributed early in 1982 (RD-19, RD-20).

Purpose

The purpose of this document is to assist Corps of Engineers and other planners by providing a bibliography and abstracts of selected publications relevant to emergency planning for dams and preparation of flood evacuation plans. Within this overall purpose, it serves three specific objectives:

- Review of the abstracts provides an introduction to emergency planning for dams and illustrates the large number of considerations which enter into such planning and the high level of technical sophistication required for dealing with some aspects. This information can assist planners in avoiding omission of important points during preparation of plans of study and other activities requiring a broad overview.

- The abstracts provide assistance in identifying publications which contain detailed listings useful in establishing field inspection procedures and in performing the required planning.
- Many of the publications listed in the bibliography contain an extensive list of references. They, therefore, provide a convenient starting point in finding examples and further information concerning specific aspects of emergency planning for dams and flood evacuation planning.

Scope

The literature which addresses emergency planning for dams is limited in amount and subject. Additional and more comprehensive materials will doubtless become available as experience is gained in planning and maintenance of emergency plans for dams. However, at present, much of the directly related literature consists of detailed analytical information concerning some specific point. Somewhat the reverse situation exists with regard to flood evacuation planning. Guidance and other documents tend to be general and focused on the conceptual aspects of planning and detailed analytical information is limited.

The bibliography includes some publications of each type, including all references included in the "Federal Guidelines for Dam Safety"¹. Abstracts are included for most of the publications cited in those guidelines.

Organization

The remainder of this publication is divided into two attachments which respectively include: a) bibliography of useful references; and, b) abstracts of selected publications.

¹ Ad Hoc Interagency Committee on Dam Safety, Federal Coordinating Council for Science, Engineering and Technology. "Federal Guidelines for Dam Safety. Washington, DC. 25 June 1978.

Attachment 1

Bibliography of Useful References

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Attachment 2
Abstracts of Select Publications

The Evaluation of Dam Safety

American Society of Civil Engineers, Engineering Foundation Conference Proceedings, New York, New York, 1977.

The document is the proceedings of a conference held November 28 – December 3, 1976. The conference was attended by over 150 representatives of engineering organizations and agencies in the United States and representatives of five other countries. Session titles and papers presented at each session include:

Status of Dam Safety

- Status Report on Public Law 92-367.
- Status of States' Dam Safety Programs.
- British Reservoir Legislation and the Reservoir Act (1975).
- Summary of the Session on Status of Dam Safety.

Failure and Near Failure

- Teton Dam Failure.
- Summary of Session on Failure and Near Failure.
- The Malpasset Dam.

Safety Inspections

- California's Dam Surveillance Program.
- Forest Service Safety of Dams Studies.
- A State's View of the Recommended Inspection Guidelines.
- Bureau of Reclamation's Assessment of Safety of Old Dams.
- Summary of Session on Safety of Dams.

Potpourri Session

- Dam Safety Program of the East Bay Municipal District.
- Evaluation of Seepage Stability of Dams.
- Unit Curves for Judging Spillway Adequacy.
- Summary of Potpourri Session.

Evaluation of Static Stability

- Identifying Potential Stability Problems.
- Latent Stability Deficiencies.
- Acoustic Emission Monitoring of Dams.
- Summary of Session on Evaluation of Static Stability.

Evaluation of Seismic Stability

- The Oroville Earthquake and Oroville Dam.
- Developing Design Earthquakes.
- Summary of 1st Session on Evaluation of Seismic Stability.
- Seismic Stability Evaluation of Existing Concrete Dams.
- Comments on Seismic Stability Evaluation of Embankment Dams.
- Summary of 2nd Session on Evaluation of Seismic Stability.

Evaluation of Hydrologic and Hydraulic Conditions

- Evaluation Guidelines for Spillway Adequacy.
- The PMF Concept.
- Downstream Hydrograph from Dam Failure.
- Proposed Additions to Inspection Guidelines.
- Summary of Session on Evaluation of Hydrologic and Hydraulic Conditions.

The Role of Engineering Firms in a National Dam Safety Program

- Capabilities of the Private Engineering Sector for Dam Safety Inspections.
- Dam Safety Guidelines – Responsibility and Liability.

Inspection, Maintenance and Rehabilitation of Old Dams

American Society of Civil Engineers, Engineering Foundation Conference Proceedings, New York, New York, 1973.

The document is the proceedings of a conference held 23-28 September 1973. The conference was attended by over 200 people, primarily representatives of federal and state agencies and consulting engineering firms. Session and workshop titles and the papers presented at each session include:

Keynote Session

- Opening Remarks.
- Rehabilitation of Dams: Retrospect and Prospect.
- National Program for Inspection of Dams.

Federal Inspection Activities

- Dam Inspection Program for the Federal Power Commission.
- TVA Dam Inspection Activities.
- Bureau of Reclamation Examination Program.
- Corps of Engineers Dam Inspection Program.
- Summary of the Session on Federal Inspection Activities.

States Experience and Their Problems

- Introduction.
- States' Experiences in Dam Safety Regulation.
- Experience and Problems with Dams in Idaho.
- Experience and Problems with Dams in Texas.
- Administration of Dam Safety in California in 1973.
- Dam Safety Program in Pennsylvania.

International Experiences

- Supervision of Dams at the Swedish State Power Board.
- Dam Safety Laws and Inspection Procedures in the United Kingdom.
- French Laws and Regulations Regarding Dam Supervision and Inspection.

- Electricite de France Experiences and Practice in Safety Inspections of Old and New Dams.
- Dam Safety Laws and Dam Safety Inspection in South Africa.
- Summary.

Workshop A – Hydrology and Spillways

- Summaries of Sessions.
- Reaction to Uscold's Proposed Law for Dam Safety.
- Some Procedures for Determining Extreme Precipitation Criteria.
- Conversion of Maximum Rainfalls to Floods (Bureau of Reclamation Techniques).
- Probabilities of Rare Floods.
- Reevaluating Spillway Adequacy of Existing Dams.
- Selecting Spillway Floods for Existing Structures (Bureau of Reclamation Application).
- Safety of Dams – Hydrologic & Hydraulic Aspects.
- Selecting the Appropriate Design Flood.
- Making Decisions in the Face of Uncertainty.
- Review of Spillway Adequacy at Existing Bureau of Reclamation Dams.
- Flood Inflation.

Workshop B – Materials Deterioration and Ancillary Equipment

- Safety Appraisal of Old Dams: An Updated Perspective.
- Stress Studies of Three Old Arch Dams.
- Mechanical Equipment Problems in Old Dams.
- Maintenance and Repairs of Ancillary Equipment.
- Underwater Inspection by Submarine.
- Alkali-Silica Reaction: A Major Cause of Concrete Deterioration.
- Determination of Concrete Properties in Old Dams.
- Rehabilitation of an Old Concrete Dam.
- Application of New Methods of Structural Analysis for Safety Investigation of Concrete Dams.
- An Owner's Program for the Investigation and Analysis of its Dams (Los Angeles Flood Control District).
- Owner's Comments.
- Summary of Presentation and Discussions on Materials Deterioration and Ancillary Equipment.

Workshop C – Foundations

- Summary of Workshop.
- Investigation by Geophysical and Instrumentation.
- Purpose or Need for Grouting in the Treatment of Foundations.
- When is Foundation Seepage Unsafe?

- Foundations of Existing Dams – Seepage Control.
- Evaluating Foundation Seepage Problems.
- Investigations into Control of Seepage.
- A Review of TVA's Problems and Treatments of Foundations of Existing Dams.
- Foundation Seepage Control Options for Existing Dams.
- Stability of Existing Dam Foundations.
- Stability of Old Dams as Related to Their Foundations.
- Norwood Dam Foundation Stabilization: A Case History.
- Determinations of the Adequacy of Investigations for Evaluation of Dam Safety.
- Analyzing and Strengthening Concrete Dams on Deficient Foundation.

Workshop D – Seismic Hazards and Problems

- General Report.
- Potentially Active Faults in Dam Foundations.
- Evaluation of Effects of Ground Shaking on Concrete Gravity Dams.
- Current Program of Seismic Safety
- Current Programs for Seismic Safety – Bureau of Reclamation.
- Program for Investigation and Analysis of Dams (Los Angeles Flood Control District).
- Silver Lake Reservoir Reconstruction.
- Ebmud's Programs for Inspection and Remedial Treatment of Old Dams.
- Some Seismic Studies of Old Dams.
- Inspection, Maintenance and Remedial Treatment: San Francisco Water Department.
- Seismic Safety Study of Henshaw Dam.

Responsibility and Liability of Public and Private Interests on Dams

American Society of Civil Engineers, Engineering Foundation Conference. New York, New York, 1976.

The document is the proceedings of a conference held 28 September – 3 October 1975. Papers included in the proceedings are:

- Federal Legislation and Activities for Dam Safety.
- National Program of Inspection of Dams: Existing Practices and Capabilities.
- National Program of Inspection of Dams: National Dam Inventory.
- Dams in Relation to Balanced Public Safety.
- Review and Responsibility of State Dam Safety Programs.
- Missouri Dams: A Case History.
- Dam Safety – Texas Style.
- An Outline of the Enforcement of Safety of Dams Statutes in California.
- Case History – Problems in Obtaining Repairs to Barber Dam.
- The Agency, the Owner, and the Engineer, in Texas.
- One Owner's Dam Safety Program and its Application Under Government Regulation.
- Text of Comments Regarding California's Legal Experience in the Liability of Public Interests.
- Liability of the United States Under the Federal Tort Claims Act (28 U.S.C. ss 1346(b), 2672-80).
- Liability Considerations in State Dam Permit and Inspection Programs (A Look at Ohio's Program).
- Dams for Others.
- Policy Making and Acceptable Earthquake Risk.
- Alberta's Viewpoint on Risk.
- Liability of Consultants in Dam Investigations.
- Judgment in Dam Design.
- Liability of Public and Private Interests on Dams.
- Conference Summary.

Safety of Small Dams

American Society of Civil Engineers, Engineering Foundation Conference Proceedings. New York, New York, 1975.

The document is the proceedings of a conference held 4-9 August 1974. The conference was attended by one hundred and ten persons representing over thirty individual states, numerous federal agencies, and private firms. The following papers are included in the proceedings:

- Status of Corps Activities.
- Inspection Guidelines – General Aspects.
- Guidelines Proposed for the Hydrologic & Hydraulic Engineering Aspects of the National Program for Inspection of Dams.
- Inspection Guidelines – Stability Aspects.
- Dam Safety Legislation: A Solution or a Problem.
- State Safety of Dams Legislation: The Maine Experience.
- Decision Analysis in Dam Safety Monitoring.
- Evaluation and Repair of Stonewall-Earth Dams.
- Michigan Statutes Regulating Dam Construction and Inspections.
- Kentucky's Experience with Dams and Dam Safety.
- New Hampshire Water Resources Board.
- Safety, Investigations, Inspections, and Analyses of Existing Dams.
- Investigation of Old Dams and Their Message.
- Notes on the Inspection of Federal Flood Control Dams.
- Safety Inspection for Small Dams.
- Corps of Engineers Views on Safety of Dams.
- Procedures Used by the Bureau of Reclamation.
- Maintenance and Inspection Programs for Soil Conservation Service Dams.
- The Miami Conservancy District.
- Reevaluating Spillway Adequacy of Existing Dams.
- Ohio's Guidelines for Dam and Spillway Design.
- Hydrologic Aspects of Spillway Design Requirements.
- Dam Safety and Spillway Design Considerations.
- Bureau of Reclamation's Criteria for the Design of Spillways.
- Identifying Foundation Problems.

A Perspective on Disaster Planning

Dynes, Russell R. and E.L. Quarantelli, Disaster Research Center, The Ohio State University, Columbus, Ohio, June 1972.

The report summarizes the results of a systematic study of behavior and response in over 100 community disasters. It describes an approach to conceptualization of disasters which is generally applicable to all situations. The report covers planning, characteristics of disaster agents, behavior during disasters, community organization and elements of response to disaster.

The report focuses on social disruption caused by the physical impact of a disaster agent. The dimensions of disaster agents (predictability, frequency, controllability, speed of onset, length of forewarning, duration of impact, scope of impact, and intensity of impact) are described and the relevance of each of these factors is briefly discussed. Time phases for disasters are also defined including pre-disaster (normal situation), pre-impact (from first warning to impact), impact (period of occurrence), emergency (period of response to disaster generated demands) and recovery. The potential for overlap of phases due to multiple and secondary threats are briefly discussed.

The types of demands on a community which occur are discussed including those generated by the disaster agent and those generated by the response to the disaster agent.

The report also discusses the popular concepts of disaster behavior and the differences from demonstrated behavior in disaster situations. Implications of each to planning are identified and described.

Succeeding sections of the report describe the impact of disaster agents on the community's social structure, the process of mobilizing manpower and resources and the changed conditions for operation which exist in disasters. The elements of an organized response in disasters are discussed including the definition of organizational domains of responsibility, tasks to be accomplished and activities to implement the tasks. Specific issues involved in disaster planning are presented.

Federal Guidelines for Dam Safety

Federal Coordinating Council for Science, Engineering and Technology. Ad Hoc Interagency Committee on Dam Safety. Washington, DC, 25 June 1978.

The guidelines were prepared in response to a memorandum from President Carter dated 23 April 1977 which directed federal agencies to review their dam safety practices. The Agencies' reviews and the assessment of the reviews by a Federal ad hoc interagency committee and by an independent review panel showed that sound practices were generally being used, but concluded that improvement was needed in some management practices. The guidelines are intended to promote management control of dam safety and a common approach to dam safety practices. They outline Federal agency management procedures that will continually stimulate technical methods in dam planning, design, construction, and operation for minimizing risk of failure.

The guidelines are organized into three parts, supplemented by five appendices, Part I covers the background, authority and implementation of the document and defines key terms. Part II describes the objectives and scope. Part III contains the actual guidelines and constitutes the major portion of the document. It addresses numerous matters including:

- Organization management.
- Management of technical activities related to site investigation and design.
- Management of technical activities related to construction.
- Management of technical activities related to operation and maintenance.

Appendices to the guidelines list members of the committees and independent review panel responsible for preparation of the document, acknowledge individuals who carried out specific assignments in preparing various sections, and provide a bibliography of pertinent references.

The Warning System in Disaster Situations: A Selective Analysis

McLuckie, Benjamin F., Department of Sociology, Disaster Research Center, The Ohio State University Columbus, OH, July 1970.

The report examines the processes making up a warning system. Processes are described in terms of psychological and sociological aspects and the influence affected by the socio-cultural framework, the historical setting, and the immediate ongoing social situation.

Warning is defined as the "the transmission to individuals, groups, or populations of messages which provide them with information about (1) the existence of danger, and (2) what can be done to prevent, avoid, or minimize the danger". Distinction is made between the human components of warning and the mechanical devices such as sirens and radios which are the means of warning.

Key points discussed in the report are:

- Implications of warning of the major characteristics of disaster agents.
- The search for information initiated by recognition of a serious threat (including descriptions of information collection using various means of communications, meetings, and other techniques).
- Matters affecting evaluation of information with respect to reliability, interpretation of meaning, and resolution of conflicts. Major aspects affecting reliability are discussed.
- Means of disseminating warning messages and associated problems.
- Types of community subsystems which are set in motion when a decision is made to warn of an impending disaster.
- Content of warning messages including degree of specificity, degree of urgency, conveyance of projected consequences of the threat and implied probability of occurrence.
- Responses to warnings with respect to the effect of sociological framework, historical setting and immediately ongoing social setting on individual and group responses, the reaction of individuals and organizations to warnings, and responses to warnings later in a disaster.

An appendix to the report presents a case study of the warning system operation in Topeka when a tornado occurred in 1966.

Guide for Flood and Flash Flood Preparedness Planning

National Oceanic and Atmospheric Administration, National Weather Service, Washington, DC, May 1977.

The Guide provides assistance to communities and planners in assessing the adequacy of existing flood warning systems and flood preparedness plans, identifying the appropriate content and detail of new preparedness plans, and developing adequate warning systems and preparedness plans. The report is organized into five parts plus a check-list and a list of useful references.

Part I provides a brief introduction including description of purpose, background and scope. General procedures for evaluating existing warning systems and preparedness plans are described as are those for developing a plan of study for preparedness planning and managing the preparedness planning process.

Part III lists tasks and subtasks to be considered in developing a comprehensive flood warning system and flood preparedness plan. Tasks are organized into plan "elements". Guidance provided for each element includes a brief statement of objectives, listing of relevant tasks, and descriptions of the subtasks comprising the tasks. The need is noted for multiple warning systems in communities subject to flooding from more than one source and for varying plan sophistication according to the expected frequency and severity of flooding; the size of population affected, and required speed of warning.

Part IV of the Guide contains general observations concerning the preparedness planning process and the effect of various factors on the nature of the plan. Communications are discussed with regard to disseminating warnings and numerous means are identified. Types of organizations and categories of individuals requiring special warnings are listed. Numerous suggestions are also included concerning preparing maps and organizing the preparedness planning document for maximum usefulness.

Part V of the Guide describes assistance and information available from various federal agencies for development of warning systems and preparedness plans. It also identifies the types of state, local and private organizations which may have useful information or be able to assist in either planning or execution of the plan.

Fundamentals of Earthquake Engineering

Newmark, N.M. and E. Rosenblueth, Englewood Cliffs, NJ. Prentiss Hall, 1971.

The book is essentially a reference work and graduate textbook. The reader is assumed to have under-graduate knowledge of mechanics, applied mathematics and structural engineering. The book includes material on: (1) the dynamics needed to follow and apply the rest of the text; (2) the characteristics of earthquake motions, mostly in a probabilistic framework, and behavior of materials when subjected to such motions; and (3) recommended design concepts and methods. Appendices cover specialized topics. The first part of the book contains several worked-out examples and problems to which answers are provided. The book is divided into the following part and chapters:

Part 1 - Dynamics

- Simple Linear Systems.
- Linear Systems with Several Degrees of Freedom.
- Linear Systems with Distributed Mass.
- Numerical Computation of Steady-State Responses and Natural Modes.
- Nonlinear Systems.
- Hydrodynamics.

Part 2 – Earthquake Motions and Structural Responses

- Characteristics of Earthquakes.
- Seismicity.
- Probability Distributions of Response Spectral Ordinates.
- Responses of Linear Multidegree Systems.
- Responses of Nonlinear Systems.
- Earthquake Effects on Reservoirs.
- Behavior of Materials and Structural Components under Earthquake Loading.

Part 3 – Design

- Basic Concepts in Earthquake-Resistant Design.
- Earthquake – Resistant Design of Buildings.
- Other Topics in Earthquake-Resistant Design.
- Tests and Observations.

The chapter on Hydrodynamics discusses pressures against dams including computation of earthquake induced pressures, distribution of pressures for various dam shapes, effect of slope failures and water compressibility, effects of dam flexibility and base rotation, and effects of motion of the free surface. The chapter on earthquake effects on reservoirs also focuses on hydrodynamic pressures, specifically those caused by compression waves and surface waves.

Inspection of Water-Control Structures Associated with Nuclear Power Plants

Nuclear Regulatory Commission, Regulatory Guide 1.127 (Revision 1), Washington, DC, March 1978.

This document is a broad guide for developing an inspection and surveillance program for dams, reservoirs and water conveyance facilities associated with emergency cooling water systems or flood protection of nuclear power plants. The inspection procedures proposed are similar to those published by the Corps of Engineers as "Proposed Guidelines for Safety Inspection of Dams" (39 FR 31334).

Sections of the guide deal with general aspects of dam failures; compiling engineering data on design, construction and operation; onsite inspection programs; evaluating conditions; inspection frequency; and inspection reports. The section on onsite inspection programs lists features and items to be inspected for concrete structures, embankment structures, spillway structures and outlet works, reservoirs, safety and performance instrumentation, and operation and maintenance features.

Stevens Creek, A Plan for Flood Warning and Preparedness

Santa Clara Valley Water District, San Jose, CA, April 1979.

A portion of the Stevens Creek Watershed within the City of Cupertino in Santa Clara County, California, is subject to flooding. The Santa Clara Valley Water District undertook development of a flood warning system and flood preparedness plan for the area to reduce risk to both life and property. Development of the warning system and preparedness plan included extensive effort to analyze both the nature and extent of the flood hazard and the characteristics of the area at risk.

Numerous alternative approaches were investigated for each major element of the warning system and preparedness plan including those for flood recognition, flood warning, evacuation and rescues, traffic control and area security, flood fighting and erosion control, property damage reduction, public information, and plan maintenance. Selection of the approaches to be used for each element considered efficacy, cost, adaptability to future improvement, coordination and integration with other existing systems and plans, and policy implications of establishing a precedent.

Selected approaches were developed in detail including engineering design and specification of hardware and preparation of written operational instructions for warning and response. Implementation activities were identified including acquisition and installation of hardware, execution of an intergovernmental agreement and conduct of a public education and information program. Future tasks to extend, refine or otherwise improve the warning system and preparedness plan were identified.

The major features of the plan are:

- Inclusion of specific provisions for evacuation, flood damage reduction, public information and plan maintenance.
- Division of needed actions into distinctly separate sub-plans.
- Separation of actions called for in the sub-plans according to participating agency and predicted flood level.
- Inclusion of provisions for emergency curtailment of gas and electricity.
- Inclusion of dam failure as one of several conditions requiring evacuation.
- Provision of appendices with detailed information such as call lists, example press releases, and types and quantities of materials and equipment required for plan execution.

Earth and Earth-Rock Dams

Sherard, James L., Richard J. Woodward, Stanely F. Gizienski, and William A. Clevenger, New York, NY. John Wiley and Sons, Inc., 1963.

This book presents the main elements of current practice, experience and opinion concerning earth dams with emphasis on empirical aspects. It focuses on consideration of the foundation and embankment after site selection. Except for brief treatment of the relationship of spillways to the design of the embankment, problems of appurtenant structures are not covered. Hydraulic fill dams are excluded.

Chapter 1 describes design considerations including factors influencing design, types of earth dams, design details and design provisions to control pore pressures. Chapter 2 describes various types of failures and damages while Chapter 3 describes measurement of movements and pore water pressure.

Chapter 4 of the book addresses explorations for foundations and embankment construction materials. Discussions are included of the influence of topography and subsoil conditions on site selection, the process for subsurface exploration, and studies of embankment construction materials.

Chapters 5 and 6 treat seepage. The former presents a theoretical analysis of seepage and computational procedures while the latter describes techniques for preventing or controlling seepage.

Chapter 7 concerns stability analysis. Topics addressed include methods of analysis and their historical development, shear strength, forces involved and calculation procedures, stability conditions under various reservoir conditions, and theories of elasticity and plasticity.

Chapter 8 deals with special design problems and details including measuring instruments and performance observations, design considerations in earthquake regions, upstream slope wave protection, and downstream slope protection. Portions of this chapter are particularly relevant to emergency planning for dams.

Chapters 9, 10, and 11 describe techniques of construction for various types of dams including manufacture and placement of upstream membranes, treatment of rock foundations and embankment construction.

The book contains an extensive list of references.

General Construction Specifications No. G-2 for Plain and Reinforced Concrete

Tennessee Valley Authority, Division of Engineering Design, Knoxville, TN, 1970.

This specification prescribes acceptable materials for concrete and methods of producing and placing plain and reinforced concrete for TVA dams and hydro and thermal power plants. It also describes the controls for such work. Subjects treated include:

- Classes of concrete.
- Concrete quality, testing and control.
- Batching.
- Mixing concrete.
- Preparations for placing concrete.
- Forms and reinforcement.
- Conveying concrete.
- Placing concrete.
- Compacting concrete.
- Curing concrete.
- Depositing concrete under water.
- Joints.
- Architectural treatment.

Portions of the specifications provide a general description of materials, definitions of relevant terms and references.

General Construction Specifications No. G-9 for Rolled Earthfill for Dams and Power Plants

Tennessee Valley Authority, Division of Engineering Design, Knoxville, TN, 1972.

This specification prescribes acceptable materials and methods for constructing rolled earthfill dams and placing rolled earthfill at TVA's hydro and thermal power plants. It also describes the controls under which such work is to be done. The specification is written for the broader scope of earthfill dams. Subjects treated include:

- Definition of terms.
- Materials.
- Batching.
- General construction procedures.
- Foundation preparation.
- Earthfill placing.
- Compaction equipment.
- Compaction.
- Compaction control.
- Details features.
- Inspection.
- Tests.
- Records.

General Construction Specifications No. G-26 for Pressure Grouting of Rock Foundations with Portland Cement

Tennessee Valley Authority, Division of Engineering Design, Knoxville, TN, April 21, 1965.

This specification is intended only for work performed by TVA forces. It governs drilling of necessary holes, mixing of grout, and injection of the grout into rock. Subjects dealt with in the specification include:

- Equipment for drilling, grouting and communications.
- Materials including water, cement and admixtures.
- Control of grouting program.
- Procedures for drilling, testing, mixing of grout and application of grout.
- Interaction of grouting and other work such as blasting.

+Appendices to the specifications provide references and drawings of typical grouting layouts and equipment details.

Flood Preparedness Planning: Metropolitan Phoenix Area

U.S. Army Corps of Engineers, The Hydrologic Engineering Center, Davis, California, 1981.

This report presents the formulation and evaluation of enhancements to existing flood preparedness plans for metropolitan Phoenix, Arizona. The report documents a stage II planning study made as part of the comprehensive Central Arizona Water Control Study. The primary study area includes portions of the cities of Phoenix, Tempe and Mesa directly flooded by the Salt and Gila Rivers. The area experienced major flooding in February and December of 1978, and again in February of 1980.

Elements of preparedness plans investigated include: flood threat recognition; warning dissemination; emergency actions; post-flood recovery and continuous plan management. Evaluation procedures included exhaustive interviews with involved federal, state and local agency personnel, development of hypothetical flood scenarios, and technical analyses of the flood hazard and flood damage conditions. The technical evaluations were performed using a geographic information system (spatially gridded database) as the basis for formulating temporary flood emergency actions (flood fight, content adjustments, perimeter barriers, etc.) of the preparedness plans. Emphasis was placed on defining present arrangements and plans, and identifying potential plan enhancements. Estimates of benefits and costs associated with proposed enhancements were also provided.

Major features of the document are:

- Presentation of a comprehensive set of specific components for flood preparedness plans.
- Determination of feasible enhancements to existing preparedness plans.
- The use of a spatially gridded database to perform flood damage assessments of existing and enhanced preparedness planning conditions.
- Utilization of flood event scenarios to assist the reader in understanding the sequential actions and potential impacts associated with existing and enhanced conditions.

Lee County Florida Flood Emergency Evacuation Plan

U.S. Army Corps of Engineers, Jacksonville District and Southwest Florida Planning Council, Jacksonville, FL, May 1979.

Lee County covers a land area of approximately 785 square miles along Florida's southwest coast. It includes several low-lying offshore and barrier islands paralleling a flat, low-lying mainland. The western portion of the County is heavily populated. Major population centers in the County include Fort Myers, Cape Coral and Sanibel. The County's population is approximately 184,000, of which approximately 110,000 reside in coastal areas with an elevation of 10 feet or less. The area is subject to flooding from both ocean surges caused by hurricanes and heavy rains accompanying hurricanes and other severe storms. Only limited access routes to higher inland areas exist and those are characterized by points of low elevation subject to early inundation by rising water.

The plan consists of an implementation report, technical data report and pamphlets. It extends through the shelter phase of emergency response and makes recommendations for formulating a post-flood recovery plan. The plan addresses all areas of the County including islands accessible by automobile. The plan focuses on evacuation. Protection of personal and real property is not addressed.

The plan provides five levels of response to cope with the varying intensity and direction of storms. Other estimates of conditions included in the plan, such as population, are made in a conservative fashion to assure covering all foreseeable conditions. The plan describes the methodology for various analyses such as those relating to traffic flow.

The evacuation plan is organized as a brief formal plan including lists of response actions and Standard Operating Procedures for specific key individuals, supplemented by prepared brochures for public distribution.

A Report on Flood Emergency Evacuation for Pineville, Kentucky

U.S. Army Corps of Engineers, Nashville District, Nashville, TN, December 1978.

Pineville, Kentucky is located along the Cumberland River. A local protection project consisting of a levee and floodwall protects the town against what was the highest flood on record at the time of project design. However, a flood in 1977 exceeded the design flood elevation by approximately five feet, overtopping both the levee and floodwall. The town was evacuated with no loss of life but the confusion that occurred made the need for an evacuation plan apparent.

The preliminary sections of the evacuation plan present background information, identify and discuss coordination of plan participants, and describe relevant legal authorities. Action portions of the plan are contained in eight chapters and an appendix addressing weather and river stage forecasting, levels of warning, emergency operations center, evacuation, flood fighting, search and rescue, shelter areas and standard operating procedures. Supplemental information is included on personnel and equipment availability, and disaster related organizations.

The principal features of the plan are the system for three levels of warning and the standard operating procedures. The standard operating procedures provide detailed assignments of responsibility for the director and staff of the emergency operating center.

Flood Preparedness Plan: Monroe County Pennsylvania

U.S. Army Corps of Engineers, Philadelphia District, Philadelphia, PA, 1980.

Monroe County and the boroughs of Stroudsburg and East Stroudsburg are located in Pennsylvania, approximately 80 miles northeast of Philadelphia. Portions of the area are subject to flooding by several streams. Levees which protect some parts of the area have been damaged in past floods. The preparedness plan addresses four elements including:

- Identifying impending floods and disseminating warnings.
- Assuring the structural integrity during floods of the levee system shared by the two boroughs.
- Evacuating residents and visitors from the flood threatened area.
- Sheltering and caring for evacuees.

The plan document is divided into sections dealing with legal authority, warning levels, responses to each level of warning, standard operating procedures, and implementation of the plan. Appendices describe levee patrolling and flood fighting methods, and provide an emergency call list and emergency equipment list. Standard operating procedures identifying available resources are provided for each borough's command post, police and fire department, and street and/or public works department.

Lessons from Dam Incidents USA

U.S. Committee on Large Dams/American Society of Civil Engineers, New York, NY, 1975

This report covers incidents to dams in the United States which occurred from January 1, 1966 to December 31, 1972, excluding mine tailings or refuse dams. Information in the report is based on questionnaires sent in 1973 to a total of 2,000 owners, operators, engineers, government agencies and constructors.

The report consists of a narrative section followed by a data summary and write-ups of each dam that had one or more reported significant incident. The narrative portion describes the background and purpose of the report and defines categories of incidents. It also contains numerous tables and figures which summarize incidents by decade, ownership, age, type, and other parameters.

The report also describes briefly the experience of other member nations to the International Committee on Large Dams and presents conclusions and recommendation regarding:

- Re-evaluation and inspection of dams.
- Accidents to dams.
- Geological conditions.
- Earth and rockfill dams.
- Concrete dams.
- Continuation of the accumulation of data on accidents and failures.

A Guide for Design and Layout of Earth Emergency Spillways as Part of Emergency Spillway Systems for Earth Dams

U.S. Department of Agriculture, Soil Conservation Service, Washington, DC, February 1973.

The Guide presents rules for laying out and designing earth or vegetated earth spillways. It does not treat the problems of design of rock spillways or those spillways in the transition zone between earth and rock spillways. The guidance applies principally to dams with watersheds in excess of ten square miles. Topics addressed in the guide include:

- The basic concept of use of earth spillways.
- Means of reducing the volume of discharge per unit width of spillways.
- Description of soils with respect to resistance to erosion and gullyng.
- Requirements to be met in laying out earth emergency spillways.

Design Guide for Metal and Nonmetal Tailings Disposal

U.S. Department of the Interior, Bureau of Mines, Information Circular 8755, Washington, DC, 1977.

The guide was prepared to assist the mining industry in the management of mill tailings disposal. It covers selecting sites, sampling, laboratory testing, designing, constructing, operating, and inspecting tailings embankments. The effects of environment, topography and hydrology are also included, and various methods of stability analysis and factors affecting stability are reviewed. The guide does not cover specific solutions to problems encountered in tailings embankments. However, it is useful as a checklist for designers, operators and inspectors dealing with that type of structure.

Design recommendations in the guide deal specifically with waste from metal and nonmetal ores. Many of the points discussed are also applicable to coal waste embankments, dry mine waste piles, leach dumps, and strip and placer operations.

The guide contains numerous photographs of features of disposal sites and illustrations explaining their design. Tables in the guide give basic data and information relevant to design.

Concrete Manual

U.S. Department of the Interior, Bureau of Reclamation, 8th Edition, Washington, DC, 1975.

The manual is intended for use by the Bureau's construction engineers and inspectors. It supplies engineering data and outlines methods and procedures for administering construction specifications and contracts.

The eight chapters of the manual address:

- Components and properties of concrete, the types of damage to which concrete is subject, and the effect of various factors on the properties of concrete.
- Investigating and selecting concrete materials including necessary sampling and laboratory testing.
- Computing and selecting proportions of mixes and adjusting trial mixes.
- Inspecting concrete, laboratory equipment, purpose and content of reports, and evaluating test data.
- Concrete manufacturing including materials, batching and control facilities, mixing, quality control, and precautions to be taken in hot and cold weather.
- Handling, placing, finishing and curing concrete.
- Repairing and maintaining concrete.
- Special types of concrete and mortar including lightweight and heavyweight concrete, nailing concrete, and porous concrete. Various flood finishes, shotcrete, grouting mortar, and mortar lining of steel pipe are also described.

Appendices to the manual describe detailed test procedures and list selected references.

Design of Gravity Dams

U.S. Department of the Interior, Bureau of Reclamation, Denver, CO, 1976.

The manual presents instructions, examples, procedures, and standards for use in the design of concrete gravity dams. It covers all heights of dams except small dams under fifty feet. Foundations for the design of dams discussed in this book are assumed to be rock. Chapters of the book address the following major topics:

- Design considerations.
- Design data and criteria.
- Layout and analysis.
- River diversion.
- Foundation treatment.
- Temperature control of concrete.
- Joints in structures.
- Spillways.
- Outlet works and power outlets.
- Galleries and adits.
- Miscellaneous appurtenances.
- Structural behavior measurements.
- Concrete construction.
- Ecological considerations.

Appendices describe analytical methods applicable to design of gravity dams and inflow design flood studies. Specifications for concrete and for air and water pollution are also presented. Bibliographies are included throughout the book, appearing immediately after the topic to which they are relevant. The book is extensively illustrated with both photographs and engineering drawings.

Design of Small Dams

U.S. Department of the Interior, Bureau of Reclamation, Denver, CO, 1973.

This book presents instructions, standards and procedures for use in designing small dams. It is intended to serve primarily as a guide to safe practices for those concerned with designing small dams for public works programs in the United States. The book serves this purpose in three ways: 1) it provides engineers with information and data necessary for the proper design of small dams; 2) it provides specialized and highly technical knowledge concerning the design of small dams in a form that can be used readily by engineers who do not specialize in this field; and, 3) it simplifies design procedure for small earthfill dams.

Although this text is related almost exclusively to the design of small dams and appurtenant structures, it includes an outline discussion of a desirable project investigation covering project purposes, considerations influencing justification, and manner of selecting the size and type of structure to be built.

Only the more common types of small dams are discussed including concrete gravity, earthfill (rolled-type), and rock-fill. Emphasis is placed on rolled earthfill dams. The book only deals with structures having heights above streambed not exceeding fifty feet except for concrete dams on previous foundations. For the latter structures, the maximum net heads (head-water) to tailwater do not exceed twenty feet. The text does not cover dams of such large volumes that significant economics can be obtained by utilizing the more precise methods of design usually reserved for large dams. In recognition of the limited engineering costs justified for small dams, emphasis is placed on efficiency and relatively inexpensive procedures for determining the necessary design data. Simplified design methods are given to avoid the complex procedures and special investigations required for large dams or for unusual conditions.

This text is addressed to the designer of the structure and excludes construction practices and methods. However, appendices are included on "Construction of Embankments", "Concrete in Construction", and "Sample Specifications".

Earth Manual

U.S. Department of the Interior, Bureau of Reclamation, 2nd Edition, Washington, DC, 1974.

The manual provides technical information on the field and laboratory investigations and construction control of soils used as foundations and materials for dams, canals, and other structures. It contains standardized procedures and general guidelines intended to assist but not to substitute for engineering judgment.

Chapter I describes the Unified Soil Classification System and discusses the various properties of soils relating to engineering uses. Soils investigations are covered in Chapter II including the various stages of investigation and the technical aspects of planning and executing explorations and presenting results.

Chapter III presents information on controlling construction from the soils standpoint, for both foundation treatment and compaction control of fills. In addition to a general treatment of the subject applicable to all types of earthwork, separate sections are devoted to problems of rolled earth dams, canals, and miscellaneous construction features. For each of these, information is provided on design features and usual specifications provisions to assist control personnel in implementing the recommended control techniques.

An appendix contains detailed procedures for sampling, classification, and field and laboratory testing of soils. Instructions for installing and obtaining information from instruments that measure pore-water pressures and displacements within and adjacent to earth embankments are also included. A tabulation of conversion factors commonly used in earth construction is included at the end of the appendix. An additional appendix describes laboratory test procedures used in project laboratories and the central Bureau laboratory.

Ground Water Manual

U.S. Department of the Interior, Bureau of Reclamation, Washington, DC, 1977.

The manual was prepared as a guide for field personnel in the more practical aspects and commonly encountered problems in investigating, developing, and managing groundwater.

Information is presented concerning such aspects as groundwater occurrence and flow, well-aquifer relationships, groundwater investigations, aquifer test analysis, aquifer yield estimates, data collection, and geophysical investigations. In addition, the manual discusses permeability testing, well design, dewatering systems, well specifications and drilling, well sterilization, and pumps. An extensive bibliography is included. The manual is divided into the following chapters:

- Groundwater Occurrence, Properties, and Controls.
- Theory of Groundwater Flow, Aquifer Properties, and Definitions.
- Well and Aquifer Relationships.
- Planning Groundwater Investigations and Presentation of Results.
- Analysis of Discharging Well and Other Test Data.
- Estimates of Aquifer Yield, Hydrologic Budgets and Inventories.
- Initial Operations and Collection of Correlative Data.
- Geophysical Investigations, Bore Hole Logs, and Surveys.
- Methods of Determining Aquifer Characteristics.
- Permeability Tests in Individual Drill Holes.
- Components of a Well and Particulars of Design.
- Infiltration Galleries.
- Dewatering Systems.
- Corrosion and Incrustation.
- Well Specifications.
- Water Well Drilling.
- Water Well Development.
- Well Sterilization.
- Vertical Turbine Pumps.
- Well and Pump Cost Factors, Operation and Maintenance.
- Well Rehabilitation.

Safety Evaluation of Existing Dams

U.S. Department of the Interior, Bureau of Reclamation, (Water and Power Resources Service), Denver, CO, 1980.

The manual provides guidelines and procedures for inspecting and evaluating concrete and embankment dams. Specific detailed criteria, design standards, methods of analysis, and construction standards are omitted. The general topics discussed are:

- Policy of the Water and Power Resources Service including the concept, responsibility, coordination, and frequency of evaluations.
- Principle and concepts of safety evaluations including the purposes and phases of evaluations and summarization of the modes and causes of failure.
- Makeup of the evaluation team including disciplines and qualifications, training, duties and responsibilities.
- Collection from source documents of information needed as a basis for performing a safety evaluation.
- Items to be considered and procedures for evaluation of design, construction and operation aspects.
- Conduct of onsite examinations including prior arrangements, needed equipment, features to be examined, and appropriate types of notes to be prepared.
- Preparation of the report of a field examination including contents, items to be considered for inclusions or exclusion, conclusions and recommendations, and distribution.

The manual contains a bibliography of references providing a general background on factors affecting dam safety. There are also three appendices dealing respectively with considerations for making safety evaluations, items and evidence to be examined, and sample checklists for field examinations.

Engineering and Design Manual: Coal Refuse Design Manual

U.S. Department of the Interior, Mining Enforcement and Safety Administration, Washington, DC, 1975.

This manual presents procedures for use in the design of coal refuse embankments. Its primary purpose is to serve as a uniform guide to safe refuse disposal practices by providing:

- Characteristics of coal refuse and its disposal for use by experienced embankment design engineers.
- Specialized technical knowledge concerning embankment design in a form that can be used by engineers not specializing in the field.
- A comprehensive view of disposal requirements and limitations.
- Suggested minimum design storms and stability factors for a range of standardized embankment classifications

In addition to safety, the manual treats the importance of environmental control and cost of refuse disposal.

Chapter II defines coal refuse and its origin, summarizes past disposal practices, and predicts general disposal practices of the future.

Chapter III classifies refuse disposal facilities based on history, configuration, and hazard potential while Chapter IV describes planning and technical requirements for disposal site selection and facility design.

Chapter V presents procedures for the geotechnical investigation; analysis and design of coal refuse disposal facilities. The discussion presents the unique characteristics of refuse disposal that differentiate the design of this type facility from more commonly encountered geotechnical structures. Major design considerations related specifically to new and existing facilities with and without impoundments are presented.

Chapter VI summarizes hydrologic and hydraulic technology relating to the requirements of coal refuse disposal. Basic hydrologic and hydraulic design principles are discussed and a rational procedure is presented for determining the appropriate design storm for all types of conditions encountered in practice. The last section in Chapter VI describe methods for calculating inflow and for performing design analyses and routing storms through impoundments.

Chapter VII identifies major environmental factors relating to coal refuse disposal and presents procedures and guidelines for incorporating appropriate control methods into procedures for planning, design and construction.

Chapter VIII discusses construction and refuse placement techniques, procedures for choosing equipment that will minimize disposal costs, information for selecting construction materials and requirements for performing construction quality control and field testing. Portions of the chapter provide an introduction to training of personnel for monitoring of construction quality.

Chapter IX discusses procedures for monitoring a facility's behavior during its operational life and upon abandonment. The discussion describes: a standard procedure for visual observations by operating personnel; installation and monitoring requirements for commonly used instruments to measure embankment movements, pore water pressures, water flow rates; and several miscellaneous items required in some instances. Finally, the normal requirements for routine facility maintenance are summarized for ready reference.

Coal Refuse Inspection Manual

U.S. Department of the Interior, Mining Enforcement and Safety Administration, Washington, DC, April 1975.

The manual was prepared to introduce coal mine inspection personnel to the fundamental procedures required for performing safety inspections of coal refuse disposal facilities. It is intended to serve both as a reference work for classroom instruction and as a guide and checklist for inspections. The inspection manual is divided into three parts.

Part I of the manual describes the history of coal refuse disposal and the Mining Enforcement and Safety Administration's regulatory program. One section describes conditions leading to the Buffalo Creek Flood of 1972 in which a coal refuse impoundment failed, killing 118 persons and leaving another 4,000 homeless.

Part II of the manual contains technical information pertaining to the identification and classification of coal refuse facilities and characteristics of refuse disposal facilities that could result in failure if not properly addressed during the design and construction phases. Aspects discussed include general area conditions, construction and site conditions, embankment slopes, hydraulic considerations, and ultimate disposition of the refuse facility.

Part III of the manual cover the inspection process with respect to types of inspections (periodic, interim or special, and annual) and pre-inspection procedures. It also describes physical signs or indication of instabilities. Items to be observed during inspections are described, illustrated with photographs or sketches, and presented as brief checklists.

National Program of Inspection of Dams.

Public Law 92-367

U.S. 92nd Congress, Washington, DC, 1972.

The law directs the Secretary of the Army to carry out a national program of inspection of dams for the purpose of protecting human life and property. Certain dams are exempted from the Act on the basis of size, jurisdiction, construction pursuant to specific licensing, recent inspection and gubernatorial request, and discretion of the Secretary of the Army. Results of inspections are to be provided to the Governor of the State in which the dam is located and, upon request, advice is to be given concerning timely remedial measures for hazardous conditions. The Secretary of the Army is to report to Congress by July 1, 1974 on activities under the Act. The report is to include recommendations for a comprehensive national program for inspecting and regulating dams and for the respective responsibilities of Federal, state and local governments, public interests and private interests.

