

APPENDIX F  
SEISMIC SAFETY EVALUATION PROCESS FOR CONCRETE STRUCTURES AND  
FOUNDATIONS

F-1. SEISMIC SAFETY REVIEW

a. General.

(1). Types and levels of programs for seismic evaluation of concrete dams needed at various times and for various purposes start with a Seismic Safety Review (SSR) and may be followed by special studies consisting of preliminary seismologic investigations coupled with simplified seismic evaluations (Phase I), full seismologic investigations and dynamic analysis of the project (Phase II), and preparation of design documents, plans and specifications (Phase III). Flexible guidelines, consistent with the policy in paragraph 5.b. of ER 1110-2-1806 are needed to permit experienced investigators to do the best practical and economical job for each specific situation.

(2). A review is required to identify specific problem areas and establish priorities for further study. Generally, Seismic Safety Reviews are based on evaluations of available pertinent data and surface inspections. Seldom do SSR level investigations include extensive exploratory or testing provisions.

b. Project Description. Briefly describe the project, including type of dam or major structure and seismic zone. Enclose a location map and the tabulated pertinent project data. Describe design and current project operations.

c. Geology/Seismicity. Describe site specific geology and provide current detailed seismicity of the site including faulting, seismic evaluation parameters used in the design and changes or experienced shaking at site based on a search of existing project files and current professional literature. Describe site specific ground motion data.

d. Structural Investigations. Summarize structural design and results of recent analyses, if available. Describe those analyses used to conduct the evaluation.

e. Evaluation. Provide diagnostic seismic evaluation of the structure and foundation based on the data presented. Evaluate post-seismic stability. Develop a basis for decision on the need for and justification of additional studies or departure from further studies of risk assessment based on probabilities of occurrence of earthquakes, operating pool

elevations and structural failure.

f. E&D Cost Estimate and Schedule. Provide scope of recommended studies and associated study costs and schedule.

g. Conclusions and Recommendations. Provide conclusions and specific recommendations based on existing data evaluations. Schedule and conduct the PCCR.

#### F-2. PHASE I SPECIAL STUDY CONTENT

a. Project Authorization. Reference the Project Guidance Memo (PGM) from the Policy Compliance & Criteria Review (PCCR) of the SSR for the project.

b. Project Description. Briefly describe the project, including type of structures. Provide tabulated pertinent project data. Describe design and current project operations.

c. Purpose and Scope. Describe the purpose of the study, scope, and deficiency identified in the SSR.

d. Seismologic Investigations. Provide detailed seismologic study results, including fault study investigations, related field investigations, and laboratory studies.

e. Seismicity. Develop design earthquakes in relation to active fault systems and their activity.

f. Seismic Evaluation. Provide seismic evaluation of features subjected to design earthquakes. Provide basis for selection of parameters, method of analysis, and rationale for the decision on seismic assessment of the project.

g. Conclusions and Recommendations. Develop conclusions and recommendations for terminating the study or proceeding to a Phase II seismic evaluation in accordance with the requirements of ER 1110-2-1806.

h. Cost Estimate and Schedule. Provide scope, cost estimate, and schedule of recommended Phase II studies. Conduct the PCCR.

#### F-3. PHASE II SPECIAL STUDIES - GUIDELINES FOR DYNAMIC ANALYSIS OF CONCRETE STRUCTURES

a. Design Earthquakes and Ground Motions. Design earthquakes and ground motions for the seismic evaluations of concrete dams and appurtenant structures shall be determined in accordance with ER 1110-2-1806, paragraphs 5.h., 6 and 8.f. The study scope shall be

consistent with the PGM for the Phase I PCCR.

b. Dynamic Analyses of Existing Structures and Proposed Remedial Alternatives.

(1) Review the candidate earthquake, location, and ground motions for most severe conditions to concrete structures.

(2) Select design response spectra.

(3) Select appropriate acceleration-time history records compatible with the design response spectra.

(4) Select dynamic properties for the concrete and foundation.

(5) Analyze and evaluate any cracking.

(6) Follow guidance in the current technical guidance and EM appropriate for that concrete structure.

c. Conclusions and Recommendations. Discuss remedial alternatives in the DSAP Evaluation Report and selection of remediation plan to be developed in Phase III Plans and Specifications. Provide a summary of the Phase II studies in the DSAP.

F-4. PHASE II SPECIAL STUDY CONTENT

a. Introduction

- (1) Authorization
- (2) Purpose
- (3) Project Description
- (4) Method of Analysis

b. Static Finite Element Analysis

- (1) General
- (2) Development of Static Properties
- (3) Results of Static FEM Analyses

c. Design Earthquake Motions

- (1) General
- (2) Design Earthquake and Ground Motions
- (3) Response Spectra
- (4) Time Histories

d. Dynamic Finite Element Analyses

- (1) General
- (2) Field and Laboratory Tests & Results
- (3) Development of Dynamic Properties
- (4) Dynamic Analyses
- (5) Dynamic Response
- (6) Evaluate Cracking in Concrete Structures
- (7) Fracture Mechanics Analysis
- (8) Non-Linear Analyses of Concrete Structures

e. Seismic Stability Assessment

- (1) Evaluation of Dynamic Strengths
  - Laboratory Data
  - Field Data
- (2) Dynamic Structural Response

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- (3) Soil Structure
- (4) Interaction of  
backfill, structure and piles
- (5) Earthquake Induced  
Cracking Analyses

f. Post Earthquake  
Stability  
Analyses

- (1) General
- (2) Evaluate Cracking in  
Concrete structures
- (3) Evaluate Structural  
Stability
- (4) Post Earthquake  
Stability

g. Remediation

- (1) General
- (2) Alternatives
- (3) Cost

h. Summary

i. Conclusions and  
Recommendations

j. References

k. Attachments