DEPARTMENT OF THE ARMY ER 1110-2-1156
US Army Corps of Engineers
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Regulation
No. 1110-2-1156 31 March 2014

Engineering and Design
SAFETY OF DAMS – POLICY AND PROCEDURES

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This regulation supersedes EC 1110-2-6071, dated 31 July 2010, EC 1165-2-210, dated 9 April 2010; PB 2013-01, dated 11 January 2013; ECB 2012-17, dated 7 May 2012; and ER 1110-2-1156, dated 26 October 2011.

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SUMMARY of CHANGES

a. USACE is no longer using the word “shall” in policy documents. So update has replaced “shall” with “must”, “should”, or “will” where appropriate.
b. Deleted from ER 1110-2-1156, dated October 2011:

(1) Chapter 20 – Asset Management and Condition Assessments.
(2) Appendix K – Observations on How Reclamation Uses Their Guidelines.
(3) Appendix AB - Seismic Safety Evaluation Process for Embankment Dams and Foundations
(4) Appendix AC - Seismic Safety Evaluation Process for Concrete Structures and Foundations.

c. Added to this version of ER 1110-2-1156:

(1) Chapter 20 – Remote Control and Operation of Water Control Systems.
(2) Chapter 24 – Dam Safety Considerations for Storage Allocation, Reallocation, and Related Studies.
(3) Appendix E – USACE Dam Safety Fact Sheet Template.
(4) Appendix M – USACE Dam Safety Officer Sample Development Plan.
(5) Appendix N – Roles and Responsibilities Matrix.
(6) Appendix U – Dam Performance Data Documentation.
(7) Appendix X – Post Implement Evaluation.
(8) Appendix AE – Periodic Inspection and Periodic Assessment Report Format.
(9) Appendix AG – Example of a Foundation Approval Report.
(10) Appendix AH – Notification of Non-Federal Entities Regarding Water Supply in USACE Reservoirs.
(11) Appendix X – Details of Post Implementation Evaluation (PIE).

d. Changed Title of Chapter 11 to Continuing Evaluation Inspections, Periodic Inspections and Periodic Assessments.
e. Reorders the appendices to be in the order referenced within the ER.

Changes of Note in the Chapters:

Chapter 1 - Dam Safety Program - Introduction, Overview, and Guiding Principles

a. Added a definition for the term ‘Dam’.
b. Principles for Dam Safety program management and the principles for implementing IRRM were blended and revised. The list of separate IRRM principles were deleted from Chapter 1 but were left in Chapter 7.
c. Added a section on authorities for non-Federal dam repairs.
d. Added guidance for assigning a structure to the dam safety program or the levee safety program.

Chapter 2 - Dam Safety Program Framework

SUMMARY of CHANGES (Continued)

a. Deleted the OMB risk analysis text and statement that risk analysis is composed of assessment, management, and communications.
b. Added figure to show the components of risk.
c. Expanded discussion on hazard identification and characterization, exposure assessment, and risk characterization.
d. Introduced the inundation scenarios for dam safety.
e. Changed the term ‘inundation risk’ to ‘flood risk’.
f. Refined definition of risk estimate.
g. Deleted the use of the term ‘baseline risk estimate’ and introduced the term ‘existing and future without Federal action condition risk’.
h. Introduced the term residual risk with its components of incremental and non-breach risk.
i. Introduced the requirement for the USACE Dam Safety Fact Sheet.

Chapter 3 - Dam Safety Portfolio Risk Management

a. New – Issue Evaluation Study will be performed for dams assigned a DSAC 1, 2, 3, or 4.
b. Major revision of the Dam Safety Action Classification table and the names and definitions of the five DSAC classifications.
c. Added emphasis on the process of DSAC recommendation and approval levels.
d. Expanded the description of the Issue Evaluation Study process steps.
e. Incorporated the dam safety production centers into the text of the chapter.
f. Revised the Periodic Assessment discussion to match the revised process as outlined in Chapter 11.
g. Added a new section to present guidance on modifications for non-Federal hydropower.
h. The DSAC 5 assignment process/protocol was clarified and specific details provided.

Chapter 4 - Management of USACE Dam Safety Program

a. Moved committee and group membership lists to Appendix O.
b. Expanded guidance on DSO development plan and added Dam Safety officer development plan example.
c. Clarified the role of the Dam Senior Oversight Group in relationship to HQUSACE and the MSC.
d. Introduces the roles and responsibilities of the Dam Safety Modification Mandatory Center of Expertise.
e. Clarification of MSC DSO/DSPM role pertaining to the dam safety aspects of the MSC water control management at the projects.
f. Introduces the roles and responsibilities pertaining to the MSC Dam Safety Production Center.

SUMMARY of CHANGES (Continued)

g. Expands on the Dam Safety Modification (DSM) Lead Engineer role and responsibilities. The term Lead Engineer in this regulation designates the senior engineer assigned to a dam safety modification study or project. The Lead Engineer must be either a senior level registered professional engineer or engineering geologist with extensive knowledge and skills related to the primary features associated with the project. The engineering geologist is required to be a registered professional engineer.

Chapter 5 - Tolerable Risk Guidelines

a. Clarification on the use of the tolerability of risk concepts as pertaining to dams.
b. Refined the discussion on the consequences associated with incremental risk.
c. Changed the tolerable risk guideline charts.
d. Deleted the differing tolerable risk guideline requirements for existing dams versus new dams or major modification of a dam.
e. Requires non-breach risk to be determined and presented.
f. Revised the average annual life loss (AALL) guideline text for actions above and below the AALL line.
g. Removed the concept of disproportionality and all related text and figures from the regulation.

Chapter 6 - Dam Safety Risk Management Prioritization

Clarified some wording and made changes to align with the new DSAC table.

Chapter 7 - Interim Risk Reduction Measures for Dam Safety

a. Principles for implementing interim risk reduction measures at high risk dams were revised when the guiding principles in Chapter 1 were revised. The two sets now are better aligned with the content of their respective chapters.
b. Expanded discussion on the IRRM plan and formal deviations.
c. Clarification made in the funding source of IRRM.
d. Discussion on the appropriateness of an IRRM is clarified.

Chapter 8 - Issue Evaluation Studies

a. New - For projects where the DSAC has been determined by SPRA, a semi-quantitative risk assessment (SQRA) will first be conducted by the risk cadre and district at the beginning of the IES to re-evaluate the SPRA derived DSAC, determine the need for a Phase 1 Issue Evaluation Study, and identify the significant and credible failure modes that will become the focus of the Phase 1 quantitative risk assessment.
b. New – Requires a determination that the existing authorized project purposes warrant continued Federal investment.
c. New - Review and update the essential USACE guidelines that are applicable to that dam and evaluate the dam for compliance with the essential guidelines.

SUMMARY of CHANGES (Continued)

d. Site characterization documentation is now required to be generated in support of the IES. "Prepare detailed drawings that synthesize all pertinent data including boring logs, instrumentation, geologic features, laboratory data, etc."A reservoir diagram showing Minimum Flood Space, Variable Flood Space and other vital pool elevations is now required for the IES.
e. IES and IESSF report formats significantly revised.
f. Slight revision to the review and approval process for IES.

Chapter 9 - Dam Safety Modification Studies (DSMS) and Documentation

a. The need to address the dam safety issues and meet the risk-reduction objectives must be supported by a determination that the existing authorized project purposes warrant continued Federal investment and an assessment of whether changes in the authorized project purposes warrant investigation. The level of detail of this determination should be consistent with that of a reconnaissance study under the GI program or initial appraisal of a Section 216 study (Reference A.7).
b. There was a moderate level of revision done to chapter 9 to clarify the alternative development, comparison, evaluation, and selection process.
c. New - Essential USACE guidelines will be reviewed and a determination made if any additional guidelines, beyond those identified by the Issue Evaluation study, are to be included for consideration.
d. Any alternative recommended for implementation must be evaluated for its effects on the authorized project purposes.
e. The SMART planning initiatives are incorporated into this chapter and the appendices that support the Dam Safety Modification study.
f. Applying risk informed concepts to the Value Engineering process for the DSMS.
g. Clarified the use of the 'future without and with Federal action condition' concept.
h. Emphasis added that risk reduction alternatives should not be formulated around or to compensate for deficient EAPs and evacuation plans.
i. Expanded on the guidance dealing with the level of detailed each alternative must be developed to identify, evaluate, and compare each alternative.
j. A mitigation plan for species and habitat loss or impact should be developed for each alternative. The cost for such mitigation should be integral component of each alternative.
k. Expanded the discussion on the project study work plan.
l. Expanded the guidance for the ATR of the DSMS. The ATR team will include the expertise necessary to evaluate the planning, engineering, real estate, and economics.
m. Added requirement for Post Implementation Evaluation (PIE) and environmental analysis, cost estimating and scheduling of the products/projects being reviewed.
n. Added the requirement for constructability evaluations at 2 times during PED, prior to Step 3 and at 60% design of the project.
o. Added construction evaluation to figure 9-1.
p. The USACE Dam Safety Fact Sheet will be prepared at the end of the DSMS.

SUMMARY of CHANGES (Continued)

q. Expanded the guidance for the processing and approving of the NEPA documentation.
r. The requirements for when a supplemental DSM decision document is required were clarified.
s. Figure 9.1, DSM Study, Review, Decision, and Approval Process, was updated to match the changes in the content of Chapter 9 and the various appendices supporting chapter 9.
t. Paragraph and appendix references were added for the various steps of the process in figures.

Chapter 10 - Dam Safety Risk Communication

Chapter 10 underwent significant revision and should be read in its entirety to obtain the latest guidance on dam safety risk communications.

Chapter 11 - Periodic Inspection, Periodic Assessment and Continuing Evaluation

a. Chapter 11 underwent a major revision to fully coordinate the periodic inspection and the periodic assessment.
b. For a PI only, the completed periodic inspection/periodic assessment (PI/PA) report, which is to include the former PA if one was done, is to be submitted to the MSC DSO for approval within 90 days of completion of the PI at the dam.
c. For a PI/PA, the completed PI/PA the report must be certified and submitted to the RMC for consistency review within 90 days upon completion of the risk assessment. Certification consists of the PA team concurrence, the facilitator certification, and the District DSO's certification of review. After the PI/PA report is returned from the RMC consistency review, comments are to be resolved and the PI/PA report sent for MSC DSO approval within 45 days of the Consistency Review.
d. The format for the PI and PA are now combined into one standardized report. The intent is to automate the data collection during the onsite inspection so that generation of a draft PI/PA report can be automated as much as possible.
e. The Asset Management operational condition assessment (OCA) will be conducted, when possible, with the periodic and annual inspections.
f. The essential agency guidelines are to be identified and the project evaluated for compliance with these applicable essential USACE guidelines as part of the periodic inspection process. If the list of applicable essential USACE guidelines and the project evaluation for compliance with those guidelines does not exist, it must be developed and documented during the next scheduled PI, the next PI/PA, or by an Issue Evaluation Study if that is to be done before the next PI or PI/PA.
g. Review the referenced supporting appendices to gather the details of the inspection process and reporting formats.
h. Requirements for presentation of site characterization and instrumentation and monitoring data are expanded in this chapter and chapter 14.

SUMMARY of CHANGES (Continued)

Chapter 12 - Operations and Maintenance Activities

a. Major change in the process of reporting distress in ‘12.5 Reporting Distress’.

b. Use the ‘Engineer Circular for Budget Development’ for the budget year being considered to determine the Major Maintenance threshold dollar amount.

c. Drilling for instrumentation or other purposes in or near a dam or dam foundation is not to be done without prior approval of a drilling plan. A risk assessment, at least the equivalent of that done in support of the Periodic Assessment, which addresses the need of the additional or replacement instrumentation, is required to support the drilling plan.

Chapter 13 - Reporting Evidence of Distress in Civil Works Structures

Clarification in the discussion explaining the types of evidence of distress to be reported.

Chapter 14 - Instrumentation for Safety Evaluations of Civil Works Structures

a. Major changes and expansion in the requirements.

b. Added text to emphasize the role of a risk informed approach to planning, implementing, and operating the instrumentation and monitoring program for a dam. A risk assessment, at least the equivalent of that done in support of the Periodic Assessment, that addresses the need of additional or replacement instrumentation is required as the basis to support the need for the new or replacement instrumentation.

c. The text presenting the role of the DSAC and the potential failure modes in influencing the number of instruments, locations, types, and frequency of readings was expanded.

d. Text was added to clarify when automation of the instrumentation is recommended.

e. Text was added to expand on the need to assure instrumentation systems are properly functioning, calibrated, and conform to accepted standards and practices. The required quality management documentation is put forth.

f. The section on data collection, interpretation and evaluation was significantly expanded to cover increased surveillance and monitoring, personnel qualifications, and field review of collected data.

g. The section on data presentation and interpretation was expanded to require presentation of the instrument and performance data on cross sections that show the location of and installation details of the instrument, the foundation geology, the cross section of the dam with design details of the zones of embankment dams or the cross section of concrete dams, and the range of the design (design assumption and performance threshold) values and measured values at the instrument location.

h. Requires annual review and evaluation of the data collection, reduction, and evaluation methods to identify ways to improve the process, make it more efficient, and adjust monitoring frequencies as appropriate to project conditions.

SUMMARY of CHANGES (Continued)

i. The annual dam safety instrumentation program review and project performance review was expanded and clarified. Report format for the annual report is specified. A new appendix was added to provide additional guidance for this report.

Chapter 15 - Dam Safety Training

a. Basically only minor edits were done to this chapter.
b. The one notable addition is the emphasis on operational personnel participating in regularly scheduled emergency exercises at their project or other projects in order to develop a better understanding of their role in an actual emergency.

Chapter 16 - Emergency Action Plans

a. There are two changes or additions to the chapter beyond minor edits.
b. Under emergency exercises emphasis was added for proper coordination with the appropriate project operations personnel since they will have first-hand knowledge of the incident and the affected community.
c. Table for the review and approval of emergency action plans was revised.

Chapter 17 - Reservoir Filling Plans

Very minor editorial changes with no change in content.

Chapter 18 - Risk Assessment Methodology

a. Test was added to clarify what was meant by the intervention in the sentence, “All risk estimates must give due consideration for intervention”.
b. A paragraph was added to explain the accounting for risk for a dam in a system of dams in the larger watershed.
c. A paragraph was added to address incremental risk and the concepts of how it is obtained.
d. A paragraph was added to address the requirement that risk assessments will prepare and communicate a risk estimate for the non- breach flood risk.
e. In the “Risk Assessment Documentation” section a paragraph was added requiring site characterization documentation for dam any risk assessment. This is the process of sorting through site specific information, pulling out the most applicable data (instrument, geological, geotechnical, construction and current condition photographs, drawings, etc.) and then assimilating it into a useful and concise format for understanding the dam and foundation characteristics and how they relate to potential failure modes.

SUMMARY of CHANGES (Continued)

Chapter 19 - Program Administration and Funding Process

Minor edit was made to clarify the FY-2 and FY-1 terms for the budget years.

Chapter 20 - Remote Control and Operation of Water Control Systems

This is a new chapter to provide references and other information to guide the remote control and operation of water control systems.

Chapter 21 - Dam Safety Policy for Planning and Pre-Construction Engineering and Design

a. This chapter underwent major revision. Some highlights are listed below.
b. Role of the Dam Safety Production Centers was incorporated into this chapter.
c. Value Engineering (VE) During PED. The Information and Function phases of the VE study must include the risk-informed decision criteria to include the tolerable risk guidelines, ALARP and essential engineering guidelines. Additionally, the objective of the project will be the objectives of the dam safety modification study.
d. To ensure dam safety risks are adequately addressed by the designs and that all construction-related risks are fully identified and mitigated to an acceptable level, a constructability evaluation will be performed by a team designated by the Dam Safety Modification Mandatory Center of Expertise and the Dam Safety Production Centers to will evaluate the constructability, the schedule, and the cost will evaluate the constructability, the schedule, and the cost estimate at the 65 percent plans and specifications during PED. See Section 22.2.6 for details on this constructability review.

Chapter 22 - Dam Safety and Construction (Modification and New Dams)

a. Roles of the Dam Safety Modification Mandatory Center of Expertise and the Dam Safety Production Centers were incorporated into this chapter.
b. Added the section on construction evaluations and construction risk. This is a significant addition to the requirements.
c. Text was added to clarify the content of the project update report prepared by the project manager during the construction phase.
d. Added clarification stating the “Project Geotechnical and Concrete Materials Completion Report for Major USACE Projects” will be written by a qualified USACE registered professional engineer or engineering geologist that was involved with the construction or modification of the dam.
e. Clarified the requirements for constructability evaluations. Performed by a team designated by the MCX/DSPC.
f. Added a requirement for Post Implementation Evaluation (PIE) which is detailed in Appendix X.

SUMMARY of CHANGES (Continued)

Chapter 23 - Critical Infrastructure Protection and Resilience

a. Incorporated text to clearly define portfolio prioritization approach for scheduling security risk assessments and detailed blast damage analysis at USACE civil works projects.
b. Added sub-section to explicitly clarify HQUSACE and MSC/Districts roles and responsibilities on security risk assessments scheduling planning, resourcing, and implementation activities.
c. Added sub-section to clarify how the outcomes from the security risk assessment process will support identification and prioritization of physical security requirements at USACE civil works projects.

Chapter 24 - Dam Safety Considerations for Storage Allocation, Reallocation, and Related Studies

a. This is a new chapter.
b. Incorporates EC 1165-2-210, Water Supply Storage and Risk Reduction Measures for Dam Safety, and PB 2013-01, Dam Safety Considerations for Water Supply Storage Allocation and Reallocation Studies and lessons learned related to those two guidance documents.
c. The purpose of this chapter is to establish policy and provide guidance on the impacts of dam safety deficiencies for storage allocation, reallocation, and related studies.

Changes of Note to the Appendices:

APPENDIX E – USACE Dam Safety Fact Sheet Template

New appendix that provides a format for the USACE Dam Safety Fact Sheet that is releasable to the public. Districts will prepare a USACE Dam Safety Fact Sheet at the completion of any risk assessment performed on a dam in support of the USACE dam safety program.

APPENDIX F - Dam Safety Action Classification 5 Protocol and Essential USACE Guidelines

a. Added the Dam Safety Action Classification (DSAC) 5 protocol.
b. Expanded the essential guidelines to include instrumentation and operations and maintenance.
c. Added Table F.1 - Dam Safety Action Class Adjustment Guidelines with DSAC 5 adjustment guidance.
d. Added Table F.2 - DSAC 5 Protocol Check List.

SUMMARY of CHANGES (Continued)

APPENDIX K - Potential Failure Mode Analysis (PFMA) for Dams

Added requirement to review, update, and document the list of applicable essential USACE guidelines and the evaluation for compliance with these essential USACE guidelines.

APPENDIX L - Screening for Portfolio Risk Analysis Process (SPRA)

Updated Table L.1.b - Dam Safety Action Class Adjustment Guidelines to show the DSAC 5 protocol changes.

APPENDIX M - USACE Dam Safety Officer Sample Development Plan

New appendix that lists the requirements of a dam safety officer development plan.

APPENDIX N - Roles and Responsibilities Matrix

New appendix that lists the USACE Dam Safety Program Roles and Responsibilities Matrices that are published in several documents. The master version of these matrices is this appendix as published in ER 1110-2-1156. This version of the matrices govern if future changes result in conflicts between ER 1110-2-1156 and the copy published in other documents.

APPENDIX O – Membership of Dam Safety Committees and Groups

Revisions made to this appendix to provide membership details for the committees and groups discussed in Chapter 4.

APPENDIX P - Calculation of the Cost to Save a Statistical Life (CSSL)

The general equation to determine the CSSL is presented. Detailed guidance for incorporation of for temporal changes in costs, consequences, benefits, and life loss estimates are contained in a separate, more detailed technical document.

APPENDIX T – Periodic Assessment Procedures

Failure to complete the chapters and to prepare and organize the above information in advance of the PA may result in the PA being postponed or cancelled.

SUMMARY of CHANGES (Continued)

APPENDIX U – Documentation of Dam Performance and Site Characterization Requirements for Dam Safety

a. This appendix consists of two sub-appendices that address the requirements for documentation of dam performance and site characterization requirements for dam safety.

b. Sub-appendix U-1 outlines recommended minimum requirements for evaluation, review, documentation and data access.

c. Sub-appendix U-2 provides guidance on the effective communication of the information contained in the instrumentation, geological, and geotechnical data is essential for evaluating the performance of a dam and its foundation and for estimating risk associated with the presences of the dam. The objective of this appendix is to provide guidance and outline the tasks for interpreting, sorting, summarizing, and portraying the information contained in this data.

APPENDIX V - Format and Content for Issue Evaluation Study Documents

a. New requirement to include a summary of the site characterization and dam performance. The two reports required by Appendix U are stand alone reports that this summary is to extract information from and reference to support the observations, evaluations, and conclusions stated in the risk assessment.

b. Added requirement for Appendix C - Applicable Essential USACE Guidelines and Compliance Review.

APPENDIX W - Dam Safety Modification Study Activities, Decision Points, and Report Format

a. This appendix was divided into two sub-appendices.

b. The first, W-1, presents a process chart in Figure W-1.1 showing the activities and decision points within the DSMS process which incorporates the SMART planning process.

c. Second sub-appendix, W-2, provides the outline and format for the DSMR.

d. Added the requirement for the detailed risk assessment to include a summary of the performance of the dam and site characterization documentation as a part of the risk assessment documentation. The summary of the performance of the dam and site characterization is taken from the reports required per Appendix U. The two reports required by Appendix U are stand alone reports that this summary is to extract information from and reference to support the observations, evaluations, and conclusions stated in the risk assessment.

SUMMARY of CHANGES (Continued)

APPENDIX X – Post Implementation Evaluation

This appendix presents the requirements for a post implementation evaluation (PIE). The PIE is required to verify that the implemented risk reduction measures were successful in reducing risk to the level consistent with the objectives of the approved DSMR.

APPENDIX AC - Dam Safety Vegetation Management

This appendix was revised to state that there are no vegetation variances for USACE dams and none will be granted.

APPENDIX AE - Periodic Inspection and Periodic Assessment Report Format

Added requirement for a report appendix to document the “Applicable Essential USACE Guidelines and Compliance Review”.

APPENDIX AF - Management Control

a. Revised to a 2 year frequency.
b. Revised to assure the “Lead Engineer” is a senior level engineer or engineering geologist, with professional engineering registration.

Glossary

a. Added the following terms: Automatically Operated System; Average Annual Life Lost (AALL); Combined Annual Probability of all Failure Modes; Critical feature – For Seismic Evaluation; Failure of a Water Control System; Future Without Federal Action Condition; Interlock; Locally Controlled System; Remotely Controlled System; Remotely Operated System; and Water Control System Water Control System.
b. Revised the definitions for the following terms: As-Low-As-Reasonably-Practicable (ALARP); Dam Safety Modification (DSM) Lead Engineer; Lead Engineer; Earthquake, Maximum Credible (MCE); and Earthquake, Maximum Design (MDE).
c. Deleted the following terms: annualized life loss; concept of disproportionality; disproportionality ratio; Existing and Future Without Federal Action Condition and Seismic Safety Review (SSR).

CHAPTER 1

Dam Safety Program – Introduction, Overview, and Guiding Principles

1.1 Purpose. This regulation prescribes the guiding principles, policy, organization, responsibilities, and procedures for implementation of risk-informed dam safety program activities and a dam safety portfolio risk management process within the United States Army, Corps of Engineers (USACE). Risk is defined as a measure of the probability and severity of undesirable consequences or outcome. The purpose and intent of this regulation is to ensure that responsible officials at all levels within USACE implement and maintain a strong dam safety program in compliance with "Federal Guidelines for Dam Safety" (reference A.114). The program ensures that all dams and appurtenant structures are designed, constructed, and operated safely and effectively under all conditions, based on the following dam safety and dam safety program purposes, as adopted by the Interagency Committee on Dam Safety (ICODS).

1.2 Applicability. This regulation applies to Headquarters, United States Army, Corps of Engineers (HQUSACE) elements, major subordinate commands (MSC), districts, the Engineer Research and Development Center (ERDC), and other Field Operating Agencies (FOA) and Centers having responsibility for planning, site selection, design, construction, operation, maintenance, inspection, evaluation, and rehabilitation of dams and appurtenant structures.

1.3 Distribution Statement. This regulation is approved for public release; distribution is unlimited.

1.4 References. Pertinent references are listed in Appendix A.

1.5 Glossary. Abbreviations and terms, which may not be familiar to the reader, are defined in the Glossary.

1.6 Definition of Dam. An artificial barrier, including appurtenant works, constructed for the purpose of storage, control, or diversion of water, and which (1) is twenty-five feet or more in height from the natural bed of the stream or watercourse measured at the downstream toe of the barrier or from the lowest elevation of the outside limit of the barrier if it is not across a stream channel or watercourse, to the maximum water storage elevation or (2) has an impounding capacity at maximum water storage elevation of fifty acre-feet or more. Any such barrier which is under six feet in height regardless of storage capacity, or which has a storage capacity at maximum water storage elevation not in excess of fifteen acre-feet regardless of height is not considered a dam. This lower size limitation should be waived if there is a potentially significant downstream hazard. This definition applies whether the dam has a permanent reservoir or is a detention dam for temporary storage of floodwaters. The impounding capacity at maximum water storage elevation includes storage of floodwaters above the normal full storage elevation.

1.7 Dam Safety Definition. Dam Safety is the art and science of ensuring the integrity and viability of dams such that they do not present unacceptable risks to the public, property, and the environment. It requires the collective application of engineering principles and experience, and a philosophy of risk management that recognizes that a dam is a structure whose safe functioning is not explicitly determined by its original design and construction. It also includes all actions taken to routinely monitor, evaluate, identify or predict dam safety issues and consequences related to failure including ensuring all reservoir regulation activities are performed in accordance with established water control plans. These actions are to be performed in concert with activities to document, publicize, and reduce, eliminate, or remediate, to the extent reasonably practicable, any unacceptable risks.

1.8 Dam Safety Program. The purposes of a dam safety program are to protect life, property, lifelines, and the environment by ensuring that all dams are designed, constructed, regulated, operated, and maintained as safely and effectively as is reasonably practicable. USACE has had an active Dam Safety Program since the 1970's. The program was last evaluated using an external peer review in 2001. The results of that evaluation using the Association of State Dam Safety Official Peer Review procedures were published in a report entitled "Peer Review of the Dam Safety Program of the U.S. Army Corps of Engineers" dated September 30, 2001 (reference A.131).

1.9 Dam Safety Officers. To comply with the Federal Guidelines for Dam Safety (reference A.114), the Chief of Engineers has designated a USACE Dam Safety Officer (DSO) by General Order. This regulation further defines the requirements and responsibilities of the Dam Safety Officers at each level of the command. Commanders and Dam Safety Officers at all levels are responsible to ensure that sufficient highly qualified personnel are available to meet project purposes and that programs related to dam safety are established and funded to achieve compliance with the requirements herein. These responsibilities are further defined in Chapter 4.

1.10 Transition to a Risk Informed Dam Safety Program. USACE has moved from a solely standards-based approach for its dam safety program to a dam safety portfolio risk management approach. The standards-based or essential guidelines approach is included in the risk-informed approach to the dam safety program and dam safety program decisions will now be risk-informed. One of the bases for a risk-informed decision, and prioritization of the work, is a consideration of the achievement of tolerable risk guidelines following implementation of risk reduction measures. In addition, it should be recognized that other non-quantitative factors will influence practical decision making for the dam safety program.

"There was previously a view in some quarters that risk assessment was a means to justify less costly safety upgrades of dams than those required by the traditional approach. It is now recognized that such a view seriously misunderstands the true aim of risk assessment, which is more informed decision-making than would be possible from reliance on the traditional approach alone. It may be that the additional understanding that comes from the risk assessment process, will reveal that a less costly solution to a dam safety problem could be justified, though a decision that way should be made with great care and having regard to all of the community risk and business risk considerations. But it could as easily be the case that risk assessment shows that a more stringent safety level, and thus a more costly solution, ought to be implemented." (Guidelines on Risk Assessment, Australian National Committee on Large Dams (ANCOLD), October 2003, reference A.130).

1.11 Principles for Dam Safety Program Management. The following guiding principles, which represented a paradigm shift for USACE, have been established for the USACE Dam Safety Program Management process:

1.11.1 Public Safety. A key mission of the USACE dam safety program is to achieve an equitable and reasonably low level of risk to the public from its dams. USACE executes its project purposes guided by its commitment and responsibility to public safety. Since “Life Safety is Paramount”, it is not appropriate to refer to balancing or trading off public safety with other project benefits. Instead, it is after tolerable risk guidelines are met that other purposes and objectives will be considered. Dam Safety Officers (DSO) are the designated advisors and advocates for life safety decisions.

1.11.2 Do No Harm. The principle of ‘Do No Harm’ must underpin all actions intended to reduce dam safety risk.

1.11.2.1 USACE will ensure that USACE dams are designed and operated in a way that during a flood the spillway flow will not, at any time during the event, result in downstream flooding more severe than that which would have been the circumstance had the dam not existed. Herein is the basic principle upon which dam safety programs are based as regards to managing flows in excess of the authorized purposes; this ‘non-breach’ situation of flow past the dam is not to result in greater flood hazard than that which would have occurred without the dam in place.

1.11.2.2 USACE will implement Interim Risk Reduction Measures (IRRM) while long-term solutions are pursued. USACE will ensure that proposed IRRM implementation, emergency or permanent construction, or a temporary or permanent change in regulation plans will not result in the increased risk of unsatisfactory performance of the dam, adjacent structures, and other basin/system components or operations over existing risk at any time. See Chapter 7 for more information on principles and development of IRRM plans.

1.11.3 Risk-Informed Corporate Approach. The USACE dam safety program will be managed from a risk-informed USACE-wide portfolio perspective applied to all features of all dams on a continuing basis. Decisions are risk-informed, not risk-based. Risk-informed decisions integrate traditional engineering analyses with numerical risk estimations of risk through the critical foundation of experience-based engineering judgment. ”Risk-based” can imply that life-safety decisions can be reduced to simple, numerical solutions.

1.11.4 Congressional Authorizations. USACE projects have specific Congressional authorizations and legal responsibilities that often cover a broad array of purposes and objectives. Because of the complexity of these authorities, the public safety responsibility is critical to informing how we implement these statutory responsibilities. The public safety responsibility requires USACE to assure projects are adequately safe from catastrophic failure that results in uncontrolled release of the water in the reservoir. USACE has specific public safety responsibility, when a project has known safety issues, to take appropriate interim risk reduction measures - including reservoir operating restrictions - to assure safety of the project and to protect the public. USACE statutory responsibilities do not give authority to operate dams in a manner that increases the project's probabilities of failure when there are known issues with the integrity of the project.

1.11.5 Manage Flood Waters. USACE manages risks of flood waters--it does not control them. USACE projects do not have unlimited operational capacity to control extreme floods. Outlet works have limited capacity to release flows in a controlled manner, and thus all properly designed projects have a capacity above which the inflow is passed through without attenuation. These are very large releases that may cause damage downstream of the dam but not to a greater degree than would have occurred under pre-project conditions. Decision makers must understand these limitations and operational constraints.

1.11.6 Unique Dynamics over Time. All projects have unique geographic, physical, social, and economic aspects that are subject to dynamics over time. Decision making within Interim Risk Reduction Measure Plans should not be overly prescriptive because of these complexities.

1.11.7 Tension between Loss of Life and Economic Damage. The operations of a very high, high or moderate risk dam during flood conditions can create a dynamic tension between the potential for loss of life and economic damage resulting from an uncontrolled release due to failure and the surety of economic damages resulting from operational release to prevent failure. Operational releases can be accompanied with planning, advanced warnings, and evacuations with the goal of avoiding loss of life. Economic impacts may be incurred and options for mitigating these impacts can be explored. The advanced planning and execution of mitigating measures is far more effective with planned, controlled release of the pool than with the case of unplanned, uncontrolled release resulting from failure of the project.

1.11.8 Urgency of Dam Safety Actions. The urgency of actions, including funding, to reduce risks in the short term (i.e., Interim Risk Reduction Measures) and in the long term (i.e., Dam Safety Modifications) will be commensurate with the level of risk based on current knowledge. This may require first addressing only those failure modes that contribute significantly to the overall risk.

1.11.9 Risk Communication. USACE will provide risk information to internal and external stakeholders. An informed and engaged public is an empowered public that understands risk, can contribute to the evaluation of risk-reduction options and can take some degree of responsibility for its safety. USACE will assess and communicate the breach and 'non-breach' risk in all level of dam safety studies to internal and external stakeholders.

1.11.10 Prioritization of Studies and Investigations. Studies and investigations will be scoped with the goal of confirming dam safety issues and prioritized to reduce knowledge uncertainties and risk across the portfolio of dams in a cost effective and timely manner.

1.11.11 Formulation and Prioritization of Risk Management Measures. Where practical, risk-management measures will be formulated as separable measures and these will be prioritized to achieve tolerable risk as quickly as practicable and in a cost-effective manner across the portfolio of dams.

1.11.12 Level of Detail of Risk Assessments. The level of effort and scope of risk assessments will be scaled to provide an appropriate level of confidence considering the purpose of the risk management decision.

1.11.13 Routine Dam Safety Activities. Execution of inspections, instrumentation, monitoring, Periodic Assessments, operations and maintenance, emergency action planning, training, and other routine dam safety activities are an essential part of effective dam safety risk management for all USACE dams.

1.11.14 Risk Reporting. The current level of risk for USACE dams will be documented and routinely reported. The basis for decisions will be formally documented.

1.12 <u>History of Dam Safety</u>. A history of dam safety within USACE, and how it relates to dam safety in the nation, is provided in Appendix B.

1.13 <u>Federal Guidelines for Dam Safety</u>. A summary of the guidelines is provided in Appendix C. The guidelines are referenced at A.114.

1.14 <u>Levels of USACE Responsibility for Dam Safety</u>. Appendix D provides guidance on USACE responsibility for dam safety at dams where USACE has been involved in one way or another with the dam.

1.15 <u>Authorities for non-Federal Dam Repairs</u>. USACE has very limited authority for repairing dams owned by others (Federal or non-Federal).

1.15.1 There is no standing authority for making routine repairs to dams not owned by USACE. Such routine repairs may be authorized on a case by case basis by special legislation and congressionally added funding.

1.15.2 USACE may make repairs to dams owned by the various military departments using appropriated funds provided by the requesting military agency.

1.15.3 In some cases USACE may make repairs to dams owned by others on a reimbursable basis under the “Work for Others” authority.

1.15.4 There is limited authority for repairing non-Federal dams that are part of a flood reduction projects and that are damaged due to a flood event. The policy for using this authority is found in ER 500-1-1, Emergency Employment of Army and Other Resources Civil Emergency Management Program and EP 500-1-1, Emergency Employment of Army and Other Resources Civil Emergency Management Program – Procedures (references A.38 and A.66).

1.16 Guidance for Assigning a Structure to the Dam Safety Program or the Levee Safety Program. When dams are built there are often auxiliary or appurtenant structures constructed that could be considered a dam or a levee. If the structure is upstream, within the pool, around the pool, etc., the district DSO should ask the basic question: Would this 'levee, embankment, dike, etc.', exist if there was no dam/reservoir? If the answer is 'yes', it is most likely a levee and should be in the Levee Safety program. If the answer is no, then it is associated with the dam that is enabling the reservoir pool to be used and/or needed for reservoir regulation and should be managed as a 'dam'. Generally, that structure should be in the Dam Safety program. When a district considers this guidance is unclear or is not applicable to a particular structure, it will be decided by the USACE Special Assistant for Dam and Levee Safety on a case by case basis.

CHAPTER 2

Dam Safety Program Risk Framework

2.1 Scope. This chapter presents the guiding principles and policy for implementation of risk-informed dam safety program within USACE. It also presents a generalized dam safety risk framework based on these principles with an elaboration of the concepts of risk assessment, risk management, and risk communication. Finally, this chapter presents a generalized dam safety portfolio risk management process.

2.2 General Risk Framework Principles.

2.2.1 Evaluating and reducing risk requires a framework that explicitly evaluates the level of risk if no action is taken and recognizes the monetary and non-monetary costs and benefits of reducing risks when making decisions. This decision framework requires separating the whole of risk into its component tasks by assessing the risk and related uncertainties for the purpose of successful management of the risk, facilitated by effective communication about the risks. In this way, the risk framework comprises three tasks: risk assessment, risk management, and risk communication.

2.2.2 Figure 2.1 shows the interrelatedness of these three tasks and the notion that risk communication is a vital and joining activity that must take place to achieve effective risk decisions. Note that the technical scientific work takes place in the risk assessment task while the risk management task is more concerned with applying social values and policy to sort through options and tradeoffs revealed in the risk assessment.

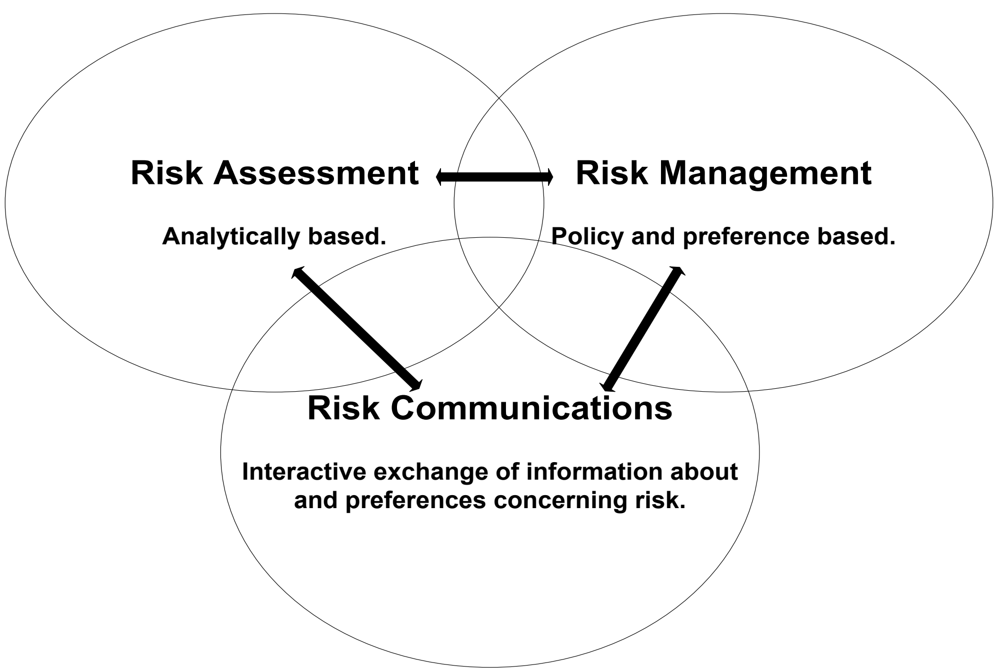


Figure 2.1 - General Risk Framework

2.2.3 Risk Assessment.

2.2.3.1 Risk assessment is a broad term that encompasses a variety of analytic techniques that are used in different situations, depending upon the nature of the risk, the available data, and needs of decision makers. It is a systematic, evidence-based approach for quantifying and describing the nature, likelihood, and magnitude of risk associated with the existing and future conditions without action and the values of the risk resulting from a changed condition due to some action.

2.2.3.2 Uncertainty is the result of imperfect knowledge concerning the present or future state of a system, event, situation, or (sub) population under consideration. Uncertainty leads to lack of confidence in predictions, inferences, or conclusions. It is important to distinguish uncertainty that results from a lack of knowledge from the uncertainty that results from variability. Variability and uncertainty are in many ways interchangeable; variability could be thought of as a specific source of uncertainty. For example, a risk assessor may be very certain that stream flows vary over a year but may be uncertain about the amount of that variability. Collecting more and better data can often reduce uncertainty, whereas variability is an inherent property of the system/population being evaluated. Variability can be better characterized and addressed quantitatively with more data but it cannot be reduced or eliminated. Efforts to clearly distinguish between variability and uncertainty are important because they can influence risk management decisions.

2.2.4 Risk Management.

2.2.4.1 Risk management is the process of problem-finding and initiating action to identify, evaluate, select, implement, monitor and modify actions taken to alter levels of risk, as compared to taking no action. The purpose of risk management is to choose and implement those technically sound integrated actions to reduce risks after consideration of the effectiveness and costs of each increment of risk reduction. Environmental, social, cultural, ethical, political and legal considerations all factor into the decision made on how much cost will be incurred for each increment of risk reduction (how safe is safe enough?). Risk management for dams includes short-term Interim Risk Reduction Measures (IRRM), long-term structural risk reduction measures, and strengthening recurrent activities - such as monitoring and surveillance, emergency action planning, operations and maintenance, and staff training.

2.2.4.2 In choosing among alternative approaches to reduce risk in the dam safety program, USACE follows the principles recommended by OMB.Page 10, reference A.126), (Principles for Risk Assessment, Management, and Communication, January 12, 1995 (reference A.126) and Updated Risk Principles (M07-24), September 19, 2007 (reference A.128)). This means USACE seeks to choose among alternatives that “offer the greatest net improvement in total societal welfare, accounting for a broad range of relevant social and economic consideration such as equity, quality of life, individual preference, and the magnitude and distribution of benefits and costs (both direct and indirect, both quantifiable and non-quantifiable)” (reference A.128).

2.2.4.3 Equity considers placing all members of society on a (more) equal footing in terms of the risks faced. The equity objective is addressed by requiring that all risks higher than a limit value be brought down below the limit, except in extraordinary circumstances.

2.2.4.4 Efficiency considers the following:

2.2.4.4.1 Ensuring that resources and expenditures directed to safety improvements are cost-effective;

2.2.4.4.2 Ensuring an appropriate balance between the monetary and non-monetary benefits and the monetary and non-monetary costs; and

2.2.4.4.3 Achieving the greatest reductions in risk for each unit of resources committed.

2.2.4.4.4 The efficiency objective is recognized by allowing risks to be assessed and addressed on a dam portfolio basis to assign priority and urgency to risk reduction actions, thereby making best use of resources. It can also be addressed for an individual dam through consideration of the cost effectiveness of risk reduction to and below limit values in tolerable risk guidelines that are described in Chapter 3 of this regulation.

2.2.5 Risk Communication. Risk communication is the open, two-way exchange of information, opinion, and preferences about hazards and risks leading to a better understanding of the risks and better risk management decisions. Risk communication is integrated into the assessment and management processes. It is not a task that occurs only after decisions have been made. Risk communication ensures that the decision makers, other stakeholders, and affected parties understand and appreciate the process of risk assessment and in so doing can be fully engaged in and responsible for risk management.

2.3 Dam Safety Risk Framework.

2.3.1 A further refinement and consolidation of activities associated with these principles for evaluating and reducing risk in the area of dam safety are presented in Figure 2.2.

2.3.2 Risk Defined. Risk is a measure of the probability and severity of undesirable consequences. Risk is determined by the components depicted in Figure 2.3: load on the dam (magnitude and likelihood of the hazard); the performance or response of the dam due to the load; the exposure of the item(s) at risk (population at risk, property, infrastructure, etc); the vulnerability of the items at risk to harm; and the consequences (number of fatalities, dollar economic damages, environmental impacts, etc.).

2.4 Risk Assessment – An Elaboration.

2.4.1 The risk assessment process attempts to answer the following four questions:

2.4.1.1 What can go wrong?

2.4.1.2 How can it happen?

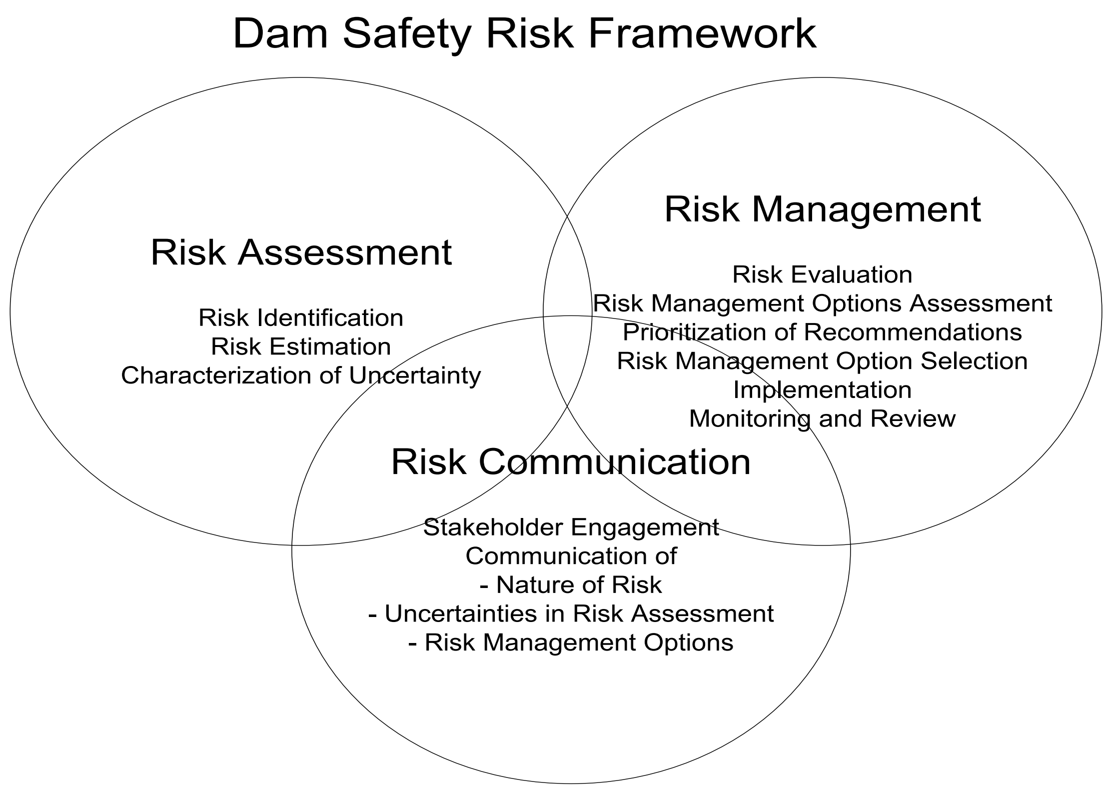


Figure 2.2 – Dam Safety Risk Framework

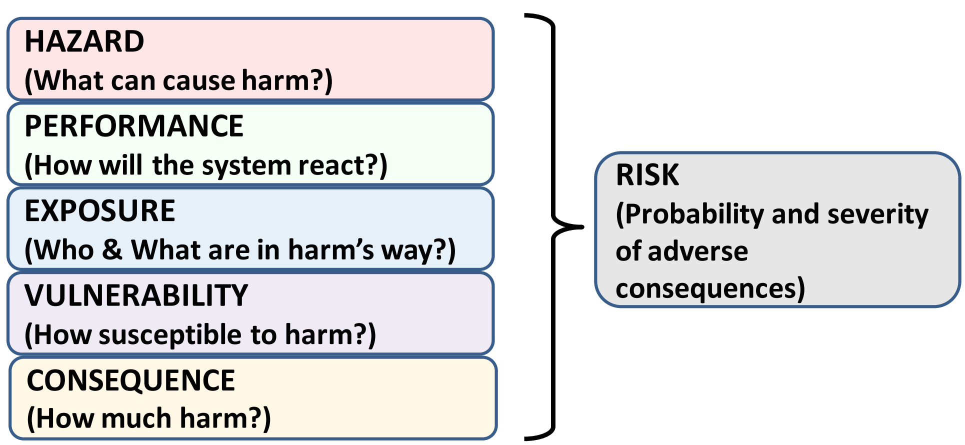


Figure 2.3 – Components of Risk

2.4.1.3 What is the likelihood?

2.4.1.3 What is the likelihood?

2.4.1.4 What are consequences?

2.4.2 Risk assessment has a somewhat different meaning than the USACE terminology of "risk-informed" or "risk and uncertainty." It may be characterized as a more formal and focused effort to describe and define the impacts of risk to facilitate their effective management. The draft OMB Proposed Risk Assessment Bulletin, January 2006 (reference A.127) defined the term:

'"risk assessment" means a scientific and/or technical document that assembles and synthesizes scientific information to determine whether a potential hazard exists and/or the extent of possible risk to human health, safety, or the environment."'

2.4.3 Risk assessment would augment the technical work done throughout USACE. An update of the traditional definition of risk assessment taken from the 1983 National Research Council's Risk Assessment in the Federal Government: Managing the Process (reference A.147) includes the following steps:

2.4.3.1 Hazard Identification (Risk Identification)

2.4.3.2 Hazard Characterization (Risk Identification)

2.4.3.3 Exposure Assessment (Risk Estimation)

2.4.3.4 Risk Characterization (Risk Estimation)

2.4.4 Hazards are the focal point of this process and the major change would be to add an explicit hazard identification step to the various tasks. In a general sense, "hazard" is anything that is a potential source of harm to a valued asset (human, animal, natural, economic, and social). It is important that one not limit the notion of a hazard to a natural hazard. So in this sense, a hazard can be thought of as an assumption about some uncertain value or parameter that, if incorrect, can result in the undesirable consequence of the failure to achieve the economic return anticipated.

2.4.4.1 Hazard Identification (Risk Identification). This identifies all biological, chemical, social, economic, and physical agents or natural/anthropogenic events capable of causing adverse effects on people, property, economy, culture, social structure, or environment. The hazard identification step explicitly identifies the hazards that will be of concern in the risk management activity.

2.4.4.2 Hazard Characterization (Risk Identification). Hazard characterization is the qualitative and/or quantitative evaluation of the nature of the adverse effects associated with the identified hazard(s), which may be present in the situation of interest. The hazard characterization step describes the harm that can be done when the hazard is present.

2.4.4.3 Exposure Assessment (Risk Estimation). Exposure occurs when a susceptible asset comes in contact with a hazard. An exposure assessment, then, is the determination or estimation (which may be qualitative or quantitative) of the magnitude, frequency, or duration, and route of exposure. This task describes how the asset/entity/receptor of interest comes in contact with the hazard.

2.4.4.4 Risk Characterization (Risk Estimation). Risk characterization is the qualitative and/or quantitative estimation, including attendant uncertainties, of the probability of occurrence and severity of known or potential adverse effects in a given watershed or decision problem based on the evidence gathered in hazard identification, hazard characterization and exposure assessment. In the dam safety arena the term risk estimation is used due to the significant influence of subjective probability in the risk characterization.

2.4.5 Risk Assessment Applied to Dam Safety.

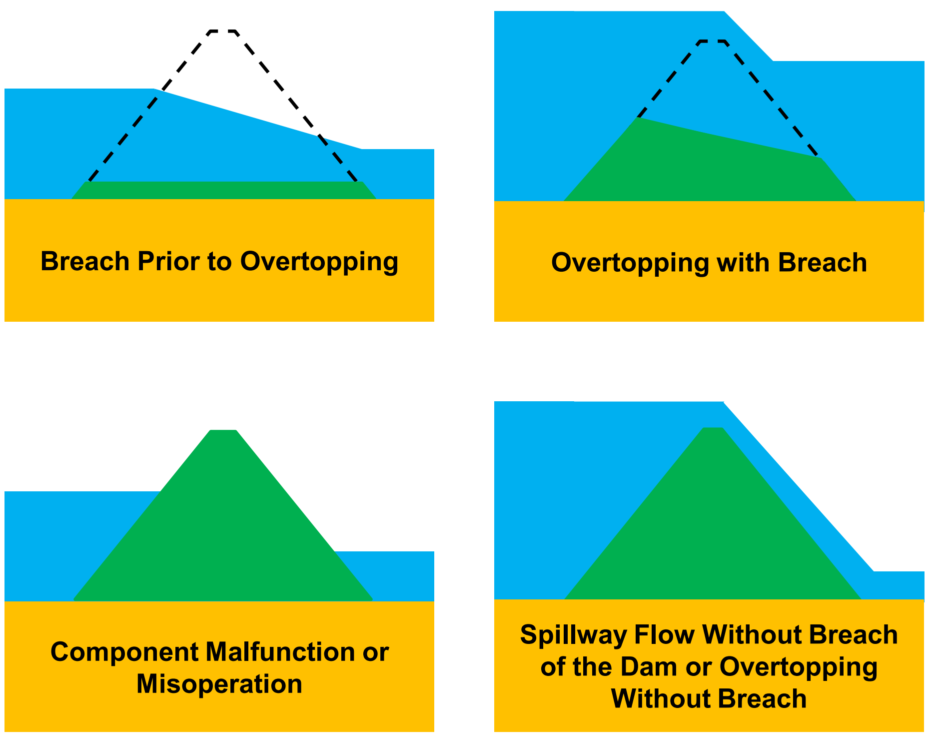


Figure 2.4 – The Four Inundation Scenarios for Dam Safety

2.4.5.1 Inundation Scenarios. The flood risk associated with a dam may arise from the following four inundation scenarios shown in Figure 2.4: breach prior to overtopping; overtopping with breach; inundation resulting from the malfunction of dam components or misoperation, and spillway flow without breach of the dam or overtopping without breach (non-breach). “Spillway flow” means controlled release of water through the outlet works or spillway up to and including full outlet works or spillway discharge.

2.4.5.2 Risk estimate. A risk estimate is performed at a point in time. It may change over time based on changes in: a) information; b) the condition of the dam; c) the load or hazard, d) factors affecting the inundation consequences, or e) from implementation of risk management measures. Incorporating any of these changes or a change in the scope or purpose of a decision to be made will result in a new risk estimate.

2.4.5.3 The existing and future without Federal action condition risk is assessed and then alternative risk management options are assessed and compared in relation to each other and with existing and future without Federal action condition risk. The resulting characterization of the ‘with’ and ’without’ risk is communicated to responsible decision makers. These include the cost-sharing partner, other community stakeholders, the Administration, and the Congress. Based on that information and the authorities and resources available to the USACE and the different stakeholders, risk management decisions are made. USACE will be involved with the selection and implementation of alternatives to reduce risk from breaches or component malfunction within the limits of its authorities and in cooperation with the sponsor, responsible stakeholders, and affected stakeholders. These same stakeholders make decisions on how the remaining risks will be managed. The decision making process will consider the following: the financial cost; the economic costs and benefits of the alternatives, the environmental effects of the alternatives; who bears the risk; what risks are reduced; the remaining risks; and the risks that have been transformed or transferred to others.

2.4.5.4 Residual Risk. The risk in the pool area and downstream of the dam at any point in time (i.e., prior to, during, or after implementation of risk reduction measures) is herein referred to as ‘residual risk’, i.e. the risk that remains. The residual risk associated with a dam consists of two components as shown in Figure 2.5.

2.4.5.4.1 Incremental Risk. The USACE dam safety program makes use of a risk classification system named Dam Safety Action Classification (DSAC) to help guide key decisions within the program. This classification system portrays the need for urgency of action and the priority for responding to risk associated with USACE dams. The DSAC assignment is informed by the ‘incremental risk’. The ‘incremental risk’ is the risk (likelihood and consequences) to the pool area and downstream floodplain occupants that can be attributed to the presence of the dam should the dam breach prior or subsequent to overtopping, or undergo component malfunction or misoperation. The consequences typically are due to downstream inundation, but loss of the pool can result in significant consequences in the pool area upstream of the dam.

2.4.5.4.2 ‘Non-Breach’ Risk. The area in the pool area and the downstream affected floodplains may remain in a state of high risk even if the dam functions as intended. This risk in the pool area and affected downstream floodplains is due to ‘normal’ dam operation of the dam or ‘overtopping of dams without breach’ scenarios.

This is referred to as the ‘non-breach’ risk. In the spirit of transparency and full disclosure the USACE dam safety program will carefully and systematically assess, communicate, and consider in safety dam decisions the ‘non-breach’ risks associated with the dams in its portfolio.

2.4.5.5 Risk Assessment of Systems of Dams. The above paragraphs apply to systems of dams as well as individual dams where appropriate.

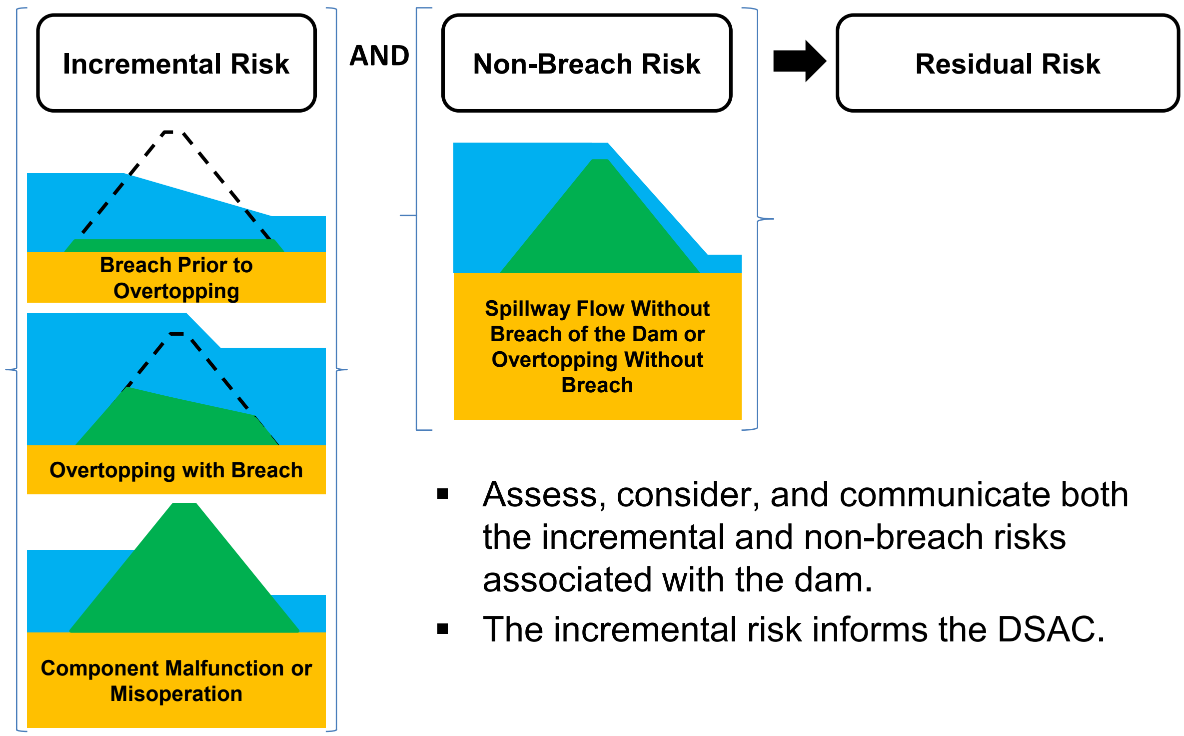


Figure 2.5 – Dam Safety Residual Risk

2.5 <u>Risk Management – An Elaboration</u>.

2.5.1 Risk management is the work required to answer the following questions:

2.5.1.1 What is the problem?

2.5.1.2 What can be done to reduce the likelihood or severity of the risk described?

2.5.1.3 What are the tradeoffs in terms of costs, benefits, and risks among the available options both now and in the future?

2.5.1.4 What is the best way to address the described risk?

2.5.2 In summation, risk management is the process of problem finding and initiating action to identify, evaluate, select, implement, monitor and modify actions taken to alter levels of risk. Figure 2.6 shows a generalized risk management process for dams used by USACE. The risk management process emphasizes its ongoing and iterative nature and the usefulness of adapting to new information.

2.5.3 Some broad categories of risk management activities can be identified as described below.

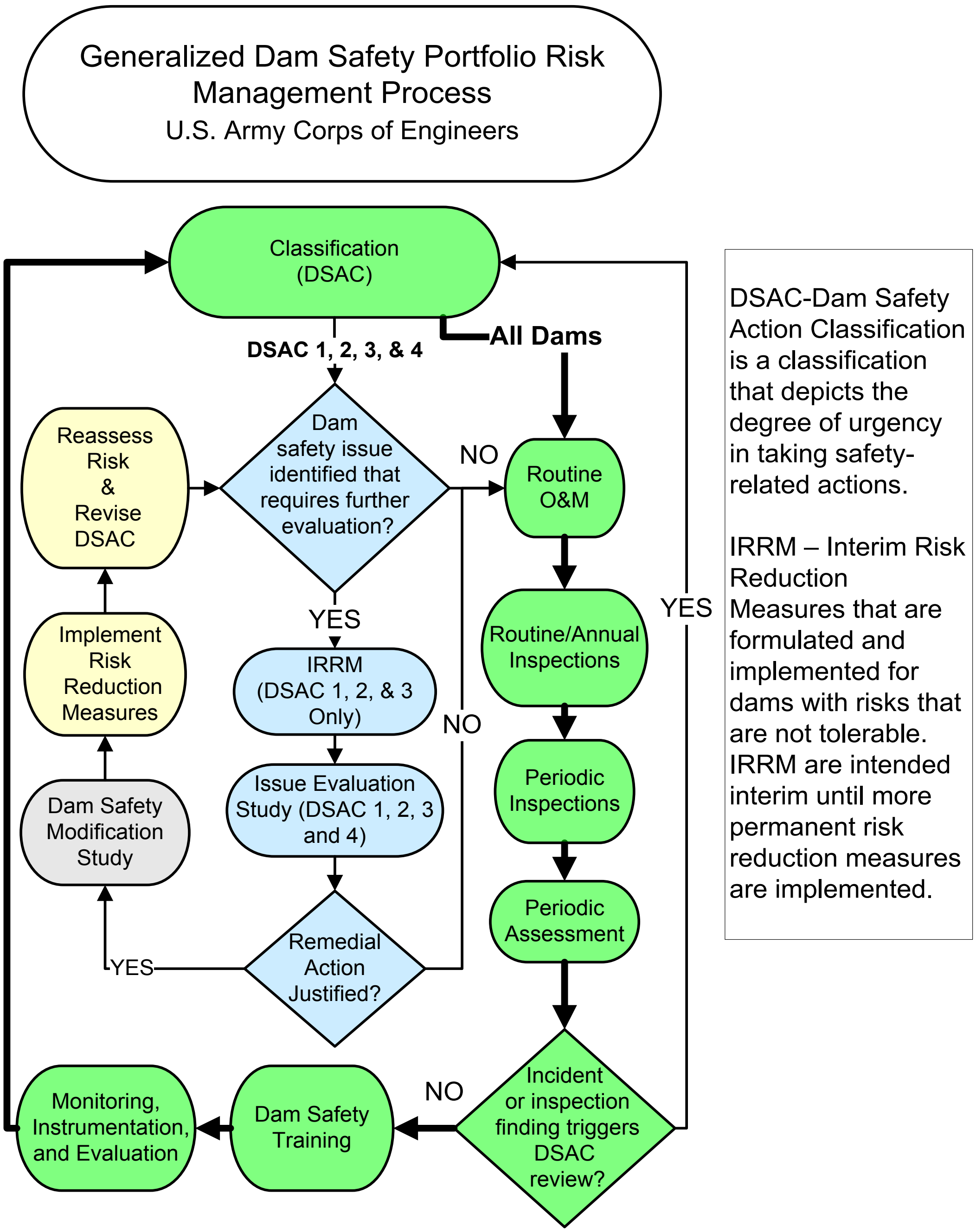


Figure 2.6 – Generalized Dam Safety Portfolio Risk Management Process

2.5.3.1 Assess Risk Management Options. Options assessment activities include the process of identifying, evaluating, and selecting actions that can be taken to alter levels of risk. This is a deliberate process of systematically considering all options and their associated trade-offs. Risk management options generally fall into one or a combination of the following categories; risk avoidance to eliminate the risk; risk prevention to reduce the likelihood of the risk; risk mitigation to reduce the consequence of the risk; risk transfer by insuring against the risk; or risk retention by accepting and budgeting for the risk. Risk management means deciding the level of risk that is tolerable including the consideration of the costs and other consequences of different risk management actions. Risk management also means giving appropriate consideration to inherent variability and knowledge uncertainties identified during the risk assessment and other evaluations.

2.5.3.2 Implement Risk Management Decisions. Implementation activities include executing all steps necessary to make the chosen risk management alternative a reality. Part of implementation may include adaptive management processes to learn while acting when uncertainties identified in the preceding steps are significant and the costs of making a “wrong” decision (economic regret) are deemed to be high.

2.5.3.3 Monitoring and Review. Monitoring and review activities are undertaken to improve understanding and reduce uncertainty over time through learning to assure the success of the implemented risk management measure(s). Over time, with experience, even the goals of the risk management measure(s) may be adjusted. Risk management policies may induce changes in human behaviors that can alter risks (i.e., reduce, increase, or change their character), and these linkages must be incorporated into evaluations of the effectiveness of such policies, OMB 2007 (reference A.128).

2.6 Risk Communication – An Elaboration.

2.6.1 See Chapter 10 for a full discussion on Risk Communication. As an introduction, risk communication is the work that must be done to answer the following questions for a risk management activity.

2.6.1.1 Why are we communicating?

2.6.1.2 Who is our audience?

2.6.1.3 What do we want to learn from our audience?

2.6.1.4 What do they want to know?

2.6.1.5 What do we want to get across?

2.6.1.6 How will we communicate?

2.6.1.7 How will we listen?

2.6.1.8 How will we respond?

2.6.2 Internal and External Communication Components. Effective two-way risk communication has both internal and external communication components.

2.6.2.1 Internal risk communication requires early and continuing communication, coordination, and collaboration among risk assessors and agency officials throughout the decision making process.

2.6.2.2 External Stakeholder Engagement.

2.6.2.2.1 The external process includes all communication between the agency analysts, officials and affected stakeholders. Stakeholder involvement goes beyond the traditional public participation process of conveying information to the public. It supports decision-making and ensures that public values are considered in the decision making process. Public perceptions are an important source of information.

2.6.2.2.2 Involvement of stakeholders improves the knowledge base for decision-making and can reduce the overall time and expense involved in decision-making. It may improve the credibility of the agencies responsible for managing risks. It should generate better-accepted, more readily implemented risk management decisions. Furthermore, it is USACE policy to engage stakeholders in meaningful input and feedback opportunities in the risk management process.

2.6.3 Successful risk communication leads to a common recognition and understanding of the hazards, risk management options, and shared acceptance of the risk management decisions.

2.6.4 Communicating About the Nature of Risk.

2.6.4.1 Stakeholders need awareness and an understanding of the characteristics and importance of the hazard of concern. It is important to convey the magnitude and severity of the risk, as well as the urgency of the situation. People must understand whether the risk is becoming greater or smaller (trends) as well as the likelihood of exposure to the hazard.

2.6.4.2 The geographic, temporal, and specific distribution of exposure to the hazard needs to be understood as well as the amount of exposure that constitutes a significant risk. For flood hazards, this is easy to imagine. The nature and size of the population at risk as well as knowledge of who is at the greatest risk all need to be conveyed to stakeholders.

2.6.4.3 Risk is only one part of the issue. People accept higher risk (e.g., living in floodplains) for many good reasons. The actual or expected benefits associated with each risk should be identified and understood. It is important to know who benefits and in what ways. The magnitude and importance of those benefits need to be weighed to find the appropriate tradeoff between risks and benefits.

2.6.5 Communicating Uncertainties in Risk Assessment.

2.6.5.1 One of the challenges of risk communication is conveying the existence and significance of uncertainties encountered in the assessment of the risks to both decision makers and stakeholders as appropriate. The methods used to assess the risk should be described and made available. Significant uncertainties need to be explicitly and specifically identified. The importance of each of the uncertainties, as well as the weaknesses of, or inaccuracies in, the available data need to be communicated. The assumptions on which estimates are based must be identified. Sensitivity analysis of the risk estimates and other decision-making criteria must be conducted and the results communicated. The effects of changes in assumptions on risk management decisions must be thoroughly explored. It is important to objectively assess and convey the assessors' level of confidence in the results of the risk assessment.

2.6.5.2 The risk assessment should convey the extent and significance of uncertainty in the technical aspects of a decision process. Management needs to weigh its importance in the decision process.

2.6.6 Communicating Risk Management Options.

2.6.6.1 The action(s) taken to control or manage the risk must be carefully communicated and a common understanding about the risk management actions needs to be developed among the affected public. The case for supporting the choice of a specific risk management option must be made explicit, transparent, and based on a shared responsibility for the choice made. The effectiveness of a specific option and any residual, transformed or substitute risks must be recognized. The actions individuals may take to reduce personal risk should be carefully communicated as a part of the risk management alternative that is chosen.

2.6.6.2 The benefits of a specific option, the cost of managing the risk, and who pays for each option considered are essential information. The residual risks that remain after a risk management option is implemented need to be clearly understood by all affected parties and decision makers.

2.6.7 USACE Dam Safety Fact Sheet. To facilitate risk communication of the flood risk to internal and external interests the district will prepare a USACE Dam Safety Fact Sheet at the completion of any risk assessment performed on a dam in support of the USACE dam safety program. The fact sheet will contain an inundation map. This is a map showing the predicted extent of inundation from controlled or uncontrolled reservoir releases for a pre-determined event scenario or scenarios. Releases may be a result of normal reservoir operation, a result of structural failure or a result of misoperation. The fact sheet is releasable to the general public. For a sample Fact Sheet, see Appendix E (USACE Dam Safety Fact Sheet Templates) and also on the Technical Excellence Network (TEN) website under the Dam Safety Sub Community at (https://ten.usace.army.mil/TechExNet.aspx?p=s&a=CoPs;7).

CHAPTER 3

Dam Safety Portfolio Risk Management

3.1 Purpose/Objective.

3.1.1 This chapter presents an overview of the USACE Dam Safety Portfolio Risk Management for the USACE portfolio of dams and Dam Safety Action Classification (DSAC) System using the principles outlined in Chapter 2.

3.1.2 The overall Dam Safety portfolio risk management process is a series of hierarchical activities that are used to assess, classify, and manage the risks associated with the USACE inventory of dams. The accompanying hierarchical documentation generated by the portfolio risk management process documents the USACE risk assessment and risk management decisions for each dam and facilitates risk communication. The set of documents consists of the reports generated by the normal operations and maintenance (O&M) activities and those documents generated when USACE addresses a dam safety issue. The routine day-to-day dam safety and O&M reports are periodic inspections and periodic assessments; reservoir or water management plans; general operations and maintenance plans; emergency action plans; and instrumentation, monitoring and evaluation plans and reports. The documents generated when addressing a dam safety issue are Screening for Portfolio Risk Analysis report; Interim Risk Reduction Measure Plans; Issue Evaluation Study reports; and Dam Safety Modification Reports.

3.2 Dam Safety Action Classification System.

3.2.1 The DSAC system provides consistent and systematic guidelines for appropriate actions to address the dam safety issues and deficiencies of USACE dams. USACE dams are assigned a DSAC informed by the probability of failure and the incremental risk. The 'incremental risk' is the risk (likelihood and consequences) to the pool area and downstream floodplain occupants associated with the presence of the dam that can be attributed to breach prior or subsequent to overtopping, or component malfunction or misoperation. The risk associated with the non-breach scenario will be assessed, communicated, and considered in USACE actions, but it will not be used to inform the assignment of the DSAC. Until fully evaluated no dam will be considered a DSAC 5; therefore, all dams were initially assigned to classes 1 to 4. The classification of a dam is dynamic over time as project characteristics are modified or more refined information becomes available affecting the loading, probability of failure, or consequences of failure.

3.2.2 DSAC Table Structure. The DSAC table presents different levels and urgencies of actions that are commensurate with the different classes of the safety status of USACE dams. These actions range from immediate recognition of a situation with very high urgency requiring extraordinary and immediate action through normal operations and dam safety activities.

3.2.3 Reconciliation with Past Dam Safety Management Practices. In the past, the USACE dam safety program essentially recognized two categories of actions: those for dams considered safe, which comprised routine dam safety activities, normal operation and maintenance; and those for dams that were considered in need of remediation, for which investigations, remediation funding justification documents, and design and construction of remediation measures were additional activities. However, these two categories do not provide formal recognition of an adequate range of actions and degrees of urgency, especially for dams with issues that are very high or extremely high risks, which warrant heightened actions that are not provided for in the traditional standards-based approach. The choice of five action classes is to provide adequate parsing in the range of levels of actions.

3.2.4 DSAC. The five action classes used by the USACE dam safety portfolio risk management program are summarized in Table 3.1 and described below. The five classes depict the range of dams from those critically near failure to those considered to have very low risk and meet all essential USACE guidelines. Between these two extremes are three classes that define distinctly different levels of actions and urgencies of action that are commensurate with a transition in safety status from critically near failure to adequately safe.

3.2.4.1 Classification 1 (Very High Urgency). Classification 1 is for those dams where progression toward failure is confirmed to be taking place under normal operations and the dam is almost certain to fail under normal operations within a few years without intervention; or the incremental risk – combination of life or economic consequences with likelihood of failure – is very high. USACE considers this level of life-risk to be unacceptable except in extraordinary circumstances.

3.2.4.2 Classification 2 (High Urgency). Classification 2 is for dams where failure could begin during normal operations or be initiated by an event. The likelihood of failure from one of these occurrences, prior to remediation, is too high to assure public safety; or the incremental risk – combination of life or economic consequences with likelihood of failure – is high. USACE considers this level of life-risk to be unacceptable except in extraordinary circumstances.

3.2.4.3 Classification 3 (Moderate Urgency). Classification 3 dams have issues where the incremental risk – combination life, economic, or environmental consequences with likelihood of failure – is moderate. USACE considers this level of life-risk to be unacceptable except in unusual circumstances.

3.2.4.4 Classification 4 (Low Urgency). Classification 4 dams are inadequate with low incremental risk such that the incremental risk – combination of life, economic, or environmental consequences with a likelihood of failure – is low and the dam may not meet all essential USACE guidelines. USACE considers this level of life-risk to be in the range of tolerability but the dam does not meet all essential USACE guidelines.

3.2.4.5 Classification 5 (Normal). Classification 5 is for dams where the incremental risk - combination life, economic, or environmental consequences with likelihood of failure – is very low and the dam meets all essential USACE guidelines (see Appendix F). USACE considers this level of life-safety risk to be tolerable.

3.2.4.6 Background information on the USACE DSAC System along with examples of dams in the various classes in provided in Appendix G.

3.3 Dam Safety Portfolio Risk Management Process.

3.3.1 Overview. The flow chart in Figure 3.1 incorporates all USACE dams at the various stages of dam safety portfolio risk management.

3.3.1.1 Exceptions are dams found to have insignificant or no incremental consequences should they fail. At this time, such structures are to be tagged as exceptions and are exempt from the portfolio management process. Concurrence of the Dam Senior Oversight Group (DSOG) is required for all such dams. These dams will be later considered for decommissioning or transfer. See Appendix H for additional guidance.

3.3.1.2 For the purpose of this regulation, the term “routine” as used in connection with “dam safety activities” is defined as all those activities in the outer ring of Figure 3.1. The “non-routine” when used in connection with “dam safety activities” is defined as all the activities that occur within the center area of Figure 3.1. These terms may have different definitions in budget and other operations regulations and documents.

3.3.2 DSAC Assignment. Starting at the top of Figure 3.1, the ‘classification’ bar or decision point 1a (D 1a) can be viewed as the sorting or binning point that includes all USACE dams, each of which is classified into one of the five Dam Safety Action Classifications as presented in Table 3.1. Note that dams are managed in accordance with their safety status as reflected by their assigned DSAC.

3.3.3 Role of Prioritization and Queues.

3.3.3.1 There are three prioritization processes and associated queues.

3.3.3.1.1 Prioritization of Issue Evaluation Studies (P1)

3.3.3.1.2 Prioritization of Dam Safety Modification Studies (P2)

3.3.3.1.3 Prioritization of approved remediation projects awaiting design and construction funding (P3).

3.3.3.2 Prioritization and queues are necessary due to resource limitations and the desire to reduce overall portfolio risk as efficiently as possible. The associated queues contain the set of dams awaiting studies or processing to the next step, reflecting their prioritization. While the intent is that the queues are eventually cleared, it is certainly possible that a higher priority dam, from a dam safety issue viewpoint, could come into a queue and move ahead of others already there based on the individual dam’s safety status and circumstance.

3.3.3.3 The responsibility for the management of the prioritization process is presented in Chapter 4 - Management of USACE Dam Safety Program, the tolerable risk guidelines are presented in Chapter 5 - Tolerable Risk Guidelines, and the prioritization for risk management is presented in Chapter 6 – Dam Safety Risk Management Prioritization.

3.3.4 Dam Safety Decision Points.

3.3.4.1 There are four major decision points in the dam safety portfolio risk management process.

3.3.4.1.1 Approve Dam Safety Action Classification,

3.3.4.1.2 Selection of Interim Risk Reduction Measures or heightened monitoring,

3.3.4.1.3 Determination if Dam Safety Modification Studies are to proceed based on the results of the Issue Evaluation Study, and

3.3.4.1.4 Approval of Dam Safety Modification Reports.

3.3.4.2 Decisions dealing with the DSAC determination are located at the following points in the dam safety portfolio risk management process:

3.3.4.2.1 Decision Point D 1a. Assign DSAC informed by available risk assessment using the incremental risk data and other dam information. The DSOG recommends the DSAC and the USACE DSO approves the recommended DSAC.

3.3.4.2.2 Decision Point D 1c. When reclassification is the result of an Issue Evaluation Study, the dam can be reclassified to any of the other classes. The DSOG recommends revising the DSAC and the USACE DSO approves the recommended DSAC.

3.3.4.2.3 Decision Point D 1d. An incident, inspection, or assessment finding triggers DSAC review. The DSOG recommends revising the DSAC and the USACE DSO approves the recommended DSAC.

3.3.4.2.4 Decision Point D 1e. Post implementation DSAC review and modification of DSAC as appropriate. Review IRRM plan and modify as appropriate. The DSOG recommends revising the DSAC and the USACE DSO approves the recommended DSAC.

3.3.4.3 Decisions dealing with the implementation of IRRM recommendations for DSAC 1, 2, and 3 dams are located at Decision Point D 2a. The decision related to heighten monitoring for DSAC 4 dams is located at Decision Point D 2b.

3.3.4.4 Decision Point D 3 relates to the determination of whether to proceed to Dam Safety Modification Studies (DSMS) for DSAC 2, 3, and 4 dams.

3.3.4.5 Decision Point D 4 deals with the approval of Dam Safety Modification Reports (DSMR).

3.3.5 Screening. Initially, all dams in the USACE inventory will be subjected to a screening level risk assessment called the Screening for Portfolio Risk Analysis (SPRA), defined later, and assigned a DSAC at decision point D 1a.

3.3.6 Routine dam safety activities and normal operations and maintenance (O&M).

3.3.6.1 The outer loop of the chart depicts continuing and recurrent actions of routine dam safety activities and normal O&M, periodic assessments (PA), incident identification and reporting, review and update of the Dam Safety Program Management Tools data (See Appendix I), and review of the DSAC using the current risk assessment and related dam information. All USACE dams are in the outer loop regardless of their DSAC. Exceptions are those dams found to have insignificant or no consequences should they fail (see paragraph 3.3.15). The ideal end state for all USACE dams is that they are classified DSAC 5 and therefore they are only in the outer loop of the Dam Safety Portfolio Risk Management process diagram.

3.3.6.2 Periodic Inspections (PI) and Periodic Assessments (PA). The PI will be conducted on a routine and systematic schedule not to exceed five fiscal years. All USACE significant and high hazard potential dams will undergo a PA on a routine and systematic schedule not to exceed ten fiscal years. Normally the PA will be combined with the PI. The definition of the various hazard potential levels is given in Appendix J. This ensures that all dams in the USACE portfolio are systematically and routinely evaluated leading to a high likelihood of detecting dam safety issues in a timely manner. Periodic inspections and assessments are described in more detail later in Chapter 11. Periodic Assessment findings are to be used to review the DSAC assignment.

3.3.7 Interim Risk Reduction Measures Plans and Implementation. Interim Risk Reduction Measure (IRRM) plans will be developed for all DSAC 1, 2, and 3 dams. The IRRM plan addresses identified potential failure modes, defines general consequences associated with each identified potential failure mode, quantifies risks for each likely failure mode to the detail required to support the decisions to be made, evaluates loss in project benefits due to the IRRM measures, and evaluates the potential of the IRRM alternatives considered to reduce the probability of failure and/or consequences associated with the failure modes. A risk assessment, scaled to a level of effort related to the decision to be made, may be performed during development of the IRRM plan. Preparation of an Interim Risk Reduction Measures Plan (IRRMP) is required as per guidance associated with the DSAC table and discussed in detail in Chapter 7.

3.3.8 DSAC 1 Expedited Process. DSAC 1 dams with life safety risk are immediately processed through several key steps to formulate, approve (Decision Point D 2a), and implement interim risk reduction measures. Note: DSAC 1 dams with very low or without life-safety risk will be coordinated with the appropriate Business Line Manager for determining priorities within the larger Civil Works mission and assigned a lower priority within the Dam Safety Program, including typically being placed lower in priority than DSAC 2 or 3 dams with life-safety risk. At Decision Point D 2a the USACE Dam Senior Oversight Group (DSOG) will review DSAC documentation and make a recommendation to the USACE senior leadership that the agency does or does not accept the DSAC 1 classification for that dam. The IRRM plan must be developed and implemented as quickly as possible for DSAC 1 dams. The Issue Evaluation Study will be expedited for DSAC 1 dams that are given the highest priority for funding and resources (Prioritization Point P1). For DSAC 1 dams the Dam Safety Modification Study will be prioritized and scheduled at Prioritization Point P 2 and sent to the funding and resource queue. The next step is the Dam Safety Modification Study and decision document process to determine the appropriate risk management measures. See Figure 9.1 for a detailed flow chart of the DSM study and report development, review and approval process. The Dam Safety Modification Study report will then be reviewed and approved or returned for more studies and investigation (Decision Point D 4). If the decision is for additional study and investigation the project will be prioritized and scheduled with the other dams recommended for Dam Safety Modification Studies (Prioritization Point P 2). If the decision is to approve the report, and risk reduction measures are required, the project will be prioritized for funding (Prioritization Point P 3) and moved to the resource queue to wait for funding to implement the risk management measures. Once the approved risk management measures are implemented the DSAC will be reviewed and modified as appropriate and the IRRM plan will be reviewed and modified. This action is taken at Decision Point D1e in the flow chart. The implementation of approved risk management measures may not move a dam from a DSAC 1 all the way to a DSAC 5.

3.3.9 DSAC 2 and 3 Process. All dams placed into DSAC 2 and 3 (Decision Point 1a) will have IRRM plans developed and implemented. The IRRM plans identify the risk management measures that should be submitted for approval (Decision Point 2a) to the MSC Dam Safety Officer. After the IRRM plan is approved the district is to develop and submit an Issue Evaluation Study Plan for DSAC 2 and 3 dams which are prioritized and scheduled for Issue Evaluation Studies (Prioritization Point 1). Once scheduled, the individual projects are put into the funding and resource queue. After the Issue Evaluation Study is completed and based on the results of the study the DSAC is reviewed and modified as appropriate at Decision Point 1c (D 1c). Based on the risk assessment performed during the Issue Evaluation Study a dam could be reclassified into any DSAC. If a dam is put into the DSAC 1, it will then be addressed using the DSAC 1 Expedited Process. If a dam is in DSAC 2, 3, or 4 it will be reviewed to determine if a Dam Safety Modification Study (DSMS) should be undertaken (Decision Point D 3). If the determination is to proceed with a DSMS, then the project is prioritized and scheduled (Prioritization Point P 2) and sent to the funding and resource queue. From that point forward the process is the same as for DSAC 1 dams.

3.3.10 DSAC 4 Process. For DSAC 4 dams an IRRM plan is not required but a decision has to be made related to heightened monitoring (Decision Point 2b). From this point forward the process is the same for a DSAC 4 dam as it is for a DSAC 2 or 3 dam. When the assigned DSAC for a dam is changed from a 1, 2, or 3 to a 4 the district will review the available risk assessment information, (such as potential failures modes, associated loads on the dam, performance of the dam, and related consequences) to identify the appropriate level of monitoring and evaluation above the routine level. The level of monitoring must be such that it will provide the district with an adequate level of awareness and lead time to take any actions needed if there is indication of deteriorating performance of the dam. See Chapter 14 for additional guidance on monitoring and evaluation requirements.

3.3.11 DSAC 5 Process. To assign a dam a DSAC 5 normally requires a quantitative risk assessment estimate with as low as reasonably practicable (ALARP) considerations included to determine the incremental risk and an evaluation of compliance with all essential USACE guidelines with no unconfirmed dam safety issues. There may be specific dams where the semi-quantitative risk assessment used in support of the Periodic Assessment could be used to inform the decision to assign a DSAC 5 to that dam. Normally, the risk assessment in support of the Issue Evaluation Study (if the incremental risk is determined to be tolerable), the risk assessment in support of the DSMS, or the risk assessment in support of the Post-Implementation Evaluation will be used to inform the decision on assignment of a DSAC 5. The post-implementation evaluation of the dam will determine how well the implemented risk management measures meet the prescribed performance levels and applicable essential USACE guidelines as outlined in the DSMR. The essential USACE guidelines and DSAC 5 protocol are discussed in Appendix F.

3.3.12 Periodic Assessments (PA) and Phase 1 Issue Evaluation Study (IES) risk estimates will use currently-available information for the loading functions, the determination of component and system response curves (conditional probability of failure), and development of the consequence estimate by the Modeling, Mapping, and Consequences Center (MMC). Additional information and analysis to reduce uncertainty and increase confidence in the risk estimate may be warranted to support the Phase 2 IES and the decision to go forward with a Dam Safety Modification Study. In all cases the risk estimate should be obtained with the minimum expenditure of time and resources. The scope of the risk assessment should be determined on the basis of the decisions to be made.

3.3.13 Issue Evaluation Studies (IES) are studies to better determine the nature of the safety issue and the degree of urgency for action within the context of the full USACE inventory of dams. The Issue Evaluation Study has multiple steps that increase with rigor and detail beginning with a semi-quantitative risk assessment and progresses through a quantitative risk assessment that might require a Phase 2 IES if necessary to reduce uncertainty. DSAC 1 dams go through the same steps as the DSAC 2, 3, and 4 dams but in an expedited manner. The semi-quantitative risk assessment is more robust and detailed than the SPRA and is used to validate the current DSAC. If this risk assessment results in a less urgent DSAC, then the IES is suspended and is reprioritized. If the current DSAC is validated, a quantitative risk assessment will be conducted that will develop a risk estimate and enable informed decisions about the need for a Dam Safety Modification Study, further investigations, the DSAC reclassification, and interim risk reduction measures implementation. The level of detail should only be what is needed to develop the risk estimate. Based on the results of previous or current investigations and an Issue Evaluation Study, a dam could be reclassified as DSAC 1 and thus warrant the expedited process for a DSAC 1 dam. The report documenting the IES will have an Agency Technical Review (ATR) performed to include Risk Management Center (RMC) representatives. The IES report presents the rationale and the basis for proceeding to a Modification Study and changes to the IRRM plan. The IES report shows the current condition of the dam with respect to the tolerable risk guidelines. Issue Evaluation Studies are discussed in detail in Chapter 8 and the process is depicted in Figure 8.1.

3.3.14 Dam Safety Modification Studies and Decision Documentation. Dam Safety Modification Studies may require, beyond the Issue Evaluation Study, additional data gathering and detailed studies. Formulation and evaluation for a full range of risk management alternatives with preliminary level cost estimates will be performed at this time. A detailed risk assessment is required to establish the existing and future without Federal action condition risk (incremental and non-breach) and will look at incremental risk management alternatives that together meet the tolerable risk guidelines (details in Chapter 5) and cost effectiveness of reducing the incremental risk below the tolerable risk limit guidelines. However, the level of detail for the risk assessment and DSM study should only be what is needed to support the modification decision. Related National Environmental Policy Act (NEPA) (reference A.6) and Endangered Species Act (ESA) (reference A.10) studies will be conducted at this time in support of the recommended risk reduction measures. The DSM decision document presents the rationale for the alternative recommended, to include life, economic and environmental risk reduction, and other non-tangible aspects. The report will show how this alternative complies with the tolerable risk guidelines. The Dam Safety Modification decision document will present a comparison of alternatives and the recommended plan to include actions, components, risk reduction by increments or phases, evaluation of the risk in relation to the tolerable risk guidelines, implementation plan, detailed Risk Cost and Schedule Assessment per ER 1110-2-1302, Civil Works Cost Engineering (reference A.50), the NEPA (reference A.6), and the ESA (reference A.10) determinations. This document will have an ATR performed to include RMC representatives and will normally have an independent external peer review. Dam Safety Modification Studies process, contents, reviews, and the approval process are discussed in detail in Chapter 9.

3.3.15 Dams Exempt from the Dam Safety Portfolio Risk Management Process. USACE inventory has a number of dams and associated structures that no longer serve a beneficial purpose or have been found to have insignificant or no consequences should they fail. At this time, such structures are to be tagged exceptions and are exempt from the portfolio management process. Concurrence of the DSOG is required for all such dams. These dams will be handled in accordance with Appendix H and may be considered for decommissioning or transfer.

3.3.16 At any point in the portfolio risk management process a determination may be made that it would be more advantageous to resolve a dam safety deficiency through the regular Operations and Maintenance program rather than the Dam Safety Modification process. If this is the case the district DSO should consider transferring the action to the Operations and Maintenance program. Such minor modifications for dam safety would be funded with Operations and Maintenance funds. When significant risk reduction can be made at high risk dams without completing a full Dam Safety Modification Report, the district DSO and the district Operations chief should coordinate with the MSC and HQ dam safety program managers and the O&M appropriation program managers to determine when O&M funds can be made available. Dam Safety O&M funded modification plans and specifications are to be reviewed by the appropriate Dam Safety Production Center (DSPC) with issues forwarded to the DSOG as needed.

3.3.17 The development of dam safety products is complex and involves district and DSPC staff. When making a determination on which organization has the lead for a given activity see paragraph 4.4.1.5.1 and the definition of dam safety modification.

3.4 <u>Scope of Risk Assessments in Support of Dam Safety Evaluations</u>. There are six specific instances of evaluations in the process- Screening for Portfolio Risk Analysis (SPRA), Interim Risk Reduction Measures Plans (IRRMP), Periodic Assessments (PA), Issue Evaluation Studies (IES), Dam Safety Modification Studies (DSMS), and Post-Implementation Evaluations (PIE). The USACE Dam Safety Portfolio Risk Management process uses risk assessments in each of these instances of evaluations. These risk assessments vary in purpose and therefore in the data required, detail and robustness of analysis, and in uncertainty and confidence in the results. However, in all cases the level of detail should only be what is needed to support the decision(s) that will be informed by the risk assessment.

3.4.1 General Steps in Risk Assessment. The general steps of a quantitative risk assessment (listed below) are scalable to fit the purpose of the risk assessment.

3.4.1.1 Potential failure mode analysis (See Appendix K, “Potential Failure Mode Analysis (PFMA) for Dams” for guidance in determining potential failure modes;

3.4.1.2 Develop event trees for potential failure modes;

3.4.1.3 Develop the loading function for each failure mode carried forward in the assessment;

3.4.1.4 Determine the conditional probability of failure and system response curve for each failure mode carried forward in the assessment;

3.4.1.5 Estimate the consequences associated with each failure mode carried forward in the assessment;

3.4.1.6 Risk estimate calculations for incremental risk and ‘non-breach’ risk; and

3.4.1.7 Compare the incremental risk to the USACE tolerable risk guidelines for life safety.

3.4.2 Screening for Portfolio Risk Analysis (SPRA). This process screened projects to expeditiously identify the dams with very high and high urgency for action (DSAC 1 and 2 dams) with low chance of missing any such dams. Also, the SPRA provided information for preliminary classification of the remainder of the USACE dams into DSAC 3 and 4. SPRA did not provide sufficient information to confirm a dam can be placed in DSAC 5. The intent was that SPRA would be performed only once for every dam in the USACE inventory. The SPRA DSAC will remain the official classification until a more detailed assessment leads to a reclassification. The SPRA process is described in Appendix L.

3.4.3 Interim Risk Reduction Measures Plans (IRRMP). At the minimum a potential failure mode analysis (PFMA) is to be completed to support the IRRMP. If needed to support the IRRM plan a risk assessment will be conducted using existing information and easily obtained consequence data. The primary purpose is to support and provide a basis for the selected interim risk reduction measures. The risk assessment will have to be scaled depending on the significance of the dam safety issue and the impact of the interim risk reduction measures.

3.4.4 Periodic Assessments (PA). PA's will normally be conducted for all High and Significant Hazard Potential dams on a 10 fiscal year cycle, but can be conducted more frequently as indicated by performance of the dam. The periodic assessment will consist of a site visit, typically associated with a periodic inspection, a potential failure modes analysis, and a semi- quantitative risk assessment based on existing data and limited development of estimated consequence data developed by the Modeling, Mapping, and Consequence Production Center. The primary purposes of the Periodic Assessment are as follows.

3.4.4.1 Evaluate the project vulnerabilities and associated risks, including non-breach risks;

3.4.4.2 Reevaluate the DSAC of a project and recommend a change, if necessary;

3.4.4.3 Review and if necessary revise the IRRMP;

3.4.4.4 Identify the need for issue evaluation studies and provide data to prioritize issue evaluation studies;

3.4.4.5 Identify and prioritize any data collection, analyses, and study needs;

3.4.4.6 Identify operations and maintenance, monitoring, emergency action plan, training and other recurrent needs; and

3.4.4.7 Provide a better understanding of vulnerabilities and a basis for future dam safety inspections and activities.

3.4.5 Issue Evaluation Study. Risk assessments in support of the Issue Evaluation Studies (IES) are conducted for the following purposes:

3.4.5.1 Primary. Confirm that dam safety issues do or do not exist and determine if a Dam Safety Modification Study is warranted. Thus the scope of the study is to identify all significant potential failure modes (or groups of credible failure modes) that are significant risk drivers and to determine the incremental and non-breach risk of the dam.

3.4.5.2 Secondary.

3.4.5.2.1 Verify the current DSAC or reclassify based on these findings;

3.4.5.2.2 Determine if a dam should be reclassified as DSAC 1 and thus warrants the expedited process for a DSAC 1 dam;

3.4.5.2.3 Verify the adequacy of current or need for additional interim risk reduction measures;

3.4.5.2.4 Provide information to support prioritization of Dam Safety Modification Study; and

3.4.5.2.5 Develop or update the risk estimate for the incremental and ‘non-breach’ risk.

3.4.6 Dam Safety Modification Study (DSMS). The risk assessment supporting the DSMS leads to definitive decisions and documentation to support dam safety actions to achieve reduction in life-safety risk, economic risk, and environmental risks. Additional data will be gathered as appropriate to support the decision to be made. The primary purposes of the DSMS are the determination or update of the risk estimate for the incremental and non-breach risk; identification, evaluation, document support for, and recommendation of long-term risk management measures; and the estimation of the incremental risk, the ‘non-breach’ risk, and residual risk of the remediated project.

3.4.7 Post-Implementation Evaluation. In support of the PIE, the risk assessment in support of the DSMS must be updated after implementation of the risk management plan and the dam evaluated to determine if the risk management objectives were achieved to include evaluation of compliance with applicable essential USACE guidelines.

3.4.8 These risk assessments must be reviewed by the DSOG and any resulting DSAC change approved by the USACE DSO.

3.5 Risk Reporting and Data Management. The following will be tracked and reported on per guidance in Appendix I using the Dam Safety Program Management Tools (DSPMT).

3.5.1 SPRA ratings and findings,

3.5.2 Current DSAC,

3.5.3 Listing of dam safety issues,

3.5.4 Residual risk of current conditions and confidence of the risk estimate (range of risk),

3.5.5 Previous reports and summary of recommendations,

3.5.6 Current IRRM,

3.5.7 Findings of the most recent Potential Failure Mode Analysis,

3.5.8 Findings, recommendation, and final decisions of the last PA and PI,

3.5.9 Results of the essential USACE guidelines (Appendix F) evaluation,

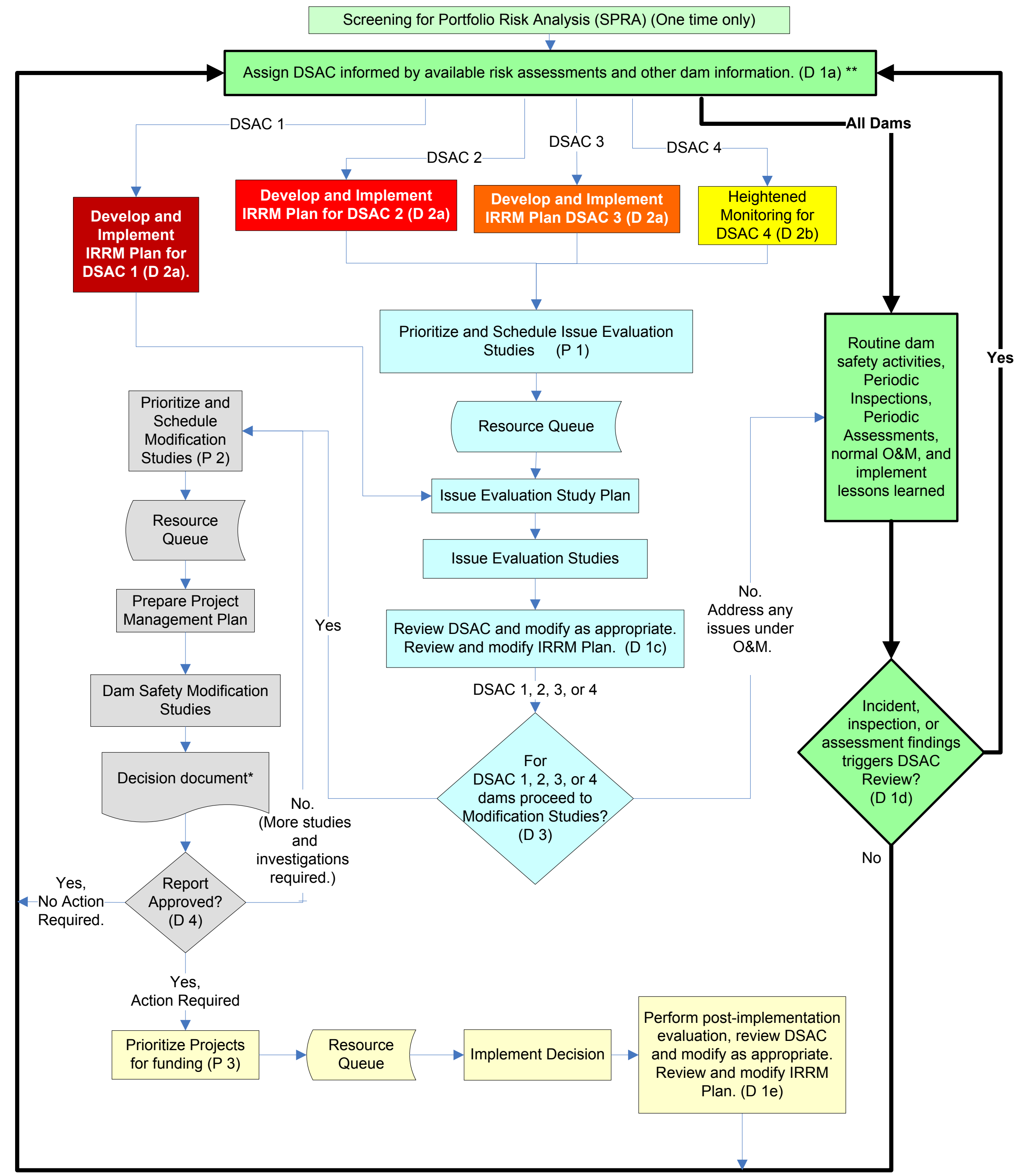
3.5.10 Consequences - list estimated consequences related to the identified potential failure modes,

3.5.11 IES results, recommendations and final decisions, and

3.5.12 DSMS results, recommendation, and final decisions.

3.6 Water Storage and Risk Management Measures. Dam safety must be on the critical path of all decisions regarding water supply storage in USACE reservoirs. When water supply is requested by non-Federal customers, USACE decision makers at all levels must fully consider the condition of the dam, DSAC of the dam, associated risks, and their impacts on inspection, operation and maintenance of the project. While public safety is paramount, the benefits of providing safe and reliable water supply storage to non-Federal customers also must be considered. A reallocation that would require raising the conservation pool is not permitted while a project is classified DSAC 1, 2, or 3 (See Chapter 24).

3.7 Modifications for Non-Federal Hydropower. Dam safety must be on the critical path of all decisions regarding installation of non-Federal hydropower plant at USACE dams. When installation of non-Federal hydropower is requested by non-Federal developers, USACE decision makers at all levels must fully consider the condition of the dam, DSAC of the dam, associated risks, and their impacts on inspection, operation and maintenance of the project. While public safety is paramount, the benefits of providing reliable electrical power to the nation also must be considered. A reallocation that would require raising the conservation pool is not permitted while a project is classified DSAC 1, 2, or 3. Generally, modifications of a DSAC 1 dam for non-Federal hydropower will be discouraged. In any case, modifications of DSAC 1 and 2 projects will require detailed review during planning and a developer-sponsored Type II IEPR. All alterations of USACE dams to non-Federal Hydropower require a Section 408 permit. For additional guidance on Section 408, see CECW-PB memorandum, Subject: Clarification Guidance on the Policy and Procedural Guidance for the Approval of Modifications and Alterations of Corps of Engineers Projects, dated November 17, 2008 (reference A.100).



Decision Points are label as (D 1a), Prioritization Points are labeled as (P 1), and the details for each point is explained in Chapter 3.
*** Independent External Peer Review requirements are to be addressed per guidance in Chapter 9.**
**** Regardless of DSAC classification, dams with insignificant or no consequences should they fail are considered exceptions; will be so tagged, and are exempt from the dam safety portfolio management process depicted here in Figure 3.1.**

Figure 3.1 – USACE Dam Safety Portfolio Risk Management Process.

Table 3.1 - USACE Dam Safety Action Classification Table - 27 Jan 2014*

URGENCY OF ACTION (DSAC)	ACTIONS FOR DAMS IN THIS CLASS***	CHARACTERISTICS OF THIS CLASS
VERY HIGH (1)	Take immediate action to avoid failure. Communicate findings to sponsor, local, state, Federal, Tribal officials, and the public. Implement interim risk reduction measures, including operational restrictions. Ensure the emergency action plan is current and functionally tested for initiating event. Conduct heightened monitoring and evaluation. Expedite investigations to support remediation using all resources and funding necessary. Initiate intensive management and situation reports.	CRITICALLY NEAR FAILURE: Progression toward failure is confirmed to be taking place under normal operations. Dam is almost certain to fail under normal operations to within a few years without intervention. OR EXTREMELY HIGH INCREMENTAL RISK**: Combination of life or economic consequences with likelihood of failure is very high. USACE considers this level of life-risk to be unacceptable except in extraordinary circumstances.
HIGH (2)	Communicate findings to sponsor, local, state, Federal, Tribal officials, and the public. Implement interim risk reduction measures, including operational restrictions as warranted. Ensure the emergency action plan is current and functionally tested for initiating event. Conduct heightened monitoring and evaluation. Expedite confirmation of classification. Give very high priority for investigations to support the need for remediation.	FAILURE INITIATION FORESEEN: For confirmed and unconfirmed dam safety issues, failure could begin during normal operations or be initiated as the consequence of an event. The likelihood of failure from one of these occurrences, prior to remediation, is too high to assure public-safety. OR VERY HIGH INCREMENTAL RISK**: The combination of life or economic consequences with likelihood of failure is high. USACE considers this level of life-risk to be unacceptable except in extraordinary circumstances.
MODERATE (3)	Communicate findings to sponsor, local, state, Federal, Tribal officials, and the public. Implement interim risk reduction measures, including operational restrictions as warranted. Ensure the emergency action plan is current and functionally tested for initiating event. Conduct heightened monitoring and evaluation. Prioritize investigations to support the need for remediation informed by consequences and other factors.	MODERATE TO HIGH INCREMENTAL RISK**: For confirmed and unconfirmed dam safety issues, the combination of life, economic, or environmental consequences with likelihood of failure is moderate. USACE considers this level of life-risk to be unacceptable except in unusual circumstances.
LOW (4)	Communicate findings to sponsor, local, state, Federal, Tribal officials, and the public. Conduct elevated monitoring and evaluation. Give normal priority to investigations to validate classification, but do not plan for risk reduction measures at this time.	LOW INCREMENTAL RISK**: For confirmed and unconfirmed dam safety issues, the combination of life, economic, or environmental consequences with likelihood of failure is low to very low and the dam may not meet all essential USACE guidelines. USACE considers this level of life-risk to be in the range of tolerability but the dam does not meet all essential USACE guidelines.
NORMAL (5)	Continue routine dam safety activities and normal operations, maintenance, monitoring, and evaluation.	VERY LOW INCREMENTAL RISK**: The combination of life, economic, or environmental consequences with likelihood of failure is low to very low and the dam meets all essential USACE guidelines. USACE considers this level of life-safety risk to be tolerable.

*At any time for specific events a dam, from any action class, can become an emergency requiring activation of the emergency plan.
** INCREMENTAL RISK is used to inform the decision on the DSAC assignment; NON-BREACH RISK is not reflected in this table.
***DSAC 1 and 2 dams with no life loss will be referred to the appropriate business line program and are given lower priority in the dam safety program.

CHAPTER 4

Management of USACE Dam Safety Program

4.1 General. USACE maintains a three-level decentralized organization, HQUSACE, MSC (Regional) and district. Each level should be staffed with qualified personnel in areas of design, construction, inspection and operations of dams and appurtenant structures, with appropriate training and experience in dam safety risk assessment, risk management, and risk communications. Each organizational level must have a Dam Safety Officer (DSO) with supporting organization as outlined in this chapter. USACE utilizes risk-informed procedures to aid in the prioritization of dam safety deficiency corrections on a nation-wide basis with budgeting for dam safety studies and modifications managed at the HQUSACE level. National oversight is furnished by the Dam Safety Steering Committee (DSSC), Dam Safety Production Center Steering Committee (DSPCSC), and the Dam Senior Oversight Group (DSOG), which are further described herein. Prioritization of all risk assessments, studies and remediation are managed on behalf of HQUSACE by the Risk Management Center (RMC) with oversight by the DSOG and Special Assistant for Dam and Levee Safety. Routine day-to-day operation, maintenance and safety evaluations of dams remain the primary responsibility of the district commander.

4.2 Overall Responsibility for Dam Safety Program. The Commanders at each level of USACE have the ultimate responsibility for dam safety within their commands. Each District Commander having responsibility for dams must ensure that the organization has a dam safety program which complies with USACE policy and criteria, assuring compliance with the “Federal Guidelines for Dam Safety” (reference A.114). Commanders exercise this responsibility through officially designated (appointed) Dam Safety Officers (DSO) at each level. Although the DSO is located in the technical element of each organizational level, dam safety crosses all business lines and office elements, and the DSO must coordinate dam safety issues and activities with the leaders of those business lines and office elements as they manage the dam safety activities in their areas of responsibility. This includes coordination between the district office and the project field offices (that serve as the first line of defense for dam safety) concerning such issues as emergency action plans, dam safety training, and control of project documentation as discussed in subsequent chapters as well as ER 1130-2-530 (reference A.61).

4.2.1 For the USACE Dam Safety program to be fully successful, it is imperative that technically and managerially qualified personnel who are passionate advocates of dam safety be in place at every key level of the organization. This is even more vital for a DSO because of the implications that their decisions can have on life safety. Their decision-making must be based solely on the best technical approach which protects life and property and cannot be clouded by political considerations. Technical capability/experience alone, while vitally important, does not assure that a person is qualified to function as a DSO. That person must also possess the desire to be an advocate for the program, possess excellent communications skills, and be capable of sound decision-making under pressure. If any of these is lacking, then the person is not fully qualified even if they are extremely qualified technically.

4.2.2 For these reasons, all leaders who appoint Dam Safety Officers at the HQ, MSC, and District levels must thoroughly review and verify the qualifications and suitability for a person to function in this key role. Paragraph 4.7 provides the procedures for selecting and appointing a DSO.

4.2.3 If the highest ranking technical individual in the command lacks a particular skill set (or needs additional development in an area) in order to meet the DSO qualifications, it is the responsibility of the leader with appointment responsibilities to put a developmental plan in place which will assure the full skill set is achieved within a reasonable (12 to 18 months) time frame. This developmental plan might include formal training coursework, conferences, mentor relationships with other Dam Safety Officers, and short-term assignments in districts where key dam safety decisions are being made. For a sample developmental plan, see Appendix M (USACE Dam Safety Officer Sample Development Plan) and also on the Technical Excellence Network (TEN) website under the Dam Safety Sub Communities at (https://ten.usace.army.mil/TechExNet.aspx?p=s&a=CoPs;7).

4.2.4 Overview of Dam Safety Roles and Responsibilities. Although the DSO's have responsibility for Dam Safety within their respective areas of responsibility (AOR), many organizations within USACE play an integral part in maintaining an overall effective Dam Safety Program. An overview of those organizations with their roles and responsibilities are shown in Appendix N and are further defined in the following paragraphs.

4.3 Headquarters, US Army Corps of Engineers.

4.3.1 Organization. The USACE Dam Safety Officer (DSO) is appointed by the Chief of Engineers based upon qualifications and is typically the Senior Executive Service (SES) member in charge of the Engineering and Construction Community of Practice (CoP). A Special Assistant for Dam and Levee Safety and the USACE Dam Safety Program Manager (DSPM) support the USACE DSO. The USACE Dam Safety Steering Committee (DSSC), the Dam Safety Production Center Steering Committee (DSPCSC), and the HQUSACE Dam Safety Committee provide additional advice and support to the USACE DSO concerning the program. The Dam Senior Oversight Group (DSOG) is the surrogate for the HQUSACE Dam Safety Committee. The DSOG coordinates with the MSC's and presents the resulting proposed items to the DSO for concurrence and/or decision. Memoranda from the DSO document the concurrence, decisions, and agreements. Other key decisions and performance elements are briefed to leadership through the Annual Dam Safety Program Review.

4.3.2 Responsibilities and Qualifications. The roles, responsibilities, and qualifications presented below are based on "Dam Safety Officer Roles, Responsibilities, Qualifications, and Professional Registration Requirements" (reference A.104).

4.3.2.1 USACE Dam Safety Officer: The USACE DSO must be a registered professional engineer with civil engineering background and with management abilities and be competent in the areas related to the design, construction, operation, maintenance, inspection or evaluation of dams and understand adverse dam incidents and the potential causes and consequences of dam failure. As the USACE DSO, this individual is responsible directly to the Chief of Engineers for all dam safety activities and is appointed by written order of the Chief of Engineers. The USACE DSO coordinates dam safety activities with the various elements of the Directorate of Civil Works and informs the Director concerning the condition of USACE dams. The USACE DSO is responsible for ensuring that USACE maintains a proactive dam safety program, implementing all practices and procedures outlined in the "Federal Guidelines for Dam Safety" (reference A.114). The USACE DSO is responsible for establishing policy and technical criteria for dam safety, and prioritizing dam safety related work. The USACE DSO or designated representative(s) represents the Department of Defense on the National Dam Safety Review Board (NDSRB) and Interagency Committee on Dam Safety (ICODS). The USACE DSO ensures that programs to implement dam safety needs and to monitor the activities at the various levels of the USACE are established. The USACE DSO serves as chair of the HQUSACE Dam Safety Committee. The USACE DSO assesses USACE dam safety activities utilizing the best available techniques and programs, and periodically report to the Director of Civil Works and Chief of Engineers.

4.3.2.2 Special Assistant for Dam and Levee Safety. The Special Assistant acts for the USACE DSO in the execution of daily program activities and serves as Chairman of the DSSC and the DSOG. The Special Assistant must be a registered professional engineer with civil engineering background and with management abilities, be competent in the areas related to the design, construction, operation, maintenance, inspection or evaluation of dams and understand adverse dam incidents and the potential causes and consequences of dam failure. The Special Assistant must be appointed in writing by the USACE Dam Safety Officer. The Special Assistant works for and reports directly to the USACE DSO. The Special Assistant provides operational direction to the director of the RMC. The Special Assistant represents the USACE DSO in the development of the budget submission, working with the appropriate Business Line Managers to ensure that dam safety priorities are addressed. The Special Assistant serves as the Department of Defense and/or USACE representative on various national teams as directed by the USACE DSO.

4.3.2.3 USACE Dam Safety Program Manager. The USACE Dam Safety Program Manager (DSPM) must be a registered professional engineer with civil engineering background (or registered engineering geologist as described in paragraph 4.6) and with management abilities and have knowledge and experience in the design, construction, operation, maintenance, inspection, or evaluation of dams. The USACE DSPM must be appointed in writing by the USACE Dam Safety Officer and works in coordination with the Special Assistant for Dam and Levee Safety. The USACE DSPM conducts the daily activities of the overall dam safety program. The USACE DSPM coordinates the HQ review of dam safety reports and prepares USACE-wide dam safety budget submissions in coordination with the DSSC and the RMC. The USACE DSPM serves as the Department of Defense and/or USACE representative on various national teams as directed by the USACE DSO or the Special Assistant. The USACE DSPM maintains an updated membership list of the HQUSACE Dam Safety Committee, the DSSC, the DSOG, and all USACE DSO's and DSPM's.

4.3.2.4 Risk Management Center: USACE is using a risk-informed dam safety program management process to effectively evaluate, prioritize and support dam safety decision making. In order to realize the full benefits of risk-informed program management, the RMC has been established to provide technical expertise and advisory services to assist in managing and facilitating the USACE-wide dam safety program. The RMC is a support organization, partially project funded, and located within the Institute of Water Resources (IWR). The director of the RMC reports through the IWR Director to the Director of Civil Works. The RMC has close ties to the Chief of Engineering and Construction and to the Special Assistant for Dam and Levee Safety. The RMC assists the Special Assistant in implementation of dam safety policy using a combination of centralized staff as well as other national, regional, and district resources.

4.3.2.4.1 The RMC Director must be a registered professional engineer with civil engineering background and with management abilities, be competent in the areas related to the design, construction, or evaluation of dams and understand adverse dam incidents and the potential causes and consequences of dam failure. The director must have knowledge of risk management concepts and implementation.

4.3.2.4.2 The roles and responsibilities of the Risk Management Center are established in ER 10-1-55, Organization and Functions, Risk Management Center (reference A.32).

4.3.2.5 Dam Safety Steering Committee (DSSC). The DSSC is a committee charged with facilitating and promoting dam safety as a fundamental USACE mission in all levels of the organization, promoting dam safety career development, disseminating pertinent information throughout the USACE, and reviewing and evaluating policy, technical criteria and practices, administrative procedures, and regulatory functions to support the dam safety program. The DSSC reviews experience and qualifications of dam safety staffing at all levels for within the USACE to assess competency, review MSC funding requirements for achieving program requirements, and make recommendations for future research and development in areas related to dam safety. The DSSC meets as required, and provides advice and information to the Special Assistant for Dam and Levee Safety. Additional information on the DSSC membership is provided in Appendix O.

4.3.2.6 The Dam Senior Oversight Group (DSOG) generally consists of senior engineers and other team members as defined in Appendix O.

4.3.2.6.1 The DSOG reviews the DSAC of existing dams, dam safety risk assessment reports and other decision documents, and dam safety work priorities based on portfolio risk findings. DSOG makes recommendations on dam safety modifications to the Special Assistant for Dam and Levee Safety and the USACE DSO.

4.3.2.6.2 The Special Assistant may assign additional ad hoc members to act as reviewers for the DSOG for any decision documents as required. These ad hoc members will meet as necessary to accomplish these reviews in a timely fashion to prevent delays in the execution of risk management measures.

4.3.2.7 Dam Safety Modification Mandatory Center of Expertise (DSMMCX).

4.3.2.7.1 The DSMMCX is responsible for assisting HQUSACE with the overall coordination and oversight of the dam safety modification mission. The DSMMCX conducts sufficient reviews and coordination of the DSPCs to ensure consistency in product development and continual improvement through lessons learned. The DSMMCX promotes the development of technical competencies and facilitates coordination between the DSPCs to align resources with project needs and agency priorities. The DSMMCX is co-located at a regional DSPC and under the direct control of the MSC Commander with strong relationships and accountability to the Special Assistant for Dam and Levee Safety. The detailed roles and responsibilities of the DSMMCX are further defined in ER 10-1-51 (reference A.30) and in Appendix N.

4.3.2.7.2 The DSMMCX Director must be a registered professional engineer with a civil engineering background and with management abilities. The director must be competent in the areas related to the design, construction, or evaluation of dams and understand adverse dam incidents and the potential causes and consequences of dam failure. The Director is a member of the DSOG and chairs the Dam Safety Production Center Management Group (DSPCMG).

4.3.2.8 Dam Safety Production Center Management Group (DSPCMG). The DSMMCX is responsible for scheduling, coordinating, and facilitating DSPCMG activities. The DSPCMG meets no less than semi-annually and focuses on consistency of DSPC products, how to make delivery of DSPC products/services more efficient, ensures widest distribution of lessons learned and promotes resource sharing between the DSPCs. The membership of the group is defined in Appendix O.

4.3.2.9 Dam Safety Production Center Steering Committee (DSPCSC). The Committee membership consists of the Chief of Engineering and Construction at Headquarters, or designee, and senior leadership representation from the MSCs as determined by the USACE DSO. The Committee is chaired by the USACE DSO, or designee. The DSPCSC meets annually and focuses on strategic planning, and ensuring effectiveness and efficiency of the Dam Safety Production Centers.

4.3.2.10 The Modeling, Mapping, and Consequences Production Center (MMC) supports both the USACE Dam Safety and Critical Infrastructure Protection & Resilience (CIPR) Programs. In support of HQUSACE management of the dam safety program, the MMC performs hydraulic modeling, mapping, and consequences analysis for USACE dams in support of the Dam Safety and CIPR programs. The MMC is led by a district with a core staff that is supplemented by a virtual staff of Hydraulic Engineers, Economists, and GIS professionals from across USACE. The MMC leverages H&H modeling, consequences analysis, and GIS mapping capabilities/resources via close coordination with USACE RMC to accomplish national mapping, hydraulic analysis, and consequences requirements for the Dam Safety and CIPR Programs. The following are the major initiatives for the MMC: Develop consistent and scalable hydraulic models and consequence data for USACE dams; develop consistent mapping for Emergency Action Plans (EAP); and develop standards for GIS, consequence analysis, and, modeling and mapping. The MMC is located within the Vicksburg District. The detailed roles and responsibilities of the DSMMCX are further defined in ER 10-1-54 (reference A.31) and in Appendix N.

4.3.2.10.1 The Modeling, Mapping, and Consequences Production Center Steering Committee (MMCSC) is charged with providing oversight and guidance to the MMC program manager. The committee reviews and interprets policy, technical criteria and best practices, administrative procedures, and performs other functions as required to support the MMC mission. The committee meets as required.

4.3.2.10.2 The membership of the MMCSC is defined in Appendix O.

4.4 Major Subordinate Commands (MSC) (Regional Headquarters).

4.4.1 Organization and Qualifications. The roles, responsibilities, and qualifications presented below are based on “Dam Safety Officer Roles, Responsibilities, Qualifications, and Professional Registration Requirements” (reference A.104).

4.4.1.1 MSC Dam Safety Officer (DSO). The MSC DSO must be a registered professional engineer with civil engineering background and with management abilities and be competent in the areas related to the design, construction, operation, maintenance, inspection, or evaluation of dams and understand adverse dam incidents and the potential causes and consequences of dam failure. The MSC DSO should be the SES or MSC technical lead who is responsible for the engineering elements of the organization. The Commander must ensure the MSC DSO meets the technical qualifications and experience. The MSC DSO must be appointed by written order of the MSC Commander following the process identified in paragraph 4.7. A copy of the appointment order for each DSO must be forwarded to the USACE DSO. The MSC DSO serves as the Chair of the MSC Dam Safety Committee.

4.4.1.2 MSC Dam Safety Committee. The MSC Dam Safety Committee includes the MSC DSO, MSC DSPM, and the MSC Dam Safety Production Center (DSPC) Director plus additional members as required. The members should include the various technical engineering disciplines as well as Operations, Water Management, and Programs from within the MSC headquarters. Other disciplines and areas of expertise, e.g., Security, Public Affairs, Construction, Emergency Management, Planning, and Office of Counsel, may be represented, as required by the DSO or Commander. The MSC Dam Safety Committee should meet at least annually and preferably twice a year.

4.4.1.3 MSC Dam Safety Program Manager. The MSC Dam Safety Program Manager must be appointed in writing by the MSC DSO. The MSC DSPM must be a registered professional engineer with civil engineering background (or registered professional engineering geologist as described in paragraph 4.6) and with management abilities and be competent in the areas of design, construction, operation, maintenance, inspection or evaluation of dams. The MSC DSPM conducts the daily activities for the MSC dam safety program, coordinates the review of dam safety reports, and provides support to districts within the MSC. The MSC DSPM works with the programs budget managers to ensure that dam safety requirements are included and properly prioritized in budget submissions. The MSC DSPM serves on various national teams as requested by the USACE DSO and on the DSSC. The MSC DSPM must maintain an updated membership list of the MSC Dam Safety Committee. The MSC DSPM reports directly to the MSC DSO on dam safety matters.

4.4.1.4 For those MSC that have a Water Control Management Program at the MSC level, the MSC DSO and MSC DSPM monitors the dam safety aspects of the MSC's Water Control Management Program and ensures the projects are regulated in accordance with the MSC's Water Control Mission.

4.4.1.5 MSC Dam Safety Production Center (DSPC). The Dam Safety Production Centers (DSPC), in coordination with the local districts, are responsible for the development of the Dam Safety Modification Reports.

4.4.1.5.1 Technical development of all engineering products associated with a Dam Safety Modification Study, including development and evaluation of risk reduction alternatives documented in the Dam Safety Modification Report (DSMR), final design and preparation of the Design Documentation Report (DDR), preparation of construction contract drawings and technical specifications, development of alternative and project costs at all stages of the Dam Safety Modification, and engineering and design support during construction will be the responsibility of the DSPC. The level of involvement of the DSPC on dam safety modifications that do not require a DSMS will be scalable depending on the complexity and risk associated with the project. Each project will be considered on a case-by-case basis by coordination between the director of the DSPC and the district DSO. If the decision is that the district is the lead, the DSPC must remain sufficiently engaged (through consultation and review) to ensure the appropriate level of oversight and expertise is provided (See definition of dam safety modification).

4.4.1.5.2 The DSPC must sustain technically competent staff capable of effectively developing Dam Safety products to include Modification Reports, Design Document Reports, and Plans & Specifications (P&S). The DSPC will also provide construction oversight assistance to the Districts as needed.

4.4.1.5.3 The DSPC Director must be a registered professional engineer with a civil engineering background and with management abilities. The director must be competent in the areas related to the design, construction, or evaluation of dams and understand adverse dam incidents and the potential causes and consequences of dam failure. The Director is a member of the DSPCMG. The Director is responsible for coordinating all Dam Safety modifications with the local Districts. The Director in coordination with the district DSO must ensure that the appropriate engineering members as assigned to the Project Delivery Team (PDT) for project execution.

4.4.1.5.4 Dam Safety Modification (DSM) Lead Engineer - The DSM Lead Engineer serves as technical leadership in the development of the dam safety modification study, design and plans and specification for the project. The DSM Lead Engineer[1] for all dam safety modification studies, designs, plans and specification, and engineering during construction must be assigned by the Director of the DSPC in consultation with the district DSO. The DSM Lead Engineer must be a senior level engineer or engineering geologist, with professional engineering registration and with extensive knowledge and skills related to the primary features associated with the project. The DSM Lead Engineer must coordinate with the resource providers for the establishment of the engineering team members to ensure competent and capable personnel are resourced to the project. The DSM Lead Engineer must provide the general oversight and have primary control and responsibility for the technical development of all engineering products produced by the PDT and for engineering support during construction. The DSM Lead Engineer will work in close coordination with the DSM Project Manager for the development of project schedules and funding requests. The DSM Lead Engineer will serve as the technical point of contact for the geographic district E&C members, the RMC and the DSMMCX for the coordination of the development and review of technical products. The same individual should function as the DSM Lead Engineer from the start of the dam safety studies until the completion of the modifications to the dam. In addition to leading the technical development of the study, design and plans and specification for the project, the DSM Lead Engineer's duties include the following activities;

4.4.1.5.4.1 Brief the Bidability, Constructability, Operability, and Environmental (BCOE) review team on the potential failure modes mitigated by construction and on potential failure modes that may be present during construction activities

4.4.1.5.4.2 Assist with development of assumptions to be submitted to the cost estimating team in support of cost estimates that are prepared for the various levels throughout the Preconstruction Engineering and Design (PED) phase.

4.4.1.5.4.3 Identify during the Preconstruction Engineering and Design (PED) phase those submittals that require review and comment by a specific engineering discipline.

4.4.1.5.4.4 Develop Engineering Considerations and facilitate a coordination meeting prior to the start of construction to ensure the entire project team fully understands the project scope, design intent, limitations, risks, roles and responsibilities of the staff, and other issues which could have an effect on the project.

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[1] The term Lead Engineer in this regulation designates the senior engineer assigned to a dam safety modification study or project. The Lead Engineer must be a registered professional engineer and must be either a senior level (typically civil/geotechnical/structural) engineer or engineering geologist with extensive knowledge and skills related to the primary features associated with the project. The engineering geologist is required to be a registered professional engineer.

4.4.1.5.4.5 Work with the Resident Engineer to ensure that an effective program is established for the evaluation of Contractor Quality Control Data and analyze the instrumentation data and inspection results as it relates to the expected behavior of the dam throughout the construction period.

4.4.1.5.4.6 Conduct technical workshops for the field inspection personnel and appropriate construction management staff to assure there is a good understanding of the monitoring requirements and their design implications for projects that include special features such as load tests, pile driving monitoring, grout monitoring, etc.

4.4.1.5.4.7 Review contractor designed construction features such as cofferdams and dewatering plans.

4.4.1.5.4.8 Provide assistance to the resident construction staff during modification of a dam.

4.4.1.5.4.9 Confirm design assumptions during construction.

4.4.1.5.4.10 Review critical changes in field conditions to evaluate any impact they might have on the design.

4.4.1.5.4.11 Be responsible for and provide oversight and direction to the required mapping, inspection and approval of all foundation surfaces that are to be covered by fill and/or concrete in coordination with the resident engineer.

4.4.1.5.4.12 Work with Resident Engineer to establish the foundation inspection procedures.

4.4.1.5.4.13 Ensure lessons learned are officially entered into the USACE Enterprise Lessons Learned, the Dam Safety CoP site on the Technical Excellence Network (TEN), or another accepted forum.

4.4.2 MSC DSO Responsibilities. The MSC DSO is responsible for quality assurance, coordination, and implementation of the MSC dam safety program. In this capacity the MSC DSO must establish procedures to ensure that the MSC DSO is fully advised on all dam safety issues. Quality assurance responsibilities include:

4.4.2.1 Ensuring that the organization is staffed with qualified personnel for program implementation and to meet program requirements.

4.4.2.2 Establishing dam safety related work priorities and ensuring that these priorities are addressed during budget development.

4.4.2.3 Ensuring that an appropriate technical review is conducted of the inspection, evaluation, and design for all features of dam safety projects.

4.4.2.4 Ensuring that the MSC DSPC is fully functioning and implemented according to the regional operating plan for the execution of non-routine dam safety modifications.

Ensuring, in technically complex cases, that the project development team includes members from the MSC, DSMMCX, and RMC starting early in the process to ensure that the analytical methods and processes used by the district and DSPC comply with policy and criteria.

4.4.2.5 Ensuring that adequate performance monitoring and evaluations of all dams are conducted and documented. Participating in periodic inspections and field visits to ensure that the district programs are conducted in accordance with the district quality control plans and requirements of this regulation. Reviewing and approving periodic inspection reports in accordance with Chapter 11 of this regulation.

4.4.2.6 Ensuring that Emergency Action Plans are maintained and regularly updated.

4.4.2.7 Ensure districts establish and execute a public awareness program and coordinate with State and local agencies as required.

4.4.2.8 Ensuring that adequate dam safety training and dam safety exercises are being conducted.

4.4.2.9 Monitoring the accuracy of data that are submitted for the inventory of USACE dams and DSPMT.

4.4.2.10 Participating in and monitoring district dam safety exercises.

4.4.2.11 Conducting quality assurance activities for all features of civil works dam projects, including review of district dam safety related plans.

4.4.2.12 Perform reviews and approve Interim Risk Reduction Measures Plans and related decision documents and coordinate results with HQ and the DSOG for consistency.

4.4.2.13 Monitoring the performance of district dam safety programs including DSPMT, upward reporting, and submitting data to HQ for National Inventory of Dams (NID) and biennial reports to Congress.

4.4.3 Coordination with District Commands. District DSOs and DSPMs should be invited to MSC Dam Safety Committee meetings for interaction on regional dam safety issues. The MSC Dam Safety Committee should periodically meet at a district or project location. A representative from the MSC Dam Safety Committee should participate in district Dam Safety Committee meetings whenever possible.

4.5 <u>District Commands</u>.

4.5.1 Organization and Qualifications. The roles, responsibilities, and qualifications presented below are based on “Dam Safety Officer Roles, Responsibilities, Qualifications, and Professional Registration Requirements” (reference A.104).

4.5.1.1 District Dam Safety Officer (DSO). The District Dam Safety Officer (DSO) must be a registered professional engineer with civil engineering background and with management abilities and be competent in the areas related to the design, construction, operation, maintenance, inspection or evaluation of dams and understand adverse dam incidents and the potential causes and consequences of dam failure. The District DSO should generally be the chief of the engineering organization. The District Commander must ensure the District DSO meets the technical qualifications and experience. The District DSO must be appointed by written order of the District Commander after completion of the process outlined in paragraph 4.7. A copy of the appointment order for each District DSO must be forwarded to the USACE DSO and the MSC DSO. The District DSO serves as the Chair of the District Dam Safety Committee.

4.5.1.2 District Dam Safety Committee. The District Dam Safety Committee includes the DSO and DSPM plus additional members as required. The members should include the various technical engineering disciplines as well as Operations, Water Management, and Programs. Other disciplines and areas of expertise, e.g., Security, Public Affairs, Construction, Emergency Management, Planning, and Office of Counsel, may be represented, as required by the DSO or Commander. The District Dam Safety Committee should meet at least twice a year to review the District's dam safety program and advise the District DSO.

4.5.1.3 District Dam Safety Program Manager (DSPM). The District DSPM must be appointed in writing by the District DSO. The District DSPM must be a registered professional engineer with civil engineering background (or registered professional geologist as described in paragraph 4.6) and with management abilities and be competent in the areas of design, construction, operation, maintenance, inspection or evaluation of dams. The DISTRICT DSPM conducts the daily activities for the District dam safety program and coordinates the review of dam safety reports. The District DSPM works with the programs budget managers to ensure that dam safety requirements are included and properly prioritized in budget submissions. The District DSPM must maintain an updated membership list of the District Dam Safety Committee. The District DSPM reports directly to the District DSO on dam safety matters.

4.5.1.4 Dam Safety Modification Project Manager. The DSM Project Manager for all dam safety modification studies must be assigned by the Chief of the district Project Management Branch or Division, in full coordination with the district DSO, and must have extensive knowledge and skills related to the primary features associated with the project. The DSM Project Manager's duties include, but not be limited to, the following activities.

4.5.1.4.1 The DSM Project Manager has primary responsibility for overall project execution, upward reporting and vertical team coordination, and interfacing with federal/non-federal cost share partners, stakeholders and customers.

4.5.1.4.2 The DSM Project Manager must fully coordinate with the DSM Lead Engineer for the establishment of the engineering team members to ensure competent and capable personnel are resourced to the project.

4.5.1.4.3 The DSM Project Manager must work in close coordination with the DSM lead engineer for the development of project schedules and funding requests, and is responsible for ensuring PDT members are adequately funded to complete the work.

4.5.1.4.4 The DSM Project Manager tracks the project schedule and budget.

4.5.2 District DSO Responsibilities. The District DSO is responsible for ensuring that the dam safety program is fully implemented and documented, in accordance with the District Dam Safety Program Management Plan. The Dam Safety Committee, advisory to the DSO, should meet at least twice annually and forward meeting minutes electronically to the MSC. The districts must notify the MSC DSPM of the date and time of upcoming committee meetings and invite the MSC to send representative(s) to the meeting. District DSO responsibilities include, but are not limited to:

4.5.2.1 Ensuring that organizational staff of qualified technical and field personnel is sufficient for program implementation.

4.5.2.2 Monitoring and evaluating the performance of all dams and appurtenant structures and recommending risk management measures when necessary. Collect data for the NID and biennial reports to Congress. Monitoring and reporting dam safety items using the Dam Safety Program Management Tools (DSPMT). A description of the DSPMT database is given in Appendix I.

4.5.2.3 Establishing priorities for dam safety related work. The DSO, as a member of the district Corporate Board, defends the list of dam safety work priority items. Dam safety work items are any work items impacting the safety, operation, and structural integrity of the project. The DSPMT can be used to track priorities over time.

4.5.2.4 Ensuring that dam safety training of technical staff and project operation and maintenance personnel is conducted.

4.5.2.5 Ensuring each dam has an adequate surveillance plan, and updated and fully implemented IRRMP if applicable.

4.5.2.6 Ensuring adequate and appropriate independent technical reviews for inspection, evaluation, and design for dams and appurtenant structures are accomplished. The District DSO must certify that all design documents and periodic inspection reports have been subjected to district quality control (DQC) reviews and that the documents and reports are technically adequate.

4.5.2.7 Ensuring that adequate exploration and testing are accomplished during design and construction of civil works water control projects.

4.5.2.8 Performing periodic assessments and inspections, other supplemental inspections, and field visits. Periodically evaluate the district dams, appurtenant structures, and other water control projects using current criteria.

4.5.2.9 Coordinating and participating with local and State dam safety officials in the inspection and evaluation of non-Federal dams, upon request.

4.5.2.10 Developing Dam Safety Products

4.5.2.10.1 Ensuring that dam safety products are developed in accordance with documented district Project Management Business Processes as outlined in ER 5-1-11 (reference A-26) and ER 1110-2-1150 (reference A.49). The development of dam safety products is complex and often involves district and DSPC staff. For making a determination on which organization has the lead for a given activity see paragraph 4.4.1.5.1 and the definition of dam safety modification.

4.5.2.10.2 Ensuring compliance with the current review policy (reference A.96) and the use of the RMC as the review management organization for dam safety modifications where appropriate.

4.5.2.10.3 For routine dam safety projects, designates a "Lead Engineer".

4.5.2.10.4 Because of the complexity and life safety implications of dam safety projects it is vitally important that the district DSO ensures that a qualified registered professional engineer or engineering geologist, that is a registered professional engineer, is assigned as the lead engineer. In addition, the DSO must also ensure that the assigned project manager possesses adequate understanding of the dam safety business prior to their assignment to the project. Communication within the PDT can be particularly challenging as it routinely involves internal district coordination as well as coordination with several vertical elements (MSC, HQ, RMC, etc…). For this reason both positions require a solid combination of technical and communication skills.

4.5.2.11 Monitoring the dam safety aspects of the district's Water Control Management Program and ensuring the projects are regulated in accordance with the District's Water Control Mission.

4.5.2.12 Monitoring and reporting any evidence of operational restrictions or distress including earthquake effects, of dams and appurtenant structures.

4.5.2.13 Ensuring that each dam owned by the district has an up-to-date Emergency Action Plan in accordance with Chapter 16. Ensuring emergency notification procedures for utilization in a dam safety emergency situation and for use during dam safety exercises are maintained. Ensuring that annual coordination and review is accomplished, including review of emergency notification procedures. Emergency Action Plans should be distributed to and coordinated with all affected local agencies to use as a basis for preparing their evacuation plans. Ensuring emergency exercises are conducted.

4.5.2.14 Establishing dam safety public awareness programs and coordinating them with local interests.

4.5.2.15 Maintaining awareness of security related activities, issues, and initiatives at dams and related structures. Ensuring the security program and the dam safety program activities and initiatives are coordinated.

4.5.2.16 Monitoring, in collaboration with the DSPC, ongoing planning, design, and construction of project modifications for dam safety for adequate funding, and ensuring that they are executed in accordance with applicable regulations.

4.5.2.17 Coordinating in collaboration with the DSPC, with local and State dam safety officials concerning their review requirements for projects initiating the design phase.

4.5.2.18 Reviewing proposed design changes to district water control projects under construction and providing dam safety input at design change meetings.

4.5.2.19 Ensuring that the district has an up-to-date Dam Safety Program Management Plan.

4.5.2.20 Ensuring that each dam safety related report or design has a Quality Control Plan and that the final product is certified with a Quality Control Certificate upon completion.

4.5.2.21 Developing, reviewing and approving IRRMP as described in Chapter 7.

4.5.2.22 Ensuring structural and operational modifications to USACE-owned dam projects do not diminish factors of safety or limit the ability to make flood releases.

4.5.2.23 Assuring all Category 2 dams that have a High or Significant Hazard Potential classification are properly operated and maintained. See Appendix D for definition and additional details.

4.6 Professional Registration. DSO's, DSPM's, and various other positions providing final approval of engineering products and services to ensure the protection of life, property and the environment, are required to be registered professionally. It is intended and desirable that the DSPM at every level be a registered professional engineer with civil engineering background; however, the DSO may approve the selection of a highly qualified registered professional engineering geologist as the DSPM when filling the position. Persons holding a DSPM position without appropriate professional registration on 26 October 2011 may continue in the position until they move to another position or retire.

4.7 Dam Safety Officer Selection Process. An individual being considered for appointment as a DSO must meet the qualifications listed in paragraph 4.3.2.1, 4.4.1.1, or 4.5.1.1. The individual should generally be the highest qualified person in the technical chain meeting the qualifications.

4.7.1 Process for District Dam Safety Officer. The District Commander should forward the name and qualifications of the individual that is being considered for the

District DSO to the MSC DSO for review and comments. The individual should be in a position not lower than a branch chief within the engineering organization.

4.7.1.1 The MSC DSO will review the recommendation, request comments from the other District DSOs within the region, consolidate comments, and furnish a recommendation to the District Commander.

4.7.1.2 If no one at the District level is qualified, the District Commander and the MSC DSO will coordinate the assignment of the DSO duties to another District DSO on an interim basis.

4.7.1.3 The District Commander must develop a plan for filling position at the District level in accordance with paragraph 4.2.3. This plan could include training, mentoring, or recruitment from outside the district. Progress on this plan will be reported to the MSC DSO at least twice annually. The DSO Development Plan should include the elements shown in Appendix M, paragraph M.2.

4.7.1.4 The District Commander must ensure that an Interim DSO filling the position exceeding 3 months at the District level must meet the requirements of 4.7.

4.7.1.5 For a sample development plan see Appendix M (USACE Dam Safety Officer Sample Development Plan) and the Technical Excellence Network (TEN) website under the Dam Safety Sub Community (https://ten.usace.army.mil/TechExNet.aspx?p=s&a=CoPs;7).

4.7.2 Process for Division (MSC) Dam Safety Officer. The MSC Commander should forward the name and qualifications of the individual that is being considered for the MSC DSO to the USACE DSO at for review and comments. The individual should be in a position not lower than the chief of the technical directorate (or GS-15 level).

4.7.2.1 The USACE DSO will review the recommendation, request comments from the other MSC DSO's across the USACE, consolidate comments, and furnish a recommendation to the MSC Commander.

4.7.2.2 If no one at the MSC level is qualified, the MSC Commander and the USACE DSO will coordinate the assignment of the DSO duties to another MSC DSO or a District DSO within the region on an interim basis.

4.7.2.3 The MSC Commander will develop a plan for filling position at the MSC level in accordance with paragraph 4.2.3. This plan could include training, mentoring, or recruitment from outside the MSC. Progress on this plan will be reported to the USACE DSO at least twice annually.

4.7.3 Process for Designation of USACE Dam Safety Officer. The DSOG, with input from MSC DSO's, will review the qualifications of candidates at HQUSACE and furnish a recommendation through the Special Assistant for Dam and Levee Safety to the Chief of Engineers. The individual should be in a position not lower than GS-15 level.

4.7.3.1 If no one at HQUSACE is qualified, the Chief of Engineers and the DSOG Chair must coordinate the assignment of the USACE DSO duties to an MSC DSO on an interim basis.

4.7.3.2 The DSOG in coordination with the Chief of Engineers will develop a plan for filling position at HQUSACE in accordance with paragraph 4.2.3. This plan could include training, mentoring, or recruitment from outside HQUSACE. Progress on this plan will be reported to the Chief of Engineers by the DSOG at least twice annually.

4.7.4 An example of a Dam Safety Officer Appointment order can be obtained from a MSC or USACE DSPM.

CHAPTER 5

Tolerable Risk Guidelines

5.1 Introduction.

5.1.1 Role of Tolerable Risk Guidelines in Risk Assessment and Risk Management. Tolerable risk guidelines are used in risk management to guide the process of examining and judging the significance of estimated risks obtained using risk assessment. The outcomes of risk assessment are inputs, along with other considerations, to the risk management decision process. Tolerable risk guidelines should not be used alone to prescribe decisions on “How safe is safe enough?" Meeting or achieving the tolerable risk guidelines is the goal for all risk reduction measures, including permanent and interim measures. The available options for IRRM may be limited by time, available funding, and potential negative effects on public health and safety due to the IRRM. The loss of project benefits should not override the need to reduce life safety risk.

5.1.2 Development of Tolerable Risk Guidelines USACE. USACE is working with the Bureau of Reclamation (USBR) and the Federal Energy Regulatory Commission (FERC), to craft common risk management guidelines. Reclamation had been using “Guidelines for Achieving Public Protection in Dam Safety Decision Making” (reference A.111), which were originally issued as interim guidance in 1997 and subsequently in final form in 2003. USBR revised the 2003 guideline and issued an interim document in August 2011 titled, “Interim Dam Safety Public Protection Guidelines - A Risk Framework to Support Dam Safety Decision-Making” (reference A.112). Guidelines are also being used in other countries, such as the Australian National Committee on Large Dams (ANCOLD) - Guidelines on Risk Assessment (2003) (reference A.130). Although these guidelines have some fundamental common characteristics, there are some subtle and important differences.

5.1.3 Continued Development of Guidelines. As USACE works with Reclamation and FERC to achieve a common risk management framework and guidelines, USACE will use an adaptation of the 2011 Reclamation public protection guidelines, the risk evaluation guidelines published by Australian National Committee On Larger Dams (ANCOLD) in 2003 (reference A.130) and some adaptations of the ANCOLD guidance implemented by the New South Wales Government Dam Safety Committee (NSW DSC) Risk Management Policy Framework for Dam Safety, 2006 (reference A.147).

5.2 Background on Tolerable Risk Guidelines.

5.2.1 Definition of Tolerable Risk. Tolerable risks are:

5.2.1.1 Risks that society is willing to live with so as to secure certain benefits;

5.2.1.2 Risks that society does not regard as negligible or something it might ignore (i.e. the risk is not considered a broadly acceptable risk - see definition below);

5.2.1.3 Risks that society is confident are being properly managed by the owner; and

5.2.1.4 Risks that the owner keeps under review and reduces still further if and as practicable (Adapted from HSE, 2001 reference A.146).

5.2.2 Definition of Broadly Acceptable Risk. "Broadly acceptable risk" is contrasted with tolerable risk. "Risks falling into this (broadly acceptable risk) region are generally regarded as insignificant and adequately controlled. The levels of risk characterising this region are comparable to those that people regard as insignificant or trivial in their daily lives. They are typical of the risk from activities that are inherently not very hazardous or from hazardous activities that can be, and are, readily controlled to produce very low risks" (HSE, 2001 reference A.146). By the nature of the hazard that USACE dams pose it is inappropriate to attempt to manage them as posing a broadly acceptable risk and therefore the concept of the broadly acceptable risk level or limit does not apply to USACE dams.

5.2.3 Definition of Tolerable Risk Range. Figure 5.1 shows how in general tolerable risk is a range between unacceptable, where the risk cannot be justified except in exceptional circumstances, and broadly acceptable, where the risk is regarded as negligible (Adapted from HSE, 2001 reference A.146). This figure illustrates the point at which the incremental risk for a specific dam is tolerable within the general range of tolerability as defined by the definition in 5.2.1 and the incremental risk being reduced as informed by the as-low-as-reasonably-practicable (ALARP) considerations.

5.2.4 Equity and Efficiency.

5.2.4.1 Two fundamental principles, from which tolerable risk guidelines are derived, are described as follows in ICOLD, 2005 (reference A.143):

5.2.4.1.1 Equity. The right of individuals and society to be protected, and the right that the interests of all are treated with fairness, with the goal of placing all members of society on an essentially equal footing in terms of levels of risk that they face. (See Section 2.2.4.3 for additional definition.)

5.2.4.1.2 Efficiency. Efficiency is the need for society to distribute and us e available resources so as to achieve the greatest benefit. (See Section 2.2.4.4 for additional definition.)

5.2.4.2 The Conflict between Equity and Efficiency. There can be conflict in achieving equity and efficiency. Achieving equity justifies the establishment of maximum tolerable risk limits for individual and societal risk. Efficiency is defined by the risk level where

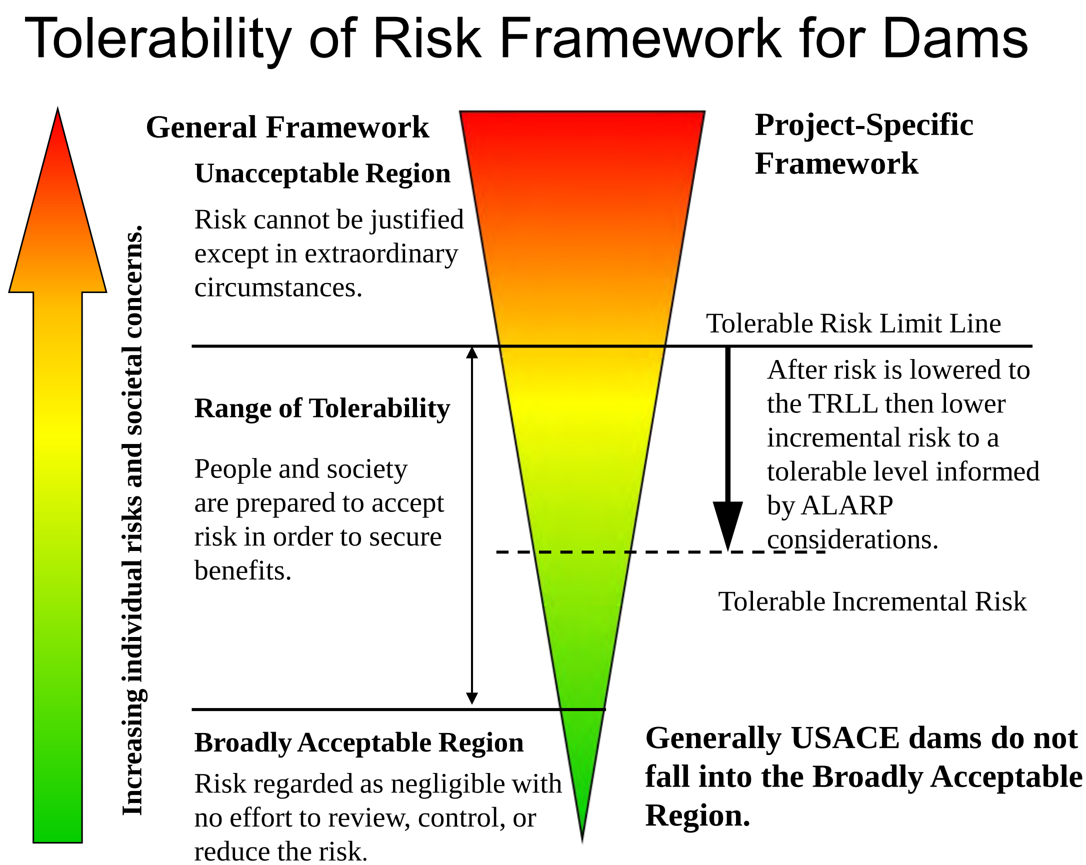


Figure 5.1 - Generalized and Project Specific Tolerability of Risk Framework for the USACE Dam Safety Program. (Adapted and Modified from HSE, 2001 reference A.146)

marginal benefits equal or exceed the marginal cost. Equity requires that a tolerable risk limit should be met regardless of the lack of economic support or the magnitude of the cost. Equity implies the need for this limit even if efficiency does not support reducing risks to meet the tolerable risk limit. There is, therefore, a need to obtain an appropriate balance between equity and efficiency in the development of tolerable risk guidelines. In general, society is more averse to risks if multiple fatalities were to occur from a single event and hence impact on society as a whole. In contrast, society tends to be less averse to risks that result from many individual events resulting in only one or two fatalities, even if the total loss from the sum of fatalities from all of the small loss accidents is larger than that from the single large loss accident. This leads to the notion that tolerable risk should consider both societal and individual risks as an integral part of the framework for managing risks. Note: Cost effectiveness analysis will be done to guide selection of the risk reduction measures to assure achieving the tolerable risk limit is done in a cost effective manner.

5.2.5 “As-Low-As-Reasonably-Practicable”. The “as-low-as-reasonably-practicable” (ALARP) considerations provide a way to address efficiency aspects in both individual and societal tolerable risk guidelines. The ALARP considerations apply below the tolerable risk limit of Figure 5.1. The application of ALARP considerations mean that actions should be taken to reduce risk below the tolerable risk limit until such actions are impracticable or not cost effective. ALARP is an explicit consideration under Reclamation guidelines, 2011 (reference A.114), and ANCOLD, 2003 (reference A.130) and NSW DSC, 2006 (reference A.147) tolerable risk guidelines. Determining that ALARP is satisfied is ultimately a matter of judgment. In making a judgment on whether risks are ALARP, the following factors should be taken into account (adapted from NSW DSC, 2006 reference A.147):

5.2.5.1 The level of risk in relation to the tolerable risk limit;

5.2.5.2 The cost-effectiveness of the risk reduction measures;

5.2.5.3 Any relevant recognized good practice; and

5.2.5.4 Societal concerns as revealed by consultation with the community and other stakeholders.

5.3 <u>USACE Risk Measures and Guidelines</u>.

5.3.1 Four types of risk measures will be evaluated by USACE:

5.3.1.1 Two of the risk measures are considered within the context of tolerable risk guidelines:

5.3.1.1.1 Annual probability of failure and

5.3.1.1.2 Life safety risk – which include incremental and non-breach risk. The concept of incremental risk is defined in 5.3.3.

5.3.1.2 The other two risk measures are

5.3.1.2.1 Economic risk – which includes incremental and non-breach risk and

5.3.1.2.2 Environment and other non-monetary incremental and non-breach consequences.

5.3.2 Additional Considerations. In addition to the tolerable risk limit guidelines for annual probability of failure (APF) and Life Safety, the ALARP considerations will be applied to determine how much below the tolerable risk limit line the life safety risk is to be reduce. All of these risk measures together will be considered when evaluating a dam and making risk management decisions; but life safety risk will be given preference, with economic risk and environmental consequences being given due consideration. For those projects where there is very low or no life safety risk, economic consequences and annual probability of failure will be the primary considerations along with environmental consequences in making risk management decisions.

5.3.3 Consequences Associated With Incremental Risk. In applying these tolerable risk guidelines, the incremental consequences will be considered. The incremental consequences are a component of incremental risk and are defined as follows:

Incremental consequences	=	Consequences associated with the estimated performance of the project with breach, component malfunction, or misoperation.	-	Consequence associated with the estimated performance of the project without breach, component malfunction, or misoperation.

5.3.3.1 This definition, when applied to flood-induced breach, is illustrated in Figure 5.2 such that incremental consequence for a particular inflow flood magnitude are represented as the difference between the consequences represented by the dam breach and non-breach lines at the inflow flood magnitude. This figure also distinguishes between the following:

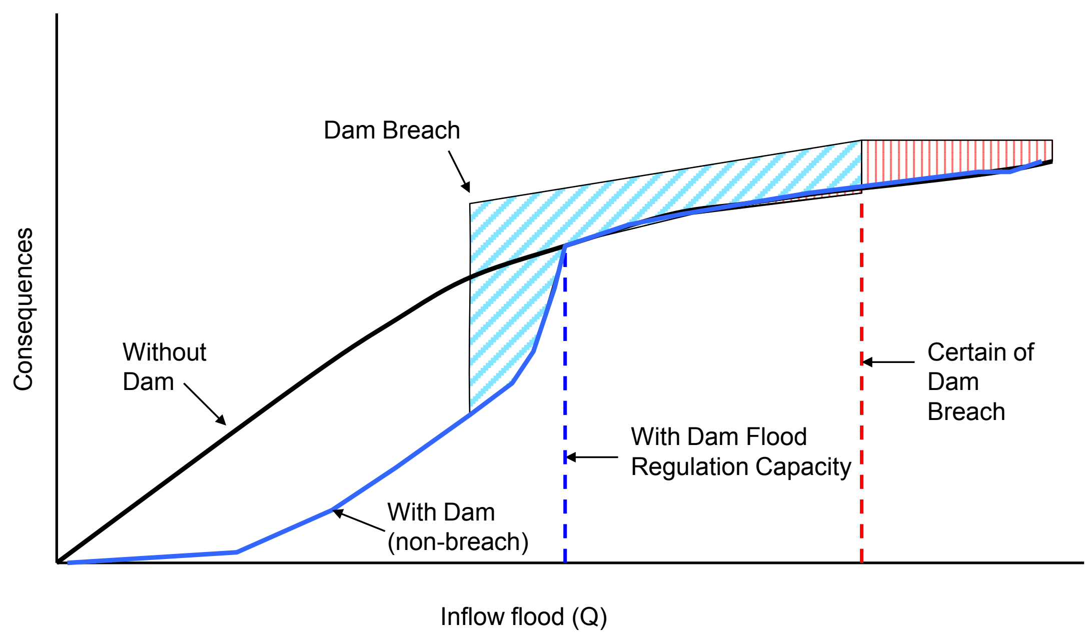


Figure 5.2 – Abstract Illustration of Incremental Consequences for Flood Induced Dam Breach

5.3.3.1.1 The loading condition at which dam breach is certain although the dam may breach at a lesser loading condition; and

5.3.3.1.2 The flood regulation capacity, which is the maximum loading condition above which the project no longer can regulate inflow to provide any flood damage reduction benefits.

5.3.3.2 Figure 5.2 also distinguishes between the following cases of incremental consequences:

5.3.3.2.1 The condition, for which breach does not occur until the loading exceeds the capacity at which breach is certain (vertical line shading); and

5.3.3.2.2 The condition that breach may occur at loading levels less than the capacity at which breach is certain (diagonal line shading).

5.3.3.3 Incremental consequences for other initiating events such as internal erosion and seismic-induced dam breach are the differences due to the initiating event with and without dam breach.

5.3.3.4 The USACE water control operations principle that a dam is not to be operated at any time in such a way that the downstream flood hazard is greater than it would have been had the dam not been constructed (EM 1110-2-3600 Section 4-5 reference A.91 and EM 1110-2-1420 Section 14-4 reference A.73) is important. This principle will be reflected when assessing and evaluating the risk associated with the non-breach inundation scenario, which is represented by the non-breach (blue) line on Figure 5.2.

5.3.4 Annual Probability of Failure Guideline.

5.3.4.1 Annual probability of failure (breach) will be estimated for those failure modes associated with the incremental risk. Annual probability of failure (breach) will be estimated from all failure modes associated with all loading or initiating event types. Although only the combined annual probability of failure of all failure modes is to be evaluated against this guideline, it is important that the contributions to the APF from the individual failure modes, loading types, loading ranges, exposure scenarios, etc., are analyzed. The analysis and evaluation of the individual failure modes can lead to an improved understanding of the failure modes that affect the combined annual probability of failure of the dam. It can also provide insights that can lead to the identification of both structural and non-structural risk reduction measures, including interim measures.

5.3.4.2 The policy for the estimated APF under USACE tolerable risk guidelines, based on the equity principle, is:

5.3.4.2.1 APF ≥1 in 10,000 (1E-04) (0.0001) Per Year. Annual probability of failure in this range is unacceptable except in extraordinary circumstances. The basis to take action to reduce or better define risk increases as the estimates become greater than 1E-04 (0.0001) per year.

5.3.4.2.2 APF < 1 in 10,000 (1E-04) (0.0001) Per Year. Annual probability of failure in this range will be considered tolerable provided the other tolerable risk guidelines are met, to include all aspects of tolerable risk listed in paragraph 5.2.1, and the ALARP considerations are used to evaluate how far to reduce the APF. The basis to take action to reduce or better define the risk diminishes as the estimates become smaller than 0.0001 (1E-04) per year.

5.3.5 Life Safety Risk Guidelines.

5.3.5.1 Life Safety Risk Guidelines. Three types of life safety risk guidelines will be used under the USACE tolerable risk guidelines.

5.3.5.1.1 Individual incremental life safety flood risk using probability of life loss for the identifiable person or group by location that is most at risk of loss of life due to dam breach.

5.3.5.1.2 Societal incremental life safety flood risk expressed in two different ways described below.

5.3.5.1.2.1 Probability distribution of potential life loss due to dam breach (F-N chart as discussed in the section on Probability Distribution of Potential Life Loss).

5.3.5.1.2.2 Average Annual Life Loss due to dam breach (sloping dashed line on the f-$\bar{N}$ chart as discussed in the section on Average Annual Life Loss).

5.3.5.2 Evaluation of Life Safety Flood Risk.

5.3.5.2.1 Incremental Life Safety Flood Risk. The incremental life safety flood risk is to be evaluated against all three life safety guidelines. However, it is important that the contributions from all individual failure modes, loading types, loading ranges, exposure conditions, subpopulations at risk, etc., are analyzed and accounted for. This analysis and evaluation of each individual failure mode can lead to an improved understanding of the failure modes and the exposure conditions that most affect the incremental life safety risk. It can also provide insights that can lead to the identification of both structural and non-structural risk reduction measures, including interim risk reduction measures.

5.3.5.2.2 Non-breach Life Safety Flood Risk. The life safety flood risk associated with the non-breach inundation scenario is to be assessed, communicated, and considered in guiding USACE actions. The non-breach life safety flood risk is to be plotted on the probability distribution of potential life loss (F-N) chart with the X axis showing Life Loss, N, from non-breach flood (See Figure 5.4). Additional guidance and discussion is provided in Section 5.3.5.4.5.

5.3.5.3 Individual Incremental Life Safety Flood Risk Guideline.

5.3.5.3.1 The individual incremental risk is represented by the probability of life loss for the identifiable person or group by location that is most at risk of loss of life due to dam breach. This is computed from all exposure conditions and all failure modes associated with all loading or initiating events, with due regard for non-mutually exclusive failure modes.

5.3.5.3.2 Existing Dams. For existing dams, the individual incremental risk to the identifiable person or group by location, that is most at risk, should be less than a limit value of 1 in 10,000 per year, except in extraordinary circumstances. This follows the ANCOLD, 2003 (reference A.130) individual life safety risk guideline (Figure 5.3.a).

5.3.5.3.3 New Dams and Major Modifications. For new dams or major modifications under Section 216 (reference A.7)[2], the individual incremental risk to the identifiable person or group by location, that is most at risk, should be less than a limit value of 1 in 10,000 per year, except in extraordinary circumstances. However, it is expected that new dams, with the opportunity to make use of state of practice designs and technology, will likely result in lower individual incremental risk being warranted when applying the ALARP principle.

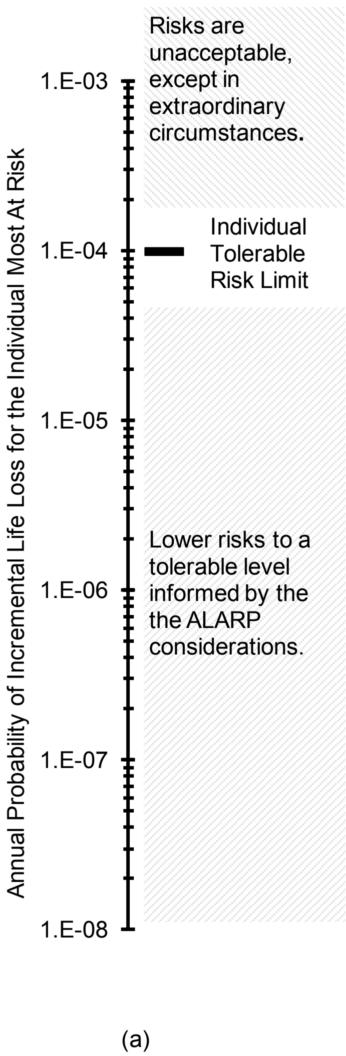
5.3.5.3.4 Multiple Structures. Individual incremental risk should be checked below the main and each auxiliary structure (e.g., dike, levee, saddle dam) to verify that the person or group, which is most at risk, to assure that the level of risk satisfies this individual incremental life safety tolerable risk guideline.

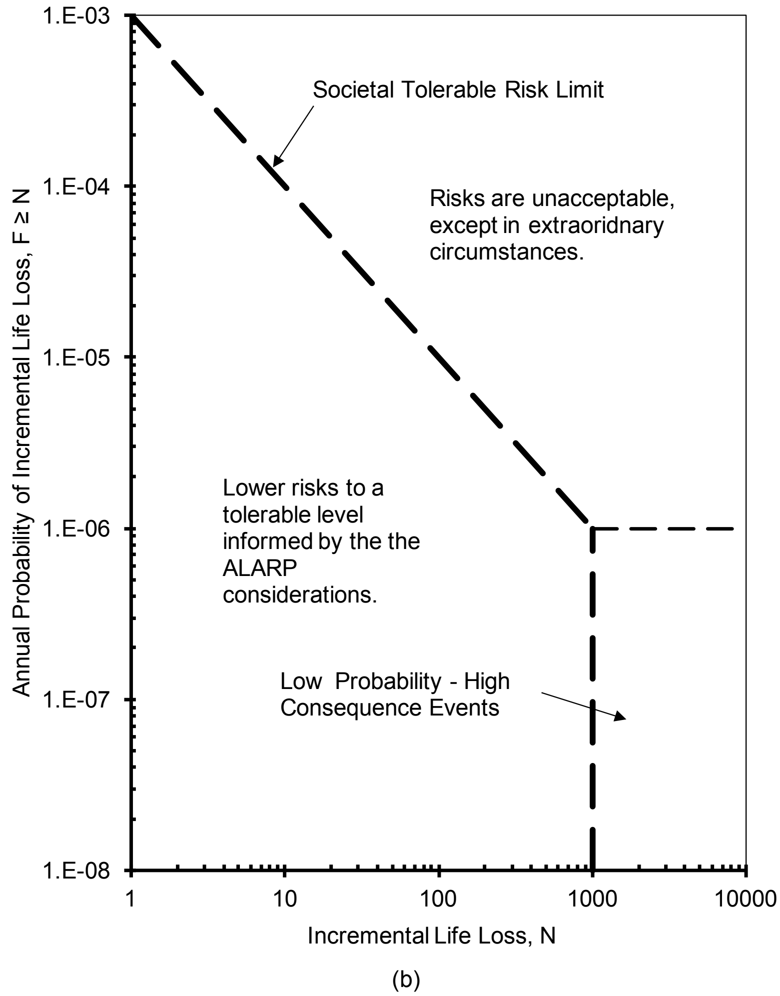
5.3.5.3.5 Relation between Probability of Individual Life Loss and Probability of Failure. The probability of individual life loss, which is used in the evaluation of individual incremental life safety risk, is not necessarily the same as the probability of failure that is used in the evaluation of the APF guideline, which is described in Section 5.3.4. The probability of life loss is based on the probability of failure and further takes into consideration the exposure factors to characterize the day-night, seasonal, warning, or other exposure scenarios, and the conditional probability of life loss given exposure to the dam failure flood. The level of detail that is appropriate for use in characterizing exposure factors should be "decision driven."

5.3.5.4 Probability Distribution of Potential Incremental Life Loss Guideline. This societal incremental risk guideline is represented by a probability distribution of the estimated annual probability of potential life loss from dam failure or breach, for all loading types and conditions and all failure modes and all population exposure scenarios. This is displayed as an F-N chart which is a plot of the annual probability of exceedance (greater than or equal to) of potential life loss (F) vs. incremental potential loss of life (N)[3] associated with the incremental flood risk (See Figure 5.3.b).

[2] A Section 216 study addresses major modification of a dam that changes authorized purposes of that dam.

[3] In probability textbooks a cumulative (probability) distribution function (CDF) is defined to have probability "less than or equal to" on the vertical axis and a complementary cumulative (probability) distribution function (CCDF) is defined to have probability "greater than" on the vertical axis. Although similar to a CCDF, an F-N chart is subtly, but in some cases importantly, different because it has probability "greater than or equal to" on the vertical axis rather than "greater than" as in the CCDF.





Figures 5.3.a – Individual Guideline for Incremental Risk and 5.3.b – Societal Guideline for Incremental Risk

Thus, the F-N chart displays the estimated probability distribution of life loss for a reservoir encompassing all failure modes and all population exposure scenarios for a particular dam for the incremental flood risk

5.3.5.4.1 Existing Dams. For existing dams, the societal incremental risk should be less than the tolerable risk limit lines shown in Figure 5.3.b, except in extraordinary circumstances, following an adaptation of the ANCOLD, 2003 (reference A.130) and NSW, 2006 (reference A.147) societal life safety risk guideline.

5.3.5.4.2 New Dams and Major Modifications. For new dams or major modifications under Section 216 (reference A.7), the societal incremental risk should be less than the tolerable risk limit line shown in Figure 5.3.b, except in extraordinary circumstances. However, it is expected that new dams, with the opportunity to make use of state of practice designs and technology, will likely result in lower societal incremental risk being considered when applying the ALARP principle.

5.3.5.4.3 Dams with Unacceptable Level of Incremental Risk. Dams with incremental risks that exceed the tolerable societal risk limit on the F-N chart are considered to have an unacceptable level of societal incremental risk. As with the individual tolerable risk limit, risks should be reduced to the tolerable societal risk limit regardless of cost considerations and then further until ALARP is satisfied, except in extraordinary circumstances.

5.3.5.4.4 Low Probability – High Consequence Events. If incremental life loss is estimated to equal or exceed 1,000 lives or if probability per year of potential life loss is less than 1 in 1,000,000 (1E-06) for an estimated life loss of in the range of 1000 or greater the evaluation of the tolerability of risk must be based on an official review of the benefits and risks as described in the “Except in Extraordinary Circumstances” section (paragraph 5.3.6).

5.3.5.4.5 Plotting of Non-Breach Life Safety Flood Risk.

5.3.5.4.5.1 The estimated non-breach life safety flood risk is to be plotted on the probability distribution of potential life loss (F-N) chart shown in Figure 5.4.

5.3.5.4.5.2 The line shown on this F-N plot (Figure 5.4) does not have the same meaning as the Societal Tolerable Risk Limit shown above in Figure 5.3.b. Figure 5.3.b is for communicating the life safety risk associated with the incremental flood risk in relation to the Societal Tolerable Risk Limit. Figure 5.4 provides a reference line for communicating the estimated life safety flood risk for the non-breach inundation scenario and allows comparison of the estimated non-breach life safety risk with the estimated incremental life safety risk.

5.3.5.4.5.3 Use of Figure 5.4 allows for comparing the estimated non-breach risk with the estimated incremental risk, after risk reduction and risk management measures have been implemented, thus framing and enabling the discussion that life safety flood risk would continue to exist with a properly functioning dam. Plotting the non-breach risk on similar plot as various risk reduction alternatives will make the discussion of non-breach risk more meaningful. Such plotting will make it obvious how each risk reduction alternative being considered is estimated to the non-breach risk, and perhaps suggest ways of improving the alternatives to lessen the likelihood of inadvertently increasing this non-breach risk and to improve management of the remaining non-breach risk.

5.3.6 Except in Extraordinary Circumstances. The qualifier “except in extraordinary circumstances” refers to a situation in which government, acting on behalf of society, may determine that risks exceeding the tolerable risk limits may be tolerated based on

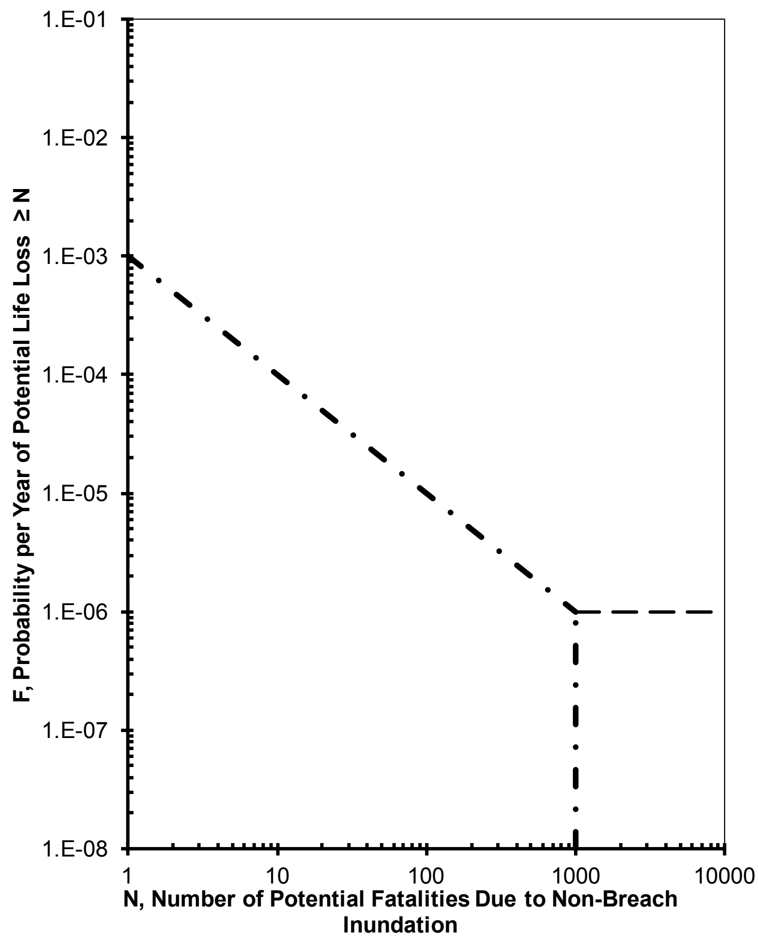


Figure 5.4 - Chart for Plotting of Non-breach Life Safety Flood Risk

special benefits that “the dam brings to society at large”. "The justification for tolerating such high risks is the wider interests of society. Risks, which would normally be unacceptable, can be tolerated on account of the special benefits, which the dam brings to society" (ANCOLD, October 2003 reference A.130). This is an example of the conflict between the fundamental principles of equity and efficiency. Specifically, the maximum risk level that satisfies equity considerations can be at the expense of reducing efficiency. The equity consideration might be relaxed because of special benefits that are deemed to outweigh the increased residual risk. This exception might be made where the incremental potential life loss and economic consequences are large, but where the probability of failure or breach is very low and state-of-the- practice risk management measures have been implemented. For dams in this area on Figure 5.3.b USACE will look critically at the confidence in the estimate of the incremental risk. Full compliance with essential USACE guidelines will be expected. The adequacy of potential failure modes analysis and risk assessment will be carefully examined. HQUSACE would reach a decision based on the merits of the case.

5.3.7 Average Annual Life Loss (AALL) Guideline.

5.3.7.1 The AALL associated with the incremental risk will be evaluated based on the limit value of 0.001 estimated lives loss per year as shown in the AALL guideline (Figure 5.5). The value of this metric for a dam should be estimated from all failure modes associated with all loading or initiating event types and considering all exposure conditions associated with life loss. The estimated life loss plotted on the horizontal scale in f-N̄ charts is the estimated average incremental life loss. This value is averaged over all flood and earthquake loading magnitudes, all failure modes and all exposure conditions (e.g. day and night) that are considered in the risk assessment. The average value tends to be closer to the life loss estimated for those failure modes that are most likely to occur. Simply put, N̄ is the weighted average life loss per failure and can be computed as AALL/APF.

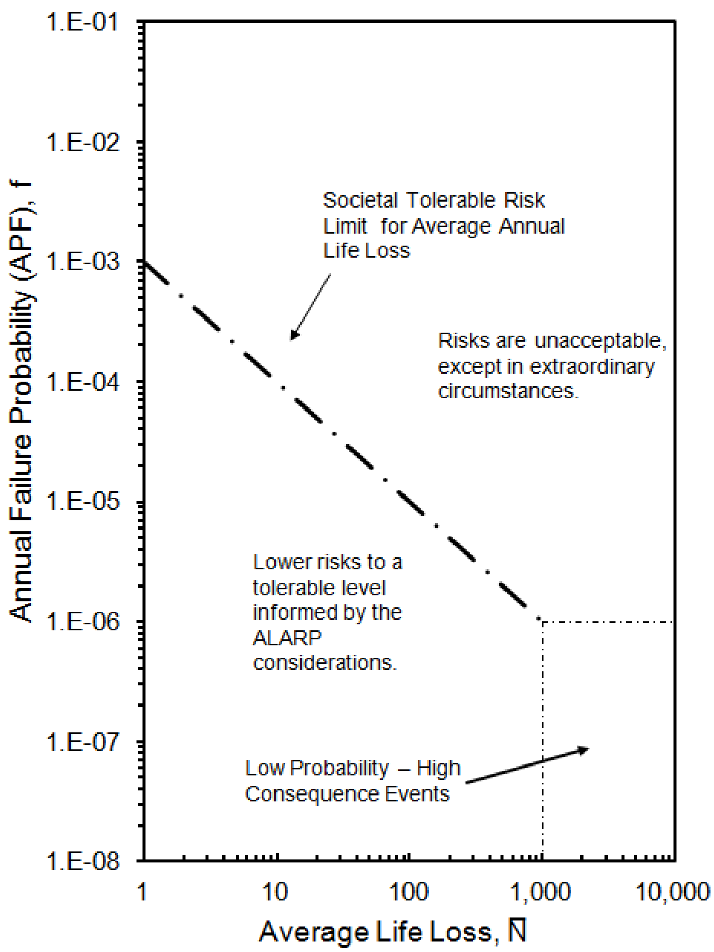


Figure 5.5 – f - N̄ Chart for Displaying Annual Probability of Failure and Average Annual Life Loss for Incremental Risk.

5.3.7.1.1 AALL ≥ 0.001 (1E-03) Lives Per Year. AALL in this range is unacceptable except in extraordinary circumstances. The basis to take action to reduce or better define the risk increases as the estimates become greater than 0.001 lives per year

5.3.7.1.2 AALL < 0.001 (1E-03) Lives Per Year. AALL in this range will be considered tolerable provided the other tolerable risk guidelines are met, to include all aspects of tolerable risk listed in paragraph 5.2.1, and the ALARP considerations are used to evaluate how far to reduce the AALL. The basis to take action to reduce or better define the risk diminishes as the estimates become smaller than 0.001 lives per year.

5.3.7.2 Dams with Unacceptable Level of Incremental Risk. Dams with incremental flood risks that plot above a tolerable risk limit on an f–$\bar{N}$ chart are considered to have an unacceptable level of incremental risk. Risks should be reduced to the tolerable risk limit regardless of cost considerations and then further until ALARP is satisfied, except in extraordinary circumstances.

5.3.7.3 Low Probability – High Consequence Events. If the incremental life loss is estimated to equal or exceed 1,000 lives and the APF is estimated to less than 1 in 1,000,000 (1E-06) per year the evaluation of the tolerability of risk must be based on an official review of the benefits and risks as described in the “Except in Extraordinary Circumstances” section (paragraph 5.3.6).

5.3.8 As-Low-As-Reasonably-Practicable Considerations.

5.3.8.1 The ANCOLD, 2003 (reference A.130) individual and societal risk guidelines include an important consideration that the risk is to be reduced below than the tolerable risk limit values to an extent determined in accordance with the ALARP considerations. Reclamation (reference A.113) cites the New South Wales Dam Safety Committee guidance which is based on ANCOLD guidelines. The ANCOLD guidelines provide some overall guidance on evaluating whether risks have been reduced to ALARP. Determination is both qualitative and quantitative in nature.

5.3.8.2 In making a judgment on whether incremental risks are ALARP, the USACE must take the following into account: the level of incremental risk in relation to the tolerable risk limit; the cost-effectiveness of the risk reduction measures; compliance with essential USACE guidelines; and societal concerns as revealed by consultation with the community and other stakeholders. The specific ALARP considerations to be used by the USACE are listed, with commentary, below.

5.3.8.2.1 The level of incremental risk in relation to the tolerable risk limit. When the estimated life safety incremental risk has been reduced to the tolerable risk limit the ALARP consideration leads to the question, "How far below that limit is the level of risk to be reduced?" The further below the tolerable risk limit the weaker the rational for further risk reduction efforts.

5.3.8.2.2 The cost-effectiveness of the incremental risk reduction measures.

5.3.8.2.2.1 Cost-effectiveness of the risk reduction measures and the alternative plans will be used to guide the selection of the measures and plan to be implemented.

Reducing the incremental life loss risk to the tolerable risk limit lines and below is to be done in a cost effective manner.

5.3.8.2.2.2 This entails the use of the following two measures: 1) a cost effectiveness measure called, the "cost-to-save-a-statistical-life" (CSSL); and 2) a "willingness-to-pay-to-prevent-a-statistical-fatality" (WTP), commonly referred by the Office of Management and Budget (reference A.148) and other federal agencies as the "value-of-statistical-life" (VSL). VSL is used by OMB, the United States Department of Transportation (USDOT) (reference A.129), and other federal agencies to evaluate the case for regulating risk or investing in life-saving risk reduction measures.

5.3.8.2.2.3 The value to use for VSL in USACE dam safety risk assessments will be the current value used by US Department of Transportation (USDOT) (reference A.129). That information is available at http://www.dot.gov/regulations/economic-values-used-in-analysis in the US DOT report titled, “Guidance on Treatment of the Economic Value of a Statistical Life in U.S. Department of Transportation Analyses” (reference A.129). CSSL calculations are shown in Appendix P.

5.3.8.2.4 The strength of the justification for additional risk reduction is stronger when the CSSL is less than the WTP and weaker when the CSSL is to equal to greater than the WTP.

5.3.8.2.3 Compliance with Essential USACE Guidelines. Essential USACE Guidelines are the state-of-the-practice for design, construction, operation, and maintenance of USACE dams as documented in current USACE or applicable industry related publications. See Appendix F for essential guidelines.

5.3.8.2.4 Societal concerns as revealed by consultation with the community and other stakeholders. Societal concerns in terms of community expectations are to be identified, documented, and resolved in a public meeting and comment process modeled after similar procedures already established by USACE.

5.3.9 Economic Risk.

5.3.9.1 Economic considerations to help inform risk management decisions include both the direct losses of the failure of a dam and other economic impacts on the regional or national economy. Part of the direct losses is the damage to property located downstream from the dam due to dam failure. Items in this category include those commonly computed for the National Economic Development (NED) account in any USACE flood risk management study (USACE 2000). These include damage to private and public buildings, contents of buildings, vehicles, public infrastructure such as roads and bridges, public utility infrastructure, agricultural crops, agricultural capital, and erosion losses to land. Direct losses also include the value from the loss in services provided by the dam such as hydropower (incremental cost to replace lost power), water supply, flood damage reduction, navigation (incremental cost for alternate transportation - if available), and recreation. Another category of NED values is the emergency response for evacuation and rescue and the additional travel costs associated with closures of roads and bridges. The sudden loss of pool due to a dam failure could result in losses to property and infrastructure within the pool area. The NED value of these losses should be included in computing direct economic loss due to dam failure. (NOTE: Unless determined at the start of the Dam Safety Modification Study an NED plan will not be developed.) (NOTE: one potential direct loss is the cost of repairing the damage to the dam. This is a complicated issue and to some degree depends on the extent of damage to the dam. If the dam can be repaired, these repair costs could be counted as an economic cost. In the case of catastrophic failure, these rebuilding costs should not be included in the direct costs, as the decision to rebuild the dam depends on the post-failure benefits which would be a separate analysis.)

5.3.9.2 These direct economic losses can be compared to costs of any dam modification to display a measure of the economic efficiency of the modification. This takes the form of net economic benefits and a benefit-cost ratio for each modification. Additionally, these direct economic losses are used to net against the cost of remediation measures in the calculation of CSSL.

5.3.9.3 Indirect economic impacts are those associated with the destruction of property and the displacement of people due to the failure. The destruction due to the failure flood can have significant impacts on the local and regional economy as businesses at least temporarily close resulting in loss of employment and income. Similarly, economic activity linked to the services provided by the dam will also have consequences. These would include economic impacts on business that provide goods and services for the recreation activities associated with the reservoir. All these indirect losses then have ripple or multiplier effects in the rest of the regional and national economy due to the resulting reduction in spending on goods and services in the region. In this way, a dam failure can have widespread economic losses throughout the region. These losses are the increment to flood losses above those that would have occurred had the dam not failed.

5.3.10 Environment and Other Non-Monetary Risk.

5.3.10.1 A dam failure has both direct and indirect consequences that cannot be measured in monetary terms. These stem from the impacts of the dam failure flood and loss of pool on environmental, cultural, and historic resources. In most cases, the assessment of the impacts of dam failure will be the reporting of area and type of habitat impacted, habitat of threatened and endangered species impacted, number and type of historic sites impacted, and the number and type of culturally significance areas impacted.

5.3.10.2 An additional indirect non-monetary consequence could be the exposure of people and the ecosystem to hazardous and toxic material released from landfills, warehouses, and other facilities. An estimate of the locations and quantities should be compiled identifying where significant quantities are concentrated. A potential additional source of hazardous and toxic material is the sediment accumulated behind the dam. Identifying and enumerating these indirect hazards could be important enough to require additional risk assessments including estimating additional fatalities due to exposure to theses hazards. Although these non-monetary consequences may not provide the sole basis for risk reduction, they can provide additional risk information for decision making. They can also be used to identify risks to be managed separately from dam modifications.

5.3.10.3 Intangible consequences are those that have no directly observable physical dimensions but exist in the minds, individually and collectively, of those affected. Such consequences are real and can support decisions. Intangible consequences identified in ANCOLD, 2003 (reference A.130) include such things as:

5.3.10.3.1 The grief and loss suffered by relatives and friends of those who die;

5.3.10.3.2 The impact of multiple deaths on the psyche of the community in which they lived;

5.3.10.3.3 The stress involved in arranging alternative accommodations and income;

5.3.10.3.4 The sense of loss by those who enjoyed the natural landscape destroyed; and

5.3.10.3.5 The fear of lost status and reputation of the dam owning organization and its technical staff.

5.3.10.4 The effect of these intangible consequences can be observed more tangibly in terms of increased mental health expenditures and increased suicides.

5.4 Considerations in Risk Estimation for Risk Assessment and Risk Evaluation.

5.4.1 Assessing Ability to Reduce Uncertainty. The quantification of risk estimates is dependent on data and analysis regarding the design, construction, and current condition of a dam, as well as the identified loads to which the dam could be subjected to over its operating life. Additional uncertainty is introduced due to limited data and knowledge in the life loss, economic, and environmental consequences. When making a decision regarding future actions, one should consider the risk estimates, the issues most influencing the risks, the sensitivity of the risks to particular inputs, the cost of additional actions, and the potential for reducing uncertainty. Uncertainty may be reduced by performing additional actions such as collecting more data, by performing more analysis, or by performing a more detailed assessment of the risks. However, there are occasions when additional efforts may not result in significant reduction in uncertainty. It is important to recognize when this is the case and consider the anticipated value of the additional efforts to reduce uncertainty as a factor in selecting a course of action. Uncertainty should also be considered in evaluating the performance of risk reduction measures. Each measure will likely not have the same surety in achieving the intended risk reduction. This needs to be revealed and provided to decision makers.

5.4.2 Risk Estimate Ranges (range of means) Straddling the Guidelines. When significant uncertainties or assumptions related to a lack of data or interpretations of data result in a range of risk estimates, the results may straddle the guideline values with portions of the risk estimates range portrayed both above and below the guidelines. In these cases, it is important for decision-makers to assess the portion of the risk estimate range that exceeds the guidelines to determine if it is significant enough to warrant further action or studies. The entire range should be used to assess the need for future actions as well as an aid in setting the priority for initiating the actions. If the range extends into the zone that warrants expedited risk reduction, studies to better define the risk should be the minimum response of the agency.

5.4.3 Risk Estimate With and Without Intervention. All risk estimates must give due consideration for intervention. The risk estimates for with and without intervention scenarios will be plotted on the tolerable risk guidelines. Further guidance is provided in Chapter 18 - Risk Assessment Methodology.

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CHAPTER 6

Dam Safety Risk Management Prioritization

6.1 Purpose. This chapter provides guidance for the prioritization processes at the three primary prioritization queues in USACE Dam Safety Portfolio Risk Management Process shown in Figure 3.1. Each queue contains a subset of USACE dams that are waiting for funding to proceed to the next step in the Portfolio Risk Management Process. The queues are:

6.1.1 Prioritization of Issue Evaluation Studies (P1);

6.1.2 Prioritization of Dam Safety Modification Studies (P2); and

6.1.3 Prioritization of approved remediation projects awaiting engineering design and construction funding (P3).

6.2 Organizational Roles and Responsibilities in the Prioritization Process. The RMC, in coordination with the DSOG, will assist the USACE DSO with the prioritization of Issue Evaluation Studies (IES) and Dam Safety Modification Studies (DSMS), and the implementation of risk management action queues. The ultimate goal is to prioritize the national inventory, manage risks across the entire portfolio of structures, and reduce the overall portfolio risk as quickly as possible. The decision on priorities in these queues will be risk informed and done at the national level.

6.3 General Philosophy on Prioritization.

6.3.1 Clearance of Queues. While the intent is that the dams in the queues are eventually cleared in the priority order assigned, a more urgent issue may arise due to new information such as a dam safety incident or a significant change in that state of the art. This new information may introduce a dam into the queue and move it ahead of other dams in the queue. Thus, prioritization within the queues will be an iterative process with changes in priority being affected by other dams in the queue and the availability of new information.

6.3.2 DSAC Priority, and Urgency.

6.3.2.1 DSAC 1 dams have a dam safety issue with very high urgency that requires taking immediate and expedited actions to avoid failure. Therefore, DSAC 1 dams with life-safety risk will be given the highest priority for an expedited issue evaluation study and if warranted proceed to DSM studies. DSAC 1 dams without life-safety risk will be coordinated with the appropriate Business Line Manager for determining priorities within the larger Civil Works mission and assigned a lower priority within the Dam Safety Program, including typically being placed lower in priority than DSAC 2 or 3 dams with life-safety risk.

6.3.2.2 Dams will be prioritized within their DSAC. For example not all DSAC 2 dams have the same priority.

6.3.2.3 Priority and urgency are different but should be compatible, thus higher priority dams are normally associated with the more urgent DSAC dams.

6.3.2.4 Prioritization decisions for Issue Evaluation Studies (P1) and subsequent Dam Safety Modification Studies (P2) can have a significant impact on the speed and efficiency of risk reduction for the overall portfolio of USACE dams. Therefore, there may be times when a lower risk dam will be funded ahead of a dam with higher risk when it is demonstrated that this action will be a more effective and expeditious in reducing the overall portfolio risk.

6.3.3 Quantitative and Qualitative ALARP Considerations. Significant weight will be given to the tolerable risk guidelines, but other ALARP considerations, will also be used to provide a more complete basis for prioritization of the queues.

6.3.3.1 Quantitative Considerations.

6.3.3.1.1 The level of incremental risk in relation to the tolerable risk limit. The greater the estimated annual probability of failure and the further the estimated incremental life risk is above the tolerable risk limit the greater the urgency to act;

6.3.3.1.2 The cost-effectiveness of the reduction in the incremental risk (the project with lower overall cost for the same level of risk reduction would be given higher priority). The more cost-effective a risk management plan is in reducing the annual probability of failure and the life-safety risk to and below the tolerable limit, the greater the rationale to select that plan;

6.3.3.1.3 Net benefits achieved;

6.3.3.1.4 The magnitude or severity of the economic and environmental impacts.

6.3.3.2 Qualitative or Non-Monetary Considerations.

6.3.3.2.1 Any relevant recognized good practice (essential USACE guidelines) (risk management measures that satisfy all essential USACE guidelines would be given more weight than those that do not).

6.3.3.2.2 Societal concerns as revealed by consultation with the community and other stakeholders.

6.3.3.2.3 Impacts on any facilities critical to national security and well being,

6.3.3.2.4 The magnitude of impact on community, regional, or national well being.

6.3.3.3 For more detail, see the following sections of Chapter 5 - 'Economic Risks' (5.3.9) and 'Environment and Other Non-Monetary Risk' (5.3.10).

6.4 Prioritization Queues and Related Issues.

6.4.1 Issue Evaluation Studies Queue (P1).

6.4.1.1 Within the IES queue are those projects awaiting approval to begin the Phase 1 IES as well as those projects awaiting approval for an additional Phase 2 IES effort where supplemental information and study is needed for confirmation of issue(s) that have arisen from the Phase 1 IES. For some dams, no Phase 2 study will be needed and for others it is possible that more than one Phase 2 study may be needed. All of these studies will be prioritized for approval and funding based on the information obtained from risk assessments and tolerable risk limits evaluations performed as part of overall dam safety portfolio risk management process.

6.4.1.2 At any time during an IES, if evidence is obtained that supports a very high urgency for action, the dam should be promptly recommended for reclassification as a DSAC 1 and moved to the expedited process that is associated with a DSAC 1 dam.

6.4.1.3 Phase 1 IES are typically based on existing available information except for estimating consequences. Since the basis for continuing IES into Phase 2 is that dam safety issues are not confirmed with adequate confidence, it may be useful to perform sensitivity or bounding analysis on the risk assessment to explore the range of uncertainty in risk estimates and the comparison to the tolerable risk guidelines. The resulting range of risk estimate and associated risk evaluations may be useful in assigning priority to Phase 2 IES.

6.4.1.4 Information that will be considered, if available, for use in prioritizing dams for IES includes:

6.4.1.4.1 Information developed in the Screening for Portfolio Risk Analysis (SPRA);

6.4.1.4.2 Information from a Periodic Assessment (PA);

6.4.1.4.3 Evaluations performed as part of recommending Interim Risk Reduction Measures, and;

6.4.1.4.4 Evaluations against tolerable risk guidelines and essential USACE guidelines, inspection records, previous studies for prior project remediation, project engineering documents prepared during design and construction, and other studies as may have been performed.

6.4.1.5 See Table 6.1 for a summary of P1 prioritization factors.

6.4.2 Dam Safety Modification Studies Queue (P2). Dam Safety Modification Studies (DSMS) will be performed for all dams that do not satisfy the tolerable risk limits as determined by the issue evaluation study. In general DSAC 1 dams, except those with low life risk, are given the highest priority for starting the DSMS. All dams are prioritized for the DSMS on information available from IES and periodic assessments. See Table 6.1 for a summary of P2 prioritization factors.

6.4.3 Prioritize Approved Projects for Funding Queue (P3). Approved dam safety risk management actions from the DSMS are prioritized for Construction funding. The ultimate decision to fund implementation of the DSMS recommendation must be based on the results of the DSMS and the priorities of the USACE DSO considering all approved DSMR's. The decision on construction priority will be risk informed based on the magnitude and relative importance of the life, economic, and environmental risks and the cost-effectiveness of the proposed risk reduction measures for each dam in relationship to other dams of the same DSAC. Estimates of the reduction in annual probability of failure, reduction in the estimated incremental life safety risk, evaluations of incremental risk management measures against tolerable risk guidelines, and the cost effectiveness of incremental risk management alternatives will be available from the DSMR. Staged incremental risk management alternatives should be developed in DSMS, where appropriate and practicable. These staged incremental risk management alternatives will be used to assist the prioritization. See Table 6.1 for a summary of P3 prioritization factors. When funding is provided to implement the approved DSMR recommendations, the district, in coordination with the DSPC, will commence pre-construction engineering and design (PED). Construction will commence once design is completed subject to concurrence by Office of the Assistant Secretary of the Army (Civil Works) (OASA(CW)).

Table 6.1 - Prioritization Factors

Prioritization Queue	What is being prioritized?	Prioritization Factors	RA and other information available for Prioritization
P1) Issue Evaluation Studies (IES)	Phase 1 IES to confirm a dam safety issue exists that warrants a DSMS	• DSAC • SPRA evaluations and ratings if no PA or IRRM PFMA or risk assessment is available. • From the PA report, use the likelihood of failure and magnitude of incremental consequences for individual significant failure modes. • Critical infrastructure, economic and environmental aspects of the estimated incremental consequences and risk. • Recommendations from the RA team	• SPRA or PA, and IRRM plan. • Possibly a PFMA performed in support of the IRRM plan.
	Phase 2 IES to confirm a dam safety issue exists that warrants a DSM study for any issues for which insufficient confidence exists after a Phase 1 IES or previous Phase 2 IES	• DSAC • For the issue(s) being evaluated: the APF, individual incremental life safety risk, and the societal incremental life safety risk for the significant PFMs. • Sensitivity analysis to identify the effect of current uncertainty on DSAC and risk evaluations. • Critical infrastructure, economic and environmental aspects of the estimated incremental consequences and risk. • Recommendations from the RA team	• Phase 1 IES risk assessment

Prioritization Queue	What is being prioritized?	Prioritization Factors	RA and other information available for Prioritization
FP2) Dam Safety Modification Studies (DSMS)	Studies and other work required to support completion of a DSM report	• DSAC • From the PA report, use the likelihood of failure and magnitude of incremental consequences for individual significant failure modes. • From the IES use the APF for individual failure modes and combined APF of all failure modes, individual incremental life safety risk, and the societal incremental life safety risk for the identified PFMs. • Consideration of the range of uncertainty in risk estimates. • Critical infrastructure, economic and environmental aspects of the estimated incremental consequences and risk. • Recommendations from the RA team	• IES report • PA risk assessment (if done)
P3) Risk Management Projects	Funding of design and implementation of risk reduction measures	• DSAC • Combined and individual PFM estimated risk showing APF, individual incremental life safety risk, and societal incremental life safety risk • Magnitude of the reduction in and the residual combined and individual PFM risk showing APF, individual life safety risk, and societal life safety risk • Cost-effectiveness as measured by the CSSL. • Benefit cost ratio (BCR) • Critical infrastructure, economic, and environmental aspects of the estimated incremental consequences and risk.	• DSMR

CHAPTER 7

Interim Risk Reduction Measures for Dam Safety

7.1 Purpose. This chapter provides guidance and procedures for developing and implementing Interim Risk Reduction Measures required for all DSAC 1, 2, and 3 dams based upon the USACE Dam Safety Action Classification Table 3.1 of Chapter 3, except for those dams as noted in paragraph 3.3.1 and referenced in Figure 3.1. Interim Risk Reduction Measures (IRRM) are developed, prepared, and implemented, to reduce the probability and consequences of catastrophic failure to the maximum extent that is reasonably practicable while long term risk management measures are pursued.

7.2 Principles for Implementing Interim Risk Reduction Measures at High Risk Dams.

7.2.1 Public Safety and Execution of Project Purposes. USACE executes its project purposes guided by its commitment and responsibility to public safety. In this context, it is not appropriate to refer to balancing or trading off public safety with other project benefits. Instead, it is after public safety principles are met that other purposes can be considered. Dam Safety Officers are the designated advisors and advocates for life safety decisions.

7.2.2 Do No Harm. The principle of 'Do No Harm' should underpin all actions intended to reduce dam safety risk. Applying this principle will ensure that proposed IRRM implementation would not increase risks over existing risk at any point in time or during IRRM implementation.

7.2.3 Risk-Informed Decisions. Decisions should be risk-informed, not risk-based. Risk-informed decisions integrate traditional engineering analyses with numerical estimations of risk through the critical experience-based engineering judgment. Decisions are not referred to as risk-based decisions because of the inappropriate implication that life safety decisions can be reduced to simple, numerical solutions.

7.2.4 Congressional Authorizations. USACE projects have specific Congressional authorizations that cover a broad array of purposes, objectives, and legal responsibilities. The public safety responsibility is critical to informing how these statutory responsibilities are implemented and requires USACE to assure projects are adequately safe from catastrophic failure. USACE has specific public safety responsibility, when a project has known safety issues, to take appropriate interim risk reduction measures including reservoir releases USACE statutory responsibilities require operation of dams in a manner that reduces the project's probabilities of failure when there are known issues with the integrity of the project.

7.2.5 Flood Risk Management. Risk from flood waters are managed, not controlled. Our projects do not have unlimited operational capacity to control extreme floods. Outlet works have limited capacity to release flows in a controlled manner, and thus all properly designed projects have a capacity above which the inflow is passed through without attenuation. These are very large releases that may cause damage downstream of the dam but not to a greater degree than would have occurred under pre-project conditions. Decision makers must understand these limitations and operational constraints.

7.2.6 Project Dynamics. All projects have unique geographic, physical, social, and economic aspects that are subject to changes over time. Interim Risk Reduction Measure Plans (IRRMP's) should, accordingly, be regularly updated.

7.2.7 Tension between Loss of Life and Economic Damages. The operations of a high risk dam during flood conditions can create dynamic tension between the potential for loss of life and economic damages resulting from an uncontrolled release due to failure and the associated economic damages resulting from operational release to prevent failure. Operational releases can be accompanied with planning, advanced warnings, and evacuations with the goal of avoiding loss of life. Economic impacts may be incurred and options for mitigating these impacts can be explored. The advanced planning and execution of mitigating measures is usually more effective with a planned, controlled release of the pool.

7.2.8 Interim Risk Reduction Measure Plan. The Interim Risk Reduction Measure Plan (IRRMP) is the key document that frames operational decision making for DSAC 1, 2, and 3 dams. It is a must that the IRRMP consider changes to the supporting Water Control Plan and consider evaluation and improvement in the emergency response plans of affected communities.

7.2.8.1 The Water Control Plan establishes the specific threshold events, decision points, and actions required. A formal deviation is required for temporary changes to the Water Control Plan and must be approved by the MSC. Permanent changes to a Water Control Plan must comply with applicable NEPA requirements and typically involve significant public coordination. See paragraph 7.8.3.1 for additional details.

7.2.8.1.1 The IRRMP should recognize the need for two primary water control management objectives.

7.2.8.1.1.1 First, a recommended safe operating reservoir level that is maintained for the vast majority of time through non damaging releases to restore the reservoir to restricted level as quickly as reasonable.

7.2.8.1.1.2 Second, a plan for which emergency measures such as rapid reservoir drawdown and recommendations on evacuation of the reservoir storage must occur. The threshold event could be a combination of pool level and visual and/or measured signs of distress.

7.2.8.1.2 This approach to water control management recognizes that pool restrictions established for safety purposes cannot and should not be viewed as "must meet" requirements in all flood events, but that there does come a point when emergency measures are necessary.

7.2.8.2 Flood warning and evacuation plans are key components of life-safety risk reduction activities associated with potential flooding resulting from a possible dam failure and must receive priority attention in formulating IRRMs. It is imperative that evaluation and improvement in the emergency response plans of affected communities be done in a partnership with those communities.

7.2.9 Responsibilities for IRRMP's. In the centrally led and decentrally executed USACE Dam Safety Program, responsibilities and decision making for IRRMP's and IRRM's are vertically distributed.

7.2.9.1 Districts. Develop IRRMP, coordinate plans, and execute all plans. Any IRRM plan that potentially poses a significant threat to human life must have a Review Plan prepared as defined in current review policy (reference A.96) and the RMC will be considered the RMO for those actions. The MSC, DSMMCX and DSPC must be engaged in the development and/or oversight of the IRRMP as required by ER 10-1-51 (reference A.30).

7.2.9.2 Divisions (MSC). Coordinate, review, and approve plans for DSAC 1, 2 and 3 dams. In particular, divisions are critical in assuring system and watershed issues are considered and coordinated.

7.2.9.3 HQUSACE. Establishes, in consultation with the RMC and the DSOG, the DSAC for all dams, reviews, and concurs on IRRMP for DSAC 1, 2, and 3 dams, and aligns investment strategies for all dams.

7.2.10 Risk Communications. Familiarity with IRRMP is the key to effective risk communications. It is important that managers and leaders discuss issues consistently and openly with affected stakeholders. See Chapter 10 for additional considerations on communicating risk.

7.3 General. IRRMP's must be established for DSAC 1, 2 and 3 dams. The DSAC Table (Table 3.1) provides the actions and characteristics for each DSAC, including preparation of an IRRMP, considerations for preparation of the plan, and example interim measures. All dams are unique and have specific vulnerabilities and potential failure modes that require expert judgment in the development of the IRRMP's. Interim Risk Reduction Measures are a temporary approach to reduce Dam Safety risks while long-term solutions are being pursued. However, they should not (unless otherwise approved) take the place of long-term approaches. Guidelines for determining if the planned interim risk reduction measure is an interim or a more permanent measure are explained in Section 7.8. In establishing IRRMP, life safety is paramount, followed by prevention of catastrophic economic or environmental losses. The process of identifying and evaluating IRRM must be conducted as expeditiously as possible and must be a collaborative effort between all district elements as well as technical experts (reference paragraph 7.2.9.1). The dialogue and coordination between district technical elements, Operations, and Programs is particularly important. After initial assessment within USACE, early involvement with the project stakeholders will be established with the goal of coordinating support for the IRRMP. The public trust must be established through frequent and early interaction and maintained through an effective Communication Plan. A risk assessment may be required as part of the IRRMP to support significant restrictions in project storage and release regulation schedules. When feasible, a PFMA will be preformed to support the development of the IRRMP. Pool restrictions should not be held up or delayed waiting for this risk assessment.

7.4 Funding for IRRMP and IRRM. Funding for IRRMP preparation for DSAC 1, 2, and 3 dams is from the O&M account (or the Maintenance portion of the MR&T account). Funding for IRRMP implementation for DSAC 1, 2, and 3 dams is from the O&M account. Studies and planning leading to a Dam Safety Modification Report are funded from the Construction account as part of the Dam Safety and Seepage/Stability Correction Program (WEDGE funds). For example, Program funds can be used for inundation maps since that will provide information to advance the DSMS. Design and implementation of permanent risk reduction measures described in the DSMR are funded from the Construction account, beginning with the Dam Safety and Seepage/Stability Correction Program until line-item Construction funds become available.

7.4.1 For the O&M account, the work category code (WCC) for IRRMP and IRRM is 61130 for navigation, 61230 for flood damage reduction, and 61630 for joint activities. While these budgeted items will be fully coordinated with program management and operations funding personnel, it is the job of the technical team to make sound, reasonable recommendations on the correct IRRMs and implementation schedules without making compromises due to perceived funding shortfalls. While funding challenges are often a reality, dealing with them is a secondary action that comes only after reaching agreement on the right technical course of action.

7.4.2 Construction funds must not be used for maintenance repairs, IRRMP, or IRRM. O&M funds must not be used for the DSMS or implementation. Districts must seek O&M funds, through the budget process and/or reprogramming, for IRRMP and IRRM.

7.4.3 O&M funds for IRRMP and IRRM will be cost shared at the same portions as other O&M work on the project. Construction funding for IRRM items required to the DSMS will not be cost shared. Construction funding during PED and Construction for permanent risk reduction measures described in the DSMR will be cost share (See Chapter 9).

7.5 Interim Risk Reduction Measures Plan (IRRMP). Districts with DSAC 1, 2, and 3 dams must develop and submit to the MSC DSO an IRRMP outlining the proposed risk reduction measures for approval. IRRMP's for DSAC 1 dams must be submitted within a 60-day period after being designated as DSAC 1, or within 90 days after being designated as a DSAC 2, or within 120 days after being designated as a DSAC 3. Prior to submission of the IRRMP, the plan must be subjected to a district Quality Control Review (DQC) with Regional Technical Specialists, or other appropriate specialists. NEPA coordination should be started early in the IRRMP process and be continued to avoid later problems (See Appendix Q). Stakeholders should also be engaged in developing the plan to the extent possible. Submission of the IRRMP must include a formal briefing to the HQ DSO for DSAC 1, 2 and 3 dams if requested. The IRRMP should as a minimum include the following:

7.5.1 Overall project description, brief construction history, operational history, and purposes.

7.5.2 Overview of identified potential failure modes.

7.5.3 General consequences associated with each identified potential failure mode.

7.5.4 Structural and nonstructural IRRM alternatives considered to reduce the probability of failure and/or incremental consequences associated with the failure modes (reservoir pool restrictions and modification of reservoir regulation plan and evaluation and improvement in the emergency response plans of affected communities must always be included as options that are addressed). Updating of the project's emergency action plan (EAP) to specifically address the potential failure mode(s) which are driving the DSAC assignment is required as part of the IRRMP.

7.5.5 General discussion of predicted reduction in the probability of failure and associated consequences, impact on project purposes, environmental impacts, and economic impact to region associated with potential IRRM, both positive and negative.

7.5.6 Recommendations and risk informed basis for IRRM to be implemented.

7.5.7 Schedules and costs to the USACE and others for implementation of IRRM recommendations.

7.5.8 If necessary, proposed cost and schedules for conducting a risk assessment to estimate the benefits and costs for incremental evaluation of IRRM. Risk may justify significant restrictions in project storage and release schedules. Pool restrictions should not be held up or delayed waiting for this risk assessment.

7.5.9 DQC comments and comment resolutions.

7.5.10 Hyperlink to electronic version of updated EAP which reflects site specific risks, and which includes emergency exercises for DSAC 1, 2, and 3 dams conducted in manners that are appropriate for the risk involved (See paragraph 7.6 for more information on the appropriate level of emergency response exercise).

7.5.11 Communication Plan (Internal and External).

7.6 EAP and Emergency Exercises. The frequency of emergency exercises should correspond directly to the DSAC and Hazard Potential of the project. The completion of these exercises should be incorporated into the official IRRMP for the project if applicable. Refer to Chapter 16 for guidance on the appropriate type and frequency of exercises.

7.7 Decision Process for USACE Dam Safety Interim Risk Reduction Actions. The decision process associated with Dam Safety-related actions will depend on the nature of the action under consideration, the consequences of the action in both the short and long term, and the potential for national and international interest and attention. The decisions will be made based on life safety first, economic risk second, and other considerations last.

7.7.1 IRRM's should be formulated to lower risk as much as practically possible using methods as discussed in Section 7.8.

7.7.2 Fundamentally, decisions within USACE are the responsibility of the district Commander. Technical decisions related to Dam Safety are generally delegated to the district DSO. IRRMP and associated decisions require MSC approval after HQ USACE concurrence; and there are certain USACE actions that are executed by warranted officials, such as procurement, that function outside the usual Commander's chain. Additionally, actions whose implementation or improper implementation could potentially pose a significant threat to human life require that the RMC be the RMO.

7.7.3 In the Dam Safety area, the principal team members involved in the decision process are the district Dam Safety Officer and Dam Safety Program Manager, the MSC Dam Safety Officer and Dam Safety Program Manager, and at the HQ USACE level, the USACE Dam Safety Officer, the Special Assistant for Dam and Levee Safety, and the Dam Safety Program Manager (DSPM). These principals inform and at times execute decisions on behalf of the Commanders in whom the decision authority is vested.

7.7.4 For non-controversial Dam Safety-related actions, following routine review within the local district, MSC, and Headquarters Dam Safety staff, the decision by the district Dam Safety Officer, acting on behalf of the Commander, would be expected. As the level of controversy and potential consequences and attention escalates, a more thorough review would progressively include Commanders at the District, MSC, and HQ USACE levels, perhaps informed by outside experts, and engaging Public Affairs officers. The decision may then be retained by the district Commander and in the case of highly significant dam safety problems, the MSC Commander. While the decision authority lies with the Commanders, the process leading to the final choice for action is informed by technical, policy, and management staff at the district, MSC, and HQ USACE levels.

7.7.5 Table 7.1 depicts a summary of the principal participants in the decisions involving IRRMP formulating, informing and reviewing, and final solution selection and implementation. An electronic copy of the IRRMP (review copy) must be uploaded to the RMC's centralized data repository (RADS II website) at the time of review copy submittal. A copy of the final IRRMP reflecting all updates and revisions required from the review process must be uploaded after IRRMP approval.

7.7.6 A MSC DSO annual review of all DSAC 1 and 2 IRRMP's are required unless some event occurs that would trigger an earlier review, e.g., rise in piezometers readings, completion of a remediation phase, etc. These reviews should also include review of the communication plan with stakeholder engagement and public involvement plans.

7.7.7 A standard IRRMP review checklist is provided in Appendix R to assist developers and reviewers in the completion of approvable plans.

Table 7.1 - Decision Levels for Interim Risk Reduction Plans

DSAC	District	MSC	HQ USACE
1, 2, and 3 (including significant changes)	Formulate, recommend, and implement	Concurrent Review Followed by MSC Approval	
1 and 2 (Annual Review)	Annual Review and update required.	Annual Review	No action required.

7.8 <u>Interim Risk Reduction Measures (IRRM)</u>.

7.8.1 The following principles (and associated questions) can be used to determine if a proposed interim risk reduction measure is appropriate. Practical options will vary from dam to dam, and therefore a creative effort may be needed to identify the options that exist for a specific project. The objective is to reduce the probability of catastrophic failure and associated consequences to the maximum extent reasonably practicable while long-term risk management measures are pursued. IRRMP must be developed on an aggressive timeline to reduce the probability of failure or potential for loss of life once a major dam safety issue is identified. Interim Risk Reduction Measures development guidance is detailed in Table Q.1 in Appendix Q. Interim risk reduction measures are not intended to be the means for permanently remediating dam safety concerns.

7.8.2 Expert Judgment. Internal erosion has been identified as a primary failure mode governing risk for the USACE' dam inventory. Internal erosion failure modes can take a long time to develop but may lead to catastrophic loss of pool with little or no warning. An example of an internal erosion failure development continuum is shown in Figure S.1 in Appendix S. As such, expert judgment is required to match IRRM with the identified potential failure modes, geology, dam design and loading, and determination of where the dam is on a failure line continuum.

7.8.2.1 Timeliness. Will the measure be implemented in a timely manner (typically within six months or less) to reduce risk? Taking several years to implement a measure may mean it is not an interim risk reduction measure. Efforts that require significant investment in time and money for studies and investigations should most likely be included in the Dam Safety Modification Study as a potential alternative.

7.8.2.2 Cost. Is the cost of the measure within budgetary threshold for major maintenance or O&M as outlined in the current budget EC? Measures exceeding the threshold for major rehabilitation modifications are generally not appropriate for interim risk reduction measures.

7.8.2.3 Risk. Does the measure increase the overall risk from the dam to the downstream public? Does the proposed measure have an adverse effect on other system or basin features (including other dams)? This may be a concern for measures that involve changes to the current approved water control plan and may require a risk estimate to be developed to adequately assess the proposed changes.

7.8.2.4 Emergency Actions. While a specific action taken during a response to a dam safety emergency is not an interim risk reduction measure, the preparation and regular exercising of a comprehensive, site-specific EAP is a fundamental part of any IRRMP.

7.8.3 Examples of non-structural Interim Risk Reduction Measures.

7.8.3.1 Reservoir pool restrictions or change in water control plan. If this measure is considered viable then the district should begin immediate action to update the water control plan to reflect the operational change or pool restriction. Guidance is provided in ER 1110-2-240, Water Control Management (reference A.45) for water control plan deviations and updates. In the interim a deviation from the current water control plan should be implemented until the water control plan is updated to reflect the operational change or pool restriction. Regulation plan changes must be documented, and formal deviation requests from the Water Control Plan must be approved by the MSC.

7.8.3.2 Pre-position emergency contracts for rapid supply of other needed items/equipment.

7.8.3.3 Stockpiling emergency materials, e.g., rock, sand, sand bags, emergency bulkheads, or other operating equipment, etc.

7.8.3.4 Use of other reservoirs in the system may be required to mitigate the impact of regulation schedule changes. If the change in regulation schedule is required for other dams in the system, then a regulation deviation for those dams would be required as well.

7.8.3.5 Improved and/or increased inspection and monitoring to detect evidence of worsening conditions to provide an earlier warning to the public for evacuation.

7.8.3.6 Update the EAP and the inundation mapping to include project-specific failure mode(s). The NWS must be included in the EAP to take advantage of their television/radio announcement and stream forecasting capabilities. The Modeling, Mapping, and Consequences Production Center (MMC) has overall responsibility for developing dam failure, inundation mapping, and consequence models for USACE dams in support of the EAP. In parallel with updating the project’s EAP USACE must work with local authorities on evaluation of and improvement in the emergency response plans of the affected communities.

7.8.3.7 Explicit procedures, communications systems, and training of appropriately skilled team members for prompt and effective emergency response by the USACE in the event of the detection of worsening or catastrophic conditions.

7.8.3.8 Conduct appropriate emergency exercises that plan for a range of failure scenarios (including the combined effects of multiple failure modes and different timing of detection) to improve warning and evacuation times. Refer to Chapter 16 for guidance on the appropriate type and frequency of exercises.

7.8.3.9 Coordination with local interests and Federal and non-Federal agencies, including the National Weather Service (NWS) and local Emergency Management Agencies (EMA), with a focus on the specific failure mode(s) and the effectiveness of response including appropriate response exercises.

7.8.3.10 Identify instrumentation/monitoring “trigger” or threshold pools that would initiate more urgent monitoring or emergency response. In addition, threshold values should be established for instrument readings where possible.

7.8.3.11 Installation of early warning systems to increase the time available for evacuation should be included as an alternative.

7.8.3.12 Preventive maintenance and repairs such as cleaning drains and improving spillway gate reliability where non-functioning components would exacerbate the existing conditions in an emergency.

7.8.3.13 Acquisition of real estate (if possible) that would preclude potential loss of life and damages from a potential dam failure or other IRRM should be included as an alternative since life safety is paramount.

7.8.3.14 Annual command level reviews of IRRM implementation are required for DSAC 1, 2, and 3 dams and revision to the IRRM plan are to be made as necessary. These reviews should also include review of the communication plans with stakeholder engagement and public involvement plans.

7.8.4 Examples of Structural Interim Risk Reduction Measures (Some can be incorporated in Long Term Remedial Measures).

7.8.4.1 Isolate problem area (e.g., cofferdam around problem monolith(s) or other project feature).

7.8.4.2 Improve seepage collection system.

7.8.4.3 Lower the spillway crest to aid in prevention of failure (A consequence estimate may be warranted to ensure overall risk is not increased by this measure).

7.8.4.4 Increase spillway capacity/construct another spillway. (A consequence estimate may be warranted to ensure overall risk is not increased by this measure).

7.8.4.5 Breach/lower saddle dams along the reservoir perimeter. (A consequence estimate may be warranted to ensure overall risk is not increased by this measure).

7.8.4.6 Strengthen weak areas (e.g., upstream or downstream blanket to cut off/slow seepage; install tie-backs/anchors; and install additional buttresses).

7.8.4.7 Construct a downstream dike to reduce head differential.

7.8.4.8 Construct stability berm.

7.8.4.9 Increase dam height. (A consequence estimate may be warranted to ensure overall risk is not increased by this measure).

7.8.4.10 Modify outlet discharge capability such as by installing temporary siphon(s).

7.8.4.11 Increase erosion protection where necessary.

7.8.4.12 Protect downstream critical facilities (e.g., medical and emergency services).

7.8.4.13 Construct shallow cutoff trench to slow seepage.

7.8.4.14 Target grout program specifically for suspected problem area(s) to slow seepage/leakage.

7.8.4.15 Remove significant flow restrictions (downstream bridge conditions may restrict maximum discharge from the outlet works. Upstream bridges or small dams may restrict flow caused by debris buildup that could result in a large release).

7.8.5 Contrasting Interim Measures with Permanent Measures. The above examples of IRRMs are a good guide for how interim measures differ from permanent measures; however, there are always situations for which judgment must be used in determining what measures are appropriate. Following are principles for making such distinctions:

7.8.5.1 Interim measures should not induce additional risks beyond what the dam safety deficiency present;

7.8.5.2 Interim measures should be timely (i.e. implemented within 6 months or less);

7.8.5.3 Some interim measures – whether structural or non-structural - may become permanent based on the recommendations of an Issue Evaluation Study or Modification Report;

7.8.5.4 Interim measures are funded out of the operations and maintenance account and are subject to the dollar limitations for O&M described in the Major Rehabilitation guidance; and

7.8.5.5 Emergency measures may exceed the dollar and scope limitations established for the O&M account.

7.9 Evaluation Factors for IRRM. Some types of IRRM's may significantly impact authorized project purposes (e.g., water supply, recreation, hydropower, etc), project beneficiaries, and others who depend indirectly on the project. Additionally, some IRRM's may result in more frequent discharges from the dam and from lower pool elevations than originally designed, impacting stakeholder interests. Public safety must always be given a higher priority over all other project purposes and benefits. In evaluating and formulating IRRM's, it must be kept in mind that each project has its own unique attributes that have to be addressed on a case by case basis using expert judgment. The following must be considered and addressed:

7.9.1 Providing protection of life, property and the environment. Examples to consider are loss of life; increased sickness and disease; employment losses; business income losses; private property damage; infrastructure damage including roads and utilities; losses in social and cultural resources including community effects and historical resources; environmental losses including aquatic and riparian habitat, threatened and endangered species; and HTRW (such as flooding a Superfund site). Early and frequent NEPA coordination with IRRMP is recommended.

7.9.2 Reducing the probability of failure and consequences of uncontrolled pool releases. Increasing the confidence that any changes associated with the dam that are related to development of a failure mode will be promptly detected.

7.9.3 Increasing the confidence that emergency management agencies will be notified promptly.

7.9.4 Increasing the warning time and effectiveness of evacuation of the populations at risk.

7.9.5 Reducing the probability of the initiating loading (critical pool levels).

7.9.6 Improving the organizational capability to implement IRRM (resources, time, funding, technology, etc.).

7.9.7 Preserving the public trust.

7.9.8 Addressing stakeholder issues and impacts.

7.9.9 Understanding the degree of confidence in the scope of the problem and effectiveness of the interim solution.

7.9.10 Capability for incorporating IRRM into the permanent solutions.

7.9.11 Impacting authorized project purposes or other project benefits.

7.9.12 Maximizing cost effectiveness.

7.9.13 Minimizing social disruption and environmental impacts.

7.10 Communications Plan. A communication plan is to be submitted for review as part of the Interim Risk Reduction Measures Plan. Information about the communication plan is in Chapter 10 of this document.

7.11 Approval and Implementation of IRRMP. IRRMP for DSAC 1, 2, and 3 dams are approved by the MSC DSO after concurrent review by HQUSACE (see Table 7.1). If significant changes are made to a previously approved IRRMP, the revised plan is to be submitted for review and approval as a new plan.

CHAPTER 8

Issue Evaluation Studies

8.1 Purpose of Issue Evaluation Studies (IES).

8.1.1 This chapter provides guidance and procedures for developing the IES report that presents the assessment of the incremental risk and the non-breach risk, documentation, and basis to proceed with conducting a DSMS for completed USACE projects. In addition, this chapter provides guidance for completing IES plans, studies, and reports. Figure 8.1 is a graphical representation that shows the work flow process for IES.

8.1.2 IES for dams assigned DSAC 1, 2, 3 and, 4 are studies to determine the nature of a safety issue or concern, whether the existing project authorized purposes warrant continued Federal investment, and the degree of urgency for action within the context of the entire USACE inventory of dams. The purpose of the IES is to determine whether or not to pursue DSMS by focusing on all significant potential failure modes when evaluating risk, verify the current DSAC and guide the selection and gauge the effectiveness of interim risk reduction measures. IES results are used to assist dam safety officials with making risk informed decisions, and prioritize dam safety studies and investigations within the context of the entire USACE inventory of dams.

8.2 Objectives of Issue Evaluation Studies**.** The overall objective of an IES is to evaluate a dam safety issue found during an incident, inspection, or study, in relation to the USACE tolerable risk guidelines and determine if the issue warrants further actions either through interim measures, formal study, or both. The scope of the issue evaluation study is to evaluate both confirmed and unconfirmed issues related to the performance, maintenance, and operational concerns of the dam, and whether the existing project authorized purposes warrant continued Federal investment.

8.2.1 Confirmed Dam Safety Issues. Confirmed issues are those that pose a significant incremental risk (approaching or exceeding tolerable risk limits) with a high level of confidence (giving due regard for uncertainty) such that additional studies and investigations are not likely to change the decision that dam safety modifications are warranted. Confirmed dam safety issues are manifested or obvious issues that impact the safe operation of a dam. Examples of confirmed issues can be described as performance concerns, such as a lack of spillway capacity, or deficiencies that are demonstrated by signs of internal erosion, known flaws or defects, component distress or malfunction, unusual settlement, unsatisfactory instrument readings, etc. that can be specifically linked to one or more potential failure modes. Confirmed dam safety issues are typically addressed in Phase 1 Issue Evaluation Studies, where there is sufficient performance data and documentation to prepare a risk estimate that contains minimum uncertainty and provides an adequate level of confidence that a Dam Safety Modification Study is warranted.

8.2.2 Unconfirmed Dam Safety Issues. Unconfirmed issues are issues that are judged to pose significant incremental risk (approaching or exceeding tolerable risk limits), but are based on data with such high uncertainty that the conclusions may be significantly influenced or changed if additional data was obtained. Examples of unconfirmed dam safety issues can be described as performance concerns where the contributing factors are unclear due to limited or outdated design documentation, or subtle changes in performance that cannot be visually inspected or obviously linked to a potential failure mode. In these cases, additional studies, investigations, and analysis may be needed to clearly identify the potential failure mode, or more accurately predict the system response probabilities of the potential failure mode causing the concern. Unconfirmed issues are typically addressed in Phase 2 Issue Evaluation Studies where additional funding and time is warranted to further investigate the dam safety issue prior to finalizing the risk estimate.

8.2.3 Warrant Continued Federal Investment. Make a determination that the existing authorized project purposes warrant continued Federal investment and an assessment of whether changes in the authorized project purposes warrant investigation. This will be done utilizing existing information by comparing existing benefits, costs, and the project authorization and the findings summarized in the IES report. See paragraph 9.3.1.2 for a complete statement of this issue.

8.2.4 Scope of Issue Evaluation Studies. The scope and level of rigor required for an Issue Evaluation Study will be based upon the complexity of the dam safety issue, and the ability to evaluate these issues and potential failure modes typically using existing data, assessment, and performance history. The level of effort for this study is that level required to determine if USACE should proceed with a Dam Safety Modification Study. Thus the scope of the study is to identify all significant potential failure modes (or groups of credible failure modes) that are significant risk drivers, to determine the incremental and non-breach flood risk of the dam, and to review and update as needed those essential USACE guidelines that are applicable to that dam. The evaluation for compliance with the identified applicable essential USACE guidelines, as documented in the periodic inspection reports, will be done after the incremental risk is determined to be tolerable. If a Dam Safety Modification Study is to be undertaken, the risk assessment results from the Issue Evaluation Study will be used as the starting point for the existing and future without Federal action condition risk assessment. For projects where a risk estimate has been prepared during a previous risk informed study, that risk estimate should be updated to address the current issue or concern.

8.2.5 Based on the results of an Issue Evaluation Study, the following actions can be taken:

8.2.5.1 Confirm that dam safety issues do or do not exist;

8.2.5.2 Verify or reclassify the current DSAC based on these findings;

8.2.5.3 Determine if a dam should be reclassified as DSAC 1 and thus warranting the expedited process for a DSAC 1 dam;

8.2.5.4 Gauge the effectiveness, and guide the selection, of current and additional interim risk reduction measures;

8.2.5.5 Use the IES results to review effectiveness of IRRMP's, identify data deficiencies, develop DSMS plans, and prioritize DSMS; and

8.2.5.6 Determine if there is basis (or not) to proceed to a DSMS.

8.3 Issue Evaluation Study Plan. The IES Plan must include, at a minimum, the following sections:

8.3.1 Overall project description and purposes;

8.3.2 Overview of the previous findings and reason(s) for the current DSAC;

8.3.3 Description of the specific dam safety issues of concern, and how these dam safety issues were identified. Include narrative that explains if these issues are a result of identified defects, flaws, or unsatisfactory performance, or if these are unconfirmed dam safety issues that require additional data, analysis or site investigations to confirm the dam safety issue does or does not exist;

8.3.4 Description of the interim risk reduction measures that were implemented as a result of previous risk estimates and PFMA;

8.3.5 A listing of all PFMA reports or previous risk assessments that have been performed for the project to date, the names of the lead facilitator and lead risk estimator who completed these efforts, and the dates they were completed. This would include reference to prior PFMA's conducted by the district for the development of PA's, IRRMP's, IES's, etc.

8.3.6 Issue Evaluation Study Plan/Scope. The scope of work will contain a detailed description of data preparation and site characterization efforts and will identify any hydrologic, seismic, project purpose benefits and consequence analyses or instrumentation evaluations, etc. needed to adequately understand, evaluate, portray, and communicate the risk at the project and project purpose accomplishments. Additional guidance on documenting dam performance and site characterization is located in Appendix U. The district will coordinate with the RMC, MSC, and the assigned risk assessment cadre to obtain concurrence of the scope of work prior to the development of the plan. The RMC will help the district develop the scope of work and deliverables for each IES plan. The plan should then be submitted for review and approval.

8.3.7 A listing of the proposed key district team members and disciplines who will participate in the proposed PFMA and IES, the project delivery team lead engineer who will be responsible for preparing the issue evaluation report, and a listing of the specialties required to be part of the ATR team.

8.3.8 The IES study plan is a living document. The scope of work should be updated and reviewed after key milestones in the IES study process (i.e. SQRA, Team Elicitation, etc.) to reflect the level of effort required to effectively communicate the risk and support the study recommendations. Refinement of the data preparation is a part of the risk assessment process and may change as the team understands, refines, and confirms the potential failure modes and the level of uncertainty with the risk estimates and project purpose accomplishments.

8.3.9 Phase 1 study plan examples are available upon request by contacting the RMC.

8.4 Funding for Issue Evaluation Study Plans. The preparation of Issue Evaluation Study plans will be funded from Dam Safety and Seepage/Stability Correction Program ("Wedge Funds"). The 5 to 7 page IES plan will be used to ensure the scope and cost of the proposed study is appropriate, and will act as the official requesting document that enters the project into the dam safety program funding queue for IES.

8.5 Schedules for Submittal of Issue Evaluation Study Plans. Preparation of IES plans begin after the project's dam safety action classification is determined by the DSOG and the district is notified by the RMC/HQUSACE to proceed with preparation of the IES plan. For DSAC 1 dams, the IES plan preparation and IES study execution with be expedited. For DSAC 2 - 4 dams, the IES plan must be submitted to the MSC DSO within 60 days after such notification for review.

8.6 Approval Authority. IES Plans for Phase 1 and addendums to Phase 1 plans for Phase 2 studies are prepared by the district and approved by the district's DSO. The study plan will contain a District Quality Control plan as per the current review policy (reference A.96). The need for Phase 2 studies will be determined by the vertical team based on findings documented in the IES draft report. The PMP may document requirements to conduct additional data gathering during a Phase 1 or Phase 2 IES, based on preliminary findings from such activities as a PA, Seismic Study, or Hydrologic Re-evaluation. The execution strategy for incremental Phase 2 efforts must be formulated during a collaborative meeting between the risk cadre and district to assure that the district obtains the information required to complete the risk estimate with the minimal expenditure of time and resources. Due to the complexity of work efforts and funding required for Phase 2 efforts, the RMC must concur with the Phase 2 work scope prior to budgetary approval for Wedge Funds from the USACE DSPM. Table 8.1 depicts a summary of the principal participants in the decisions involving the development, review, and approval of study plans.

8.7 Submittal Requirements. IES plans must be submitted electronically to the MSC DSO, MSC DSPM, USACE DSPM, and the RMC. An electronic copy of the study plan (review copy) must be uploaded to the RMC's centralized data repository site (RADS II) at the time of hard copy submittal. A copy of the final study plan reflecting all updates and revisions must be uploaded after approval.

8.8 Issue Evaluation Studies - Phase 1.

8.8.1 Warrant Continued Federal Investment. Make a determination that the existing authorized project purposes warrant continued Federal investment and an assessment of whether changes in the authorized project purposes warrant investigation. The level of detail of this determination should be consistent with that of a reconnaissance study under the GI program or Initial appraisal of a Section 216 (Reference A.7) study. More detail should be applied as needed to support the determinations and decision making within the Dam Safety Program. See paragraph 9.3.1.2 for a complete statement of this issue.

8.8.2 Risk Estimates. Risk estimates in support of the IES are conducted to determine the flood risk (incremental and non-breach risk); if the incremental risk approaches or exceeds the USACE tolerable risk limits; and if DSMS are warranted. Phase 1 efforts typically utilize existing data and information. The risk estimate resulting from an issue evaluation study is used to obtain a better estimate and understanding of the incremental and non-breach flood risk of the dam, to verify or reclassify the current DSAC, to guide the selection and gauge the effectiveness of interim risk reduction measure requirements, and to provide information to support prioritization of Dam Safety Modification Studies from a national portfolio level.

Table 8.1 - Issue Evaluation Study Plan – Review & Approval Requirements

<table>
<tr><th>IES Phases</th><th>District</th><th>MSC</th><th>RMC</th><th>USACE DSO</th></tr>
<tr><td rowspan="2">Phase 1 Study Plan</td><td>Study Plan Approval by DSO</td><td>Concurrent Quality Assurance Review</td><td>Concurrent RMC Review</td><td rowspan="2">USACE DSPM Budgetary Approval</td></tr>
<tr><td colspan="3">District will coordinate with the MSC and RMC and obtain RMC concurrence on the scope of work prior to development of the study plan.</td></tr>
<tr><td rowspan="2">Phase 2 Study Plan</td><td>Addendum to Study Plan Approval by DSO</td><td>Concurrent Quality Assurance Review</td><td>Concurrent RMC Review</td><td rowspan="2">USACE DSPM Budgetary Approval</td></tr>
<tr><td colspan="3">Collaborative meeting between the PDT, the district, the Risk Assessment Cadre, MSC, and RMC to develop work scope. Study Plan will be submitted by district after joint agreement has been reached on Scope for Phase 2 efforts.</td></tr>
</table>

8.8.3 Scope of Risk Estimates. The scope of the risk estimate must be more rigorous than the level of detail executed in SPRA and PA risk estimates, and is intended to achieve a defensible, risk informed basis for initiating Dam Safety Modification Studies. Typically, estimates of the incremental risk for confirmed issues can be established with existing data and performance history because the physical manifestations are visual and measurable. Unconfirmed issues may require the collection of additional data if the missing data required to assess performance is not available or cannot be linked to a specific failure mode or observation.

8.8.3.1 Semi-Quantitative Risk Assessment. For projects where the DSAC has been determined by SPRA, a semi-quantitative risk assessment (SQRA) will first be conducted by the risk cadre and district at the beginning of the IES to re-evaluate the SPRA derived DSAC, justify the need for a Phase 1 IES, and identify the significant failure modes that will be used to determine the existing flood risk as part of the Phase 1 quantitative risk assessment.

8.8.3.2 If the semi-quantitative risk assessment of each significant failure mode finds that, with a high degree of confidence, the likelihood of failure is believed to be Remote, Low, or Moderate with a consequence category less than or equal to Level 2 as presented in the Incremental Risk Matrix shown in Figure T.1 of Appendix T, the semi-quantitative risk assessment can be used as the basis to conclude the Issue Evaluation Study, document the results, and recommend a change in DSAC to a lower level of urgency and concern. The semi-quantitative risk assessment report should be prepared following a similar report format for periodic assessments.

8.8.3.3 If the semi-quantitative risk assessment of each significant potential failure mode finds that the likelihood of failure is high or very high regardless of consequences, or the consequence category is greater than or equal to Level 3 with likelihood category of moderate or higher, or Level 4 with a likelihood category of low or higher, or there is a significant data uncertainty or a low degree of confidence in the risk estimate, the results of the semi-quantitative risk assessment will be documented, and the Issue Evaluation Study will be completed using quantitative methodology.

8.8.3.4 The Risk Assessment Report is suitable for use as a Periodic Assessment if approved by DSOG and combined with a Periodic Inspection. The Periodic Assessment Report should be updated as appropriate to address any new findings or issues of concern that were unknown at the time of the semi-quantitative risk assessment.

8.8.4 Data for Risk Estimates. For dams with no risk estimate (see Chapter 3) the IES estimates of the incremental and non-breach risk should be conducted using existing data and should include the significant failure modes to determine if the incremental risk supports going on to a DSMS. For dams where a previous risk estimate has been calculated from other dam safety studies, the potential failure modes should be reviewed, and the risk estimate should be updated based on any changes in condition or new information that may have become available since the last risk estimate was performed.

8.8.5 Finding of Very High Urgency. At anytime during the conduct of an Issue Evaluation Study, if a finding of major concern or evidence is identified requiring a very high urgency for action (DSAC 1), such as if the dam is judged critically near failure, the project should immediately be moved to the expedited process.

8.8.6 Minimum Phase 1 Study Tasks. As a minimum, the following tasks must be performed to develop a risk estimate for Phase 1 Issue Evaluation Studies:

8.8.6.1 Prepare detailed drawings that synthesize all pertinent data including boring logs, instrumentation, geologic features, laboratory data, etc. See Appendix U for further guidance.

8.8.6.2 Perform a facilitated Potential Failure Mode Analysis.

8.8.6.3 Evaluate potential failure modes, using existing information and data, based on the collective knowledge and expertise of the facilitator, risk assessment cadres, regional technical specialists, district dam safety engineers, and the project staff. Potential failure modes that cannot be confirmed without additional analysis or investigations should be identified and documented.

8.8.6.4 For all potential failure modes that pose significant risk to the project, identify the initiators, the failure progression mechanisms, and the resulting impacts.

8.8.6.5 Estimate load-frequency and load-response probabilities for a full range of pools using the best available methodology and risk tools

8.8.6.6 Utilize consequence estimates provided by the MMC.

8.8.6.7 Include a reservoir diagram showing Minimum Flood Space, Variable Flood Space and other vital pool elevations,

8.8.6.8 Prepare a quantitative risk assessment using the significant potential failure modes identified during the semi-quantitative methodology to determine if the existing incremental flood risk approaches or exceeds the tolerable risk limits.

8.8.6.9 Prepare an estimate of the non-breach risk.

8.8.7 Dam Safety Risk Assessment Process for IES. USACE Dam Safety Risk Assessment processes along with team elicitation can be used to calculate load-frequency and load-response probabilities for all potential failure modes included in the risk estimate. The RMC will provide guidance on selection of the most appropriate risk estimating process and methodologies to be employed (see Chapter 18 for methodologies). USACE and the Reclamation have developed risk assessment methodology guidance. Risk assessments should use the joint-agency document entitled “Best Practices in Dam and Levee Safety Risk Analysis” (reference A.113) as a guide to the risk assessment process. The instructional material is available at http://www.usbr.gov/ssle/damsafety/Risk/methodology.html.

8.9 Issue Evaluation Studies - Phase 2.

8.9.1 Additional Study. When existing data and design documentation is either unavailable or insufficient to reduce the uncertainties in the computation of load-response probabilities and resulting risk estimate, parametric (sensitivity) studies should be conducted to determine what influence the data has on the load-response probabilities and resulting risk computations. The need for additional information, studies and investigations to resolve uncertainty should be determined after the parametric studies are completed and insight is gained as to what improvements in the confidence of the risk estimate can be gained from the additional expenditure of time and resources.

8.9.2 Rational for Phase 2. Phase 2 efforts should be considered when there is a lack of confidence in the ability to make a decision regarding whether to proceed to a DSMS. Phase 2 studies are warranted when it can be clearly demonstrated that additional reductions in uncertainty or a greater level of confidence can be achieved in the IES estimate of the incremental risk from the additional time, resources, investigations, and analyses that are proposed. Phase 2 efforts will be incrementally funded by the dam safety WEDGE funds to support increasing levels of rigor until the uncertainties are sufficiently minimized.

8.9.3 Study Plan Addendums. Study plan addendums for Phase 2 efforts must be prepared and submitted to the RMC and the MSC if issues require further analysis or field investigations that are beyond the scope of completing a Phase 1 study. A parametric study should clearly show that additional studies, analyses, and investigation efforts will better define the issue, and determine if the additional studies are warranted. The addendum should clearly summarize the following information:

8.9.3.1 Results from the risk estimate performed during the initial Issue Evaluation Study.

8.9.3.2 A detailed description of specific uncertainties in the existing data, analyses, and site conditions, that appears to be major risk drivers in the initial risk estimate.

8.9.3.3 A detailed description of proposed studies, analysis, and investigations that are required to reduce uncertainty or investigate the unconfirmed issues.

8.9.3.4 A description of how these additional work efforts will reduce uncertainty or confirm a hidden flaw or defect.

8.9.3.5 A detailed description of how these efforts will be phased, and how the results of these studies will be incrementally assessed prior to advancing to the next phase of study.

8.9.3.6 Results of sensitivity analysis or other appropriate uncertainty analysis methods to explicitly show how the uncertainty influences the risk estimate.

8.9.3.7 The estimated cost and schedule duration to complete these more detailed studies.

8.10 Use of Tolerable Risk Guidelines.

8.10.1 The results of the estimate of the incremental risk in an Issue Evaluation Study will assist the vertical team in determining what additional actions are warranted and the urgency of such actions.

8.10.2 Projects with an approved IES that concludes that the estimated incremental risk exceeds the USACE tolerable risk limits will undergo a DSAC review. The project will be prioritized, scheduled, and moved into the resource queue for funding of a DSMS.

8.10.3 If the IES concludes that the incremental risk estimate is significantly below the tolerable risk limits, the study should recommend that an evaluation of the tolerability of the incremental risk and compliance with the applicable essential USACE guidelines be conducted accordance with Chapter 5 and Appendix F. The DSAC classification will then be reviewed.

8.10.4 Prioritization of projects for Dam Safety Modification Studies will be based on the following three criteria as well as additional criteria listed in Chapter 6, Dam Safety Risk Management Prioritization:

8.10.4.1 The annual probability of failure for all failure modes;

8.10.4.2 The magnitude of the individual incremental risk above the limit line for life safety for all failure modes; and

8.10.4.3 The incremental societal risk estimates for life safety for all failure modes.

8.11 Issue Evaluation Study Documentation.

8.11.1 Objective. The document for this phase of the dam safety portfolio risk management process is an Issue Evaluation Study (IES) report. The IES report is used to present information that confirms the dam safety issues , answers the question of whether authorized purposes warrant continued Federal investment, and support the need for a DSMS, or states the case to revise the current DSAC. Therefore the dam safety issue or issues must be clearly defined and supported by the related risk estimate. In the event that a DSMS is not warranted, or at any point in the IES process a determination is made that it would be more advantageous to resolve a dam safety issue through the regular O&M program rather than the Dam Safety Modification process, the IES is stopped and documented, and the project is assigned to the routine O&M processes as defined in Figure 3.1. See paragraph 3.3.16 for additional guidance. At the minimum a semi-quantitative risk assessment will be conducted. The IES document includes information that provides the rationale for the decisions presented in the report and shows how this dam does or does not comply with the tolerable risk guidelines, and describes the recommended plan and why it is warranted.

8.11.2 Organization and Scope. The IES report consists of three separate documents, the publicly releasable USACE Dam Safety Fact Sheet, the Issue Evaluation Study Summary of Findings (IESSF) report, and the IES Report.

8.11.2.1 The USACE Dam Safety Fact Sheet will use a standardized format to communicate flood risk information that is releasable to the general public. See Appendix E for the format for this fact sheet.

8.11.2.2 The IESSF for an IES is intended to be a an internal stand-alone component of the IES report that provides information to senior USACE officials to make dam safety decisions, and is not intended for public release. The IESSF concisely summarizes the following: the history and status of safety issues and actions for the subject dam; the recommended actions and supporting facts; the outcomes from analysis and assessment; and the degree of confidence in the basis for the recommendations. The document will be ten to fifteen pages, well formed and will comprise text, tables, diagrams, and photos.

8.11.2.3 The IES contains all background data pertinent to all significant failure modes, risk computations, findings, conclusions, and recommendations, and supporting documentation. It will act as the technical reference and supporting document for the IESSF Report and is not intended for public release.

8.11.2.4 The format and content of these two complimentary IES Report documents are detailed in Appendix V.

8.12 Roles and Responsibilities.

8.12.1 Risk Management Center (RMC). The RMC will provide support to the USACE DSO and the DSOG for the formulation of dam safety policy, actions, and budgets, for risk informed management of USACE national portfolio of dams. The RMC will coordinate with the DSOG, MSC, DSPC's, DSMMCX, and district offices to prioritize the IES and DSMS from a national perspective. The RMC will schedule and budget all centralized resources needed for the execution of IES based on the DSOG's prioritization and assign facilitators and regional cadre members to perform the PFMA and risk estimate. The RMC is responsible for coordinating and managing agency technical review (ATR) of the IES reports in accordance with the current review policy (reference A.96).

8.12.2. Risk Cadre. A risk cadre and an approved PFMA facilitator, with support from the district, will be responsible for conducting and documenting the results of the PFMA and all semi-quantitative and quantitative risk assessment results and findings. The risk cadre will provide the district with recommendations on implementing or revising IRRM, provide recommendations for Phase 2 studies when warranted, and collaborate with the district staff concerning the scope of the recommended phase 2 work efforts. The risk cadre will also provide limited consulting services to the district during formulation of the Risk Management Plan, and during preparation of the IES report. The risk cadre will also perform a quality control review of the final IES and companion IESSF report prior to the agency technical review.

8.12.3 District. The district is responsible for the overall management and execution of IES. This includes formation and management of an IES PDT as directed in ER 5-1-11 (reference A.29). The PDT will coordinate the development of the IES plan scope of work with the RMC; prepare and submit the IES plans; collect, compile, and present project data in support of the PFMA and risk assessment; support the risk assessment cadre during the PFMA, the risk estimate; conduct additional investigations required to reduce uncertainty; conduct parametric studies required to support development of additional IRRM; coordinate requests for funds with the RMC; and schedule the various work efforts required to complete the IES. The district is ultimately responsible for preparation of the IES report and should receive input from the cadre on the risk assessment documentation, conclusions, recommendations, and IRRM's. The districts are also encouraged to utilize the PFMA and risk estimate work efforts conducted by the risk assessment cadres as risk management training opportunities for additional members of their technical staff who are not specifically assigned to the IES PDT. The makeup of the PDT is critical to the expeditious accomplishment of the IES. The PDT will have one or more engineer members, one of which will be designated as the team's 'lead engineer' in accordance with ER 1110-2-1150 (reference A.49). Care should be taken that the appointed 'lead engineer' has the experience and qualification to perform as the coordinator of engineering activities and serve as the single-point-of contact within the PDT on engineering technical matters for the IES. While not necessarily appropriate for later phases of a project when the administrative requirements significantly increase, the lead engineer should be strongly considered for assignment as the project manager during the IES phase.

8.13 Funding. IES will be funded by HQUSACE from the Dam Safety Assurance and Seepage/Stability Correction Program ("WEDGE") funds. Projects will be prioritized and funded based on the prioritization policies outlined in Chapter 6. The IES is part of the study phase of the project and as such is 100% Federally funded (no cost sharing).

8.14 Schedule. The schedule for completion of an IES is dependent on the complexity and urgency of the project being studied, and its position in the national funding priority queue. Once funding is received, work should be accomplished in accordance with the schedule presented in the IES plan. Phase 1 IES should be completed within 6 months from receipt of funds. For projects where Phase 1 efforts find that a Phase 2 study is warranted, the study should be executed in accordance with the approved study plan addendum for the Phase 2 efforts.

8.15 Review, Approval, and Submittal of IES.

8.15.1 Review Process.

8.15.1.1 Review of IES involves both sequential and concurrent actions by a number of participants. This process includes: the PDT; the district, MSC and RMC; ATR team; and HQUSACE. It is therefore imperative that the vertical teaming efforts are proactive and well coordinated to assure collaboration of the report findings, conclusions, and recommendations, and that there is consensus at all levels of the organization with the recommended path forward. IES Reports will comply with the Civil Works Review Policy and will undergo District Quality Control (DQC) Review, Agency Technical Review (ATR), and Dam Senior Oversight Group (DSOG) Review.

8.15.1.2 The dam safety program will follow the policy review process described in the current review policy (reference A.96). The RMC will be the review management office for the ATR, and the RMC must certify that the risk assessment was completed in accordance with the USACE current guidelines and best risk management practices.

8.15.1.3 After ATR comments have been resolved, the Risk Cadre and PDT will present the technical findings of the risk assessment to the RMC and District DSO to achieve final consensus on conclusions, recommendations, and follow-on actions. Upon satisfactory completion of the ATR and certification of the review effort, the District DSO will present the final report to DSOG. All revisions resulting from the DSOG review must be completed prior to the report being forwarded to the MSC and HQUSACE for quality assurance and policy compliance review. Upon completion of the MSC and HQ review efforts, all comments must be resolved and the document updated prior to final submittal for approval by USACE DSO.

8.15.2 Approval Process.

8.15.2.1 Once DSOG, MSC, and HQ comments are resolved, the district DSO will initiate a joint memorandum recommending USACE DSO approval, and forward to the MSC DSO and the Chairman, DSOG for signature. This memorandum will state that all agency requirements, certifications, reviews, and documentation have been satisfactorily completed.

8.15.2.2 The report will then be sent to the USACE DSO for approval. The USACE DSO will then notify the Director of Civil Works and the MSC commander that the IES report has been approved. See figure 8.1 for a flow chart of the process.

8.15.2.3 Table 8.2 depicts a summary of the principal participants in the decisions involving approval of Issue Evaluation Studies.

8.15.3 Report submittal requirements are as follows:

Review Center	Number of Paper Copies	Number of CD-R Copies
MSC DSO	1	2
USACE DSPM	1	2
Risk Management Center	1	3

8.15.3.1 An electronic copy of the IES report (review copy) must be uploaded to the RMC's centralized data repository (RADS II) at the time of hard copy submittal.

8.15.3.2 A copy of the final IES Report reflecting all updates and revisions required from the review process must be uploaded after report approval.

Table 8.2 - Issue Evaluation Study Report – Review and Approval

	District	MSC	RMC	USACE DSO
Includes:	ATR w/Risk Cadre Certification	Quality Assurance Review	Review & Approval of Risk Estimate	Policy & Compliance Review
Report with Appendices, to include Risk Estimate	Joint Recommendation for Approval signed by District DSO	Joint Recommendation for Approval signed by MSC DSO	Concurrence with Recommend-ations	Joint Recommendation for Approval signed by DSOG Chairman Approval by the USACE DSO

8.15.4 Following approval of the IES, the RMC, MSC, and district will be notified, and the project will be placed back into the Dam Safety Portfolio Risk Management Process and prioritized for a DSMS or returned to the routine O&M activities to address any IES recommendations. There may be times when the project will be put into the national queue for a DSMS and also have actions taken under the routine O&M activities.

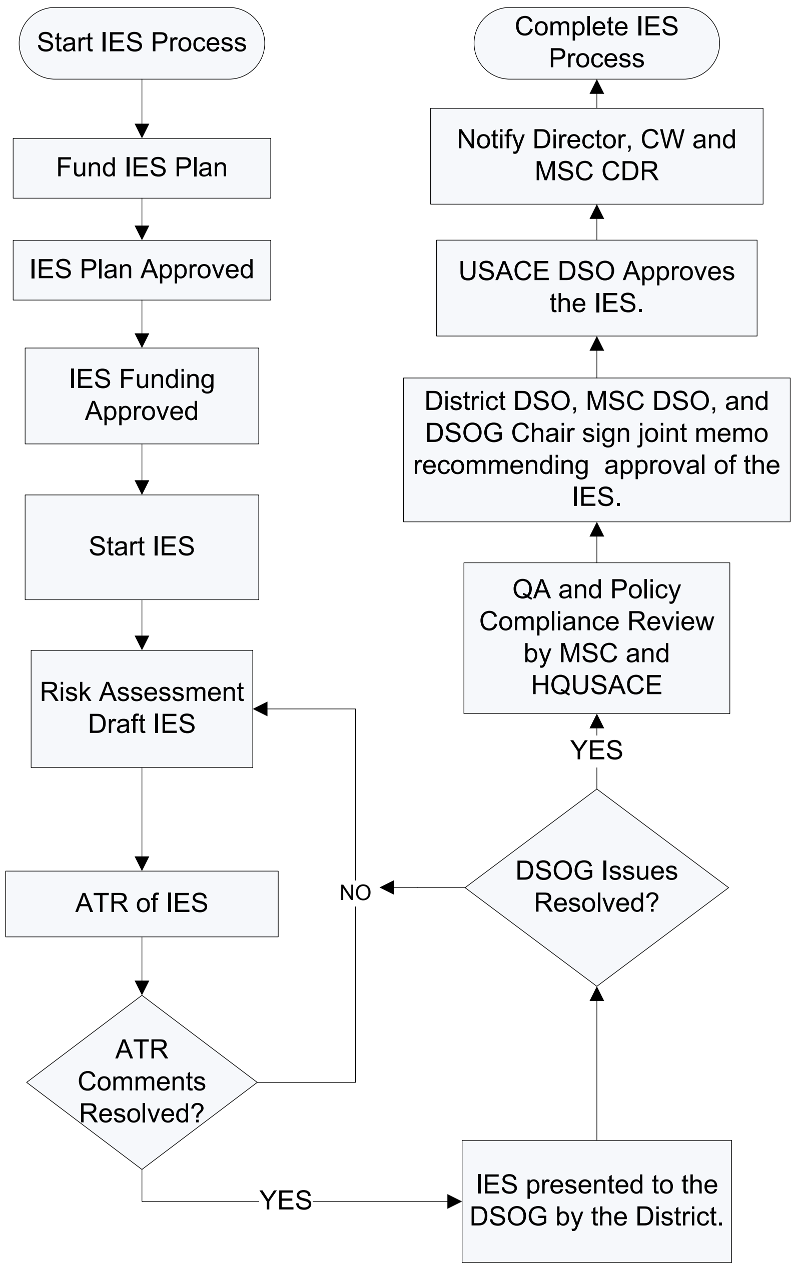


Figure 8.1 – Flowchart of the IES Decision, Review, and Approval Process

CHAPTER 9

Dam Safety Modification Studies and Documentation

9.1 Purpose. This chapter provides guidance and procedures for developing the dam safety modification report that presents the investigation, documentation, and rationale for modifications for dam safety at completed USACE projects. This chapter provides a description of the requirements to obtain approval to modify a dam to address the risks associated with a dam safety issue(s) and to meet USACE tolerable risk guidelines. A dam safety issue is any condition at a dam that results in unacceptable life safety, economic, and environmental risks posed by the failure of the dam (See Glossary for definition of dam failure). A single type of decision document – Dam Safety Modification Report (DSMR) – will be used for all dam safety modification projects not requiring additional authorization by Congress. The DSMR is prepared for any Dam Safety Action Classification (DSAC) 1, 2, 3, and 4 dams upon the recommendation of the Dam Senior Oversight Group (DSOG) and approval of the USACE DSO in accordance with national priorities. Figure 3.1, USACE Dam Safety Portfolio Risk Management Process, depicts the process by which dams can be identified, approved, and prioritized for a Dam Safety Modification Study. Figure 9.1 presents the Dam Safety Modification Study (DSMS), review, decision, and approval process flowchart. The DSMR documents the DSMS and includes a risk assessment for all potential failure modes (PFM) that have been determined to contribute to significant risk for that dam. The report must also document additional efforts (if any) to further define the dam safety issue, and must establish the Federal interest in continuing project operations. The risk assessment in support of the DSMS must address the life safety, economic, and environmental consequences associated with the identified significant failure modes. The goal of the risk management alternatives, including potential staged implementation options, is to achieve the tolerable risk guidelines presented in Chapter 5 by reducing and managing the incremental risk. The report format and additional technical guidance including a more detailed chart on the Dam Safety Modification study process is contained in Appendix W.

9.2 Change from Previous Guidance. The Dam Safety Modification Study process described in this chapter replaces the Major Rehabilitation Evaluation report for Dam Safety and the Dam Safety Assurance Evaluation reports described in previous regulations. For projects with currently approved Dam Safety Assurance reports or major rehabilitation reports a DSMR will not be required

9.3 Eligibility. This guidance encompasses all structural and non-structural project modifications to address dam safety issues. Potential operational failures, identified by the DSM risk assessment, such as the failure of operating equipment not directly impacting dam safety, will generally not be addressed with a DSMR. Those actions should follow normal O&M or major rehabilitation paths for funding. Only projects that have received approval as a national priority project by the USACE DSO, based on an assessment of risk, will be funded to go through the DSMS process. The decision to modify a dam should be based upon the magnitude of existing life, economic, and environmental incremental risks; the effectiveness of the proposed alternatives to reduce the incremental risk to tolerable levels, and meeting essential USACE guidelines. Funding for preparation of the report and implementation of the action(s) is addressed in a following paragraph.

9.3.1 Eligibility Requirements.

9.3.1.1 In order to qualify without needing additional authorization, the modifications must fall within the existing authority of the Army Corps at the project. Guidance that will assist in making this determination is contained in ER 1110-2-240 “Water Control Management” dated 8 October 1982 (reference 45). Essentially, the requirement is that the proposed modification must not significantly impact the congressionally authorized purposes. Further guidance is provided in ER 1105-2-100, Appendix E, Section 57 ‘Other Authorities’, paragraph d. ‘Reallocation of Storage’ (reference A.39).

9.3.1.2 The need to address the dam safety issues and meet the risk-reduction objectives must be supported by a determination that the existing authorized project purposes warrant continued Federal investment and an assessment of whether changes in the authorized project purposes warrant investigation. The level of detail of this determination should be consistent with that of a reconnaissance study under the GI program or Initial appraisal of a Section 216 (Reference A.7) study. More detail should be applied as needed to support the determinations and decision making within the Dam Safety Program. The overall level of detail for the DSMS is described in 9.5.4.3 below. If the continuation of existing project purposes is not warranted, then a decision document addressing deauthorization should be considered. If changes in the project purposes appear to be warranted, then the decision document should determine whether the dam safety concerns are separable from the potential changes in project purposes. If they are separable, then the investigation of the dam safety concerns may proceed separately from investigations of potential changes in project purposes. If they are not separable, then a cost-shared shared feasibility study should be initiated under Section 216 of the Rivers and Harbors Act of 1970 (reference A.7) to address both the dam safety concerns and potential changes in the project purposes.

9.3.1.3 Any alternative recommended for implementation must be evaluated for its effects on the authorized project purposes. If it is determined any point during a DSMS that any alternative in the final array of alternatives is likely to significantly affect an authorized project purpose or is dependent upon the authorized purposes changing, the study process should transition to the Review of Completed Projects Program, as described in “Additional Authorizations” (paragraph 9.3.2 below) and ER 1165-2-119 Modifications of Completed Projects (reference A.62). This transition should be affected in such a manner as to maintain continuity and efficiency in the study to the extent possible, including consideration of completing the study with dam safety wedge funding. Close coordination with USACE Planning and Policy Division leadership will be necessary.

9.3.1.4 A DSMS is not required for major maintenance work under the Operation and Maintenance appropriation (generally items costing less than the current cap for major maintenance in the budget EC and that can be completed in one construction season).

9.3.1.5 Once a DSMR is prepared and approved, budget justification and other supporting data will be prepared in accordance with directions from the USACE DSO in coordination with the business line managers. The DSMR will be used to approve projects to be funded with Construction appropriation funding.

9.3.2 Additional Authorization. Project modifications, which require additional authorization, should be studied under the authority of Section 216 of the Rivers and Harbors Act of 1970 (reference A.7), following the guidance in Chapter 2 of ER 1105-2-100 (reference A.39) and ER 1165-2-119 (reference A.62). Additionally, the DSMS recommendations documented in the DSMR will identify any known needs for modifying existing project purposes under Section 216 of the Rivers and Harbors Act of 1970 (reference A.7) and any additional studies or authorizations necessary to address the non-breach flood risk in locations where the non-breach risk warrants additional investigations. In the event additional studies are recommended, the studies will be subject to the current authorization and budget guidance.

9.4 DSMS Objective.

9.4.1 The objective of a Dam Safety Modification Study is to identify and recommend a risk management plan that supports the expeditious and cost effective reduction of risk within the overall USACE portfolio of dams. Recommended risk management alternatives are to be technically feasible and acceptable following current best practices (reference A.109), comply with applicable laws, and satisfy applicable tolerable risk and the identified applicable essential USACE guidelines for remediation of existing dams. The risk associated with each failure mode being addressed by a risk management alternative must be reduced to a level that satisfies the tolerable risk and applicable essential USACE guidelines in Chapter 5 and Appendix F on an individual failure mode basis, including ALARP considerations.

9.4.2 The intent is to achieve remediation of those individual failure mode(s) being addressed by the plan to support the goal of having a dam with low risk for confirmed and unconfirmed dam safety issues where the combination of life, economic, or environmental consequences with the probability of failure is low; however, the dam may not meet all applicable essential USACE guidelines, but the incremental risk is considered tolerable. Each alternative risk management plan must be formulated to support effective and efficient risk reduction within the USACE portfolio of dams which may require a staged implementation approach. The principle of “Do No Harm” (see paragraph 1.10.2) must be respected in development of the risk management plan.

9.5 Basic Approach and Principles for Execution of a DSMS.

9.5.1 DSMS will be undertaken following the six step framework of civil works planning presented in ER 1105-2-100 "Planning Guidance Notebook" (reference A.39) as adapted herein for addressing dam safety issues.

9.5.1.1 Identify dam safety issues and risk-reduction opportunities;

9.5.1.2 Estimate existing and future without Federal action condition risk;

9.5.1.3 Formulate alternative risk management plans;

9.5.1.4 Evaluate alternative risk management plans;

9.5.1.5 Compare alternative risk management plans; and

9.5.1.6 Select a risk management plan.

9.5.1.7 A description of each step is presented in subsequent paragraphs. USACE dam safety decision making is based on the accomplishment and documentation of all of these steps. It is important to stress the iterative nature of this process, and the need to tailor the scope and detail of the study to the specific dam and its suspected safety issue, and its evidenced urgency for action. As more information is acquired and developed, it may be necessary to reiterate some of the previous steps. The six steps, though presented and discussed in a sequential manner for ease of understanding, usually occur iteratively and sometimes concurrently. Iterations of steps are conducted as necessary to formulate efficient, effective, complete and acceptable plans. The results of and data from previous interim risk reduction measure plans (IRRMP), Issue Evaluation Studies (IES), and periodic assessments (PA) completed under Chapters 7, 8, and 11 must be gathered and used when beginning the DSMS.

9.5.1.8 Environmental Compliance. DSM Studies and modifications must be in compliance with ER 200-2-2 (reference A.34) and all applicable Federal, State, and local environmental protection statutes and regulations. The National Environmental Policy Act (NEPA) (reference A.6) requires Federal agencies, including the USACE, to comply with a process that includes the inventory and assessment of the environmental resources within the study area. NEPA also requires the evaluation and comparison of alternatives to determine the effects of proposed actions to those ecological, social, cultural, economic, and aesthetic resources identified and investigated. Involvement by resource agencies with jurisdictional responsibilities for, or special knowledge of, significant resources and the general public during the study process is also required. USACE guidance for implementation of NEPA is provided in 33 CFR 230. The NEPA process and the USACE six step planning process will be integrated for DSMS. This should also include all measures required for compliance with other applicable environmental statutes, such as the Endangered Species Act (reference A.10), the Clean Air Act (reference A.3), the Clean Water Act (reference A.9), the Fish and Wildlife Coordination Act (reference A.2), and the Historic Preservation Act (reference A.5), among others. (See ER 1105-2-100, Appendix C for compliance requirements. (reference A.39)) This integration is intended to reduce process overlap, duplication, and inconsistencies. The integrated process will help assure that well-defined study conditions and well-researched, thorough assessments of the ecological, social, cultural, economic, and aesthetic resources affected by the proposed dam safety activity are incorporated into dam safety decisions.

9.5.1.9 Value Engineering During DSMS. The Information and Function phases of the VE study, as required by ER 11-1-321 (reference A.33), must include the risk-informed decision criteria to include the tolerable risk guidelines, ALARP, and essential engineering guidelines. Additionally, the objective of the project will be the objectives of the dam safety modification study.

9.5.2 Step 1 – Identify Dam Safety Issues and Risk-reduction Opportunities. Dam safety issue and risk-reduction opportunity statements will be framed in terms of the USACE dam safety program objectives, identified dam safety issues (significant potential failure modes), and tolerable risk and essential USACE guidelines.

9.5.2.1 Issues and risk-reduction opportunities should be defined in a manner that does not preclude the consideration of all potential alternatives to resolve the dam safety issues. Issues and risk-reduction opportunity statements will generally encompass current conditions, but in some instances, may need to encompass future conditions (changes in consequences, on-going changes in site, downstream, and reservoir pool terrain conditions, etc.) if they are expected to be significantly different from the current conditions and thus be relevant to risk characterization and decision making. Thus, they can be, and usually are, re-evaluated and modified in subsequent steps and iterations of the DSMS process.

9.5.2.2 Properly defined statements of dam safety issues and risk-reduction opportunities will reflect the priorities and preferences of the Federal Government, the non-Federal sponsors and other groups participating in the DSM study process; thus active participation of all stakeholders in this process is strongly recommended. Proper identification of dam safety issues and risk-reduction opportunities are the foundation for scoping the DSMS process.

9.5.2.3 Once the dam safety issues and opportunities are properly defined, the next task is to define the DSMS risk reduction objectives and the constraints that will guide efforts to resolve the safety issues and achieve these opportunities. Dam safety risk reduction objectives are statements that describe the desired results of the DSMS process by resolving the dam safety issues and taking advantage of the opportunities identified. Objectives must be clearly defined based on tolerable risk guidelines and applicable essential USACE guidelines. At this point the identified applicable essential USACE guidelines will be reviewed and a determination made if any additional guidelines, beyond those identified by the Issue Evaluation study, are to be included for consideration.

9.5.2.4 Constraints are restrictions that limit the DSMS process and are unique to each DSMS. Some general types of constraints that need to be considered are resource, legal, and policy constraints. It is also essential that the team focus on practical and realistic plans so that quick and efficient evaluation may occur. Resource constraints are those associated with limits on knowledge, expertise, experience, ability, data, information, financial, and time. Legal and policy constraints are those defined by law, USACE policy and guidance. Plans should be formulated to meet the DSMS risk-reduction objectives and to avoid violating the constraints. Thus, a clear definition and documentation of risk-reduction objectives and constraints is essential to the success of the DSMS process.

9.5.3 Step 2 – Estimate Existing and Future Without Federal Action Condition Risks.

9.5.3.1 A quantitative and qualitative description is made, for both current and future risks. A vital activity during this step is to identify all key assumptions and sources of uncertainty in defining this risk. These activities would include the potential failure mode analysis (PFMA) and detailed risk assessment of existing and future without Federal action conditions.

9.5.3.2 Existing conditions are those at the time the study is conducted and most often constitute the existing condition risk. The future without Federal action condition risk is the condition mostly likely to exist during the period of analysis if USACE does not take additional action and considers what others would do absent USACE action. The future without Federal action condition includes the IRRMs that can be reasonably assumed to be in place until such time as the dam safety issues can be addressed. For situations with deficient warning and evacuation plans, the future without Federal action condition must include improved warning and evacuation plan(s). When the future without Federal action condition risk is expected to be different from the existing condition risk, the risk assessment must include the future condition. Additionally, the future without project condition will not assume the dam will be rebuilt in the event of catastrophic failure. If the expected future condition is not significantly different from the existing condition risk, an explanation should be documented and the existing condition should be utilized as the future without Federal action condition. The future without Federal action condition risk provides the basis from which alternative plans are formulated and their impacts are assessed. Because impact assessment is the basis for plan evaluation, comparison and selection, clear definition and full documentation of the condition risk is essential. Consequence analysis will consider existing and future population at risk and threatened population for fatality estimates.

9.5.3.3 All dam safety issues (significant failure modes) will undergo a risk assessment to determine the risk of the existing and future without Federal action conditions. Each potential failure mode must be shown to lead to a plausible failure of the dam. This risk assessment will undergo ATR at the end of this step of the process.

9.5.3.4 The starting point for the risk assessment in support of the DSMS is the risk assessment used in support of the IES, if one was done. A scoping meeting for the risk assessment will be held prior to the start of Step 2 with the district, the DSPC, the PDT, the risk cadre, the MMC, and the RMC to determine what additional work needs to be done beyond that accomplished for the risk assessment used in support of the IES. If additional work is required to determine the existing and future without Federal condition then the risk assessment will undergo ATR at the end of this step of the process.

9.5.4 Step 3– Formulate Alternative Risk Management Plans. Alternative risk management plans must be formulated to identify specific ways to achieve dam safety objectives within constraints, so as to resolve the dam safety issues and realize the risk-reduction opportunities that were identified in Step 1. Alternative plans should be formulated in such a way so as to first address the life safety issues and then to restore the full authorized benefit of the dam. A risk management alternative plan consists of a system of structural and/or nonstructural measures, strategies, or programs formulated to meet, fully or partially, the identified DSMS risk-reduction objectives subject to the constraints. At least one proposed risk management alternative must be shown to reduce the risk to the levels defined in the tolerable risk guidelines (Chapter 5). It may not be possible to achieve tolerable risk guidelines for life safety at projects with very high consequences even with low annual probability of failure. A risk management measure is a feature or an activity that can be implemented at a specific geographic site to address one or more objectives. Risk management measures are the building blocks of alternative plans and are categorized as structural and nonstructural. An alternative plan is a set of one or more risk management measures functioning together to address one or more objectives. A range of alternative plans must be identified at the beginning of the study process and screened and refined in subsequent iterations throughout the study process. However, additional alternative plans may be identified at any time during the process. Plans should be in compliance with existing statutes, administrative regulations, and common law. Alternative plans must not be limited to those USACE could implement directly under current authorities. Plans that could be implemented under the authorities of other Federal agencies; State and local entities; and non-government interest should also be considered.

9.5.4.1 The first phase in the plan formulation process is the identification of dam safety risk management measures that could be implemented, giving consideration to structural and non-structural measures, for individual significant failure modes. The second phase is the formulation of alternative risk management plans by combining the risk management measures as appropriate for multiple significant failure modes. Alternative risk management plans should be significantly differentiated from each other and not scales of one alternative. As a general rule risk-reduction alternatives must be formulated to contribute toward achieving the tolerable risk and applicable essential USACE guidelines, and should be informed by the ALARP considerations. Risk reduction alternatives should not be formulated around or to compensate for deficient EAPs and evacuation plans.

9.5.4.1.1 Minimum required alternatives are:

9.5.4.1.1.1 No action alternative (future without Federal action condition risk);

9.5.4.1.1.2 Meeting full tolerable risk guidelines using ALARP considerations to include applicable essential USACE guidelines;

9.5.4.1.1.3 Achieving only tolerable risk limit for life-safety;

9.5.4.1.1.4 Remove structure; and

9.5.4.1.1.5 Replace structure.

9.5.4.1.2 Each alternative risk-reduction management plan must be formulated in consideration of the four criteria completeness, efficiency, effectiveness, and acceptability as described in the Planning Guidance Notebook (ER 1105-2-100) (reference A.39).

9.5.4.1.2.1 Completeness is the extent to which an alternative risk management plan provides and accounts for all necessary investments or other actions to ensure the realization of the DSMS risk management objectives, including actions by other Federal and non-Federal entities.

9.5.4.1.2.2 Efficiency is the extent to which an alternative risk management plan is the most cost effective means of achieving the objectives.

9.5.4.1.2.3 Effectiveness is the extent to which an alternative risk management plan contributes to achieving the objectives.

9.5.4.1.2.4 Acceptability is the extent to which an alternative risk management plan is acceptable in terms of applicable laws, regulations and public policies.

9.5.4.1.2.5 Appropriate mitigation of adverse effects must be an integral component of each alternative risk management plan.

9.5.4.2 Non-structural measures must be considered as means for addressing dam safety issues and risk-reduction opportunities.

9.5.4.2.1 For the purposes of this regulation, non-structural measures include those actions that are not considered as remediation or ‘fixes’ for the identified structural deficiencies of the dam. Such measures would include, but not be limited to: Flood warning response plans and evacuation plans; modification, relocation, or removal threatened properties; land use regulations; early warning and detection systems; changes to reservoir regulation plans, to include emergency operation procedures; and public awareness programs.

9.5.4.2.2 Non-structural measures may be combined with structural measures to produce a risk management plan or considered as a stand-alone alternative. Non-structural measures must receive equal consideration in the alternative development process to structural risk management measures.

9.5.4.2.3 Flood warning and evacuation plans are key components of life-safety risk reduction activities associated with potential flooding resulting from a possible dam failure and must receive priority attention in formulating alternatives DSRM plan. It is likely that such a plan will be found to be an appropriate measure for inclusion in most of the alternative plans that will be formulated and evaluated seeking to reduce life-safety risk. As a consequence, early in the formulation process, the DSRM study team is encouraged to engage the local community and the responsible local emergency management agency to ensure this key measure is appropriately addressed in the study. A sound understanding of the existing flood warning response and evacuation process system and how it may be improved will play a significant role in potential life loss estimates thus directly impacts how alternative DSRM plans will be evaluated. For situations with deficient warning and evacuation plans, the suggested approach to formulating and evaluating alternatives would be to formulate an improved plan as one of the measures to be considered, and make that measure a component of all proposed alternatives. Thus, ensuring that deficient warning and evacuation plans are not used as the rationale to implement structural risk management measures at a dam.

9.5.4.2.4 When formulating and evaluating alternatives, measures and alternative plans must not be limited to those that USACE could implement directly under current authorities. Measures and alternative plans for implementation by others should be given equal consideration to those implemented by USACE. Costs for implementation should be allocated in the implementation of the recommended plan, but the allocation should not be considered in the evaluation and comparison of alternative plans.

9.5.4.3 Level of Development for Each Alternative Plan

9.5.4.3.1 Each project and risk-reduction and management alternative is unique and the level of detail needed to identify, evaluate, and compare each alternative will require different efforts. Critical thinking is needed to consider those factors that have the potential to impact the technical adequacy, cost, life-safety risk reduction, economics and other factors for each plan early in the process. However, each alternative in the final array of alternatives will be developed to similar levels of detail for comparison and evaluation in steps 4 and 5.

9.5.4.3.2 Each risk-reduction and management alternative plan must to be prepared to a level of detail that will permit the identification, evaluation, and comparison of key features of each alternative plan and their associated impact on reducing the risk and the plan’s estimated construction cost. This requires that key parameters for each alternative plan to be refined to the point that technical adequacy, the associated construction costs, and consequences comprising economic, environmental, and life risk can be identified with reasonable certainty.

9.5.4.3.3 As a minimum, each alternative plan that includes construction should include an overall plan view of the alternative and cross sections and profiles, as appropriate, of the key features of the plan. The figures/drawings should be of sufficient detail to clearly illustrate the extent and dimensions of the key features and support the quantities used to develop the estimated construction costs.

9.5.4.3.4 In addition, each alternative plan that includes construction should include a cost estimate that identifies the construction items and costs in sufficient detail to estimate the construction costs with some certainty. Construction activities and items for which a large uncertainty exists and for which the activity or item has the potential to significantly impact the overall construction cost should be further refined to reduce the cost uncertainty.

9.5.4.3.5 Each alternative should include sufficient data and analysis to identify any change in consequences and/or benefits provided by the project and changes to life safety. The economic and financial costs of each alternative must be calculated and displayed. Additionally, costs should include those borne by entities outside USACE, including local communities, other Federal agencies, etc when appropriate. The economic costs and benefits will be utilized in calculations involving a benefit to cost ratio and/or cost effectiveness analysis for risk reduction alternatives. The value of a statistical life will not be utilized in the benefit to cost ratio. The constant dollar financial costs at the current price level (also known as the Project First Cost) will be the utilized in the DSMR.

9.5.4.3.6 Each alternative should include an assessment of the overall environmental impacts (both positive and negative) to include estimated loss or impact on species and habitat for each of the alternatives. A mitigation plan for species and habitat loss or impact should be developed for each alternative. The cost for such mitigation should be integral component of each alternative.

9.5.4.4 Uncertainty should be characterized in the analysis for each alternative.

9.5.5 Step 4 - Evaluate Alternative Risk Management Plans. The evaluation of effects is a comparison of the with Federal action risk reduction condition to the future without Federal action condition for each risk management alternative. This necessitates risk assessment be performed for all viable alternatives.

9.5.5.1 Evaluation consists of four general tasks.

9.5.5.1.1 The first task is to determine the most likely condition expected under each alternative risk management plan. This requires an assessment of the risk under each alternative risk management plan. Each with Federal action risk reduction condition will describe the same critical variables included in the future without Federal action condition developed in step 2 (risk evaluation factors of annual probability of failure, life safety and economic and environmental consequences, and costs and benefits). When evaluating the alternative plans include all significant resources used by the alternative, the anticipated results of the alternative, and the plan effects on life-safety, economics, and environment. They also include contributions to the dam safety risk management objectives, compliance with environmental laws and regulations, the four evaluation criteria (completeness, effectiveness, efficiency and acceptability) (reference ER 1105-2-100, reference A.39) and comparison with tolerable risk and dam safety objectives.

9.5.5.1.2 The second task is to compare each with Federal action condition risk to the future without Federal action condition risk and document the differences between the two.

9.5.5.1.3 The third task is to characterize the beneficial and adverse effects of each plan with respect to magnitude, location, timing and duration. Beneficial and adverse effects of each plan must be evaluated against the without future Federal action plan.

Special care must be taken to insure that the plan will not result in increase incremental or non-breach risks. Identification and documentation of tradeoffs will be required to support the final recommendation. The effects include those identified during the evaluation phase and any other significant effects identified in step 5 (Compare Alternative Risk Management Plans).

9.5.5.1.4 The fourth task identifies the plans that will be further considered, dropped or reformulated in the DSMS process. A plan will be further considered based on a comparison of the adverse and beneficial effects and the extent that the plan achieves the dam safety objectives.

9.5.5.1.5 As part of the need to consider completeness, efficiency, effectiveness, and acceptability those alternatives that will be carried forward will undergo a constructability evaluation at or near the completion of this step (see 9.6.8.2.2).

9.5.5.2 Steps in the procedures may be abbreviated by reducing the extent of the analysis and amount of data collected where greater accuracy or detail is clearly not warranted by the cost of the plan components being analyzed or the lack of their impact on decision making. The steps abbreviated and the reason for abbreviation must be documented in the study reports.

9.5.6 Step 5 – Compare Alternative Risk Management Plans. In this step, plans (including the without future Federal action plan) are compared against each other, with emphasis on the outputs and effects (anticipated results of the alternative and the plan effects on life safety, economics, and the environment) that will have the most influence in the decision making process, e.g. annual probability of failure, life-safety tolerable risk limits, ALARP considerations to include applicable essential USACE guidelines. Beneficial and adverse effects of each plan must be compared. The comparison step can be defined as a reiteration of the evaluation step, with the exception that in this step each plan (including the future without Federal action plan) is compared against each other and not solely against and future without Federal action condition. The output of the comparison step will be a ranking of plans.

9.5.7 Step 6 – Selecting a Risk Management Plan. After the initial MSC and HQUSACE policy compliance review and public review a single risk management plan will be selected for recommendation from among all alternative plans that have been considered, including the future without Federal action plan. The criteria for selecting the recommended risk management plan will generally be based on the ranking resulting from the comparisons of plans described in 9.5.5. The primary evaluation factors of life-safety, annual probability of failure, relationship to the tolerable risk limits, and ALARP considerations including applicable essential USACE guidelines form the basis for plan selection. Beneficial and adverse effects of each plan must be compared. Technical acceptability, cost effectiveness, constructability, redundancy, resiliency, and robustness should also be considered and documented. Other considerations, such as economic and environmental which may be used in selecting a risk management plan must be fully documented and defensible.

9.6 Dam Safety Modification Study Project Management Plan and Tasks.

9.6.1 Project Manager, Lead Engineer, Project Delivery Team, and the Project Management Plan.

9.6.1.1 The first actions under the study are the assignment of a DSM Project Manager, a DSM Lead Engineer, creation of a project delivery team, identification of the vertical team, the development and completion of a project management plan (PMP) for the study per ER 5-1-11, U.S. Army Corps of Engineers Business Process (reference A.29) and ER 1110-2-1150, Engineering and Design of Civil Works Projects (reference A.49), and the development a review plan in accordance with the current Civil Works Review Policy (reference A.96) The Regional DSPC is responsible for the assignment of the engineering members to the PDT in coordination the district DSO. The DSM Lead Engineer must be a member of the Regional DSPC, or as approved by the DSPC.

9.6.1.2 Review and approval process for the PMP is shown in Table 9.1. A copy of the final DSM PMP reflecting all updates and revisions required from the review process must be uploaded after PMP approval.

Table 9.1 - Dam Safety Modification Study Project Management Plan – Review & Approval

Activity/Document	District	MSC (DSPC & DSO)	HQ	
			RMC/ DSMMCX*	DSO**
Dam Safety Modification Study PMP	Approval of PMP by DSO	Concurrent Review (NTE 30 days)	Concurrent Review (NTE 30 days)	Concurrent Review (NTE 30 days)
Review Plan	Prepare	Review and Approve	Concurrent Review and Certify (NTE 30 days)	N/A
*Review Management Organization ** Includes DSPM, RIT, and other appropriate HQS elements				

9.6.2 Establish Vertical Team. Establish the vertical project delivery team (PDT) to include the appropriate level of district, MSC, DSMMCX, Risk Management Center, and HQUSACE members.

9.6.2.1 The DSM lead engineer is responsible for leading and directing development of a comprehensive technical scope and DSM work plan that is incorporated into the Project Management Plan by the Project Manager and PDT.

9.6.3 Vertical team meetings.

9.6.3.1 Kickoff Meeting. The district and DSPC will hold a kickoff meeting with HQUSACE, Risk Management Center, MSC, DSMMCX, and all others involved to review and obtain concurrence of the PMP prior to approval by the District Dam Safety Officer and the start of the DSMS study (See Table 9.1). Any review comments are to be provided the district within 30 days of submission of the PMP for review or the district will proceed with the submitted plan. An electronic copy of the DSMS study PMP (review copy) must be uploaded to the Risk Management Center's centralized data repository at the time of review copy submittal.

9.6.3.2 Risk Management Measures Identification Meeting. After step 2 (Estimate Existing and Future without Federal Action Condition Risks) and initial risk management measures identification, a vertical team meeting must be held to identify and confirm risk management measures to be used in the development of the risk management alternatives and to confirm the identified applicable essential USACE guidelines.

9.6.3.3 Risk Management Plan Meeting. After step 3 (Formulate Alternative Risk Management Plans) there must be a vertical team meeting where the district will present various alternatives and the initial screening of alternatives will be presented and discussed. The outcome of this meeting will be agreement on whether authorized project purposes warrant continued Federal investment and how to proceed. The meeting notes will document these findings as required in paragraph 9.3.1.2. If authorized purposes warrant continued Federal investment then, there will be agreement on those alternatives that will be carried forward to steps 4 (Evaluate Alternative Risk Management Plans), 5 (Compare Alternative Risk Management Plans), and 6 (Selecting a Risk Management Plan), and the level of design, cost estimate, economic, and environmental evaluation that will be required for each alternative.

9.6.3.4 In-Progress Reviews. Additional in-progress review meetings are to be scheduled with the vertical team on a regular basis not to exceed six month time intervals. Vertical team coordination and agreement on each step in the progress and continued advancement is intended to make better use of appropriate USACE personnel and resources throughout the study. In an attempt to avoid or minimize the time and expense of these reviews, this process requires active communication and integration of key vertical team members prior to key study decisions, focusing on the decisions made to move the study ahead. Documentation of key decisions is to be the product of the IPR with the vertical team.

9.6.3.5 Tentatively Selected Plan (TSP) Meeting. After step 5, there will be a vertical team meeting to confirm the plan formulation and selection process, the tentatively selected plan, and the definition of Federal and non-Federal responsibilities are consistent with applicable laws, statutes, Executive Orders, regulations and currently policy guidance. The vertical team meeting should identify any legal or policy concerns that would otherwise delay approval of the release of the draft DSM Report and the NEPA document for public review. The TSP meeting ensures vertical team concurrence on the TSP that will be released as part of the draft DSMR for public, technical, policy, and legal review and concurrence on the analysis and risk assessment the PDT used to inform the TSP decision. This is an in-progress review to align the vertical team in advance of the DSOG meeting (see 9.6.3.6 below).

9.6.3.6 DSOG Meeting. The purpose of this meeting is to obtain DSOG endorsement and confirmation of the tentatively selected plan and draft DSM Report prior to release for concurrent policy, public, IEPR, and legal review. This is further described in 9.6.8.2.4 DSOG Review. If policy review, legal certification or any other review results in comments that impact the tentatively recommended plan, the district will return to the DSOG to present the review findings, including any changes made, prior to recommending the report for approval. If policy review, legal certification or any other review does not result in significant comments and does not impact the tentatively recommended plan, the District DSO, MSC DSO and DSOG Chair recommend the report for approval and sign the approval memorandum.

9.6.4 External Consultants. In consultation with the vertical team, determine if an expert advisory panel to support the DSM study effort is recommended and outline the scope of services to be provided by the board of consultants. The use of these external consultants is separate from the IEPR.

9.6.5 Project Study Work Plan. Based on the study scope, a study schedule and cost estimate must be developed for inclusion into the Project Study Work Plan. The work plan is developed by the lead engineer, and becomes the technical basis for the overall Project PMP. The work plan must contain an activity based, cost loaded project study schedule, that reflects the required and anticipated phases and steps of the study formulation, risk assessment, decision making process, reviews, PED, and Construction. The PMP should ultimately include a comprehensive breakdown of these activities and budget requirements presented by fiscal year and total project costs. PED and Construction activities should be projected for budget planning purposes and reflect funding requirements by fiscal year. The PED and Construction budgets should be updated at each project milestone that more clearly defines the proposed risk reduction plan. The overall activity based, cost loaded project schedule should be updated semi-annually to reflect changes in the progress of the work, with monthly status reports submitted to the RMC for program level budgeting and performance metric reporting to the USACE DSO. Copies of the Project Study Work Plan must be included in the PMP and provided to the MSC and USACE DSO.

9.6.6 Investigations and Studies. The DSM Study must include sufficient field investigations, model studies, and other studies to ensure that all dam safety issues have been adequately defined and the data will support the identified and recommended permanent risk management alternatives and that a supportable cost estimate can be prepared for inclusion in the DSM Report.

9.6.7 Risk Assessment. One of the first major tasks of a DSM Study is to perform risk assessments for the existing condition (or update a previous risk assessment) and future without Federal action condition as stated in “9.5.3 Estimate Existing and Future without Federal Action Condition Risks (Step 2).” This is to ensure that all credible potential failure modes that contribute significantly to the incremental risk of the dam are evaluated and the risk associated with those potential failure mode is estimated. All risk assessments done up to this point are to be reviewed and considered as input for use in this full risk assessment of the dam. The scope of this risk assessment is to be established by the district, the DSPC, the PDT, the risk cadre, the MMC, and the RMC. See paragraph 9.5.3 for more detail. In support of this risk assessment the documentation of applicable essential USACE guidelines, dam performance report, and a site characterization report is to be completed prior to the start of the risk assessment. If these reports where done in support of the IES then they are to be updated as needed.

9.6.8 Product Review.

9.6.8.1 Review Plan (RP). The District, in coordination with the Dam Safety Production Center (DSPC) will prepare a review plan in accordance with the current Civil Works Review Policy (reference A.96). The Risk Management Center is the RMO. This plan includes all levels of review: District Quality Control (DQC), Agency Technical Review (ATR), quality assurance and policy compliance review, DSOG review, and Independent External Peer Review (IEPR). DQC and ATR will occur during key stages in the development of the particular work product as outlined in the review plan. Figure 9.1 shows the sequence for the various levels of review. (A chart with more detail concerning the Dam Safety Modification study process is contained in Appendix W.) If a particular level of review is not anticipated, the RP will document the risk-informed decision not to perform that level of review. The review plan will include a plan to capture and document comments and responses throughout the study process. DSM Reports that recommend the ‘no Federal action’ alternative are to be reviewed in the same manner as DSM Reports that recommend a Federal action alternative.

9.6.8.2 Agency Reviews.

9.6.8.2.1 In accordance with ER 10-1-51 (reference A.30), the DSMMCX must establish ATR team membership in coordination with the RMO and appropriate Planning Centers of Expertise (PCXs). Regional DSPCs must coordinate with the DSMMCX for establishment of the ATR teams. ATR will be conducted including the district, MSC, DSPC, DSMMCX, and RMC. The district, DSPC, and the risk cadre will present the existing and future without Federal action condition risk assessment at the end of Step 2 – Estimate Existing and Future Without Federal Action Condition Risks for ATR. The next phase of the ATR will be the presentation of the risk management alternatives considered by the PDT to the ATR team. Key risk information (performance, consequences, and construction) that will be important to choosing the recommended plan will be presented for discussion and concurrence. The ATR team will include the expertise necessary to evaluate the planning, engineering, real estate, economic and environmental analysis, cost estimating, and scheduling of the products/projects being reviewed. ATR certifications must also include determinations that the DQC efforts, to include district construction personnel involvement and review, have been performed adequately.

9.6.8.2.2 A constructability evaluation (CE) will also be required at least two times during the review process, 1) near the end or at the completion of Step 3 – Formulate Alternative Risk Management Plans to evaluate the constructability and construction risks of the various Risk Management Plan alternatives, and 2) during PED (as discussed in Chapter 22 – Dam Safety and Construction) at the 65% level of plans and specifications. CE may be required at other times during the life of a project. Requirements for a CE team are described in paragraph 22.2.6 of Chapter 22. A Constructability Evaluation Report will be prepared by the CE team, reviewed and approved by the DSPC and briefed to the PDT.

9.6.8.2.3 The Risk Management Center will review the risk assessment and verify that risk assessment is in compliance with the current policy for dam safety risk assessments. The Risk Management Center will review the risk management recommendations and verify the estimated risk reductions.

9.6.8.2.4 DSOG Meeting and Review. The district and DSPC presents the existing and future without Federal action condition risk assessments, risk management alternatives considered, alternative screening criteria and screening methodology, the TSP, and the draft DSMR to the Dam Senior Oversight Group prior to the release for concurrent policy, public, IEPR, and legal review. The review managers will present the major review comments to date, resolution to those comments, and any unresolved comments to the DSOG at this time.

9.6.8.2.5 Initial MSC and HQUSACE Policy Compliance Review of the Draft DSMR. The draft DSMR is sent to the MSC and HQUSACE for an initial agency policy compliance, technical assurance, and legal review of the draft DSMR after the Tentative Selected Plan is identified and agreed to by the vertical team and reviewed by the DSOG. The HQ DSPM will provide the RIT with copies of the DSMR and will log the report into the Office of Water Project Review, indicating the appropriate recommended reviewers. The Office of Water Project Review will approve release of the draft DSMR and NEPA documentation for concurrent public and policy review, and, if required, IEPR.

9.6.8.2.6 Independent External Peer Review (IEPR). Section 2034 of WRDA 2007 (P.L. 110-114) requires an IEPR for all new projects and for all project modifications that meet the criteria listed in the current Civil Works Review Policy (reference A.96). This review must be completed before the DSM report is approved. Reference A.96 contains the current guidance for the review for all civil works products. If a Type I IEPR is not required the Type II IEPR scope will contain a comprehensive review of the DSM report in addition to the Safety Assurance Review (Section 2035 of WRDA 2007, P.L. 110-114.) The intent is not to have two separate review panels for the same dam safety project. This review will be completed within a designated time frame for all DSAC 1 and 2 dams or the project will go forward without the review being completed due to life safety concerns.

9.6.8.2.7 Final MSC and HQUSACE Policy Compliance Review of the DSMR. The district submits a revised draft DSMR to HQUSACE for final policy compliance review and legal certification after the district and the DSPC resolves any IEPR comments and any outstanding ATR or DSOG comments.

9.6.9 IRRM Plan. After completion of the DSMS existing condition risk estimate in Step 2, the district must review and update the IRRM plan as appropriate.

9.6.10 Post-Implementation Evaluation (PIE). The PMP must include the task of updating the DSMS risk assessment after implementation of the risk management plan. The dam must be evaluated to determine if the DSMS objectives were achieved to include evaluation of compliance with applicable essential USACE guidelines. See Appendix X for further guidance on this post-implementation risk assessment. The DSAC will not be changed until the PIE is reviewed and approved.

9.7 Dam Safety Modification Decision Document.

9.7.1 Name of Decision Document. The decision document for this phase of the dam safety portfolio risk management process is called a Dam Safety Modification Report (DSMR) and must be approved in accordance with paragraph 9.8, before initiation of detailed design leading to the preparation of the plans and specifications.

9.7.1.1 The DSMR report will include a Dam Safety Action Decision Summary (DSADS) which is intended to be an extractable, stand alone component of the DSMR that meets the information needs of senior USACE officials in making dam safety decisions. The DSADS should be developed as a public document with unrestricted distribution, but it is not designed to be a public communications tool. Detailed guidance for preparation of the DSADS is in Appendix Y.

9.7.1.2 The DSM report format, detailed description of the report requirements, and additional technical guidance is contained in Appendix W. All technical sections must be appended to the report. The reporting requirements are the same for all projects, regardless of the type of deficiency or mode of failure.

9.7.1.3 USACE Dam Safety Fact Sheet. The USACE Dam Safety Fact Sheet will be prepared at the completion of the DSM study to facilitate risk communication to internal and external interests. This fact sheet is releasable to the general public. See Appendix E for the format for this fact sheet.

9.7.2 Reports for DSAC 1 and 2 Dams. When a project is placed in DSAC 1 and 2, an expedited process must be followed in the preparation of the DSM Report. This expedited process is accomplished by the maximum use of vertical teams, concurrent ATR, and early initiation of design documentation report and plans and specifications for the first contracts. This expedited process must not short cut any necessary investigations and analysis. Field investigations should be started early and include concurrent analysis for findings as the investigations continue. The NEPA (reference A.6) and other environmental compliance process (reference A.34) and real estate processes (reference A.35) must start as early as possible. While the report must be expedited, it should still follow the format outlined in Appendix Y. During preparation of the report, extensive and more frequent communication with approving authorities is required to assure a smooth and successful expedited approval process.

9.7.3 Cost Estimate, Economic Analysis, and Total Project Cost.

9.7.3.1 Recommended Risk Management Plan Cost Estimate. A Micro Computer Aided Cost Engineering System (M-CACES) cost estimate is required for the recommended risk management plan. Cost estimates must include a cost risk analysis showing the uncertainty per ER 1110-2-1302, Civil Works Cost Engineering (reference A.50). The level of detail in the cost estimate is to be that of a feasibility report in order to more accurately identify the baseline cost estimate.

9.7.3.2 Economic and Total Project Costs. The DSMR will present the results of the economic cost analysis, including the net benefits, and the total project cost for the recommended risk management plan.

9.8 Submittal, Policy Compliance Review, and Approval Process.

9.8.1 Submittal. For the initial and final submission for MSC and HQUSACE review the district DSO must submit the DSM report package including a cover letter requesting policy compliance review in preparation for approval to the MSC DSO, RMC, DSMMCX, and HQUSACE in the number listed in Table 9.2. Two complete copies and 6 copies of the main report without appendices must be transmitted directly by the district to the USACE DSO at HQUSACE, ATTN: CECW-CE for concurrent review. The transmittals must include the completed review checklists as given in Appendix Z - Dam Safety Modification Report Issue Checklist and Appendix AA - Post-Authorization Decision Document Checklist. Once the report is transmitted, further work on the project is accomplished only after consultation with the MSC and the USACE DSO's and their concurrence is obtained. An electronic copy of the DSMR (review copy) and a USACE Dam Safety Fact Sheet must be uploaded to the Risk Management Center's centralized data repository (RADS II) at the time of hard copy submittal. A copy of the final DSMR reflecting all updates and revisions required from the review process must be uploaded after report approval.

Table 9.2 - DSM Report Submission

Office	Number of Complete Reports (Includes Appendices) Paper Copies	Number of Main Report (No appendices) Paper Copies	Number of CD-R Copies of Full Report
MSC DSO	6	-	10
USACE DSO, RIT, and DSPM*	2	8	8
RMC	2	-	8
DSMMCX	2	-	8

* The USACE DSO will send two copies with CDs to the MSC RIT

9.8.1.1 Modification to the Water Control Plan. If one of the alternatives recommended is a change to the water control plan, the district is to follow the normal process of submitting a formal request to the USACE chain-of-command for approval of the changes in the official water control plan after the DSMR is approved. Guidance is provided in ER 1110-2-240, Water Control Management (reference A.45).

9.8.1.2 An appropriate level of communication is recommended for all projects. For DSAC 1 and 2 dams, during preparation of the report, extensive and higher frequency of communication with approving authorities is required to assure a smooth and successful approval process.

9.8.2 Policy Compliance Review. HQUSACE will conduct agency policy compliance review on the draft DSMR once the Tentatively Selected Plan is identified and concurrence by the vertical team and the DSOG is obtained. HQUSACE will conduct a second review for policy compliance and legal certification when the final DSMR is submitted for approval. The USACE DSPM will provide the RIT with copies of the DSMR and will log the report into the Office of Water Project (OWP) Review, indicating the appropriate recommended reviewers.

9.8.3 Approval of Dam Safety Modification Reports (Table 9.3).

9.8.3.1 If the DSMS and the NEPA documents are processed as separate documents:

9.8.3.1.1 If the NEPA process ends with a Finding of No Significant Impact (FONSI) the District will submit the DSMR, and the Environmental Assessment (EA) with a draft unsigned copy of the FONSI to HQUSACE. After the report, the EA, and draft FONSI are reviewed at all three levels, and all the HQ comments are resolved the documents are ready for signature. The District will be notified and the District Engineer should then sign the FONSI and transmit the signed FONSI to HQUSACE. Upon receipt of the signed FONSI the USACE DSO may sign the DSMR.

9.8.3.1.2 If the NEPA process requires a Record of Decision (ROD) the District will submit the DSMR with the Environmental Impact Statement including comments from the public and from agencies, responses to the comments received, and a draft unsigned ROD. After the report, EIS and draft ROD are reviewed at all three levels, and all the HQ comments are resolved the documents will be approved for signature by the USACE DSO. The USACE DSO is the signatory for both the DSMR and the ROD.

Table 9.3 - Dam Safety Modification Report – Review & Approval Requirements

<table>
<tr><th rowspan="2">DSAC
1, 2, 3, & 4</th><th rowspan="2">District</th><th rowspan="2">MSC</th><th colspan="2">HQ</th></tr>
<tr><th>RMC</th><th>DSO</th></tr>
<tr><td rowspan="2">DSMR Includes:

Appendices & Risk Estimate.</td><td>ATR w/Risk Cadre Certification*

IEPR

Joint recommend-ation for approval by District DSO</td><td>Quality Assurance and Policy Compliance Review

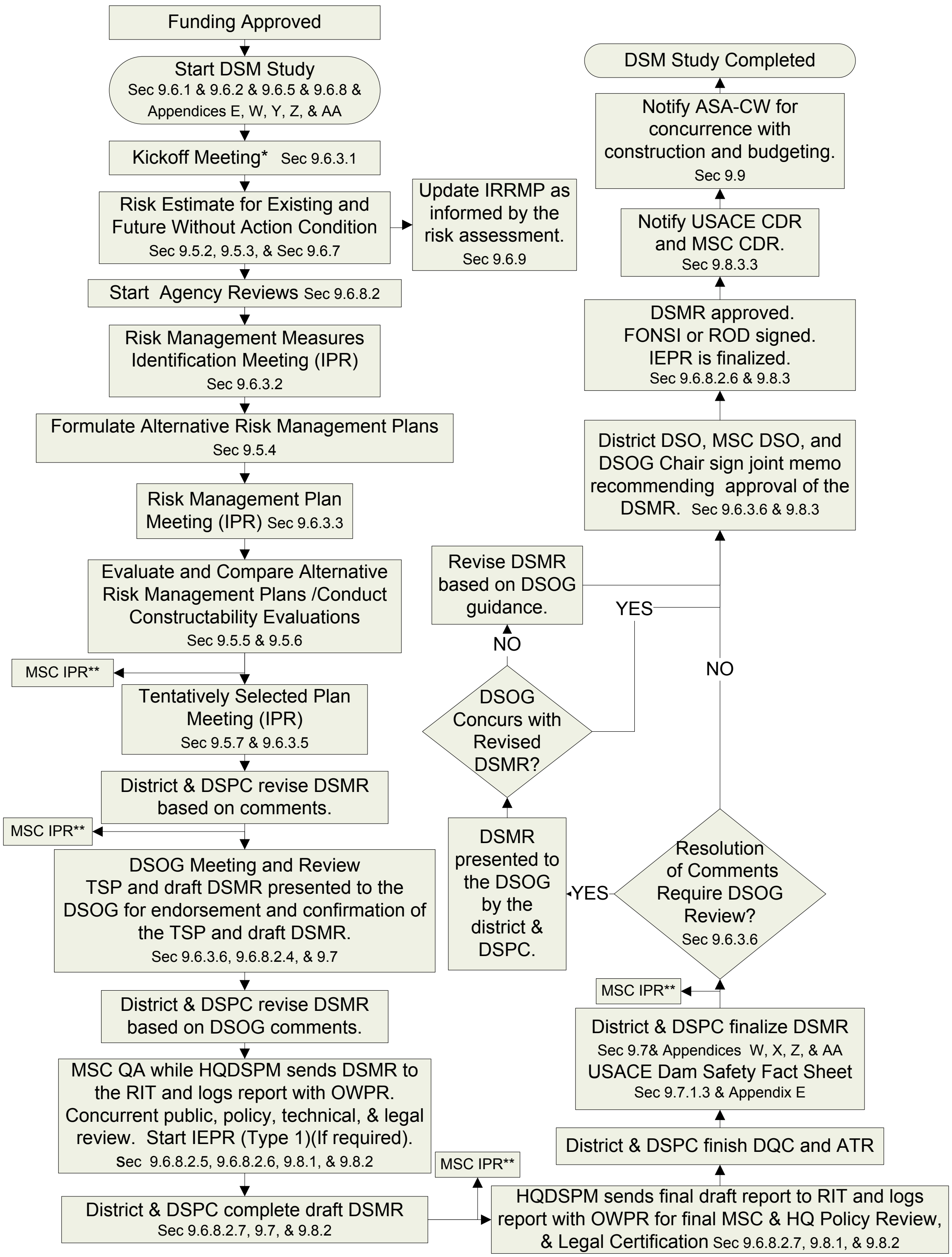
Joint recommend-ation for approval by MSC DSO</td><td>Concurrence with Report Recommend-ations</td><td>Policy Compliance Review (OWPR)

Joint recommendation for approval by DSOG Chairman**

Approval by USACE DSO</td></tr>
<tr><td colspan="4">Coordination and collaboration of report findings, conclusions, and recommendations, and joint approval of the DSMR, are required for the development of a unified path forward.</td></tr>
<tr><td colspan="5">* Risk Cadre certification that the risk assessment was properly utilized in the DSMR.
** DSOG Chairman is the USACE, Special Assistant for Dam and Levee Safety</td></tr>
</table>

9.8.3.2 When the DSMR and the NEPA documents are processed as a single integrated document the FONSI or the ROD, per se, (whichever is appropriate) will be a separate document from the integrated report.

9.8.3.2.1 If the NEPA process ends with a FONSI the integrated DSMR-EA will be transmitted to HQUSACE with a draft unsigned FONSI. After the integrated report and draft FONSI are reviewed at all three levels, all the HQ comments are resolved and the documents are ready for approval. The District will be notified and the District Engineer should then sign the FONSI and transmit the signed FONSI to HQUSACE. Upon receipt of the signed FONSI the USACE DSO may sign the DSMR.



*The Kickoff meeting starts the ongoing process of the vertical team QA and policy compliance review which will be completed at the time the District DSO, MSC DSO, and DSOG Chair sign the joint memo to the USACE DSO recommending approval of the DSM report.
** MSC IPR as required.

Figure 9.1 - Dam Safety Modification Study, Review, Decision, and Approval Process.

9.8.3.2.2 If the NEPA process ends with a ROD the integrated DSMS-EIS will be transmitted to HQUSACE with a draft unsigned ROD. The integrated document will include comments from the public and agencies, responses to the comments received, and a draft unsigned ROD. After the DSMS-EIS and draft ROD are reviewed at all three levels, and all the HQ comments are resolved the documents will be approved for signature by the USACE DSO. The USACE DSO is the signatory for both the DSMR and the ROD.

9.8.3.3 The USACE DSO will notify the Chief of Engineers, the MSC commander, and the District commander after the DSMR and ROD, if applicable, are signed.

9.8.3.4 Approval-Subject-To-Comments. If the report is approved subject to resolution of specific comments, the district must provide the MSC and HQUSACE acceptable documentation during the design phase of the project to show compliance with the comments.

9.9 Assistant Secretary of the Army for Civil Works (ASA(CW)) Notification and Concurrence with Construction. The USACE DSO must notify ASA(CW) of report approvals and the start of the design phase of the project. Two copies of the approved and final reports must be provided to ASA(CW) for concurrence with construction and consideration of budgeting as a continuing line item under the project name in the Construction program.

9.10 Supplemental DSM Decision Documents.

9.10.1 When the original cost of the selected plan in the approved DSMR is exceeded by 20 per cent, for whatever reason, a supplement to the DSMR will be prepared and processed for approval in accordance with the guidance for the decision document.

9.10.2 A supplement to the DSMR will be submitted for approval if additional significant failure modes are identified after the DSMR is approved.

9.10.3 The supplement to the DSM Report will be prepared and processed for approval in accordance with the guidance for the decision document. See paragraph 9.10.4 for changes resulting in the need for additional environmental compliance.

9.10.4 If substantial changes are made to the proposed action that are relevant to environmental concerns; or there are significant new circumstances or information relevant to environmental concerns and bearing on the proposed action or its impacts after the DSMR and FONSI or DSMR and ROD are signed, the District will prepare supplements to the NEPA documents and other environmental compliances in accordance with applicable regulations.

9.11 Funding of Dam Safety Modification Studies, Reports, and Construction Projects.

9.11.1 Initial Funding for the Study and Report Preparation. For dams operated and maintained by USACE, funds for preparation of DSM Reports will be made available from Dam Safety and Seepage/Stability Correction Program (WEDGE) line item in the Construction Account, except for projects on the Mississippi River and its tributaries funded by the Flood Control, Mississippi River and Tributaries (FC, MR&T) Account. Those projects will be funded from the Construction portion of the FC, MR&T Account. Districts and the RMC should coordinate plans for studies and should submit a joint request for Dam Safety WEDGE study funds in accordance with guidance from HQUSACE. Subject to overall budget constraints, funds should be sufficient in any one year for the study effort required for a newly identified problem, especially for expediting risk reduction to DSAC 1 dams. Additional Dam Safety WEDGE funds will be made available in future years until the report is completed or a no action required determination is made. For the definition of the Dam Safety WEDGE line item, refer to the current budget EC.

9.11.2 Funding for Engineering and Design Documents: Following DSM Report approval, the district must request and use Dam Safety WEDGE funds to proceed with preconstruction engineering and design activities, and in some cases completion of plans and specifications and initiation of construction. The USACE DSO will consider the project's DSAC status, national priorities, and overall funding limitations when approving or disapproving the release of funds. Priority will be risk informed, based on the magnitude and relative importance of the life, economic and environmental consequences and the effectiveness of the proposed risk reduction measures for each dam in relationship to other dams of the same DSAC rating in the USACE portfolio of dams. The district submits a budget for preconstruction engineering and design activities during the next budget cycle in accordance with guidance from HQUSACE. See chapter 6, Dam Safety Risk Management Prioritization, for further details on the prioritization guidance.

9.11.3 Funding Construction Activities: The decision to fund construction is based on the results of the DSM studies, the priorities of the USACE DSO considering all approved DSM reports, and overall budget priorities. The decision on construction priority is risk informed based on the magnitude and relative importance of the life, economic and environmental consequences and the effectiveness of the proposed risk management measures. See Chapter 6, Dam Safety Risk Management Prioritization, for further details on the prioritization guidance.

9.11.3.1 Districts request funding for the construction of approved dam safety projects in accordance with current budget guidance from HQUSACE as a line item project. See annual budget EC, Appendix III – Flood Risk Management for the budget submission requirements and timeline. Typically the DSMR has to be approved by 1 June PY-2 to be funded in the PY, where PY stands for the program year.

9.11.3.2 When a project is ready for construction or land acquisition prior to receiving appropriations under the project name, the district DSO may request funds from the Dam Safety and Seepage/Stability Correction Program (WEDGE) line item to initiate construction; except for projects on the Mississippi River and its tributaries funded by the Mississippi River and Tributaries (MR&T) Account, in which case construction funds should be requested in the Construction portion of the MR&T

Account. Allocation of WEDGE funds for physical Construction or land acquisition requires approval of both the USACE DSO and the ASA(CW).

9.11.3.3 Construction or land acquisition may not commence until construction funds have been specifically allocated for the required work, and a project partnership agreement (PPA) or amendment has been executed, if required. For DSAC 1 and some DSAC 2 projects, the USACE DSO may recommend to the ASA(CW) that construction commence without an approved PPA due to the risk to the public. Even if a PPA is not required, consideration should be given to developing one, especially for older projects, to make sure that they meet the provisions of modern day agreements.

9.11.4 Funding Minor Modifications: When the initial analysis of a dam safety deficiency indicates that the work will cost less than Major Rehabilitation funding cap (see guidance in the annual budget EC) or the work can be accomplished in one construction season, the district DSO should consider going directly to a major maintenance action. Such minor modifications for dam safety would be funded as major maintenance with Operation and Maintenance funds. If significant risk reduction can be made at high risk dams for amounts costing less than the Major Rehabilitation funding cap, districts should coordinate with the MSC and HQ DSPM's and the Operation and Maintenance Account Manager to determine if Operation and Maintenance funds are available.

9.12 Cost Sharing Requirements. Dam Safety modifications are cost shared in accordance with the following policies.

9.12.1 All construction funded work beyond the DSMR requires cost sharing based on the original cost sharing for the project. The PED and Construction phases of a modification are cost shared. The study phase (IES and DSMS) is not cost shared and is 100% federally funded.

9.12.2 Section 1203 of WRDA 1986: Section 1203, WRDA, 1986 (reference A.12) provides for special cost-sharing for modification of dams and related facilities constructed or operated by USACE. In accordance with long standing Army policy, Section 1203 cost sharing must only apply to modifications needed to address new hydrologic or seismic data. While Section 1203 also addresses modifications related to changes in the state of the art design or construction criteria, this terminology makes it difficult to define the kinds of repairs that would be applicable, and so it is not used. Instead, any modifications that are required for safety that are not related to new hydrologic or seismic data (such as seepage and stability corrections) must be addressed through the Seepage/Stability Correction Program and cost shared in accordance with the provisions in effect at the time of initial project construction. The cost of dam safety modifications needed to address new hydrologic or seismic data must be cost shared as described below. Section 1203 also may be used to modify dams built by the USACE where local interests are responsible for operation, maintenance, repair, rehabilitation, and replacement, but only if Congress directs the Secretary of the Army to do so, in law, for a specifically named project. Without specific congressional direction, in law, non-Federal sponsors remain responsible for operation, maintenance, repair, rehabilitation and replacement of these projects, as required by their authorizations and the terms of the agreements under which they were constructed by the Federal government.

9.12.2.1 In accordance with Section 1203 of WRDA 1986 (reference A.12) and the Army policy specified above, costs incurred for modifications for dam safety assurance (i.e., strictly limited to new hydrologic or seismic data) must be recovered in accordance with provisions of the statute. The local share of costs must be provided in accordance with the provisions of the water supply agreement or PPA, generally during construction . Costs assigned to irrigation must be recovered by the Secretary of Interior in accordance with Public Law 98-404 (reference A-6).

9.12.2.2 Under Section 1203 and Army policy, for project modifications due to changes in hydrologic or seismic data, 15% of the cost of the modification is allocated to the project purposes in the same percentages as the original project costs. General procedures for determining the amount of sponsor cost are outlined in the following subparagraphs. These are general procedures that will need to be tailored to fit the specifics of each individual project.

9.12.2.2.1 Projects with a Formal Cost Allocation. In this case, 15% of the cost of the modification for dam safety assurance must be allocated among project purposes in the same percentage as the construction expenditures in joint-use facilities are allocated in the cost allocation currently in effect.

9.12.2.2.1.1 The cost allocated to each project purpose will then be shared in the same percentage as when the project was constructed, or when the purpose was added, whichever is appropriate.

9.12.2.2.1.1.1 For large reservoir projects, it is likely that the cost assigned to flood control is 100% Federal. The cost assigned to power generation is most likely 100% non-Federal (to be reimbursed by the sale of the power). Costs may have been allocated to water supply or to conservation. Costs allocated directly to water supply are 100% non-Federal costs. Where costs have been allocated to conservation, water supply users may have contracted for a portion or all of the conservation storage. In such cases, the contract will need to be modified if it does not include provisions of payment for the proposed work.

9.12.2.2.1.1.2 For illustrative purposes, assume a dam safety modification cost of $15 million, and a formal cost allocation that assigns 60% of the construction costs to hydropower, (with 45% as the hydropower joint-use construction costs); and 40% of the construction costs to flood control. Under this example, hydropower interests would have to repay $1,012,500 [($15,000,000 x 0.15) x 0.45].

9.12.2.2.1.1.3 If there was no sharing of the initial construction costs (either cash or the value of real estate) allocated to flood risk management, all of the modification costs assigned to flood risk management would be Federal.

9.12.2.2.1.1.4 If a sponsor shared in the initial construction costs allocated to flood risk management (either cash or the value of real estate), the dam safety costs assigned to flood risk management would be shared on the same percentage basis.

9.12.2.2.1.2 In cases where storage is reallocated from flood risk management to another purpose, the sponsor for the added purpose is responsible for repaying a share of the dam safety modification costs. For example, if a contract is executed for water supply that assigned 1.5% of the joint-use cost of major replacements to a water supply sponsor, this sponsor would be required to repay $33,750 of the dam safety costs [($15,000,000 x 0.15) x 0.015].

9.12.2.2.2 Projects without a Formal Cost Allocation, but with a signed Project Partnership Agreement or Project Cooperation Agreement or Local Cooperation Agreement: An agreement for the initial project construction may contain an allocation or assignment of costs among project purposes.

9.12.2.2.2.1 For projects with this type of agreement, 15% of the cost of the dam safety modification must be assigned to project purposes in the same manner as costs were allocated for the agreement, and shared in the same percentage according to the terms of the agreement. The percent joint-use facilities cost should be used if available; otherwise, the assignment is based on the percent of total cost.

9.12.2.2.2.2 As before, assume a dam safety modification of $15,000,000; project agreement requiring a sponsor to provide a one-time payment of $3,000,000 (5%) toward the construction of a project with an actual initial construction cost of $60,000,000. The sponsor in this example would be required to repay $112,500 [($15,000,000 x 0.15) x 0.05].

9.12.2.2.3 Projects without a Formal Cost Allocation or a signed agreement: In most cases where there is no signed agreement, there was some sort of a letter of intent at the time of construction that indicated what items of local cooperation that non-Federal interests would provide, such as lands, easements, rights-of-way, relocations, or disposal areas (LRRED).

9.12.2.2.3.1 These projects will require a review of letters of intent or other documentation of arrangements for provision of LERRD, or of cash contributions by a sponsor at the time of project construction. If a sponsor accomplished some portion of the required work, such as relocations, or made cash contribution, the value of the work or the contribution should be converted to a percent of total initial project cost. Fifteen percent of the cost of the dam safety modification will be shared in the same percentage as the percentage of total initial project cost, computing the non-Federal share as the percent of contribution to total cost. The percentage should be computed based on actual rather than estimated cost of construction, if available.

9.12.2.2.3.2 For example, if the actual construction cost was $50,000,000, and non-Federal interests contributed LERRD's valued at $500,000, the non-Federal share of initial construction was 1%. In this case the non-Federal share of a $15 million dam safety assurance modification would be $22,500 [($15,000,000 x 0.15) x 0.01].

9.12.2.2.4 Contract for Storage. In some cases water supply storage may have been reallocated from conservation or from flood control storage. The agreement for the reallocation of storage is a contract. The terms of the contract will specify what storage capacity is provided in return for the payment amount. The contract usually defines how the amount paid by the contract holder was computed and shows the basis for the assignment of costs. The share of cost to be paid for the dam safety modification should be allocated in the same percent as the cost of joint use facilities was allocated. In such a case, the contract will need to be modified if it does not include a provision for payment of the proposed work.

9.12.3 Seepage/Stability Corrections do not qualify under Section 1203, WRDA 1986 (reference A.12). Therefore, 100% of the modifications must be cost shared in accordance with current cost sharing policy as defined below.

9.12.3.1 Projects with a formal agreement with a non-Federal sponsor that identifies the cost sharing percentages for major rehabilitation or dam safety modifications must be cost shared in accordance with the current agreement (contract).

9.12.3.2 Projects without a formal agreement will be cost shared at the same ratio as the original cost sharing for the project.

9.12.4 Special Cost Sharing for Navigation and Hydropower.

9.12.4.1 For navigation projects, dam safety modifications must be cost shared by the Inland Waterways Trust fund or the Harbor Maintenance Trust Fund in accordance with WRDA 1986 as amended (reference A.12).

9.12.4.2 For hydropower dam safety modifications, costs are reimbursed, over time, by the affected Power Marketing Administration (PMA) in accordance with the joint use percentage for that particular dam.

9.12.4.3 Cost sharing for major maintenance work under the Operation and Maintenance account will be the same as cost sharing for ordinary annual operations and maintenance.

9.13 Sponsor Identification. Requirements for cost sharing, and the identification of non-Federal sponsors (or partners) must occur very early in the study process to ensure that the non-Federal interests are willing cost share partners. Uncertainty about sponsorship and the lack of meaningful sponsor involvement in the scope and extent of dam safety repairs can cause delays to the dam safety modification work. Before initiating discussions with project sponsors (or potential sponsors) on cost sharing, an interpretation on the need for sponsorship and the application of the generic guidance contained in this regulation must be forwarded to HQUSACE, ATTN: Dam Safety Officer for information. This should occur within 60 days after the DSMS is started and study funding is received.

9.13.1 Reports must include documentation of substantive involvement and coordination with non-Federal sponsors (or partners), and expressions of their willingness to cost share in the dam safety assurance work when required

9.13.2 On projects classified as DSAC 1 or 2, the lack of sponsor identification must not delay completion of the report. When a sponsor cannot be identified, the district must notify HQUSACE, ATTN: Dam Safety Officer and request that project work continue without cost sharing due to the risk to public safety. Efforts must continue to find the appropriate sponsor for the modification and recoup the non-Federal share of the modification cost. Extension of Interim Risk Reduction Measures, including permanent extension, should be considered in lieu of the dam safety modification in those cases where a non-Federal sponsor is unwilling or unable to participate as the cost share partner.

9.14 Cost Recovery. Recovery of the non-Federal share of the dam safety modification cost will be determined by the current arrangement for project cost recovery.

9.14.1 For costs that are reimbursable through the sale of power, the share of dam safety cost under Section 1203 will be reported to the power marketing administration for recovery in the same manner as major rehabilitation costs.

9.14.2 For cost sharing based on a project partnership agreement that does not have a provision for dam safety cost sharing, the agreement will need to be modified to include the dam safety costs, or a new agreement will be required.

9.14.3 Where the project cost sharing was based on a letter of intent, an agreement will be negotiated with the sponsor.

9.14.4 In the case of water supply, the existing contract may need to be modified, or a new contract signed to cover the dam safety cost sharing.

9.14.5 If no current agreement addresses repayment of this cost, the sponsor may elect to repay the cost, with interest, over a period up to 30 years in accordance with the provisions of Section 1203 (a) (2) of the Water Resources Development Act of 1986 (reference A.12). If a sponsor is unwilling or unable to cost share the modification, the district/division will either seek authorization to terminate the project or perform the dam safety modification at 100% Federal cost and seek reimbursement from the sponsor through litigation, or extend the Interim Risk Reduction Measures until a non-Federal sponsor can be identified.

CHAPTER 10

Dam Safety Risk Communication

10.1 Purpose/Objective. This chapter provides guidance for USACE to integrate risk communication throughout USACE Dam Safety Program activities including dam safety inspections, risk assessments, Dam Safety Action Classification (DSAC), risk reduction measures and other key actions. The goal is to include the elements of communication throughout the Safety of Dams regulation. This chapter provides background on the philosophy and information on strategies and methods. Key elements of this chapter include:

10.1.1 The importance of communicating project benefits and flood risk during each step of the Dam Safety Portfolio Risk Management process to include the Dam Safety Action Classification,

10.1.2 The more consistent inclusion of recommended actions for the public and others in information releases

10.1.3 The procedures for release of information, and

10.1.4 The coordination and the identification of the shared responsibilities among the Dam Safety Program, the USACE Flood Risk Management Program and other entities with responsibilities for communication of flood risk and dam safety.

10.2 USACE Dam Safety Risk Communication Philosophy.

10.2.1 Risk communication is important throughout a successful dam safety program, and is reflected in the guiding principles for the program.

10.2.2 Risk Communication: USACE will ensure communication regarding potential inundation hazard, consequences, and solutions are open, transparent and understandable to the public. USACE will document and routinely report the risk communications and management decisions.

10.2.3 Communicating risk to the public is a shared responsibility among USACE and its various stakeholders. An open, interactive and ongoing dialogue is critical. Communicating risk is as important as assessing and managing risk. Today's risk communication goes beyond just communicating technical information — it includes recognition of important cultural values and ideas that affect decisions. Social context and culture can influence the beliefs and action for all parties — technical and non-technical. Communicating the ongoing residual risks associated with the most robust dam is as important an activity as is communicating any change to risk because of a change in the dam's status. Research has shown that communicating recommended actions to the public is an effective way to change behavior. In emergency situations communicating the immediate hazard is important and, in most cases, local authorities will be communicating about the imminent danger.

10.3 Definition of Communications Terms.

10.3.1 Risk Communication: Risk communication is the open, multi-dimensional exchange of information. This information includes characterization of the incremental and non-breach risk, uncertainty in the risk assessment, the life safety impacts, other benefits and costs (monetary and non-monetary) and the actions that should be taken.

10.3.1.1 Risk communication is a fundamental part of the risk framework and is integrated into the risk assessment and management steps and ensures that the decision makers, other stakeholders and affected parties understand and appreciate the process of risk assessment and in doing so can be fully engaged in and responsible for risk management. It must begin early and continues throughout the portfolio risk management process, includes the dissemination of information of any adverse impacts of the risk reduction actions and how those impacts can be mitigated, and is essential to risk-informed management. For the purposes of this Engineer Regulation and because the research strongly points to its effectiveness, public education is included under the umbrella of risk communication.

10.3.1.2 A critical component of risk communication is the non-breach risk, or the dam operating as intended, but the risk that remains from spillway flow without breach or from the dam overtopping without a breach. Districts are expected to compile a publicly releasable USACE Dam Safety Fact Sheet that provides updated information about the project at each stage within the portfolio risk management process. This fact sheet should address the incremental and non-breach risk posed by the dam, and should graphically display inundation information. Fact sheets should be revised and redistributed as risk evaluations advance through Periodic Assessment, Issue Evaluation, and Dam Safety Modification phases. See Appendix E for the fact sheet format.

10.3.1.3 It is very important for stakeholders to understand and consider the "non-breach" risk as it applies to normal operations. In most cases, normal operation during high-runoff periods causes the most public concern. The high-runoff periods which result in high river stages downstream of projects may involve high project releases, but are still within the range of normal operations. In some cases, residents/businesses have encroached on the floodway downstream of the project over the years and are under the misperception that downstream flooding would be eliminated, rather than reduced, by the operation of the dam. Incremental unregulated runoff, which is the flow entering the river downstream of the project from tributaries, can be a major contributor to the resultant flow and stages observed at locations downstream of a project. Downstream users need to gain and maintain awareness that each project has a detailed water control plan and these plans are followed closely as release decisions are made. Public involvement during the update of water control plans does give the opportunity for USACE and the public to share information and impacts as it applies to the project, its operations, and its authorized purposes. The water control plans are intended to properly balance risk in meeting all authorized purposes while assuring that the dam is safely operated. Most dams are authorized to serve multiple purposes (e.g.

flood risk management, hydropower, navigation, environmental compliance, water supply, recreation) and the plan must reflect that.

10.3.1.4 USACE Dam Safety Fact Sheet examples are located on the Dam Safety CoP intranet sites and also on the Technical Excellence Network (TEN) website, Dam Safety Sub Community at (https://ten.usace.army.mil/TechExNet.aspx?p=s&a=CoPs;7).

10.3.2 Public Affairs: Public Affairs fulfills USACE's obligation to keep the public informed and helps to establish the conditions that lead to confidence in USACE. Every member of USACE contributes to effective public affairs. USACE employees are the most credible and influential spokespersons and they should be encouraged to communicate with the public by using all communication mediums and using and adhering to the guidance in this regulation. The primary Public Affairs functional areas are internal information, public information, and community engagement.

10.4 Types of Communication. There are essentially two types of dam safety risk communication:

10.4.1 Long term communication; lending itself more to information and actions that foster involvement in decision making and to public education, and

10.4.2 Warnings or hazard communication of an immediate or imminent danger.

10.5 Communication Planning. Issuing warnings or hazard/emergency communications is performed by responsible local officials — the mayor, city council, police, fire or emergency management official, and is, therefore, under their direction. Generally, the emergency action plan for a project will identify applicable emergency response officials. Long term communication activities can support the hazard or emergency communication activities by building an awareness of the possible hazard and educating people about possible actions in the event, for instance, what to pack when evacuating, evacuation routes or where shelters are. This chapter of the regulation deals more with communication over the long term, and communication planning will include steps to foster better-informed and educated stakeholders.

10.5.1 Communication Planning Scope and Elements: For each step of the Portfolio Risk Management Process within the dam safety program, it is important that communication planning include elements related to public education, risk communication and any appropriate stakeholder involvement. Research has shown that the most effective plans have these characteristics:

10.5.1.1 They are ongoing (not a singular or set of individual acts);

10.5.1.2 They use multiple channels of communication to reach the audiences and do not employ a one-size-fits-all strategy (using experts, partnerships with other organizations, various media and events);

10.5.1.3 They make full use of a range of communication modes (written materials, television and print media, special events, social media);

10.5.1.4 They have effective messages (clear, consistent, posing the problem and solutions, explicit about the potential events, losses, and actions that should be taken, incremental and ongoing);

10.5.1.5 They use "windows of opportunity" such as a near miss in a near-by community or a gathering of experts to lead a discussion on a related issue; and

10.5.1.6 They have an evaluation component to determine whether the program is successful and where improvements can be made.

10.5.2 Communication plans should include the information shown in Table 10.1, Communication Plan Elements. Communication planning is a management function, accomplished among numerous staff elements. For detailed communication planning, the Public Affairs Officer is the appropriate point of contact.

Table 10.1 - Communication Plan Elements

Plan Elements	Element Content
Purpose	Directly related to the reasons for disseminating and gathering information
Background and Issues	Lays out the situation and the issues
Audience	Identifies the specific organizations and individuals in the responsible, affected and interested groups with regard to this project
Messages	Most important points for the audiences to know including the benefits and services provided by the project, the potential issues and recommended actions by the residents
Strategy	How will you achieve the purpose—what methods and communication channels will you use?
Activities and Tactics	What planned activities will support your strategy?
Products	What products will you develop to provide information. A minimum requirement of a fact paper, talking points and frequently asked questions will provide you with the basic documents to ensure consistent communication (Sample Frequently Asked Questions are provided in Appendix AB
Evaluation	How will you know the plan's purpose has been achieved?

10.5.3 Social Media: USACE social media sites have played an integral role in keeping communities apprised during flooding and other emergency situations as well as on current events. USACE leadership encourages the safe and responsible use of social media platforms and tools to enhance credibility and increase transparency. Under the direction on social media provided in Directive-type Memorandum 09-026, USACE officials are able to instantly communicate missions, initiatives, and major events to stakeholders. Social media provides USACE the ability to share information while allowing the public the opportunity to provide comment, ask questions and discuss USACE topics.

10.5.4 Guidelines on Release of Information: Department of Army regulations call for the release of unclassified information about the Army and its activities to the public with maximum disclosure and minimum delay. As noted in other chapters in this regulation, release of information regarding dams should be coordinated with the appropriate public officials, such as elected officials and State Dam Safety agencies, prior to the public release. Advance coordination helps assure our partners that USACE is taking appropriate actions. Operating project personnel are often the first to receive public inquires, and should assist in communication activities.

10.5.5 Public Affairs Guidance on Release of Information: In some instances Public Affairs Guidance may be issued on a particular element of the Dam Safety Program. This guidance should be used when developing the communication plan and incorporated into the strategy and activities.

10.5.6 Specific Release Guidance: For security reasons, numerical risk results, aggregate lists of dams with the assigned DSAC, detailed description of dam deficiencies, and portfolio ranking should not be released to the public. Such information may be provided on a regional and project specific basis to federal agencies, adjacent and potentially impacted dam and levee owners and sponsors, and state and local authorities who provide emergency management services. Information should only be provided on a need to know basis, when it assists those entities in protecting health, safety and welfare. Sharing in that manner while limiting the extent to which the information could be used to threaten the project's security, advances Federal Governmental interests. Sharing of inundation maps and associated data must be in accordance with current USACE policy (reference A.97).

10.5.7 Risk Communication Specifics: Research has shown that many people are not as concerned about the “perceived risk” or “event probability” – just about what they should be doing. However, in projects where the public and other stakeholders are looked to for input on the decisions, knowing and understanding specifics about the risk is important. There are basically three challenges that must be addressed.

10.5.7.1 Knowledge: The audience needs to understand the technical information surrounding the risk assessment. To meet the knowledge challenge, the technical information will have to be presented in a variety of ways.

10.5.7.1.1 Information materials (pamphlets, fact sheets, and publically releasable reports) must comply with USACE Policy on Release of Inundation Maps (reference A.97) and must coordinate potential release of sensitive information with Security Officer and Office of Counsel regarding,

10.5.7.1.2 Visual representations of risk (graphics, such as simple diagrams, pie charts and conceptual drawings),

10.5.7.1.3 Face-to-face communication (presentations with detailed graphics and handouts),

10.5.7.1.4 Stakeholder participation (small group discussions with facilitators who are knowledgeable about the risk), and

10.5.7.1.5 Technology assisted communication (websites and interactive models of risk).

10.5.7.2 Process: The audiences need to feel involved in the risk management process. To meet the process challenges, the audience will have to be included in how the risk is being managed. The audience may be involved in helping to develop the ways the decisions will be made, making the decision or even implementing.

10.5.7.3 Communication Skills: The audience and those who are communicating the risk need to be able to communicate effectively. To meet the communication skills challenge, those who are communicating must have and react to continual feedback regarding how the information is received and may need to meet with smaller groups or even more often.

10.5.8 Behavior Change: Research shows that the kinds of information many people want is related to the actions they should take. Table 10.2 provides examples of target audiences and desired behavior changes. These example types of behavior changes should be considered in communication planning, purpose, and documents.

10.6 Coordination. A critical element of risk communication is the coordination that is necessary within USACE and external to the agency. Communication is a management function among numerous staff elements. The Public Affairs Office should act as technical lead in communication plan development.

10.6.1 USACE uses a risk-informed process to manage dam safety issues on a nation-wide basis. HQUSACE manages the program from the national level, setting policies, prioritizing studies and actions, and ensuring appropriate support for the districts in execution of their assigned mission. National oversight is furnished by the DSSC and the DSOG.

Table 10.2 - Behavioral Change

Target Audience	Behavior Change Desired (Examples only)	Information & Tools (Examples only)
Homeowners	Buy flood insurance on elevate/flood proof home	National Flood Insurance Program Information; height of potential flooding; information on FEMA assistance with flood proofing; calculator of household damage at various depths of flooding
	Elevate/flood proof home	Information on FEMA assistance, technical specifications, articulation of financial benefits, calculator of damage with x feet of water
Individuals living in an inundation area	Develop emergency plan	Examples of emergency plans; height of potential flooding; evacuation routes; checklists for what to take and timeline
	Evacuate when instructed	Marked evacuation routes, e-mail alerts, checklists for what to take, articulation of consequences of staying
State and local governments	Develop and maintain robust emergency action programs	Information regarding number of people at risk, estimates of damage to critical infrastructure, economic impacts
Developers, realtors, homebuilders	Promote flood proofing in new construction and renovation	Long term benefits to clients and customers and the sustainability of the community as a whole
Media	Educate and inform public about dam safety issues	Info about compliance, educate public about potential consequences of dam failure
School Children	Increase geographical understanding of students benefitting from dams, awareness of benefits and risks, encourage parents to know how to evacuate and practice (similar to fire)	Education programs, field trips, incorporate into history and geography curriculum
Insurance	Provide financial incentives to those who take steps to mitigate damage through raising buildings, flood proofing and emergency plans	Mitigation measures that can be provided to customers.

10.6.1.1 The Dam Safety Program Manager (DSPM) coordinates the internal communication of dam safety information to the appropriate team members, to include operations, engineering, Emergency Management, project management, and public affairs.

10.6.1.2 The Dam Safety Program, with support from PAO, and other staff CoP's as appropriate, will communicate dam safety information to stakeholders, local officials and the public.

10.6.1.3 When a situation exists that requires the development of Interim Risk Reduction Measures (IRRM), it becomes even more critical for public communication.

10.6.2 Internal coordination: Within USACE, those who will be involved with the Dam Safety Program, including the communication planning and implementation, will include, but are not limited to the Dam Safety Officer, the Dam Safety Program Manager, and representatives from the Flood Risk Management Office and Silver Jackets, Engineering, Operations, Emergency Operations, Planning, Office of Counsel and Public Affairs. As the situation dictates, the Commander, the Deputy for Project Management and other senior civilians in the district and MSC may be involved.

10.6.3 Interagency coordination: Because USACE inspections and risk assessments may influence other federal agencies, it is imperative that coordination with these respective agencies be accomplished close to the time that the information is provided to the public. This may include the National Weather Service, U.S .Geological Survey, the USBR, the National Resources Conservation Service as well as other Federal, state and local agencies.

10.6.4 Tribal Coordination: If activities impact or affect tribal land, coordination with the local tribes will be accomplished by the District's Tribal Coordinator.

CHAPTER 11

Continuing Evaluation Inspections, Periodic Inspection, and Periodic Assessment

11.1 Applicability and Policy. This chapter on continuing evaluation inspections, periodic inspections (PI), and periodic assessments (PA) is applicable to Civil Works structures including dams, navigation structures, and other water control facilities.

11.1.1 Continuing evaluation inspections consist of annual, routine and intermediate site inspections having the purpose of visually observing the dam and foundation surface for evidence of unusual or unexpected behavior. The annual and routine inspections occur after specified time intervals. Intermediate inspections are unscheduled and typically occur after unusual loadings such as floods and earthquakes or as investigations of unusual behavior. Continuing Evaluations are performed for all dams.

11.1.2 Periodic inspections are recurrent engineering inspections conducted at dams and other civil works structures whose failure or partial failure could jeopardize the operational integrity of the project, endanger the lives and safety of the public or cause substantial property damage to ensure their structural stability, safety, and operational adequacy.

11.1.3 Periodic assessments consist of a site visit, typically in conjunction with a periodic inspection, a potential failure modes analysis, and a risk assessment based on existing data and estimated potential consequences. The MMC Production Center will typically produce information to assist with estimating consequences. Periodic assessments will only be done for significant and high hazard potential dams in the USACE portfolio dams.

11.1.4 The Asset Management operational condition assessment (OCA), when possible, will be conducted with the periodic and annual inspections (See Joint Memorandum, 16 October 2009, “Interim Guidance – Operational Condition Assessments for Inland Navigation” (reference A.101)).

11.1.5 Vegetation management for USACE dams is presented in Appendix AC.

11.2 Institutional Knowledge and Technical Expertise. It is essential that USACE maintain institutional knowledge and technical expertise in the disciplines related to dam design and dam safety, including risk assessment and forensic engineering. An important component of this knowledge is gained by conducting periodic inspections, periodic assessments and evaluations by district and MSC engineering, construction, and operations personnel along with RMC facilitators for periodic assessments. Lessons learned by multi-disciplinary assessment and inspection teams over a long period of observations and analyses can be applied to the design, construction, operation, and maintenance of existing and future projects.

11.2.1 Periodic inspections and assessments of Significant and High Hazard Potential structures should not be contracted. Where in-house manpower constraints exist, inspections and assessments may be augmented, in order of preference, by (1) use of trained and experienced USACE personnel from other districts, or other MSC's, on a fully reimbursable basis; or by (2) contracting for individual qualified personnel as inspection participants for highly specialized functions, such as underwater diving or camera work, or other tasks requiring special skills or equipment not readily available in the USACE.

11.2.2 It cannot be over emphasized that inspections other than routine inspections should be performed with licensed Professional Engineers or Engineering Geologist present. Care must be taken to maintain in-house capability for the on-site conduct of the program and continue to keep the involved disciplines (design, construction, and operations personnel) fully integrated in project inspections and assessments. This does not justify maintaining all technical disciplines in all districts. It may be in the best interests of the project and smaller districts to let other districts assist in management of their dam safety programs.

11.3 Inspection and Assessment Policy. Civil Works structures whose failure or partial failure could result in loss of life or major damage to permanent structures, utilities, or transportation facilities must be periodically inspected and assessed to ensure structural stability, safety, and operational adequacy. The Hazard Potential of each dam will be reviewed and revised as informed by the results of the periodic inspection or the periodic assessment. Changes in the hazard potential category will be made in the Dam Safety Program Management Tools (DSPMT) which will feed into the National Inventory of Dams (NID). This policy is to be accomplished using risk assessment and management tools provided by HQUSACE as follows:

11.3.1 Appropriate instrumentation programs that provide timely and accurate data for evaluations under all operating conditions support visual inspections and periodic assessments. During periods when a reservoir is, or is expected to be, above the maximum pool of record or above a potential "triggering" threshold level established from past performance, an appropriate team must monitor and evaluate performance and verify the adequacy of flood and outlet control gates and other equipment, which facilitate downstream releases. A report of performance outlining the findings and evaluation must be prepared and documented in a memorandum with a copy furnished to the MSC for information within 14 days after the event. Evaluation reports provide a basis for initiating timely remedial or rehabilitation measures and also serve as a reference for future monitoring.

11.3.2 The operating entity of facilities constructed by USACE and turned over to others for operation and maintenance is responsible for periodic inspections and all continuing evaluation inspections after the first and second periodic inspections. USACE may conduct subsequent inspections and write a report on behalf of the Project Sponsor, provided appropriate procedural and financial reimbursement arrangements are made. Inspections must be conducted in accordance with appropriate guidance contained in the operation and maintenance manual for the facility and in accordance with applicable portions of this regulation. In addition, any inspection responsibilities established by the Project Cooperation Agreement (PCA) must be relayed to the operating entity at the time of their acceptance of the structure. Dams built by USACE and turned over to others for Operation, Maintenance, Repair, Replacement and Rehabilitation (OMRR&R) must include in the Operation and Maintenance (O&M) manual, a requirement that USACE conducts inspections/assessments; they will be completed in accordance with this regulation. At a minimum, USACE will verify the sponsor is complying with the terms of the PCA through audits of inspection reports and site inspections. USACE is responsible for the. USACE is responsible for the first and second periodic inspections. See Policy Guidance Letter No. 39, dated 13 November 1992 (reference A.98) for USACE and sponsor responsibilities.

11.3.3 Under the authority of ER 1130-2-530 (reference A.61), USACE should participate in inspections/assessments of a sponsor-operated and maintained structure (e.g., local flood protection project) to ensure that the structure is conforming to the requirements of the PCA, the agreed upon inspection program, and the operation and maintenance program. USACE participation in these inspections must be funded under Inspection of Completed Works (ICW) Program.

11.3.4 In cases where ownership, operation, maintenance, or other activities at a project or its major elements are divided between USACE and other organizations, private sector (e.g., power plants), government or municipal, USACE should inspect and/or assess at the appropriate frequency, those features of non-USACE elements that could adversely affect the stability, safety, or operational adequacy of any USACE owned, operated, maintained, or otherwise related portion of the project, including features not constructed by the USACE.

11.3.5 Non-Federal dams located upstream or downstream of a USACE project may potentially affect the safety of a USACE project. A list of significant dams upstream or downstream and their points of contact must be prepared and maintained in the project Emergency Action Plan (EAP). When inspecting/assessing a USACE structure or project it may be appropriate to evaluate the safety of the upstream or downstream non-Federal dam(s) and to ascertain operational procedures or emergency situations that could make excessive demands on a USACE project. When failure of a neighboring non-Federal structure would cause overtopping or other major damage to USACE project, USACE should obtain and review the current comprehensive inspection report, such as a FERC or State Dam Safety Agency report, for the non-Federal structure. If the non-Federal project has not been inspected within the last five years, USACE should coordinate with the owner and the regulatory authority to have the dam inspected. Every effort should be made to encourage owners of such projects to comply with the inspection requirements in the Model State Dam Safety Program (FEMA Publication 316 reference A.116).

11.3.6 For projects spanning an international border, every effort should be made to coordinate with those responsible for the facility across the border to ensure the continued safe operation of the project. This includes, but not be limited to, inviting representatives to participate in periodic inspections and periodic assessments;

providing copies of evaluation reports; requesting copies of their latest inspections, data collection efforts, and evaluations; and coordinating emergency management activities.

11.3.6.1 For the USACE portion of the dam, the inspections and assessments must be performed and documented in the same manner as the inspections of all other USACE dams.

11.3.6.2 For Federal dams owned by other agencies, the inspections and assessments for the U.S. portion of the dam should be performed and documented in the same manner as the inspections of USACE dams, unless the owning agency specifically requests otherwise

11.3.7 Federally owned dams (non-USACE) on a military installation might have a substantial bearing on the safety of life and endanger downstream property. USACE, on request of the installation, may inspect, and/or assess these dams on a cost reimbursable basis. This policy extends to non-federally owned dams on a military installation where the safety of life and Federal property are in jeopardy from a failure. These inspections and assessments must be performed and documented in the same manner as the inspections of USACE dams, except that the reports should be forwarded to the requesting service branch, installation, and/or agency, which may include the Installation Management Agency (Army), Naval Facilities Command (NAVFAC), Installation Department of Public Works (DPW) and to the owner of the dam if not owned by the installation. For Navy and Air Force dams the reports should be forwarded in accordance with the MOA between the service and the USACE dam safety lead district.

11.3.8 Other Federal agencies may request USACE to inspect Federally-owned dams on their lands or non-Federally owned dams on Federal lands. These inspections and assessments must be performed and documented in the same manner as the inspections of USACE dams, unless the other Federal agency specifically requests otherwise.

11.4 <u>Program Implementation</u>. A periodic and comprehensive inspection and assessment schedule must be established based on the project size, importance, and hazard/risk potential. Other inspections, including routine intermediate and informal inspections, may be conducted between Periodic Inspections/Assessments. MSC Dam Safety Officers are responsible for management and oversight of the periodic inspection/assessment program. District Dam Safety Officers are responsible for implementing the inspection and periodic assessment program.

11.4.1 Frequency of Inspections/Assessments. Inspections and assessments of all water control facilities must be conducted as outlined below:

11.4.1.1 Dams and Appurtenant Structures. All dams are included in the Dam Safety Program without regard to the hazard potential classification of the dam. The guidance for developing the interval for initial inspections and subsequent periodic inspections/assessments of dams and appurtenant structures set forth in the following subparagraphs does not preclude other intervals as the situation or structural integrity warrants. Nor does this guidance supersede the requirements for a surveillance plan for the initial filling of USACE reservoirs as prescribed by ER 1110-2-1150 (reference A.49) and Chapter 17 of this regulation.

11.4.1.1.1 Periodic Inspections.

11.4.1.1.1.1 The first periodic inspection and evaluation of a dam must be carried out prior to impoundment of the pool; however, if involuntary impoundment occurs before the first inspection is accomplished; the inspection must be performed at that time. This inspection will be funded using Construction funds. The initial periodic inspection of navigation locks must be made immediately prior to flooding of cofferdams, culverts or chambers. The applicable essential USACE guidelines for the dam will be identified and documented as a result of this first PI.

11.4.1.1.1.2 Subsequent Periodic Inspections. A second periodic inspection for new dams must be performed no later than one year after impoundment is initiated. The 3rd and 4th periodic inspections must also be performed at one fiscal year intervals. The 5th and 6th periodic inspections must be performed at two fiscal year intervals. Subsequent periodic inspection intervals may then be extended to a maximum of five fiscal years with a periodic assessment (generally for Significant and High Hazard Potential dams), which typically includes the periodic inspection, held at intervals not to exceed ten years, i.e., generally at alternating periodic inspections. Annual and routine inspection intervals more frequent than indicated above may be scheduled, if conditions warrant, as approved by the District Dam Safety Officer. The second and all subsequent regular Periodic Inspections will be funded with Operations and Maintenance funds. The identified applicable essential USAEC guidelines from the first PI must be reviewed, updated as needed, and the project evaluated for compliance with these applicable essential USACE guidelines. That list of applicable essential guidelines and the compliance evaluation must be documented in the subsequent PI reports. If the list of applicable essential USACE guidelines and the project evaluation for compliance with those guidelines does not exist it must be developed and documented during the next scheduled PI, the next PI/PA, or by an Issue Evaluation Study if that is to be done before the next PI or PI/PA.

11.4.1.1.1.3 For additional guidance on the PI procedures see Appendix AD.

11.4.1.1.2 Special Inspections.

11.4.1.1.2.1 Special intermediate inspections should be performed during and immediately after the dam has passed unusually large floods and after the occurrence of significant earthquakes, sabotage, or other unusual events reported by operating personnel.

11.4.1.1.2.2 Special post-earthquake inspections are to be conducted if post earthquake damage is observed; the ground motion is felt at the dam, or in accordance with the following earthquake magnitude and epicenter distance from the dam criteria provided in Table 11.1.

Table 11.1 – Criteria for Post-Earthquake Inspections of USACE Dams

Earthquake Magnitude	Epicenter Distance From the Dam (Miles) (Inspect dam if epicenter is within this distance to the dam.)
4.5	10
5.0	50
6.0	75
7.0	125
8.0	200

11.4.1.1.3 Periodic Assessments (PA).

11.4.1.1.3.1 PA Schedule. All significant and high hazard potential dams operated and maintained by USACE will undergo a PA on a routine and systematic schedule not to exceed ten fiscal years. A PA is typically to be done in conjunction with the scheduled PI. For projects where a risk assessment in support of an Issue Evaluation Study (IES) or Dam Safety Modification Study (DSMS) has been approved that project may be excluded from the PA process until 10 fiscal years after approval of the risk assessment. Intervals in excess of 10 fiscal years require approval by the USACE DSO. Dams which are under construction for risk-reduction actions may be excluded from a PA until 10 years after modifications are complete because there is to be a risk assessment at the end of construction.

11.4.1.1.3.2 Initial Periodic Assessments – Level of Effort. Initial periodic assessments involve a greater level of effort due to the data gathering and documentation requirements. Once completed, this information will be available for future assessments, and data collected in the interim and performance history will be added to the subsequent PA Reports. The periodic assessment will generally be accomplished in conjunction with a periodic inspection. The district will coordinate and schedule initial periodic assessments with the Risk Management Center.

11.4.1.1.3.3 Additional guidance on the PA procedures is contained in Appendix T.

11.4.1.1.4 Continuing Evaluation Inspections - Intermediate, Annual and Routine. For projects on a five-year periodic inspection schedule with periodic assessments on an alternating cycle of the periodic inspections, an intermediate or annual inspection of all or some of the features may be scheduled, if warranted. The periodic inspection and assessment schedule is based on consequences of failure, age, and degree of routine observation, performance record and history of remedial measures. Intermediate inspections must also be made of any portion of a project exposed during dewatering that could not be accomplished during the scheduled inspection. Completion of dam modifications, e.g., major rehabilitations, addition of appurtenant structures, addition of hydropower, etc., requires a series of intermediate inspections to determine the effect and performance of new work. A summary of the findings from intermediate inspections is to be included in the next PI Report. It is mandatory that district dam safety personnel and project staff participate in intermediate and annual inspections for all high hazard potential dams. The intent is to have an engineer(s) of the appropriate discipline and experience level, based on project specific issues, to participate on the intermediate or annual inspections. These intermediate and annual inspections of high hazard potential dam are considered intermediate inspections for reporting purposes. As per Federal Guidelines for Dam Safety (reference A.114), intermediate and annual inspections should include a thorough field inspection of the dam and appurtenant structures, and a review of the records of inspections made at and following the last periodic inspection. If unusual conditions are observed that are outside the expertise of these inspectors, arrangements should be made for inspections to be conducted by specialists. Routine inspections are performed by Operations personnel, in accordance with paragraph 11.4.1.1.5 below and ER 1130-2-530 (reference A.61).

11.4.1.1.5 Routine Inspections. Appropriate employees at the project must make frequent observations of the dam and appurtenant structures and instrumentation measurements. The purpose is to identify and report abnormal conditions and evidence of distress in accordance with training instructions and guidance. Any unusual conditions that seem critical or dangerous must be reported immediately as Evidence of Distress, using proper procedures and channels to the DSO, as required by Chapter 13, paragraph 13.4, of this regulation, and the Emergency Action Plan Notification Plan for the project. In many cases it will be appropriate to develop a visual inspection checklist for Operations personnel to use on a recurring basis (e.g. weekly or monthly) to ensure that critical areas are observed and conditions documented on a regular basis.

11.4.1.2 Other Structures. The district is responsible for establishing periodic inspection and periodic assessments intervals, for other USACE-owned and -operated water control facilities. Inspection intervals must be defined in the project Operation and Maintenance (O&M) manual using a risk informed approach and methodologies. Projects designed and constructed by the USACE, but operated and maintained by the sponsor, must also have inspection intervals defined in the O&M manual.

11.4.1.3 Hydraulic Steel Structures (HSS). ER 1110-2-8157 (reference A.58) requires fracture critical members to be inspected every five years and that all HSS be inspected not to exceed 25 fiscal years, even if dewatering is required. Based on the periodic assessment or other risk assessments, a more frequent frequency may be necessary. When several of the same type of HSS exists at a project, at least one of each type of HSS must be inspected as part of each periodic inspection. A different HSS should be selected for each inspection. For HSS whose failure could result in loss of life, the critical components should be subjected to at least a thorough visual examination during each inspection. Hydraulic Steel Structures include lock gates, dam spillway gates, Tainter valves, flood protection gates, stop logs, bulkheads, and lifting beams used for installing other Hydraulic Steel Structures. A summary of findings and deficiencies from the HSS inspection must be included in the next PI Report. The HSS inspections should be coordinated to coincide with periodic or intermediate or annual inspections wherever possible.

11.4.1.4 Stilling Basins. When feasible, stilling basins should be dewatered for inspection for each periodic inspection if there have been significant releases through the stilling basin or potential damage or wear is suspected. If no significant releases through the stilling basin have occurred, or there is no suspicion of damage or wear, the schedule for dewatering may be deferred until the next periodic inspection. The district DSO may perform a diver inspection or hydro-acoustic survey to verify that there is no significant debris in the basin or damage to the structure. When stilling basins cannot feasibly be dewatered, except for emergency repairs, diver inspections or hydro-acoustic surveys are recommended to be performed at five fiscal year intervals. If there is a need, due to acceleration in erosion damage, then surveys may be necessary more frequently. Changes in the operational release patterns for environmental, fish and wildlife, or other purposes may warrant more frequent inspections of the stilling basin. After there have been significant releases through the stilling basin or potential damage or wear is suspected, the stilling basin must be dewatered for a special inspection or an underwater inspection performed immediately after the event.

11.4.1.5 DSPMT will be used to schedule PA activities, development of consequence data, and facilitator support. Therefore, it is essential that districts keep their PI and PA schedules updated in the DSPMT.

11.4.2 Report.

11.4.2.1 A formal technical report of the periodic inspection and periodic assessment must be prepared for permanent record and for reference for needed remedial work. The report must be based on a detailed, systematic technical inspection, and appropriate risk assessment methodology for each structure and its individual components regarding its safety, stability, structural integrity, operational adequacy, and risk. A single report format must be utilized for periodic inspections and periodic assessments as described in Appendix AE, Periodic Inspection and Periodic Assessment Report Format.

11.4.2.2 When the periodic inspection does not include a periodic assessment the results of the previous PA findings must be reviewed for appropriateness considering current conditions or state of practice. If there are no significant changes and the risk assessment is considered adequate, the previous PA sections must be repeated in the report, and the results of the just completed periodic inspection must be incorporated.

11.4.2.3 If there are unusual performance issues or other issues that need to be evaluated further to review priorities, an out-of-cycle periodic assessment should be conducted, and the appropriate report sections must be updated. If a periodic inspection is performed prior to the initial periodic assessment, the report sections pertaining to the periodic assessment may be omitted.

11.4.2.4 USACE Dam Safety Fact Sheet must be prepared based on the PA results. This fact sheet is releasable to the general public. See Appendix E for the format for this fact sheet. The fact sheet will address the incremental and non-breach risk.

11.4.2.5 Routine and other inspection observations indicating that the safety of a structure is in jeopardy must be reported in accordance with Chapter 13 of this regulation.

11.4.2.6 The Executive Summary of the report must be provided electronically to USACE DSPM (HQ-DamSafety@usace.army.mil) and the MSC DSPM within 90 days of completion of the periodic inspection for a PI only and within 45 days of the consistency review for a PI/PA. The Executive Summary and Major Findings must also be entered into the DSPMT database after the PI/PA is approved. The electronic summary should be limited in length to 3 pages and contain the information listed in Appendix AE under Executive Summary.

11.4.3 Report Completion, Submittal Schedule and Quality Control.

11.4.3.1 Report Completion and Submittal Schedule.

11.4.3.1.1 For a PI only, the completed periodic inspection/periodic assessment (PAI/PA) report, which is to include the former PA if one was done, is to be submitted to the MSC DSO for approval within 90 days of completion of the PI at the dam.

11.4.3.1.2 For a PI/PA, the completed PI/PA the report must be certified and submitted to the RMC for consistency review within 90 days upon completion of the risk assessment. Certification consists of the PA team concurrence, the facilitator certification, and the District DSO's certification of review. After the PI/PA report is returned from the RMC consistency review, comments are to be resolved and the PI/PA report sent for MSC DSO approval within 45 days of the Consistency Review.

11.4.3.1.3 One printed copy and one copy as a searchable PDF file, on a compact disc, of the report must be submitted by the district to the MSC DSO.

11.4.3.2 District Quality Control Review. The district must establish completion and tracking standards for the review of the report. The submission must include all review comments and the resolution of the comments. For periodic assessments, the PA facilitator will be included in the DQC. An additional signature sheet will be used to document the PA team concurrence with and facilitator certification of the content of the report and that the PA was conducted in accordance with current USACE guidance. The district Dam Safety Officer must certify the review of the report prior to submittal for the RMC consistency review.

11.4.3.3 Consistency Review and DSOG Presentation.

11.4.3.3.1 Prior to approval of the PA by the MSC DSO and presentation of the PA to the DSOG a consistency review of the PA will be done with respect to the PI/PA evaluations, recommendations, and documentation. This review will be coordinated by the RMC.

11.4.3.3.2 RMC will have the lead for scheduling presentations to the DSOG. Any DSOG comments that require changes to the PI/PA report will be documented by supplemental memorandum to the report since the DSOG review will typically be after the MSC DSO approval of the PI/PA.

11.4.3.4 At least two printed copies of the report must be retained at the district. Reports Control Symbol (RCS) is exempt based on AR 335-15 (reference A.26). Each printed copy of the report must also contain an electronic version of the report (CD or DVD). The report must also be electronically archived on the RADS II website as a searchable PDF file.

11.4.4 Report Approval. The MSC DSO is responsible for approval of all the periodic inspection/assessment reports on dams operated and maintained by USACE. The MSC DSO has discretionary authority to delegate approval of the reports to the district DSO. The DSO will make an approval decision on the periodic assessment report within 45 days of submittal from the District. Approval of the Periodic Assessment report by the district or MSC DSO is not approval of the DSAC recommendation. The USACE DSO has retained approval authority of the DSAC assignment.

11.4.5 Distribution of Approved Reports.

11.4.5.1 Library Copy. Upon approval of the report, one copy as a searchable PDF file together with a copy of all correspondence on a compact disc will be sent by the originating district directly to:

Commander, U.S. Army Engineer Research & Development Center
ATTN: Research Center Library
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

11.4.5.2 District Copies. The districts determine the distribution of printed reports within their respective offices, to include the project site, local sponsor, military installation, and other Federal agency and/or state agency, as deemed appropriate.

11.4.6 Obligation to Others. In cases where ownership, operation, maintenance, and other activities at a project or its major elements is divided between USACE and others, information pertinent to the condition of project elements owned, operated, or maintained, or otherwise affected by others, as observed by USACE inspection or periodic assessment teams, must be furnished to the co-owner. The district DSO must furnish this information to the FERC, when hydroelectric power projects are under the purview of the Federal Power Act (41 Stat. 1063, U.S.C. 791-823) 10 June 1920, as amended (FPA) (reference A.1). Owners and operators of such FERC licensed facilities must be advised that the information made available by USACE must not be presented as representing results of inspections/assessments performed for the licensee by USACE and is not a substitute for the FERC inspection under the FPA.

11.5 Presentation of Instrumentation and Routine Inspection Data. Plots and written assessments and evaluations of the instrumentation and routine inspections data must be included in pre-inspection packets, and in PI/PA reports in accordance with EM 1110-2-1908 (reference A.77), EM 1110-2-4300 (reference A.92), and Appendix U. The instrumentation data presented in a PA report will extend at least back to when the dam was constructed and if available groundwater data from pre-construction should be included. The data should include precipitation and tail water data and key milestones such as end of construction, first filling, major modifications, and changes in operations should be noted on the plots.

11.6 Responsibilities.

11.6.1 District Dam Safety Officer. The district DSO is responsible for:

11.6.1.1 Formulating the inspection/assessment plans, conducting the inspections/assessments, processing and analyzing the results of the instrument observations, evaluating the condition of the structures, recommending the schedule of the next inspection/assessment, and preparing and submitting the resulting reports.

11.6.1.2 Coordinating with the district Operations, and Programs & Project Management (PPMD) Divisions to ensure sufficient funding for inspections, assessments and remedial measures is budgeted in the Operations and Maintenance, General account, prioritizing recommended remedial measures as necessary using HQUSACE national risk-informed priorities for major remedial measures.

11.6.1.3 Notifying the district Commander, the MSC DSO, and the USACE DSO when allocated funding is insufficient for conducting inspections or other activities required by USACE criteria and standards and the Federal Guidelines for Dam Safety (reference A.114).

11.6.1.4 Coordinating with Operations Division personnel of scheduled inspections/assessments and requesting their assistance and participation. For projects or structures being inspected for the first time, personnel from the Construction Division must be invited to participate. A representative(s) of the sponsor and the appropriate State Dam Safety official(s) must also be invited to attend the inspection. If hydropower is a feature of the project, the regional FERC office and any licensee must be invited to the inspection.

11.6.1.5 Forwarding the approved reports to the district Operations Division for implementation of any routine recommendations. The DSO must coordinate with PPMD and Operations Divisions to develop schedules and any funding prioritization based on the PIs and PAs.

11.6.1.6 Ensuring the inspection team is comprised of the technical, and where appropriate professionally registered, expertise necessary to execute a thorough and technically sound inspections and assessments. Lacking district expertise, the Dam Safety Officer may obtain assistance from HQUSACE, MSC, or other districts. HQUSACE personnel will not normally participate in inspections unless requested, or when project conditions dictate. See Appendix AD for further details.

11.6.1.7 Ensuring all recommendations made in the reports are resolved. If the recommendation is related to confirmed and unconfirmed dam safety issues and interim risk reduction measures, the district DSPM will update the DSPMT.

11.6.1.8 Updating the deficiency spreadsheet module in the Dam Safety Program Management Tools and assigning the District priority code 1 through 6 to each recommendation so the assigned priority can be tracked over time. Only Confirmed and Unconfirmed Dam Safety Issues and Interim Risk Reduction Measures should be updated to the DSPMT.

11.6.1.9 Performing annual program review, see paragraph 11.7.

11.6.1.10 The DSO must coordinate with the RMC, who manages and recommends prioritization of Wedge funded activities, for the scheduling and funding of non-routine recommendations such as Issue Evaluation Studies.

11.6.2 District Operations Division. The district Operations Division is responsible for:

11.6.2.1 Performing needed maintenance, such as mowing and dewatering, to support a thorough and safe inspection, and allowing full access to critical project features.

11.6.2.2 Accompanying the inspection/assessment team and providing the field support required for the team. The project staff must be prepared during the inspection/assessments to operate those project components whose failure to operate properly could impair the operational capability and/or usability of the structure. Where the operation of these components is vital to the safe operation of the project under emergency conditions, the components must be operated using emergency power to ensure the inspection/assessment team that all critical project features will function under emergency conditions or in the absence of the normal source of power. Testing of the emergency power source requires, if possible, the maximum power demand expected under emergency conditions. Additional details and requirements are described in Appendix AD.

11.6.2.3 Performing required inspections, such as Gate Operability and Capability Inspections, and furnishing completed reports to the inspection team.

11.6.2.4 Acting on inspection recommendations for routine O&M in a timely manner in accordance with the deficiency classification in Table AD.1 in Appendix AD.

11.6.2.5 Completing an annual inspection of all water control projects and providing documentation of the findings and status of previous recommended actions to the district DSPM.

11.6.2.6 Annual budgeting and funding of sufficient funds for the district DSO to execute the district's Dam Safety Program.

11.6.3 District Programs and Project Management Division (PPMD). The district PMD is responsible for:

11.6.3.1 Supporting the program with proper funding and coordinate with the project sponsor as needed.

11.6.3.2 Ensuring the sponsor fulfills all terms of the applicable Project Cooperative Agreement, Local Cooperative Agreement, or other agreements based on Section 221 of the Flood Control Act of 1970 (PL 91-611) (reference A.4).

11.6.3.3 Coordinating the timely correction of all noted deficiencies with the project sponsor.

11.6.4 MSC Dam Safety Officer. The MSC DSO provides quality assurance, oversight and management for this program. As a minimum, the MSC DSO must:

11.6.4.1 Provide representation at the first and second post construction inspections, the inspection of high hazard potential structures, and the inspection of structures whose condition or performance has warranted more frequent attention.

11.6.4.2 Provide oversight for the monitoring of data collection, processing, and assessment using risk informed methodology.

11.6.4.3 Retain approval authority for the frequency and scope of periodic assessments, and review/approve the schedules for them in coordination with the RMC. Intervals in excess of 10 fiscal years require written request and approval by USACE DSO.

11.6.4.4 Provide oversight and review of the regional database using DSPMT to include schedules and history of project remedial measures, unless this information is otherwise recorded in an official database.

11.6.5 Responsibilities for Periodic Assessments

11.6.5.1 District's PA Team Leader: The district will select a team leader (coordinator) to lead the PA team, coordinate with the facilitator, district/MSC DSPM, and any technical specialists needed from outside the district to accomplish the completion of a PA, ensures the PI findings are incorporated into the report and any PI recommendations are consistent with the risk assessment findings, coordinate the DQC review, coordinate the response to review comments, and coordinate the presentation of the PA findings and recommendations to the district and DSOG with the facilitator.

The PA team leader signs a concurrence sheet indicating that the report is complete, properly assembled and formatted, and that the DQC review comments were resolved. It also represents concurrence with the risk assessment as described below for the district PA team.

11.6.5.2 District's PA Team: The district's PA team consists of appropriate in-house personnel from engineering and operations divisions including field personnel. Other technical specialists from outside the district may also be called upon as needed to accomplish completion of the PA. The team compiles all background data and uploads it to the RADS II website. The team prepares draft versions of some of the chapters of the PA report and reviews the background data and consequence products prior to the PFMA, participates in the PFMA and risk assessment, and prepares the remaining report sections upon completion of the risk assessment. The PA team signs a concurrence sheet stating the risk assessment represents the results of the team's deliberations and adequately documents the potential failure modes, estimated risks, and recommendations.

11.6.5.3 Modeling, Mapping, and Consequences (MMC) Production Center: The MMC Production Center provides consequence estimates, warning time sensitivities for life loss estimates, and inundation mapping products.

11.6.5.4 Risk Management Center (RMC): The RMC helps identify dams for PA's each year using information obtained from the DSPMT, coordinates with the MMC Production Center to develop breach and non-breach consequence estimates, and assigns facilitators and any additional technical specialists. The RMC coordinates a consistency review of PA reports prior to presentation to DSOG for consistency with respect to their evaluations, recommendations, and documentation. The RMC coordinates presentations to the DSOG. The RMC manages and recommends prioritization of the non-routine recommendations from the PA's related to Wedge funding on a national level considering DSAC as well as other important factors.

11.6.5.5 Facilitator: The RMC-approved facilitator verifies appropriate district staff is assigned to the PA team and notifies the RMC if additional technical specialists if needed. The facilitator coordinates with the district's team leader on logistics and scheduling of the site visit, PFMA, and risk assessment. The facilitator conducts an in-briefing presentation on the PA process, facilitates the PFMA and risk assessment, participates in the DQC review, and certifies that the PA was conducted in accordance with current USACE guidance and that the report represents the spirit of the risk assessment and team dynamics and properly builds the case for the risk estimates and recommendations. The facilitator contacts the RMC when the report is ready for consistency review, participates in the consistency review discussions, transmits the consistency review comments to the district PA team leader, and coordinates revisions and vetting of the revised report with the RMC when complete. The facilitator coordinates the presentation of the PA findings and recommendations to the district and DSOG with the PA team leader. If alternative views are held by the district those views are to be presented to the DSOG by the District DSO.

11.6.5.6 MSC Dam Safety Officer: After all comments resulting from the consistency and DSOG review have been resolved and closed the MSC DSO approves the PA report or may delegate approval of the PA report to the district DSO.

11.6.5.7 District Dam Safety Officer: The district DSO signs a certification sheet stating that the DQC procedures were sufficient and documented and that all comments resulting from the DQC review have been resolved and closed. The district DSO's certification of the review of the PI/PA report serves as the district DSO's recommendation on the DSAC to the DSOG. The DSAC assignment decision is the responsibility of the USACE DSO. If alternative views are held by the district, the District DSO presents those views to the DSOG. The district DSO coordinates with the PPMD and Operations Division to develop schedules and any funding prioritization for routine recommendations. The district DSO coordinates with the RMC, who is responsible for prioritization of Wedge funded activities, for the schedule and funding of non-routine recommendations.

11.6.5.8 District Dam Safety Program Manager: The district DSPM schedules and budgets for the PA and assigns the district PA team leader and PA team.

11.6.5.9 Dam Senior Oversight Group: The DSOG reviews the PA results and recommended DSAC and recommends a DSAC to SACE DSO for concurrence and/or decision, and assists the USACE DSO.

11.6.5.10 USACE Dam Safety Program Manager: The USACE DSPM drafts a Memorandum for Record (MFR) of the DSAC assignment.

11.6.5.11 USACE Dam Safety Officer: The USACE DSO approves the DSAC assignment and provides a written notification to the MSC DSO and the district DSO.

11.6.5.12 Sponsors and Trainees: These individuals may participate in the PFMA and risk assessment at the discretion of the district.

11.7 Program Review. At the end of each fiscal year, the district DSO must review and set priorities for the recommended routine actions for the next budget submission and ensure PI and PA schedules in the DSPMT are updated and accurate.

11.8 Reporting Distress. Refer to Chapter 13, paragraph 13.4, of this regulation for procedures when reporting evidence of distress.

11.9 Funding. Funding for all routine Dam Safety activities and report preparation should be budgeted in the minimum funding level of the district's fiscal year budget request for project operation and maintenance. Periodic inspections and periodic assessments are considered routine, recurring actions that can be budgeted in the initial O&M increment for each project. Costs incurred by HQUSACE and MSC personnel are not funded by the district.

11.9.1 Funding During Construction. Funding for inspections and other Dam Safety activities for a project during the period of construction must be under Cost Code

51, Appropriation 96X3122, Construction. The term "period of construction" is defined as the period from the issuance of the solicitation for the first construction contract to the date the district Commander notifies the sponsor in writing of the government's determination that construction is complete; or, to the date the Government takes beneficial occupancy (for solely USACE retained projects).

11.9.2 Funding During Operations. Funding for inspections and other Dam Safety activities after the project components are placed in operation must be under Appropriation 96X3123, Operation and Maintenance, General. Funding for periodic assessments must be included in the minimum program of the Operations and Maintenance budget submission.

CHAPTER 12

Operations and Maintenance Activities

12.1 General. The transition from construction to operation may consist of overlapping activities. Therefore, it is very important that problems encountered during construction be adequately documented and resolved prior to the operational phase. Rigorous and continuous vigilance, checking, and inspection, for as long as the dam is operational, are necessary for dam safety, as problems may occur following many years of trouble-free operation. This is particularly true for untested flood risk management dams where a significant percentage of the maximum head has not occurred. Guidance on control of construction is available in EM 1110-2-1911 (reference A.78). Operations and maintenance policies for flood control operations are covered in ER 1130-2-530 (reference A.61).

12.2 Operations and Maintenance Manual. The Operations and Maintenance (O&M) manual provides guidance and instructions to project personnel for proper operation and maintenance of the facility. The O&M manual contains a narrative summary of the critical dam features including design features with safety limits, equipment operating and testing procedures, instrumentation requirements, potential failure modes, a history of problems, and how those problems could adversely affect the structure under stress. The O&M manual must be prepared during the construction phase and updated as features are added to the project, when equipment is replaced, or when changes in project operations are implemented.

12.3 Project Geotechnical and Concrete Materials Completion Report for Major USACE Projects. ER 1110-1-1901 (reference A.42) requires, as part of the permanent project record, documentation of the as-constructed geotechnical and concrete materials aspects of all major, complex and unique engineered projects constructed by USACE, including all subsequent modifications. This report must be identified, scheduled, and resourced in the Project Management Plan (PMP). The information and data in this document must be presented and discussed with the sponsor/owner. The report provides, in a single document, the significant information needed by the sponsor, USACE technical staff, and other team members to become familiar with the project. The report facilitates accurate, timely inspections and performance evaluations, and serves as the basis for developing and implementing appropriate and effective modifications, “flood fighting” efforts, and emergency and/or remedial actions to prevent flood damage, or required as a result of unanticipated conditions or unsatisfactory performance.

12.4 Instrumentation and Monitoring. All USACE dams and other water control facilities are required to have a level of instrumentation that enables proper monitoring and evaluation of the structure during the construction period and under all operating conditions. Instrumentation systems are also required to furnish data on structural behavior for application to future designs. Each dam or other water control structure should have instrumentation to measure hydrostatic pressure, embankment and abutment seepage, foundation under seepage, and displacement of major elements of the structure as appropriate to address potential failure modes and risks. Strong motion accelerometers are to be installed in structures located in designated seismic regions in accordance with ER 1110-2-103 (reference A.44). After a project is operational for several years, scheduled maintenance, repair, and replacement of instrumentation must be part of the normal plan of operation. Instrumentation must be properly maintained or replaced, as necessary, in order to obtain accurate and timely data. Readings must be made at scheduled frequency and properly recorded and analyzed. Detailed information on instrumentation for earth and rock fill dams is given in EM 1110-2-2300 (reference A.87) and EM 1110-2-1908 (reference A.77). Information on instrumentation for concrete dams is given in EM 1110-2-2200 (reference A.85) and EM 1110-2-4300 (reference A.92). Full reliance must not be placed on instrumentation alone to find problems or to forecast performance since it is impossible to install sufficient instrumentation to monitor every possible problem area. An extremely important part of the monitoring program is visual observation to determine evidence of distress and unsatisfactory performance (reference A.136). Project personnel must receive training in basic engineering considerations pertaining to major structures, with procedures for surveillance, monitoring, and reporting of potential problems, and with procedures for emergency operations.

12.5 Reporting Distress. Evidence of distress in dams, and other water control structures must be immediately reported to the district DSO. If an engineering evaluation of the evidence of distress indicates the need for immediate remedial action, the DSO must immediately report such conditions through command channels to the USACE DSO. For additional guidance see Chapter 13.

12.6 Operations and Maintenance Program.

12.6.1 Operations activities for Dam Safety includes instrumentation readings, daily monitoring of the structures, routine equipment testing, and other work items included in the Operations and Maintenance Manual as routine operations items.

12.6.2 Maintenance activities are divided into two categories (normal repair and rehabilitation work). Work that does not qualify for Construction funding under either the Dam Safety Program or the Major Rehabilitation Program must be funded under the regular O&M Program. Work recommended in the Periodic Inspection Report must be prioritized and funded through this program unless qualifying under another program.

12.6.2.1 Recurring Maintenance for Dam Safety includes maintenance of instrumentation, cleaning and flushing toe drains and relief wells, and other work items included in the Operations and Maintenance Manual as recurring maintenance items. Drilling for instrumentation or other purposes in or near a dam or dam foundation is not to be done without prior approval of a drilling plan. A risk assessment, at least the equivalent of that done in support of the Periodic Assessment, which addresses the need of the additional or replacement instrumentation, is required as the basis to support the drilling plan. See ER 1110-1-1807 (reference A.41) for guidance on development, review, and approval of the drilling plan.

12.6.2.2 Major Maintenance for Dam Safety includes non-routine major repairs that exceed a threshold that is defined in accordance with guidance provided in Engineer Circular for Budget Development for the budget year being considered. Some examples of major maintenance include concrete and riprap repairs and/or replacements.

12.6.3 The establishment, maintenance, and control of vegetation pose Engineering, as well as routine maintenance considerations. In accordance with ETL 1110-2-571 (reference A.95), this guidance establishes minimum requirements for maintenance/control of vegetation at USACE-owned dams, abutments, spillways, inlet/outlet channels, and other appurtenances. Details concerns vegetation maintenance is included in Appendix AC.

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CHAPTER 13

Reporting Evidence of Distress in Civil Works Structures

13.1 Purpose. This chapter prescribes the responsibilities and procedures for the immediate notification to higher authority of evidence of major distress or potential failure of civil works projects. These procedures apply to projects under construction or currently in operation.

13.2 General. Evidence of distress in dams, levees, and other water control structures must be immediately reported to the District Dam Safety Officer. If an evaluation of the evidence of distress indicates the need for immediate remedial action, the Dam Safety Officer must, as soon as practical, report such conditions through command channels to the USACE Dam Safety Officer. Actions that could impact life safety must take precedence over notifications to command. The USACE Dam Safety Officer must notify the Director of Civil Works, the Deputy Commander for Civil Works and Contingency Operations, and the USACE Commander, if necessary.

13.3 Discussion. The intent of these requirements is to keep the USACE chain of command situationally aware of dam safety-related issues by ensuring the immediate reporting, inspection, and follow-up evaluation of conditions that demonstrate evidence of distress or conditions that could result in a potential hazard at civil works projects. In all cases the overriding concern must be to get the information in the hands of the technical staff as quickly as possible so that appropriate evaluation and response decisions can be made. This is even more critical in cases involving severe distress (sinkholes, significant seepage/leakage, large slides, gate failures, etc…) because the response time may be critical in limiting damage and saving lives. In these types of situations it would be better to have a “chain of command violation” rather than lose valuable time in the reporting process. It would also be better to raise the alarm of concern on something that ultimately turned out to be only a moderate issue as opposed to under-reacting on a problem that turned out to be severe. It is not the intent for reporting requirements to ever interfere with the local responsibility to react appropriately in the event of severe distress. The primary focus must always remain on taking all necessary emergency measures with the appropriate notification following thereafter as quickly as possible.

13.4 Procedures.

13.4.1 When evidence of distress is reported to the district DSO, the DSO must confirm the situation and determine if an engineering evaluation of the condition is needed or remedial measures are required. Initial notification must be made by telephone to the MSC Dam Safety Officer and Dam Safety Program Manager, with follow-up documentation and digital photos via email or express mail. The MSC DSO must notify USACE DSO. If the USACE DSO cannot be contacted, the reporting office must follow the notification sequence shown in HQUSACE Notification Plan. A narrative summary with an assessment of risks, and with appropriate photographs, endorsed by the MSC DSO must follow the initial notification to the USACE DSO and be recorded in the Incident Manager within the Dam Safety Program Management Tools (DSPMT). The DSPMT software contains a built-in mechanism to enter details of the observed distress.

13.4.2 After action reports must be prepared and submitted to the MSC and HQUSACE. A post-distress field inspection, and if necessary, a periodic assessment of risk should be performed to assess damages or physical changes caused by any event listed in the following subparagraph. If the distress is significant enough to require operational restrictions, the implementation of restrictions must immediately be coordinated with the Special Assistant for Dam and Levee Safety. See Chapter 7 for guidance on interim risk reduction measures.

13.4.3 HQUSACE Dam Safety Notification Plan. The USACE DSPM maintains and periodically publishes an official HQUSACE Dam Safety Notification Plan. This plan must be distributed electronically to all DSOs and DSPMs. It must be updated annually, or as needed, to ensure that names and telephone numbers are current and accurate. If none of the individuals on the notification plan can be reached, the USACE Operations Center should be notified at (202) 761-1001.

13.5 Signs of Distress. Typical examples of distress are listed in the paragraphs below. Distress may be detected by any means, but should be confirmed by visual inspections, measurements/instrumentation, and monitoring. Since all USACE projects are different, engineering judgment must always be exercised in determining whether or not an item warrants upward reporting. The list below simply offers some examples of things which could eventually rise to that level. Generally, anything which has the potential for life loss, for significant negative economic implications, or for something which could garner political or media attention should be reported.

13.5.1 Sloughs, settlement, or slides in embankments such as earth or rock fill dams, and bridge abutments or slopes of spillway, channels, and lock and dam abutments.

13.5.2 Evidence of piping, muddy water boils in the areas of a structure such as embankments, abutments, dam monoliths, outlet works structures, lock walls, or cofferdams.

13.5.3 Abnormal increase or decrease of flow from foundation drains, structural joints, or face drains of concrete dams.

13.5.4 Any increase in seepage quantities through or under embankments or in abutments.

13.5.5 Any significant change in pore-water pressure in either embankments or their foundations or abutments.

13.5.6 Any significant change in uplift pressures under concrete structures.

13.5.7 Unusual vertical or horizontal movement, bulges, or cracking of embankments, abutments, or structures.

13.5.8 Significant cracking of mass concrete structures, either during construction or after completion.

13.5.9 Sinkholes or local subsidence in the foundation of or adjacent to embankments or other pertinent structures critical to the safe operation of the project.

13.5.10 Excessive deflection, displacement, or vibration observed in concrete structures (e.g. tilting or sliding of intake towers, bridge piers, lock walls, or floodwalls).

13.5.11 Erratic movement, binding, excessive deflection, or vibration of outlet and spillway gates and large flow control valves observed during operations.

13.5.12 Significant damage to any structure (e.g. barge damage to bridge piers/lock walls or ice flow damage to intake towers and access bridge piers, spillway erosion damage (lined and unlined), stilling basin damage, cavitation damage to outlet works and spillways).

13.5.13 Significant damage to, or changes in, structures, foundations, reservoir levels, groundwater conditions, and adjacent terrain as a result of seismic events. Special inspections for damages should be made immediately following the events as described in ER 1110-2-1802 (reference A.52) and in Table 11.1 – Criteria for Post-Earthquake Inspections of USACE Dams.

13.5.14 Any other indications of distress or potential failure that could inhibit the operation of a project or endanger life and property.

13.5.15 Excessive vibration, binding, unusual noises, movements, or deflections of gate hoist operating equipment.

13.5.16 Actual hydraulic equipment operating pressure observed in excess of 125% of the normal operating pressure. Electric motor operating equipment overheating or stalling.

13.5.17 Erratic movement or unusual sounds such as bumping, jumping, or popping miter gates.

13.5.18 Wire rope lifting cables or lifting chains observed to have broken strands or deformed, worn, or severely corroded links.

13.5.19 Frequent power interruptions.

13.5.20 Excessive movement of penstock flexible couplings observed during operations.

13.5.21 Penstocks or turbine spiral cases that show signs of distress such as deformation or cracking.

13.5.22 Major mechanical or electrical equipment at locks and dams or local flood protection projects observed to fail during project operations.

13.6 Inspections. Special inspections to evaluate damages or changes should be made immediately following any of the events outlined above. Results of these inspections and associated recommendations should be forwarded to the district DSO. The report should include what is believed to have led to the situation, a description of the incident, damage occurred, distress seen, etc. Actions taken to remedy and future changes to surveillance and monitoring plans. The RMC will maintain a record of these reports to help in identifying trends and/or reoccurring problems. The DSO must ensure that this information is promptly communicated through command channels (MSC and HQUSACE) so that appropriate decisions regarding the project’s DSAC and national priority can be made. HQUSACE will ensure proper coordination and involvement of the RMC.

CHAPTER 14

Instrumentation for Safety Evaluations of Civil Works Structures

14.1 Policy. All Civil Works water control projects must have an adequate level of instrumentation, as appropriate to address potential failure modes and risks, to enable design engineers to monitor and evaluate the safe performance of the structures during the construction period and under all operating conditions. The term "project" includes all dams, appurtenant structures, facilities, saddle dams, and any other feature whose failure or malfunction would cause loss of life, severe property damage, or inability to perform the authorized purpose. Where it is determined that instrumentation is a necessary monitoring component, instrumentation will be utilized to enable designers and operators to verify performance is within tolerable limits relative to potential failure modes.

14.1.1 The District DSO is responsible to ensure projects are adequately monitored and must advise the District Commander, MSC, and Headquarters (HQ) if performance does not comply with safety thresholds or suggests distress of the structure. Concerns regarding the adequacy of instrumentation, funding, frequencies, procedures, and staffing must be elevated to the DSO for resolution with District Senior leadership.

14.1.2 Appropriate instrumentation and monitoring frequency must be based on that dam's design and potential failure modes analysis. Seepage for example is a pervasive risk driver within the USACE inventory of dams. Districts must ensure that critical seepage areas are instrumented and equipment is in good working order. Monitoring programs must be tailored to each individual dam.

14.2 Risk Informed Instrumentation Monitoring. Instrumentation data is an extremely valuable asset that supplies insight into the actual behavior of the structure relative to design intent for all operating conditions. Instrumentation data demonstrates performance that is uniquely characteristic to the structure and provides a basis for predicting future behavior. Instruments are used where data is needed to enhance visual surveillance performed in order to ensure that the risk to life, property, and the environment presented by the project is within tolerable limits. Instrumented monitoring is also used to augment investigations of unexpected behavior.

14.2.1 The number of instruments, locations, types, and frequency of readings should be commensurate with the DSAC and significant potential failure modes identified for each project. Note: there may be a set of credible potential modes that when combined they are significant contributors to the flood risk associated with the dam. These credible potential failure modes should be evaluated and an appropriate level of instrumentation and monitoring should be implemented to provide an adequate level of information for evaluating the performance of the dam pertaining to these credible potential failure modes. Redundancy and use of automated data collection should be considered for high risk features or for locations that have limited on site staff or are difficult to access for monitoring and emergency response. Repair, replacement, and installation of new devices must be evaluated throughout the life of the project subject to potential failure modes analysis (PFMA), flood performance, and other risk considerations. Increased data monitoring and analysis should be performed in conjunction with unusual loading events, such as high reservoir levels or following earthquakes. Specific devices and frequency of readings must be documented in project specific surveillance plans and included as an appendix to the Emergency Action Plan.

14.2.2 The planning, design, and layout of an instrumentation program are integral parts of the project design and operation. A life cycle approach is needed; instruments that were critical for the construction phase may not be critical for the operations phase. The number and locations of instruments must be annually reviewed to assess if devices should be abandoned, added, or read at different time intervals. As structures age and new design criteria are developed, the historical data are relied upon to evaluate the safety of the structure with respect to current standards and criteria. Older structures may require additional instrumentation to gain a satisfactory level of confidence in assessing safe performance.

14.2.3 Instrumentation data can be of benefit only if the instruments consistently function reliably, the data values are compared to the documented design limits and historical behavior, and the data are received and evaluated in a timely manner.

14.2.4 Automation of dam safety instrumentation is a proven, reliable approach to obtaining instrumentation data and other related condition and performance information, particularly when investigating and analyzing performance conditions that require frequent, and/or difficult access for obtaining measurements. Automated instrumentation should be periodically calibrated and verified manually, when possible. Further guidance for instrument automation is available through ER 1110-1-8158 (reference A.43). Automation should augment field visual inspection and not take the place of it. It is recommended that automation be accomplished to provide data sufficient to document the behavior of the structure in response to loadings, to increase warning times, and reduce exposure of field personnel to harsh conditions. Where feasible, automation should include verification procedures.

14.2.5 Successful risk management requires a healthy routine monitoring program, including maintenance, repair, and staff who are trained in data collection and interpretation. Data assessment must consider the anticipated design performance of the project, and whether the actual performance is within design safety thresholds. Data anomalies in critical areas must be promptly evaluated by experienced technical staff. Evaluation may include but is not limited to verification readings, verification of calibration and collection methods, visual observation of area and instrument for damage or distress, and comparison with available redundant instrumentation.

14.2.6 In some cases, where data is complex and is relied upon for life safety risk reduction decisions, it may be appropriate to utilize independent expert consultants to review instrumentation data analyses and help validate conclusions.

14.3 Planning.

14.3.1 Instrumentation Systems. The design and construction of new projects as well as the rehabilitation, dam safety modifications, and normal maintenance of older projects present opportunities for planning instrumentation systems for the future engineering analyses of structural performance. Careful attention and detail must be incorporated into the planning of instrumentation systems and programs to ensure that the appropriate potential failure modes are adequately monitored. Once the parameters that are critical to satisfactory performance are determined by the design, appropriate instrument devices are selected to provide the engineering measurements to the magnitude and precision, and response time necessary to measure the parameters and evaluate project performance. Generally, the types of parameters measured are as follows;

14.3.1.1 Horizontal and vertical movement;

14.3.1.2 Alignment and plumb;

14.3.1.3 Strains in soil, rock-fill, and foundations;

14.3.1.4 Piezometeric pressure;

14.3.1.5 Uplift pressure;

14.3.1.6 Seismic effects;

14.3.1.7 Seepage clarity (turbidity) and quantity over time, and instantaneous flow;

14.3.1.8 Reservoir levels;

14.3.1.9 Tailwater / River water levels;

14.3.1.10 Precipitation; and

14.3.1.11 Temperature of the structure, ambient air, and water.

14.3.2 References.

14.3.2.1 ER 1110-2-103 (reference A.44) gives guidance on instrumentation for seismic effects, including instrumentation, automation, and determination of performance parameters.

14.3.2.2 EM 1110-2-1009 (reference A.72) gives guidance on Structural Deformation Surveys.

14.3.2.3 EM 1110-2-2300 (reference A.87) provides information on design and construction of earth and rock-fill embankments.

14.3.2.4 EM 1110-2-4300 (reference A.92) provides information on instrumentation requirements for concrete structures.

14.3.2.5 EM 1110-2-1908 (reference A.77) provides detailed information on all aspects of instrumentation, including staffing qualifications, data management, analysis, reporting, and long-term reassessments of embankments dams.

14.3.2.6 EM 1110-2-1901 (reference A.74) provides information on analysis of seepage.

14.3.2.7 Additional information on data documentation is included in Appendix U.

14.3.3 Instrumentation System Requirements. Baseline readings for all instrument data must be generated. Statistical and graphical methods are simple ways to establish those baselines. In all circumstances, background information that may affect the validity of the data or the analysis of the performance must be documented, archived, and readily available for data reviewers. Other considerations include the potential for damage during construction and operations; the effects of a severe environment on the instruments; the personnel requirements for maintenance and data collection; and the evaluation of the instrument data. Automated systems have additional requirements as follows:

14.3.3.1 Each instrument must have the ability to be read manually or have another appropriate instrument that allows verification of the automated data.

14.3.3.2 Each instrument must have the capability to be read at the site and should be able to be uploaded to a network via satellite / radio / or other telemetry system.

14.3.3.3 A backup communication link to the district should be provided for the data transmission to allow redundancy for data acquisition when real time data is deemed critical to the operation and safety of the structure.

14.3.3.4 Automated data acquisition system should include (1) desktop microcomputer and (2) laptop/portable microcomputer and / or (3) hand held rugged reader. The desktop microcomputer serves as the local monitor station to collect, process, display and produce a hard copy of the data at the project office or other designated point. This local monitoring station must also be capable of performing a quality control check of instrument readings, responding to a preset threshold level, interfacing with existing project hardware and software applications and should have the ability to be queried from the district or other remote location. The laptop/portable microcomputer is for infield trouble shooting and maintenance. This laptop/portable microcomputer will also serve as a backup capable of collecting data manually from the infield data loggers. Hand held reader may be used as a more rugged and portable alternative for many of the laptop/portable microcomputer purposes.

14.3.3.5 In addition to these primary automation requirements, consideration must also be given to backup power supply, lightning protection, maintenance, vandalism, system diagnosis, and software versatility.

14.4 Installation and Maintenance.

14.4.1 New Projects. Instrumentation for a project must be included in the design phase, during construction, and throughout the life of the project as conditions warrant to reduce or characterize risk. After a project has been turned over to operational status, appropriate maintenance, repair, and replacement of instrumentation must be accomplished during the normal operation to ensure continuous data acquisition and analyses of critical performance parameters. Specialized expertise may be required to install and maintain instrumentation. Installation should be closely coordinated with construction activities to minimize instrument damage. Instrumentation systems are to be properly functioning, calibrated, and conforming to accepted standards and practices. All monitoring devices and systems will be periodically inspected, maintained, and calibrated in conformance with established procedures. Results of those procedures are to be documented and maintained as official records. Repairs, replacement, reinstallation, and the installation of new instruments are to be documented and completed in a prompt manner consistent with accepted practices. Documentation of all essential and significant details concerning repairs or modifications to existing devices, or the installation of new devices, are to be maintained as official records.

14.4.2 Existing Projects. Existing projects must be evaluated to ensure that the original instrumentation is functioning as intended and is still appropriate. Threshold limits determined for original design condition or major modifications must be examined and reviewed against current criteria. The instrumentation plan may require modification to delete some instruments and/or add other instruments in areas on the project where additional monitoring is required by performance concerns or advances in design practices. Replacement or addition of instrumentation by drilling or other invasive methods in an embankment or in the foundation of a dam is not to be done without prior approval of a drilling plan. A risk assessment, at least the equivalent of that done in support of the Periodic Assessment, which addresses the need of the additional or replacement instrumentation, is required as the basis to support the drilling plan. See ER 1110-1-1807 (reference A.41) for guidance on development, review, and approval of the drilling plan.

14.5 Data Collection, Interpretation and Evaluation.

14.5.1 Collection

14.5.1.1 Frequency. The frequency with which instrumentation data is obtained must be tailored to the instrument purpose, period of construction, investigation or other interest, and project operating conditions. In all cases, sufficient calibration and background data must be obtained to ensure that a reliable database is available to facilitate subsequent comparisons. All instrument readings and associated information and observations are to be recorded in a maintained database as official records. The reading frequency of instruments during construction and operating conditions must be based on needed warning times and anticipated rate of loading, such as changes in reservoir levels. Reading frequencies are to be determined by a dam safety engineer familiar with the design, potential failure modes, and performance parameters of the project.

14.5.1.2 Increased surveillance and monitoring, to include more frequent readings, may be required when operating under Interim Risk Reduction Measures (IRRM) or during critical Dam Safety events such as high or surcharge pool or near record pool. The district must document when this increased surveillance and monitoring is to be invoked in the project specific surveillance plan. Those instruments that are critical for monitoring during the increased surveillance and monitoring periods are to be documented in an addendum to the project specific surveillance or monitoring plan.

14.5.1.3 Personnel Qualifications. Instruments are to be read by qualified personnel trained in up to date procedures. The specialized experience and skills necessary for instrument reading are to be maintained for each project. Specialists in the use of instrumentation are to ensure that field personnel are knowledgeable in the use and purpose of each instrument. Readings are to be obtained from properly functioning instrumentation systems that conform to accepted performance monitoring standards and practices. A schedule that lists when and how field personnel are to collect, review, and transmit readings is to be maintained for each project.

14.5.1.4 Field Review of Collected Data. Instrument readings collected by project personnel are to be compared with previous data and reviewed for unexpected changes or anomalies during the collection process or as soon as practicable. All processed readings and associated commentary are to be maintained as an official record and in a readily available database.

14.5.2 Data Presentation and Evaluation.

14.5.2.1 The timely reduction and evaluation of instrumentation data is essential for a responsive safety evaluation of the project. For all USACE projects, this reduction and evaluation must occur as soon as conditions warrant from the time that the data was obtained.

14.5.2.2 As a minimum;

14.5.2.2.1 All instrument data should be plotted as instrument response with respect to time (time-history plot), as well as to reservoir level or other range of loading (correlation plot).

14.5.2.2.2 Present the instrument and performance data on cross sections that show the location of and installation details of the instrument, the foundation geology, the cross section of the dam with design details of the zones of embankment dams or the cross section of concrete dams, and the range of the design (design assumption and performance threshold) values and measured values at the instrument location.

14.5.2.3 All instrumentation data must be reviewed regularly (typically not less than quarterly for most instrumentation) and evaluated not less than annually by a qualified and experienced engineer and/or engineering geologist familiar with the project.

14.5.2.4 Periods of Increased surveillance and monitoring will require more frequent and intensive review and interpretation of instrumentation data in accordance with established plans. Structural behavior that appears to increase risk will be considered a safety issue and will be investigated.

14.5.3 Performance Prediction. During the initial project design, or reevaluation in the case of existing structures, the physical properties of the construction materials, design data, loading conditions, potential failure modes, associated factors of safety, and the level of risk must be utilized to determine the desired threshold limits for each performance parameter. In addition, for existing structures, historical performance data should be utilized. Quantitative values must be established for these limits that can be translated into measurements of appropriate precision that are readily obtained in the field, which will enable the designers and operators to evaluate the behavior and performance of the structure. A detailed discussion of the design assumptions must be presented in the design documentation report (DDR) for new or modified features. The threshold limits along with the predicted performance levels must be addressed in the project instrumentation DDR and in detailed instructions to project personnel and any other personnel involved with the instrumentation. The method of deriving the thresholds must be documented to aid response to future exceeded thresholds. Exceeded thresholds must trigger increased scrutiny and evaluation of structural integrity.

14.5.4 Monitoring Plans.

14.5.4.1 Monitoring plans should remain adaptive to real time events. The scope, frequency, and intensity of monitoring and data collection and evaluation are to be adapted as appropriate to conditions.

14.5.4.2 Data collection, reduction, and evaluation methods should be reviewed and evaluated routinely (at least annually) to identify ways to improve the process, make it more efficient, and adjust monitoring frequencies as appropriate to project conditions. If resources limit data collection / reduction / evaluation, priority should be given to gather and assess data associated with high risk project features, based on a PFMA or detailed risk assessment.

14.5.5 More detailed guidance for data acquisition, interpretation and presentation can be found in Appendix U of ER1110-2-1156, EM 1110-2-1908 (reference A.77), and EM 1100-2-4300 (reference A.92).

14.6 <u>Reporting.</u>

14.6.1 Upon completion of new projects or significant modifications to projects, the instrumentation data along with the written evaluation must be consolidated and submitted to the MSC DSO in accordance with Appendix U and ER 1110-1-1901 (reference A.42). A written evaluation must also be incorporated in the subsequent periodic inspection reports. This activity is to be budgeted and paid for by the project construction funds.

14.6.2 Annual Dam Safety Instrumentation Program Review and Project Performance Review.

14.6.2.1 The District DSO must provide annually to the MSC DSO a written summary and evaluation of the district's instrumentation program. The annual program review must present a district level review of the Dam Safety instrumentation program (one to two pages) and a summary evaluation of the performance of each dam in the district's dam safety program.

14.6.2.2 The project summary will be a one or two page summary for each dam addressing the instrumentation status (document changes in instrumentation), evaluation of project data and performance and presentation and discussion of any abnormal readings.

14.6.2.2.1 The summary will include a plan showing project features and instrumentation location and a representative cross section(s) that show the range of readings measured for the year. The cross section will show the location of and installation details of the instrument, the foundation geology, the cross section of the dam with design details of the zones of embankment dams or the cross section of concrete dams, and the range of the design (design assumption and performance threshold) values and measured values at the instrument location.

14.6.2.2.2 The annual summary will also include a specific write up on the performance of all high risk (DSAC 1 and 2) dams.

14.6.3 The project information obtained annually must be included in periodic inspection reports of the project in a format in accordance with Appendix U and AE of this ER, EM 1110-2-1908 (reference A.77), and EM 1110-2-4300 (reference A.92).

14.6.4 Instrumentation program records must also be reported to and retained by the operations project staff.

14.7 Funding. The appropriate funding (General Investigation, Construction General, Operation and Maintenance, General appropriations, etc.) must be utilized to accomplish the level of instrumentation outlined in this regulation for a new dam or modification of a dam. Funding for maintenance of instrumentation, data collection, data analysis, and reporting must be included in the minimum routine program of the annual Operations and Maintenance budget submission. New or replacement instruments must be programmed in the annual budget submissions as non-routine work items, and prioritized based on criticality. A risk assessment, at least the equivalent of that done in support of the Periodic Assessment that addresses the need of the additional or replacement instrumentation is required as the basis to support the need for the new or replacement instrumentation. The DSAC, the magnitude of the flood risk, and the potential failure modes that are contributing to the flood risk must be considered in budget prioritization, and coordinated with Operations and Programs staff.

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CHAPTER 15

Dam Safety Training

15.1 Overview. USACE has an extensive program for training personnel in all matters related to its mission in water resources development. Much of the training is directly or indirectly related to dam safety. A comprehensive training program is conducted for dam operation and maintenance personnel. This program is designed to acquaint project personnel with basic engineering considerations pertaining to the major structures, with procedures for surveillance, monitoring and reporting of potential problems, and with emergency operations. In addition, the technical staff at the district office requires training to build expertise and ability to respond to emergencies. USACE has a training course on “Dam Safety” and has supported the development of the Training Aids for Dam Safety (TADS) Program (reference A.120). In 1991, the FERC initiated a training course on “Emergency Action Plan”. ASDSO maintains a list of currently scheduled dam safety training courses on the website at http://www.damsafety.org.

15.2 USACE Training Course on Dam Safety. USACE Proponent Sponsored Engineer Corps Training (PROSPECT) program offers a course titled “Dam Safety”. Through lectures, case histories, and structured student discussions, the course covers all aspects of a dam safety program. The course outlines technical considerations (hydrologic, seismic, geotechnical, electrical/mechanical and structural) as well as the operational requirements (operation, maintenance, surveillance, preparedness, training, and notification). Because of this broad coverage of the entire program, this course is appropriate for technical, management, and operations staff. The scope and implementation details of the Dam Safety Program are covered in detail. Presentations, video modules, case histories, and a walk-through inspection are used to effectively present a multidiscipline approach to the successful monitoring and evaluation of USACE dams. Additional technical coursework within the PROSPECT program is under consideration and development to allow students even more in-depth training opportunities.

15.3 National Dam Safety Conferences. National dam safety conferences, such as the Association of State Dam Safety Officials (ASDSO) annual conference, the United States Society on Dams (USSD) annual conference, the USACE Infrastructure Conference, the USACE Dam Safety CoP Conference, and conferences sponsored by other agencies, have speakers who are involved in state-of-the-art dam safety evaluations and remediation. These conferences are a great opportunity to share the technology and experiences of dam safety with people from other agencies, and within USACE. Participation in these conferences can be valuable training in dam safety activities.

15.4 Exchange Training – District to District. Participation in another district’s dam safety training, periodic inspections, and emergency exercises can be good training in dam safety and can spread the good things learned in one district to other districts. Other districts should be invited to attend periodic inspections, dam safety training, and emergency exercises, and whenever feasible, dam safety personnel should participate in those activities in other districts. There is a lot of information and experience available that could be beneficially shared within districts and both districts could gain from the activities. In addition, developmental opportunities to a construction office to participate in an on-going dam rehab/remediation can be an extremely valuable training tool.

15.5 Training Program for Operations and Maintenance Personnel.

15.5.1 Dam Safety. Recognizing the important role that onsite operations and maintenance personnel have in dam safety, MSC commanders were directed in 1978 to develop a training program that addresses the following items:

15.5.1.1 Discussion of basic typical design considerations for various types of construction, including hydraulic considerations and foundation factors

15.5.1.2 Procedures for monitoring potential problem areas

15.5.1.3 Dam safety features in design and construction.

15.5.1.4 Normal operation, surveillance, monitoring, and reporting procedures

15.5.1.5 Emergency operations, surveillance, monitoring, and reporting procedures

15.5.1.6 Project specific features and history of problems and potential problems.

15.5.2 Training Frequency. All new field employees and field contractor personnel must have a minimum of 6 hours training shortly after starting duty and at least 6 hours refresher training every five fiscal years.

15.5.3 Records. The Operations Project Manager must document all formal training. These records must be kept on file at the employee's project office and must be available to the periodic inspection team and readily accessible for emergency response.

15.5.4 Exercises. Upon completion of the initial safety training at a new project, EAP exercises are developed based on the most probable emergency situations that might occur on each major dam feature. Operations personnel should participate in all regularly scheduled emergency exercises at their project or other projects in order to develop a better understanding of their role in an actual emergency.

15.6 Sample Dam Safety Training Course Outline for Project Personnel.

15.6.1 Purpose of Training Program. Include the following subjects in the training; basic objectives, history of dam failures, and films or slides depicting dam safety problems or failures.

15.6.2 Dam Safety Features in Design and Construction. Design philosophy for dams, design assumptions, construction history, salient features and regulating philosophy for the project, and past monitoring, experiences and performance for projects.

15.6.3 Normal Operation, Surveillance, Monitoring and Reporting Procedures. The value and use of instrumentation, effect of pool rises on monitoring requirements, reservoir regulation manuals, day-to-day surveillance, documentation of plans, records, reports, etc, generalizations on what is and what is not critical to safety of the structure, public relations with local communities, and coordination and notification to downstream water users and recreationists on controlled releases and flushing operations.

15.6.4 Emergency Operation, Surveillance, Monitoring and Reporting Procedures. Observations of evidence of distress, methods of treating obvious safety problems, knowledge of potential flood area downstream, alerting USACE offices to emergency conditions, and alerting police and local civil defense groups to emergency conditions must be established for each dam.

15.7 Dam Safety Training Courses.

15.7.1 Existing Available Courses.

15.7.1.1 Bureau of Reclamation Safety Evaluation of Existing Dams (SEED). The USBR has a dam safety training course for their personnel. In some cases it is more cost effective for USACE personnel in the western portion of the country to attend these courses than the PROSPECT courses. This training is another option that should be considered when selecting training for USACE personnel in dam safety.

15.7.1.2 Training Aids for Dam Safety (TADS).

15.7.1.2.1 Background. In 1986, USACE, along with 13 other Federal Agencies, all members of the Interagency Committee on Dam Safety (ICODS), joined forces to develop a professionally prepared TADS Program (reference A.120). The TADS materials are arranged in three components that cover dam safety inspections, dam safety awareness and program development, and evaluations and remedial actions (reference A.115).

15.7.1.2.2 Structure. The entire package consists of 21 self-paced individual instruction modules that focus on performance of job tasks. Each module features a workbook text. The material is presented in a straightforward, easy-to-manage manner. Each workbook contains a glossary of terms and a list of references from which to obtain additional information. Some modules are supplemented with videotapes that illustrate certain concepts. Because the modules are self-contained, individuals may tailor a learning program to meet specific work requirements or personal needs.

15.7.1.2.3 Utilization of the Program. The TADS Program (reference A.120) offers a standardized approach to dam safety training. USACE, as one of the primary sponsors of the TADS Program, distributes the materials to each USACE field office through the Engineering and Construction, Directorate of Civil Works, HQUSACE. All MSC's and districts must maintain a complete set of modules including the videotape supplements. A copy of the full Program can be obtained on DVD from FEMA Publications at no costs (reference A.120).

15.8 Risk Assessment Training. The RMC will provide training on those activities and procedures that support risk assessments.

15.9 Consequence Training. Training on state-of-the-art USACE approaches for estimating consequences with initial emphasis on life loss and direct economic loss. As the tools evolve, training in additional consequences such as indirect economic losses, environmental and other non-monetary consequence will be offered. This training in support of dam safety risk assessments is provided by several means. For district staff committed to providing consequence assessment services to the MMC, annual courses are provided by the USACE Hydrologic Engineering Center (HEC). The focus is on bringing these staff up-to-speed so that they can fulfill the requirements of their agreement with the MMC. At present, there is an agreement between the MMC and the trainee's district that requires the district to allocate 50% of the trainees' time to support the MMC for a period of 2 years. Also, consequence assessment training can be provided by HEC on a reimbursable basis. A PROSPECT course (Consequence Estimation with HEC-FIA) presenting HEC-FIA (the most common tool used for estimating consequences in support of dam safety risk assessments) has been added to the PROSPECT catalog. Over the coming years, consequence estimates for risk assessments material will be worked into other regular PROSPECT courses to enable access by a broader audience.

CHAPTER 16

Emergency Action Plans

16.1 General. An Emergency Action Plan (EAP) is a formal document that identifies potential emergency conditions (either dam failure or large spillway releases) at a dam and specifies preplanned actions to be followed in order to minimize property damage and loss of life. The EAP specifies actions the dam owner[4] should take to moderate or alleviate the problems at the dam. It contains procedures and information to assist the dam owner in issuing early warning and notification messages to responsible down-stream emergency management authorities in the event of an emergency. It also may contain inundation maps intended to highlight the critical areas for action for these emergency management authorities.

16.1.1 Historical references that provide the background for emergency action plans with USACE are as follows:

16.1.1.1 U.S. Army Corps of Engineers, Hydrologic Engineering Center, 1980 (Jun), “Flood Emergency Plans Guidelines for Corps Dams,” Research Document No. 13. Davis, CA (reference A.105).

16.1.1.2 U.S. Army Corps of Engineers, Hydrologic Engineering Center, 1982 (Jan), “Emergency Planning for Dams, Bibliography and Abstracts of Selected Publications,” Davis, CA (reference A.106).

16.1.1.3 U.S. Army Corps of Engineers, Hydrologic Engineering Center, 1983 (Aug), “Example Emergency Plan for Blue Marsh Dam and Lake,” Research Document No. 19, Davis, CA (reference A.107).

16.1.1.4 U.S. Army Corps of Engineers, Hydrologic Engineering Center, 1983b (Aug), “Example Plan for Evacuation of Reading, Pennsylvania, in the Event of Emergencies at Blue Marsh Dam and Lake,” Research Document No. 20, Davis, CA (reference A.108).

16.1.2 While the dam owner retains overall responsibility for the development of the EAP, this (and all subsequent revisions) must be done in close coordination with those having emergency management responsibilities at the state and local levels. Emergency management agencies will use the information in a dam owner's EAP to facilitate the implementation of their responsibilities. State and local emergency management authorities will generally have some type of plan in place, either a Local Emergency Operations Plan or a Warning and Evacuation Plan.

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[4] As used in this chapter, the term “dam owners” and their responsibilities are intended to have the same meaning as used in FEMA’s dam safety guidelines for emergency action planning, issued in 1998 by the Interagency Committee on Dam Safety to supplement the 1979 Federal Guidelines on Dam Safety. See Federal Guidelines for Dam Safety: Emergency Action Planning for Dam Owners” (1998) (April 2004 reprint) at page 3, footnote 1 (“The term dam owner, as used in these guidelines, refers to the individual dam owner or the operating organization.”).

16.1.3 The effectiveness of an EAP is greatly enhanced by utilizing a consistent format which ensures that all aspects of emergency planning are covered in each plan. Having both a uniform EAP and advance coordination with local and state emergency management officials/organizations are critical in facilitating a timely response to a developing or actual emergency situation. Ownership and development of the floodplain downstream from dams varies, therefore the potential for loss of life as a result of failure or operation of a dam will also vary. For this reason every EAP must be tailored to site-specific risks/conditions and failure modes yet should remain simplistic enough to encourage its use. This should include the full range of failure scenarios (including upstream landslide failures, if appropriate) as well as different detection times for the incident.

16.1.4 Recognizing the importance of overall federal uniformity in the management and design of dams, an ad hoc Interagency Committee on Dam Safety (ICODS) was established and issued a report containing the first guidelines for federal agency dam owners. The Federal Guidelines for Dam Safety (reference A.114) generally encourage strict safety standards in the practices and procedures employed by federal agencies or required of dam owners regulated by the federal agencies. To supplement these published guidelines, ICODS also prepared and approved "Federal Guidelines for Dam Safety: Emergency Action Planning for Dams" (reference A.117). This document is intended to serve as the over-arching guidance which governs the content, structure, and implementation of EAPs for USACE.

16.2 Requirements. There are a few exceptions/elaborations to the Federal Guidelines related to EAPs that should be noted. These include:

16.2.1 EAPs are required for all USACE Dams, including appurtenant structures having separate consequences from the main dam. This policy is more comprehensive than the Federal Guidelines, which specify EAPs only for high and significant hazard potential dams. EAP format/content for dams with high and significant hazard potential should follow the specifics outlined in this document and the Federal Guidelines. For dams that are very similar and possibly on the same waterway such as navigation projects, one EAP may be developed for the system with different call sheet for each project. For dams classified as low hazard potential, whether flood risk management or navigation, dam owners should scale back the complexity of the EAP to better fit the unique situation at the project. However, as a minimum the EAP should include information on notification, emergency detection, responsibilities, and preparedness.

16.2.2 Inundation maps are required for any dam whose failure could result in loss of life or significant property damage as a direct result of the incremental flooding caused by failure of the dam. When required, inundation maps must be prepared for the following three inundation scenarios: 1) Sunny day with dam failure, 2) Flood with dam failure, and 3) Flood without dam failure (non-breach inundation). Coordination with the MMC is required to obtain the most current and appropriate definitions of these scenarios for a particular project or study. Inundation maps are generally not required when the dam failure does not cause any incremental flooding, when dam failure discharges would not exceed downstream channel capacities or flood stages, or when consequences are limited to loss of service (e.g. navigation or hydropower disruption due to loss of pool).

16.3 Emergency Exercises.

16.3.1 Emergency Incidents. Emergency incidents at dams are not common events. Therefore, training and regular exercises are necessary to maintain proper operational readiness. In addition, annual meetings between a dam owner and emergency responders can facilitate a better understanding of roles and responsibilities and will enhance emergency readiness. The state of readiness should also be determined through periodic and regular simulations of emergency events. These emergency exercises should be initiated by the dam owner and should involve all of the key players who would normally be involved in an actual event. Consideration should be given to combining exercises for projects in the same watershed or multiple projects in the same geographical area. Periodic exercises will result in an improved EAP as lessons learned during the exercise can be incorporated into the updated document.

16.3.2 Participants in Exercises. Because nearly any dam safety incident has detection and reaction components, conduct of these exercises should be jointly led by a district's dam safety/technical elements (DSO, DSPM, and technical elements) and the Emergency Management Office. The entire exercise should also be coordinated properly with the appropriate Operations personnel since they will have first-hand knowledge of the incident and the affected community. Exercises should ensure that both the technical aspects (i.e. internal district performance relating to detection and decision-making) as well as emergency management aspects of dealing with appropriate state/local officials are fully covered and evaluated. Focusing on only one aspect at the expense of the other can be dangerous as it could lead to a false sense of security regarding performance.

16.3.3 Exercise Frequency. The frequency of emergency exercises should correspond directly to the Dam Safety Action Classification (DSAC) rating and hazard potential of the project. The definition of the various hazard potential levels is given in Appendix J. That is, the higher the level of urgency (DSAC 1 being the highest level of urgency) the more frequently exercises should be conducted. As a minimum the EAP exercise schedule listed in table 16.1, Emergency Exercise Frequency, must be followed for all projects having significant life/property loss implications. Note that actual emergency events may be substituted for the appropriate exercise provided they are properly documented and the lessons learned from that event are incorporated into the updated EAP.

16.3.4 Exercise Levels. The definitions of the exercise levels are included in Glossary. It is recommended that all exercises be based on a failure mode of concern for the particular dam. If an exercise has not been done in the last 5 fiscal years, it is recommended to start with a tabletop exercise and work up to the level appropriate for the DSAC. Low hazard potential projects, regardless of the assigned DSAC, require only an initial orientation seminar or drill and then subsequent exercises at the discretion of the DSO. At their discretion and judgment, districts may choose to periodically conduct something more elaborate (i.e., tabletop, functional, or full-scale) if they deem the situation warrants.

Table 16.1 - Emergency Exercise Frequency

Exercises* / Classifications	Drill	Tabletop	Functional Exercise	Full Scale Exercise
DSAC 1 and High Hazard Potential		Year 1, 3, 5, etc….	Year 2, 4, 6, etc….	At DSO discretion
DSAC 2 or 3 and High Hazard Potential	Year 1, 3, 5, etc…	Year 2, 4, 6, etc	At DSO discretion	At DSO discretion
DSAC 4 or 5 and High Hazard Potential and All Significant Hazard Potential	Year 1 - 4 and 6 – 9, etc….	Year 5, 10, etc…	At DSO discretion	At DSO discretion
All Low Hazard Potential	Initial orientation seminar and subsequent exercises at the DSO discretion			

*Orientation Seminars must be held for all new dams and whenever new information is developed. Frequency is on a fiscal year cycle.

16.3.5 Homeland Security Exercise and Evaluation Program (HSEEP). This is a national exercise program being developed by the Department of Homeland Security.

16.3.5.1 The Homeland Security Exercise and Evaluation Program (HSEEP) is a capabilities and performance-based exercise program which provides a standardized policy, methodology, and terminology for exercise design, development, conduct, evaluation, and improvement planning (reference A.125). HSEEP Policy and Guidance is presented in detail in HSEEP Chapters I-III. Adherence to the HSEEP policy and guidance ensures that exercise programs conform to established best practices and helps provide unity and consistency of effort for exercises at all levels of government.

16.3.5.2 HSEEP constitutes a national standard for all exercises. Through exercises, the National Exercise Program (reference A.125) supports organizations to achieve objective assessments of their capabilities so that strengths and areas for improvement are identified, corrected, and shared as appropriate prior to a real incident.

16.3.5.3 Use of the policy and guidance presented in HSEEP is recommended to ensure that exercise programs conform to established best practices and aids interaction with emergency service partners. Additional information about HSEEP is available from DHS at https://hseep.dhs.gov/pages/1001_About.aspx.

16.4 Modeling, Mapping, and Consequences Production Center (MMC). Inundation maps and data are one of the most useful tools to the emergency responders when dealing with an emergency event. They delineate the areas that would be flooded due to a dam failure or flooding resulting from large operational releases. Recognizing the need to have a more consistent, user friendly (i.e. easier to read/interpret), and accurate product the MMC was established. The mission of this center (comprised of H&H, GIS, and economist professionals from across USACE) is to employ the latest technological tools to ensure consistency in how inundation maps and associated consequences are developed. While the actual production work may still be completed locally, coordination with this center is mandatory prior to work beginning so that the most current and appropriate guidance can be provided for a specific study or project.

16.5 Security Provisions. In recent years, man-made disasters (i.e. acts of terrorism) have been a cause of increasing concern. A comprehensive EAP should not only include security provisions surrounding a dam during an emergency event but must also consider actual failure modes (and associated consequences) initiated by such an event. These are particularly critical as they can potentially occur with no warning thereby resulting in very little response time

16.6 Communications. Good communication is a key element for successful execution of any EAP. This includes not only internal communications between USACE team members, but also between others who could potentially play a role in an emergency event. The dam owner should always strive to raise the level of public awareness (e.g. utilization of the media and internet) as it relates to dam operations and emergency response procedures. A detailed communications plan is recommended to be included as part of the official notification flowchart/chapter or as a stand-alone appendix to the EAP in order to reinforce its importance. Items recommended for inclusion are:

16.6.1 Notification Lists. Listing of persons to be notified about each emergency condition for which plans are made and procedures for notification. This should include a description of primary and secondary means of communication to be used, listing of telephone numbers and addresses, and other information needed for reliable and prompt contact for:

16.6.1.1 Notifications Internal to USACE. This would include all communications within the district (e.g. notification to DSO, DSPM, EM, and/or appropriate technical element) as well as formal notification through command channels in accordance with this regulation.

16.6.1.2 Notifications from USACE to Principal Local Officials.

16.6.1.3 Notifications from USACE to Other Federal Officials.

16.6.1.4 Distribution of warnings from USACE to officials responsible for dissemination to the general public (e.g. National Weather Service for use in public warning system).

16.6.1.5 Dissemination of warnings by USACE directly to the general public in the immediate vicinity of the dam and reservoir.

16.6.1.6 As a minimum, full descriptions and separate actions required under each of three emergency classifications (failure imminent or has occurred, failure situation is developing, and non-failure emergency condition).

16.6.2 Example Press Releases. Example press releases for each emergency condition for which a plan is prepared and instructions for adaptation before their use to the specifics of an emergency situation including but not limited to:

16.6.2.1 Exact nature of emergency and degree of danger

16.6.2.2 Remedial action under way

16.6.2.3 Expected course of events and timing

16.6.2.4 Appropriate action for public to take

16.6.2.5 Description of the procedure and means for dissemination of warnings directly to the general public in the immediate vicinity of the dam and reservoir

16.7 Dam Owner's Responsibilities. Each EAP must include information to help guide the dam owner in making immediate operational decisions in the event of various types of emergencies. Information must be included to identify the need for equipment, material, labor, and other necessities for carrying out emergency repairs. Items to be considered include:

16.7.1 Identification of the appropriate response to the type and severity of existing or potential emergencies.

16.7.2 Emergency gate operation.

16.7.3 Reservoir dewatering plan.

16.7.4 Description of equipment and materials to be stockpiled for use in carrying out emergency operations and repairs.

16.7.5 Assignments of responsibilities for carrying out emergency operations and repairs.

16.7.6 Description of needs for equipment, material, and labor not available at the site which are needed to carry out each type of emergency operation or repair.

16.7.7 Listing of nearby contractors and other sources of needed equipment, material, and labor and description of procedures for securing their assistance on an emergency basis.

16.8 Responsibility for Evacuation (Non-Federal).

16.8.1 Non-Federal officials are to be encouraged to develop evacuation sub-plans as a complement to the EAP prepared by USACE. Evacuation sub-plans should be considered for the following conditions:

16.8.1.1 Flood without dam failure

16.8.1.2 Flood with dam failure

16.8.1.3 Dam failure under sunny day or normal pool conditions.

16.8.2 Coordination with the RMC is required to obtain the most current and appropriate definitions of these scenarios for a particular project or study.

16.8.3 The objectives of the evacuation sub-plan are to provide for the timely and safe evacuation of threatened areas and the minimization of property damage. Items that might be covered in the sub-plan would include:

16.8.3.1 Description of traffic control arrangements to expedite evacuation and passage of emergency vehicles and prevent accidental travel into dangerous areas.

16.8.3.2 Provisions for any necessary assistance to evacuees such as transportation and aid to invalids.

16.8.3.3 Arrangements for sheltering, feeding, and other care of evacuees.

16.8.3.4 Description of actions to be taken to reduce damages and other losses.

16.8.3.5 Arrangements for security of evacuated areas.

16.8.3.6 Listing of vital services and facilities outside the area of inundation which will or may be disrupted by the level of inundation associated with each emergency condition for which plans are made.

16.8.3.7 Listing of major secondary problems resulting from the level of inundation associated with each emergency condition for which plans are made.

16.8.3.8 All areas which should be evacuated because of inundation, secondary problems, loss of services, isolation, or other reasons which are associated with each emergency condition for which plans are made.

16.8.3.9 Major evacuation routes.

16.8.3.10 Areas requiring priority in evacuation.

16.8.3.11 Potential obstacles to timely evacuation.

16.9 Review and Approval of EAP. The organizations responsible for review and approval of original EAP's and updates to EAP's are as shown in Table 16.2.

Table 16.2 - Review and Approval of EAP

	District	MSC
All Dams	Formulate, recommend, and implement	Review and Approval
All Dams	Annual Review and update required.	Review during Periodic Inspection

CHAPTER 17

Reservoir Filling Plans

17.1 Applicability. This chapter applies to all new and existing flood risk management dams, to all new navigation dams, and to all other dams constructed and/or operated by the USACE.

17.2 Introduction. Reservoir filling is defined as a deliberate impoundment to meet project purposes and is a continuing process as successively higher pools are attained. This may take place over only a few months but in many instances may be a process that takes several years. The initial reservoir filling is the first test of the dam to perform its design function. For this reason it is imperative that a comprehensive reservoir filling plan be developed well in advance of any actual impoundment event. It must also be recognized that existing reservoirs which have not yet experienced a design pool are actually undergoing a type of initial filling each time they achieve a new pool of record. Likewise, significant repairs or modifications to a dam might also necessitate the need to view the project as though it is once again undergoing an initial filling.

17.3 Reservoir Filling Plan.

17.3.1 A detailed reservoir filling plan must be established on a dam-by-dam basis for all reservoirs which are new, which have been significantly modified, or those which have yet to be filled to their design elevation. In general, the objective is to provide a planned program which allows adequate time for monitoring and evaluating the performance of the dam and its foundation as the reservoir is being filled (or as it achieves periodic record pool levels). This plan will utilize all pertinent hydrologic, hydraulic, structural, and geotechnical criteria that was developed during the design and construction of the project. If the plan is being developed for an existing dam, it must consider operational experiences. It must also consider all significant potential failure modes for monitoring and evaluation. Just because a dam is old in terms of years does not mean that it is old in terms of experience. Many factors must be considered when new or record impoundments are expected. These considerations might include:

17.3.1.1 Purposes of the new, modified or existing reservoir.

17.3.1.2 Risks associated with the filling - including potential failure modes.

17.3.1.3 Hazard potential both upstream and downstream.

17.3.1.4 Type of dam.

17.3.1.5 Dam Safety Action Classification (DSAC) of the dam.

17.3.1.6 The geology and seismicity in the vicinity of the dam/reservoir.

17.3.1.7 Landslide potential along the banks (both upstream and downstream).

17.3.1.8 Inflow characteristics (controlled or uncontrolled).

17.3.1.9 Hydrology of the river/basin as it relates to the time necessary to fill the reservoir.

17.3.1.10 Releases required to meet project minimum requirements.

17.3.1.11 Potential for flood releases.

17.3.1.12 Flood Emergency Plan and associated requirements.

17.3.1.13 Amount/type of instrumentation installed.

17.3.1.14 Provisions for monitoring/evaluating the instrumentation. Note: threshold readings should be established for instruments that change readings as a function of pool fluctuation.

17.3.1.15 Communicating the event.

17.3.2 Reservoir filling plans should consider all of the items listed above and must be organized to include (as a minimum):

17.3.2.1 Introduction and scope.

17.3.2.2 Project background and pertinent data (including history of pools experienced).

17.3.2.3 Preparations needed ahead of reservoir first filling.

17.3.2.4. Definition of reservoir filling which is specific to the reservoir (elevations, durations, etc…)

17.3.2.5 The preferred filling rate (for new projects), reasoning behind the recommended rate, and means to be used to control the rate of reservoir rise (if possible).

17.3.2.6 An inspection/surveillance plan designed to detect the most likely occurring problems. This must be tied to the identified significant potential failure modes associated with the dam. A visual inspection checklist must be developed to facilitate the effectiveness of the surveillance efforts and the reporting of results. Specific distress indicators for various failure modes must be identified in the checklist.

17.3.2.7 A plan for reading the instruments and evaluating the data throughout the entire filling process. This should also include the expected readings (i.e. what is normal for pools already experienced and what is expected for pools higher than yet experienced) and tied to specific responses in the event of readings outside the prescribed range. Reference EM 1110-2-2300 Appendix E (reference A.87) for detailed guidance relating to the establishment of performance/monitoring parameters and threshold limits.

17.3.2.8 Instructions for observers (inspectors and/or instrumentation evaluators) on conditions that require immediate attention of personnel authorized to make emergency decisions. Plan must clearly define reporting requirements and specific actions to be taken for all observed problems. An appropriate level of response should be clearly identified and matched with the severity of the observation.

17.3.2.9 Discussions regarding public safety contingency plans. The Emergency Action Plan for the project should be complete, current and tested in accordance with the provisions of Chapter 16.

17.3.3 Initial reservoir filling plans for new reservoirs should be very comprehensive and exhibit an overall conservative approach due to the large number of unknowns. For existing reservoirs, the level of inspection, monitoring, etc… prescribed in the reservoir filling plan should be directly proportional to the perceived/identified risks as categorized by the project's DSAC. Because of their higher level of assigned risk, projects designated as DSAC 1, 2, and 3 should strongly consider establishing elevations (or pool frequencies) somewhat lower than the pool of record where actions in the reservoir filling plan would be initiated. In any event, a thorough review and testing of the reservoir filling plan should routinely be included as part of any project's Interim Risk Reduction Measures Plan (IRRMP).

17.3.4 A completed and approved reservoir filling plan must be furnished to design, inspection, monitoring and operations personnel prior to any applicable event. It is recommended that an on-site meeting be held prior to the initiation of any filling event. This would include both initial filling as well as forecasted record pools. This meeting would bring all of the interested parties together and would assure the plan, including all roles and responsibilities, is clearly understood. In addition, periodic emergency exercises (as outlined in Chapter 16) should introduce scenarios whereby record pools are forecast so that implementation of the reservoir filling plan can be tested and improved.

17.4 <u>Plan Approval</u>. Reservoir filling plans must be prepared by the District, approved by the District DSO and furnished to the MSC DSO for informational purposes. Reservoir filling plans must include water control plans and reservoir regulation schedules that are developed and approved in accordance with ER 1110-2-240 (reference A.45).

17.5 <u>Performance Report</u>. A performance report must be prepared upon completion of a first filling (or new pool of record) event. This report will be transmitted through the appropriate district technical elements to the district DSO within 2 weeks of the event.

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CHAPTER 18

Risk Assessment Methodology

18.1 General.

18.1.1 The RMC is responsible for the development, dissemination, and interpretation of methodology guidance for use in conducting dam safety risk assessments. As the state of the practice for risk assessment continuously evolves and improves, the RMC should be contacted for the most current risk assessment methodology guidance. Methodology guidance is developed and provided at two basic levels. A best practices manual (reference A.109) has been developed jointly with the United States Bureau of Reclamation (Reclamation) for the purpose of summarizing the overall philosophy, methods, and approach to risk assessment for dam safety. In support of the best practices manual, a suite of toolboxes has been developed to provide specific methods and tools for performing analyses of loading, failure modes, and consequences needed to inform inputs to a risk assessment.

18.1.2. A goal is that models and software tools used for dam safety risk assessment will be certified following the appropriate model quality policies and procedures. Occasionally, a dam safety study will involve significant economic or environmental concerns and the study may specifically need a certified model. If an existing certified model does not exist, it may be appropriate to fund certification of the model with dam safety modification study funds. Model certification in support of dam safety studies should be coordinated with the RMC.

18.2 Philosophy and Approach.

18.2.1 The methodology contained in the best practices manual (reference A.109) and supporting toolboxes provide a suite of scalable assessment approaches that provide information to promote critical thinking and guide a risk analyst's judgment. These methods are scalable and can be applied with varying degrees of effort (time and cost) to provide the appropriate level of accuracy and rigor required to make credible risk informed decisions. It is important to understand that every decision does not require a high level of rigor, detail, and accuracy in the risk estimate in order to support a credible decision.

18.2.2 Risk cadres and others conducting risk assessments are accountable for understanding the methodology, making and documenting credible and transparent decisions on key input parameters, explaining why the results either do or do not make sense, and adjusting the risk estimate accordingly. The risk analyst will always decide the final answer, not the method or analytical tool. This will require some judgment and team elicitation to translate the results obtained from the toolboxes and other likelihood factors to a logical risk estimate. Analysts must apply an understanding of the failure modes, key factors, uncertainties, and sensitivities to obtain a risk estimate that they are willing and able to defend with a set of logical arguments.

18.2.3 The risk assessment results will be challenged and debated. The risk analyst must be prepared to explain and defend the logic behind the risk estimate. This process leads to better decisions in an environment of imperfect information. A group of experts will rarely agree on all of the details of a risk assessment but can usually obtain agreement on the key decisions and the path forward. This agreement is achieved by working for consistency between the risk estimate, recommended actions, and understanding of the situation (i.e. does it make sense).

18.2.4 All risk estimates must give due consideration for intervention. Intervention includes those actions that can lead to preventing a breach from occurring or mitigating the consequences of a breach. Successful intervention requires taking actions to detect a developing failure mode and then taking actions to arrest further development of the failure mode. Risk estimates are to be made and presented for both with and without intervention scenarios. It is important to understand the potential benefits of intervention while at the same time not masking the potential seriousness of a dam safety issue by using intervention to reduce the estimated risk. The risk estimates for with and without intervention scenarios will be portrayed on the tolerable risk guidelines.

18.2.5 All risk estimates must give due consideration for uncertainty and sensitivity. Key areas of uncertainty and sensitivity are to be identified and their potential effect on the risk estimate and resulting decisions presented. This can be accomplished either qualitatively or quantitatively depending on the needs of the risk assessment. It is important to understand that lack of information does not increase risk, but rather it increases uncertainty.

18.2.6 The event of interest in a dam safety risk assessment is failure which is defined as a set of events leading to sudden, rapid, and uncontrolled release of the reservoir impoundment. The probability of exceeding an analytical limit state (i.e. factor of safety less than one) is not the same as probability of failure. Limit state exceedance is only one factor to consider and may not necessarily initiate a failure mode. Similarly, the probability of a serious incident is not the same as probability of failure.

18.2.7 Individual dams are often part of larger infrastructure systems. Within these watershed systems, risk is attributed to the specific infrastructure that is the source of the risk. This includes due consideration for cascading impacts in the ‘downstream’ direction. If failure of the dam being assessed would result in overtopping and subsequent breach of downstream dams and/or levees, then the risk associated with these cascading failures would be attributed back to the dam being assessed. Risks generated by failures of ‘upstream’ infrastructure are usually not considered. If failure of an upstream dam would result in overtopping and breach of the dam being assessed, then increases in the magnitude and frequency of loading caused by failure of the upstream dam would not be included in the risk estimate. To support portfolio prioritization decisions or to communicate the flood risk from multiple flooding sources, there may be a benefit in estimating the risk from a systems perspective in certain situations. These analyses can support improved prioritization decisions within the larger watershed to obtain more efficient and effective risk reduction across the portfolio. In these special cases, it may be appropriate to evaluate the cascading impacts of failure in both the 'upstream' and 'downstream' directions.

18.2.8 Risk assessments in support of dam safety primarily focus on the incremental risk resulting from failure of the infrastructure. This is done to separate the risks imposed by failure of the dam from the non-breach and residual flood risks that exist in the floodplain. The incremental risk is obtained by estimating the incremental consequences associated with each failure pathway in the event tree. For a given scenario defined by a specific pathway, the incremental consequences are computed as the difference between the consequences assuming the failure occurs and the consequences assuming the failure does not occur.

18.2.9 Risk assessments will prepare and communicate a risk estimate for the non-breach risk which is essentially the risk that remains even if the infrastructure performs its intended function without failing. The non-breach and residual risk can still be high and should be communicated to affected parties. Most of the information needed to estimate risk for non-breach scenarios is readily available because it is already needed to build the event tree and estimate the incremental risk.

18.3 Best Practices. The USACE Best Practices manual must be maintained and updated on an as needed basis by the RMC. The current version of the USACE Best Practices Manual (reference A.109) may be obtained from the RMC. The risk cadres must use the USACE Best Practices manual to guide their efforts in determining the loads, the conditional probability of failure associated with each failure mode, and the consequences associated with each failure mode.

18.4 Combining and Portraying Risks. After all potential failure modes have been identified, described, and evaluated relative to the risk they pose, the results need to be combined and portrayed so that the technical reviewers and decision makers can understand and act upon them. This requires some attention to detail, which if not undertaken properly, can result in an improper portrayal of the risk. During risk assessments, estimates of risk are generated for individual failure modes. These estimates might include probability or risk values for different loading conditions, loading ranges, failure modes, spatial segments, or other situations. Not only do the individual estimates result from an aggregation of their own constituents, but they themselves are often combined in some way to express their collective effect. In practice, the most common problems encountered during risk assessments are related to systems, correlations, common-cause loading, and combining risks. Although the methods to evaluate these issues can be complex, some simplifications can be applied to situations commonly seen when evaluating risks for dams. The Best Practices Manual (reference A.109) guidance provided the details on how to properly combine and portray risks.

18.5 Risk Assessment Documentation.

18.5.1 The basis for the recommended actions should be documented in an objective, transparent manner, portraying the data, analysis, findings and any associated uncertainties in data or analysis on a factual basis. The findings and recommendations are presented in the formal risk assessment report in support of the PA, IES, or DSMS. The objective of the risk assessment report is to present logical and rational documentation of analysis and results that accurately portray the risk assessment and recommended course of action in a manner and style that is to be read and understood by senior decision makers. The three basic risk components, (i.e. load probability, response probability, and consequences) should portray the dam's existing condition and ability to withstand future loading, the risk estimates, and provide the basis for the recommended actions. Since uncertainty is inherent in data, analysis, and conclusions/interpretations, the documentation should also address whether confidence is high enough for the recommendations to stand on the basis of existing evidence. The risk assessment report should present information regarding two main issues. First, data, analysis, and conclusions should support that risk falls within one or the other of the action-justification categories. Second, the risk assessment report must substantiate the confidence in the assigned DSAC, and whether additional exploration, investigation, or analysis has a reasonable likelihood of changing the perceived risk such that the dam could be assigned a different DSAC.

18.5.2 It is the factual information and associated interpretation presented in the risk assessment report that determines whether the risk numbers generated and the actions recommended make sense or 'feel right' in light of an understanding of the condition of the facility and its recent history of structural behavior. For many dams, the volume of available information can be substantial. The process of sorting through this information, pulling out the most applicable data (instrument, geological, geotechnical, construction and current condition photographs, drawings, etc.) and then assimilating it into a useful and concise format is extremely important for understanding the dam and foundation characteristics and how they relate to potential failure modes. Further guidance on documenting dam performance and site characterization in support of risk assessments is provided in Appendix U.

18.5.3 A risk assessment report built upon sensitivity studies should investigate what would happen if more information was gathered, and whether the information is important. Plausible upper and lower bound values for variables in question can be chosen and processed through whatever assessment is being considered. When this test causes the perceived risk to move significantly, action may be warranted to obtain additional information. A move is significant if it changes the risk tolerability category. Additional reasoning to show why the upper or lower bound values are plausible is necessary to support a recommendation for acquiring additional information and why the additional information being requested is likely to reduce the uncertainty.

18.6 Quantitative and Semi-Quantitative Risk Assessments. Quantitative or semi-quantitative risk assessments can be desirable in some cases where it is desired to apply risk assessment principles to the decision making without the time, cost, and data/assessment requirements associated with a quantitative risk assessment; for screening assessments of a portfolio where it is desired to get a quick evaluation of the risks so that risk reduction studies and actions can be prioritized; and for sensitive cases that involve stakeholders that are more likely to understand and accept qualitative assessments rather than detailed numerical analyses.

18.7 Facilitating Risk Assessments.

18.7.1 Facilitators are assigned to teams to assist them through a potential failure mode analysis (PFMA) and the risk assessment process. The facilitator contributes to the process by bringing experience with risk assessments, consistency in approach, knowledge of latest technology in risk assessments, and serves as a resource to the risk assessment team for technical input and questions. The facilitator must be experienced and generally familiar with most aspects of dam behavior. In addition, skills are needed to guide a team through the process. Facilitation is a critical part of the process to develop credible risk estimates during an assessment of risk. In general, the facilitator meets with the team prior to a risk assessment to ensure engineering analyses are completed to support the team assessment and ensure the team composition is appropriate to develop credible risk estimates, facilitates the team risk assessment, helping the team develop potential failure modes, event trees, strategies for estimating risks, and developing ranges of likelihood and consequence estimates; and reviews the final report.

18.7.2 The facilitators are primarily tasked to ensure appropriate methodologies are followed to develop risk estimates; the methods used during the assessment are consistent with current practice; alternative viewpoints are elicited, discussed, and recorded; the team contains the appropriate staff to arrive at a credible risk estimate; the final risk assessment report contains failure modes that are adequately described; the recommendations reflect the information developed during the risk assessment; and risk assessment report adheres to the principles described in this engineering regulation.

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CHAPTER 19

Program Administration and Funding Process

19.1 Purpose. The DSO and the DSPM at the district and regional levels are responsible for the local and regional dam safety programs. To accomplish these duties the DSO and DSPM work closely with the Operations, Engineering, and Program elements in developing and administrating the dam safety program.

19.2 Program Documentation. Dam Safety is documented for each dam in the DSPMT. The DSPM manages input into DSPMT by the project operating personnel and various other personnel within the district. From the DSPMT, the status of each project is reviewed using the dam safety Scorecard.

19.2.1 The DSPM should maintain a file copy of all appointment orders, the minutes of the dam safety committee meetings, and a copy of all Emergency Action Plans.

19.2.2 On a two year cycle (or as otherwise required by Army), the DSO should review the questions on the Management Control Checklist and complete DA Form 11-2-R (Management Control Evaluation Certification Statement). The Management Control Checklist for Dam Safety activities is in Appendix AF for this regulation.

19.3 Funding Process. The majority of the dam safety work in the district is funded through the Operations appropriation at the individual projects. This work includes the routine annual activities for inspections and instrumentation and any special interim risk reduction measures for the dam. When additional studies are required, funding for an Issue Evaluation Study should be requested from the Construction appropriation.

19.3.1 The annual budget cycle for a project is divided into three phases that run concurrently.

19.3.1.1 Prepare. This phase runs from January FY-2 (budget year minus 2 years) until February FY-1 (budget year minus 1 year). The district DSPM works with the Operations and Program elements to insure that the annual fiscal year dam safety requirements are included in the budget submission. The MSC DSPM and the USACE DSPM review the information from the districts and work with the business line managers to help prioritize the work. During this phase, the district DSPM should be reviewing the cycles for Periodic Assessments and Periodic Inspections to insure that approximately 10% of the district's required assessments and inspections are included in each year.

19.3.1.2 Defend. This phase runs from February FY-1 to the start of the fiscal year. The DSPM's at all levels work with Program elements to provide background information on the dam safety program as requested.

19.3.1.3 Execute. This phase runs from the start of the fiscal year on 1 October to the end of the fiscal year on 30 September. The district DSPM works with the Operations, Engineering, and Programs elements to insure that the program is fully executed. Work item changes between projects are coordinated with the district to make allowances for changed conditions since the start of the budget cycle 21 months earlier. Adjustments are subject to the annual reprogramming limits established by policy or enacted in legislation.

19.4 Funding Appropriations. Dam safety is funded from the following appropriations on a routine basis.

19.4.1 Routine Work is funded from the Operation and Maintenance appropriation (or MR&T Operations). This includes training, instrumentation readings and analysis, all levels of inspections, and other work items. Interim Risk Reduction Measures are also funded from the Operation and Maintenance appropriation. Minor dam safety repairs or modifications can be funded for the maintenance portion of this appropriation.

19.4.2 Evaluation Studies and Dam Safety Modification Studies are funded from the Construction appropriation. Districts submit requests for studies through the MSC and the RMC to HQUSACE for prioritization based on the project's DSAC.

19.4.3. Construction of modifications for dam safety is funded from the Construction appropriation as line item projects in the budget.

CHAPTER 20

Remote Control and Operation of Water Control Systems

20.1 Purpose and Status. The purpose of this chapter is to provide references and other information to guide the remote control and operation of water control systems.

20.2 Introduction.

20.2.1 Operation of water control systems can be accomplished in various forms. USACE has installed remotely controlled and remotely operated systems to operate tainter gates, sluice gates, and valves on flood risk management, hydropower, and navigation projects throughout the nation. The concept of remote operation is that a water control system can be operated from an offsite office location by offsite personnel without requiring the operator to physically travel to the site for local operation. This approach can also improve the efficiency of operations and reduce staffing requirements. The remote method of operation could allow one person to operate multiple water control systems at different projects from a single location. The remote operation location can be a regional project office, District office, MSC, or other appropriate facility depending on the distance from the project site. The concept of automatic operation is that a water control system can be operated without any direct input from personnel. The system uses automated instrumentation data to make operational decisions based on a pre-defined set of parameters/criteria.

20.2.2 Any decision on how to operate a water control system must be carefully considered to ensure safe operation of the project and adequate protection of the public, property, and environment. The cost saving benefits derived from reduced staffing requirements must be balanced with the potential increased risk associated with an unstaffed project.

20.2.3 As the owner and operator of projects with water control systems, USACE considers public safety to be paramount. Potential risks must be evaluated to ensure that water control systems are robust and processes are established to validate systems are in good working order. In some cases, mitigation and/or contingency measures are required to reduce the likelihood of a system failure that could result in an uncontrolled reservoir release. Additionally, spillway systems must be regularly maintained, inspected and tested to ensure functionality at all times.

20.3 Eligibility of Water Control Systems.

20.3.1 Automatically operated systems must not be used for water control systems when misoperation or failure of the system could result in life loss, property damage, environmental impact, or lifeline disruption. In cases where property and environmental losses would be limited to the project site, automatically operated systems may be considered.

20.3.2 Remotely operated systems must not be used for water control systems when misoperation or failure of the water control system could result in loss of life.

20.3.3 Remotely controlled, remotely operated, or automatically operated systems must not be used for water control systems involving hydraulic steel structures unless all applicable requirements for design, inspection, and evaluation have been accomplished in accordance with ER 1110-2-8157 (reference A.58).

20.3.4 Remotely operated or automatically operated systems must not be used for dams with a DSAC I or DSAC 2. Formal approval through the MSC is required if a district believes that a special exemption is warranted.

20.3.5 Remotely controlled, remotely operated, or automatically operated systems must not be used for water control systems on projects requiring a water control plan unless the water control plan meets the requirements of ER 1110-2-240 (reference A.45).

20.3.6 Remotely controlled, remotely operated, or automatically operated systems must not be used for water control systems that require an emergency action plan unless the plan is current and an exercise has been conducted commensurate with the projects DSAC.

20.3.7 For projects with existing remotely controlled, remotely operated, or automatically operated water control systems, a plan must be developed to implement the requirements of this regulation. The plan and timeline for implementation must be approved in accordance with the requirements of paragraph 20.8 of this regulation.

20.4 Water Control System Considerations and Requirements. Best practices outlined the following sub paragraphs must be considered and implemented as appropriate at each project for each remotely controlled, remotely operated, and automatically operated water control system. Additional considerations and requirements must be developed as appropriate to address site specific conditions.

20.4.1 Redundancy. Appropriate redundancy must be provided for all water control systems. At a minimum, redundancy must be provided for communication, warning issuance, upstream and downstream water level readings, and gate opening information. In addition, all water control systems must maintain capability to be operated locally with appropriate interlocks.

20.4.2 Public Safety and Warning. Restricted zones upstream and downstream of the project must be established and enforced where appropriate. Visual and audible warnings must be provided at appropriate locations upstream and downstream of the facility to notify the public prior to making any operation that could pose a hazard to the public. Operations requiring public warning would typically only include those that increase discharge releases (i.e. opening gates, turning on pumps, etc), but might include other types of operation depending on site specific conditions. A visual warning such as a flashing light must be provided along with an audible siren or horn. The warning issuance should be confirmed by the operator prior to operating the system. For remote operation, this would typically require a microphone and/or camera system for visual and audible confirmation. For remote control, confirmation requirements would depend on the proximity of the operator and the ability to hear and/or see the alarm. For automatic operation, the system should have capability to automatically confirm the warning. An interlock system should be provided to prevent operation of the system if the audible warning is not confirmed. Appropriate warning signs must be provided to notify the public of the type of operation and potential for changes in discharge due to operation. Signs should conform to EP 310-1-6a, (Sign Standards Manual), Volume 1 (reference A.65). Additional warning considerations can be obtained from "Guidelines for Projects" (FERC) (reference A.121). Considerations in this reference document are not necessarily limited only to hydropower projects.

20.4.3 Personnel Safety and Warning. Visual and audible warnings must be provided at appropriate locations on the project itself to notify project personnel prior to making any operation that could pose a hazard to the project personnel. Operations requiring personnel warning would typically include those involving movement of machinery and parts that could create and entrapment or similar hazard. A visual warning such as a flashing light must be provide along with an audible siren or alarm. The warning should be visible and audible to the operator for confirmation of the warning. For remote operation, this would typically require a microphone and/or camera system. For remote control, confirmation requirements would depend on the proximity of the operator and the ability to hear and/or see the alarm. For automatic operation, the system should have capability to automatically confirm the warning. An interlock system should be provided to prevent operation of the system if the warning is not confirmed. The interlock system should also provide capability for on-site personnel to disable the remote or automatic operations when performing gate maintenance or other similar activities.

20.4.4 Incremental Operation. Appropriate controls and interlocks must be provided to limit the rate of change and maximum change in discharge releases with each operation to an acceptable level. Acceptable level is considered that which would not endanger project personnel or the public. The appropriate rate of change and maximum change will be site specific and should be determined for each water control system.

20.4.5 Confirmation. Prior to operating a water control system, the operator must visually inspect by personal observation, which may be accomplished by remote camera viewing the following: gate opening, downstream gage, personnel in gate and/or discharge areas.

20.4.6 Training. Operators must attend appropriate training for both local and remote operation of all controls and warning systems at the facility. Refresher training must be provided on an annual basis.

20.4.7 Staffing for Routine Operation. Adequate staffing must be available to conduct routine onsite inspection and maintenance activities in accordance with the project O&M manual and any other similar requirements. The frequency and level of routine maintenance and inspection should be appropriate for the needs of the project and not be reduced solely based on a decision to remotely operate.

20.4.8 Staffing for Non-Routine Operation. Adequate staffing must be available to conduct non-routine operation, inspection, and maintenance activities. These might include flood surcharge operation, deviations from the approved water control plan due to drought or other emergency or emergency inspection and/or repairs due to an incident. The distance and time required for personnel to reach the site for non-routine operation should be a consideration when developing plans to remotely operate. During extreme flood events, roads may be inundated and transportation to the project may be interrupted. Alternate methods may be necessary, such as use of helicopters, especially for emergency surveillance of the project. The capability to remotely operate must not be used as a basis to postpone on-site emergency surveillance. The ability for personnel to access the project site should also be considered (e.g. can the site be accessed during flood conditions or are the access roads flooded). The number of personnel required to staff multiple projects at the same time during a large scale event (e.g. system wide flood) should be considered and addressed.

20.4.9 Emergency Response Time. The ability to quickly respond to emergency conditions must be considered when developing plans to remotely operate. Remote operation should not be performed when a foreseeable issue could lead to partial or total failure before an emergency response team could be deployed to the site to intervene. A potential failure mode analysis is recommended to assist with the identification of such issues.

20.4.10 Emergency Action Plan. If required, the emergency action plan for the project must be updated to reflect appropriate changes due to remote control, remote operation, or automatic operation.

20.4.11 Operation and Maintenance. The project operation and maintenance manual and drawings must be updated to reflect changes in the water control system and operating features.

20.4.12 Monitoring and Inspection. Required monitoring and inspection must continue at the project regardless of the mode of operation. This includes both routine and non-routine activities. Additional monitoring and inspection requirements should be considered as appropriate for all remote control, remote operation, or automatic operation to ensure safe operation.

20.4.13 Hydraulic Capacity. The capacity of the downstream channel should be considered when developing a plan for remotely or automatically operate. If capacity of the water control system exceeds the downstream channel capacity, then additional warning systems and safety measures may be appropriate. In some cases, these conditions might be a basis for a decision to not allow remote or automatic operation of a particular water control system.

20.4.14 Diagnostics and Feedback. Appropriate features should be provided to inform the operator of the overall health of the operating system and diagnose system problems. Appropriate diagnostic and feedback systems should be provided to identify and resolve issues in a safe and timely manner.

20.5 Other Requirements.

20.5.1 Dam Safety. A risk informed decision making process must be used when making a decision to remotely or automatically operate a water control system. Some key factors to consider include the DSAC for the project, redundancy and resiliency of the water control system, discharge capacity, storage capacity, freeboard, type of dam, known dam safety issues, potential failure modes, and downstream consequences. Provisions need to be made to satisfy both routine and non-routine dam safety related inspections and activities. A potential failure mode analysis is required to identify issues related to misoperation or failure that could lead to loss of life, property damage, environmental damage, or lifeline losses.

20.5.2 Security. There are three primary elements of a water control system that must be protected. These features are communications, software, and physical equipment. In order to remotely control or remotely operate a water control system, communication to and from the project site is required. This communication system must be DoD Information Assurance Certification and Accreditation Process (DIACAP) certified and follow the Information Assurance Implementation guidance. The system includes the equipment on the water control system and the computers and communication lines that are used to access the system. The equipment on the water control system must be adequately protected by following routine security measures.

20.5.3 Water Management.

20.5.3.1 Remotely controlled, remotely operated, or automatically operated water control systems must not modify the project regulation schedule containing the operating criteria, guidelines, rule curves, and specifications that govern the authorized storage and/or discharge functions of the project without updating the water control plan.

20.5.3.2 Modification of the operating equipment or procedures at a project to implement remotely operated or automatically operated water control systems are considered to be a change to the water control plan which requires a water control manual update and public coordination in accordance with ER 1110-2-240 (reference A.45). Significant changes to existing remotely operated or automatically operated water control systems are also considered a change to the water control plan.

20.5.3.3 Minor changes (e.g. replacement or upgrade with similar equipment) to existing remotely operated or automatically operated water control systems do not constitute a change to the water control plan and should be addressed during routine water control manual updates following ER 1110-2-8156 (reference A.57). Modification of the operating equipment or procedures at a project involving remotely controlled water control systems does not constitute a change to the water control plan and should be addressed during routine water control manual updates following ER 1110-2-8156 (reference A.57).

20.6 Procedures.

20.6.1 Routine Operation. Routine operations may be made using remote control, remote operation, or automatic operation systems in accordance with the project O&M and water control manuals. A typical routine operation procedure is illustrated below.

20.6.1.1 Log in to remote control software.

20.6.1.2 View cameras upstream and downstream to look for people, debris, or possible hazards.

20.6.1.3 Check current level of gate to be operated by looking at the inclinometer or position indicator readings. If gate is off sill and the two inclinometers have a significant difference the interlock system will not allow this gate to be moved. At this point someone should be sent to the project site to assess the situation and to recalibrate the inclinometers if required.

20.6.1.4 Sound siren for prescribed amount of time. If applicable, listen to speakers to audibly confirm the siren.

20.6.1.5 View cameras upstream and downstream to look for people, debris, or other possible hazards.

20.6.1.6 Use remote control system to move the gate to the desired height. This may take several operations to move past the set increments.

20.6.1.7 View cameras upstream to look for people, debris, or other possible hazards. View cameras downstream to look for hazards and confirm flows.

20.6.1.8 Once the gate is at the desired height the user must verify proper downstream flow and re-adjust if necessary.

20.6.2 Non-Routine Operation.

20.6.2.1 Flood. Local or remote control operations are required for induced surcharge operation during significant flood events. Remote operation or automatic operations are not permitted under these conditions.

20.6.2.2 Ice and/or Debris Passage. Local or remote control operations are required for passage of ice and debris. Remote operation or automatic operations are not permitted under these conditions.

20.6.2.3 Emergencies. Local or remote control operations are required for emergency operations. Remote operation or automatic operations are not permitted under these conditions.

20.7 Maintenance.

20.7.1. Inspection. Appropriate inspection frequency and procedures must be established for all remotely controlled, remotely operated, and automatically operated systems. The procedures must be formally documented in the project O&M manual and other appropriate project documents.

20.7.2 Testing. Appropriate testing frequency and procedures must be established for all remotely controlled, remotely operated, and automatically operated systems. The procedures must be formally documented in the project O&M manual and other appropriate project documents.

20.7.3 Recurring Maintenance. Required maintenance is categorized as "as needed maintenance" and "preventative maintenance".

20.7.3.1 The as needed maintenance might include:

20.7.3.1.1 Cleaning the camera housings and lenses.

20.7.3.1.2 System reboots.

20.7.3.1.3 Repair, if and when failures of equipment occur.

20.7.3.1.4 Calibrating the sensors.

20.7.3.2 The preventative maintenance might include:

20.7.3.2.1 Visually inspecting all remote equipment. This includes cameras, housings, sensors, servers, exposed communication lines and conduits.

20.7.3.2.2 Cleaning all components of the system, including camera housings.

20.7.3.2.3 Providing and installing, upon verification of proper operation on an offline test computer and in accordance with the DIACAP certification, any software upgrades that are necessary.

20.7.3.2.4 Providing and installing any hardware upgrades that are necessary.

20.7.3.2.5 Testing each component of the system by following the standard operating procedures.

20.7.3.2.6 Repairing or replacing any damaged, worn, or failed equipment.

20.7.3.2.7 Keeping written documentation stating every action taken.

20.7.3.3 The installation and operation of remote control equipment will not change the required maintenance for the electrical and mechanical hoist equipment.

20.7.4 Replacement. All equipment has a finite lifespan. The maintenance and upgrades include replacing any failed equipment, monitoring equipment to find possible failures before they occur, and upgrading any equipment that is obsolete or worn. Equipment is recommended to be scheduled for upgrade or replacement as follows:

20.7.4.1 Controller Computers - 3 year cycle,

20.7.4.2 Monitors - 6 year cycle.

20.7.4.3 Cameras - 3 to 5 year cycle or as needed.

20.7.4.4 Sensors - As needed.

20.7.4.1 Control Devices - As needed.

20.8 Approval Authority. Approval authority may not be delegated below the level prescribed by the following sub paragraphs.

20.8.1 Remote Control. The District Commander must approve decisions to remotely control water control systems.

20.8.2 Remote and Automatic Operation. The MSC Commander must approve decisions to remotely or automatically operate water control systems.

CHAPTER 21

Dam Safety Policy for Planning and Pre-Construction Engineering and Design

21.1 Purpose and Status. This chapter provides guidance on incorporating USACE dam safety policy, including the guiding principles of risk assessment, risk communication and risk management into the planning and design of new dams and modification of existing dams for non-safety related reasons through the Civil Works processes. It applies to all structures that meet the definition of a dam in the National Dam Safety Program. It encompasses and implements the dam safety requirements from WRDA 1986 for new projects (reference A.12).

21.2 General. The civil works planning and design process for a new dam or for modification of an existing facility for non-dam safety related reasons is continuous, although the level of technical detail varies with the progression through the different phases of project development and implementation. The phases of the process for a new dam are reconnaissance, feasibility, pre-construction engineering and design (PED), construction, operation and maintenance[5], and finally decommissioning and removal. Modification of an existing dam for non-dam safety reasons might also include an initial appraisal prior to the reconnaissance phase. Detailed engineering guidance and requirements for each phase is given in ER 1110-2-1150 (reference A.49).

21.3 Project Delivery Team. A Project Delivery Team (PDT) is established for all projects in accordance with ER 5-1-11 (reference A.29). The PDT consists of a project manager and the technical personnel from engineering, planning, operations, public affairs office, and others necessary to develop the project. When more than one individual from the engineering organization is on the PDT, the technical chief must designate a lead engineer. For dam safety modification the lead engineer will be assigned or approved by the DSPC in consultation with the district DSO. At each phase of a project it is vitally important that team members possess a solid combination of both technical and communication skills. External communication with the public and stakeholders is a certainty on dam projects and guidance on how to properly communicate risk is covered in Chapter 10. Equally important is the internal communications aspect as it typically involves team members from within the district, the DSPC, the MSC, the DSMMCX, the RMC, and HQUSACE. Selection of team members and their specific roles should not overlook this fact. The PDT may also include personnel from the local sponsor's staff and from other Federal agencies. Partnering with the local sponsor is a key element during the planning and design of a project, and those partners are key members of the PDT. Partnering must occur in all phases of project development.

21.4 Dam Safety Items for the Planning Phase.

[5] Operation and maintenance is used in this regulation to include both “Operation and Maintenance (O&M)” and “Operation, Maintenance, Repair, Replacement and Rehabilitation (OMRR&R)”

21.4.1 Reconnaissance. During the reconnaissance phase, the Project Delivery Team (PDT) determines if the water resource(s) problems warrant Federal participation in feasibility studies, defines the Federal interest, completes a 905(b) Analysis or a Reconnaissance Report, prepares a Project Management Plan for the Feasibility Phase, assesses the level of interest and support from non-Federal entities, and negotiates and executes a Feasibility Cost Sharing Agreement. At this phase, if a modification to a dam or new dam is identified as a potential alternative, the required documentation in the feasibility study phase must be identified, budgeted for, scheduled, and resourced in coordination between the PDT, DSPC, and Dam Safety Officer or the Dam Safety Officer's designee.

21.4.2 Feasibility. During the feasibility phase, the Project Delivery Team (PDT) develops a Recommended Plan. The feasibility study must address the following items related to Dam Safety when evaluating an alternative that includes construction or modification of a dam. Additionally, if construction of a dam is the recommended alterative, all supporting and necessary required documentation will be identified, budgeted for and scheduled to be completed either during the feasibility phase or Preconstruction Engineering and Design (PED) phase in close coordination with the Dam Safety Officer.

21.4.2.1 Project OMRR&R and dam safety requirements must be identified and discussed with the sponsor and State. The local sponsor must be informed that they will be expected to comply with all State and Federal dam safety requirements. In accordance with Policy Guidance Letter (PGL) No 39 (reference A.98), a turnover plan for non-Federally operated dams must be prepared to establish responsibilities and a definite point for the turnover of the project to the sponsor should be documented in the Feasibility Report. The contents of the turnover plan are further described in PGL No 39.

21.4.2.2 Project Cooperation Agreement (PCA). Guidance on policy and procedures for the turnover of completed dam projects to local sponsors is given in Policy Guidance Letter No. 39 (reference A.98). When the PCA is developed during the feasibility phase, the DSO or his representative must ensure that all dam safety requirements are included in the agreement.

21.4.2.3 Consequence and Potential Failure Mode Analysis and Preventative Measures. All reports to be submitted to Congress for authorization of water impoundment facilities must include information on the consequences of failure and geologic or design factors which could contribute to the possible failure of such facilities (Water Resources Development Act of 1986 (Section 1202) (reference A.12) and ER 1105-2-100, Planning Guidance Notebook, Appendix G (reference A.39)).

Consequences are defined as potential life loss, economic damages, and environmental damages. At the minimum estimate the consequences related to failure of the dam from a breach of the dam with the reservoir at the maximum pool – no spillway discharge, maximum pool with full spillway discharge, and overtopping of the dam. The geologic site conditions that could lead to failure are identified, the associated failure mode described, and design steps taken to prevent the failure from occurring are presented. Address the general potential failure modes related to dams and present the how the design for this dam prevents these failure modes from occurring.

21.4.2.4 Value Engineering (VE) During PED. The Information and Function phases of the VE study must include the risk-informed decision criteria to include the tolerable risk guidelines, ALARP and essential engineering guidelines. Additionally, the objective of the project will be the objectives of the dam safety modification study.

21.4.2.5 Downstream Lands. A real estate interest is required in downstream areas where a spillway discharge would create or significantly increase a potentially hazardous condition. Specific guidance on this issue is found in ER 1110-2-1451 (reference A.51).

21.4.2.6 Low-level Discharge Facilities. In 1975 a policy was established that all future lakes impounded by Civil Works projects would be provided with low-level discharge facilities capable of lowering the reservoir pool to a safe level within a reasonable time. This feature provides capability for safely responding to unanticipated needs such as repair or major rehabilitation for dam safety purposes.

21.4.2.6.1 It is the policy of the Chief of Engineers that all future lakes impounded by Civil Works projects be provided with low level discharge facilities to meet the criteria for drawdown. Low level discharge facilities, capable of essentially emptying the lake, provide flexibility in future project operation for unanticipated needs such as major repair of the structure, environmental controls or changes in reservoir regulation. The criteria will govern in the majority of impoundment projects. However, it may be impracticable to provide the drawdown capability to meet the criteria for certain projects because of their size (unusually small or large) or because of their unique function. Such projects may be exempt from the criteria upon presentation of information in accordance with paragraph 21.4.2.6.3, below.

21.4.2.6.2 Design Criteria. As a minimum, low level discharge facilities will be sized to reduce the pool, within a period of four months, to the higher of the following pool levels:

21.4.2.6.2.1 A pool level that is within 20 feet of the pre-project “full channel” elevation, or

21.4.2.6.2.2 A pool level which will result in an amount of storage in the reservoir that is 10 percent of that at the beginning pool level.

21.4.2.6.2.3 The beginning pool level for drawdown will be assigned at spillway crest for uncontrolled spillways and at top of spillway gates for controlled spillways. Inflow into the lake during the drawdown period will be developed by obtaining the average flow for each month of the year.

21.4.2.6.2.4 The drawdown period inflow will then be assumed equivalent to the average flow of the highest consecutive four-month period.

21.4.2.6.3 Design Study and Reporting Requirements. Feasibility (survey) reports and subsequent pertinent design memoranda should include the results of studies made to determine facilities required for drawdown of impoundments. The discharge capacity required to satisfy project purposes and diversion requirements during construction may be sufficient to meet the drawdown criteria set forth in paragraph 21.4.2.6.2, above. Where additional capacity is required, studies will be made to determine the most practical and economical means of increasing the capacity to meet the drawdown criteria. A synopsis of the alternatives considered and details of the recommended plan should be included in the Design Documentation Report. The reporting should include the effects of the required discharge capacity on project costs, on existing downstream projects, and on the potential for downstream damage. When, due to specific project conditions, a drawdown capacity is recommended which does not meet the criteria set forth in paragraph 21.4.2.6.2, above, the following information should be presented:

21.4.2.6.3.1 The drawdown period using the maximum drawdown capability of the proposed project facilities, under the situation described in paragraph 21.4.2.6.2, above. Information should be included on the pool elevation and corresponding storage volume at end of the period.

21.4.2.6.3.2 Information on facilities that would be required to meet the design criteria for drawdown, including the estimated first cost and annual cost of these facilities. If the estimated cost for such facilities is significantly greater than for the proposed project facilities, similar information on temporary facilities should be provided.

21.4.2.6.3.3 Reporting subsequent to the Design Documentation Report should include related discharge rating curves; hydrographic with inflow, outflow and pool stage plots; lake regulation plans needed for project purposes and needed to satisfy the drawdown criteria; and other data essential in evaluating the study.

21.5 Dam Safety Items for the PED Phase. Prior to beginning the PED phase the DSO, or his representative, must ensure that the design criteria include the most current dam safety requirements, that a review plan has been developed and approved, and that the design will be properly documented for the project records. Based on experience with the design, construction, and performance of existing dams, specific areas of dam safety concerns during the design phase include the following items.

21.5.1 Design Criteria. Current USACE criteria must be used on all federally funded designs. When the design is being prepared for a sponsor on a cost-reimbursable basis, the district DSO may consider use of state criteria. Deviations from USACE criteria require written concurrence from the USACE DSO.

21.5.2 Constructability Review. To ensure dam safety risks are adequately addressed by the designs and that all construction-related risks are fully identified and mitigated to an acceptable level, there will be a review of the constructability, the schedule, and the cost estimate at the 65 percent plans and specifications during PED. See Section 22.2.6 for details on this constructability review.

21.5.3 Public Safety Awareness. A policy of public safety awareness must be adhered to in all phases of design and operation of dam and lake projects to ensure adequate protection for the general public.

21.5.4 Downstream Lands. See section 21.4.2.4 Downstream Lands.

21.5.5 Low-level Discharge Facilities. See section 21.4.2.5, Low-level Discharge Facilities.

21.5.6 Instrumentation and Monitoring. An adequate instrumentation and monitoring system is required by the "Federal Guidelines for Dam Safety" (reference A.114) as well as by good engineering practice.

21.5.6.1 Purpose. The purposes of the instrumentation are the following:

21.5.6.1.1 To provide data to validate design assumptions,

21.5.6.1.2 To provide information on the continuing behavior of the water control structure,

21.5.6.1.3 To observe the performance of critical features, and

21.5.6.1.4 To advance the state-of-the-art of dam engineering.

21.5.6.2 The rationale for the instrumentation must be defensible and thoroughly documented via the use of potential failure mode analysis. Use the potential failure mode analysis along with engineering analysis to identify the required type of instruments, general location, and expected range of performance.

21.5.6.3 The instrumentation plan must be prepared and documented in the DDR. Although the monitoring system is expected to evolve commensurate with the observed performance of the dam, an initial system must be designed and constructed to provide a background of data during initial reservoir filling, sufficient to identify problems and to verify design assumptions. Provide flexibility in the instrumentation plan to allow for changes from anticipated foundation conditions that are encountered during construction and/or operations. Specific guidance on design of instrumentation and monitoring systems is given in Chapter 14.

21.5.7 Operations during Construction. Safe operation of the dam during the construction of a new dam or modification of an existing dam needs to be considered during the development of the Water Control Plan ER 1110-2-8156 (reference A.57).

21.5.8 Initial Reservoir Filling Plan. The Initial Reservoir Filling Plan (IFP) must be prepared prior to construction, modified during construction to reflect the as built conditions, and documented in the DDR. See Chapter 17 for additional information in initial filing plans.

21.5.9 Surveillance Plan. The Surveillance Plan must be prepared during construction. The plan will address the routine and non-routine surveillance of the dam after the initial reservoir filling.

21.5.9.1 Define the level or intensity of the surveillance for given pool levels. For pool elevations above historical initial filling conditions exist and actions similar to the initial filling surveillance must be addressed in this plan.

21.5.9.2 The surveillance necessary to detect most likely occurring failure modes.

21.5.9.3 A plan and schedule for reading the instruments and evaluating the data.

21.5.9.4 A plan and schedule for inspecting the dam and downstream areas.

21.5.9.5 Instructions for observers on observed conditions or instrumentation readings requiring immediate attention of personnel authorized to make emergency decisions.

21.5.10 O&M Manual. The O&M (or OMRR&R) Manual must be prepared during construction. Specific guidance for preparation of the manual is given in ER 1110-2-401 (reference A.48) and ER 1130-2-500, (reference A.60).

21.5.11 Emergency Action Plan. The EAP must be prepared during construction. Specific guidance for preparation of the EAP is given in ER 1130-2-530 (reference A.61), and in Chapter 16 of this regulation.

21.5.12 Water Control Plan. The Water Control Plan must be prepared for use during the construction phase of the project. Guidance on water control management is available in ER 1110-2-240 (reference A.47).

21.6 Consulting with State Dam Safety Officials. The district must consult with state dam safety officials on the design, safety, and inspection of USACE dams when requested by state officials. This will be accomplished by making engineering design and construction criteria, studies, and reports available to the state officials, inviting state officials to attend design conferences and periodic inspections, and inviting state officials to participate in risk assessments.

21.7 Documents Completed During PED. At the conclusion of PED, as the project moves to construction, generally the following documents should have been completed: Design Documentation Reports (DDR's), manuals, plans, and reports, including the Emergency Action Plan (EAP), Control of Water Plan (during construction), Initial Reservoir Filling Plan, Embankment Surveillance Plan, Project Security Plan, Instrumentation Plan, O&M (or OMRR&R) Plan, Turnover Plan, Water Control Plan (operational), Reservoir Control Report, and post-construction documentation of foundation, materials, and construction.

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CHAPTER 22

Dam Safety and Construction (Modifications and New Dams)

22.1 Purpose. Construction (design implementation) is a crucial phase in achieving an adequately safe dam as these projects often have significant life and economic loss implications. The objective for construction management is always to deliver a quality project in a timely manner at a reasonable cost. During construction, the entire project team (particularly the on-site construction staff) is responsible for assuring that the design is compatible with field conditions. Inspection and quality assurance are required to prevent deficiencies in materials and construction practices. This is particularly important when working on dam safety projects as these projects often have significant life and economic loss implications. General processes to manage construction are already covered in detail in existing USACE regulations. The intent of this chapter is to supplement those regulations from a dam safety perspective.

22.2 Design/Pre-Construction Phase. Involvement of construction expertise in the design phase of a project is vital to assure the constructability of the proposed project. This is particularly true on a dam safety project because of the uniqueness of the technical requirements. Experiences offered from a construction perspective regarding things such as the structuring of bid items, phasing, proper construction techniques, buildability, bidability, etc… are invaluable in assuring the project meets technical requirements while at the same time limiting government contractual risk (ER 415-1-11, reference A.36).

22.2.1 In order to provide the best opportunity for project success, a district should always strive to build a cohesive team built upon the principles in ER 5-1-11 (reference A.29). This entire team must be involved in the project from planning, design, and through completion of construction. This includes not only the technical elements within a district and the DSPC (planners, designers, constructors, PMs, etc…) but also the involvement of vertical elements such as the regional/HQ staff, the RMC, and the DSMMCX. While the day-to-day execution of a project remains the responsibility of a district, the RMC and DSMMCX are able to bring an agency-wide perspective to the project to ensure uniformity and adoption of best practices from across USACE. The RMC and DSMMCX fill a vital part of the overall QA function for HQ in dam safety modification projects. Their early and continual involvement as part of the PDT is essential. Involving all elements from the inception of a project will ensure the failure modes are identified, the correct alternatives are evaluated, and that the best project solution is chosen.

22.2.2 It is vital that the PM ensure the district’s construction staff is active and budgeted members of the PDT throughout the life of a project, beginning with the earliest planning phases. This will ensure that each potential alternative is evaluated from an implementation perspective. While restoring a dam to a fully functional condition so that it can meet its intended purpose is the ultimate goal, the more fundamental premise is that any modification undertaken must first do no additional harm to a structure (thereby increasing risks of failure). The PDT should never lose sight of the unique risks that might be present during the construction period and should remain diligent in monitoring and mitigating those risks. One way this can be assured is through frequent instrumentation reading/analysis and on-site inspections throughout construction – particularly during high water periods. This can be accomplished using a combination of design, construction and/or operations personnel. Particular care and oversight should always be given to activities such as dewatering; spillway/gate/outlet works modifications; excavating/blasting; drilling; and grouting. Analysis of the instrumentation data and inspection results as it relates to the expected behavior of the dam must be done by the DSM Lead Engineer or his designated PDT representative throughout the construction period.

22.2.3 Engineering Considerations and Information for Field Personnel (ECIFP). It is paramount to the success of the dam safety modification project that the PDT clearly defines and communicates the design intent, including the risk reduction objectives, as early as possible so it is conveyed through the specifications and enforced by the construction field staff reviewing/inspecting the work. Clear communication of this information has the potential to avoid costly modifications and claims. Construction personnel must pay particular attention to the ECIFP prepared by the PDT during the PED phase in accordance with Appendix G of ER 1110-2-1150 (reference A.49). The document will outline the proposed risk reduction measures, the potential failure modes to be mitigated, the logic that has gone into previous decisions, as well as the expected risk reduction to be achieved. This effort would then carry forth, in a risk-informed framework, through the critical phases of construction. The document must be reviewed during ATR and revised, as necessary, as the project progresses through construction. It is USACE's policy to include key design intent descriptions within the construction specifications.

22.2.4 The PDT/construction personnel should develop a construction schedule with appropriate logic and work breakdown structure (WBS) of the preferred risk management alternative to assess potential constraints based upon the site conditions, construction season and production rates to aid/facilitate the design and estimating phases.

22.2.5 Quality Assurance Plan (QAP). The construction staff must prepare a project-specific Quality Assurance Plan (QAP) that is consistent with the scope and complexity of the work. It must be in accordance with the specific requirements in ER 1180-1-6 (reference A.64). The plan must ensure that the quality of the construction meets the specifications requirements and design intent. This plan should be prepared during the design phase of the project in conjunction with development of the ECIFP as it is important to help establish the complete project picture and to ensure the project is staffed with sufficient numbers of trained and/or otherwise experienced personnel to adequately oversee these life safety projects. It should be updated as required as the project scope is modified. The QAP should be included along with the DDR/Plans and Specification package and be subjected to ATR and RMC/HQ review.

22.2.6 Constructability Evaluations (CE) and Construction Risk.

22.2.6.1 To ensure dam safety risks are adequately addressed by the designs and that all construction-related risks are fully identified and mitigated to an acceptable level, a review will be made of the constructability, the schedule, and the cost estimate at the alternative development phase and at the 65 percent plans and specifications during PED (ER 415-1-13, reference A.37). A construction risk assessment involving event tree preparation and risk estimation may be required if potential failure modes introduced by construction activities are perceived to introduce significant risk. If a construction risk assessment is required, it would be performed as a part of the constructability evaluation. The DSM Lead Engineer/PDT will coordinate with the DSMMCX/DSPC to identify the CE team. The PDT may need to brief the CE team on the potential failure modes mitigated by construction and on potential failure modes that may be present during construction activities. A Constructability Evaluation Report will be prepared by the CE team, reviewed and approved by the DSPC, and briefed to the PDT so that any recommendations forthcoming from the review may be incorporated into the project.

22.2.6.2 It is relevant to point out that the requirements of Constructability Evaluations (CE) differ from the requirements of the Bidability, Constructability, Operability, Environmental, and Sustainability review (BCOES) required by ER 415-1-11 (reference A.36).

22.2.6.2.1 CE are performed much earlier in the process than are BCOES reviews. CE is performed at the following points in the project:

22.2.6.2.1.1 The alternative development phase; and

22.2.6.2.1.2 At the 65% design during PED.

22.2.6.2.2 Different personnel are involved. The CE process will utilize a team composed of DSMMCX and DSPC members often from outside the geographic district while the BCOES is primarily a district PDT function.

22.2.6.2.3 CE reviews the risks posed by construction alternatives while BCOES covers bidability, constructability, operability, environmental, and sustainability concerns of a completed design.

22.2.6.2.4 CE can provide input into other efforts to include the VE process and Engineering Considerations and Instructions to Field Personnel (ECIFP).

22.2.6.3 The following constructability issues should be evaluated and discussed, if applicable, by the CE review:

22.2.6.3.1 Borrow, staging, and processing area locations, sizes, ownerships, and accesses

22.2.6.3.2 Borrow, staging, and processing areas with respect to flooding

22.2.6.3.3 Borrow materials characteristics in relation to processing requirements

22.2.6.3.4 In situ moisture conditions

22.2.6.3.5 Unwatering and dewatering requirements

22.2.6.3.6 Foundation characteristics in relation to excavation and drilling operations

22.2.6.3.7 Waste and stockpile issues

22.2.6.3.8 Zoning

22.2.6.3.9 Protection of work from flooding and inundation from reservoir

22.2.6.3.10 Reservoir operations/restrictions during construction

22.2.6.3.11 Specialized Quality Control/Quality Assurance requirements

22.2.6.3.12 Instrumentation monitoring and associated restrictions on construction

22.2.6.3.13 Reservoir operations and associated construction constraints

22.2.6.3.14 Availability of equipment and materials, delivery times, and their sources

22.2.6.3.15 User deliveries and special needs

22.2.6.3.16 Climatic effects on construction schedules

22.2.6.3.17 Available right of way

22.2.6.3.18 Expected acquisition times

22.2.6.3.19 Road relocations

22.2.6.3.20 Material utilization

22.2.7 Construction personnel must assist the DSM Lead Engineer and PDT with development of assumptions to be submitted to the cost estimating team in support of cost estimates that are prepared for the various levels of estimates that are prepared throughout the PED phase.

22.2.8 During the construction period the emergency action plan (EAP) must be updated to reflect the specific risks that have been identified. This update should include identification of visual signs or instrument readings that could indicate a problem is developing. The EAP is to be used by operations and construction personnel to trigger decisions points which may require implementation of emergency actions at the project.

22.2.9 During the PED phase the DSM Lead Engineer and PDT must identify those submittals that require review and comment by a specific engineering discipline. Once a submittal is received, comments must be provided to the construction staff (either the construction manager or RE depending on district processes) in a timely manner. The appropriate construction staff member must review/resolve all comments prior to sending them to the contractor to ensure the comments are consistent from both a technical and contractual standpoint.

22.3 Construction Phase. Similar to the importance of having construction personnel involved in the planning and design phases of a project, it is equally vital that the design team remain integrally involved and integrated throughout the entire construction period. This is consistent with ER 5-1-11 (reference A-26) and ER 1110-1-12 (reference A.40).

22.3.1 On dam safety construction/modification projects it is imperative that construction management personnel are aware of design philosophies, intent and assumptions as to the site conditions and functions of project structures. They must also understand the designer's basis for special technical provisions in the specifications in terms of the intended risk reduction objectives of the design. To this end, the DSM Lead Engineer with the PDT will facilitate a coordination meeting prior to the start of construction to ensure the entire project team fully understands the project scope, design intent, limitations, risks, roles and responsibilities of the staff, and other issues which could have an effect on the project. Documents which will form the basis of the discussions at the coordination meeting may include (but are not limited to) Engineering Considerations and Instructions for Field Personnel; Design Documentation Report (DDR); Results of Risk Assessment study and summary of risk reduction objectives; project EAP; construction plans and specifications, NEPA compliance documents and permits; and Real Estate agreements. For projects that include special features such as load tests, pile driving monitoring, grout monitoring, etc the DSM Lead Engineer must conduct technical workshops for the field inspection personnel and appropriate construction management staff to assure there is a good understanding of the monitoring requirements and their design implications.

22.3.2 Large and complex dam safety modification projects will require the establishment of an on-site USACE field office that is functioning prior to the beginning of construction activities. Development of the Quality Assurance Plan (QAP) outlining the responsibilities and duties of on-site personnel should be reviewed and clearly understood by all USACE employees working in the Field Office. The logistics of Resident Management System (RMS) computer systems and the pertinent administrative personnel to aid with the RMS set-up should be staffed at the site to troubleshoot USACE/contractor system problems and to ensure that information can be processed properly at contract start-up. All field office quality assurance (QA) staff, including the technical personnel, should have access to RMS and ensure that detailed daily QA reports are generated. The RMS daily QA reports are the official contract documents of all construction processes. If the field office is not the office of record, the method of routing contract documents needs to be developed. The field office, however, should be the contractor's direct point of contact (POC) to USACE, and all documents should pass through the field office. The field office should also maintain a file copy of all contract documents.

22.3.3 Performance of Quality Assurance: Dams with safety deficiencies usually have a high potential for loss of life, a risk of significant property damage, potential significant costs to the Government, and negative political impacts. Therefore, dam safety projects are considered of such critical nature that, to the extent practicable, quality assurance must be performed directly by USACE forces. This includes, but is not limited to, performing inspection of all contract-related construction operations, materials testing, equipment factory inspection, survey control, and foundation testing. Inspection or testing by private consultants should be utilized only in situations where it is impractical for USACE to perform the inspection or testing, or the work is of such a specialized nature that USACE is not capable of performing it. Use of third parties to provide quality assurance should be limited to noncritical items/features. All quality assurance processes must be in accordance with ER 1180-1-6 (reference A.64).

22.3.4 A communication/ information protocol flow chart for the dissemination of information between the Resident Engineer and the contractor must be developed ahead of any work beginning. This protocol should address external and internal communications so that real-time information is released in a timely manner. The communication/information protocol should increase the efficiency of the field office by eliminating the burden on the field office of having to deal with numerous requests from different offices for the same information.

22.3.5 Contractor designed construction features such as cofferdams and dewatering plans must be properly designed, approved, and monitored during the construction or modification of a dam. In many cases, they serve as the dam or structure for periods of time while modifications are being implemented. Where failure of these features could potentially cause loss of life and property damage these features will be designed and constructed using USACE criteria for permanent dam features (See ER 1110-2-8152, Planning and Design of Temporary Cofferdams and Braced Excavations; reference A.56). The design of these features must be reviewed and approved by the project DSM Lead Engineer.

22.3.6 When a project includes the installation or modification of major electrical or mechanical equipment, special inspections must be performed at the place of manufacture, upon delivery to the site, during installation, and during acceptance testing.

22.3.7 The DSM Lead Engineer and the PDT must be actively involved in the confirmation of design assumptions during construction. Frequent and mandatory inspections must be scheduled during construction to confirm that site conditions conform to those assumed for design or to determine if design changes may be required to ensure risk reduction objectives will be met. Critical changes in field conditions must be carefully reviewed and forwarded to the DSM Lead Engineer and the command chain, including the Dam Safety Officer. In accordance with ER 1110-2-112 (reference A.46), key design members of the PDT (with appropriate support of management) must visit the site regularly to evaluate changed conditions and to evaluate any impact they might have on the design. When necessary, work may need to be stopped until the conditions are reviewed. It is imperative that any changed condition be properly documented and entered into RMS. Temporary duty assignments to the project construction site during critical phases of foundation and embankment construction are desirable and can serve as a unique opportunity to develop key technical skills.

22.3.8 Many dam safety modification projects are related to poorly excavated, cleaned and/or treated foundations during the original construction. For this reason, many dam safety modifications will involve a solution which exposes the bedrock foundations and abutments. Current state of the dam engineering practice involves careful excavation, cleaning and surface treatment prior to placement of any fill material. EM 1110-2-1911 (reference A.78) must be referenced for additional details relating to the construction or modification of rock fill dams. As previously mentioned, risks to a dam during the construction phase must be carefully identified, monitored and mitigated. This is especially true on items such as dewatering, spillway/gate/outlet works modifications, excavation/blasting, drilling, and grouting to name just a few. A detailed plan must be required for any work related to these items (or ones posing similar risks). For example, if blasting is required on a project, a detailed blasting plan must be developed. This plan must clearly show blast hole spacing, depths, orientation, delays, powder factors and monitoring for peak particle acceleration. It is critical that construction personnel monitor the drilling and loading of blasts to ensure that it follows the blasting plan. Not following the approved blasting plans may result in additional excavation, treatment and support creating contractual issues and quantity overruns. Where specialized blast procedures are required, consideration should be given to retaining a blasting consultant. All similar plans must be reviewed by experienced personnel in order to assure the desired results are achieved without causing excessive damage requiring additional excavation, support and/or treatment. As with all construction activities, requirements of EM 385-1-1, Section 29 (reference A.68) must be enforced as applicable.

22.3.9 All cleanup, treatment, and support (bolts, mesh, shotcrete, etc.) of dam or structure foundations and excavated slopes (temporary or permanent) must be directed by trained and experienced USACE construction personnel, engineers, and geologists. It is critically important that these surfaces are photographed, geologically mapped and as-built geometry surveyed for subsequent dam safety evaluations.

22.3.10 All foundation surfaces that are to be covered by fill and/or concrete must be formally inspected and approved by the DSM Lead Engineer or their designated representatives. No foundation surface may be covered until this formal review is completed (an example of this formal review is in Appendix AG). The specifications should include the following:

22.3.10.1 A specific period of contract time for geologic mapping by USACE personnel.

22.3.10.2 A specific amount of contractor's staff and/or equipment time to assist in the cleanup of the foundation to allow for either or both the geologic mapping and/or foundation inspection.

22.3.10.3 A specific notification period and specific period of contract time for foundation inspection by USACE personnel.

22.3.11 In order to effectively accomplish this critical task, the DSM Lead Engineer, the PDT, and Resident Engineer should work together to establish the foundation inspection procedures. This should be accomplished prior to, or shortly following, award of the construction contract. The foundation and acceptance procedures should include the following:

22.3.11.1 Describe an adequate and inadequate foundation.

22.3.11.2 Measures to be considered where an inadequate foundation is identified.

22.3.11.3 Measures to ensure the integrity of an adequate foundation once it has been prepared and prior to placing the structure on the foundation.

22.3.11.4 Procedures to be used when inspection and approval are made onsite.

22.3.11.5 Procedure to be used when inspection is made by field personnel and approval made via telephone.

22.3.11.6 Identify appropriate field testing to be conducted prior to, or during, foundation inspections.

22.3.11.7 Preparation of a foundation inspection checklist which should be used by field personnel.

22.3.12 Formal approval must be documented in a "Foundation Approval Memorandum" including photographs and geologic maps. Multiple memorandums may be utilized depending on the construction schedule/sequence. These must be included in the final project geotechnical report (reference paragraph 22.4.4).

22.3.13 Engineering representatives from RMC, DSMMCX, and MSC office are an integral part of the vertical team and thus should be continually advised of construction progress in order to permit participation by personnel from those offices in field inspections at critical construction stages in accordance with the requirements of ER 1110-2-112 (reference A.46). This involvement, along with Design Construction E inspections, is a vital part of the QA role associated with MSC/HQ on dam safety modification projects. This includes their participation in the latter stages of construction (prior to final acceptance). This must be accomplished through a regular project update prepared by the Project Manager and distributed to the entire vertical/horizontal team. This project update must include updates on construction progress to include charts, photographs, graphs that depict current status, progress for the current month, issues (both funding and technical), and a 30 to 90 day look-ahead. Summaries of field tests, trials, and status of IRRM must be included. The frequency of the project update will be agreed upon at the time of initiation of construction.

22.3.14 Construction operations at an existing facility result in unique problems associated with existing O&M activities. The construction activities will directly overlap into the active O&M program in place at the site. Therefore, it is very important that problems encountered during construction be adequately documented and resolved with the PDT members prior to the operational phase. Special emphasis must be placed on coordination activities between the Resident Engineer and O&M manager in charge of the facility.

22.4 Post Construction Phase.

22.4.1 Many important lessons, both positive and negative can be learned from dam safety projects. Near the end of construction (or as each phase of work is completed), the PDT (including all vertical and horizontal members) must assemble and conduct a brainstorming session in order to capture lessons learned from both the design and construction phases of the project. The DSM Lead Engineer and Resident Engineer must ensure these lessons learned are officially entered into DrChecks, the Dam Safety CoP site on the Technical Excellence Network (TEN), or another accepted forum. These lessons should then be built into the official design/construction checklists (typically part of a Design Quality Management Plan) so that future projects can reap the benefits. The district must organize and facilitate such brainstorming sessions. Typical subjects of discussion are:

22.4.1.1 Dam Safety Modification Studies (DSMS) problems/issues

22.4.1.2 Communications issues between design/construction/contracting and contractor as well as the public and other agencies/entities

22.4.1.3 Environmental issues

22.4.1.4 Procurement of the contract

22.4.1.5 Bid quantities

22.4.1.6 Key specification requirements

22.4.1.7 Problems encountered

22.4.1.8 Design issues

22.4.1.9 Contractor methods

22.4.1.10 Contract modifications

22.4.2 At the completion of the contract, all costs should be summarized and compared with the estimated costs. This will provide valuable information for future programmatic budgeting.

22.4.3 The Operation and Maintenance (O&M) Manual must be revised/updated as a result of dam safety modifications. The O&M manual provides guidance and instructions to project personnel for proper operation and maintenance of the facility. It contains a narrative summary of the critical dam features including design features with safety limits, equipment operating and testing procedures, instrumentation requirements, potential failure modes, a history of problems, and how those problems could adversely affect the structure over the range of loading conditions. The O&M manual must be prepared during the construction phase and must be updated as features are added to the project, when equipment is replaced, or when changes in project operations are implemented.

22.4.4 ER 1110-1-1901 (reference A.42), Project Geotechnical and Concrete Materials Completion Report for Major USACE Projects, requires documentation of the as-constructed geologic, geotechnical and concrete materials aspects of all major, complex and unique engineered projects constructed by USACE, including all subsequent modifications.

22.4.4.1 It is imperative that the report be all encompassing and records the geologic conditions encountered, solutions of problems, methods used, and experiences gained. It is imperative that data such as observations, notes, and photographs be collected and maintained during construction, describing procedures, conditions encountered, and the results of each major operation. This is particularly important for features representing departures from the anticipated conditions.

22.4.4.2 This report must be identified, scheduled, and resourced in the Project Management Plan (PMP). The information and data in this document must be presented and discussed with the sponsor/owner. The report provides significant information potentially needed by the sponsor, USACE technical staff, and other team members to become familiar with the project. The report facilitates accurate, timely inspections and performance assessments, and serves as the basis for developing and implementing appropriate and effective modifications, and emergency and/or remedial actions to prevent flood damage, or required as a result of unanticipated conditions or unsatisfactory performance.

22.4.4.3 The report must be written by a qualified USACE professional engineer or engineering geologist that was involved with the construction or modification of the dam.

22.4.5 Post-Implementation Evaluation (PIE). Review and update the DSM study risk assessment after implementation of the risk management measures. The dam must be evaluated to determine if the DSMS objectives were achieved. See Appendix X for further guidance on this post-implementation evaluation. The DSAC will not be changed until the PIE is reviewed and approved.

CHAPTER 23

Critical Infrastructure Protection and Resilience

23.1 Purpose and Status. This chapter sets forth policy, guidance, and procedures for the implementation of a comprehensive security risk assessment and management framework supporting the effective implementation of critical infrastructure protection efforts across USACE Civil Works portfolio of projects (conventional dams, navigation locks, and appurtenant structures). The chapter provides references and other information to guide dam safety personnel on critical infrastructure protection and physical security efforts and to facilitate their coordination with security personnel.

23.2 Policy. The HQUSACE Office of Homeland Security Critical Infrastructure Protection and Resilience (CIPR) Program supports security risk assessment and prioritization efforts for USACE Civil Works portfolio of projects in order to enhance its security, protection, and resilience. The CIPR Program security risk assessment framework is fully aligned with national policy defined by Presidential Policy Directive/PPD-21 "Critical Infrastructure Security and Resilience (CISR)" (reference A.16), Executive Order 13636 "Improving Critical Infrastructure Cyber security" (reference A.18) and Presidential Policy Directive/PPD-8 "National Preparedness Goal" (reference A.15). In this context, critical infrastructure refers to "those systems and assets, whether physical or virtual, so vital that the incapacity or destruction of such may have a debilitating impact on the security, economy, public health or safety, environment, or any combination of these matters, across any Federal, State, regional, territorial, or local jurisdiction". USACE prioritizes on those Civil Works assets that enable meeting its mission, also outlined in the USACE Antiterrorism Strategic Plan, "Securing the Castle" (reference A.102). All dams within USACE will maintain an adequate security posture so as to allow the project to be operated in a safe and secure manner. The safety of employees, project visitors, and area residents is paramount. All project employees must be familiar with all applicable security regulations, standard operating procedures, and regulatory guidance and be capable of discharging their duties on the project site relative to security matters. The operations chief is responsible for the implementation and oversight of project operations, to include protection of project assets. The engineering chief and the security chief provide technical and subject-matter expert support to the operations chief through the execution of their respective responsibilities. The District Engineer is ultimately responsible for the security of the project site and personnel within the District's operational area (OA).

23.3 General. The security posture will vary from project to project. The determination of the recommended steady-state security posture for USACE dams will be based on the completion of a security risk assessment. Enhanced security postures may be triggered by changes in the threat environment, new construction, changes of mission, change in condition of security systems, or changes in project operations. Steady-state and enhanced security postures will be described in the corresponding project-specific physical security plan. Priority for completing security risk assessments and implementing enhanced security measures should be given to those USACE dams determined as most critical based on the Consequence-Based Top Screen methodology.

23.4 Protective Measures. Protection can include a wide range of activities, such as hardening facilities; building resiliency and redundancy; incorporating hazard resistance into initial facility design; initiating active or passive countermeasures; installing security systems; promoting workforce surety, training, and exercises; implementing cybersecurity measures; etc. Protective measures are site-specific and can include personnel and waterside/landside access controls, cybersecurity safeguards, intrusion detection systems, and personnel screening. All USACE dams must implement appropriate physical security protective measures designed to effectively and efficiently meet the needs of the Command in protecting its assets against aggressors. A physical security plan is required to include a list of planned physical security inspections, and a list of physical security measures designed and constructed in accordance with the appropriate chapters of AR 190-11 (reference A.22), AR 190-13 (reference A.23), AR 190-51 (reference A.24), AR 190-56 (reference A.25), and AR 380-5 (reference A.27). The security plan must clearly and succinctly address the facility's current state of security in terms of its hardware and procedures. It should also provide a description of the facility, including its critical physical and cyber assets, restricted areas, communication procedures and redundant features, protective measures, and personnel and visitor screening procedures. Information regarding how the facility's security posture will be enhanced in response to an increase in threat condition should also be included. Security plans should be coordinated with emergency action plans, as there may be potential overlap between the plans; therefore, appropriate emergency management representatives should be involved in the development of the security plan. There are existing security requirements that are executed at the District level that provide a baseline level of protection at Civil Works portfolio of projects. Details on the implementation of various programs to address these can be obtained from local District security manager.

23.5 Antiterrorism (AT). All USACE dams must have a project-specific AT plan in place and in accordance with Department of Defense (DoD) Instruction 2000.16, "DoD Antiterrorism Standards," (reference A.20) and Army Regulation 525-13, Antiterrorism (reference A.28). The plan will, at a minimum, address the management of the Force Protection Conditions (FPCONs), implementation of project-specific FPCON measures (as addressed in the IP OPORD) and the requirements for terrorist related reports. Plans should be affordable, effective, and attainable; tie security measures together; and integrate security efforts by assigning responsibilities, establishing procedures, and ensuring that other security and safety plans complement each other.

23.6 Security Portfolio Prioritization. Consequence-based prioritization constitutes the first step in the implementation of a security risk management framework. The Consequence-Based Top Screen (CTS) methodology is used to identify the most critical projects within USACE's portfolio from a critical infrastructure perspective. This methodology is based on characterizing impacts or effects associated with failure or disruption of a project, considering human impacts, economic impacts, and impacts on critical functions. The relative prioritization of USACE Civil Works critical infrastructure projects using the CTS process informs which projects should be assigned a higher priority for scheduling security risk assessments and detailed blast damage analyses. The official list of critical projects is transmitted annually to the Command through a memorandum issued by the Director of Contingency Operations and Homeland Security. The CIPR Program centrally funds the implementation of the CTS screening and prioritization, which is performed with the support of the USACE Modeling, Mapping, and Consequence (MMC) Production Center. The MMC has overall responsibility for developing dam break failure modeling, flood inundation mapping, and consequence estimation studies for USACE dams. The CTS process addresses DoD and DA Standard 5 Criticality Assessments (CA) requirement for USACE Civil Works projects.

23.7 Security Risk Assessment. At a minimum, a security risk assessment will be conducted every five years in conjunction with the project's dam safety periodic inspection or periodic assessment.

23.7.1 The security risk assessment methodology should be complete (assess consequence, vulnerability, and threat for every defined scenario), documented (clearly document which information is used and how it is synthesized to generate a risk estimate), reproducible (produce comparable, and repeatable results), defensible (technically sound, free from significant errors or omissions, and address the uncertainties associated with consequence, vulnerability, and threat variables). The risk assessment methodology should identify specific attack vectors and attack scenarios. The threat should be estimated as the probability that the adversary would attempt an attack using a given attack vector against a specific target. For a given attack scenario, the vulnerability should be defined as the probability of attacker's success, given that an attack is attempted. Estimation of vulnerability should account for protective measures in place as well as law enforcement tactical response capabilities.

23.7.2 The USACE Common Risk Model for Dams (CRM-D) risk assessment methodology meets the assessment criteria in 23.7.1 and will be used to conduct security risk assessments at USACE Civil Works projects. The CRM-D security risk assessments address the DoD and DA Standard 6 Vulnerability Assessments (VA) requirement for USACE Civil Works projects. These VAs, which are an integral component of the CRM-D security risk assessments, are defined as Tier 1 Vulnerability Assessments. The CIPR Program will centrally fund and host CRM-D training sessions to assist District staff in conducting the CRM-D security risk assessments.

23.7.3 The results of the CRM-D security risk assessment should be referenced (with date completed) in the periodic inspection/periodic assessment report. Consideration should be given to conducting a revalidation of the security risk assessment between periodic inspections/ assessments. Additionally, in cases where there has been a significant change in project conditions (threat, construction, project operation, security systems, etc.), the revalidation should be implemented immediately by the District to document any change(s) and impact it would have on the initial, or subsequent analysis.

23.7.4 The CIPR Program and the USACE Operational Protection Division (OPD) will jointly assist Commanders in the development of a multi-year schedule to conduct CRM-D security risk assessments. Higher priority for scheduling security risk assessments and detailed blast damage analyses will be given to USACE Civil Works critical infrastructure projects identified and prioritized using the CTS process based on their relative criticality ranking. This schedule will be part of a “USACE Security Risk Assessment Implementation Plan” to implement a comprehensive security risk assessment framework across USACE Civil Works projects.

23.7.5 Divisions and Districts will prioritize their resourcing decisions and will be responsible for the development of budget funding requirements to implement scheduled CRM-D security risk assessment and supporting ATPlanner-Dams blast damage assessments. Both of these activities will be prioritized by the Districts through the Civil Works budget development process. Once District –level staff is properly trained, CRM-D risk assessments will be conducted by District staff, while ATPlanner-Dams blast damage assessments will be performed with the support of the U.S. Army Engineer Research and Development Center (ERDC). ERDC personnel expenses (labor and site-visits travel) will also be funded by the Districts based on similar resource prioritization through the annual Civil Works budget development process. The CIPR Program Manager will centrally fund a Risk Assessment Team Facilitator and a Risk Assessment Team Cadre Member, both independent of the District, to serve as the Technical Leads of the CRM-D security risk assessment implementation activities.

23.7.6 The CRM-D security risk assessments will support risk-informed decisions to implement physical security risk mitigation measures across the portfolio of USACE Civil Works projects. The systematic quantification of risk reduction will assist USACE Project Operations Managers in measuring progress towards mitigating physical security risks, and will provide solid and consistent justification for the development of physical security requirements through the Civil Works budget development process. OPD will monitor the implementation of physical security measures at Civil Works critical infrastructure projects identified through the CRM-D security risk assessments, utilizing the Security Management Software (Countermeasures) (SMS(CM)) tool.

23.8 Security Training and Resources. The following training courses and resources are available in support of critical infrastructure security activities:

23.8.1 The two-day training course “Dam Security and Protection Technical Seminar”, which provides dam owners and operators, emergency managers, and other relevant stakeholders with information on the fundamental aspects of security and protection for dams, levees, and related facilities. It provides a solid foundation for the effective implementation of security and protection programs. This course provides participants with basic concepts related to threat, vulnerability, and consequence as key risk variables. It overviews of threats and relevant attack vectors and describes potential suspicious activities. The course addresses common physical vulnerabilities and related protective measures, including both land-side and waterside considerations. It includes information on the basic components of effective security and crisis management programs, including the development of security plans and incident response plans. It also addresses cybersecurity risks, security compromises, and privacy incidents. Additional information on this training course is available by contacting dams@hq.dhs.gov.

23.8.2 The web-based training module "IS-870 Dams Sector: Crisis Management" (reference A.122) is available on FEMA's Emergency Management Institute website. This is part of a series of web-based training courses whose purpose is to provide general information pertaining to security awareness, protective measures, and crisis management of dams. This course explains how crisis management is an important component of an overall risk management program and provides guidelines to assist owners and operators in developing Emergency Action, Continuity of Operations, Pandemic Preparedness, and Exercise plans. The IS-870 module is available at the following link: http://training.fema.gov/EMIWeb/IS/IS870.asp.

23.8.3 The web-based training module "IS-871 Dams Sector: Security Awareness" (reference A.123) is designated as 'For Official Use Only' and are thus only accessible through the Homeland Security Information Network – Critical Sectors (HSIN-CS) Dams Portal (https://cs.hsin.gov/C2/DS/default.aspx). This module provides information to enhance the ability to identify security concerns, coordinate proper response, and establish effective partnerships with local law enforcement and first responder communities. The training course describes common security vulnerabilities, potential indicators of threats, surveillance detection, and reporting of incidents and suspicious activities.

23.8.4 The web-based training module "IS-872 Dams Sector: Protective Measures" (reference A.124) is designated as 'For Official Use Only' and are thus only accessible through the Homeland Security Information Network – Critical Sectors (HSIN-CS) Dams Portal. This module addresses protective measures related to physical, cyber, and human elements, and describes the importance of these measures as components of an overall risk management program. The training course describes the basic elements of the risk management model, and discusses the steps required to develop and implement an effective protective program.

23.8.5 Additional reference documents addressing security awareness, protective programs, and crisis management are available through the Homeland Security Information Network - Critical Sectors (HSIN-CS) Dams Portal. The District's Security Officer needs to understand the Homeland Security documents aforementioned and the applicable DoD requirements, and coordinate with the Division Security Officer and HQUSACE Office of Homeland Security as a security plan is developed for each dam.

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CHAPTER 24

Dam Safety Considerations for Water Supply Storage Allocation and Reallocation and Related Studies

24.1 Purpose. The purpose of this chapter is to establish policy and provide guidance on the impacts of dam safety on storage authorized for domestic, municipal, industrial and irrigation water supply purposes and operational changes related to storage duration or elevation for those purposes. Initiation of a water supply study at projects where a DSAC 1, 2, or 3 is currently assigned to the dam, levees, dikes, or an appurtenant structure requires approval of the USACE DSO. Requirements of this chapter also apply to reallocations of storage specifically authorized for other project purposes.

24.2 Dam Safety Action Classifications (DSAC).

24.2.1 USACE dams are classified into one of five classifications based on incremental flood risk (DSAC 1 being the most urgent and typically the highest risk level). DSAC considers event probability, probability of failure, and the incremental inundation consequences (See Chapter 2), given the physical properties of the dam. See Chapters 1, 2, and 3 for more comprehensive information on the guiding principles and concepts USACE used in its dam safety program.

24.2.2 See Chapter 7 for the policies for developing, preparing and implementing IRRM to reduce the probability and consequences of catastrophic dam failure to the maximum extent that is reasonably practicable while long term risk management measures are pursued.

24.2.3 The provisions of this chapter also apply to Federal levees, dikes, appurtenant structures, etc constructed as part of the reservoir project.

24.3 Water Supply Storage in USACE Reservoirs.

24.3.1 National policy regarding water supply states that the primary responsibility for water supply rests with states and local entities. USACE may participate and cooperate in assisting water supply development in connection with construction, operation and modification of Federal navigation, flood risk management, or multipurpose projects. However, certain conditions of non-Federal participation are required. ER 1105-2-100 (Reference A.39) establishes the policies and procedures for including water supply storage in USACE reservoirs.

24.3.2 Dam safety must be on the critical path of all decisions regarding water supply storage in USACE reservoirs. When water supply storage is requested by a non-Federal entity, USACE decision-makers at all levels must fully consider the condition of the dam and associated project levees, IRRM and other remediation, impacts to pool levels and inspection, operation and maintenance of the project.

24.3.3 Operational changes for purposes other than supplying storage for municipal and industrial use must also adhere to and meet the requirements herein.

24.4 Conditions for Allocation and Reallocation of Storage.

24.4.1 DSAC 1, 2, and 3

24.4.1.1 Transfers and assignments of existing agreements and new agreements for the allocation of authorized, uncontracted water supply storage or the reallocation of storage from the existing conservation pool (or in rare cases, the inactive pool or sediment reserve) are permitted, provided the reallocation report, if required, is approved, all other implementation requirements are completed, and the district commander has informed the non-Federal entity, in writing, of the project's DSAC and the current status of the dam and reservoir; that water supply storage may be reduced by IRRM or other remediation; and that, upon execution of a water storage or surplus water agreement, the non-Federal entity will be required to share in the costs of IRRM and other remediation consistent with current policy. See Appendix AH for suggested language.

24.4.1.2 A reallocation that would require raising the conservation pool is not permitted while a project is classified DSAC 1, 2, or 3.

24.4.2 DSAC 4.

24.4.2.1 Transfers and assignments of existing agreements and new agreements for the allocation of authorized, uncontracted water supply storage or the reallocation of storage from the existing conservation pool (or in rare cases, the inactive pool or sediment reserve), are permitted, provided the reallocation report, if required, is approved, all other implementation requirements are completed, and the district commander has informed the non-Federal entity, in writing, of the project's DSAC and the current status of the dam and reservoir; that the dam will be subject to elevated monitoring and evaluation; that water supply storage may be reduced by IRRM or other remediation; and that, upon execution of a water storage or surplus water agreement, the non-Federal entity will be required to share in the costs of IRRM and other remediation consistent with current policy. See Appendix AH for suggested language. See paragraph 3.3.10 in Chapter 3 for guidance on determining elevated monitoring and evaluation requirements.

24.4.2.2 Recommendations for reallocations that would require raising the conservation pool will be considered by Headquarters USACE (USACE DSO and CECW-P) on a case-by-case basis. Reallocation reports that recommend pool raises must include a review of the Potential Failure Mode Analysis (PFMA) for the dam and an analysis of the effect of a higher pool elevation on the probability of failure and consequences associated with the changed pool elevation.

24.4.3 DSAC 5.

24.4.3.1 Although DSAC 5 dams have very low incremental life-safety risk and meet all essential USACE guidelines, reallocation reports that recommend pool raises must include a review of the Potential Failure Mode Analysis (PFMA) for the dam and an analysis of the effect of a higher pool elevation on the probability of failure and consequences associated with a changed pool elevation.

24.4.3.2 A non-Federal entity that has requested water supply storage must be informed, in writing that the project's current DSAC 5 classification could change in the future. The information provided should include the possible impacts of such a change, including IRRM and other remediation, and, upon execution of a water storage agreement, the requirement to share in the costs of these measures consistent with current policy. See Appendix AH for suggested language.

24.4.4 Pending DSAC Assignment. When a dam's DSAC has not yet been assigned or is pending reassignment, the policies and procedures in ER 1105-2-100, Planning Guidance Notebook, Appendix E, Section VIII (reference A.39), and the following conditions apply.

24.4.4.1 Upon receiving a request from a non-Federal entity for water supply storage in a USACE reservoir, the district commander must inform the non-Federal entity, in writing, that the dam is pending risk assignment or DSAC reassignment and explain the possible impacts of this DSAC assignment on storage, including IRRM and other remediation, and, upon execution of a water storage agreement, the requirement to share in the costs of these measures. See Appendix AH for suggested language.

24.4.4.2 If a DSAC assignment is pending, reallocation decisions that would raise the conservation pool should be deferred until the dam has been evaluated and classified in accordance with Chapter 3.

24.5 Surplus Water Agreements and Interim-use Irrigation Agreements. Surplus water agreements under Section 6 of the Flood Control Act of 1944, as amended (reference A.4), and interim-use irrigation agreements under Section 8 of the Flood Control Act of 1944, as amended (reference A.4), may be executed in accordance with ER 1105-2-100, Planning Guidance Notebook, Appendix E, Section VIII (reference A.39), provided the district commander has informed the non-Federal entity, in writing, of the project's DSAC assignment and the current status of the dam and reservoir; that water supply storage, and thus the availability of water, may be reduced by IRRM or other remediation; and that, upon execution of a surplus water or interim-use irrigation agreement, the non-Federal entity may be required to share in the costs of IRRM and other remediation. See Appendix AH for suggested language.

24.6 Emergency Withdrawal Permits. Permits for emergency withdrawals of water from USACE reservoirs for municipal and industrial purposes may be issued in accordance with ER 1105-2-100, Planning Guidance Notebook, Appendix E, Section VIII (reference A.39) without regard to a project's DSAC. District commanders, however, must inform permit applicants and permit holders, in writing, of any dam safety issues that may affect the quantity of water available for withdrawal. See Appendix AH for suggested language.

24.7 Water Supply Allocation and Reallocation and Related Studies.

24.7.1 Reallocation Studies are not allowed at projects where a DSAC 1, 2, or 3 is currently assigned to the dam, levees, dikes, or appurtenant structures, except when approved by the USACE DSO. Preliminary planning and the request for exception must be well coordinated among the District, MSC and HQ DSOs, District, MSC, and HQ Planning Division Chiefs, and the Water Management and Reallocation Studies Planning Center of Expertise.

24.7.2 When considering whether to request an exception to initiate a reallocation study at a DSAC 1, 2 or 3 project, districts must make a brief, preliminary assessment of water needs in the study area, benefits of the proposed operation of the project for additional water supply, and potential changes to risk due to modifications to the federal project. Sources of information for water supply benefits may include published studies of population and economic growth projections, current and future water needs, water supply source, transmission and treatment alternatives, and surface and groundwater yields commissioned or prepared by federal, state and local governmental entities. Discussion of changed risks should reflect the most current information available through the district's Dam Safety program and other available flood risk information.

24.7.3 Examples of types of studies and possible reasons for exception are listed below. The list is not exhausted and serves to demonstrate possible exceptions.

24.7.3.1 Studies to support State water planning;

24.7.3.2 Hydrology and hydraulic studies to determine dependable yield;

24.7.3.3 Water demand studies;

24.7.3.4 Studies where the hydrology has changed resulting in the availability of additional storage;

24.7.3.5 Studies where the District is aggressively pursuing their ongoing dam safety study or studies;

24.7.3.6 The future without project condition is clear and amenable to plan formulation;

24.7.3.7 The effect on risk is minimal.

24.7.4 Requests for exceptions must address the following considerations:

24.7.4.1 A clear and consistent logic outlining why the project should be granted an exception (See Paragraph 24.7.2), including the purpose and need for the proposed study or action.

24.7.4.2 The sponsor must be well-informed, including in writing, of the financial risks and acknowledge the information in a letter, as described in Paragraph 24.7.6.

24.7.4.3 Identification of all stakeholders or stakeholder groups, upstream and downstream, that must be informed and invited to participate in the study in accordance with the requirements of the National Environmental Policy Act (NEPA) (ER 200-2-2), Planning Guidance Notebook (ER 1105-2-100), and the risk communications in Chapter 10 of this regulation.

24.7.4.4 The study schedule and availability of necessary funding to complete all analyses, including the requirements of this chapter and other relevant guidance, policy, law, and regulations.

24.7.5 Requests for an exception should be coordinated with the Water Management and Reallocation Studies Planning Center of Expertise and submitted by the District through the Division to HQUSACE. The request should be coordinated through the Regional Integration Team (RIT) at Headquarters.

24.7.6 In all cases, prior to initiation of a reallocation study, the non-Federal entity must be informed, in writing, by the District Commander of the project's DSAC and the current status of the dam and reservoir; that dam safety risks are dynamic and future performance could require elevated monitoring and evaluation, IRRM or other remediation; the restrictions and conditions imposed by this ER; that water supply storage may be reduced by IRRM or other remediation; and that, upon, execution of a water storage or surplus water agreement, the non-Federal entity will be required to share in the costs of IRRM and other remediation consistent with current policy. See Appendix AH for suggested language. The non-Federal entity must submit a Letter of Intent that includes their understanding of the costs typically associated with reallocation, including potential costs of modifications for Dam Safety related reasons.

24.7.7 A decision by the district commander to initiate or continue a water supply allocation or reallocation study requires following the guidance in paragraph 24.7.2, above, and considering all relevant internal and external factors that determine the safety of USACE dams and the potential risks to public safety. Early consultation with the District Dam Safety Officer is mandatory.

24.7.8 In some cases, the District may receive an exception to initiate a water supply allocation or reallocation study while repair work or other remediation is underway. However, District recommendations submitted to Headquarters USACE (CECW) must be consistent with the policies in paragraph 24.4, above, and will not be conditioned on the completion of work or the upgrading of a dam's DSAC.

24.7.9 Studies which are underway or completed should be updated as necessary to reflect changed conditions or a change in DSAC prior to submitting a report to Headquarters USACE (CECW). In such instances, the district commander must provide to the non-Federal entity, in writing, the information in paragraph 24.7.2, above, as applicable.

24.7.10 Dam safety evaluations are conducted by the district dam safety team and regional Dam Safety Production Centers as part of the USACE dam safety program. The results of these evaluations must be addressed in all water supply allocation or reallocation studies. The District Dam Safety Officer should be on the study team.

24.7.11 Reallocation studies and reports must include a review of the Potential Failure Mode Analysis (PFMA) for the dam and an analysis of the effect of a higher pool elevation, longer storage duration, or any other modification on the probability of failure and consequences associated with the project. The level of detail of this analysis should be commensurate with the risk.

24.7.12 Determinations of surplus flood risk management storage are subject to the provisions of this paragraph.

24.8 Existing Agreements.

24.8.1 District commanders must periodically inform current water supply users, in writing, of the safety status of dams; potential impacts on water supply storage; IRRM underway or expected to be initiated; and long-term remediation that is planned or contemplated. See Appendix AH for suggested language.

24.8.2 Notwithstanding any IRRM or long-term remediation to address dam safety concerns, the terms of existing agreements with water supply users remain in effect and water supply users are obligated to abide by the terms of their agreements, to include making the payments prescribed therein.

24.8.3 For irrigation contracts administered by the USBR, district commanders must periodically inform the appropriate USBR area manager, in writing, of the safety status of dams; any potential impacts on water stored for irrigation; IRRM underway or expected to be initiated; and long-term remediation that is planned or contemplated.

24.8.4 At a minimum, the information listed in 24.8.1 and 24.8.3 must be conveyed after a Periodic Inspection, after a Periodic Assessment, when the DSAC assignment changes, or there is a changed condition associated with the dam.

24.9 Unique Situations. Unique situations, such as those related to sedimentation, will be addressed on a case-by-case basis.

24.10 Principal Advisor. The USACE Dam Safety Officer is the principal advisor to the Chief of Engineers and the Director of Civil Works on all dam safety matters.

24.11 Exceptions. Requests for exceptions to the policies and procedures in this chapter, beyond those described in 24.7, will be considered on a case-by-case basis by the Director of Civil Works upon the advice and recommendation of the USACE DSO. Requests will be submitted through command channels to the appropriate Headquarters USACE Regional Integration Team (RIT) in Washington, DC.

FOR THE COMMANDER:

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R. MARK TOY, P.E.
Colonel, Corps of Engineers
Chief of Staff

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APPENDIX A

References

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APPENDIX B

Dam Safety in the United States Army Corps of Engineers (USACE)

B.1 Introduction. It is difficult to quantify the overall safety of a dam; however, the way to achieve maximum dam safety is to apply the utmost care and competence to every aspect of design, construction, operation, and maintenance. The most important prerequisite for dam safety is the professional competence of persons associated with the dam over its life span. A dam with a record of safe performance may still experience failure from undetected deficiencies within the dam structure or in the foundation. Dam safety must take precedence over all other considerations (references A.132, A.134, A.135, and A.137).

B.2 Background.

B.2.1 USACE Dam Safety. The safety of dams has been a major concern of USACE since it began building dams in the 1840s. As part of the flood control development of the Muskingum River in northeast Ohio in the 1930's, the USACE started a multiple level of review requirements for dam design. As dam designers and operators, USACE retains responsibility and accountability for the continued safe performance of our applicable dams and appurtenant structures, under the full range of anticipated loading conditions. For many years the USACE has made extensive use of experts to consult and advise on unusual and difficult designs. Advisory boards have been helpful in establishing design criteria and standards. Experience gained from the 1938 slide in the embankment of Fort Peck Dam led the USACE to adhere to the highest design standards and comprehensive inspection and testing for construction. USACE was one of the first agencies to initiate a periodic inspection and evaluation program, and its program was used as input to the development of the "Federal Guidelines for Dam Safety" (reference A.116) due to its early, comprehensive and effective program.

B.2.2 Federal Dam Safety Action. As a result of several dam failures in the mid 1970's, none of which were USACE owned or operated, a Presidential Memorandum was issued on 23 April 1977 that required each Federal agency having responsibility for dams to review their practices and activities related to dam safety (reference A.14). This memorandum also directed the Federal Coordinating Council for Science, Engineering and Technology to prepare guidelines for management practices and procedures to ensure dam safety. "Federal Guidelines for Dam Safety" (reference A.116) was published in June 1979, and with a memorandum dated 4 October 1979, President Carter asked each Federal agency having responsibility for dams to adopt and implement these guidelines and report their progress to the Federal Emergency Management Agency (FEMA) on a biennial basis. Executive Order 12148 gives FEMA the responsibility to coordinate dam safety in the nation (reference A.17). The purpose of these guidelines is to enhance national dam safety and to encourage high safety standards in the management procedures and technical activities of Federal agencies. The guidelines require the head of each Federal agency having responsibility for design, construction, operation and regulation of dams to establish a dam safety office (officer), which reports directly to the head of the agency. The Interagency Committee on Dam Safety (ICODS) was established in 1980 to promote and monitor Federal and State dam safety programs. USACE is the Department of Defense representative on ICODS.

B.2.3 USACE Dam Safety Officer. On 7 February 1980, the Chief of Engineers appointed the Chief of the Engineering Division, Directorate of Civil Works, as the USACE Dam Safety Officer (DSO). This appointment also required that the DSO chair a standing committee composed of individuals having assigned responsibilities for dam safety to include programming and policy functions. The purpose of this committee is to provide surveillance, evaluation, and guidance for the administrative, technical, and regulatory practices within USACE. The DSO is advisory to the Chief of Engineers, through the Director of Civil Works. The USACE DSO is now Chief, Engineering and Construction.

B.3 History of Dam Safety.

B.3.1 Early Development of Dams. History indicates that dams have been vital to civilization for more than 5,000 years. The early United States settlers constructed dams in the 1600's for water supply and to power gristmills and sawmills. The oldest USACE dams are six locks and dams on the Green and Kentucky Rivers built between 1836 and 1844.

B.3.2 Dam Safety. Although construction of dams dates back many years, the history of dam safety covers a much shorter time span. Only a limited number of states had any laws regulating dam safety prior to 1900. The failure of the South Fork Dam in 1889 at Johnstown, Pennsylvania, resulting in 2,209 deaths, had limited influence on dam safety programs. California initiated a dam safety program following failure of the St. Francis Dam in 1928. Failure of the Buffalo Creek Dam in West Virginia and the Canyon Lake Dam in South Dakota in 1972 contributed to Congress passing "The National Dam Inspection Act" in 1972 (reference A.8). "The Reclamation Safety of Dams Act" in 1978 (reference A.11) followed failure of Teton Dam in Idaho in 1976. Failure of the Laurel Run Dam in Pennsylvania and the Kelly Barnes Dam in Georgia in 1977 set in motion the development of the "Federal Guidelines for Dam Safety" issued in 1979 by the Federal Coordinating Council for Science, Engineering, and Technology (FCCSET) (reference A.116).

B.3.3 Interagency Committee on Dam Safety. Although the Interagency Committee on Dam Safety (ICODS) was created in 1980, the Water Resources Development Act (WRDA) of 1996 codified it (reference A.13) as a permanent forum for the various government agencies to advise FEMA on institutional, managerial, technical, legislative, and policy issues affecting national dam safety. The following Federal agencies serve on ICODS:

Department of Agriculture
Department of Defense

Department of Energy
Department of Interior
Department of Labor
Federal Emergency Management Agency
Federal Energy Regulatory Commission
International Boundary and Water Commission (U.S. Section)
Nuclear Regulatory Commission
Tennessee Valley Authority

B.3.3.1 ICODS encourages the establishment and maintenance of effective Federal programs, policies, and guidelines intended to enhance dam safety for the protection of human life and property. This is accomplished through (1) coordination and information exchange among Federal agencies and State dam safety agencies; (2) coordination and information exchange among Federal agencies concerning implementation of the "Federal Guidelines for Dam Safety" (reference A.116); (3) Federal activities that foster State efforts to develop and implement effective programs for the safety of dams; (4) improved techniques, historical experience, and equipment for rapid and effective dam construction, rehabilitation, and inspection; and (5) devices for the continued monitoring of the safety of dams. ICODS has an Operations Subcommittee, which focuses on activities essential to carrying out the operating activities of ICODS.

B.3.3.2 The Director of the Federal Emergency Management Agency was designated coordinator of the National Dam Safety Program in WRDA96, and is the Chair of the ICODS and the National Dam Safety Review Board.

B.3.4 National Dam Safety Review Board. The Water Resources Development Act of 1996 (reference A.13) established the National Dam Safety Review Board (NDSRB). The NDSRB monitors state implementation of dam safety programs, and advise the Director of FEMA in national dam safety policy. The Director of FEMA based on their dam safety expertise selects nominees to the NDSRB. The USACE Dam Safety Officer recommends a qualified individual to serve on the NDSRB. Five subcommittees serve under NDSRB and focus on activities essential to carrying out the goals of the Program. These subcommittees are:

Dam Safety Research Work Group
Dam Safety Training Work Group
National Inventory of Dams Work Group
Guidelines Development Work Group
Dam Security Work Group

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APPENDIX C

Summary of the Federal Guidelines for Dam Safety

C.1 1977 Presidential Memorandum. In 1977, President Carter issued a memorandum directing three actions (reference A.14).

C.1.1 That all Federal agencies having responsibility for dams conduct a thorough review of their practices that could affect the safety of these structures and report their findings to the Federal Coordinating Council for Science, Engineering, and Technology (FCCSET).

C.1.2 That the FCCSET prepare the "Federal Guidelines for Dam Safety" for use by all Federal agencies.

C.1.3 That an Interagency Committee on Dam Safety (ICODS) be established to promote and monitor Federal and state dam safety programs.

C.2 Publication of Guidelines. In 1979, the "Federal Guidelines for Dam Safety" was published, and ICODS was given oversight responsibility for dam safety. The key management practices outlined in the guidelines (FEMA 93, (reference A.114)) are

C.2.1 Establish a DSO and appropriate staff,

C.2.2 Maintain an updated inventory of dams,

C.2.3 Document design criteria and construction activities,

C.2.4 Prepare initial reservoir filling plans and reservoir regulation criteria,

C.2.5 Prepare operation and maintenance instructions and document activities,

C.2.6 Maintain a training and awareness program,

C.2.7 Prepare and maintain Emergency Action Plans (EAP's) for each dam,

C.2.8 Establish a program of periodic inspections and evaluation of dams, and

C.2.9 Monitor and evaluate the performance of each dam and appurtenant structure and provide remedial construction as necessary.

C.3 Implementation of Guidelines. The "Federal Guidelines for Dam Safety" (reference A.114) requires each agency responsible for the design, construction, operation, or regulation of a dam project to be structured with a single identifiable, technically qualified head responsible for ensuring that all management and technical safety aspects of dam engineering are adequately considered throughout the development and operation of the project. That position must have continuity of guidance and direction, and authority and resources to ensure these responsibilities can be carried out. To comply with this portion of the Guidelines, the Chief of Engineers has designated a USACE DSO by General Order. This regulation further defines the requirements and responsibilities of the DSO at each level of the command.

APPENDIX D

Levels of USACE Responsibility for Dams

D.1 Involvement Categories. USACE involvement and responsibility related to dams and dam safety can be categorized into six areas (categories) based on the USACE involvement in design, construction, modification, operations, permitting, and ownership.

D.2 Category 1.

D.2.1 Involvement. Dams USACE owns, operates, and maintains. This includes appurtenant structures such as navigation locks, powerhouses and USACE owned levees, saddle dams, and dikes that retain permanent pools or flood storage pools, whose failure could potentially yield loss of life, or environmental or economic damage.

D.2.2 Responsibilities. USACE is responsible for dam safety.

D.3 Category 2.

D.3.1 Involvement: Dams USACE has designed and/or constructed, but responsibility for operation and maintenance rests with others.

D.3.2 Responsibilities: The primary dam safety responsibility is with the agency or sponsor responsible for performing operation and maintenance. USACE responsibility is to fulfill the requirements of the Project Cooperation Agreement (PCA), including periodically inspecting the project to evaluate its performance and maintenance.

D.3.2.1 Inspections: Inspections are to be done in accordance with the current Inspection of Completed Works policy. At a minimum for all high and significant hazard potential Category 2 dams the geographic district in which the dam is located will coordinate with the regulating agency or state to obtain a copy of the current inspection report (and all future inspection reports) for review.

D.3.2.2 Verification: The district DSO is to assure the adequacy of the inspection and that the agency or sponsor is fulfilling its requirements of the PCA.

D.3.2.3 Points of Contact: The district will provide appropriate USACE emergency contact information to the agency or sponsor annually and option the agency or sponsor's points of contact for emergencies.

D.3.2.4 Emergency Assistance: Additional requirements for the USACE Rehabilitation and Inspection Program for assistance under PL 84-99 are located in ER 500-1-1 (reference A.38).

D.4 Category 3.

D.4.1 Involvement. Dams designed, constructed, operated, maintained, and owned by others where flood control storage is provided at Federal expense under the authority of the 1944 Flood Control Act (Section 7 Dams) (reference A.4).

D.4.2 Responsibilities. USACE maintains pertinent data on the project and participates in inspections to ensure that the Federal flood control interest is properly maintained.

D.5 Category 4.

D.5.1 Involvement. Dams designed, constructed, operated, maintained, and owned by others and later modified by USACE for the entity responsible for operation and maintenance. (See paragraph 21.5.1 on Design Criteria)

D.5.2 Responsibilities. USACE assumes a limited responsibility for dam safety when work is accomplished by USACE to modify the dam.

D.6 Category 5.

D.6.1 Involvement. Dams where USACE has issued permits under its regulatory authority.

D.6.2 Responsibilities. USACE has no responsibility for dam safety.

D.7 Category 6.

D.7.1 Involvement. Dams inspected and evaluated by USACE under the authority of the National Program for the Inspection of Non-Federal Dams, PL 92-367.

D.7.2 Responsibilities. USACE has no responsibility for dam safety.

APPENDIX E

USACE Dam Safety Fact Sheet Template

E.1 USACE Dam Safety Fact Sheet. Districts will prepare a USACE Dam Safety Fact Sheet, for public release, at the completion of any risk assessment performed on a dam in support of the USACE dam safety program. The fact sheet will contain an inundation map. This is a map showing the predicted extent of inundation from controlled or uncontrolled reservoir releases for a pre-determined event scenario or scenarios. Releases may be a result of normal reservoir operation, a result of structural failure or a result of misoperation.

E.2 Fact Sheet Template. Figures E.1.a and E.1.b provide a template for the fact sheet that is releasable to the general public. The following guidelines are provided for use when preparing a dam safety fact sheet for public release:

E.2.1 The light blue italicized text is to be edited to fit the specifics for each dam.

E.2.2 Add a project overview photograph. After pasting, format picture for "square" text wrapping, and set picture border to black, if necessary. Locate the picture in the upper right corner of the text for Project Location and Description, just below the banner. Limit the picture size to about 2.5 to 3 inches wide by 1.5 to 2 inches tall.

E.2.3 Project Location and Description (first paragraph): List the authorized purposes for the dam and related benefits.

E.2.4 Project Location and Description (second paragraph): Describe the main components of the project but avoid using technical terms. Provide the spillway capacity in gallons per unit of time (seconds, minutes, or hours, whichever is more meaningful) and provide the swimming pool volume-equivalent. An Olympic-sized swimming pool contains about 2.5 million liters of water or 660,430 gallons, and 1 cubic foot is equivalent to 7.48 gallons.

E.2.5 Project Location and Description (third paragraph): Describe the operation of project.

E.2.6 Benefits associated with XYZ Dam: Provide pertinent information for benefits provided by the dam. Highlight flood damages prevented by any recent major flooding.

E.2.7 Risks associated with XYZ Dam: Use the incremental risk category (low, moderate, high, or very high) that corresponds to the DSAC rating. Provide a very short summary of the dam safety issues that support the DSAC rating in general terms without providing specific location detail which could be used by an adversary. Neither inspection reports nor numerical calculations are to be publicly released in an uncontrolled or unrestricted manner. However, information that may help inform the public of the risk may be summarized. All DSAC 1 through 3 dams (moderate, high, or very high risk) are required to have IRRM implemented. IRRM are not required for DSAC 4 dams, but elevated monitoring and evaluation may be performed.

E.2.8 What residents should know: List primary impact areas by city and state. Provide a map of a scale such that features of the dam and individual structures in the flood plain are not easily discerned. Include impacted downstream communities and provide flood wave arrival time and peak flood elevation in NAVD. Use the System Map provided in the Consequence Assessment Report. After pasting, format picture for “square” text wrapping, and set picture border to black, if necessary. Locate the picture in the upper right corner of the text on Page 2. Limit the picture size to less than about 4 inches wide by 2.5 tall. Compress picture after sizing to reduce the file size.

E.2.9 Public Awareness (XYZ Dam Facts): Structures at risk by reservoir level are not available from a PA. Therefore for the PA fact sheet state data is not available. Include structures at risk for IES and DSMS fact sheets if the data is available.

E.2.10 For additional information: If there are multiple emergency management agencies (i.e., multiple counties or communities affected), then do not include a phone number.

E.2.11 Modify the footer with the appropriate district, mailing address, and web address. Add the date of release.

USACE Dam Safety
Facts for XYZ Lake Dam (29 Jan 2014)

U.S. ARMY CORPS OF ENGINEERS — BUILDING STRONG®

Project Location and Description: *XYZ Lake Dam was designed and built by the U.S. Army Corps of Engineers (USACE) and completed in 1974. USACE operates XYZ Lake Dam for flood damage reduction, municipal and industrial water supply, water quality and recreation.*

The main components of the project are an earthen embankment section, which serves as the main water barrier composed of compacted earth, gates that allow controlled water flow out of the dam, and an additional ungated spillway, a segment of the structure used to provide additional release of water from the dam during major flood events. The earthen dam is 2,900 feet long, 178 feet high, and top of the dam is 30 feet wide. The elevation of the top of the embankment is 1018.4 feet[1]. The foundation is made up of clay, silt, sand, cobbles, and boulders. The ungated spillway is located at the right end of the embankment section (looking downstream) and is 210 feet wide with an elevation of 984.4 feet[1]. The spillway can pass up to 295,181 gallons per second (39,460 cubic feet per second) or approximately half the volume of an Olympic size swimming pool each second.

During the fall and winter months, when excessive rainfall is likely, the lake is kept at a relatively low level (referred to as winter pool). Should heavy rains occur, surface water runoff is stored in the lake until the swollen streams and rivers below the dam recede and can handle the release of stored water without damage to lives, property or the environment. Sometimes water must be released to protect the dam's integrity even though streams and rivers may have already reached or exceeded their capacity.

Benefits associated with *XYZ* Lake Dam: *This dam has provided $486,000 in annual flood damage reduction since placed into service.* During *the YYYY* flood the dam prevented *flooding of YY acres or ZZZ square miles and $xxx* in flood damages. *XYZ Lake* provides *92,400 acre-feet (ac-ft)[2] of water to a number of communities downstream of the dam. The annual water supply benefits gained from XYZ Lake amount to nearly $2.2 million. Annual recreational benefits to the area are $4.5 million.*

Risks associated with all dams: Dams reduce but do not eliminate the risk of economic and environmental damages and loss of life from flood events. When a flood exceeds the reservoir's storage capacity, large amounts of water may have to be released that could cause damaging flooding downstream. A fully-functioning dam could be overtopped when a rare, large flood occurs, or a dam could breach because of a deficiency, both of which pose risk of property damage and life loss. This means there will always be flood risk that has to be managed. To manage these risks USACE has a routine program that inspects and monitors its dams regularly. USACE implements short and long term actions, on a prioritized basis, when unacceptable risks are found at any of its dams.

Risk associated with *XYZ Lake Dam:* Based upon the most recent risk assessment of *XYZ Lake Dam in 20XX,* USACE considers this dam to be *a high risk* dam among its more than 700 dams *because of the risk associated with water overtopping the spillway/stilling basin wall during very high flows in the spillway associated with rare flood event, embankment erosion at the downstream end of the dam, or foundational failure surrounding the water outlets.* (For low risk dams state the following.) USACE manages this risk by conducting routine monitoring and evaluation. (For moderate, high, and very high risk dams state the following.) USACE has implemented interim risk reduction measures and/or long term risk reduction measures to reduce this risk. *(List any pool restrictions that have been implemented.)*

[1] *Mean Sea Level (MSL) is the same as North American Vertical Datum 1988 (or NAVD88)*
[2] *One acre-foot is equal to ½ Olympic-size swimming pool*

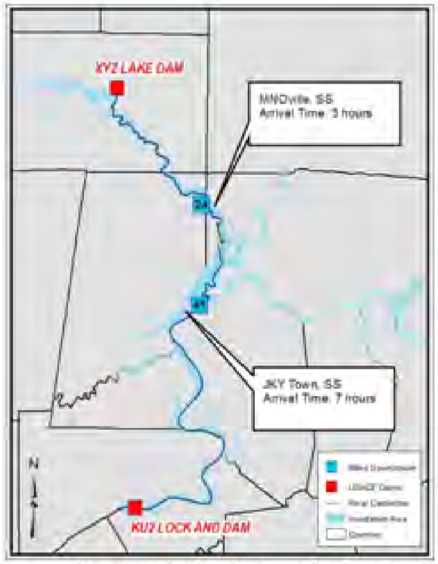
FOR PUBLIC RELEASE
U.S. ARMY CORPS OF ENGINEERS – *ZDCDEF* DISTRICT (*ZDD*), *SOME DRAINAGE* DIVISION (*SDD*)
ENTER ADDRESS HERE, ENTER WEB ADDRESS HERE
FACT SHEET DATE OF RELEASE – *DD/MMM/YYYY*

Figure E.1.a - Fact Sheet Template for Public Release (Page 1)

What residents should know: Dams do not eliminate all flood risk so it is important that residents downstream from the dam are aware of the potential consequences should the dam breach, not perform as intended; or experience major spillway/gated outlet flows. The *high* risk in *(list the communities immediately downstream of the dam) XYZville, SS* and the related consequences further downstream warrant increased efforts on the part of USACE, local emergency management officials and residents to heighten awareness of the potential flood risk associated with the dam.

The primary areas impacted should the dam breach with a full reservoir during a rare flood event; or experience major spillway/outlet works flows are shown in the map. The potential for loss of life is highest *within a couple of miles of the dam with the loss of life concerns decreasing substantially beyond 60 miles downstream of the dam.* Advanced warning of problems and events plays a major role in protecting life and property. See the map for a general indication of flooding with a rare flood event and breach.

Public Awareness: Dams are designed to pass large amounts of water on a regular basis and this means there will always be inundation risk that has to be managed (see facts below).



Map inundation area displayed is a rare flood event and breach.
Map Disclaimer: Actual areas flooded and inundation timing will depend on specific flooding and failure conditions and may differ from the areas shown on the map.

Recommendations for Residents	XYZ Lake Dam Facts
• Living with flood risk reduction infrastructure comes with risk—know your risk. • Living with flood risk reduction infrastructure is a shared responsibility—know your role. • Know your risk, know your role and take action to reduce your risk. • Listen for and follow instructions from local emergency management officials. • Strongly consider purchasing flood insurance. • Contact your elected local, county and state officials to make sound flood risk management decisions in your area.	**Estimated consequences with rare flood event and breach:** • Population at risk: *~12,300* • Structures at risk: *4,700* • Land and property at risk: $*1.2 billion* **Estimated consequences with rare flood event and no breach:** • Population at risk: *~4,200* • Structures at risk: *No data available* • Land and property at risk: $*194 million* Damages prevented to date: $*15 million (1974-2005)* National Inventory of Dams # *SS99999*

Residents should listen to and follow instructions from local authorities. For more information, please contact USACE *ZDCDEF* district office using the information on this fact sheet. You can also contact your local emergency management office at *(###) ###-####*.

For additional information about dam safety and living with dams, please visit http://www.usace.army.mil/Missions/CivilWorks/DamSafetyProgram.aspx and http://www.damsafety.org/media/Documents/DownloadableDocuments/LivingWithDams_ASDSO2012.pdf

FOR PUBLIC RELEASE
U.S. ARMY CORPS OF ENGINEERS – *ZDCDEF* DISTRICT (*ZDD*), *SOME DRAINAGE* DIVISION (*SDD*)
ENTER ADDRESS HERE, ENTER WEB ADDRESS HERE
FACT SHEET DATE OF RELEASE – *DD/MMM/YYYY*

Figure E.1.b - Fact Sheet Template for Public Release (Page 2)

APPENDIX F

Dam Safety Action Classification 5 Protocol and Essential USACE Guidelines

F.1 Policy.

F.1.1 The Dam Safety Action Classification (DSAC) 5 protocol, as outlined below, must be used to support the recommendation that a dam be assigned a DSAC 5. See Table F.1, Dam Safety Action Class Adjustment Guidelines, which is a summary of the full DSAC protocol and Table F.2 is the DSAC 5 protocol check list.

F.1.2 DSAC 5 Protocol. For a DSAC 5 determination, the incremental risk for the dam has to be considered tolerable in that the ALARP considerations are satisfied to include that the dam meets the applicable essential USACE guidelines. The life safety flood risk associated with the non-breach inundation scenario is to be assessed, communicated, and considered in guiding USACE actions.

F.1.2.1 For the risk to be considered tolerable the conditions in Chapter 5 have to be met and documented. Additional key considerations in making this determination follow.

F.1.2.1.1 The Level of Incremental Risk in Relation to the Tolerable Risk Limit Line (TRLL). It is essential to give due consideration for uncertainty in both probability of failure and consequences when making the comparison. For dams with estimates of highly unlikely probability of failure, a conservative stance is appropriate when the dam has not experienced design loading conditions of complete filling, spillway flows, and seismic loading. Estimates of uncertainty are to be displayed (as a range) and considered in DSAC 5 assignments. For the circumstance where the uncertainty range measurably exceeds the limit line, caution should be used in the decision to recommend a DSAC 5. The "Except in Extraordinary Circumstances" exemption caveat for risks above the limit line that states risks are considered tolerable in situations where "special benefits that the dam brings to society at large" does not apply in the assignment of a DSAC 5. The notion that if there is no cost effective solution that reduces risk to the tolerable risk limit, risk could be considered tolerable also does not apply in the assignment of a DSAC 5.

F.1.2.1.2 Local Emergency Action Plans and Warning and Evacuation Plans. The impact of local existing emergency action plans (EAP) and warning and evacuation plans, for both incremental and non-breach inundation scenarios, is to be estimated, documented, and considered in the classification assignment. For the risk to be considered tolerable and DSAC 5 to be recommended, state-of-the-practice EAP and warning and evacuation plans must be in place and fully operational.

F.1.2.1.3 Low Likelihood – High Consequence Dams. For the dams with low likelihood of breaching but have very high life loss or economic consequences if breach were to occur (the lower right corner of Figures 5.3.a,b and 5.4 of the tolerable risk limit lines), a special study of the situation is required. The study will document the nature of the potential failure and contributing failure modes, the major driving factors in the large life loss and economic estimates, and mitigation measures that were considered to address the potential losses. For a DSAC 5 recommendation for such dams, state-of-the-practice risk management measures for the structure and threatened area must have been implemented.

F.1.2 Essential USACE Guidelines. Essential USACE Guidelines are the state-of-practice for design, construction, operation, and maintenance of USACE dams as documented in current USACE publications. The requirements specified in these USACE publications, that are applicable to the dam under consideration, must be met for a dam to be assigned a DSAC 5. These publications include Engineer Circulars, Engineer Regulations, Engineer Manuals, Engineer Pamphlets and Engineer Technical Letters; and Engineering and Construction Bulletins, and other official HQUSACE dam safety-related Policy Letters and guidance. Current USACE guidance reflecting the state-of-practice guidance is summarized in following paragraphs.

F.1.3 Identification of Essential USACE Guidelines. The documents dealing with the essential guidelines for design, construction, operation, and maintenance of USACE dams are requirements specified in these USACE regulations to be reviewed and those guidelines identified as being applicable to the dam in question are to be use in the assessment of that dam. The identification of the applicable essential USACE guidelines is to be done during the routine periodic inspections of the dam. This listing will be reviewed and updated during the IES and DSMS.

F.1.4 Essential Guideline Compliance Evaluation. The dam must be evaluated against the identified guidelines and a determination made as to the extent the dam complies with these essential guidelines for the DSAC 5 determination. This evaluation is to be done during the periodic inspection for the dam. This evaluation will be reviewed and updated during the IES and DSMS. The information from the available risk assessments and all other available information should be used to inform the evaluation on the level of compliance with these guidelines. The evaluation needs to show that the dam essentially complies with the guidelines that are pertinent to that dam.

F.2 <u>Hydrology and Hydraulics Minimum Requirements</u>.

F.2.1 Hydrologic Design. Engineering analysis defining hydrologic capacity of the dam must be provided in accordance with Engineer Regulation 1110-8-2 (FR) (reference A.59). In order to be classified as DSAC 5, analysis must demonstrate with a high degree of assurance that the dam can pass the inflow design flood without the dam failing. Current guidance is that this requirement is achieved by providing a hydrologic analysis concluding that the dam can pass 100% of the inflow design flood with freeboard or have an adequacy study showing it is specifically designed or analyzed to safely pass the overtopping flow. If the identified threshold flood is less than the inflow design flood requirements, the classification must reflect the deficiency.

F.2.2 Spillway Capacity. The existing capacity of the spillway must be demonstrated to be able to pass with a high degree of assurance, the inflow design flood in such a manner that downstream flows will not exceed unimpaired (without-project) discharges and ensure integrity of the structure (non-failure) during the design event. Current guidance is that the spillway capacity requirement is achieved by providing an analysis that concludes that it will pass the design flood with freeboard. There may be damage to the infrastructure, but the damage should not result in failure or uncontrolled release through the spillway. Beyond the design capacity of the spillway there must be a spillway adequacy study performed to assess the integrity of the spillway in the event that spillway flows are necessary. Many of USACE spillways have never been utilized and the potential for damage/failure under significant flow conditions is highly probable. The intent of design is that the spillway should operate in such a manner that the dam is not failed. The damage may be repairable but the dam must retain pool and operational functionality. In order to be classified as a DSAC 5, a spillway adequacy study must be provided that documents expected performance of spillway for design conditions. If materials in the spillway are susceptible to erosion or expected performance is suspect, the classification should reflect that deficiency.

F.2.3 Outlet Works Capacity. The existing capacity of the outlet works must be able to pass the inflow design flood as required by the water control manual without exceeding the design capacity. In order to be classified as a DSAC 5, an outlet works adequacy study must be provided that documents the expected performance of the outlet works for design conditions OR the water control manual revised to reflect the outlet works will not be used for these conditions. If the outlet works is not safely designed to pass the required water control releases the classification should reflect that deficiency.

F.2.4 Gate Reliability. One of the significant findings of the risk assessment portfolio of USACE dams relates to the dependency on reliable gate operations for satisfactory performance of our dams. In particular many of our spillway gates have never been tested under design loads. If a dam depends on gates to pass inflow design floods there must be a gate reliability study performed addressing risk of failure or potential operating issues (such as debris) to receive a DSAC 5 classification. If gate reliability is a potential failure mechanism, the classification should reflect that deficiency.

F.2.5 Water Control. Many of USACE projects have been operating for decades and have not updated their water control operating plans. As a minimum, the authorized water control plan/manual should be updated on a periodic basis. This update could be a simple assessment resulting in “no-change” or a complete update that reflects approved operational changes. In order to receive a DSAC 5 classification the water control manual must have been updated within the last 5 years. If the water control manual is outdated, the classification should reflect that deficiency.

F.2.6 Water Management Data. Generally speaking appropriate levels of monitoring and data collection must be available to make dam safety operational decisions. This data is primarily water volume and timing but it may also include water quality parameters that impact operations. In order to receive a DSAC 5 classification an assessment of the gage availability and operational availability of critical gages must be provided. If there are gauging shortfalls and/or gages are not dependable during extreme flood events, the classification should reflect that deficiency.

F.2.7 Sustainability Issues. USACE does not have a specific regulatory requirement to assess sustainability but there has always been recognition that we must consider impacts on operational functionality over time due to potential changes in the environment. Recently Congressional guidance has mandated additional emphasis on addressing sustainability and adaptive management opportunities. These considerations should include lake sedimentation, changes in inflow design flood (updating HMR's), climate/global change, etc. In order to receive a DSAC 5 classification, a quantitative assessment/report should be provided addressing at least the near term potential for continued operations. As a minimum an engineering report must be provided addressing the basis for the inflow design flood (Note: This report should include potential for change (HMR, etc) which can be based on regional assessments) and impacts of lake sedimentation. As a minimum, results of most recent sedimentation surveys should be provided and projections for remaining life before impacting flood control storage or other project purposes.

F.2.8 Real Estate Interests. The Project should contain documentation or engineering analysis to demonstrate an adequate real estate interest downstream of the project in accordance with the guidance of ER 1110-2-1451 (reference A.51). In order to receive a DSAC 5 assignment, all real estate interests downstream of USACE projects must be adequate to assure project purposes can be accomplished within the criteria outlined in ER 1110-2-1451 (reference A.51). If any modifications have been made to the original project it is important to insure adequate real estate interests have been obtained. This should include, but is not limited to lands below spillways, fuseplugs, saddle dams, outlet works or any surface designed to be overtopped. If additional real estate interests are necessary to insure a project can operated as designed, the classification should reflect this deficiency in terms of the risks it introduces.

F.2.9 Modeling and Mapping. The dam failure model and inundation mapping used to support the Emergency Action Plan should be reviewed and updated on a periodic basis. This update could be a simple assessment resulting in "no-change" or a complete update that reflects changes in the dam or downstream consequences of potential failure. In order to receive a DSAC 5 assignment, the dam failure model and inundation mapping must have been updated within the last 10 years. If the dam failure model and/or inundation mapping is outdated, the classification should reflect this deficiency. (Note: Dam failure modeling and inundation mapping is required only for those dams whose failure could result in life loss, economic damage, or environmental consequences as a direct result of the dam failure flood. Dams with only indirect consequences (e.g. navigation, hydropower, or water supply impacts due to loss of the pool) generally do not require modeling or mapping.)

F.3 <u>Geotechnical and Materials Minimum Requirements</u>.

F.3.1 Geotechnical & Materials Design. Geotechnical engineering considerations must be addressed for all types of water-retaining structures, whether they are earth or rock fill embankments, concrete gravity dams, or concrete arch structures, due to the dependence of their engineering performance on both the foundation geology and the materials employed in the built structure. In order to be classified as DSAC 5, geotechnical analysis of the anticipated response to impoundment of the reservoir in accordance with hydraulic and hydrologic design requirements must indicate that the dam and its foundation will retain the pool without progressive degradation of seepage control features, internal erosion leading to void formation, sliding of the dam on its foundation or at the abutment contacts, excessive deformation of the embankment leading to unacceptable loss of freeboard or damage to seepage control features, differential displacements within a concrete dam that affect waterstops or appurtenant structural or mechanical elements, or bearing capacity of dam-foundation or dam-abutment contacts. Current USACE guidance reflecting the state-of-practice guidance for engineering analysis defining geotechnical and materials capacity of the dam is provided in Engineer Regulations 1110-2-1150 (reference A.49), 1110-2-1806 (reference A.53), and 1110-2-1925 (reference A.54), through procedures described in numerous Engineering Manuals, including, but not limited to Engineer Manuals 1110-1-1804 (reference A.69), 1110-1-2907 (reference A.70), 1110-1-2908 (reference A.71), 1110-2-1902 (reference A.75), 1110-2-1906 (reference A.76), 1110-2-1908 (reference A.77), 1110-2-1911 (reference A.78), 1110-2-2006 (reference A.81), 1110-2-2200 (reference A.85), and 1110-2-2201 (reference A.86).

F.3.2 Reservoir Rim. In addition to assurance of the integrity of the dam itself, stability of the reservoir rim upstream of the structure must be assured for anticipated loadings, whether of hydrologic, earthquake, or other hazards, man-made or natural.

F.3.3 Conduits. Conduits passing through soil within or beneath the dam require additional investigation to assure that their embedment conditions preclude development of seepage paths that are conducive to internal erosion of soil materials. Anti-seep collars or flanges were installed in many dams; it is difficult to compact soils around these features, and under-consolidation with time may lead to detrimental seepage along the conduit; presence of these collars preclude the assignment of DSAC 5.

F.3.4 Drainage Features. Relief wells, toe drains, drainage blankets, chimney drains and other design components intended to convey seepage downstream of waterstops or the earthen core of a dam must be free of contaminants or clogging that would impede their function. Clogged drainage features, whether by organic/bacterial attack, mechanical disturbance or constriction, or siltation, preclude assignment of DSAC 5 unless and until such contamination is cleared and surveillance reveals that contamination is not recurrent. A DSAC 5 dam will not have internal drainage elements that cannot be inspected and validated as to proper function, nor that may not be remediated in the event that such elements may be rendered ineffective at some time.

F.3.5 Filters. Internal erosion of soil materials may result if transitions between fine-grained soils forming an impervious core and surrounding, supportive shell zones or drainage features are not designed and constructed with properly graded filter zones. Damage to the impounding capability of the dam would likely remain unseen until substantial and invasive remedial action is required; absence or incompatibility of these filter zones precludes assignment as a DSAC 5 dam. Turbid or muddy seepage must be investigated to rule out internal erosion of dam or foundation soils as the source of the soil fines. A DSAC 5 dam must have no history of such unattributed sediments in downstream seepage. The presence of slumps, sinkholes or voids within the embankment or beneath or around any conduits or diaphragms such as facing or spillway armoring concrete or training/retaining structures is indicative of soil movement from some mechanism, whether seepage-related or from consolidation settlement, and precludes assignment as a DSAC 5 dam, unless the causative mechanism is fully determined and permanently resolved.

F.3.6 Earthquake Resistance. Earthquake response of site soils within and beneath the embankment to earthquake ground motions are unpredictable and may even cause damage to well-designed structures. Excess pore water pressures, above hydrostatic, may result during moderate to strong ground shaking in saturated soils; these may reduce effective shear strength and lead to sliding or permanent deformations within or beneath any dam on a soil foundation. Well-compacted earth or rock fill embankments constructed on an intact rock foundation typically perform satisfactorily during earthquakes exhibiting peak ground accelerations less than about 0.2g. If the design ground motion anticipated for a given dam is less severe than this, and if the dam otherwise meets all requirements from the engineering disciplines for which it is evaluated, it may be considered safe enough for the DSAC 5 designation. Hydraulic fill embankments, which are placed without engineering consideration other than expedience of constructability, should not be assigned as DSAC 5 unless dynamic seismic analysis indicates satisfactory performance.

F.3.7 Summary. If the geotechnical analysis indicates loads less than or equal to the design loads may create critical distress or a dam safety issue that can lead to failure, the classification must reflect this deficiency.

F.4 Structural Minimum Requirements.

F.4.1 Structural Data. Historical structural design documents, including as-built drawings and material specifications must be available or adequate field surveys, sampling and testing performed to fully define critical geometric and physical properties of any structural component whose failure would adversely affect the performance of the project. If data on structure geometry and physical properties need to be assumed, or the accuracy of existing data is suspect, the classification should reflect that deficiency.

F.4.2 Structural Condition Assessment. All structures, whose failure would adversely affect the performance of the project, must be current with all required inspections, including underwater and/or dewatered inspections. All potentially significant deterioration must be located and quantified with a high level of confidence. This includes assessment of internal conditions such as presence of alkali-silica reaction in concrete or loss of post-tensioning in anchor rods. If inspections are not current or in accordance with guidance, or if there is not a high confidence level that all significant deterioration has been located, the classification should reflect that deficiency.

F.4.3 Structural Stability Evaluation. All structural units or monoliths, whose failure would adversely affect the performance of the project, must have a stability evaluation performed in accordance with EM 1110-2-2100 (reference A.82) and EM 1110-2-6053 (reference A.93) and meet all mandatory requirements stated in those documents. If evaluation methods or results are not in accordance with current guidance, the classification should reflect that deficiency.

F.4.4 Structural Strength and Serviceability Evaluation. All structures, whose failure would adversely affect the performance of the project, must have strength and serviceability evaluated in accordance with current guidance. Guidance for reinforced-concrete hydraulic structures is contained in EM 1110-2-2104 (reference A.83). Guidance for hydraulic steel structures is contained in EM 1110-2-2105 (reference A.84). Additional guidance for specific structure types is included in EM 1110-2-2200 (reference A.85) for gravity dams, EM 1110-2-2201 (reference A.86) for arch dams, EM 1110-2-2400 (reference A.88) for outlet works, EM 1110-2-2701 (reference A.89) for vertical lift gates, and EM 1110-2-2702 (reference A.90) for tainter gates. If strength and serviceability have not been evaluated for all structures whose failure would adversely affect the performance of the project, or evaluation methods or results do not comply with current guidance, the classification should reflect that deficiency.

F.5 Instrumentation Minimum Requirements. To be considered a DSAC 5 the number of instruments, locations, types, and frequency of readings should be commensurate with the need to monitor those potential failure modes that were the reason for the implementation of any risk reduction measures. Note: there may be a set of potential failure modes that were not the primary reason for the implementation of risk management measures that when combined are significant contributors to the flood risk associated with the dam. These potential failure modes should be evaluated and an appropriate level of instrumentation and monitoring should be implemented to provide an adequate level of information for evaluating the performance of the dam pertaining to these credible potential failure modes. Redundancy and use of automated data collection should be considered for potential high risk features or for locations that have limited on site staff or are difficult to access for monitoring and emergency response. Repair, replacement, and installation of new devices must be evaluated throughout the life of the project subject to potential failure modes analysis (PFMA), flood performance, and other risk considerations. Increased data monitoring and analysis should be performed in conjunction with unusual loading events, such as high reservoir levels or following earthquakes. Specific devices and frequency of readings must be documented in a project specific surveillance plan and included as an appendix to the Emergency Action Plan. See this regulation and other USACE regulations and engineering manuals related to instrumentation and monitoring of dams for additional guidance.

F.6 Operations and Maintenance (O&M). In order to be assigned a DSAC 5, the O&M program for the dam must be in compliance with the guidance provided in Chapter 12 - Operations and Maintenance Activities and Appendix I - Dam Safety Program Management Tools of this regulation and with ER 1130-2-530 (reference A.61). The Dam Safety Program Management Tool scorecard for the ‘Routine Dam Safety Program Activities’ rating for the dam has to be green.

Table F.1 - Dam Safety Action Class Adjustment Guidelines

Dam Safety Action Class	Reasons to adjust Dam Safety Action Class	
VERY HIGH (1)	To Classification 2 • External Peer Review does not support DSAC. • Studies and Investigations do not support suspected defect or failure mode. Extreme risk is not supported	
HIGH (2)	To Classification I • Progression toward failure is confirmed or supported by field observations (boils, excessive seepage, deformation, sink holes, etc)	To Classification 3 • Primary deficiency is in the extreme loading events. • History to indicate good performance at unusual loading range.
MODERATE (3)	To Classification 2 • Field observations indicate signs of distress for unusual loading (Seepage & Piping) • Project has high component risk • Cadre belief that the dam has creditable failure modes that could initiate under unusual loading that is supported by a review of construction records and project documents. • Effectiveness of prior repairs are questionable • Site seismicity is believed to be significantly higher than original design basis.	To Classification 4 • Deficiencies are at extreme loading events • Low component risk • Consequences and life-risk low to very low. • Economic impact manageable at local and state levels.
LOW (4)	To Classification 3 • Increasing piezometric pressure over time • Dam aged yet relatively untested by design loadings or spillway flows. • Floodplain undergoing rapid urban expansion. • Consequences of inundation, including vulnerable critical infrastructure in leveed area, could result in significant local, regional, and national consequences beyond those reflected by the current estimate. Life risk moderate.	To Classification 5 • Risk (with uncertainties) is tolerable - probability of failure and societal and individual life risk are below tolerable limits; cost effective state-of-practice measures implemented; essential USACE guidelines met; societal concerns revealed by stakeholder consultation are resolved; and robust program of inspections and O&M exist. • For low likelihood-high consequences dams best practices in USACE EAP and local community, warning and evacuation plans in place. • For life loss risk > 1000, special study validates assign class 5 • Essential USACE guidelines met • DS scorecard for Routine Dam Safety = green
NORMAL (5)	To Classification 4 • Strategic national-level defense and security-related infrastructure would become in-operable due to breach or miss-operation. • Life loss and infrastructure impact with breach or miss-operation would be catastrophic; > 1,000 lives lost and permanent significant loss of local culture and economy.	Not applicable

Table F.2 - DSAC 5 Protocol Check List			
Requirement	Yes	No	Provide an explanation for either response
Tolerable Risk			
Incremental life loss risk for individual and societal risk below limits with due regard for uncertainty?			
ALARP fully satisfied: Remediation proposed/implemented cost effective and does the CSSL exceed the VSL for the next increment of risk reduction; and were the community expectations identified, documented, and resolved)?			
For low failure likelihood – high consequence dams, are state of the practice risk management measures for the structure implemented?			
For low likelihood - extremely high consequence risk, would nation be willing to accept the ensuing catastrophe?			
For low failure likelihood – high consequence dams, are state-of-the-practice EAP and warning and evacuation plans in place and fully operational at the local community level?			
Is instrumentation in place, regularly monitored, and evaluated for early detection of potential dam stress?			
Is robust inspections and O&M program in place and operational?			
USACE Essential Guidelines			
Have the essential USACE guidelines for the dam been identified and documented?			
Does the dam comply with the identified guidelines?			
Are there essential USACE guidelines that require additional evaluation of the dam to determine if compliance is met?			
Are there other national/international guidelines that warrant consideration and does the dam comply with them?			

APPENDIX G

Background Information on the USACE Dam Safety Action Classification System

G.1 Policy.

G.1.1 The Dam Safety Action Classification process is intended to provide consistent and systematic guidelines for appropriate actions to address the Dam Safety issues and deficiencies of USACE dams. USACE dams are placed into Dam Safety Action Classes (DSAC) informed by their incremental risk considered as the combination of life or economic consequences with likelihood of failure. Consequences of the dam failure considered are lives lost, economic, environmental, and other impacts. All dams were evaluated with a screening assessment and assigned a DSAC. Dams will be reclassified as new dam safety information about the dam is developed through monitoring or studies. The intent is that the classification of a dam is dynamic, changing as project characteristics change or as more refined information becomes available.

G.1.2 The structure and make-up of the DSAC table resulted from the need to formally recognize different levels and urgencies of actions that are commensurate with the different safety status of USACE dams. These actions range from immediate recognition of an urgent and compelling situation requiring extraordinary action through to normal operations and Dam Safety activities.

G.1.3 In the past, the USACE Dam Safety program essentially recognized two categories of actions those for dams considered safe, which comprised routine Dam Safety activities, normal operation and maintenance; and those for dams that were considered in need of remediation, for which investigations, remediation funding justification documents, and design and construction of remediation measures were additional activities. However, these two categories do not provide formal recognition of an adequate range of actions and degrees of urgency, especially for dams with dam safety issues that are very high or extremely high incremental risk, which warrant heightened actions that are not provided for in the current business-as-usual procedures. Five action classes are now included in the USACE Dam Safety program and the actions and characteristic for each class are presented below. Examples of Dam Safety Action Classifications are given in following sections of this appendix.

G.2 Dam Safety Action Classes. Five classes of action were selected to portray the range of actions district Dam Safety Officers are to take in executing their Dam Safety responsibilities. The USACE dams are to be assigned a Dam Safety Action Class (DSAC) informed by the likelihood of failure initiation or incremental risk.

G.2.1 DSAC 1 - Very High Urgency of Action.

G.2.1.1 Actions. A summary of the actions to be considered and pursued by the district for this class of dams are:

G.2.1.1.1 Take immediate action to avoid failure.

G.2.1.1.2 Communicate findings to sponsor, local, state, Federal, Tribal officials, and the public.

G.2.1.1.3 Implement interim risk reduction measures, including operational restrictions, and ensure that the emergency action plan is current and functionally tested for the initiating event.

G.2.1.1.4 Conduct heightened monitoring and evaluation.

G.2.1.1.5 Expedite investigations to support development of the basis for remediation using all resources and funding necessary.

G.2.1.1.6 Initiate intensive management and situation reports.

G.2.1.2.1 Characteristics. Classification 1 is for those dams where progression toward failure is confirmed to be taking place under normal operations and the dam is almost certain to fail under normal operations within a within a few years without intervention; or the incremental risk – combination of life or economic consequences with likelihood of failure – is very high. USACE considers this level of life-risk to be unacceptable except in extraordinary circumstances.

G.2.1.2 Examples of Critically Near Failure Dams.

G.2.1.2.2 Dam A. Dam A is experiencing internal erosion of the embankment into the foundation and abutment due to seepage under normal pool elevations, which can quickly progress to rapid breaching of the embankment. Loss of strength in the foundation or embankment may result in a slope stability failure which could result in dam overtopping though the lowered dam crest. Recent subsurface investigations have revealed significant degradation of the foundation and embankment soils. Extremely soft zones were found in multiple borings. Piezometers within the embankment downstream of the existing cutoff wall show significantly higher than expected pressures in reaction to the pool. Movement monuments have indicated continual and increasing settlement of portions of the embankment crest. A temperature survey of the piezometers shows cooler zones in the rock foundations which indicate direct seepage from the pool. Numerous and excessive wet areas persist in areas just downstream of the embankment. These wet areas have progressively increased over the years.

G.2.1.2.3 Dam B. Dam B is experiencing internal erosion through the foundation and abutment and through the embankment along the conduit during all pool elevations which may rapidly progress to breaching of the dam. The conduit is founded on soil and constructed in soil materials. The periodic inspections indicated that a small amount of differential settlement has occurred at one of the conduit joints. It was constructed with seepage collars that likely prevented adequate compaction of the soil around the conduit, and the seepage collars provide a seepage path along this interface that could lead to internal erosion of the embankment material. The left abutment is composed of cohesionless granular glacial deposits and has experienced significant seepage during normal pool events. The project has had several test fillings and additional seepage collection features were added after each test filling. The seepage is so severe that permanent operational restrictions have been imposed on the project to prevent high pools.

G.2.1.3 Example of Very High Incremental Risk Dam.

G.2.1.3.1 Dam C. The most likely potential failure mode is internal erosion of the embankment material into the foundation and abutments. The dam abuts highly karstic limestone formations. One documented cavity in the left rim is 77 feet deep and 15 feet wide. On the right rim, primary seepage pathways through the karst system have not been defined by previous subsurface investigations. In stream seepage measured downstream of the dam during zero releases have increased more than 40% from 90 cfs to 127 cfs in 15 years. Rim grouting has been performed twice previously with limited success. The seepage has potential to erode the earth embankment. There is a wet area downstream of the embankment that has appeared in the last 10 years. Initial foundation treatment, which consisted of minimal excavation and a single line grout curtain, is inadequate. The initial grout curtain and a curtain installed later encountered large clay-filled, solution features in the limestone. There is a potential for erosion of this clay-filled material, which would jeopardize the integrity of the embankment. Piezometer levels are higher than expected; however, some have steadily increased or decreased over the last 20 years indicating erosion of the foundation materials. There is a large metropolitan area (1,000,000 people) with high potential life loss and less than one hour of warning time for the flood wave.

G.2.2 DSAC 2 - High Urgency of Action.

G.2.2.1 Actions. A summary of the actions to be considered and pursued by the district for this class of dams are:

G.2.2.1.1 Communicate findings to sponsor, local, state, Federal, Tribal officials, and the public.

G.2.2.1.2 Implement interim risk reduction measures, including operational restrictions as warranted, and ensure that the emergency action plan is current and functionally tested for the initiating event.

G.2.2.1.3 Conduct heightened monitoring and evaluation.

G.2.2.1.4 Expedite confirmation of classification.

G.2.2.1.5 Give very high priority for investigations to provide the basis to support remediation.

G.2.2.2 Characteristics. Classification 2 is for dams where failure could begin during normal operations or be initiated by an event. The likelihood of failure from one of these occurrences, prior to remediation, is too high to assure public safety; or the incremental risk – combination of life or economic consequences with likelihood of failure – is high. USACE considers this level of life-risk to be unacceptable except in extraordinary circumstances.

G.2.2.3 Examples of Failure Initiation Foreseen Condition.

G.2.2.3.1 Dam D. The most likely potential failure mode is breaching of the dam by concentrated erosion of the embankment material through cracks in the core caused by significant displacements of the upstream shell during an Operating Basis Earthquake (OBE) or greater earthquake. Detailed evaluation of the dam foundations indicates that a loose layer of alluvial materials will liquefy during an OBE earthquake or greater earthquake. The predicted large displacements during the earthquake will cause significant cracking or loss of the integrity of the dams' core section. The displacements are large enough to result in complete failure of the upstream shell of the dam and will quickly progress to breach of the remaining dam embankment. The intake tower is located in the central part of the embankment just upstream of the core. Large displacement of the upstream shell will likely cause damage to the intake tower. The population at risk is located less than one hour travel time of the flood wave at the mouth of a narrow canyon. Loss of life is expected to be very high if the dam were to fail from an earthquake.

G.2.2.3.2 Dam E. The most likely potential failure mode is backward erosion piping in the foundation. Deficiencies in the design and construction techniques contribute to internal erosion at moderately high pools – annual exceedance probabilities of 0.05 to 0.01. Most of the embankment is founded on alluvial and glacial soils without any seepage cutoff. Additionally, the rock below the foundation soils was not inspected or treated and has a history of solutioning. The grout curtain installed on the remainder of the foundation does not meet current standards. There is a history of seepage on the downstream embankment slope, the toe of the downstream embankment, zones downstream of the toe, and along the abutment contacts with the higher pool levels. Piezometeric data show a 10 foot rise in the phreatic line over the last 20 years. There has been a continual and steady settlement of the dam crest to the left of the concrete section since at least 1978. It is likely that the settlement is the result of internal erosion. It is possible that seepage through the lift joints in the concrete section may be entering embankment materials.

G.2.2.4 Example of High Incremental Risk.

G.2.2.4.1 Dam G Dam is overtopped by several feet at 80% of the probable maximum flood (PMF) and also has potential for foundation seepage creating a piping failure at pool levels for infrequent events. The very large population immediately downstream and a major downtown urban area within 10 miles of the dam has the potential for very high consequences and thus the risk for this project is considered to be very high even though the failure mode is driven by a near PMF event.

G.2.3 DSAC 3 - Moderate Urgency of Action.

G.2.3.1 Actions. A summary of the actions to be considered and pursued by the district for this class of dams are:

G.2.3.1.1 Communicate findings to sponsor, local, state, Federal, Tribal officials, and the public.

G.2.3.1.2 Implement interim risk reduction measures, including operational restrictions as warranted, and ensure that the emergency action plan is current and functionally tested for the initiating event.

G.2.3.1.3 Conduct heightened monitoring and evaluation.

G.2.3.1.4 Prioritize investigations to provide the basis to support remediation as informed by consequences and other factors.

G.2.3.2 Characteristics. Classification 3 dams have issues where the incremental risk – combination of life, economic, or environmental consequences with likelihood of failure – is moderate. USACE considers this level of life-risk to be unacceptable except in unusual circumstances.

G.2.3.3 Examples of Moderate Incremental Risk Dams.

G.2.3.3.1 Dam H. The most likely potential failure mode is backward erosion piping through the foundation overburden materials, initiating at the left cut slope of the outlet channel. A pervious sand and gravel deposit overlying the bedrock is exposed in the outlet channel and does not have adequate seepage control filters. During pools up to the record event, seepage has been observed downstream of the toe of the dam in the cut slopes on both sides of the outlet works stilling basin. Construction of remedial seepage control filters and relief wells were constructed several years after the dam was completed but appear to be insufficient to reduce the seepage to acceptable levels based on peizometer response. Seepage on the left cut slope is still occurring and is anticipated to increase in severity under higher pool levels. The seepage being experienced along the outlet channel is occurring through a sand and gravel layer located immediately above the bedrock surface. The dam is estimated to be overtopped by several feet by the probable maximum flood and the embankment is expected to breached by erosion under this loading condition. The volume of water behind this dam at the higher pool elevations would create low to moderate loss of life consequences.

G.2.3.3.2 Dam I. Dam has a long term history of downstream movement in the clay shale foundation. The piezometric data indicate high uplift in the foundation clays that are the result of the original loading by the embankment during construction. The available inclinometer data show distinct zones of movement at high pool levels as well as a very slow creep over time. The assessment shows the factors of safety for the more extreme pool elevations approach 1.0. The dam has been loaded to top of spillway gates for a pool of record, but there is still an additional 30 feet of storage above that elevation, thus the pool elevation of concern is a rare event. There is significant data to indicate a conditionally unsafe project (potential for failure only when the pool is very high) and the very large volume of water behind this dam at the higher pool elevations would create very high economic and environmental consequences with low to moderate loss of life consequences.

G.2.4 DSAC 4 - Low Urgency of Action

G.2.4.1 Actions. A summary of the actions to be considered and pursued by the district for this class of dams are:

G.2.4.1.1 Communicate findings to sponsor, local, state, Federal, Tribal officials, and the public.

G.2.4.1.2 Conduct elevated monitoring and evaluation. When the assigned DSAC for a dam is changed from a 1, 2, or 3 to a 4 the district will review the available risk assessment information, (such as potential failures modes, associated loads on the dam, performance of the dam, and related consequences) to identify the appropriate level of monitoring and evaluation above the routine level. The level of monitoring must be such that it will provide the district with an adequate level of awareness and lead time to take any actions needed if there is indication of deteriorating performance of the dam.

G.2.4.1.3 Give normal priority to investigations to validate classification, but do not plan for interim risk reduction measures at this time.

G.2.4.2 Characteristics. Classification 4 dams are inadequate with low incremental risk such that the incremental risk – combination of life, economic, or environmental consequences with a likelihood of failure – is low and the dam may not meet all essential USACE guidelines. USACE considers this level of life-risk to be in the range of tolerability but the dam does not meet all essential USACE guidelines.

G.2.4.3 Examples of Low Incremental Risk Dams.

G.2.4.3.1 Dam J. The embankment has a potentially preferential seepage path along the top of the outlet conduit and may result in internal erosion of embankment materials during extreme hydrologic events. The dam does not have a foundation seepage cutoff system. Seepage has been apparent at the toe of the dam since the initial filling. High foundation seepage pressures are anticipated for extreme events. With the relief well system functional, it is estimated that the seepage pressure would be 2 feet above the ground surface at the toe during extreme events. It is likely that the high seepage pressures may cause some piping in the form of sand boils potentially causing embankment instability due to loss of foundation material. After the pool of record it was found that significant scouring occurred just below the outlet apron. There is currently a 140 foot long, 120 foot wide, and 13 foot (maximum) deep scour hole downstream of the outlet apron. There is potential for additional scouring and undermining of the outlet apron and wing walls under extreme conditions. The population centers downstream are all located on the elevated floodplain of a wide valley and the potential for economic consequences is low to moderate. The overall risk is considered low and some essential guidelines are met by this dam.

G.2.4.3.2 Dam K. An overtopping failure mode may result from inadequate freeboard based on existing routings. The resultant consequences are low because of a wide downstream valley, low population density, and ample warning time. Thus the risk is low.

G.2.5 DSAC 5 - Normal Urgency of Action

G.2.5.1 Actions. Continue routine dam safety activities and normal operations, maintenance, monitoring, and evaluation.

G.2.5.2 Characteristics. Classification 5 is for dams where the incremental risk - combination life, economic, or environmental consequences with likelihood of failure – is very low and the dam meets all essential USACE guidelines (see Appendix F). USACE considers this level of life-safety risk to be tolerable.

G.2.5.3 Example of a Very Low Incremental Risk Dam. Dam L meets the requirements for hydrologic capacity for passing the most current inflow design flood (IDF), there are no known internal erosion issues, and seepage control features meet current standards. The seismic capacity and performance of all the features of the project are appropriate for the current seismic loads. There are no operations and maintenance issues that impact the operations of the project for all pool and loading conditions. The project staff and water management staff are appropriately trained and qualified to deal with project operations under emergency and flood conditions. With this high level of readiness and low probability of unsatisfactory project performance a review of the project's incremental risk indicates that the risk is tolerable for all design loads and the dam is "safe." Normal operations require due diligence by a district to perform the requisite monitoring, evaluation, maintenance, and training to actively manage the inherent incremental risk associated with any dam with the goal to keep the incremental risk at or below the that which is considered tolerable for the respective dam.

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APPENDIX H

Dams Exempt from Portfolio Management Process

H.1 Purpose. To provide additional information and supplemental guidance on the identification and management of dams exempted from the portfolio management process as noted in paragraph 3.3.1 and Figure 3.1 of this regulation. These dams are referred to in paragraph 3.3. as “dams found to have insignificant or no consequences should they fail.” The purpose in identifying and flagging such dams is to provide a mechanism to enable alternative, non-routine dam safety-related management of these structures.

H.2 References.

H.2.1 EP 1165-2-1, Digest of Water Resources Polices and Authorities, Chapter 7, Paragraph 7 (reference A.67).

H.2.2 ER 200-2-2, Procedures for Implementing NEPA (reference A.34).

H.2.3 ER 405-1-12, 27 Oct 80, Real Estate Handbook, Chapter 11, Disposal (reference A.35).

H.2.4 ER 1105-2-100, Planning Guidance Notebook, Appendix G, Section IV (reference A.39).

H.2.5 ER 1165-2-119, Modifications to Completed Projects (reference A.62).

H.3 Background. The portfolio of USACE dams managed in accordance with this regulation includes all structures that meet the definition of a dam and that would have unique and separate consequences should they fail. The portfolio thus includes as separate dams to be managed for safety, main dams, appurtenant saddle dams, ring dikes within reservoir pools initially intended to protect an area that would otherwise be flooded by the reservoir pool, debris dams both within the reservoir pool area or immediately upstream and other structures as yet identified. For the purposes of this document, all such structures are referred to as dams all of which have been assigned a DSAC class informed by their risk. This policy is focused upon the subset of these dams found to have insignificant or no consequences should they fail. Thus, these dams do not warrant the same actions and attention as the larger set of remaining dams subject to routine application of the portfolio process.

H.4 Policy. Dams identified as meeting the requirements of paragraph H.4 below are exempt from the dam safety portfolio management process as described in Chapter 3 of this regulation. Subject to confirmation that exemption is warranted, such dams are retained in the USACE inventory but will be managed in a non-routine manner tailored to their site-specific characteristics and circumstances. In essence, the posture taken by USACE with respect to these dams is that there is essentially no concern with their possible failure, and thus, expenditure of scarce dam safety resources thereon is to be minimized. Non-routine management will generally take place as described in following paragraphs.

H.4.1 Dams that no longer serve an authorized purpose, nor any other Federal, state, local or tribe purpose and that pose a safety hazard to agency staff or the public if left to remain in their present state will be flagged for decommissioning.

Decommissioning will be pursued in an expedited manner as authorities and funding permit – see paragraph H.6 below for further guidance. Routine operation, maintenance, and inspection will cease. Until decommissioned, the dams will undergo a ‘routine inspection’ at five year intervals to verify their status and justify continued non-routine management.

H.4.2 Dams as described in H.4.1 that pose insignificant hazard to agency staff and the public if left to remain in their present state will be flagged for decommissioning and routine operation, maintenance, and inspection will cease. Decommissioning will be pursued as authorities and funding permit – see paragraph H.6 below for further guidance. Until either the status of the dam changes (decommissioned, becomes a hazard to agency staff and the public if left in present state, fails, or deteriorates to a non-dam status), such dams will undergo ‘routine inspection’ at five-year intervals to verify their status and justify continued non-routine management.

H.4.3 Dams that have potential to serve a USACE or other Federal purpose, or state, local or tribe purpose will be flagged as such and routine operation, maintenance, and inspections will cease. Efforts to remove such dams from the dam safety inventory will be pursued as authorities and funding permit - see paragraph H.6 below for further guidance. If such dams pose a hazard to agency staff or the public if left to remain their present state, expedited efforts will be pursued to accomplish the appropriate action. Until such time as the purpose to be served by the dams is changed and the project modified, and/or title is transferred, the dams will undergo a ‘routine inspection’ at five year intervals to verify their status and justify continued non-routine management.

H.5 Criteria for ‘Insignificant or No Consequences’. The consequences of interest for this guidance are those consequences described in this regulation which are life safety, economic impact and environmental consequences, with life safety of primary concern. Of concern is the consequences should the dam fail, e.g. there would be an uncontrolled release of the reservoir pool.

H.5.1 Life safety criteria. Dam classified as ‘low hazard potential’ and failure would not result in fatalities exceeding USACE ‘Tolerable Risk Guidelines for Life Safety.’

H.5.2 Economic criteria. Reservoir pool area or downstream damage and/or disruption of business activities would be considered in the nuisance category, requiring but a few days to a week of typical maintenance activity to resolve.

H.5.3 Environmental criteria. Stated simply, the concept is that for 'insignificant or no consequences' should the dam fail, that no environmental laws or regulation would be violated, nor would there be negative impact on aquatic and terrestrial species, cultural resources, or local community environmental values. This concept is consistent with 'Findings of No Significant Impact.' Thus, loss of reservoir pool would not permanently impact endangered species as listed by Federal or state agencies in the vicinity of the reservoir, including the reservoir pool, or downstream, nor permanently diminish what might be classified as critical habitat for threatened species. Potential erosion of sediment from the pool area may be of concern, e.g. sediment containing toxic material released or sediment movement impacting downstream in-stream habitat.

H.6 Confirmation of Meeting Exemption Criteria. A memorandum is to be prepared that documents the basis for a recommendation for exemption of the dam from 'routine' dam safety management. The memorandum is to be signed by the District Dam Safety Officer with concurrence by the MSC DSO. The copy of the memorandum is to be furnished to the USACE DSO and the Director, RMC. Scope and content of the memorandum is to include:

H.6.1 Brief dam/project/feature description,

H.6.2 DSAC classification and basis thereof,

H.6.3 Life safety, economic, and environmental consequences of dam failure, including summary of data, analysis, and confidence in estimates,

H.6.4 Hazard to agency staff and public if dam is left to remain in present state,

H.6.5 Recommended action (decommission, change purpose, transfer title, other), and

H.6.6 Approximate cost estimate/savings, schedule, potential funding source, priority to implement recommended action.

H.7 Authorities and Actions.

H.7.1 Authorization Research. The beginning point for any recommended exemption actions to decommission, modify, transfer, or dispose is thorough research of the original authorization and any other subsequent project/feature-related authorization changes or modifications. The project/feature authorization is the critical factual information.

H.7.2 Decommission. Decommissioning involves demolition of the structure, removal of the material, and restoration of the site in accordance with Federal, state, and local laws and regulations; e.g. the structure would cease to exist and any remaining authorization would be dropped or become moot and the structure removed from the dam safety inventory. There are likely to be appropriate scales of decommissioning that range from just breaching/disabling the function of the dam through to complete removal of the structure. Regardless, the site would be prepared in such a manner that any remaining physical components do not present a hazard to agency staff or the public or violate applicable laws and regulations. Authority to study a dam for de-commissioning is ‘Modification to Completed Projects’ (reference A.62). The level-of-detail required and approval level, up to and including Congress, is case-specific. The Chief of Engineers has discretionary authority to approve actions in certain circumstances that may apply. The test governing the Chief’s discretionary authority is the degree of impact on authorized project purposes. A dam meeting the criteria of this guidance might well fall into the Chiefs discretionary authority because its removal would not materially affect the authorized purpose of the project as a whole.

H.7.3 Transfer or Dispose. Should a civil works structure no longer serve an authorized Federal purpose but be of potential value to local interests, the project/structure title and all associated responsibilities may be transferred to other institutions. The hierarchy of preferred transfers documented in Chapter 11 of the Real Estate Handbook (ER 405-1-12 - Disposing Excess Property (reference A.35)), ranges from transfer to another DoD agency through to transfer to an authorized local agency. The end-point of the hierarchy is that of disposal of the property via competitive sale. Necessary investigation and decision processing is outlined in the Handbook and associated GSA regulations. Studies and documentation to justify such transfer/sale would be expected to be similar to that required for ‘Modifications to Completed Projects’ as discussed in ER 1165-2-119 (reference A.62).

H.7.4 Use of O&M Authority. On a case-specific basis, existing O&M authorities and policies may be applicable to actions outlined in this guidance. As an example, the continued maintenance of a dam meeting the criteria of paragraph H.4 may require continued operation and maintenance to ensure its presence does not present a potential safety hazard to agency staff or the public, or violate Federal or state laws and regulations, thus consuming resources while serving no useful Federal purpose. Savings in resources might be possible by disabling or removing the structure, thus accomplishing cost-effective management of the property. Coincidentally, if action is undertaken in this manner, for all practical purposes, the structure would no longer exist and could thus be removed from the dam safety inventory.

H.7.5 Convert Property to Another Purpose. On a case-specific basis, application of Section 1135 of the Water Resources Development Act of 1986 entitled ‘Project Modifications to Improve the Environment’ (reference A.12) might be applicable. This is a small project authority that permits modification of USACE projects for such purposes. Such a purpose might be accomplished by breaching and/or some other minor site preparation that enhances habitat or would serve some other environmental purpose. Thus, the project purpose could change; responsibility and management handed over to another USACE entity, and coincidentally remove the structure from the dam safety inventory.

H.8 Funding. There are several possible funding sources to pay for 'exemption' studies and for subsequently implementing the 'exemption' actions.

H.8.1 For studies to validate flagging dams for 'exemption' (e.g. justify non-routing management); the primary and logical source is regular O&M funds.

H.8.2 For studies to develop the actions and implementation plans, depending on the scale of the action, O&M funds are also a logical source. For substantial studies that would be undertaken under 'Modification to Completed Projects' (reference A.62) authorities, funding guidance provided therein would be appropriate and likely require cost sharing.

H.8.3 For implementation of actions formulated and approved under H.8.2 funding could be from a variety of sources and may or may not require cost sharing. The appropriate funding source would be case-specific.

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APPENDIX I

Dam Safety Program Management Tools

I.1 Purpose. The purpose for the Dam Safety Program Management Tools (DSPMT) is to facilitate agency wide data collection, monitor the USACE dam safety program and track compliance with the "Federal Guidelines for Dam Safety" (reference A.114) and USACE criteria.

I.2 Introduction.

I.2.1 Since implementation of the USACE Dam Safety Program, it has become increasingly clear that there are broad information needs required to support dam safety. These data needs include:

I.2.1.1 Documenting the condition of the Agency's dams

I.2.1.2 Tracking the status and progress of the MSC's and District's dam safety programs

I.2.1.3 Reporting information regarding the Agency's inventory of dams periodically to the National Inventory of Dams (NID) and Congress.

I.2.2 Satisfying many of these data needs is the Dam Safety Program Management Tools (DSPMT). The DSPMT is an information collection and management system that is controlled locally by District dam safety program managers and which interacts with MSC's, Headquarters, and National external cooperative information resources for providing as-requested and periodic information on local dam safety information, program needs, and accomplishments within each organization's jurisdiction.

I.2.3 The purpose of the DSPMT is to provide dam safety program managers a tool to collect unbiased data about dams and dam safety programs, check selected data for accuracy, and then utilize the data to achieve an accurate local, regional, and National inventory of dams and to help address programmatic questions such as:

I.2.3.1 How well are our dam safety programs being implemented?

I.2.3.2 Are we doing too much in some areas and not enough in others?

I.2.3.3 Are we spending our scarce resources in the right places?

I.2.3.4 Are we improving?

I.2.4 The DSPMT is a web-based database which provides a resource to the dam safety data owners and managers. The DSPMT includes three distinct, complementary, and interoperable modules:

I.2.4.1 The Dam Safety Program Performance Measures (DSPPM).

I.2.4.2 USACE Inventory of Dams

1.2.4.3 Dam Safety Scorecard for Routine Dam Safety Program Activities

I.2.5 Each of these modules is applicable to all levels of a dam safety organization. Output from the DSPPM at each level can be used individually and/or collectively as input at the next higher level to evaluate program performance on broader and broader scales (e.g., district, division, agency). By utilizing the tools provided by the DSPMT, data managers and providers can achieve the one-time-only data entry objective while maintaining an up-to-date, error-checked, consistent format database of dam inventory and program performance information.

I.3 Discussion. The overall objective of the DSPMT is to enable each user to have a computer program that interacts with the NID, local databases, and other external cooperative databases in a one-time-only data entry environment.

I.3.1 The vision is to eventually achieve:

I.3.1.1 One-time data entry for programs targeted at the different aspects of dam safety;

I.3.1.2 Efficient data extraction from local, state and federal databases into a consistent user-friendly and user-managed inventory and performance measure database;

I.3.1.3 Automated error checking and identification of conflicting data;

I.3.1.4 Simple online exports of local inventory and performance measure (or indicator) data and import of national level data to/from a centralized server; and

I.3.1.5 Updating and reporting of inventory, performance measure, and incident information as frequently as desired.

I.3.2 The objectives of the DSPMT are also to provide simple, unbiased, quantitative data that are useful separately and/or collectively as metrics to help users:

I.3.2.1 Evaluate how well their dam safety programs are being implemented;

I.3.2.2 Determine whether they accomplished what they set out to accomplish;

I.3.2.3 Proactively “tell” their dam safety stories to others, both internal and external to their organizations; and

I.3.2.4 Encourage uniform and consistent application of laws, policies, and regulations.

I.4 DSPMT Overview.

I.4.1 DSPPM. The DSPPM is currently divided into six subject areas:

I.4.1.1 Dam Safety Staff Size and Relevant Experience,

I.4.1.2 Inspections and Evaluations,

I.4.1.3 Identification and Remediation of Deficient Dams,

I.4.1.4 Project Response Preparedness,

I.4.1.5 Agency and Public Response Preparedness, and

I.4.1.6 Incident Manager.

I.4.1.7 These broad performance measures are supported by detailed spreadsheets which are targeted at individual aspects of the performance measures. The following detailed additional spreadsheets are currently available within the DSPMT:

I.4.1.7.1 Staffing Spreadsheet

I.4.1.7.2 Deficiencies and Budgeting Prioritization Spreadsheet

I.4.1.7.3 Documentation Spreadsheet

I.4.1.8 These spreadsheets allow graphics of data to be generated that provide insight into the capabilities and challenges faced by the organization.

I.4.2 USACE Inventory of Dams.

I.4.2.1 The USACE inventory of dams is maintained within DSPMT. Structures are added or deleted using the inventory management module. The inventory module includes data validation checks to ensure the data is consistent. The data fields match the National Inventory of Dams structure and are used to populate the NID when requested. Pictures can also be added for each project.

I.4.3 Dam Safety Scorecard for Routine Dam Safety. For several years now, we have been collectively building an unbiased dam safety database within the DSPMT. Progress of the program is being tracked using Dam Safety Program Performance Measures (DSPPMs). Selected performance measures which represent key routine activities are utilized to export in the form of the Dam Safety Scorecard. The Dam Safety Scorecard provides a numerical and graphical report of the implementation of routine dam safety activities on a per dam basis. The Scorecard is not used as an indicator of the dam's condition or to determine the dam safety action class (DSAC) except for DSAC 5. The Scorecard, provides a uniform and consistent way of evaluating routine program implementation in the form of numbers, verbal ratings (Excellent, Fair to Good and Poor), and colors (Green, Yellow, and Red). The Scorecard is generated by the DSPMT as an output on a per dam basis, or it can be rolled up for dams in a district, a division, or USACE. The Dam Safety Scorecard will be reviewed approximately quarterly by HQ.

I.4.3.1 The six sections of the Scorecard are Staffing and Funding; Inspections and Evaluations; Project Instrumentation; Project Response Preparedness; Agency and Public Response Preparedness; and Interim Risk Reduction Measures. The subjects and the numerical values assigned to each of the six sections are based on a consensus of solicited expert opinions. The weighted values were evaluated during a beta testing period and adjusted accordingly. The Scorecard index value is a reasonable, recognizable, and accepted evaluation of a routine dam safety program implementation.

I.4.3.2 The data used to populate the Scorecard is retrieved from information that the districts provide in the DSPPM module of the DSPMT. The scores, ratings and graphical output are automatically generated by the DSPMT. The Scorecard allows managers to evaluate the overall program on a per-dam basis, perform trend and gap analyses, and convey program accomplishments to others.

I.4.3.3 Districts should include discussions of their Scorecards in their dam safety committee meetings and for internal briefing on their DSAC 1 and 2 dams. It is envisioned that the Scorecards can be useful when defending budget requests to highlight the need for funding items or activities that are not being accomplished due to inadequate funding.

I.5 <u>USACE DSPMT Implementation Specifics</u>. Since the District Dam Safety Program Managers should be most familiar with the details of the individual projects in their inventory, they have the responsibility of maintaining up-to-date information on the dams in the database.

I.5.1 DSPMT databases must be fully updated quarterly prior to HQ quarterly review. As inspections are completed, the DSPMT must be updated to include any modifications to inventory information on the dam, and to include the results of the inspection and any impacts on the performance measures such as inspection date, identified deficiencies, estimated costs of remediation, priority ratings, etc.

I.5.2 The MSC is responsible for providing quality assurance and review functions on district submittal information on a periodic basis. Instructions for accomplishing these updates are described in the DSPMT User's Manual. If questions, data conflicts, or errors are noticed in district inventory information, they cannot be corrected or modified at the division level or HQ level. It is the district's responsibility to resolve the question or implement the correction in the district database.

I.6 Summary. With continued reductions in budgets and staffing, both federal and non-federal dam safety programs are in need of continuous efficiency and effectiveness improvements. In addition, there is an ever-increasing need for performance-based reporting internally and to FEMA, Congress, and State Legislatures. The DSPMT provides the tools necessary for evaluating dam safety programs, for reporting accomplishments, and for expressing program needs to others. As a working tool, it implements true one-time-only data entry, provides information to program managers in achieving continuous program improvement, is a self-evaluation tool and an internal and external reporting tool, and encourages results-oriented management practices. By using the DSPMT, the agency will be assured of a more consistent, error-checked submittal of inventory and performance measure information provided on a periodic or as-needed basis.

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APPENDIX J

Hazard Potential Classification

J.1 Discussion. The current classification system used to evaluate the hydrologic hazard potential of dams was established in response to several dam failures in the early 1970's which resulted in significant loss of life and property damage. This classification system, while useful for the evaluation of hazard to life and property, is deficient in that it does not consider the indirect losses of critical lifelines due to a dam failure. These losses, such as the loss of water supply, loss of key transportation or medical facilities, loss of power generation capability, or loss of navigation and environmental damage can have a significant impact on the public after a major hydrologic or seismic event. Some attempt has been made in the past to consider lifeline and environmental losses as economic losses; however, a standard classification system has not been established. An additional deficiency in the existing classification system is in the potential loss of life posed by the significant and high classifications. The terms "few" under the significant category and "high potential" under the high category are too vague and subject to interpretation. The following is an attempt to quantify the loss of life associated with each level of hazard potential.

J.2 Classification System. Table J.1 establishes a classification system, which groups losses into four general categories: loss of life, property, lifeline and environmental losses. This hazard potential classification is related to the functional integrity of the project, not the structural integrity of project features or components. Direct loss of life is quantified as either none, certain (one or more) or uncertain. Economic indirect losses are classified as either direct property, environmental or lifelines losses. Hazard potential ratings are based entirely upon the proximity of the project to population, which would be at risk due to project failure or operation, and the impact upon life, and property of the loss of essential services. A more detailed discussion on each of the four categories follows:

J.2.1 Loss of Life. “Federal Guidelines for Dam Safety: Hazard Potential Classification System for Dams” (reference A.119) states that the difference between the significant and high hazard potential classification levels is that a high hazard potential dam includes the probable loss of human life, regardless of the magnitude of other losses. If no loss of life is probable as the result of dam failure or misoperation, the dam would be classified as Low or Significant Hazard Potential. The probable loss of human life is defined to signify one or more lives lost. The term "probable" indicates that the scenario used to predict the loss of human life must be reasonable and realistic, not contrived. In the definition for High Hazard Potential, the probable loss of human life is further clarified to exclude the casual user of the downstream or upstream area in determining the potential for loss of human life. Potential public response to the emergency should not be used to reduce the calculated probable loss of human life.

J.2.2 Property Losses. Property losses are classified as either direct economic losses due to flood damaged homes, businesses, and infrastructure; or indirect economic losses due to the interruption of services provided by either the failed facility or by damaged property or infrastructure downstream. Examples of indirect losses include:

J.2.2.1 Loss of power generation capability at the failed dam (or at an inundated powerhouse downstream).

J.2.2.2 Loss of navigation due to evacuation of the navigation pool at a failed reservoir (or due to direct damage to a lock).

J.2.2.3 Loss of water supply due to a reservoir emptied by a failed dam.

J.2.3 Lifelines Losses. Disruption of essential lifeline services or access to these services during or following a catastrophic event can result in indirect threats to life. The loss of key transportation links such as bridges or highways would prevent access to medical facilities at a time critically injured people need access the most. Another example would be the loss or damage to medical facilities.

J.2.4 Environmental Losses. Damage to the environment caused by project failure or operation can result in the need for risk reduction measures, or can cause irreparable damage to the environment. Environmental damage estimates must consider the damage, which would normally be caused by the flood event under which the project failure occurs. Only the incremental damage caused by the project failure will be attributed to project failure or operation. Some other examples of environmental impacts are:

J.2.4.1 Environmental damage caused by the release of a reservoir contaminated by toxic or hazardous mine waste.

J.2.4.2 Environmental damage caused by sediment released by a reservoir.

J.3 Classification Table. See Table J.1 for guidance in classifying Civil Works projects as low, significant, or high hazard potential.

Table J.1 - Hazard Potential Classification for Civil Works Projects

CATEGORY[1]	LOW	SIGNIFICANT	HIGH
Direct Loss of Life[2]	None expected	None expected	Certain (one or more) (extensive downstream residential, commercial, or industrial development)
Lifeline Losses[3]	No disruption of services - repairs are cosmetic or rapidly repairable damage	Disruption of essential or critical facilities and access	Not considered for this classification
Property Losses[4]	Private agricultural lands, equipment and isolated buildings	Major or extensive public and private facilities	Not considered for this classification
Environmental Losses[5]	Minimal incremental damage	Major or extensive mitigation required or impossible to mitigate	Not considered for this classification

Notes:

[1] Categories are based upon potential consequences given failure of the dam and are not applied to individual structures within a project.

[2] Loss of life potential based upon inundation mapping of area downstream of the project. Analyses of loss of life potential must take into account the extent of development and associated population at risk, time of flood wave travel and warning time.

[3] Indirect threats to life caused by the interruption of lifeline services due to project failure, or operation, i.e., direct loss of (or access to) critical medical facilities or loss of water or power supply, communications, power supply, etc.

[4] Direct economic impact of value of property damages to project facilities and downstream property and indirect economic impact due to loss of project services, i.e., impact on navigation industry of the loss of a dam and navigation pool, or impact upon a community of the loss of water or power supply.

[5] Environmental impact downstream caused by the incremental flood wave produced by the project failure, beyond which would normally be expected for the magnitude flood event under a without project conditions.

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APPENDIX K

Potential Failure Mode Analysis (PFMA) for Dams

K.1 Purpose/Applicability. Guidance for determination of potential failure modes for use in risk assessments of dams.

K.2 PFMA Overview.

K.2.1 PFMA is a method of analysis where particular faults and initiating conditions are postulated and the analysis reveals the full range of effects of the fault or the initiating condition on the system. The methods of failure are indentified, described, and evaluated on their credibility and significances. Failure Modes are a way that failure can occur, described by the means by which element or component failures must occur to cause loss of the sub-system or system function. The failure mode encompasses the full sequence of events from initiation (cause) through to the realization of ultimate failure effect of interest to include physical, operational, and managerial systems. PFMA is the first step in conducting a risk assessment for an existing dam or a risk reduction action. A significant increase in Dam Safety awareness can be learned from this step. Thorough failure mode identifications and complete descriptions will lead to a more efficient risk assessment process. Interim risk reduction measures and study plans can be effectively developed based on the results of the PFMA.

K.2.2 A PFMA is normally a facilitated identification and examination of potential failure modes (PFM) for a dam by a diverse team of persons who are qualified by experience and/or education to evaluate the dam. It is based on a review of available data and information, first hand input from field and operational personnel, site inspections, completed engineering analyses, discussion of known issues/problems, a general understanding of dam characteristics, and an understanding of the consequences of failure.

K.3 Outcomes. The PFMA outcomes will include the following:

K.3.1 List and detailed description of each PFM with a list of the factors that make the failure mode more likely to occur and a list of the factors that make the failure mode less likely to occur.

K.3.2 Classify PFM as not credible, credible and significant.

K.3.3 Major findings and understandings

K.3.4 Initial event tree development for each PFM to be carried forward in the next step of the risk assessment.

K.3.5 Review and update routine dam safety activities to include a review and update of the list of applicable essential USACE guidelines and the evaluation for compliance with these essential USACE guidelines.

K.3.6 Identify needed additional investigations, analysis, testing, data, etc. for each PFM with unresolved issues.

K.3.7 PFMA documentation.

K.3.8 Plan for the risk assessment effort.

K.3.9 Review and update IRRM plan.

K.4 PFMA Process Description. The following is a brief overview of the steps required to perform a PFMA.

K.4.1 Step 1. RMC designates the PFMA facilitator and the facilitator coordinates with the district to assign PFMA participants.

K.4.2 Step 2. Collect and summarize background information, (requires assignment in the district).

K.4.3 Step 3. Perform a site visit/review (all members of the PFMA team should participate in the site visit).

K.4.4 Step 4. Review background information on the dam (by PFMA team)

K.4.5 Step 5. Conduct the PFMA.

K.4.6 Step 6. Generate final PFMA report.

K.5 Subject Matter Expert Facilitator Requirements / Core Qualifications.

K.5.1 The facilitator is critical to the success of the PFMA, and should have a broad background and experience in dam engineering and experience in performing a PFMA. The RMC and USACE Dam Safety Program Manager approve PFMA facilitators.

K.5.2 Typical requirements to be an approved PFMA facilitator are:

K.5.2.1 Be a licensed engineer or a licensed engineering geologist with a minimum of ten years of experience in the design, construction, or operations of dams.

K.5.2.2 Be experienced in dam safety and related risk assessments.

K.5.2.3 Have participated in a PFMA for at least one for embankment dam and one concrete structure PFMA for projects operated/regulated by USACE or Reclamation.

K.5.2.4 Complete the USACE facilitator training course.

K.5.2.5 Have consolidated data and written the report from at least one the PFMA session.

K.5.2.6 Successfully facilitated at least two PFMA sessions observed by an experienced facilitator with associated formal feedback and endorsement.

K.5.2.7 Possess good communication and group leadership skills.

K.6 <u>Development of Supporting Data for PFMA</u>. Gathering supporting data prior to the PFMA session is a critical step. The search for records should not be limited to the district files, but should include research in other locations (e.g. National Archives, university libraries, etc).

K.7 <u>Identifying and Describing Potential Failure Modes</u>. The potential failure modes must be described fully from initiation to breach and uncontrolled reservoir release and\or significant loss of operation control. Loss of operational control includes loss of projects purposes or services such as navigation capability. The reasons for completely describing the potential failure modes are shown below.

K.7.1 To ensure the PFMA team has a common understanding of the failure mode.

K.7.2 To document PFM for future reference and use.

K.7.3 To facilitate subsequent development of an event tree.

K.8 <u>Evaluating a Potential Failure Mode</u>. After the detailed PFM descriptions have been completed, the PFM are evaluated by listing the factors that make the failure mode more and less likely to occur. These are based on the team's understanding of the facility and background material.

K.9 <u>Performance Monitoring Enhancements, Data Collection Needs, Analyses, and Risk Reduction Measures</u>. Following development of a potential failure mode, the team will have a thorough understanding of the available information and circumstances leading to its development. This is the time to capture the team's thoughts on what additional information or analyses would be useful in understanding the potential failure mode, and additional opportunities for monitoring and risk reduction. Whether these will actually be implemented depends largely on the follow-on study plan and risk assessment.

K.10 <u>Major Findings and Understandings</u>. The knowledge gained from the PFMA should be documented in the form of "Major Findings and Understandings" in the PFMA report. Below are examples of a major finding and understanding.

K.10.1 Galleries. There are four galleries that penetrate the base of the dam as described above: Duck Creek, utility galleries on either side of the spillway, and the diversion gallery at the outlet works. The galleries have not been inspected during recent Periodic Inspections. Hence, the condition of the joints and any cracks and/or seepage is unknown. It is recommended that the district include inspection of the galleries as part of the Periodic Inspection program. The results of the inspection are needed to resolve the potential failure mode of internal erosion of the embankment materials into the galleries.

K.10.2 Seepage Control. Foundation reports were prepared for the outlet works and spillway structures only. However, there is little to no documentation of foundation preparation in the embankment areas. Only a 5-foot deep inspection trench was excavated during construction, and no cutoff was provided for the deep pervious foundation. The primary seepage control feature is a series of relief wells near the downstream toe. Material compatibility is essential to resolving several potential failure modes associated with internal erosion. Based on a review of embankment design gradations, it appears that filter criteria is not met at some locations. It is recommended that the district review the conclusions of the Hydraulic Fracturing Evaluation Report dated September 1997 (reference A.110, for material compatibility for both internal erosion through the embankment and from the embankment into the soil foundation. Best available gradation data for the various materials as well as the original design gradations should be used in conjunction with the filtering criteria provided in EM 1110-2-1901 Seepage Analysis and Control; Change 2 dated February 2005 (reference A.74).

K.10.3 High Consequences. The area downstream of the dam is the highly developed urban area of Made-up County that extends for miles to the bay downstream. Even if the probability of failure is determined to be low for the credible and significant potential failure modes, the incremental loss of life and economic damages for dam failure will likely generate considerable risk because of the relatively flat flood plain and high population density. Furthermore, regardless of the level of modifications or improvements to the project, there will probably always be some appreciable residual risk due to high consequences that must be managed through emergency preparedness, communication, and/or education.

K.11 Documentation. The results of the PFMA will be documented using the following outline.

K.11.1 Introduction and Background including a summary of the last risk assessment completed (SPRA, Periodic Assessment, Issue Evaluation, etc.)

K.11.2 Current Assessment Effort (include a list of participants in this section)

K.11.3 Description of Project

K.11.4 Major Findings and Understandings (Include the review and update of the list of applicable essential USACE guidelines and the evaluation for compliance.)

K.11.5 Potential Failure Modes Identified.

K.11.6 Credible Potential Failure Modes

K.11.7 Significant Potential Failure Modes

K.11.8 Potential Failure Modes with Unresolved Issues

K.11.9 Not credible Failure Modes

K.11.10 Summary and Conclusions

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APPENDIX L

Screening for Portfolio Risk Analysis Process (SPRA)

(This appendix documents the phased out SPRA process. It is replaced by the Periodic Assessment process. Table L.1.b - Dam Safety Action Class Adjustment Guidelines is still used as a consideration by USACE in the process to assign a DSAC.)

L.1 SPRA Process. The SPRA process consisted of an independent multi-discipline cadre visit the district that had dams to be screened. In one day, the cadre received a district presentation on the dam and reviewed existing reports to estimate the consequences and determine the engineering ratings to enter in the SPRA spreadsheet. A report was prepared to document the range of the load cases considered, the ratings, and consequences from the existing data.

L.2 SPRA Spreadsheet. The SPRA spreadsheet provided information in the form of average annual risk in terms of potential loss of life and economic damages as well an estimated probability of failure. These items were used to develop a recommendation for the appropriate DSAC for each dam. The methodology used for developing the information to inform the DSAC assignment (DSAC dam binning) evolved over the five year period SPRA evaluations were done. The procedure evolved to plotting the average potential loss of life per failure (for Flood Damage Reduction (FDR) structures) or average economic damages per failure (for Navigation (NAV) structures). These are referred to as the Life Risk Index and Economic Index respectively. The index values were calculated by dividing the average annual value by the resulting failure probability for the dam as rated. This calculation results in an “average” potential loss of life or economic damage for a single dam failure. These values were plotted on the x-axis as shown in Figures L.1.a and L.1.b. The y-axis plots the “Increasing Likelihood of Poor Performance” and was referred to as the Performance Index. The Performance Index was calculated by dividing the probability of failure for the dam as rated by the probability of failure for a baseline dam. The baseline dam probability of failure was for a dam meeting all current guidelines (all features were rated “Adequate”). The y-axis then represents how many more times likely the dam (as rated by the regional cadre) was to fail than a baseline dam or a dam meeting all current guidance. For example a performance index of 10 would indicate the dam is 10 times more likely to fail than one meeting all current guidance. Navigation structures with potential for loss of life were plotted on both life loss and economic loss charts and both were used to inform the recommendation of the DSAC for that dam.

L.3 SPRA Methodology. SPRA methodology calculated a probability of failure, but the methodology in the SPRA calculations included modifiers of 1, 10, 100, and 1000 for engineering ratings of Adequate, Probably Adequate, Probably Inadequate, and Inadequate respectively. These modifiers were multiplied times the baseline probability of failure for each feature and therefore resulted in a probability of failure that was comparable only to results of other dams using the SPRA spreadsheet. SPRA results represent more of a “relative comparison” between dams and the data is not compatible or comparable with the tolerable risk guidelines. DSAC 5 determinations could not be made based on SPRA data since that data was not compatible with the tolerable risk guidelines.

L.4 DSAC Binning. The DSAC binning chart used "bounding" lines based on an interpretation of the DSAC descriptions for DSAC 1, 2, 3 and 4. These "bounding" lines were not finite lines and could not be described by simple bounding limits. The basic limits for these bounding lines were shown in Table L.1.a and were not considered as absolute values as there was considerable uncertainty in the SPRA estimates. This required the values for each dam to be plotted on the chart to determine the initial estimate of the DSAC for the dam. Once plotted, the initial estimate was the beginning point that was reviewed for other factors to determine if the DSAC should be adjusted higher or lower as shown in Table L.1.b. The DSAC was then determined for each dam with a brief rationale for keeping or changing the initial DSAC for each dam.

L.5 Assignment of Initial DSAC and Review of the DSAC. The initial DSAC recommendation was made by the regional cadre following the district visit. The SPRA ratings, consequences, and DSAC assignment went through two levels of review prior to being finalized.

L.5.1 The first level of review was completed by a group of quality control personnel including past regional cadre members and the Risk Management Center and the cadre lead responsible for the dam. The review consisted of reviewing the district presentation, SPRA report, and SPRA spreadsheet. Based on the information presented, questions were asked about various SPRA items including engineering ratings, consequences, breach release severity parameters, rationale, and DSAC assignment. These items were recorded and provided to the regional cadre to vet back with the entire cadre. The cadre considered the comments and either made the recommended changes or documented why they did not make the change. A follow-up discussion was held if the changes could potentially impact the agreed upon DSAC recommendation. From this effort a presentation summarizing the results of the screening was prepared for the next review.

L.5.2 The second level of review was completed by the DSOG. The summary presentation was made by the cadre lead. DSOG members had access to the district presentation, SPRA report, and the summary presentation prepared by the cadre lead. Based on the questions and recommendations generated by the presentation to the DSOG a list of comments was created for the cadre lead to address at a later date. If the recommendations or comments impacted the proposed DSAC, the assignment of the DSAC was withheld until the comments were addressed. If the recommendations would not change the DSAC, the DSOG reviewed the recommended DSAC and voted on the final DSAC.

L.5.3 Following the DSOG meeting, any needed changes to SPRA reports and spreadsheets were made. The final DSAC recommendation was included in the SPRA report. Once finalized, the reports were and distributed to the division DSPM.

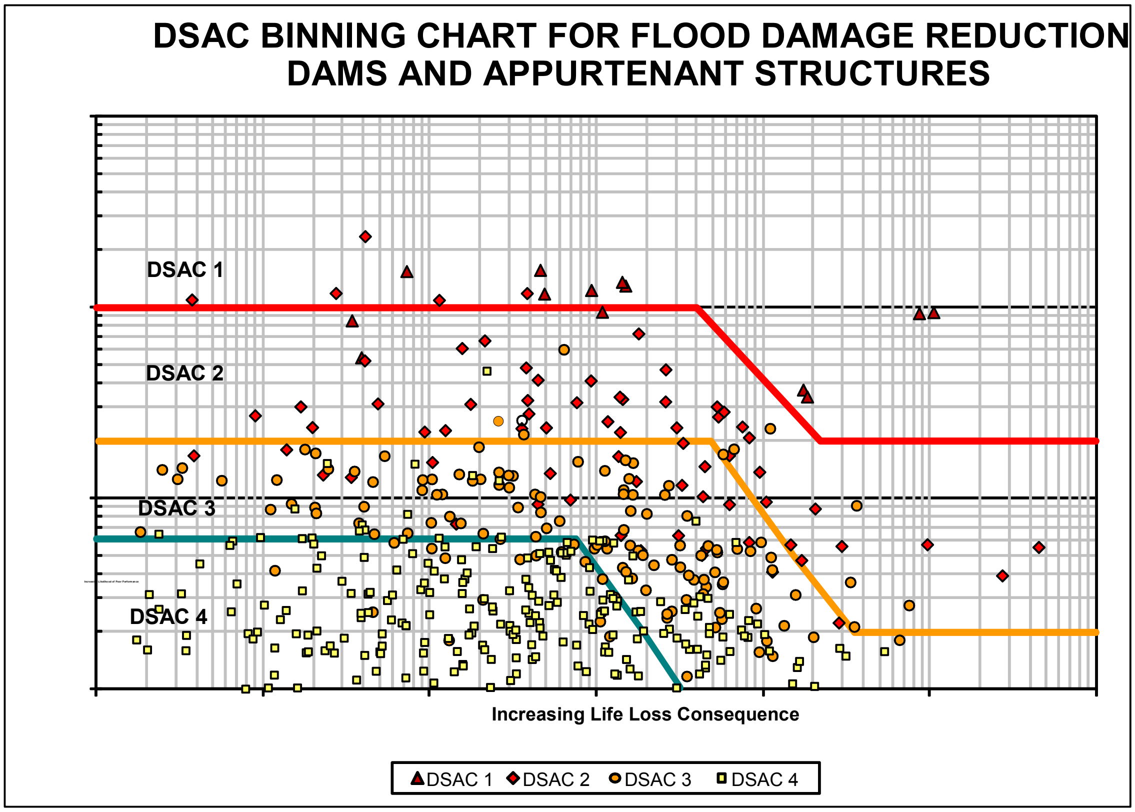

Figure L.1.a

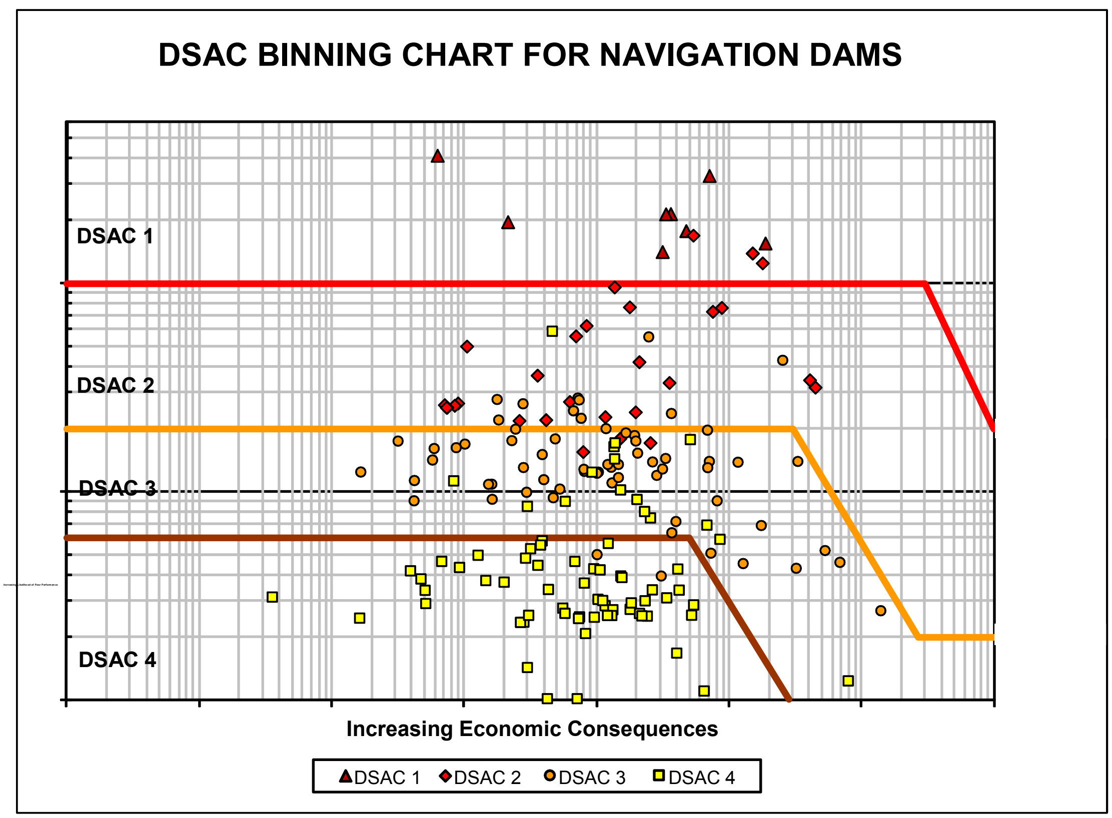

Figure L.1.b

Table L.1.a - Guidelines for determining USACE Dam Safety Action Classification using SPRA.

Urgency of Action	SPRA Classification Criteria
VERY HIGH (1)	Life Risk Index > 40 and Performance Index > 100 or Economic Risk > $3B
HIGH (2)	20 < Life Risk Index < 40 or $300M < Economic Risk < $3B or 20< Performance Index < 100
MODERATE (3)	5 < Life Risk Index <20 or $50M < Economic Risk < $300M or 6 < Performance Index < 20
LOW (4)	Life Risk Index < 5 or Economic Risk < $50M or Performance Index < 6
NORMAL (5)	Cannot be determined using SPRA

Note: DSAC 1 dams have been determined to have a confirmed very high urgency that requires taking immediate and expedited actions to reduce and manage the risk. Therefore, DSAC 1 dams with life-safety risk will be given highest priority for DSM studies and will not require a separate issue evaluation study but instead will utilize a risk assessment within the DSM Study. DSAC 1 dams without life-safety risk will be coordinated with the appropriate Business Line Manager for determining priorities within the larger Civil Works mission and assigned a lower priority within the Dam Safety Program, including typically being placed lower in priority than DSAC 2 or 3 dams with life-safety risk."

Table L.1.b - Dam Safety Action Class Adjustment Guidelines

Dam Safety Action Class	Reasons to adjust Dam Safety Action Class	
VERY HIGH (1)	To Classification 2 • External Peer Review does not support DSAC. • Studies and Investigations do not support suspected defect or failure mode. Extreme risk is not supported	
HIGH (2)	To Classification I • Progression toward failure is confirmed or supported by field observations (boils, excessive seepage, deformation, sink holes, etc)	To Classification 3 • Primary deficiency is in the extreme loading events. • History to indicate good performance at unusual loading range.
MODERATE (3)	To Classification 2 • Field observations indicate signs of distress for unusual loading (Seepage & Piping) • Project has high component risk • Cadre belief that the dam has creditable failure modes that could initiate under unusual loading that is supported by a review of construction records and project documents. • Effectiveness of prior repairs are questionable • Site seismicity is believed to be significantly higher than original design basis.	To Classification 4 • Deficiencies are at extreme loading events • Low component risk • Consequences and life-risk low to very low. • Economic impact manageable at local and state levels.
LOW (4)	To Classification 3 • Increasing piezometric pressure over time • Dam aged yet relatively untested by design loadings or spillway flows. • Floodplain undergoing rapid urban expansion. • Consequences of inundation, including vulnerable critical infrastructure in leveed area, could result in significant local, regional, and national consequences beyond those reflected by the current estimate. Life risk moderate.	To Classification 5 • Risk (with uncertainties) is tolerable - probability of failure and societal and individual life risk are below tolerable limits; cost effective state-of-practice measures implemented; essential USACE guidelines met; societal concerns revealed by stakeholder consultation are resolved; and robust program of inspections and O&M exist. • For low likelihood-high consequences dams best practices in USACE EAP and local community, warning and evacuation plans in place. • For life loss risk > 1000, special study validates assign class 5 • Essential USACE guidelines met • DS scorecard for Routine Dam Safety = green
NORMAL (5)	To Classification 4 • Strategic national-level defense and security-related infrastructure would become in-operable due to breach or miss-operation. • Life loss and infrastructure impact with breach or miss-operation would be catastrophic; > 1,000 lives lost and permanent significant loss of local culture and economy.	Not applicable

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APPENDIX M

USACE Dam Safety Officer Sample Development Plan

M.1 Basic Qualifications for a Dam Safety Officer. The qualifications for assignment as a Dam Safety Officer are presented in Chapter 4 of the basic regulation with details provided in paragraphs 4.2.3, 4.3.2, 4.4.1, 4.5.1, and 4.7. There are five basic requirements for a Dam Safety Officer as each level of command.

M.1.1 Registered Professional Engineer with Civil Engineering background;

M.1.2 Preferably the Chief of the Engineering element;

M.1.3 Possessing “management abilities;

M.1.4 Competent in design, construction, operation, inspection, or evaluation of dams

M.1.5 Understanding the adverse dam incidents and the causes/consequence of dam failure

M.2 Development Plan. If no one at the District level is fully qualified, the District Commander must develop a plan for filling position at the District level in accordance with paragraph 4.2.3. This plan could include training, mentoring, or recruitment from outside the district. Progress on this plan will be reported to the MSC DSO at least twice annually. The development plan must include training and working assignments.

M.2.1 Training should include two or more of the following courses and conferences:

M.2.1.1 Attend USSD and Association of State Dam Safety Officials (ASDSO) annual conferences;

M.2.1.2 Attend Dam Safety PROSPECT course;

M.2.1.3 Attend a Risk Communication class (PAO); and/or

M.2.1.4 Attend a Best Practices in Dam and Levee Safety Risk Framework Training session.

M.2.2 Work Assignments as part of the development process the individual’s duties should include the most, if not all, of the following work assignments:

M.2.2.1 Participation in the on-site portion of several Periodic Assessments and/or Inspections;

M.2.2.2 Visits to all dams in the district to gain an understanding of the issues at each dam;

M.2.2.3 Attend and participate in district and MSC Dam Safety Committee meetings;

M.2.2.4 Participate in an emergency exercise at a dam (tabletop or higher);

M.2.2.5 Attend and participate in an Dam Senior Oversight Group meeting;

M.2.2.6 Review SPRA reports and IRRMP's for district projects;

M.2.2.7 Attend one site-specific dam safety training class; and

M.2.2.8 Participate in formal mentoring with another experienced DSO

APPENDIX N

Roles and Responsibilities Matrix

N.1 Roles and Responsibilities. The USACE Dam Safety Program Roles and Responsibilities Matrices are published in several documents. The master version of the matrices is this appendix as published in this regulation. This version of the matrices governs if future changes result in conflicts to arise between this regulation and the copy published in other documents.

N.2 Legend of Role Symbols and Organizational Symbols. The Symbols used in the matrices are defined in Tables N.1 and N.2.

Table N.1 - Legend of Symbols

P	Primary - This represents the organization that primarily executes this role/task.
O	Oversight - This organization will provide the oversight to verify effective execution.
S	Support - This organization would be expected to be involved in supporting this activity on a regular basis (It is noted that all the organizations will support every function as necessary, but the "S" indicates the expectation of a more routine and higher level of support.)
M	Mandatory - This is a command directed, centralized role/function for an organization within USACE. Other USACE organizations are required to utilize the mandatory center of expertise for this function, and/or this organization is directed to maintain this centralized service for use by USACE. The details of this mandate will be defined within the Engineering Regulation establishing each center.

Table N.2 - Organizational Symbols

HQ	Headquarters, USACE
MSC	Major Subordinate Commands (Regions/Divisions)
Districts	Local Geographic USACE District
RMC	Risk Management Center
ERDC	Engineering Research and Development Center
DSPC	Regional Dam Safety Program Centers
DSMMCX	Dam Safety Modification Mandatory Center of Expertise
MMC	Modeling, Mapping, and Consequences Production Center of Expertise
DSOG	Dam Senior Oversight Group
DSPCMG	Dam Safety Production Center Management Group
DSSC	Dam Safety Steering Committee
DSPPT	Dam Safety Policy and Procedures Team
DSPCSC	Dam Safety Production Center Steering Committee

N.3 Roles and Responsibilities Matrix. The matrix consists of three tables for Overall Management, Routine Management, and Dam Safety Modification Management (Tables N.3, N.4, and N.5)

Table N.3 - Overall Dam Safety Program Management

Responsibilities	HQ	MSC	District	RMC	ERDC	DSPC	DSMMCX	MMC	DSOG	DSPC MG	DSSC	DSPPT	DSPC SC
Periodic review/approval of centers	M			S			S	S			S		
Participation in NDSRB and ICODS	P	S		S	S			S			S		
Select/Appoint/Approve USACE DSO	M								S				
Select/Appoint/Approve Regional DSO	O	M											
Sustain National SME's in Dam Safety engineering	O	S	S	S	S	S	M	S		O	O		
Sustain Regional SME's in Dam Safety engineering		O	S			M							
QMS (Dam Safety National level)	M	S		S	S		S	S	S	S	S	S	
Quality Management System for DS Risk Products	O			M		S	S	S					
Quality Management System for MMC Products	O			O				M					
Management of Dam Safety Records													
Maintain project records for USACE dams			M			S							
Maintain project records for routine activities	O	O	M	S	S			S			O		
Maintain project records for DS modification activities	O	O	S	S	S	M	O	S		O			
Maintain TEN for centers	M			S	S		S	S					
Budget development	M	s	S	S	S	S	S	S	O				
Policies/Procedures	M	S	S	S	S	S	S	S			O	S	
Strategic Planning	M	S		S	S	S	S	S	S	S	S	S	O
Initiate and Manage Strategic Partnerships	M	s		S			S	S			O		
Asset Mangement	O	P	S	S							S		
R&D	O	S	S	S	M		S	S			S	S	
Maintain National A-E contracts experienced in dam engineering	O		S	S		S	M	S		O			
Maintain Regional A-E contracts experienced in dam engineering			S	S		P	S	S					
Manage Dam Safety Portfolio/DSAC	M	S	S	S		S	S	S	O				
Portfolio Risk Communication	M	S	S	S		S	S				S		
Project Risk Communication	O	S	M	S		S	S	S					

Table N.4 - Routine Dam Safety Program Management

Responsibilities	HQ	MSC	District	RMC	ERDC	DSPC	DSMMCX	MMC	DSOG	DSPC MG	DSSC	DSPPT	DSPC SC
Quality Management System (Regional)	O	P	S										
Quality Management System (District)													
Develop Processes for QMS	O	O	P										
Develop Performance Measurements	P	S	S	S							S	S	
Track Performance (Including DS Scorecard)	O	O	P								S	S	
QC Reviews		O	P	O									
ATR	O	O	S	M									
IEPR Type II	O	O	S	M									
Manage Routine Dam Safety Program													
Select/Appoint/Approve District DSO	O	O	M										
Select/Approve District DSPM		O	P										
Conduct Dam Safety Committee Meetings (Regional)	O	M	S										
Conduct Dam Safety Committee Meetings (District)		O	M										
Periodic Inspection	O	O	M								O		
Periodic Assessment													
Facilitate Risk assessment/PFMA	O	O		M									
Perform Risk Assessment and Prepare Documentation	O	O	M	S				S					
Produce Mapping, Models and Consequences	O	O	S	S				M					
Instrumentation Program	O	O	M	S		S					O		
Develop/Maintain IRRMP and Implement IRRMs	O	O	M	O		S		S			O		
Develop/Maintain and Implement IOP	O	O	M	O		S		S			O		
Dam Safety Training (For Dam Operators, etc)	O	O	M								O		
Emergency Action Plans	O	O	M					S			O		
Emergency Engineering Services/Floodfighting, etc.	S	S	P	S	S	S	S	S			O		
Technical Competency (TC) Management													
Coordinate with CoPs to identify agency gaps in DS Skills	P	S	S	S							S		
Develop/Maintain Training Curricula to close gaps	P	S	S	S							S		
Develop District level plan to eliminate gaps	O	S	P								S		
Implement Plan to eliminate TC gaps	O	S	P	S							S		
Coordinate/Integrate with Related CoPs	O	S	P	S				S			S		
Manage Routine Dam Safety Projects													
Establish the Project Management Plan		O	M										
Project Management (PM)		O	M										
Lead Engineer		O	M										
Non-Technical PDT Members		O	M										
Technical PDT Members (in-house/A-E)		O	M			S		S					
Construction PDT Members		O	M										
Design Documentation Report		O	P					S					
Production of Plans and Specifications		O	P										
Cost Engineering Services		O	P										
Engineering & Design during Construction		O	P										
Advertise, Award and Administer Construction Contract		O	P										

Table N.5 - Dam Safety Modification Program Management

Responsibilities	HQ	MSC	District	RMC	ERDC	DSPC	DSMMCX	MMC	DSOG	DSPC MG	DSSC	DSPPT	DSPC SC
Quality Management System	O	O	S	O		P	O			S		S	
Develop Performance Measurements	O	O	S	S		S	M	S		S			
Track Performance	O	O	S	S		P	M			S			
Project Review Plans	O	O	M	O		S							
QC Reviews		O	S	P		P	O	P					
ATR	O		S	M		P	P	S					
IEPR	O		S	M		S							
Manage Dam Safety Modificaton Mission													
Manage and coordinate SOG activities	M			S		S	S	S	P				
Chair Dam Safety Production Steering Committee	M												
Chair DSPC Management Group meetings							M						
DSPC Management Group meeting members	M			M		M	M	S					O
Technical competency Management													
Develop Dam Safety Engineer career path	O	S		S		S	M	S		S	O		O
Coordinate with CoPs to identify gaps in DS Skills	O		S	S		S	M	S		S			O
Develop a plan to eliminate gaps	O	S	S	S		S	M	S		S			O
Develop/Maintain Training Curricula	O			S			M	P		S			O
Implement Plan to eliminate TC gaps	O	S	S	S		S	M	P		S			O
Develop a mentoring program for DS	O	S	S	S		S	M	S		S			O
Implement/execute mentoring program	O	S	S	S		S	M	P		S			O
Maintain the Dam Safety Investment Plan	O	S	S	O		S	M	S		S			O
Coordinating workload among DSPCs	O	S	S	S		S	M			S			O
Coordinate/Integrate with Related CoPs	M	S	S	S		S	S	S				O	
Ensure districts receive effective service	O	S		S		M	O	S		S			O
Reimbusable support for others (national)	O	P	S	S		S	S	S		S			O
Reimbusable support for others (international)	P	S	S	S		S	S	S		S			O
408 implementation	O	O	P			S	S						
Manage Dam Safety Modification Projects													
Establish the Project Management Plan	O		M	S		O	O	S					
Project Manager		O	P										
Lead Engineer	O	O				M	O						
Non-Technical PDT Members		O	P										
Technical PDT Members (in-house/A-E)		O	S	S		P	O	S					
Construction PDT Members		O	P			O	S						
Issue Evaluation Studies													
Risk assessment	O	S	S	M	S	S	S	S	O				
Document Preparation	O	O	M	S		S	S	S	O				
Produce Mapping, Models and Consequences	O		S	O		S	S	M	O				
Dam Safety Modifications													
Risk assessment	O	S	S	M	S	S	S	S	O				
Preparation of Technical Portion Decision DSMS & DSMR	O	O	S	O		M	O	S	O	O			
Preparation of Final DSMR and Supplements	O	O	P	O		S	O	S	O	O			
Design Documentation Report	O	O	S	O		P	O	S	O				
Production of Plans and Specifications	O	O	S	O		P	O		O				
Cost Engineering Services	O	O	S	O		P	O		O				
Engineering & Design during Construction	O	O	S	S		P	O						
Advertise, Award and Administer Construction Contract	O	O	M			S	S						
Re-evaluation post-construction risk	O		S	M		S	S	S	O				

APPENDIX O

Membership of Dam Safety Committees and Groups

O.1 General. This appendix provides a membership description of the committees and groups established in Chapter 4.

O.2 Dam Safety Steering Committee (DSSC). The steering committee members are full-time civilian employees of USACE. The DSSC seeks to maintain a diversity of civil works dam safety experience as well as a diversity of the engineering disciplines. A current list of members will be maintained on USACE Dam Safety CoP Technical Excellence Network (TEN) or SharePoint. The DSSC committee members are as follows:

O.2.1 HQUSACE Members: The DSSC Chair is the Special Assistant for Dam and Levee Safety (Committee Lead), the vice chair is the USACE DSPM (Co-Lead).

O.2.2 Major Subordinate Command (MSC) Members: Dam Safety Program Manager from each MSC that has operation and maintenance responsibility for dams.

O.2.3 National Dam Safety Centers Members: One individual appointed by each of the Directors of the Risk Management Center (RMC), Modeling Mapping and Consequences Center (MMCC), and Dam Safety Modification Mandatory Center of Expertise (DSMMCX).

O.2.4 At-Large Members: Four (4) district representatives, with experience in the safety of dams, nominated by the DSSC as at-large members with final selection by the USACE DSO. Two members should be DSPMs, one a DSO, and one from Operations.

O.3 Dam Senior Oversight Group (DSOG). The members of the DSOG include the Special Assistant for Dam and Levee Safety (Chair), RMC Director (Vice-Chair), HQDSPM (recording secretary), CoP & Regional Representatives to include Geotechnical and Materials CoP, Structural CoP, Hydraulics and Hydrologic CoP, Planning CoP, and Construction CoP, Navigation and Flood Damage Reduction Business Line Representatives, Programs Integration Representative, Dam Safety Modification Mandatory Center of Expertise Director, and other Representatives determined by the Chair. A current list of members will be maintained on USACE Dam Safety CoP Technical Excellence Network (TEN) or SharePoint.

O.4 Dam Safety Production Center Management Group (DSPCMG). The DSPCMG membership consists of the Dam Safety Modification Mandatory Center of Expertise Director (Chair), USACE Special Assistant for Dam and Levee Safety, USACE DSPM, RMC Director, MMC Director, and the directors of all DSPCs within USACE.

O-5 Modeling, Mapping, and Consequences Production Center Steering Committee (MMCSC). The MMC steering committee membership is composed of the following members: Special Assistant for Dam and Levee Safety, HH&C CoP Lead, Planning CoP Lead, GIS CoP Lead, Economics CoP Lead, CIPR program manager, RMC Director (committee chair), and MMC program manager. Committee members may delegate membership to individuals within their organization or CoP in accordance with the committee charter.

APPENDIX P

Calculation of the Cost to Save a Statistical Life (CSSL)

The CSSL is calculated as follows:

$$CSSL = \frac{AC - (EC_{w/o} - EC_{w}) - (OM_{w/o} - OM_{w})}{(AALL_{w/o} - AALL_{w})}$$

where

CSSL = cost to save a statistical life ($/life), where a negative value is taken as zero

AC = average annual cost of the alternative risk management plan ($/yr)

$EC_{w/o}$ = average annual economic consequences ($/yr) without alternative risk management plan.

EC_{w} = average annual economic consequences ($/yr) with alternative risk management plan.

$OM_{w/o}$ = average annual O&M cost ($/yr) without alternative risk management plan.

OM_{w} = average annual O&M cost ($/yr) with alternative risk management plan.

$AALL_{w/o}$ = average annual life loss (lives/yr) without alternative risk management plan.

$AALL_{w}$ = average annual life loss (lives/yr) with alternative risk management plan.

Notes:

1. USACE policy requires that evaluations of alternative risk management plans be based on values (lives lost, costs, benefits, etc.) that are representative of the time frame that is taken as the economic life of the project or feature under study.

2. Detailed guidance for incorporation of for temporal changes in costs, consequences, benefits, and life loss estimates are contained in a separate, more detailed technical document.

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APPENDIX Q

Interim Risk Reduction Management Plan Development Sequence

Q.1 General. IRRMP must be developed in an aggressive timeline to minimize the probability of failure once a potentially major dam safety deficiency is identified. IRRMPs are mandatory for DSAC 1, 2, and 3 Dams.

Q.2 Development Sequence. The following table describes the sequence for IRRM development.

Table Q.1 - Interim Risk Reduction Measures Development Sequence

Item	Process	Notes
1	Designate dam as DSAC 1, 2, or 3	One time screening or risk assessment
2	Alert MSC DSO, OPs Chief, EOC, and local PAO	
3	Use emergency contracting procedures to implement IRRM if necessary.	
4	District begins to pre-position contracts and materials and informs major stakeholders if appropriate.	
5	Obtain O&M funding from district to develop Interim Risk Reduction Measures Plan (IRRMP). Begin development of Communications Plan	District O&M funds are used for development & implementation of IRRMP.
6	District begins NEPA actions if necessary	
7	District completes IRRMP to include communications plan	
8	Public Coordination/Communication	Refine IRRM Communications Plan
9	DQC review of IRRMP done with Regional Technical Specialists	Includes Dam Senior Oversight Group and concurrent RTS reviews throughout development
10	Seek approval of IRRMP from MSC DSO. Obtain O&M Funding for PED to implement the IRRMP	If requested include formal brief of IRRMP to MSC and USACE DSO
Item	Process	Notes
11	Approval of IRRMP by MSC DSO	Concurrence of approval by USACE DSO

Item	Process	Notes
12	Public Coordination/Communication	Begin coordination
13	NEPA actions completed for IRRM	
14	District implements non-structural IRRM and begins plans, specs, and detailed cost estimate for structural IRRM activities	Pool restrictions, exercises, etc.
15	District develops plans, specs and cost estimate for structural IRRMP activities	Completion
16	District issues contracts for structural IRRM	

Q.3 Submission and Approval. IRRMPs for DSAC 1 dams must be submitted to the MSC DSO within 60 days after being designated as a DSAC 1, or within 90 days after being designated as a DSAC 2, or within 120 days after being designated as a DSAC 3. A formal IRRMP is not required for DSAC 4 dams, and remedial actions may follow more routine processes.

APPENDIX R

Interim Risk Reduction Management Plan Review Checklist

R.1 Overall Project Description and Purposes. Make sure the description includes a brief summary of construction and operational history including remediation and past and current problems. A summary of instrumentation would be good as well (needs to be in appendix). This helps provide sufficient background for evaluating the validity of the potential failure modes and how they relate to the history of the dam.

R.2 Overview of Identified "Credible and Significant" Potential Failure Modes. Include an overview of all credible and significant potential failure modes. Identify if a quick PFMA based on SPRA results was completed or facilitated PFMA was completed. Both are acceptable for the initial IRRMP. If PFMA has not been done, have all identified potential failure modes from SPRA been included? If a facilitated PFMA has not been done, it should be identified as an IRRM and completed as soon as practical.

R.3 General Consequences Associated with Each Identified Potential Failure Mode. Estimates for each potential failure mode should be included. Consequences should include at least a qualitative estimate of consequence (SPRA results, etc.).

R.4 Structural and Nonstructural IRRM Alternatives. Alternatives considered to reduce the likelihood of failure and/or consequences associated with the failure modes (reservoir pool restrictions and modification of reservoir regulation plan must always be included as an option that is addressed).

R.4.1 Reservoir Restrictions. If a reservoir restriction or pool deviation has been ruled out, very specific reasons should be included as to why.

R.4.2 Non-Structural IRRM. Non-structural measures such as increased monitoring and surveillance, stockpiling materials, help to reduce likelihood of failure by early detection and ability to intervene should an incident occur. Non-structural measures can also be testing of EAP for better notification and evacuation, updated EAP inundation mapping, etc. that all reduce potential life loss.

R.4.3 Structural IRRM. These measures typically improve the system response which will reduce the likelihood of failure.

R.4.4 For each considered IRRM, a detailed explanation of how measure reduces system loading, uncertainty in the load, improves the system response, or reduces the estimated consequences.

R.5 Discussion of Likelihood of Failure and Consequences. A general discussion of how predicted reduction in risk (the likelihood of failure and associated consequences) impact on project purposes, environmental impacts, and economic impact to region associated with potential IRRM, both positive and negative is provided. This will help reviewers discern if the cost of the IRRM is clearly warranted based on its estimated risk reduction.

R.5.1 NOTE. Analysis does not reduce risk – just reduces the uncertainty associated with the risk estimate.

R.5.2 Has NEPA coordination been started and continued throughout the process?

R.6 Recommendations and Risk-Informed Basis for IRRM to be Implemented. Each basis for action should include an estimate of the risk reduction from the IRRM implementation. Address potential for reduction in likelihood of failure and consequences along with the estimated cost and impacts on other aspects of the project (possibly environmental, recreation, flood reduction, ability to execute). A table of this information by IRRM should be included as a summary.

R.7 Schedules and Costs for Implementation of IRRM Recommendations. Verify the IRRM's have been prioritized and consider the expediency of reducing overall risk. Prioritization must consider the expediency of implementing the IRRM. Resources, funding, capability, execution time, and the time to complete the dam remediation must all be considered when prioritizing IRRM's. For example, a warning system IRRM may take 2 years to design, coordinate, and construct while performing a table top exercise with the local emergency managers can be done in the next 2 months. Clearly one is more expedient than the other. IRRM's that can be implemented quickly should be given high priority particularly those that impact the ability to warn and help evacuate the public including increased monitoring and surveillance.

R.8 Estimate of Benefits and Costs for IRRM (DSAC 1 Dams). Include the proposed cost and schedules for conducting a risk-based assessment to estimate the benefits and costs for incremental evaluation of IRRM. This is primarily for DSAC 1 dams where significant and urgent risk reduction is necessary.

R.9 DQC Comments and Comment Resolutions. Review must include multiple disciplines including water management, geotechnical, structural, hydraulics, and other disciplines as needed (environmental and counsel). Comments and resolution of comments need to be completed in a timely manner by all offices.

R.10 Updated EAP. The IRRMP should include updating the EAP to reflect site specific risks, and include emergency exercises for DSAC 1, 2, and 3 dams conducted in manners that are appropriate for the risk involved. Specifically it should include the local emergency managers for DSAC 1, 2, and 3 dams.

R.11 Communication Plan (Internal and External). Verify communication plan is in place and a way of addressing the questions and requests of the media, stakeholders, and public is in place. Check the schedule for media training based the DSAC, and discuss how the plan will be updated as the study progresses.

R.12 PFMA Report. Is an electronic link to the PFMA provided? Verify proper team skill sets were involved and that all credible and significant failure modes are addressed in the IRRMP.

R.13 MSC Internal Review Coordination. Coordination could include Environmental, Operations, Engineering, Water Management, Public Affairs, Programs, and Office of Counsel.

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APPENDIX S

Seepage Failure Mode Continuum

S.1 The Seepage Failure Mode Continuum. The Continuum (Figure S.1) was developed to illustrate the progressive nature for seepage\internal erosion failure of a dam. The failure continuum illustrates two relative and interdependent scales:

S.1.1 Stages of a seepage erosion/piping failure development, and

S.1.2 Corresponding risk reduction strategies that can be considered for implementation as the failure mode is progressing toward breach formation.

S.2 Stages. The stages of a seepage erosion/piping failure mode development as presented are generally consistent with the stages described by Foster and Fell (1999) (reference A.133), and the USBR (2000). The stages include initiation, continuation, progression, and breach formation. The literature describing these stages is somewhat ambiguous with regard to the transition between the continuation and progression phases. It is not uncommon for these terms to be used interchangeably depending on various nuances associated with a material transport (erosion and piping) failure of an embankment dam. However, the continuum developed in Figure S.1 illustrates these as two distinct and separate stages in the development of the failure mode as described further below.

S.2.1 Initiation. Initiation begins at the onset of a loading condition that leads to the development of a concentrated leak (e.g. raising the pool, development of a crack due to an earthquake, differential settlement, and hydraulic fracture). Initiation can also occur when seepage begins to exit a free (unfiltered) discharge face with sufficient gradient, quantity and velocity of flow so that soil particles begin to move. Initiation may occur in the embankment, in the foundation/abutment, or at the interface between the embankment and foundation materials.

S.2.2 Continuation. Following initiation is the continuation stage. During continuation, the pipe or erosion front moves up gradient toward the source of water and is not arrested due to the presence of a filter, cutoff, restriction or stoppage by material at the upstream end, caving because a roof does not form, or other intervention activity. The piping or erosion typically continues towards the source of water at an accelerating rate due to increasing gradients and flow quantities.

S.2.3 Progression. The progression phase occurs when the piping/erosion feature(s) widen and/or deepen as flows increase in the feature. Progression is enhanced when a roof continues to form and there are no other restraints to growth. The amount of flow continues to increase causing in most, if not all, cases the piping/erosion feature to grow rapidly. The progression phase follows the continuation phase and begins when there is a significant increase in the volume and velocity of flow in the erosion/pipe feature to cause it to enlarge. For example, the progression phase would begin when a piping feature breaks through the upstream slope of the core (for a dam having highly permeable shells) or the upstream shell (for more homogeneous or low permeability shell materials) of an embankment, or through foundation materials and into the reservoir. The formation of the sinkhole through the upstream slope of the dam signifies the completion of the continuation phase and the start of the progression phase of failure mode development. In some instances where overlying foundation and/or embankment materials are very stiff or well compacted, the progression stage may not manifest itself in the form of sinkhole development until significant progression has occurred.

S.2.4 Breach Formation. As progression continues, flow through the erosion/piping feature and the corresponding erosion of material is not arrested. Typically, the dam crest will begin to settle due to sinkhole development, localized slope instability or unraveling of the downstream slope to the point where overtopping from the reservoir begins to occur. During breach formation, the materials in the dam are eroded, widening and deepening the opening in the dam until the full contents of the reservoir are lost.

S.3 Risk Reduction Strategies. The corresponding risk reduction strategies shown on the continuum diagram have been grouped into three overall categories that generally reflect the timeframe available for intervention: long-term, short-term, and heroic (i.e., crisis management).

S.3.1 Long-term. The timeframe for implementation of long-term risk reduction strategies would be in the range of 1 to 5 years. Corrective actions accomplished during this timeframe would not only stop a piping/erosion failure mode development, but in general would provide sufficient safeguards that would prevent any future failure mode initiation. Embankment dams on Karst foundations are a special consideration and long-term solutions that prevent future failure mode initiation may not be possible. In this case, long-term solutions such as cutoff walls that do not fully penetrate the formation with Karst may provide only a limited design life.

S.3.2 Short-term. The timeframe for the implementation of short-term risk reduction strategies would be in the range of 1 to 3 months. In some circumstances, depending on how far along are the continuation stage and the rate of failure mode development, short-term risk reduction strategies such as grouting or construction of filters/drains and cutoffs may occur over slightly longer periods of time. Corrective actions accomplished during this timeframe are generally aimed at preventing the failure mode from reaching the progression phase and failure of the dam. Short-term strategies usually involve some form of reservoir drawdown or modified reservoir operations under reduced storage levels.

S.3.3 Heroic. Heroic risk reduction (crisis management) strategies are typically those that must be implemented in the range of a few hours to a few days or weeks. Heroic actions are typically required when a piping/erosion failure mode has reached an

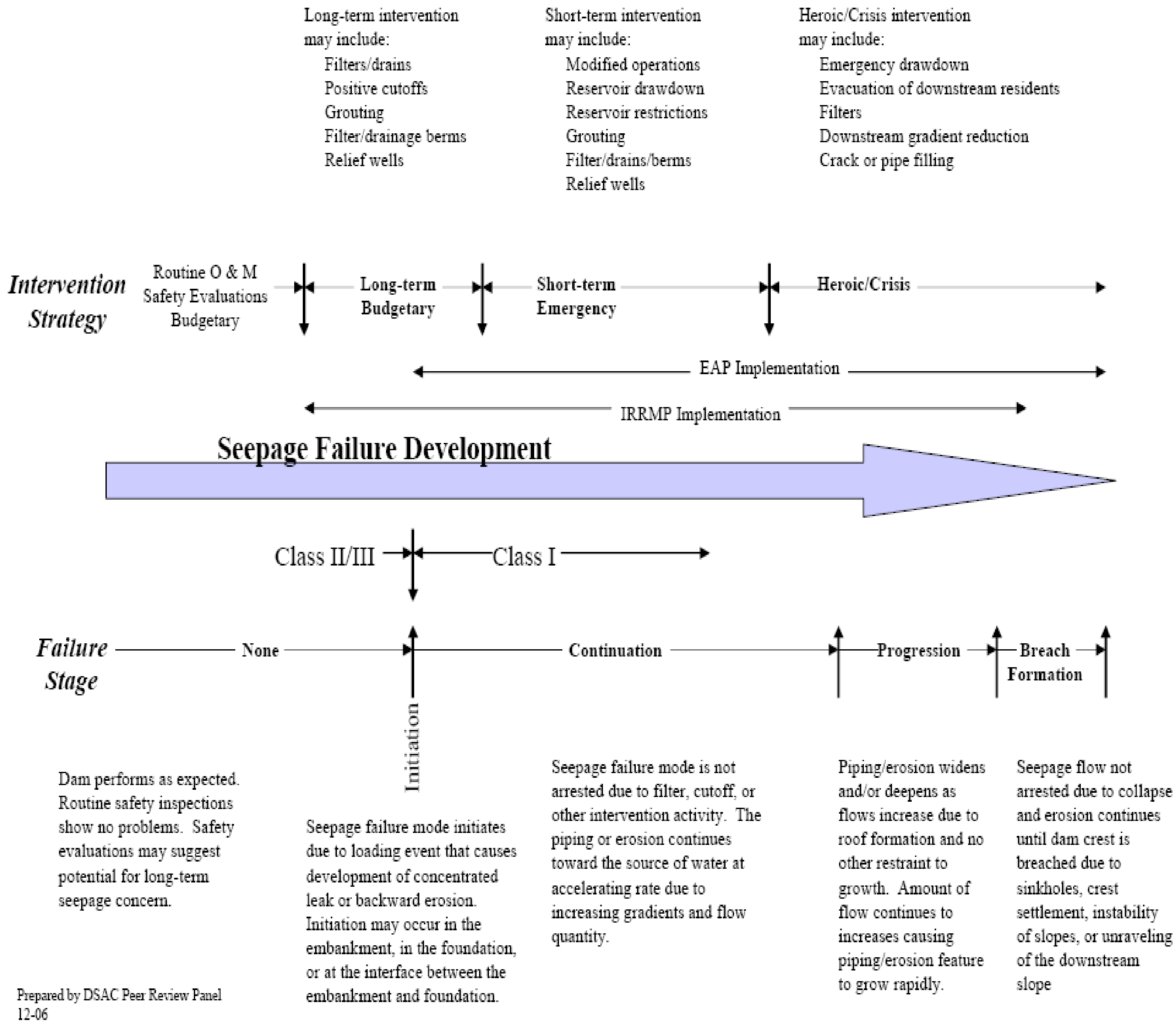

Figure S.1 – Seepage Failure Mode Development Continuum DSAC Peer Review Panel, December 14, 2006 advanced continuation stage. The actions taken are aggressive and implementable in order to prevent entry to the progression stage or to arrest the progression stage in its earliest period of development and usually involves a rapid lowering of the reservoir level. Corrective actions accomplished during this timeframe would stop a piping/erosion failure mode development, and provide enough time for planning, design and construction of short- and long-term risk reduction measures leading to a permanent solution that will prevent any future failure mode initiation. It should be noted that each dam is unique and the actions taken at each site will need to be tailored to the attributes of the dam and the nature of the failure mode that is developing.

APPENDIX T

Periodic Assessment Procedures

T.1 <u>Periodic Assessment Purpose</u>.

T.1.1 The USACE portfolio risk management process resulted in assignment of a DSAC for each project. In many cases, the data used for initial classification came from the Screening for Portfolio Risk Analysis (SPRA) process. The SPRA was an efficient approach to initially assess the large USACE portfolio, but was quick and limited. The PA applies a higher level of rigor to further identify and refine project incremental and non-breach flood risks.

T.1.2 The periodic assessment consists of a periodic inspection, a potential failure modes analysis (PFMA), and a semi-quantitative risk assessment. The risk assessment is based on existing data and estimated consequences. It is completed by a facilitated team consisting primarily of district personnel. The PA is a chance to evaluate the design, analysis, construction, and condition of a dam project, and the results of SPRA or previous risk assessments results in more detail. In the event that a PA is done out of sequence with a PI, a site inspection is required to familiarize the team with the project features, operations, and potentially observable vulnerabilities. In this case, the PA report is a stand-alone document. If the subsequent PA is scheduled more than 10 years later, a waiver is required from USACE DSO.

T.1.3 The primary purposes of the PA are to:

T.1.3.1 Evaluate the project vulnerabilities and associated risks, including non-breach risks;

T.1.3.2 Reevaluate the DSAC and recommend a change if necessary;

T.1.3.3 Review and revise the Interim Risk Reduction Measures (IRRM), if necessary;

T.1.3.4 Identify the need for issue evaluation studies and provide data to prioritize issue evaluation studies;

T.1.3.5 Identify operations and maintenance, monitoring, emergency action plan, training and other ongoing needs;

T.1.3.6 Identify and prioritize any data collection, analyses, and study needs; and

T.1.3.7 Provide a better understanding of vulnerabilities of the dam, serve as a basis for future dam safety inspections and activities, and guide district efforts to tailor and target on-going intermediate field site inspections and monitoring of dam features where significant PFM and/or high risk critical O&M features (i.e., relief wells, gallery drains) have been identified.

T.2 Overall Workflow.

T.2.1 Proper scheduling and sequencing of the PA activities by the PA team leader will be critical due to the need to engage the facilitator, the engineering staff, the site operations staff, and MSC personnel. The general PA workflow is summarized in the following sections.

T.2.2 Advanced preparation by the district is required to collect all background data and prepare draft versions of some of the chapters of the PA report. The district must compile all available design documentation reports including as-built drawings, construction records and photographs, foundation completion reports, design memoranda, seismic studies, special investigations, PI reports, Water Control Manual, Emergency Action Plan (EAP), etc. Scanning all background data and uploading it to the RADS II website is required for remote usage and electronic archival purposes. Filenames should be descriptive and indicative of the content. A reference list of all background data needs to be prepared by the district. Chapters 1, 3, 4, and 5 of the PA report (as described in Appendix AE) must be prepared by the district based on existing data, at least 30 days prior to the PFMA. The facilitator and the PA team will review the project design, construction, and performance records, previous risk assessments, flood and earthquake loading, and estimated consequences prior to the PFMA and risk assessment. Failure to complete the chapters and to prepare and organize the above information in advance of the PA may result in the PA being postponed or cancelled.

T.2.3 A site visit by the PA team and facilitator is required for the PFMA and risk assessment. Therefore, the PA will generally be accomplished in conjunction with a PI. The PA team will focus on areas of potential vulnerabilities and will not inspect other parts of the dam as required by the PI. Because the duration of the PI and proximity of the projects to the district office can vary greatly, it may not be practical to schedule the site visit, PFMA, and risk assessment in conjunction with the PI. In addition, some PA's may be performed outside the normal PI schedule to accommodate unusual performance issues or other issues that need to be evaluated further to verify or re-establish priorities.

T.2.4 Typically the facilitator and district's PA team will spend some time at the site or district office reviewing hard-copy files of background data before starting the PFMA. The district's PA team will then participate in a facilitated PFMA and semi-quantitative risk assessment. After the risk assessment is complete, the PA team will re-evaluate the rationale for the current DSAC and determine if reclassification is appropriate, develop recommendations for further studies based on the DSAC, re-evaluate IRRM's, and prioritize routine activities. The Executive Summary and Major Findings, Chapters 6 and 7, and Appendix A are to be completed before the facilitator leaves the district. The district will be responsible for incorporating the results of the field inspection into the Executive Summary and Major Findings and Chapter 2.

T.3 Potential Failure Modes Analysis.

T.3.1 The first, and perhaps the most critical, step in any dam safety risk assessment involves identifying and fully describing potential failure modes based on an evaluation of a dam's vulnerabilities. If this first step is not done in a diligent and thorough manner, the risk assessment may not be valid. The results will have significantly less value, and may even lead to incorrect or unsubstantiated conclusions.

T.3.2 A facilitator will guide the team members in developing the potential failure modes, based on the team's understanding of the project vulnerabilities resulting from the data review and current field conditions. After the list of credible potential failure modes has been developed, a key step for the PA team is to identify the potential failure modes that are believed to have the highest probability of failure resulting in loss of life or significant loss of service. Identifying the risk-drivers requires that the team critically compare all of the vulnerabilities identified during the data review and observed during the site visit. This step optimizes efficiency by having the team focus its efforts on the significant potential failure modes. All potential failure modes and their evaluation will be documented in the report, including those that were ruled out due to negligible risk contribution along with the reasoning for classifying them as such.

T.4 Risk Assessment.

T.4.1 Dam failure is characterized by the sudden, rapid, and uncontrolled release of impounded water. It is recognized that there are lesser degrees of failure and that any malfunction or abnormality outside the design assumptions and parameters that adversely affect a dam's primary function of impounding water is properly considered a failure. These lesser degrees of failure can lead to loss of services and progressively lead to or heighten the risk of a catastrophic failure. Loss of service consequences will only be considered for potential failure modes that result in sudden, rapid, and uncontrolled release of impounded water.

T.4.2 A semi-quantitative risk assessment will be performed for the potential failure modes that are judged to be "risk-drivers". For breach considerations, the incremental risk (risk due to breach) includes a consideration of both failure likelihood and consequences. During the risk assessment, a failure likelihood category (which includes the likelihood of the loading), and a consequence category (based on estimated consequences provided by MMC Production Center and the team's judgment) are assigned to each risk-driver potential failure mode. The evaluation of each risk-driver potential failure mode will be documented and include a statement of the team's confidence in the selected categories. The failure likelihood and consequence categories are used to compare the risk associated with each potential failure mode relative to the tolerable risk guidelines. This information will be used to reevaluate and verify or recommend a change to the DSAC.

T.4.3 The risk assessment will also identify and portray the non-breach risks associated with normal operational releases. This generally involves identification of releases that would exceed the downstream channel capacity, overtop any downstream levees (assuming no breach), maximum releases and freeboard that would occur during the Inflow Design Flood (IDF) if the dam is not overtopped or the threshold flood prior to overtopping if the IDF cannot be passed. The frequency of the flood drives the likelihood category. The consequence category is based on estimated consequences provided by MMC Production Center and the team's judgment.

T.4.4 Hydrologic Hazard. Hydrologic hazard curves typically take the form of annual exceedance probability for increasing pool elevations. In some cases, annual exceedance probability as a function of release flows, such as for spillway erosion potential failure modes, is also needed. Curves should extend out to a flood representing the threshold of overtopping, or to a flood approaching the Probable Maximum Flood (PMF) if the dam does not overtop under such an event. The estimated annual exceedance probability of a flood that is likely to cause failure due to internal erosion indicates the approximate likelihood of hydrologic failure. However, it may be necessary to subdivide some potential failure modes to capture the entire range of loading in the case of potentially large increases in pool elevation.

T.4.5 Seismic Hazard. An estimate of the seismic hazard is typically needed to assess the probability of earthquakes that are likely to lead to dam failure. If a detailed probabilistic seismic hazard study is available for a dam, it would be used in the assessment. However, if such a study is not available, screening-level seismic hazard curves such as those available from the USGS website are used. Hazard curves representing peak horizontal ground acceleration are typically considered. For some concrete and steel structures, hazard curves corresponding to the spectral acceleration at the natural period of the structure may be more useful. The estimated annual exceedance probability of an earthquake that is likely to cause failure indicates the approximate likelihood of seismic failure.

T.4.6 Anchoring to Historical Failure Rates for Normal Operations. Examination of dam failure rates indicates that dams have failed at a rate of roughly 1 in 10,000 per dam year of operation, depending on the failure mode and age of the structure: Douglas et al. (reference A.138), Foster et al. (reference A.139), Hatem (reference A.140), Von Thun (reference A.141), and Whitman (reference A.142). This forms the basis for evaluating failure likelihood for a given potential failure mode that could occur under normal operating conditions. For example, if the key factors affecting the potential failure mode are weighted toward adverse (more likely), the annual failure likelihood is probably greater than 1E-04/yr. If weighted toward favorable (less likely), then the annual failure likelihood is probably less than 1E-04/yr.

T.4.7 Failure Likelihood Categories. The likelihood of failure is a function of both the likelihood of the loading condition and the likelihood of failure given the loading condition. Given this background information, the following failure likelihood categories, Table T.1, and descriptors will be used. The dividing line between failure modes with greater than a 1 in 10,000 chance and those with less than a 1 in 10,000 chance of occurrence (on an annual basis) is between the descriptors for Moderate and High. In a general sense, each category represents an order of magnitude range in failure likelihood.

Table T.1 - Failure Likelihood Categories

Category Name	Category Description
Remote	Several events must occur concurrently or in series to cause failure. Most, if not all of the events are unlikely to very unlikely, and failure potential is negligible.
Low	The possibility cannot be ruled out, but there is no compelling evidence to suggest it has occurred or that a condition or flaw exists that could lead to its development (e.g., a flood or an earthquake with an annual exceedance probability more remote than 1E-05/yr would likely cause failure).
Moderate	The fundamental condition or defect is known to exist; indirect evidence suggests it is plausible; and key evidence is weighted more heavily toward unlikely than likely (e.g., a flood or an earthquake with an annual exceedance probability between 1E-05/yr and 1E-04/yr would likely cause failure).
High	The fundamental condition or defect is known to exist; indirect evidence suggests it is plausible; and key evidence is weighted more heavily toward likely than unlikely (e.g., a flood or an earthquake with an annual exceedance probability between 1E-04/yr and 1E-03/yr would likely cause failure).
Very High	There is direct evidence or substantial indirect evidence to suggest it has occurred and/or is likely to occur (e.g., a flood or an earthquake with an annual exceedance probability more frequent (greater) than 1E-03/yr would likely cause failure).

T.4.8 Consequence Categories. The other component of risk is the magnitude of consequences should dam failure occur. Dam failure consequences include life loss, destruction of downstream property, loss of project benefits, environmental damage, and socio-economic impacts. Information from the MMC Production Center, supplemented by local experience and information will be used to estimate breach and non-breach consequences. For PA's, the focus is on the potential for life loss, with the idea that the broader socio-economic, environmental, and property damages would be generally commensurate. An evaluation of dam failure case histories indicates that the number of fatalities is primarily dependent on: 1) the population at risk (PAR) within the dam break inundation boundary; 2) the severity of the flooding; and 3) the amount of warning time the PAR has to evacuate the area. Other considerations include the degree to which the PAR understands what is about to descend upon them and the availability and clarity of possible evacuation routes. The PAR can be broadly categorized by transient activity and the size of the towns and development within the inundation zone. The severity of flooding is a function of the potential destruction to structures and infrastructure within the flood plain. The warning time is a function of when the warnings are issued and the time it takes for the flood wave to reach the PAR. Considering all of these aspects of consequence evaluation, the following broad consequence categories, Table T.2, will be used. In a general sense, each category represents an order of magnitude range in consequences. Consequences related to loss of navigation will also be considered and described for navigation projects.

Table T.2 - Consequence Categories

Category Name	Category Description
Level 0	No significant impacts to the downstream population other than temporary minor flooding of roads or land adjacent to the river.
Level 1	Although life threatening flows are released and people are at risk, loss of life is unlikely.
Level 2	Some life loss is expected (in the range of 1 to 10).
Level 3	Large life loss is expected (in the range of 10 to 100).
Level 4	Extensive life loss is expected (greater than 100).

T.4.9 Confidence. An important part of the evaluation is to capture the confidence in the selected categories for failure likelihood and consequences. The level of confidence can be expressed using qualitative descriptors as follows in Table T.3.

Table T.3 - Confidence Categories

Category Name	Category Description
Low	Confidence in the estimated category is low. Key additional information could very well change the assigned category.
Moderate	Confidence in the estimated category is in between High and Low. It is highly uncertain whether additional information would change the assigned category.
High	Confidence in the estimated category is high. It is unlikely that additional information would change the assigned category.

T.4.10 Incremental Risk Matrix. A risk matrix is used to portray the incremental risk (due to failure) associated with the identified potential failure modes, with likelihood of failure on the vertical axis (using cell divisions corresponding to the failure likelihood categories described in Section T.4.6) and the associated consequences on the horizontal axis (using cell divisions corresponding to the consequences categories described in Section T.4.7). The matrix is similar to the f-N diagram used in quantitative risk assessments (see Chapter 5). Figure T.1 presents the incremental risk matrix relative to the tolerable risk guidelines. Societal tolerable risk guidelines are approximately represented by the diagonal dashed line and represent the concept that as the consequences of a man-made disaster increase, society in general expects that the probability of those events to decrease. Performance (annual probability of failure) and individual risk guidelines (assuming that the most exposed individual is exposed all the time) are approximately represented by the horizontal dashed line and represent the concept that everyone deserves some minimum level of safety regardless of the magnitude of the consequences. Cells of the incremental risk matrix, defining the failure likelihood and consequence categories, correspond to order of magnitude divisions on the f-$\overline{N}$ diagram.

T.4.10.1 A failure likelihood category and consequence category are assigned to each significant potential failure mode, and then they are plotted in the appropriate cell of the matrix. The Remote failure likelihood and Level 0 consequence categories were excluded from the displayed matrix because there may be many potential failure modes brought up during the PA and summarily ruled out, either because the chance of failure or consequences were thought to be negligible, and the matrix could become cluttered with these potential failure modes. Eliminating them from the matrix focuses on the more important potential failure modes. However, they are all captured and documented as part of the PA process.

T.4.10.2 For the purposes of PAs, the incremental risk matrix is used to delineate approximate risk relative to the tolerable risk guidelines. Incremental risks plotting in cells entirely below both red dashed lines with high confidence are likely tolerable but should be kept under review and properly managed. This requires continued monitoring and evaluation. Similarly, incremental risks plotting in cells above the red dashed lines represent risks that are likely above tolerable risk guidelines. Cells containing the diagonal red dashed line represent the approximate boundary of established guidelines, and incremental risks plotting in these cells are borderline with respect to the guidelines. The total incremental risk is evaluated against the guidelines, and the incremental risk from all risk-driver potential failure modes should be included. Experience has shown that it takes many failure modes in the area below both red dashed lines to move an order of magnitude upward. Therefore, looking at individual failure modes in the manner described above is generally adequate.

T.4.10.3 Annual probabilities of failure less than 1E-06/yr (i.e., remote) and estimated life loss greater than 1,000 are not explicitly represented on the incremental risk matrix. If potential failure modes are identified that plot in this region, they are highlighted and carefully considered in the prioritization process.

T.4.11 Non-Breach Risk. Non-breach risks associated with planned operations, typically involving release of large quantities of water through spillways in order to prevent the dam from overtopping should be identified. In some cases the planned releases are large enough to cause damage and threaten lives. However, risks associated with these conditions are smaller than if the dam were not there. In general, evaluating these risks involves identifying the maximum releases and freeboard that would occur during the Inflow Design Flood (IDF) if the dam is not overtopped during that event (or the threshold flood prior to overtopping of the dam if the IDF cannot be passed), the frequency of the flood associated with those releases, and the consequences associated with those releases. The frequency of the flood drives the likelihood category. Of course, the warnings that would go out prior to impacting the PAR with planned releases must be taken into account in assessing the consequences. Consequences are typically estimated. Thus, the incremental risks of comparing to the case of no dam are not captured. The results are plotted on a separate non-breach risk matrix as shown in Figure T.2. This is similar to the incremental risk matrix previously described, but the vertical axis is labeled “likelihood of flood” and no tolerable risk limit lines are shown since they are not applicable to non-breach conditions. If there is a levee downstream that could be overtopped by operational spillway releases, the frequency of the flood that would overtop the levees and the consequences resulting from overtopping (but not failure) of the levee are included.

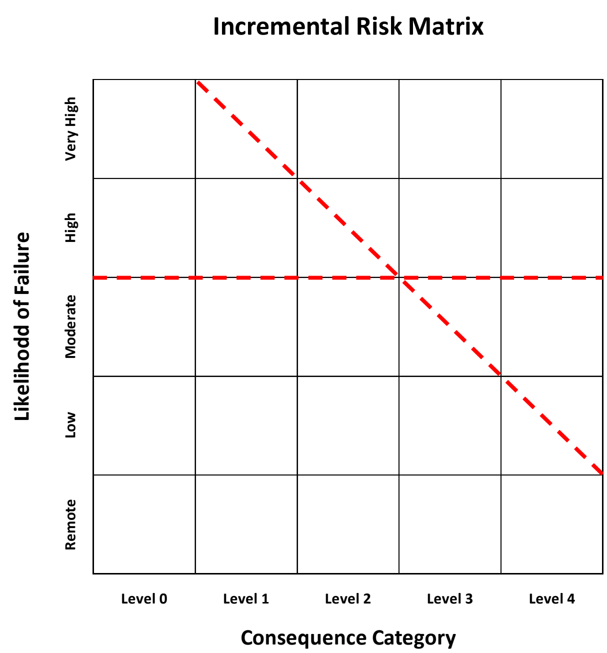

Figure T.1 - Incremental Risk Matrix

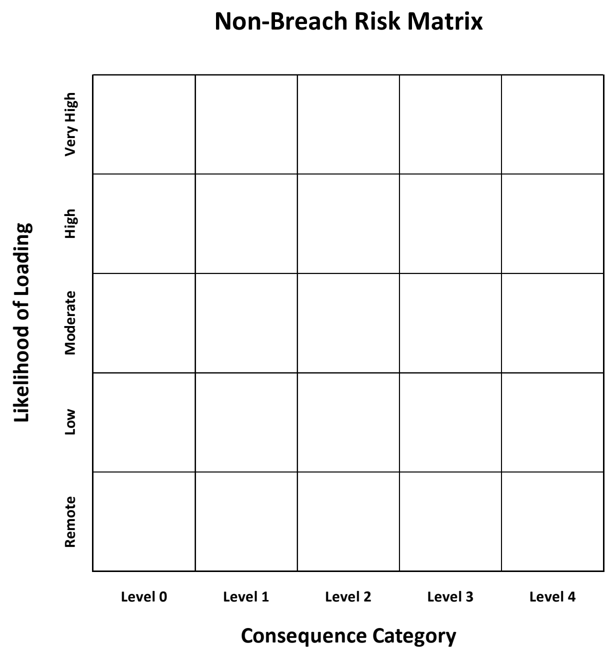

Figure T.2 - Non-Breach Risk Matrix

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APPENDIX U

Documentation of Dam Performance and Site Characterization Requirements for Dam Safety

U.1 Overview. The two sub-appendices outline the recommended minimum requirements for documenting dam performance and site characterization.

U.2 Sub- Appendix U-1 - Documentation of Dam Performance . This sub-appendix outlines recommended minimum requirements for evaluation, review, documentation and data access.

U.3 Sub-Appendix U-2 - Site Characterization Requirements for Dam Safety. The effective communication of the information contained in the instrumentation, geological, and geotechnical data is essential for evaluating the performance of a dam and its foundation and for estimating risk associated with the presences of the dam. The objective of this appendix is to provide guidance and outline the tasks for interpreting, sorting, summarizing, and portraying the information contained in this data.

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Sub-Appendix U-1

Documentation of Dam Performance

U-1.1 Purpose/Objective.

U-1.1.1 This sub-appendix provides guidance and procedures for documenting, in a standalone report, the performance of a dam in support of regular evaluation of its performance, Periodic Inspections, and in support of Issue Evaluation Studies (IES) and Dam Safety Modification Studies (DSMS).

U-1.1.2 The general concepts presented here are to be used for Periodic Assessments (PA), but the process and reporting requirements for the PA are presented elsewhere in this regulation.

U-1.1.3 The effective communication of the information contained in the instrumentation and monitoring/observation data is essential for evaluating the performance of a dam and its foundation and for estimating risk associated with the presence of the dam.

U-1.1.4 The objective of this appendix is to provide guidance and outline the tasks for evaluating, interpreting, portraying and reporting the information contained in this data. Proper communications of this data enables high quality evaluation of dam and foundation performance and reduces uncertainty in the risk estimates.

U-1.1.5 For a new dam or when there is a major modification of a dam, a report documenting the performance of the dam during and post construction will be done in support of the Project Geotechnical and Concrete Completion Report and the follow on Periodic Inspections.

U-1.1.6 If there are existing documents that address information required by the guidance in this sub-appendix then first review and evaluate those documents. Summarize the findings of those reviews and any pertinent information in this document and then refer to the appropriate locations in those documents for any detailed information that may be needed by a risk cadre or reviewer.

U-1.2 Background.

U-1.2.1 The goal of the performance data documentation is to provide the information necessary for a thorough evaluation of instrumentation data and observed performance for the full monitored history of the dam.

U-1.2.2 The process of reviewing, compiling for presentation, interpreting, and evaluating instrumentation and observation data and then assimilating it into a useful and concise format is extremely important for understanding the performance of a dam and its foundation.

U-1.2.3 This observed performance is to be compared with established performance thresholds based on the design assumptions and criteria and with related potential failure modes to assure the dam is performing as intended. Reviewing and summarizing this information should confirm that the data is being collected and managed in a proper manner that assures a high level of data quality is achieved year after year.

U-1.2.4 The compiling of and clear presentation of this data can also provide critical information for decisions when unusual conditions occur over the life of the dam.

U-1.3 Instrumentation and Monitoring Program Management, Data Management, and Data Quality Management.

U-1.3.1 Present the district level and project level programmatic documentation that governs the instrumentation and monitoring, data management, and the data quality management procedures that are in place. Document the chain of responsibility for and the administration of the instrumentation and monitoring program for the district and for the specific dam.

U-1.3.2 This documentation referred to below is typically some form of a generic ISO type documentation of the policies, processes, and procedures related to these activities. These documents might be district level or project specific, but should be fairly static once they are generated. Reference to these documents is adequate - do not repeat them in this report. Provide a summary of project specific documentation if it exists. If this district level and project specific documentation does not exist then it must be developed.

U-1.3.3 Evaluation of any project level automated data collection and handling procedures.

U-1.3.4 Typical questions to be addressed in this part of the dam performance documentation report are listed below.

U-1.3.4.1 What are and do the policies and procedures in place assure the appropriate level and type of data to properly assess the performance the dam?

U-1.3.4.2 What are and do the policies and procedures in place assure the data is properly collected and in such a manner as to assure the proper level of data quality?

U-1.3.4.3 What are and do the policies and procedures in place assure the collected data is managed properly to prevent loss of the data, to assure the data quality, and to provide the appropriate level of access to those that collect, evaluate, and use the data.

U-1.3.4.4 Is there a project specific instrumentation and monitoring or surveillance plan in place? Present a summary of the requirements and refer to the surveillance plan for details.

U-1.3.4.5 Does the project specific surveillance plans reflect increased surveillance needs according to pool level, seismic events, etc?

U-1.4 Summary of Site Specific Surveillance and Monitoring Program.

U-1.4.1 Present, in summary form, descriptions of the type and condition of all performance monitoring instrumentation including survey monuments and the supporting documentation. For each instrument document its measurement history – date installed, repairs, changes, system upgrades, and any other significant event impacting the specific instrument. Show what and how parameters are monitored, the frequency of monitoring and review along with all significant, favorable and unfavorable, aspects of the measurement and observation record. Indicate significant events such as initial fillings, historical low and high water events, modification to the dam, changes in operations, etc.

U-1.4.2 Inventory of Instrumentation.

U-1.4.2.1 What instruments are at the dam? List all instruments at the site to include model and serial number. This is best in tabular format.

U-1.4.2.2 Where are the instruments? Show on plan, map, and cross sections. On the map or plan show the dam and all appurtenant features and structures. Show on the cross sections the details of the dam and the foundation geology – soils and rock.

U-1.4.2.3 What is the purpose of each instrument? State what the instrument is monitoring, what parameters are being measured, and how the instrument relates to a potential failure mode, or a particular aspect of the performance of the dam.

U-1.4.2.4 Show the pertinent installation details for each instrument. Provide the coordinates and elevation of the instrument and for any monitoring points or sensing zones. State the degree of precision of the survey data and the datum and coordinate system used.

U-1.4.3 Data Acquisition Schedules.

U-1.4.3.1 What is the reading frequency? Does the surveillance plan call for appropriate changes in frequency of data collection and visual observations in relation to pool level, seismic events, or specific performance of a given feature of the dam?

U-1.4.3.2 Provide the required and actual frequency of observation and reading for each monitored parameter.

U-1.4.3.3 Are other observable or measureable parameters monitored that trigger changes in the surveillance plan?

U-1.4.4 Visual Observations.

U-1.4.4.1 Describe the location of visual observations, the parameter being monitored, the relationship the parameter and location of observation has to potential failure modes and performance of the dam.

U-1.4.4.2 Provide the required and actual frequency of observation and reading for each monitored parameter.

U-1.4.5 Automated Systems.

U-1.4.5.1 Present a summary of the automated system to include: component description including make and model; telemetry data transfer mechanisms and standards; application software and how it is tailored to the site; history of system upgrades; listings of equations and constants used for data reduction; status if instrument is active or inactive and the reason for inactive status.

U-1.4.5.2 If an existing standalone document exists for the automated system with this information than refer to that document and present a summary of the information in the dam performance report.

U-1.4.6 Inventory of Available Data. Describe the quantity, period and continuity of recordings and complete period of use for each measurement/observation.

U-1.4.7 Use of Plans and Sections.

U-1.4.7.1 As-built drawings. Include all original construction drawings related to instrumentation. Usually these include plans or schedules showing location, and typical construction details. Plan, profiles, and sections are to illustrate not only instrumentation location, but also features in common such as instrumentation type, monitoring purpose, dam behavior parameters, criticality, and installation period.

U-1.4.7.2 Stratigraphy Details. Include plans, profiles and sections of the instrumented features. Piezometers and other instruments in the ground should include sections showing the ground surface, stratigraphy, and measurement devices. Identify influence zone material and when needed cross reference drill hole and instrument ID numbers. They are to reference the supporting borehole logs and /or as-built drawings as appropriate. Datum used for construction and also data processing are to be listed.

U-1.4.7.3 Post construction mapping. When available and applicable, there may be a wide range of products available for specific projects, often dependent on previous studies, investigations, etc. Some projects may include GIS products, such as instrumentation arrays overlaid over aerial photography. Previous investigations may have included cross sections displaying stratigraphy, instrument measurement points, and measured water levels. Related instrumentation plan, profile and section drawings are to be cross referenced. If tables summarizing location information are not included on plan, section or profile drawings then a separate cross referenced table drawing is to be created.

U-1.4.7.3 Boring and Well Logs. When available and applicable, include logs from drilling and installation for piezometers, inclinometers, or other instruments installed in a bore hole. The logs should establish where the instrument is set relative to geologic stratigraphy and constructed features. Drafted logs are preferable, but field logs will suffice. Any drawings should clearly document installation and construction details, when available

U-1.4.7.4 For unusual or unique instrumentation, provide details and descriptive information that is not readily available elsewhere.

U-1.5 <u>Presentation of Data and Evaluation of the Data Quality</u>.

U-1.5.1 Type of Data. Data to be presented typically will include: visual observations, surfacing seepage/leakage and drainage, structural and foundation activities, piezometric and groundwater levels and other measurements or behaviors such as reservoir operation, precipitation, seismic events and landslide deformations.

U-1.5.2 Presentation Format.

U-1.5.2.1 Present the data in the appropriate graphical format – time/history; deformation over time; deformation in relation to a point of reference; readings versus the influencing variables – response to pool, air temperature; measured parameter in relationship to performance thresholds; etc.

U-1.5.2.2 For visual observations in general, report overall results of all visual observations using maps and available photographs.

U-1.5.2.3 For critical elements, scale drawings (typically with a 1:1 aspect ratio) depicting the dam's geometry, materials, and foundation geology that also show selected results from measured performance

U-1.5.2.4 Provide miscellaneous figure details for unusual, unique or uncommon instrumentation for which ready access to descriptive information is not available elsewhere.

U-1.5.3 Data Quality Evaluation.

U-1.5.3.1 Present an evaluation of the quality of the data for each instrument and its value in relation to the intended purpose for the instrument. Add notations to data plots to include notes on the quality of instrumentation data, history of associated maintenance, calibration date and method, and the skill level and experience of the person making the instrument reading or observation to aid evaluation of performance. Note unusual aspects of the data record such as periods of questionable or missing readings.

U-1.5.3.2 Discuss installation details and activities that may have affected measurements associated with a significant anomaly. Report whether or not reference points (e.g. survey control, inclinometer base, extensometer/standpipe head) are stable.

U-1.5.3.3 Report the accuracy standards (order and/or confidence limits) used for geodetic based surveys.

U-1.5.4 Cause and Effect. Present an evaluation of the data for each instrument in relation to ‘cause and affect’ and changes in the dam or foundation over time. Consider initial saturation phase during first-filling of the reservoir, changes in reservoir operation, major modifications to the embankment or its foundation, and changes in observed performance after high pool events or drought. For example, correlations based on the entire period of record for a piezometer/weir are not appropriate for forecasting future performance if a seepage berm (i.e., a major modification) was installed 10 years ago that altered the performance.

U-1.6 Data Interpretation and Performance Evaluation Narratives.

U-1.6.1 General.

U-1.6.1.1 Bring the various types of data together and present the interpretation and evaluation of this synthesis of data as it relates to potential failure modes and general performance of the dam.

U-1.6.1.2 Data interpretation and evaluation includes a narrative assessment that places all data in a meaningful structural and geologic context that addresses both the behavior of the dam and the monitoring system. Use drawings, tables, and graphical displays that illustrate the observations and findings are to be included. Graphical displays are to be used for nearly all data and are to be self explanatory. Unsatisfactory performance, especially behavior related to potential failure modes, is to be highlighted.

U-1.6.1.3 Describe and interpret the leakage, deformation and piezometric pressure behavior of the dam that is indicated by measurements and observations.

U-1.6.1.4 Evaluate the effectiveness and performance of individual instruments and the instrument arrays. Highlight elements associated with those measurements that can provide an advanced warning of failure mode initiation.

U-1.6.1.5 If a potential failure modes analysis has been completed, make conclusions concerning the future usefulness of all monitoring elements based upon instrument and dam performance in view of the potential failure modes.

U-1.6.2 Visual Observations. For visual observations report, in general, overall results of all visual observations to include items such as timeless, adequacy of coverage and intermittent phenomenon such as wet spots. Highlight unexpected observations and include available photographs. Report how unexpected observations have been addressed.

U-1.6.3 Seepage, Leakage, and Drainage.

U-1.6.3.1 Report all flow quantities that are, or potentially are, a function of reservoir surface elevation. Discuss how other influencing factors, such as tail water elevation, precipitation, snow melt and groundwater affect measured monitored flows. Describe whether or not the relationship between influencing factors and the resulting flow quantity, quality and/or location is consistent over time and highlight increasing flow responses.

U-1.6.3.2 Report whether or not drainage features appear to lose capacity or convey less expected flow over time.

U-1.6.3.3 Report any measured or evidence of material transport by seepage flow. Where erosion of water soluble salts may be a concern, report whether or not flow water quality differs from reservoir quality and whether or not reservoir water quality is aggressive toward any foundation materials.

U-1.6.4 Structural and Foundation Deformation and Displacement. Highlight any indications of steady, accelerating or otherwise unstable displacement rates. Report whether or not cyclic deformations remain predictable as functions of season or reservoir operation. Report any instances of differential deformations that could lead to cracking. For individual features (dam, dike, spillway wall, etc.) report whether or not the maximum and minimum deformations or displacements occur at the expected locations. Highlight deformations that exceed expected magnitudes or the expected rate of progression.

U-1.6.5 Uplift, Piezometric Pressure, and Ground Water Level. Highlight pressures or water levels that are greater than expected. Report whether or not the distribution of pressure conforms to the expected pattern. Report trends of increasing or decreasing pressure responses to reservoir surface level. Indicate the effectiveness, and any change in effectiveness that has occurred over time, of seepage cutoff features that affect the measurements. Indicate the effectiveness, and any change in effectiveness that has occurred over time, of drainage features that affect the measurements. Estimate seepage exit gradients in erodible materials where pressures are measured near seepage exits. Estimate uplift on planes of suspected weakness such as lift lines, joints, shale seams and foundation contact.

U-1.6.6 Seismic Monitoring. Present the evaluation of the performance of the dam for any seismic loadings the dam has experienced. Present any measured ground motion records and their evaluation. Present and discuss any observed physical displacements or cracking due to seismic loadings.

U-1.6.7 Non-routine Performance Investigation. Present an evaluation of any non-routine monitoring methods. Provide a description of what parameters are being measured, the method of measuring or monitoring, present the accuracy standards used, and explain why that method was used. State how the method was implemented. Provide an interpretation of the data and evaluation narrative of what this data is indicating as pertaining to the performance of the dam and any related potential failure modes.

U-1.7 Conclusions.

U-1.7.1 State any conclusions derived based on the evaluation of the district level programmatic policies and procedures and the project specific surveillance plan pertaining to the amount and type of data and data quality to allow adequate evaluation of the performance of the dam.

U-1.7.2 State any conclusions on the quality of the data actually collected for the specific dam. Based on the data interpretation and performance evaluation conducted for this dam state any conclusions arrived at concerning the performance of the dam or as related to any specific potential failure mode. Include conclusions derived from the interpretation and evaluation of any unexpected dam performance.

U-1.8 Recommendations. Present recommendations additional instruments, increased or decrease monitoring, different or revised graphics, etc based on the evaluations and conclusions presented. Address such items as needed maps/drawings such that the locations of monitoring program elements are fully documented. Highlight any weaknesses and make recommendations for improvements to monitoring, documentation and the plans for responding to unexpected dam performance.

U-1.9 Reporting and Review of Documentation of Dam Performance Reports.

U-1.9.1 Reporting.

U-1.9.1.1 For PI/PA the initial standalone report and then subsequently the five year updates will be summarized and published in the PI/PA report. See Chapter 14, paragraph 14.6.3.

U-1.9.1.2 For the IES and DSMR a separate detailed documentation or standalone report of dam performance is required rather than creating a large appendix to the main report. For inclusion in the IES and the DSMR a succinct summary must be written to describe the most important findings, implication, and conclusions pertaining to risk estimates.

U-1.9.1.3 This summary, when used with numerous clear references to the Documentation of Dam Performance report, should provide reviewers and decision-makers fast access to the most significant information and interpretations. This is not a lengthy discussion of the instrumentation data interpretation and evaluation, but a focused summary to pull only the most significant information together to quickly describe the performance of the dam for evaluating risks associated with the credible and significant potential failure modes. The summary must discuss the dam performance in the context of these potential failure modes to show how the risk cadre used the information to inform the risk estimates.

U-1.9.2 Reviews. Documentation of dam performance, including the reports, and the summaries to be used as an appendix in the periodic inspection report, IES and DSMR, require appropriate reviews at each stage of development. The standalone dam performance report and the summaries require DQC and ATR. Informal coordination with the RMC on input to the process and products is recommended along with a review of potential failure mode descriptions, far in advance of the DQC or ATR. A review meeting can be useful for making early adjustments and changes to the process or products which often result in more effective ATR reviews and helps to keep the reports on schedule. Scheduling of a brief half-to one-day review meeting with some members of the district staff, risk cadre, and the RMC several months prior to major milestones is recommended. These meetings should be scheduled months in advance and should be included in the scope of work for any IES and DSMS/R.

U-1.9.3 Report Format. There is no set format for this report, but it is to contain the following: Title page, table of contents, appropriate district quality control and agency technical review documentation, the sections presented below in this sup-appendix, a list of references cited, and any required figures, tables, charts, plots, and appendices to support the main report.

U-1.9.4 Location of the site characterization documentation in formal reports.

U-1.9.4.1 PI/PA report. The summary of the dam performance data will be documented in Appendix E of the PI/PA report. See Appendix AE.

U-1.9.4.2 IES report. The full detailed documentation of dam performance in support of the risk assessment for the IES should be provided in a separate stand-alone document. Clear references to specific supporting data should be included in the IES report. The succinct summary of the dam performance is to be located in the IES report Appendix C - Summary of Site Characterization Report and Dam Performance. See Appendix V - Format and Content for Issue Evaluation Study Documents.

U-1.9.4.3 DSMR - The dam performance documentation in support of the risk assessment for the DSMR should be included in a separate stand-alone document. Clear references to specific supporting data should be included in the DSMR. The succinct summary of the dam performance is to be located in the DSMR report appendix documenting the risk assessment in support of the DSMR. See paragraph W-

2.11.1 Risk Assessment and Risk Management Alternative Formulation, in Sub-Appendix W-2 - Dam Safety Modification Report Format.

Sub-Appendix U-2

Site Characterization Requirements for Dam Safety

U-2.1 Purpose/Objective. This sub-appendix provides guidance and procedures for developing site characterization information in support of Issue Evaluation Studies (IES) and Dam Safety Modification Studies (DSMS). The general concepts presented here are to be used for Periodic Assessments (PA), but the process and reporting requirements for the PA are presented elsewhere in this regulation. The effective communication of the information contained in the instrumentation, geological, and geotechnical data is essential for evaluating the performance of a dam and its foundation and for estimating risk associated with the presence of the dam. The objective of this appendix is to provide guidance and outline the tasks for interpreting, sorting, summarizing, portraying and reporting the information contained in this data. Proper communications of this data enables high quality evaluation of dam and foundation performance and reduces uncertainty in the risk estimates. Additional guidance is available in Chapter 10 of the Best Practices Manual (reference A.109, https://radsii.usace.army.mil/RMCResources.aspx).

U-2.2 Background. The process of sorting through geological and geotechnical information, pulling out the most applicable data (instrument/monitoring, geological, geotechnical, construction and current condition photographs, drawings, etc.) and then assimilating it into a useful and concise format is extremely important for understanding the dam and foundation characteristics and how these relate to potential failure modes. Summarizing this information on detailed plan, profile and cross sectional drawings with supporting narrative into a coherent site characterization is important to informing those doing the risk assessment and aids communication of the dam and foundation conditions to reviewers, decision makers, and those responsible for monitoring the structure. The clear presentation of this information provides critical information for decisions when unusual conditions occur at the dam, such as increased seepage, erosion or settlement, etc.

U-2.3 Defining Appropriate Site Characterization Efforts (Scope). A site characterization summary or report should be developed as part of the preparation needed for a risk assessment that is part of an IES or DSMS. The level of effort and the work products associated with the site characterization should be consistent with the information needed to adequately evaluate and portray the risks and the performance of the dam at each stage in the study process. Site characterization is an iterative and incremental process that is scoped and re-scoped as an understanding of the dam's vulnerabilities increases as the study advances. The level of detail and the sophistication of the presentation of this information in a report or summary will increase as the study moves from the initial stages of a semi-quantitative risk assessment (SQRA) to the end stages of a Dam Safety Modification Study and should be the minimum necessary to allow adequate evaluation of the potential failure modes and demonstration of the understanding of this information to decision makers at each stage of the study process, (i.e. the SQRA, Team Elicitation for IES, and DSMS levels of effort). A detailed scope of work should be developed and modified as appropriate for each stage of the dam safety study process. The scope should adequately and concisely communicate the data and analyses that are needed and their associated deliverables budgets and schedules. For SQRA, the site characterization information typically consists of compiling existing drawings and information. Once the dam's potential failure modes are better understood after SQRA, additional data analysis, evaluation, and drawing development may be needed for the quantitative risk assessment as part of the IES study. Further drawing and data development may be needed to evaluate alternatives at the DSMS stage. These scoping requirements are identified in the IES and DSMS chapters (Chapters 8 and 9, respectively). Chapter 8 requires that an IES study plan be prepared and reviewed that scopes the activities, deliverables, and budgets associated with site characterization as well as other analyses needed to support the risk assessment and that this plan be updated as changes in data preparation are identified. Chapter 9 requires development of a project management plan and scope development of the risk assessment which requires a site characterization report prior to the start of the risk assessment in support of the DSMS. For the SQRA at the start of the IES process, the site characterization data can be included as an appendix rather than a standalone report. For an IES study and a Dam Safety Modification Study, the site characterization data and evaluation should be included in a stand-alone report or summary that is consistent with the level of detail needed to evaluate and portray the information to decision makers. The Risk Management Center can provide guidance on the site characterization process in addition to assistance in developing an appropriate scope for each stage of the dam safety process.

U-2.4 Data Presentation and Necessary Drawings.

U-2.4.1 Detailed Plan Maps

U-2.4.1.1- In order to adequately evaluate dam performance and estimate risks associated with various potential failure modes, it is essential to clearly understand the location of all design and construction elements and everything associated with monitoring the structure, particularly the exploration and instrumentation. The plan map serves this purpose and shows the locations of all design features and the locations of each cross section or profile. This requires a full size drawing at a scale sufficient to portray the necessary details including topography, labels for all drill holes, test pits, trenches, berms, toe drains, tunnels, conduits, geologic contacts, instrumentation, etc.

U-2.4.1.2 Existing plan maps may be adequate for initial potential failure mode evaluations and the first step of the IES which is the SQRA. However, it is often necessary to update the map(s) by adding more recent explorations, instrumentation and noted design changes or additions. The need to improve and update the plan map or the as-built sections and profiles should be assessed as part of the scoping process several months prior to any risk assessment meeting at any stage of the process as part of the scoping process. These drawings should be updated as a routine dam safety activity, independent of risk assessments. Drilling should not be permitted on or near the embankment unless a current plan map and cross sections are available to clearly show the location of all existing drill holes and design features, especially buried conduits and features that can create low stress zones or other conditions that can increase drilling risks. See the requirements to obtain permission to drill in the dam or its foundation in other parts of this regulation. After any exploration, the plan map should be routinely updated to reflect current conditions.

U-2.4.2 Detailed Cross Sections

U-2.4.2.1 There is no single “correct” way to develop geologic cross sections (or profiles) that depict geology, material properties and instrumentation response data. Sometimes it makes more sense to draft these sections using CADD software. While in the early stages of evaluations, such as the SQRA, hand-drawn cross sections are the quickest and most effective, or annotations made on existing as-built sections. This improves the efficiency of the initial evaluations by relying mostly on existing information rather than spending too much time generating new products prior to confirmation of failure modes.

U-2.4.1.2 Geologic cross sections and profiles parallel to the dam axis, outlet works or spillway are important to develop at the location of potential dam and foundation problems and where instrument and observation data may provide a better interpretation of conditions. Even for the most basic study for a PI, PA or for the SQRA at the start of the IES, a few geologic sections are required to display the subsurface material properties and to help in the discussion and display of potential failure pathways. The risk cadre should discuss the location and data requirements of cross sections or profiles most important to pending discussions. The three-dimensionality of the geology/structure geometry often cannot be adequately understood or communicated with one cross section and several sections along with a detailed plan/map may be required. In more advanced studies a 3D CADD model may be very helpful. A cross section along the outlet works is generally needed, particularly for conduits through the embankments where seepage erosion will be evaluated. At a minimum, for any foundation discussions, a typical cross section perpendicular to the dam axis, often near the maximum dam section, is required that shows the foundation interpretation along with embankment zoning (or concrete dam features) and other design features. More complex sites obviously require more cross sections to define the range of conditions and geometry. Decisions for additional cross sections should be made and documented by the team and included in the scope of work.

U-2.4.3 Construction Photographs and Field Records. Construction photographs and construction field records have proven to be some of the most important data for documenting and understanding the dam embankment placement and the foundation conditions. All photographs, including historic aerial photographs should be considered extremely valuable. Every effort should be made to locate, review, and sort existing photos from all available records, especially the construction documents, as early in the evaluation process as possible. Finding these photographs sometimes requires diligence and a search of several offices. For quantitative risk assessment (team elicitation), the most significant photographic prints should be carefully scanned at very high resolution so that areas can be enlarged and digital files can be preserved and published in the current documentation . In the IES and DSMS reports it is useful to annotate the most important photographs to help support the dam safety case and efficiently communicate conditions. Key photographs that inform risk management discussions should be incorporated onto the plan and section drawings whenever possible to consolidate the most useful information. In addition, field records from construction (inspector's notebooks, Project Engineer's log book, construction payment modifications, etc) can be extremely valuable.

U-2.5 Site Data Evaluation and Interpretation. The site data is to be evaluated by a multi-disciplinary team and the important data and interpretations should be presented in relationship to each of the potential failure modes. These discussions often include, but are not limited to:

U-2.5.1 Geologic descriptions of foundation soil properties and geomorphology, as related to potential failure modes and tied to foundation drawings, logs, photos, etc.

U-2.5.2 Descriptions and properties of bedrock – foundation and abutments, as related to potential failure modes and tied to foundation drawings, logs, photos, etc.

U-2.5.3 Engineering material properties and descriptions of the embankment and/or foundation soils, as related to potential failure modes.

U-2.5.4 Design and construction records (original construction and subsequent modifications), as related to potential failure modes.

U-2.5.5 Instrumentation data dealing with the performance of the foundation and dam, as related to potential failure modes.

U-2.5.6 Design and consultant reviews and observations made throughout the history of the project, as related to potential failure modes.

U-2.6 Site Characterization Reporting and Review.

U-2.6.1 There are no set standard formats for site characterization documentation due to the different levels of risk assessments and reports and the uniqueness of each dam foundation and associated potential failure modes. The type of data and information presented in the site characterization documentation for a particular project will reflect the site geology, dam type, and potential failure modes evaluated. The detail and volume of information often increases for each higher level of assessment. Examples of site characterization reports are provided in the Geotech and Geology folder at: https://radsii.usace.army.mil/RMCResources.aspx

U-2.6.2 The investigation and assessment of potential failure modes leads to the development of important questions that will help guide the collection, evaluation and presentation of geologic and geotechnical data. The risk cadre should develop this list of foundation questions for every stage of the process. The event tree and supporting information used for team estimates can be very useful for defining data needs and major questions. Most of the critical information should be portrayed on a set of drawings with associated figures, plots, plans, cross sections, and photographs that by themselves tell the foundation story efficiently and effectively. This is the preferred method for communicating conditions, and these products should be used with the intent of focusing and minimizing the volume of text to the extent possible.

U-2.6.3 For the Periodic Assessment the site characterization is done as part of the PA process and summarized in the PA report.

U-2.6.4 For the SQRA at the start of the IES process, site characterization data can be summarized in an appendix. For the Issue Evaluation quantitative analysis (team elicitation) and Dam Safety Modification Studies a separate detailed site characterization report is usually required (assuming foundation failure modes are significant) rather than creating a large appendix to the main report. For inclusion in the IES and the dam safety modification report (DSMR) a succinct summary must be written to describe the most important foundation properties, conditions, continuity, confidence levels, available data and implications to risk estimates. This summary, when used with numerous clear references to the above list of products, should provide reviewers and decision-makers fast access to the most significant information and interpretations. This summary is not a lengthy discussion of regional geology or the long history of investigations. It is a focused summary to pull only the most significant information together to quickly describe the data used for evaluating risks associated with the credible and significant potential failure modes. The summary must discuss the foundation properties in the context of these potential failure modes to show how the risk cadre used the information to inform the risk estimates.

U-2.6.5 Site Characterization Reviews. Site Characterization work, including the reports and the summaries, to be used with the IES report and DSMR, require appropriate reviews at each stage of development. For the routine PI and PA processes, there is generally less data development and the review occurs with the normal review of the entire document. For more intensive efforts (quantitative risk assessment for the IES and DSMS) the site characterization report and associated summaries required DQC and ATR. Informal and early RMC input to the site characterization process and products is recommended along with a review of potential failure mode descriptions, far in advance of the DQC or ATR. A review meeting can be useful for making early adjustments and changes to the process or products which often result in more effective ATR reviews and helps to keep the reports on schedule. Scheduling of a brief half-to one-day site characterization review meeting with some members of the risk cadre and the RMC several months prior to major milestones is recommended. These meetings should be described in the scope of work.

U-2.6.6 Location of the site characterization documentation in formal reports.

U-2.6.6.1 PA report. The pertinent site characterization data required to support the summary of each potential failure mode judged to drive the incremental risk will be documented in Chapter 7 (Risk Assessment) of the PI/PA report. See Appendix AE - Periodic Inspection and Periodic Assessment Report Format.

U-2.6.6.2 IES report. The full detailed site characterization documentation in support of the quantitative risk assessment for the IES should be provided in a separate stand-alone document. Clear references to specific supporting data should be included in the IES report. The succinct summary of the site characterization is to be located in the IES report Appendix C - Summary of Site Characterization Report and Dam Performance. See Appendix V - Format and Content for Issue Evaluation Study Documents.

U-2.6.6.3 DSMR - The site characterization documentation in support of the risk assessment for the DSMR should be included in a separate stand-alone document. Clear references to specific supporting data should be included in the DSMR. The succinct summary of the site characterization is to be located in the DSMR report appendix documenting the risk assessment in support of the DSMR. See paragraph W-2.11.1 Risk Assessment and Risk Management Alternative Formulation, in Sub-Appendix W-2 - Dam Safety Modification Report Format.

APPENDIX V

Format and Content for Issue Evaluation Study Documents

V.1 USACE Dam Safety Fact Sheet. The USACE Dam Safety Fact Sheet will be prepared at the completion of the Issue Evaluation Study to facilitate risk communication to internal and external interests. The fact sheet is releasable to the general public. An example template of the fact sheet is located in Appendix E. In addition, contact the MSC DSPM for examples of this fact sheet used for other projects

V.2 Issue Evaluation Study Summary of Findings (IESSF). This portion of the appendix describes the format and content of the IESSF. The IESSF is intended to be an extractable, stand-alone component of the IES report that provides pertinent information about the dam to senior USACE officials to make dam safety decisions. The IESSF is FOUO and is not intended for public release.

V.2.1 Title Page. Include the following items on the title page:

V.2.1.1 Issue Evaluation Study Summary of Findings - Issue Evaluation Study

V.2.1.2 Dam Name and NID number

V.2.1.3 Location (river, city, state)

V.2.1.4 USACE District and USACE Division

V.2.1.5 Date

V.2.2 Approval Certification Sheet. Signature sheet in accordance with the approval requirements outlined in Table 8.2.

V.2.3 The IESSF Document Content.

V.2.3.1 Title page – Issue Evaluation Study Summary of Findings. The title page includes Issue Evaluation Study, name of the dam, photo, location, name of the USACE district and division, and date of the decision summary.

V.2.3.2 Executive Summary. Provide a 1-page summary of the projects historical performance concerns and issues that resulted in the current DSAC, and the overall findings and recommendations resulting from the IES (1-page).

V.2.3.3 Project Description. Provide a description of the projects location, physical features, downstream population centers, and deficiencies. Include a sketch plan and/or typical section of the dam showing primary areas of concern that were evaluated in the IES (1-page).

V.2.3.4 Project History. Provide a table or other graphical illustration showing a project history timeline that describes discovery and observation details of pertinent performance issues. Include descriptions and details of remedial actions and IRRMs that have been implemented to reduce risk (1-page).

V.2.3.5 Continued Federal Investment. Provide brief response to: The determination that the existing authorized project purposes warrant continued Federal investment and an assessment of whether changes in the authorized project purposes warrant investigation (1/2- to 1-pages).

V.2.3.6 Significant Failure Modes. Provide a brief description and a simplified sketch of each significant failure mode that is believed to be driving the risks at this project. Combine PFM's when possible. Describe any data deficiencies that may have introduced uncertainty into the risk assessment (1-page each PFM).

V.2.3.7 Interim Risk Reduction Measures. Provide a brief overview of the current IRRM's that are in place, and recommended changes to the IRRMP (1-page).

V.3.2.8 Risk Estimate: Risk estimate (f-N chart) of existing without IRRMs and existing with IRRM's (1-page).

V.2.3.9 Conclusion and Recommendations. Provide a summary of the study conclusions and recommendations contained in the IES report. Describe the similarities and differences in findings between the IES risk assessment and the SPRA results. Describe how these differences could have an impact on the current DSAC assignment. Describe the level of uncertainty in understanding the significant PFMs of dam, and the overall level of confidence in the risk assessment. Provide recommendations on the need for additional studies and data that would reduce uncertainty (1-page).

V.3 IES Report. This portion of the appendix describes the format and content of the IES Report.

V.3.1 Chapter 1 - Introduction. Overall project authority, purposes, location, and descriptions of pertinent project features.

V.3.2 Chapter 2 - Background. Discussion of past performance and key observations to include summary of the dam features and components, foundation conditions, seepage control features, unique design considerations, construction methods, historical performance, key observations, and a summary of the evaluation of compliance with essential USACE guidelines.

V.3.3 Chapter 3 - Previous Assessment. Overview from the results of any past risk assessment (such as SPRA or PA findings and the reasons for the current DSAC. The current assessment must include a summary of the objectives from the approved Issue Evaluation study plan. Include a description of the Phase 2 study efforts and investigations (if applicable).

V.3.4 Chapter 4 - Interim Risk Reduction Measures. Summary of the structural and non-structural IRRM's that have been implemented including reservoir restrictions, and the benefits and challenges of utilizing these IRRM's as an effective risk reduction strategy.

V3.5 Chapter 5 - Continued Federal Investment. Findings for the determination that the existing authorized project purposes warrant continued Federal investment and an assessment of whether changes in the authorized project purposes warrant investigation . See paragraph 9.3.1.2 for further explanation.

V.3.6 Chapter 6 - Hydrologic and Hydraulic Analysis. A discussion of the hydrologic loading events and frequency for the project as well as hydraulic modeling efforts. Document the dates of the most recent re-evaluation. A reservoir diagram showing Minimum Flood Space, Variable Flood Space and other vital pool elevations, must also be included.

V.3.7 Chapter 7 - Seismic Loading. A discussion of the seismic loading events and frequency for the project must be included in this chapter. Document the dates of the most recent re-evaluation.

V.3.8 Chapter 8 - Consequences. A detailed summary of the estimated life, economic, and environmental consequences (e.g. impact on project purposes, loss of life, environmental and economic impact to region, etc.).

V.3.9 Chapter 9 - Potential Failure Modes Analysis (PFMA) and Risk Assessment.

V.3.9.1 PFMA. A summary of the facilitated PFMA results, with a listing and evaluation of the significant, credible, and non-credible failure modes, including the loading conditions, impacts if failure was to occur, and corresponding opportunities for risk-reductions.

V.3.9.2 Expert Opinion Elicitation (EOE). An overview of the Expert Opinion Elicitation, with detailed descriptions of each significant potential failure mode, including loading conditions, initiator (evidence of flaw and initiation potential), failure progression (continuation and progression), intervention, intervention and breach, and the supporting documentation used for the assignment of conditional probabilities of failure.

V.3.9.3 Methodology. A description of the methodology and risk estimating tools used to estimate the risk. This must include a detailed description of the data input for calculation of Annualized Probability of Failure (APF) and Annualized Life Loss (ALL), discussion of logic diagrams, event trees, system response probabilities, exposure scenarios and rates, etc that were used in the risk calculations.

V.3.9.4 Summary of Risk Estimates. Discussion of the risk estimates (with and without intervention) and the four thresholds evaluated under the USACE Tolerable Risk

Guidelines, including Annual Probability of Failure (APF), life safety risk, economic risk, environmental and other non-monetary risks, and a risk summary of the overall project risk. Plot the risk estimate results on the tolerable risk guideline charts, and include a tabular summary of each potential failure mode showing the respective annual life loss, estimated life loss, range of incremental life loss, and relative contribution (percent) of each failure mode to the total incremental risk (See Chapter 5).

V.3.9.5 Sensitivity. Discussion of model and data uncertainty, and assumptions, including explicit presentation of how uncertainty influences the risk estimate using sensitivity analysis or other appropriate uncertainty analyses.

V.3.10 Chapter 10 – Conclusions and Recommendations. This section should include the findings and conclusions of the risk estimate, a discussion on future data needs required to reduce unacceptable uncertainty, recommendations on future actions and appropriateness of current DSAC assignment, and risk-informed basis for more detailed study.

V.3.11 Chapter 11 - Interim Risk Reduction Management Plan. A comprehensive discussion on the significant dam safety deficiencies identified by the risk assessment, the short and long term efficiency, effectiveness, and potential impacts of current and proposed IRRMs, the basis and urgency to take further action, the proposed scope of the efforts required to accomplish these actions, including the anticipated planning, design, and investigation tasks required to perform a DSM study.

V.3.12 Chapter 12 - Risk Communications Plan. A summary of efforts and actions the district intends or has implemented in accordance with chapters 7 and 10.

V.3.13 Supporting Documentation. Supporting documentation must be included in the following Appendices:

V.3.13.1 Appendix A – References.

V.3.13.2 Appendix B –Project Support Information (Plans, sections, details, photos, etc)

V.3.13.3 Appendix C - Applicable Essential USACE Guidelines and Compliance Review

V.3.13.4 Appendix D – Summary of Site Characterization and Dam Performance (This is the summary document of the reports required per Appendix U. The two reports required by Appendix U are stand alone reports that this summary is to extract information from and reference to support the observations, evaluations, and conclusions stated in the risk assessment.)

V.3.13.5 Appendix E – Agency Technical Review and Quality Consistency Review

V.3.13.6 Appendix F – Supporting Documentation

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APPENDIX W

Dam Safety Modification Study Activities, Decision Points, and Report Format

W.1 Overview. This appendix contains a process chart showing the additional activities and decision points associated with the Dam Safety Modification Study (DSMS) process and a detailed outline for the Dam Safety Modification Report (DSMR).

W.2 Sub-Appendix W-1 - Adaptation of SMART Planning to the Dam Safety Modification Study Process. This sub-appendix presents a process chart showing the activities and decision points within the DSMS. The process chart incorporates the SMART planning process.

W.3 Sub-Appendix W-2 - Dam Safety Modification Report Format. This sub-appendix provides the outline and format for the DSMR.

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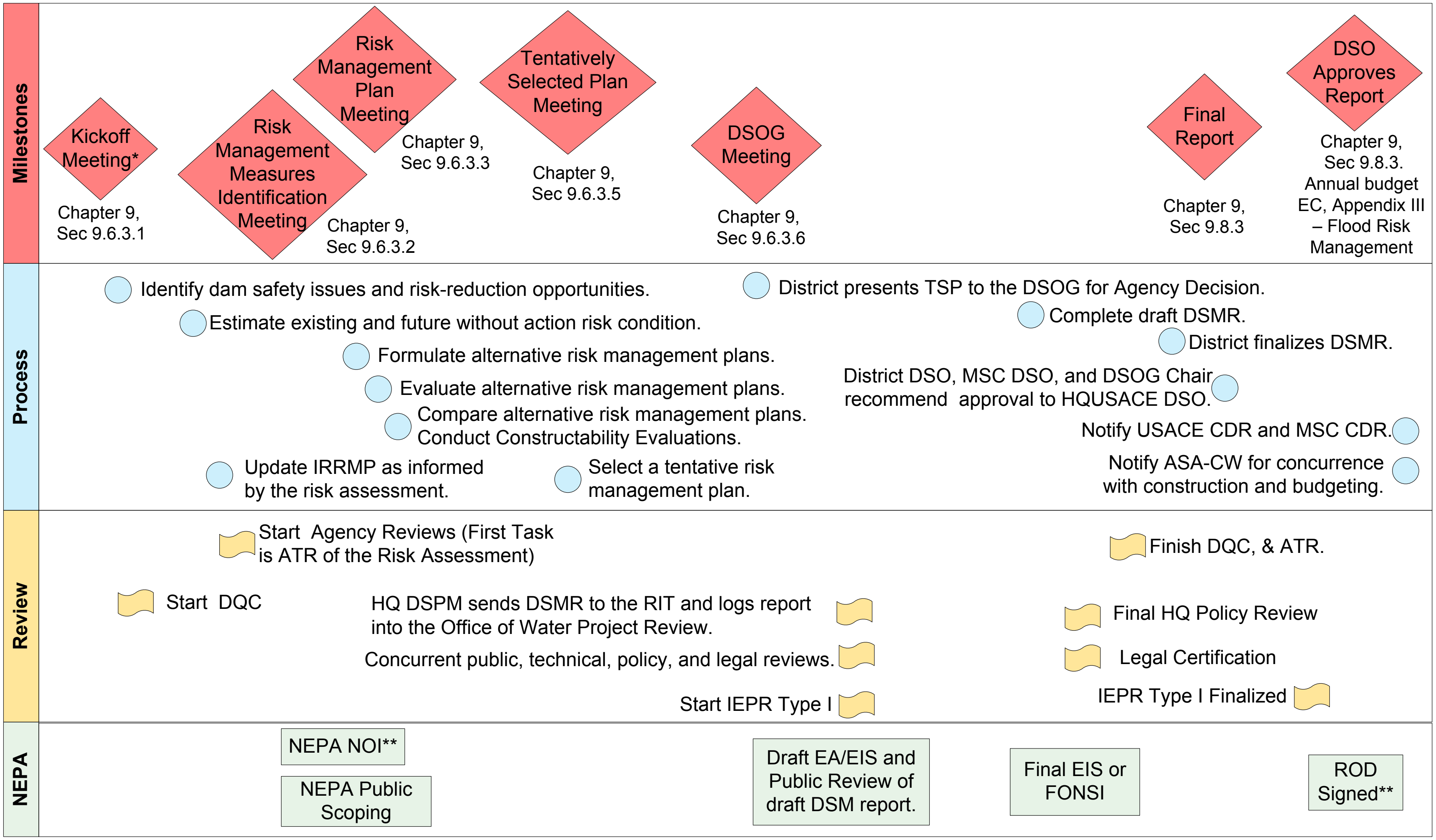
SUB-APPENDIX W-1

Adaptation of SMART Planning to the Dam Safety Modification Study Process

W-1.1 Introduction. See Figure W-1.1 for additional information on the application of the SMART planning process to the USACE Dam Safety program. The US Army Corps of Engineers (USACE) Dam Safety program is adapting the USACE SMART (Specific, Measureable, Attainable, Risk Informed, Timely) Planning process with minor modifications to accommodate the authorities granted the USACE Dam Safety officer. Chapter 9 explains how these steps of the SMART planning process are being implemented for the Dam Safety Modification Study (DSMS) process (USACE Planning Bulletin, Subject Planning SMART Guide, CEW-P, No. 2012-02, 11 January 2013) (reference A.103).

W-1.2 SMART Planning Web Link. Additional insight for USACE guidance on the SMART planning process and the associated activities can be found on the web page at http://planning.usace.aermy.mil/toolbox/smart.cfm?Section=1&Part=0.



*The kickoff meeting starts the ongoing process of the vertical team coordination and vertical team QA and policy compliance review which will be completed at the time the District DSO, MSC DSO, and SOG Chair sign the joint memo to the USACE DSO recommending approval of the DSM report.
** If environmental impact statement is required.

Figure W-1.1 - USACE Dam Safety Modification Study Process, Activities, and Decision Points

SUB-APPENDIX W-2

Dam Safety Modification Report Format

W-2.1 Format of Dam Safety Modification Report. Each report must include the requirements contained in the following paragraphs, and the report format must follow the order as presented below. The level of detail of any section should be commensurate with its relevance to decision making.

W-2.2 Title Page. Include the following items on the title page:

W-2.2.1.1 Dam Safety Modification Report

W-2.2.1.2 Dam Name

W-2.2.1.3 Location (river, city, state)

W-2.2.1.4 USACE District and USACE Division

W-2.2.1.5 Date the report was approved.

W-2.2.2 Approval Certification Sheet. Signature sheet completed in accordance with the approval requirements outlined in Table 9.3.

W-2.3 Dam Safety Action Decision Summary (DSADS). The DSADS is intended to be an extractable, stand alone component of the DSM report. (Note: This is a different document from the IESSF.) The DSADS is intended to meet the information needs of senior USACE officials in making dam safety decisions. It would be a public document with unrestricted distribution, but is not designed to be a public communications document per se. Detailed guidance for preparation of the DSADS is in Appendix Y.

W-2.4 Executive Summary. The Executive Summary will include project location, description, and DSAC; whether project purposes warrant continued Federal investment; dam safety issues and significant potential failure modes; existing and future without Federal action risk estimate and relation to tolerable risk guidelines; alternatives considered; and recommendations with expected effects on risk. The Executive Summary should be brief, about 2 to 3 pages in length, summarizing the above items in such a way as to not include sensitive information so that the Executive Summary may be released publicly without being designated as “For Official Use Only.”

W-2.5 Background.

W-2.5.1 Project Authorization Purposes and Appropriate Funding Legislation. Provide pertinent information on the project authorization, including any modifications, and quote verbatim the requirements of local cooperation in the original authorization.

W-2.5.2 Location and Description. Briefly describe the project, including type of dam or major structure and seismic zone and enclose a map to indicate its location.

W-2.5.3 Project History. Provide a chronology of the expenditures for maintenance on the project since its completion, and a brief description of all previous major rehabilitations or dam safety modifications and their associated costs.

W-2.5.4 Current Use of the Project and Projected Future Use. Provide a narrative description of the use currently being made of the project and the use projected during an appropriate period in the future (e.g., useful life without and, new useful life with, recommended modifications for dam safety). Indicate whether the project currently satisfies the authorized project purposes. Provide supporting data, as available from USACE or non-USACE sources. State whether project purposes warrant continued Federal investment – reference paragraph 9.3.1.2. A reservoir diagram showing Minimum Flood Space, Variable Flood Space and other vital pool elevations, must also be included.

W-2.6 DSMS Findings and Recommendations. This section presents a summary of the investigations, analysis, studies, and decision process for the recommended risk management plan.

W-2-6.1 Authorized Project Purposes Warrant Continued Federal Investment. Investigation and findings for the determination that the existing authorized project purposes warrant continued Federal investment and an assessment of whether changes in the authorized project purposes warrant investigation. The level of detail of this determination should be consistent with that of a reconnaissance study under the GI program or Initial appraisal of a Section 216 (Reference A.7) study. More detail should be applied as needed to support the determinations and decision making within the Dam Safety Program.

W-2.6.2 Identify Dam Safety Issues and Risk-reduction Opportunities (Chapter 9, Section 9.5.2). Dam safety issue and risk-reduction opportunity statements will be framed in terms of the USACE dam safety program objectives, identified dam safety issues, and tolerable risk and essential USACE guidelines.

W-2.6.3 Estimate Existing and Future Without Federal Action Condition Risk (Chapter 9, Section 9.5.3). The future without Federal action condition provides the basis from which alternative plans are formulated and impacts are assessed. All dam safety issues and credible potential failure modes will undergo a risk assessment to identify the significant potential failure modes and to estimate the risk. All risk estimates must give due consideration for intervention. Risk estimates are to be made and presented for both with and without intervention scenarios.

W-2.6.3.1 Provide a narrative description of the investigations and studies used to support the existing and future without Federal action risk estimates.

W-2.6.3.2 Present any investigations and studies and explain how they improved the quality and reduce uncertainty of the existing and future without Federal action risk estimates and the with Federal action risk-reduction estimates. This narrative should address the engineering assessment, related to each type of dam safety issue (failure mode); to characterize and quantify the existing conditions both deterministically and probabilistically. The narrative should address the uncertainty in all of the analyses performed. Present the loading and system response curves.

W-2.6.3.3 Dam Break Analysis and Inundation Maps. Provide a narrative description of the dam break analysis used to estimate the flood characteristics and inundation area associated with a breach for each type of significant failure mode. This analysis is required to be done for a representative range of pool elevations. (Typically this done using selected reservoir elevations that represent break points that allow reasonable determination of consequences without extensive analysis.) The Modeling Mapping Consequence Production Center (MMC) has overall responsibility for developing dam failure, inundation mapping, and consequence models for USACE dams in support of the DSMS.

W-2.6.3.4 Existing and Future Without Federal Action Consequence Analysis. Provide a narrative description and tabular summary of the consequence analysis for the baseline condition developed to estimate the consequences associated with dam breach for the full range of loading and exposure conditions. The non-breach consequences will also be presented.

W-2.6.3.4.1 Life Loss Consequences. This must include the estimate of the population at risk; threatened population, and the potential loss of life.

W-2.6.3.4.2 Economic Consequences. This must include the estimated direct economic damages to property and infrastructure, cost of emergency response, loss in regional and national income and employment, and the discounted present value of project future economic benefits.

W-2.6.3.4.3 Environmental and Other Consequences. This must include the estimated environmental damages (i.e., acres of habitat destroyed, threatened or endangered species impacted.) and Hazardous, Toxic, and Radioactive Waste contamination from contaminates either within the reservoir or in the downstream inundation area. Other consequences that cannot be quantified must be qualitatively described.

W-2.6.4 Formulating alternative risk management plans (Chapter 9, Section 9.5.4.). A risk management alternative plan consists of a system of structural and/or nonstructural measures, strategies, or programs formulated to meet, fully or partially, the identified DSM study risk management objectives subject to the constraints. Provide a narrative description of the investigations and analysis included in the report supporting alternative formulation.

W-2.6.4.1 Minimum required alternatives are:

W-2.6.4.1.1 No Action (future without Federal action condition risk);

W-2.6.4.1.2 Meeting full tolerable risk guidelines using ALARP considerations to include applicable essential USACE guidelines;

W-2.6.4.1.3 Achieving only tolerable risk limit for life-safety;

W-2.6.4.1.4 Remove structure; and

W-2.6.4.1.5 Replace structure.

W-2.6.5 Evaluate Alternative Risk Management Plans. (Chapter 9, Section 9.5.5). The evaluation of effects is a comparison of the with-risk-reduction condition to the No Action Alternative (future without Federal action condition) for each risk management alternative.

W-2.6.5.1 Present engineering analysis related to each dam safety issue (failure mode) addressed by each risk management alternative. Characterize and quantify the best estimate of the risk reduction for each alternative and the uncertainty around the best estimate of the risk reduction for each alternative. Develop and present system loading and system response curves for each alternative that relate the probability of failure to the full range of loading.

W-2.6.5.1.1 Life Loss Consequences. Provide a narrative and tabulation of estimated Life Loss reduction for each of the alternatives. Characterize and quantify the best estimate of the life loss consequences, and the associated uncertainty, for each alternative.

W-2.6.5.1.2 Economic Consequences. Provide a narrative and tabulation of economics consequences for each risk management alternatives. Characterize and quantify the best estimate of the economic consequences, and the associated uncertainty, for each alternative.

W-2.6.5.1.3 Environmental Consequences. For each alternative provide a narrative and tabulation of estimated loss or impact on species and habitat for each of the alternatives. Characterize and quantify the best estimate of the environmental consequences, and the associated uncertainty, for each alternative.

W-2.6.5.2 Alternative Cost Estimates. Provide a preliminary cost/economic analysis for each alternative included in the report.

W-2.6.6 Comparing Alternative Risk Management Plans (Chapter 9, Section 9.5.6). In this step, plans (are compared against each other, with emphasis on the outputs and effects (anticipated results of the alternative and the plan effects on life safety, economics, and the environment) that will have the most influence in the decision making process, e.g. annual probability of failure, life-safety tolerable risk guidelines, ALARP considerations, and essential USACE guidelines.

W-2.6.6.1 At a minimum for each alternative show the estimated probability of failure for the future without Federal action condition and with Federal action condition, show the estimated consequences - life loss, economic (present value of project future economic benefits that would be lost with a project failure), and environmental. Present the estimated future without Federal action condition risk and with Federal action condition risk, show the reduction in estimated incremental risk and the reduction in the estimated risk for each failure mode, list the ALARP considerations to indicate the residual risk is tolerable, display the residual and non-breach risk, and the estimated cost for the alternative.

W-2.6.6.2 Under the ALARP considerations present the cost effectiveness of reducing statistical life loss, and the benefit cost ratio for each alternative. Present the evaluation to determine if each alternative meets essential USACE guidelines. See Chapter 5 for details of the various risk guideline parameters to be used in evaluation of alternatives

W-2.6.7 Selecting a Risk Management Plan. (Chapter 9, Section 9.5.7). The primary evaluation factors of annual probability of failure, life-safety tolerable risk guidelines, ALARP considerations, and essential USACE guidelines form the basis for plan selection.

W-2.6.7.1 When available information is insufficient to justify the need for modification, recommendations will be made for additional special engineering investigation(s), which would support a decision. In this case, the most probable plan must be presented, pending the outcome of the proposed investigations.

W-2.6.7.2 Provide a narrative description of how the dam currently (no risk management measures implemented) deviates from current essential USACE guidelines.

W-2.6.7.3 Provide a narrative on the cost to fully meet current standards based criteria. A discussion of the existing and future without action risks, residual risk with the recommended plan, and residual risk for other alternatives that fully meet current standards based criteria (if different from the recommended plan) should be included in the report. Present the results of the economic cost analysis and the total project cost for the recommended plan. An M-CACES cost estimate is required for the recommended risk management plan. Cost estimates must include a cost risk analysis showing the uncertainty per ER 1110-2-1302, (reference A.50).

W-2.7 Cost Sharing Considerations.

W-2.7.1 For risk assessment and decision document approval this dam safety regulation treats the dam safety assurance work (Section 1203 cost sharing) and seepage/stability correction work (regular cost sharing) the same way. Each dam safety issue must be discussed and alternatives reviewed in light of all potential failure modes. For cost sharing purposes this section of the report must tabularize the recommended risk management alternatives and discuss the proper cost sharing for each of the risk management alternatives in light of the section 1203 and regular seepage/stability correction cost sharing guidance – the cost sharing is failure mode dependent.

W-2.7.2 Include a general explanation of the cost sharing requirements followed by a discussion of the circumstances of the particular project. Show the amount to be cost shared for each of the different cost sharing criteria. Explain the determination of cost allocation and cost sharing for the specific project. This will require documentation of pertinent agreements or contracts. The discussion must include a tabulation of the costs to be paid by the Federal Government and the sponsor(s). Identify the sponsor(s) for the project and their contributions to initial project development, and sponsor(s) subsequently added to the project. Include the sponsor(s) views concerning cost sharing. Include copies of the existing contracts or agreements.

W-2.8 Real Estate Plan(s). Present a summary of any real estate requirements. The Real Estate Plan must be prepared at a level of detail commensurate with the scope of the project and included in the DSM report appendices. If no land acquisition or relocation requirements are identified, the appendix must so document that finding.

W-2.9 Environmental Compliance Documentation. Documentation of compliance with applicable environmental laws and regulations must be prepared. This may include items such as biological assessments required by the Endangered Species Act (reference A.10) and the Fish and Wildlife Coordination Act Reports (reference A.2), in addition to NEPA documents. The NEPA document, either an EA or EIS, may either be a self-supporting document combined with and bound within the feasibility report or integrated into the text of the feasibility report. The EA/EIS should generally be integrated into the text of the report unless complex environmental impacts preclude this alternative. Additional information on environmental compliance documentation is in ER 1105-2-100, Appendix C. (reference A-37)

W-2.10 Summary of Independent External Peer Review. When an Independent External Peer Review is completed on the project; a summary of the review report should be included in the report. (The detailed review report should be presented in an appendix.)

W-2.11 Dam Safety Modification Report Appendices.

W-2.11.1 Risk Assessment and Risk Management Alternative Formulation. Provide the detailed risk assessment for the dam and also of any reliability analysis conducted concerning the operating equipment on the structure. Provide the detailed risk assessment to include a summary of the performance of the dam and site characterization documentation as a part of the risk assessment documentation. (The summary of the performance of the dam and site characterization is taken from the reports required per Appendix U. The two reports required by Appendix U are stand alone reports that this summary is to extract information from and reference to support the observations, evaluations, and conclusions stated in the risk assessment.)

W-2.11.2 Life Loss Consequences. Include all approaches, data sources, description of models, and model results for all life loss evaluations conducted to estimate the life loss consequences of dam failure. This should also include the effect of each alternative on these consequences. Provide the results of the life loss analysis for the recommended plan with detailed backup data.

W-2.11.3 Economic Evaluation and Economic Consequences. Include all approaches, data sources, description of models, and model results for all economic evaluations conducted to estimate the economic consequences of dam failure. This should also include the effect of each alternative on these consequences. Provide the results of the economic cost analysis for the recommended plan with detailed backup data.

W-2.11.4 M-CACES Estimate for Recommended Plan. A Micro Computer Aided Cost Engineering System (M-CACES) feasibility level estimate (ER 1110-2-1302 (reference A.50)) in the Civil Works/HTRW Work Breakdown Structure will be prepared for the recommended plan. Cost estimates must include a cost risk analysis showing the uncertainty following “Memorandum: Application of Cost Risk Analysis Methods to Develop Contingencies for Civil Works Total Project Costs, 3 July 2007” (reference A.99). The level of the cost detail will vary with the design information available to support the project scope, but must be at least to the sub-feature level of detail. However, a higher level of detail approaching that of a feasibility report should be the goal in order to more accurately identify the cost estimate. Although this cost estimate is not subject to reauthorization if the Section 902 limit (WRDA 86) (reference A.12) is exceeded, the goal is to make every effort to adhere to the criteria of the 20% growth limitation. Provide a Total Project Cost Summary (TPCS) and separate the costs to the sub-feature level. The TPCS must be prepared following the current cost engineering policy. Include a summary and the full detail M-CACES estimate for the recommended plan.

W-2.11.5 Environmental Documentation.

W-2.11.5.1 NEPA and ESA. Include all NEPA and other environmental investigation and study results. Provide an assessment/description (for each alternative evaluated) of the impacts on the existing environment. Highlight any significant resources that are likely to be affected as well as any that are covered by a specific law (e.g., endangered species, clean air, clean water, cultural and historical, etc.). Compare the environment impacts of constructing the modification to those environmental impacts that would occur if we did nothing and let the dam fail.

W-2.11.5.2 Pertinent Correspondence. For the recommended plan, provide the pertinent correspondence, a summarization of the studies conducted to evaluate the environmental effects of the plan, and the necessary National Environmental Protection Act (NEPA) documentation required in ER 200-2-2 (reference A.34) (e.g., EA, FONSI, EIS, or Supplement) and/or Section 404(1)(b) evaluation.

W-2.11.5.3 Hazardous, Toxic, and Radioactive Waste. Include potential hazardous, toxic and radioactive waste concerns and conduct appropriate surveys. Identify the location of impacts and explain their significance, the likelihood of being able to mitigate such impacts, and associated cost. Indicate the concurrence or non-concurrence given by resource agencies that mitigation is possible and appropriate. Identify any environmental constraints that would render an alternative infeasible.

W-2.11.6 PPA. When the project includes requirements of local cooperation, indicate the views or concurrence of local interests in the general plan of the proposed work, state whether these views were obtained by conference or public meeting, and provide a letter from local interests, which sets forth their views. Give the best available estimate of required local cooperation cost, a statement of the prospects for fulfillment of the required conditions, and the names, titles, and addresses of the principal officers and representatives responsible for fulfillment. Identify any differences in local cooperation requirements under existing agreements that should be changed and the basis therefore. Also indicate what will be done to obtain the desirable local cooperation. Include a copy of the draft PPA if required.

W-2.11.7 PMP for Design Phase. Include the detailed Project Management Plan for the investigations in support of design, additional studies, design, and construction. Include a schedule of any additional engineering investigations and studies needed in the design phase and all DDR's that will be prepared.

W-2.11.8 Schedule of Fully Funded Project Costs by FY. Federal and non-Federal – Include a schedule for fully funding the project to achieve the intended risk reduction as quickly and efficiently as possible. This is to include additional investigations and analysis, engineering and design (Pre-construction engineering and design), and construction cost. Provide a schedule of funding requirements by fiscal year to accomplish recommended modifications to the project based on current budgetary guidance. Indicate which requirements are recommended for funding under Construction, and which are recommended for funding under Operation and Maintenance, as part of continuing project operations; for example - routine instrument readings. If both authorized and unauthorized work are recommended and both items can stand on their own from an engineering and economic standpoint, a two-stage design and construction procedure may be required. The first stage would consist of work that is authorized. The second stage could involve those items of work that require additional congressional authorization.

W-2.11.9 Authorizing Legislation. Present applicable legislation dealing with the initial construction and subsequent addition of project purposes. Specifically include documentation on cost sharing of added authorized purposes. Include a copy of the original and current authorizing legislation for the project.

W-2.11.10 Existing Contracts with Sponsors, etc. Copies of existing contracts, agreements or letters of intent from project sponsor(s), cost sharing partners, and users. Provide a copy of any existing cost sharing and water supply contracts.

W-2.11.11 Engineering Analyses and Determination of Compliance with Essential USACE Guidelines. Provide annexes with the engineering analysis of the geotechnical, structural, hydrologic and hydraulic investigations for site characterization, load determination, determination of probability of failure, etc. to determine the dam's ability to meet current design and performance criteria and develop component fragility and system response curves.

W-2.11.11.1 Hydraulic or Hydrologic. Evaluate the ability to pass the spillway design flood in accordance with current policy. Document the date of the most recent hydrologic re-evaluation and whether the evaluation complies with current methodology. A reservoir diagram showing Minimum Flood Space, Variable Flood Space and other vital pool elevations, must also be included.

W-2.11.11.2 Seismic. Evaluate the ability to withstand seismic loads in accordance with current policy. Document the date of the most recent seismic re-evaluation and whether the evaluation complies with current methodologies.

W-2.11.11.3 Static stability. Evaluate the ability to withstand static pool loads in accordance with current policy. (e.g., seepage and piping, static stability)

W-2.11.11.4 Erosion and Landslides. Evaluate the ability to withstand loads generated during operation of the dam in accordance with current policy. (e.g., spillway erosion, landslides)

W-2.11.11.5 Spillway, Flood Tunnel, and Outlet Works Gate Operations. Evaluate the ability to operate within the full range of design loads in accordance with current policy. Document the date of the most recent Hydraulic Steel Structures inspections.

W-2.11.11.6 Evaluate other conditions not meeting current design or construction criteria or seriously affecting project performance.

W-2.11.11.7 Recommended Plan Drawings. Provide summary drawings for the recommended plan for use in review and presentation of the recommended plan.

W-2.11.12 Real Estate Plan (including relocations). A Real Estate Plan must be prepared at a level of detail commensurate with the scope of the project and the real estate requirements, if any, included in the modification report. If no land acquisition or relocation requirements are identified, the appendix must so state. Provide the background details concerning the Real Estate requirements for the recommended plan.

W-2.11.13 Independent External Peer Review. Section 2034 of WRDA 2007 (P.L. 110-114) requires an independent external peer review (IEPR) for all new projects and for all project modifications where an environmental impact statement (EIS) is required. The documentation of IEPR as required by current review policy (reference A.96) will be contained in this appendix.

W-2.11.14 Agency Technical Review Documentation. When an agency technical review is completed on a study, the documentation of the review should be included in the report.

APPENDIX X

Post Implementation Evaluation

X.1 Purpose of Post Implementation Evaluation (PIE). PIE is required to verify that the implemented risk reduction measures were successful in reducing risk to the level consistent with the objectives of the approved DSMR. The PIE process is shown in Figure X.1.

X.2 Objectives of PIE**.** The overall objectives of a PIE are to evaluate the implementation of the risk reduction measures in the context of the significant potential failure modes indentified in the DSMR, confirm that the failure modes have been properly addressed, evaluate the dam's compliance with applicable essential USACE guidelines, and estimate the post implementation incremental risk. The PIE will also determine if any new significant potential failure modes exist and incorporate them into the risk estimate. The post implementation risk can then be used to reclassify the dam, remove or modify Interim Risk Reduction Measures (IRRM's), and assist in prioritization of the dam safety risk management portfolio.

X.3 Scope of Post Implementation Evaluation. The scope and level of rigor required for a PIE will be based upon the complexity of the dam safety issues and potential failure modes. This evaluation will include a review of the Dam Safety Modification Study, the associated potential failure modes, risk estimates, and the recommended risk management plan. It will require a detailed review of the records generated and an assessment of any additional data collected during implementation. A new PFMA will be performed to determine if any new significant potential failure modes exist. A post implementation risk assessment will be performed to estimate the incremental risk. Recommendations will be made for appropriate actions to include revising the DSAC and modification of IRRM's.

X.4 Roles and Responsibilities.

X.4.1 Risk Management Center (RMC). The RMC will provide support by assigning a facilitator and risk cadre that will assist the dam safety production center (DSPC) and the district in performing the PFMA and risk estimate. The RMC is responsible for coordinating and managing agency technical review (ATR) of the PIE reports in accordance with the current review policy (reference A.96). The RMC will coordinate the review of the scope of work for the PIE with the vertical team and will be the approving office of the scope of work.

X.4.2. Risk Cadre. A risk cadre and an approved PFMA facilitator, with support from the dam safety production center (DSPC) and the district, will be responsible for conducting and documenting the results of the PFMA and quantitative risk assessment results and findings. The risk cadre will also perform a quality control review of the final PIE report prior to the agency technical review.

X.4.3 Dam Safety Production Center. The DSPC is responsible for the technical lead and execution of the PIE. This includes providing the Lead Engineer and key technical members for the PDT. The DSPC is ultimately responsible for preparation of the PIE report and should receive input from the cadre on the risk assessment documentation, conclusions, and recommended actions.

X.4.4 District. The District Project Manager is responsible for the overall management of the PDT as directed in ER 5-1-11 (reference A.29). The district will be in a support role to the DSPC for execution of the PIE. The district will provide PDT members from the construction field engineering and geologist staff, the resident engineer (or representative), and district dam safety engineers/geologist.

X.4.5 Project Delivery Team. The PDT will collect, compile, and present project data in support of the PFMA and risk assessment; support the risk assessment cadre during the PFMA, the risk estimate. The makeup of the PDT is critical to the expeditious accomplishment of the PIE. The PDT should include the as a minimum the Lead Engineer, members of the construction field engineering and geologist staff, the resident engineer (or representative), and DSPC and district dam safety engineers/geologist.

X.5 Funding. The PIE will be funded by Construction General (CG) funds. The cost for the PIE must be included in the project cost estimate submitted with the DSMR. Upon approval of a Dam Safety Modification Report the District must include the PIE in the Project Management Plan and budget for the PIE as part of the construction close out activities.

X.6 Post Implementation Evaluation.

X.6.1 Construction Documentation. Once implementations of the risk reduction measures are complete, the DSPC and the district must provide a summary of all relevant data and construction records to the vertical team. This must include as-built drawings, updated detailed drawings that synthesize all pertinent data including boring logs, instrumentation, geologic features, laboratory data, etc. The use of GIS to compile, sort, and present data is highly recommended.

X.6.2 Initial Assessment. The vertical team, composed of the DSO's from the District, MSC, and HQ, representatives from the RMC and the Dam Safety Modification MCX, and district dam safety engineers, must evaluate the construction documentation, compiled by the DSPC and the district, and determine if a post implementation risk assessment can proceed or if the project will need an evaluation period to determine the adequacy of the remedial measure(s). This initial assessment may include an agreement to lift operational restrictions to allow data to be collected with the project under normal loads.

X.6.3 Post Implementation Risk Estimates. After sufficient time to evaluate the remedial measure(s) has passed, a PFMA and risk assessment is conducted to estimate the incremental flood risk. Current USACE Dam Safety Risk Assessment processes along with team elicitation can be used to calculate load-frequency, load-response probabilities, and consequences for all potential failure modes included in the risk estimate. The RMC will provide guidance on selection of the most appropriate risk estimating process and methodologies to be employed (see Chapter 18 for methodologies).

X.6.3.1 Scope of Risk Estimates. The scope of the risk estimate must be an update of the risk assessment for the Dam Safety Modification Study to include a review and update of the applicable essential USCE guidelines and the evaluation of the compliance with these guidelines.

X.6.3.2 Data for Risk Estimates. In addition to the data compiled for the Dam Safety Modification Study, the risk estimates must consider all data and construction records developed during the implementation of the risk management measures.

X.6.3.3 Potential Failure Mode Analysis. Evaluate the potential failure modes, using the new information and data, based on the collective knowledge and expertise of the facilitator, risk assessment cadres, regional technical specialists, DSPC and district dam safety engineers, and the project staff. The Potential Failure Mode Analysis from the DSMR should be reviewed and used as a guide. It is possible that the PFMA from the DSMR is still appropriate and the team will just need to validate the previous report. In some cases a new PFMA may be required when construction data or dam performance during construction indicates an issue that was not covered in the previous PFMA.

X.6.3.4 Probability of Failure Estimate. The team must develop estimates for load-response probabilities for the post implementation condition for a full range of pools using the best available methodology and risk tools. This may just be a validation of the previous estimates or an update due to changes in methodology. New estimates will be required for any new significant potential failure modes.

X.6.3.5 Load Frequency and Consequences. The load-frequency curves and the consequence estimates from the DSMR must be reviewed and updated if determined to not be representative of current conditions or practice. If additional modeling is required it must be developed with assistance from the MMC.

X.6.3.6 Risk Estimate. Prepare a quantitative risk assessment using the significant potential failure modes identified and evaluate the results with the objectives of the approved DSMR.

X.7 <u>Uses of Post Implementation Evaluation Results</u>.

X.7.1 The results of the PIE, when compared to the objectives of the approved DSMR, will assist the vertical team in determining what additional actions are justified and the urgency of such actions. These actions may include:

X.7.1.1 Confirmation that dam safety issues have been appropriately addressed;

X.7.1.2 Discontinue Interim Risk Reduction Measures (including operational restrictions);

X.7.1.3 Revision of the current DSAC;

X.7.1.4 Inform prioritization of the Dam Safety portfolio.

X.7.2 The PIE should include recommendations, along with justification, for the proposed actions.

X.8 <u>Post Implementation Evaluation Documentation</u>.

X.8.1 Objective. The document for this phase of the dam safety portfolio risk management process must be called Post Implementation Evaluation report. The PIE report will be used to assess the effectiveness of the risk reduction measures that have been implemented and presents the justification for actions to modify or remove IRRM's, revise the current DSAC, and prioritize the project in the dam safety risk management queue.

X.8.2 PIE Report.

X.8.2.1 Chapter 1 - Introduction. Location and descriptions of pertinent project features.

X.8.2.2 Chapter 2 - Previous Assessment. Overview from the results of DSMR. Discuss the significant failure modes and the results of the risk assessment that led to the decisions to implement risk reduction measures. Discuss the current DSAC and primary basis for the assigned DSAC. Summarize the approved risk reduction plan.

X.8.2.3 Chapter 3 - Existing Interim Risk Reduction Measures. Summary of the structural and non-structural IRRM's that have been implemented including reservoir restrictions, and the benefits and challenges of utilizing these IRRM's as an effective risk reduction strategy.

X.8.2.4 Chapter 4 - Implemented Risk Reduction Measures. Describe all implemented risk reduction measures. Highlight any significant findings from associated investigations or inspection. Summarize any performance issues that have occurred during the implementation period. Describe any changes from the approved risk reduction plan from the DSMR.

X.8.2.5 Chapter 5 - Loading. Summarize the hydraulic and seismic (if used) loading adopted for use in the PIE. Document the dates of the most recent re-evaluation of these loads and indicate if the loading was updated from what was used in the DSMR.

X.8.2.6 Chapter 6 - Consequences. A detailed summary of the estimated life, economic, and environmental consequences (e.g. impact on project purposes, loss of life, environmental and economic impact to region, etc.). Indicate if the consequences were updated from what was used in the DSMR.

X.8.2.7 Chapter 7 - Potential Failure Modes Analysis (PFMA) and Risk Assessment.

X.8.2.7.1 PFMA. A summary of the facilitated PFMA results. Include a validation of the significant failure modes from the DSMR or any required modifications. Identify any new significant potential failure modes identified based on information obtained since the DSMR.

X.8.2.7.2 Team Elicitation. An overview of the team elicitation, with detailed descriptions of each significant potential failure mode, including loading conditions, event tree nodes, and the supporting documentation used for the assignment of conditional probabilities of failure.

X.8.2.7.3 Methodology. A description of the methodology and risk estimating tools used to estimate the risk. This must include a detailed description of the data input for calculation of Annual Probability of Failure (APF) and the Average Annual Life Loss (AALL), discussion of event trees, system response probabilities, exposure scenarios and rates, etc that were used in the risk calculations.

X.8.2.7.4 Summary

X.8.2.7.4.1 Risk Estimates. Discussion of the risk estimates (with and without intervention) and the four thresholds evaluated under the USACE Tolerable Risk Guidelines, including Annual Probability of Failure (APF), life safety risk, economic risk, environmental and other non-monetary risks, and a risk summary of the overall project risk. Plot the risk estimate results on the tolerable risk guideline charts, and include a tabular summary of each potential failure mode showing the respective average annual life loss, average incremental life loss, range of incremental life loss, and relative contribution (percent) of each failure mode to the total incremental risk (See Chapter 5). Present a plot for the non-breach life safety flood risk. Include a discussion of model and data uncertainty, and assumptions, including explicit presentation of how uncertainty influences the risk estimate using sensitivity analysis or other appropriate uncertainty analyses.

X.8.2.7.4.2 Essential USACE Guidelines. Discuss the review of the applicable essential USCE guidelines and the evaluation of compliance with these guidelines.

X.8.2.8 Chapter 8 Conclusions and Recommendations. This section should include the findings and conclusions of the evaluation and risk estimate and, recommendations on appropriate actions. Recommended changes to the IRRM's and DSAC are required.

X.8.2.9 Supporting Documentation. Supporting documentation must be included in the following Appendices:

X.8.2.9.1 Appendix A – References.

X.8.2.9.2 Appendix B – Project Support Information (Plans, sections, details, photos, etc)

X.8.2.9 3 Appendix C – Applicable Essential USACE Guidelines and Compliance Review

X.8.2.9.4 Appendix D -Summary of important construction records, data, and dam performance during construction. This appendix should be an evaluation of compiled data and records in a concise form. It is not a listing of all the data.

X.8.2.9.5 Appendix E – Agency Technical Review

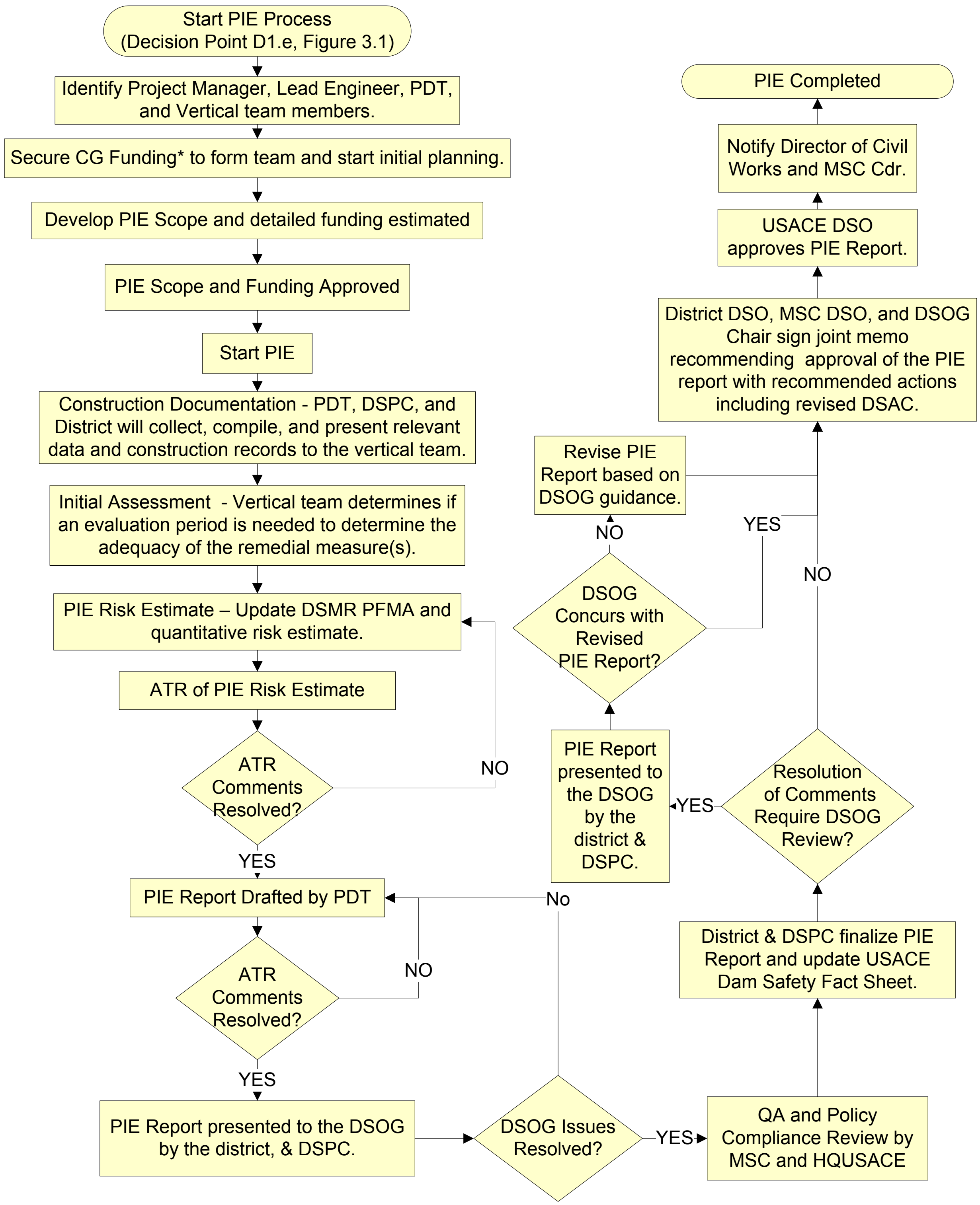
X.8.2.9.6 Appendix F – Other Supporting Documentation

X.9 Schedule. The schedule for completion of a PIE is dependent on type of risk reduction measures that were implemented and loading conditions on the dam. Construction documentation must be compiled and summarized continuously throughout construction. The initial assessment by the vertical team should occur when the primary elements of the risk reduction measures have been completed. The PIE should be completed within 6 months of the end of the evaluation period as determined by the vertical team.

X.10 Review, Approval, and Submittal of PIE.

X.10.1 Review Process. Review of PIE involves both sequential and concurrent actions by a number of participants. This process includes: the PDT; the DSPC, the district, MSC and RMC; ATR team; and HQUSACE. It is therefore imperative that the vertical teaming efforts are proactive and well coordinated to assure collaboration of the report findings, conclusions, and recommendations, and that there is consensus at all levels of the organization with the recommended path forward. The dam safety program will follow the policy review process described in the current review policy (reference A.96). The RMC will be the review management office for the ATR, and the RMC must certify that the risk assessment was completed in accordance with the USACE current guidelines and best risk management practices. After resolution of ATR comments, the district will present the report findings and recommendations to the DSOG.

X.10.2 Approval Process. Once DSOG comments are resolved the district DSO, MSC DSO, and DSOG Chair will sign the joint memorandum recommending approval to the USACE DSO. This memorandum will state that all agency requirements, certifications, reviews, and documentation have been satisfactorily completed. The report will then be sent to the USACE DSO for final approval. The USACE DSO will then notify the Director of Civil Works and the MSC commander that the PIE report and associated recommended actions have been approved. An electronic copy of the report (review copy) must be uploaded to the RMC's centralized data repository (RADS II) at the time of hard copy submittal. A copy of the final report reflecting all updates and revisions required from the review process must be uploaded after report approval. The USACE Dam Safety Fact Sheet must be updated.



*CG Funding for the PIE is to be estimated & scheduled in the DSMR.

Figure X.1 – Post Implementation Evaluation Flow Chart

APPENDIX Y

Instructions for the "Dam Safety Action Decision Summary for a Dam Safety Modification Study"

Y.1 Overview. The Dam Safety Action Decision Summary (DSADS) for a Dam Safety Modification Study is intended to be an extractable, stand-alone component of the DSM report that provides information to senior USACE officials to make dam safety decisions. The DSADS it is not designed as a public communications tool. DSADS concisely summarizes the history and status of safety issues and actions for the subject dam; the risk management alternatives considered; and the recommended actions and supporting facts; the outcomes from analysis and assessment. The document will be ten to fifteen pages, well formed and will be comprise of text, tables, diagrams, and photos.

Y.2 Document Content. The DSADS consists of:

Y.2.1 Title page – Dam Safety Action Decision Summary. The title page must include Dam Safety Modification Study, name of the dam, photograph of the dam, location, name of the USACE district and division, and date of the decision summary.

Y.2.2 Executive Summary. Provide a 1-page summary of the project and why a dam safety modification is required (1-page).

Y.2.3 Project Description. Provide a description of the projects location, physical features, purposes, downstream population centers, and deficiencies that drive the current DSAC, Include a sketch plan and/or typical section of the dam showing primary areas of concern. (1-page)

Y.2.4 Project History. Provide a table showing a project history timeline that describes pertinent performance issues for the deficiencies that must be addressed, and the IRRMs that have been implemented to reduce risk. (1-page)

Y.2.5 Purposes Warrant Continued Federal Investment. Investigation and findings for the determination that the existing authorized project purposes warrant continued Federal investment and an assessment of whether changes in the authorized project purposes warrant investigation. (1/2 page)

Y.2.6 Significant Failure Modes. Provide a brief description and a simplified sketch of each significant failure mode that drives risk and must be addressed by the proposed modification. Combine PFM's when possible, (1-page each PFM).

Y.2.7 Risk Reduction Alternatives. Provide a brief overview of each alternative that was considered and why the alternative was or was not recommended (1-page). Also include a Summary Table that addresses the cost, loss of project benefits, cost analysis and B-C ratio, and other factors, for each risk reduction alternative considered including the No Federal Action (Future Without Federal Action), Dam Replacement, Dam Breach, Permanent IRRM, Life Safety Only, and all alternatives considered. (1-Page Table)

Y.2.8. Risk Estimate: Risk estimate (f-N chart) of the existing and future without Federal action conditions and estimated residual risk of each alternative considered, and of the recommended alternative (1-page).

Y.2.9 Recommended Plan. Provide a description of the recommended plan and explain the basis for the recommendation. Describe any external concerns, issues, or constraints that could be encountered by sponsors and stakeholders. Identify any additional IRRMs that must be implemented until the permanent modifications are completed (1-page). Include a plan view sketch of the dam and a typical cross section which summarizes the proposed modification (1-page). Include an estimate of project costs, including a breakout of PED, Construction, Real Estate, and cost sharing requirements. Include a basic bar chart schedule which shows all major PED and Construction Activities (1-page).

Y.3 DSADS Security Guidance. Basic security guidance is provided Paragraph 10.5.6 Specific Release Guidance for release of information related to USACE dams.

APPENDIX Z

Dam Safety Modification Report Issue Checklist

Z.1 Sensitive Policy Areas. Areas which require vertical team coordination with MSC/HQUSACE to Washington: ____

____

____

____

Z.2 General Project Information.

Z.2.1 Project Name. (State, County, River Basin/Waterbody under Study)

Z.2.2 Project Description. (Need project description with general details, such as a fact sheet attached--if project is the same as authorization attach a summary, if different provide a description of what differs from original authorization, the authorizing language, and dimensions to give perspective of the change in scope and scale. If there was an authorizing report, what level approved it—i.e., OMB, ASA(CW), HQUSACE (include date of approval). If no prior reports, give a more detailed description.)

Z.2.3 Cost Sharing. (Describe the cost sharing for the project to be constructed. Describe whether the cost sharing follows general law or if there is other special cost sharing for the project)

Z.3 General Questions.

Z.3.1 Has a NEPA document been completed?

Response: YES ______ NO _____*

Remarks:

Z.3.2 Will the NEPA Documentation be more than 5 years old at the time of PCA signing or construction initiation?

Response: YES _____* NO ______

Remarks:

Z.3.3 Will the ESA Findings be more than 3 years old at the time of PCA signing or construction initiation? [Note: Findings refers to USACE documentation and/or US Fish and Wildlife Service's opinions and recommendations]

Response: YES _____* NO ______

Remarks:

* A response where there is a "*", requires coordination through vertical team and complete description of issues under "Remarks", before decision to approve project/report can be delegated.

Z.3.4 Is ESA coordination complete?

Response: YES ______ NO _____*

Remarks:

Z.3.5 If an EIS/EA was completed for the project, has the Record of Decision/Finding of No Significant Impact been signed?

Response: YES ______ NO _____*

Remarks:

Z.3.6 Is the proposed project consistent with the ROD/FONSI?

Response: YES ______ NO _____*

Remarks:

Z.3.7 Has there been any changes in Federal environmental laws or Administration or USACE policy since original project authorization that make updating necessary? [e.g., change to the Clean Air Act (reference A.3) status for the project area…going from attainment to non-attainment]

Response: YES _____* NO ______

Remarks:

Z.3.8 Is there a mitigation plan?

Response: a. Fish and Wildlife: YES _____* NO ______
b. Flood Damage: YES _____* NO ______
c. Cultural and Historic Preservation: YES _____* NO ______
d. Recreation: YES _____* NO ______

Remarks: [If yes, identify and describe what is being mitigated and cost shared. Describe the authority for the cost sharing.]

Z.3.9 Are the mitigation plan(s) that are now being proposed the same as the authorized plan?

Response: a. Fish and Wildlife: YES ______ NO _____*
b. Flood Damage: YES ______ NO _____*
c. Cultural and Historic Preservation: YES ______ NO _____*
d. Recreation: YES ______ NO _____*

Remarks:

Z.3.10 Is there an incremental analysis/cost effectiveness analysis of the fish and wildlife mitigation features based on an approved method and using an accepted model?

Response: YES ______ NO _____*

Remarks:

Z.3.11 Does the project involve HTRW clean-up?

Response: YES _____* NO ______

Remarks:

Z.3.12 Does the work involve CERCLA covered materials?

Response: YES _____* NO ______

Remarks:

Z.3.13 Are the project purposes now being proposed different than the authorized project? [Note: different than specifically noted in authorization or noted in Chief's report and is it measured by project outputs]

Response: YES _____* NO ______

Remarks:

Z.3.14 Are there any proposed scope changes to the authorized project? [reference: ER 1105-2-100 (reference A.39)]

Response: YES _____* NO ______

Remarks: [Describe the authority that would enable the project to proceed without additional Congressional modification]

Z.3.15 Is Non-Federal work-in-kind included in the project? [Note: Credit to a non-Federal sponsor for work-in-kind must be based upon having an existing authority. Need to identify the authority and if not a general authority such as Sec 215, provide a copy of the authority.]

Response: YES _____* NO ______

Remarks:

Z.3.16 Does project have work-in-kind authority? [Note: If there is no existing authority, as determined in conjunction with District Counsel, the only other vehicle is to propose work-in-kind and rationale in the decision document and submit to HQUSACE for specific Congressional authorization.]

Response: YES ______ NO _____*

Remarks:

Z.3.17 Are there multiple credit authorities (e.g., Sec. 104 & 215) including LERRDS, Work-In-Kind and Ability to Pay? [Note: See App. B of ER 1165-2-131 (reference A.63)]. Describe the authority for work-in-kind and if authority exists, the PM should submit a completed App. B through the vertical team.]

Response: YES _____* NO ______

Remarks:

Z.3.18 Is Ability to Pay cost sharing reduction included in the proposed project? [If yes, fully describe the proposal, citing how this authority is applicable. Include a table showing the cost sharing by project purpose and expected Ability to Pay reductions.]

Response: YES _____* NO ______

Remarks:

Z.3.19 Is the recommended plan different from the NED plan? [Note: if this answer is yes, then a series of questions arise that will need to be addressed in the Remarks section…is plan less costly than NED plan, is the plan more costly with the same cost sharing the same as NED plan (exception), is plan more costly with all costs exceeding the cost of the NED plan at 100% non-Federal cost, or has ASA(CW) already grant exception]

Response: YES _____* NO ______

Remarks:

Z.3.20 Was a standard accepted USACE methodology/model used to calculate NED benefits?

Response: YES ______ NO _____*

Remarks:

Z.3.21 Are there non-standard benefit categories? [reference ER 1105-2-100 (reference A.39)].

Response: YES ______ NO _____*

Remarks:

Z.3.22 Is there a flood damage reduction component in the project?

Response: YES ______ NO ______
(If Yes, answer following question)

Z.3.23 Are reallocation studies likely to change the existing allocated storage in lake projects?

Response: YES _____* NO ______

Remarks:

Z.4 CONCURRENCE

______________________ Date: _______
Project Manager

______________________ Date: ________
District Counsel

______________________ Date: ________
District Dam Safety Officer

_____________________ Date: ________
MSC Dam Safety Officer

______________________ Date: _________
MSC Counsel

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APPENDIX AA

Post-Authorization Decision Document Checklist

AA.1 Basic Information.

AA.1.1 Name of Authorized Project: ______________________________________

____

AA.1.2 Name of Separable Element: ______________________________________

____

AA.1.3 PWI Number: ____

AA.1.4 Authorizing Document: ____

AA.1.5 Law/Section/Date of Project Authorization: __________________________

____

(Note: attach copy to checklist)

AA.1.6 Laws/Sections/Dates of Any Post-Authorization Modification: __________

____

AA.1.7 Non-Federal Sponsor(s): ____

AA.1.8 Project/Separable Element Purpose(s): ______________________________

AA.1.9 Congressional Interests (Senator(s), Representative(s) and District(s)):

____

AA.2 Project Documents.

AA.2.1 Type of Decision Document: ______________________________________

AA.2.2 Approval Authority of Decision Document: __________________________

AA.2.3 Project Management Plan Approval Date: ___________________________

AA.2.4 Agency Technical Review (ATR) Approval Date: _____________________

AA.2.5 Independent External Peer Review (IEPR) Completion Date:___________

AA.2.6 Mitigation Authorized: ___ Yes ___ No Cost of Mitigation _____________

Describe Type of Mitigation and Whether Included in Project Report: ___________

____
(Note: Project report is the one that supports the authorization for the mitigation. Need to make sure that mitigation is authorized as part of the project cost)

AA.2.7 Current M-CACES Estimate: $ _________________________________

Date Prepared and Price Level: ___________________________________

AA.2.8 Date of Latest Economic Analysis: ___________

AA.3 Cost Sharing Summary.

Purposes	Non-Fed Cash	Non-Fed LERRD	Non-Fed Const. Credit	Non-Fed Total Share	Federal Share (%)	Total Project Cost
Totals						

AA.3.1 Projected Credit for Section 215 Work and Date Section 215 Agreement

Signed: ____

AA.3.2 Projected Credit for Section 104 or Other Authorized Creditable Work and Date Work Approved by ASA(CW) or Agreement Addressing Work Signed: ___________

____

AA.3.3 Annual Non-Fed OMRR&R Costs (1 Oct FY_____ Price Levels): _________

____

AA.4 Funding History. Appropriations History for Project/Separable Element (include Wedge Funding)

Fiscal Year	Budget Amount	Appropriated Amount
________	__________________	__________________
________	__________________	__________________
________	__________________	__________________
________	__________________	__________________

AA.5 Certification for Delegated Decision Documents. You must answer “Yes” to all of the following questions to approve the decision document under delegated authority.

AA.5.1 Project Plan.

AA.5.1.1 Has the project study issue checklist been completed and all issues resolved?

___Yes ___No

AA.5.1.2 Does the non-Federal sponsor concur in the project plan as submitted?

___Yes ___No

AA.5.1.3 Has project plan as submitted been reviewed and concurred with by the non-Federal sponsor’s counsel?

___ Yes ___ No

AA.5.2 Authority –

AA.5.2.1 Has the Dam Safety Officer at each level approved the project report?

___Yes ___No

AA.5.2.2 Is authority adequate to complete the project as proposed?

___ Yes ___ No

AA.5.3 Policy/Legal/Technical Compliance

AA.5.3.1 Has the District Counsel reviewed and approved the decision document for legal sufficiency?

_____Yes (Certification included in decision document package submittal) _____ No

AA.5.3.2 Have all aspects of ATR and IEPR have been completed with no unresolved issues remaining?

_____Yes _____No

AA.5.3.3 Has the District Dam Safety Officer documented policy/legal/technical compliance of the decision document?

_____Yes _____No

AA.5.3.4 Has the MSC Dam Safety Officer certified the policy/legal/technical compliance of the decision document?

_____Yes _____No

AA.6 Authentication.

____Date: ____________
Project Manager

____Date: ____________
District Counsel

____Date: ____________
District Dam Safety Officer

____Date: ____________
District Support Team Leader

____Date: ____________
MSC Counsel

____Date: ____________
MSC Dam Safety Officer

APPENDIX AB

Dam Safety Communication – Frequently Asked Questions

AB.1 Sample Questions and Answers. This appendix presents a number of questions that are frequently asked by the public and the stakeholders with recommended answers.

AB.1.1 Question. Am I safe?

Answer. While we cannot completely eliminate the flood risk associated with a dam, we can reduce that risk. Our dam safety action classification of this project does not mean the dam is in imminent danger of failing. It means we have identified dam safety issues that don't meet dam safety industry standards and the risk to public safety is unacceptable. The objective of our Dam Safety Program is to maintain public safety and to make sure our dams are safe and risks are minimized. Interim Risk Reduction Measures are in place to maintain public safety, until we complete engineering evaluations and develop a plan of action for permanent risk reduction measures. Routine inspections and operation of the lake and dam will continue and emergency action plans have been developed in coordination with local emergency management officials. Currently, there is no evidence to suggest an emergency situation exists, or is about to occur. USACE is responsible to take prudent risk management actions for suspected high risk, until we have adequate information to confirm risks are acceptable.

AB.1.2 Question. What is risk?

Answer. Risk is the measure of the probability and severity of undesirable consequences or outcome. A more detailed definition is risk is a measure of the likelihood, chance, or degree of belief that a particular outcome or consequence will occur along with the outcome of the failure including immediate, short and long-term direct and indirect losses and effects. Losses may include human casualties, water supply, recreation, and hydropower benefits. Effects may include downstream damages and/or adverse environmental impacts.

AB.1.3 Question. What does failure mean?

Answer. In the context of dam safety, failure is generally confined to issues of structural integrity, and in some contexts to the special case of uncontrolled release of a reservoir through collapse of the dam or some part of it. In short, failure typically means breach of the dam and uncontrolled release of the water in the reservoir.

AB.1.4 Question. What is this classification system that we keep hearing about? How many more of these will you review?

Answer. There are two classification systems for dams:

1. The Potential Hazard Classification is developed in accordance with FEMA Publication 333, Hazard Potential Classification System for Dams (reference A.119). This system ranks a dam as Low, Significant, or High Hazard Potential based on the damages or consequences that would occur if the dam failed. The hazard potential classification does not address the condition of the dam or its risk of failure.

2. The USACE Dam Safety Action Classification (DSAC) is a classification of dams accomplished by a team of USACE dam safety professionals as a means to group dams that exhibited certain characteristics for potential safety concerns. From 2005-2009, USACE conducted an initial risk-informed screening of the dams in the USACE inventory of dams. The initial screening results, along with other information associated with the dam, were used to inform the assignment of a Dam Safety Action Classification to each dam.

AB.1.5 Question. If there are DSAC 1 dams, are there other classifications? What are they and how are they defined?

Answer. The five Dam Safety Action Classes are:

DSAC 1 - Very High Urgency for action

DSAC 2 - High Urgency for action

DSAC 3 - Moderate Urgency for action

DSAC 4 - Low Urgency for action

DSAC 5 - Normal Urgency for action

AB.1.6 Question. Is this (are these) dam(s) at risk of failing?

Answer. (For DSAC 1 projects) Our classification of _____________Dam identified this project as a very high urgency dam. It is critically near failure or has very high incremental risk*. Critically near failure means progression toward failure is confirmed to be taking place under normal operations. The dam is almost certain to fail under normal operations within a few years without intervention. Very high risk incremental risk means the combination of life or economic consequences with likelihood of failure is very high. USACE considers this level of life-risk to be unacceptable except in extraordinary circumstances. Modification studies for DSAC 1 dams where the primary purpose is flood damage reduction are funded immediately. We are taking the following interim risk reduction measures ** __________.

Answer. (For DSAC 2 projects) Our classification of ____________Dam identified this project as high urgency dam. Failure could begin during normal operations or be initiated by an event such as a major flood or has high incremental risk. The likelihood of failure from a major event, prior to remediation, is too high to assure public safety. High incremental risk means the combination of life or economic consequences with likelihood of failure is high. USACE considers this level of life-risk to be unacceptable except in extraordinary circumstances. We are taking the following interim risk reduction measures _________________

Answer. (For DSAC 3 projects) Our classification of ______________Dam identified this project as a moderate urgency dam with moderate incremental risk. Moderate incremental risk means the combination of life, economic, or environmental consequences with likelihood of failure is moderate. USACE considers this level of life-risk to be unacceptable except in unusual circumstances. We are taking the following interim risk reduction measures __________.

In all cases, interim risk reduction measures are taken to reduce the risk to public safety.

*Incremental Risk is the risk that exists due to the presence of the dam and this is the risk used to inform the decision on the DSAC assignment.
** Interim risk reduction measures are only implemented for DSAC 1, 2 and 3 dams.

AB.1.7 Question. May we have copies of your risk assessment and inspection reports?

Answer. You should contact the respective district headquarters for that information. Requests for inspection reports will be evaluated on a case-by-case basis because of information that may expose a vulnerability that could be an operational security concern. In many cases, the USACE has posted information on District websites that can be accessed by the public.

AB.1.8 Question. What are interim risk reduction measures?

Answer. Interim risk reduction measures are short-term actions to reduce dam safety risks while long-term solutions are pursued. They are an important step in returning the project to a stable and safe condition. In establishing IRRM, the prevention of loss of life is the first and foremost objective, followed by prevention of catastrophic economic or environmental losses.

AB.1.9 Question. Is there funding available to complete the IRRM on these projects?

Answer. Development of IRRM Plans, and the accompanying actions should not be delayed, “contingent upon funding”. IRRM planning and implementation is a high USACE priority. In some cases, funds have been allocated from existing funding sources to initiate and implement IRRM. Some IRRM actions may require supplemental budgeting. We have been successful in obtaining critical IRRM funding via the regular budget process and emergency authorities.

AB.1.10 Question. What is the Corps doing to make sure the dam in my area gets fixed?

Answer. Funding for dam safety studies at DSAC 1 and 2 dams has been prioritized USACE wide, to allow us to advance work on the highest risk dams first. Studies are required to identify permanent risk reduction options. USACE has updated the criteria on how to conduct dam safety evaluations and projects that pose significant public safety risks are our top priority.

Routine Operations and Maintenance funds will be used for DSAC 3 projects, unless new information changes the risk classification.

USACE has also set up a new organization, called the USACE Risk Management Center, and has assigned our best engineering experts to work on dam and levee projects.

AB.1.11 Question. Is there funding available to make permanent construction repairs?

Answer. Funding for select DSAC 1 and 2 projects already in construction receive high budgeting prioritization. The assigned DSAC and the associated life safety risks are being used to set national Dam Safety construction project priorities. Projects classified as DSAC 3 and 4 will not receive funding until the higher risk DSAC 1 and 2 projects are addressed. Districts in coordination with the USACE DSO may elect to make partial repairs for DSAC 3 and 4 projects with O&M funds.

AB.1.12 Question. Why is my dam now at very high urgency, when it has been here for many years?

Answer. In 2005 we began evaluating the risks at USACE owned dams. This was in response to recommendations from a Peer Review of the USACE Dam Safety program conducted in 2001 by the Association of State Dam Safety Officials (ASDSO) (reference A.131). ASDSO recommended that USACE develop risk reduction, risk assessment, and risk management procedures for implementing a nationwide evaluation process that prioritizes the funding and allocation of dam safety resources USACE-wide. Based on that recommendation USACE is implementing a risk informed approach to consistently take appropriate actions to address our dam safety issues.

Following the risk-informed screening from 2005 through 2009 USACE assigned a Dam Safety Action Classification (DSAC) to each dam informed by the individual dam safety risk. This risk is the probability of failure and resulting potential consequences due to failure.

As a result, our understanding of the conditions at our dams has changed. In some cases we have new observations at our dams that are symptoms of potentially serious problems. In other cases we have learned that the original design and construction methods do not meet our safety standards. External independent peer reviews have confirmed that we are doing the right things to help reduce risk and increase public safety. Lessons learned from our high risk dams, such as Wolf Creek, have heightened USACE's commitment to address risks attributed to our aging infrastructure, and take all actions necessary to prevent failure of a USACE dams.

AB.1.13 Question. How long has the USACE known these dams had very high to high risk?

Answer. Those dams validated as being critically near failure is not new information. What is new is how we assess our dams and are incorporating risk concepts into dam safety management, routine activities and programming (budgeting) decisions.

AB.1.14 Question. What will USACE do with the findings?

Answer. USACE will use all the information available, including the information obtained from risk assessments, to set dam safety risk reduction priorities in its annual budget requests and to implement interim risk reduction measures. The overall objective is to reduce the risks to public safety.

AB.1.15 Question. How did USACE initially determine which dams are highest risk?

Answer. USACE developed a risk-informed screening tool to compare the condition of each dam with the risk associated with a new dam. Cadres of USACE professional personnel were trained in the use of the tool and evaluated each dam screened using information provided by the operating district. A group of senior engineers from across USACE reviewed the screening information and recommended a DSAC for each dam. This DSAC recommendation was reviewed by the USACE headquarter staff and approved by the USACE Dam Safety Officer. Subsequently, more robust risk assessments are being conducted to validate or revise the findings of the initial screening for each dam over time.

AB.1.16 Question. What criteria did USACE use in its initial screening process?

Answer. The criteria used in the screening are the current state-of-the art criteria for the design and construction of large dams. Tolerable risk guidelines from other agencies, including the Bureau of Reclamation, have been referenced to ensure consistency with public safety standards.

AB.1.17 Question. What does “critically near failure” mean?

Answer. “Critically near failure” means a condition exists at the dam that if not properly addressed, the likelihood of the dam failing in the near future is high. While we can’t physically “see” this occurrence, we know it is happening through various scientific instruments embedded within the dam and foundation. While there are no cracks visible in the dam, instrumentation may indicate settlement of the dam is occurring on a small scale. Instrumentation which monitors the water pressure in and beneath the embankment also may indicate a rise in pressure over time above what would be expected or considered to be safe. These types of instrumentation readings along with increasing wet spots showing up on the downstream face of a dam are indications that the condition at this dam is worsening over time.

AB.1.18 Question. If the dam were to fail, how do I find out if my home and business will be impacted?

Answer. USACE has developed flood inundation maps as part of the emergency action plan (EAP) for each dam. Copies of these EAPs are provided to local Emergency Response agencies. The local Emergency Response agencies and USACE District office can provide site specific flood information upon request.

AB.1.19 Question. How do I make sure my family is safe?

Answer. Safety is a shared responsibility. USACE has the responsibility to coordinate with local officials and communicate with the public on the condition of USACE operated dams. Private individuals are encouraged to become educated and aware of local conditions. One way this can be done is by contracting your local emergency management organization at the city or county level of government for additional information on emergency preparation. Personal planning is encouraged, such as purchasing weather alert radios, keeping emergency supplies on hand, and determining personal evacuation routes.

AB.1.20 Question. Should these dams be decommissioned?

Answer. Decommissioning of the dam is in the range of available options. However decommissioning a dam involves Congressional approval and to assure the safety of those living downstream of the high risk dam until that might occur, requires immediate action now to reduce the flood risk associated with the dam.

AB.1.21 Question. Are External Peer Reviews Required?

Answer. HQUSACE sponsored External Peer Reviews by nationally known dam safety experts for the first 10 to 20 dams assigned a DSAC 1. This was done to validate the findings of the initial screening process. Additionally, USACE is complying with new requirements set by Congress in 2007 to conduct Independent External Peer Review (IEPR) on dam safety studies and designs.

AB.1.22 Question. IRRM Plans are to include overview information on potential failure modes. What does this mean?

Answer. Potential Failure Mode Analyses (PFMA) is conducted as the first step in a risk assessment. This PFMA identifies credible and significant potential failure modes informed by the design, construction, and performance of the dam and by the consequences that would occur if a given failure mode would be realized.

AB.1.23 Question. Why does it take USACE so long to fix a dam?

Answer. That is a good question. Given the multiple purposes of USACE dams and the long term benefits they provide USACE requires a thorough analysis and evaluation of any modification to assure public safety and benefits are not comprised by modification to the dam.

Dam analysis and designs are complex technical efforts. Risk assessments must be performed to understand the extent of a problem and to evaluate options to fix the dam. In some cases the dam may have multiple deficiencies that require correction which increases the time required to start implementing the risk reduction measures.

We also take great effort to comply with the National Environmental Protection Act (reference A.6) and the Endangered Species Act (reference A.10), which does require significant time to assure that all requirements are met.

Once construction starts most fixes will take two or more years to implement.

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APPENDIX AC

Dam Safety Vegetation Management

AC.1 Purpose. The establishment, maintenance, and control of vegetation pose Engineering, as well as routine maintenance considerations. In accordance with ETL 1110-2-571 (reference A.95), this guidance establishes minimum requirements for maintenance/control of vegetation at USACE-owned dams, abutments, spillways, inlet/outlet channels, and other appurtenances.

AC.2 References.

AC.2.1 ETL 1110-2-571, "Guidelines for Landscape Planting and Vegetation Management at Levees, Floodwalls, Embankment Dams, and Appurtenant Structures" (reference A.95).

AC.2.2 Federal Emergency Management Agency, (2005), "Technical Manual for Dam Owners: Impacts of Plants", FEMA Document 534, Washington, DC (reference A.118).

AC.3 Background. Maintaining the integrity of our dams and appurtenant facilities is a critical USACE responsibility. Vegetation is much more than an aesthetic consideration. Proper vegetation management is necessary to preserve the design functionality of critical project features. Requirements for mowing and eradication are documented in the project specific Operations and Maintenance Manual. Changes in vegetation management practices to promote project benefits such as recreation and environmental enhancement must be carefully evaluated from a dam safety perspective and coordinated with dam safety experts. Vegetation that adversely impacts engineered structures or inhibits inspection, monitoring, and emergency response actions is not allowed.

AC.3.1 Beneficial Vegetation. Beneficial vegetation, such as grass cover, can assist in preventing erosion, controlling dust, defining zones of use, and creating a pleasant environment. Uniform grass cover enhances visual inspection, allowing the detection of seeps, settlement, displacements, and other evidence of distress. Robust grass coverage along embankments and discharge channels can help deter the natural establishment of trees and other deep rooted species.

AC.3.2 Undesirable Vegetation. Woody vegetation and aquatic plants (e.g. cattails) can obscure large portions of the dam, preventing adequate visual inspection, creating potential seepage pathways, reducing discharge capability, and can threaten the stability and integrity of a structure.

AC.3.2.1 Structural instability can occur due to falling/decaying tree/woody vegetation growth. Large, seemingly stable and innocuous trees can easily be blown over or uprooted in a storm/flood and cause a large hole left by the root system. This in turn can shorten the seepage path and initiate piping, or a breach in the dam.

AC.3.2.2 Root systems may undermine concrete slabs, causing erosion of foundation materials and subsidence or heave. Additionally, root systems can interfere with interior drainage systems. Trees and aquatic vegetation in channels can restrict flow volumes, or become a source of debris which blocks releases. Trees in channels can also initiate uneven flow patterns and cause erosion that may divert discharges out of bank. All of these can ultimately threaten public safety.

AC.4 Policy.

AC.4.1 The following areas must remain free of trees and other woody vegetation such as shrubs and vines:

AC.4.1.1 The dam and dam toe area

AC.4.1.2 In or around seepage monitoring systems or critical areas for seepage observation

AC.4.1.3 Abutments and groins

AC.4.1.4 Emergency spillways and regulating outlet channels, including channel floors, side slopes and approaches

AC.4.1.5 Outlet works discharge channels

AC.4.2 All areas of dam projects must be inspected according to Chapter 11 of this regulation and ER 1130-2-530 (reference A.61). Inspections conducted either by project personnel, or engineering personnel must always consider the potential dangers from excessive or inadequate vegetation growth. Changes in surfaces, such as cracks, depressions, and movements must also be readily observable via controlled grass cover. Any evidence of seepage or erosion must be quickly identified, monitored evaluated and controlled to prevent flows that could become detrimental to the safety of the structure. Inspection of vegetation must be part of each annual and formal periodic inspection for each project and must be discussed in the respective reports.

AC.4.3 The governing criteria for maintenance of vegetation on the dams, or areas adjacent to, or immediately downstream of dams is to provide ready and adequate visual observation.

AC.4.4 Design and construction of landscape plantings, including irrigation systems, must be carefully evaluated and reviewed from a Dam Safety perspective, comply with ETL 1110-2-571 (reference A.95), and approved by dam safety experts.

AC.4.5 Trees, brush, and weeds in spillways and inlet and outlet channels must be maintained so as not to obstruct flows, or cause any threat or potential threat to areas downstream of the dam. Specified spillway and outlet works design discharge capacities must be maintained. Tree and vegetation removal from spillway discharge areas downstream of the crest or sill is required to avoid “head cutting” or causing flow concentrations.

AC.5 Implementation.

AC.5.1 Mowing/ clearing limits for each dam must be identified by dam safety personnel within Engineering Division in accordance with ETL 1110-2-571 (reference A.95) and documented on aerial photographs or plan drawings, as part of the project Operations and Maintenance Manual. The limits must be site-specific and must take into consideration the topography, phreatic surfaces within the structure and abutments, foundation characteristics and any historical problems with the structure.

AC.5.2 At spillways, clearing must extend horizontally at least the width of the spillway to each side of the spillway entrance and form semi-circle in front of the entrance. In the vertical direction, woody vegetation must be clear cut within the horizontal clearing limits up to the elevation of the inflow design flood. Dam safety personnel within Engineering Division must establish specific clearing limits for spillways and other intake structures based on project hydrological characteristics and the limits must be permanently and clearly marked in the field.

AC.5.3 Riprap in all areas must be maintained free of vegetation. This includes embankment slopes, discharge channel slopes, and emergency rock stockpiles.

AC.6 Remediation Procedures.

AC.6.1 Undesirable woody vegetation identified by Dam Safety personnel must be removed. Removal of woody vegetation will require engineering judgment to determine if the root system has engaged water bearing regions of the dam and\or site specific geologic areas of special interests such as jointed rock formation which contain water at the toe or dam abutments.

AC.6.2 Tree and woody vegetation growth on the upstream slope should be undercut to remove all stumps, root balls, and root systems. The undercut area must be thoroughly inspected to confirm that all major root systems (greater than about one-half inch in diameter) have been removed during the undercutting operation to prohibit regrowth. Suitable backfill must be placed in the excavation and properly compacted to the dam remediation design limits. Backfill must be similar to the in-situ embankment fill material and must be compacted. Installing a slope protection system is recommended to reduce the potential for wave and surface runoff erosion.

AC.6.3 Engineering judgment will be required to identify the depth and extent of stump and root ball removal, laying back the undercut slope and selection of backfill based on dam design.

AC.6.4 Alternative methods, such as herbicide spraying, burning, or cutting trees flush to the ground surface and leaving roots in place may be considered, in consultation with dam safety experts. However, burning atop riprap is prohibited as this can weaken and degrade the rock.

AC.6.5 The suggested dam remediation design and construction procedure suggested for complete removal of trees, stumps, root balls, and root systems consists of the following activities:

AC.6.5.1 Cut the tree approximately two (2) feet above ground leaving a well-defined stump that can be used in the root ball removal process;

AC.6.5.2 Remove the stump and root ball by pulling the stump, or by using a track-mounted backhoe to first loosen the root ball by pulling on the stump and then extracting the stump and root ball together;

AC.6.5.3 Remove the remaining root system and loose soil from the root ball cavity by excavating the sides of the cavity to slopes no steeper than 1:1 (horizontal to vertical) and the bottom of the cavity approximately horizontal;

AC.6.5.4 Backfill the excavation with compacted soil placed in relatively loose lifts not greater than about eight (8) inches in thickness. Compaction of backfilled soils in these tree stump and root ball excavations typically requires the use of manually operated compaction equipment or compaction equipment attached to a backhoe.

AC.6.5.5 Procedure for total removal of trees near the toe is more complicated. Treatment of mature tree penetrations in a downstream slope may involve installation of a subdrain and/or filter system in the tree penetration excavation and backfill with compacted soil placed in maximum loose lifts of eight inches.

AC.7 Establishment of Vegetation. All disturbed areas must be protected by seeding and mulching. Regional weather and planting seasons must be taken into account (freezing winters, heavy precipitation seasons, hot or dry seasons, etc…). Timing of the seeding operations must be considered to ensure the greatest success of the grass.

AC.8 Variance. There are no vegetation variances for USACE dams and none will be granted.

APPENDIX AD

Periodic Inspection Procedures

AD.1 Periodic Inspection Program.

AD.1.1 Initial Pre-Inspection Brochure. A technical brochure must be prepared in advance of the first project inspection to familiarize inspection team members with general project features. This brochure must include a technical summary of the structural, material, and foundation conditions, instrumentation data, including settlement monuments, location of instrumentation and description of reservoir operations procedures, if pertinent. The brochure must include appropriate pertinent project data, project layout and typical section drawings, Federal and non-Federal responsibilities for OMRR&R, summaries of subsurface soil profiles and boring logs, brief construction history and construction description, construction photographs, and the checklist (see Annex 1 to this appendix) developed for conducting the inspection. The Asset Management Operational Condition Assessment, when possible, will be conducted with and incorporated into the PI and annual inspection checklist and process. Pre-inspection brochures must be completed and distributed to inspection team members at least 30 days prior to the inspection date.

AD.1.2 Pre-Inspection Packets. A technical pre-inspection packet must be prepared in advance of all subsequent project inspections to familiarize inspection team members with general project features and history. Pre-inspection packets must be completed and distributed to inspection team members at least 15 days prior to the inspection date. Packets may be tailored to each discipline to avoid excessive reproduction. To be efficient and generate a 95% complete draft of the PI Report to leave at the project site (see paragraph W-3), many paragraphs and Appendices of the PI Report may be completed with the information that would be contained in the Pre-Inspection Packet. The partially completed PI Report may be distributed to the inspection team members instead of the packet. This packet must include:

AD.1.2.1 A project access map, history of project deficiencies and remedial measures, technical summaries of the structural, material, and foundation conditions, and description of reservoir operations procedures, if pertinent.

AD.1.2.2 A written evaluation and plots of all instrumentation data, including settlement monuments must be prepared along with the location of the instruments.

AD.1.2.3 Project data, layout and typical section drawings, Federal and non-Federal responsibilities for OMRR&R, subsurface soil profiles plots, examples of typical boring logs, list of project documents and engineering data that identifies the status and location of the project documents, and the checklist developed for conducting the inspection. The objective is to incorporate the OCA criteria and process into the PI checklist.

AD.1.2.4 Findings of annual inspections since the last periodic inspection and the status of recommended action items must be reviewed and included in the packet.

AD.1.2.5 A section presenting the identified applicable essential USAEC guidelines and the results of the project's evaluation for compliance with these applicable essential USACE guidelines. This section will discuss the need for updating the project design parameters (hydraulic, seismic, HSS, etc.), if applicable.

AD.1.2.6 A brief summary of past performance and problems and concentrate on the continuing conditions that affect or may affect the overall safety and operational capability of the structure. Include narrative on intermediate inspections.

AD.1.2.7 A summary of the project's bridge inspections that may impact project safety or access during emergency conditions must be included.

AD.1.2.8 Status of seismic re-evaluations, per ER 1110-2-1806 (reference A.53) must be included in the packet.

AD.1.2.9 Status of Hydrologic re-evaluations must be included in the packet.

AD.1.3 Inspection Procedures. A systematic inspection plan, based on the most recent assessment, will be established for the inspection and operation of those features related to the safety and stability of the structure and to the operational adequacy of the project. The Asset Management process for OCA will be incorporated into the inspection plan. Operational adequacy means the inspecting, testing, operating, and evaluation of those components of the project whose failure or failure to operate properly could impair the operational capability and/or usability of the structure. Where the operation of these components is vital to the safe operation of the project under emergency conditions, these components will be operated by emergency power at least annually and these operations recorded in a project log. Emergency generators must be tested under load on more frequent intervals to maintain their integrity. In addition, standby emergency generating systems must be reviewed and tested during the scheduled inspection to assure the inspection team that all critical project features, including communication systems, can be operated under emergency conditions or in the absence of the normal source of power. The testing of emergency power must include the maximum power demand that could be expected in emergency situations. As much as possible the operation and/or inspection of all the features outlined in the inspection plan must be conducted during the scheduled periodic inspection. The inspection of the remaining features may be conducted any time prior to completion of the PI report but no earlier than occurrence of the last major flood event for the project. However, if possible, the inspection of certain features such as stilling basin dewatering, Tainter gate inspections, operability inspections, etc., must be completed before the periodic inspection so that the team can review the findings during the periodic inspection. If appropriate, a video of the event could document pertinent results of the pre-inspection for showing at the regularly scheduled inspection.

AD.1.4. Inspection Plan. The risk-informed systematic inspection plan must assure adequate coverage of the project and conduct of the associated OCA in the most expedient manner. The plan will cover technical skills required by members of the inspection team, items of equipment to be operated, areas that will be inspected and support equipment that will be required, including equipment to generate a substantially complete draft of the PI report. The plan and Site Specific Checklist must complement each other. The plan must provide, as appropriate, the examination and the operation of, but not be limited to, the following features and conditions:

AD.1.4.1 Hydraulic Steel Structures (HSS), as defined and required in ER 1110-2-8157 (reference A.58), which include flood and outlet control gates (including flood gates in levees or flood walls), navigation lock gates and valves, emergency closure gates, spillway Tainter gates, stoplogs and bulkheads, and associated lifting beams; hoists and operating machinery (including safety devices such as limit switches and fail-safe interlocks); flood control pumps and related equipment; and cathodic protection systems. When several of the same type of HSS exists at a project, at least one of each type of HSS must be inspected as part of each periodic inspection. A different HSS should be selected for each inspection. For HSS whose failure could result in loss of life, the critical components should be subjected to at least a thorough visual examination during each inspection.

AD.1.4.2 Structures including piers, overflow and non-overflow monoliths, roadways, parapets, training walls, spray walls, dam outlet conduits and tunnels, intake towers, bridges to gate towers, and steel sheet pile features. ER 1110-2-111 (reference A.45) provides guidance on bridge inspections.

AD.1.4.2.1 Structural features.

AD.1.4.2.2 Concrete surfaces.

AD.1.4.2.3 Structural cracking and deterioration of material.

AD.1.4.2.4 Joints and joint materials, including relative movement at joints between structures or portions of structures.

AD.1.4.3 Water passages.

AD.1.4.4 Embankments including foundation drains, joint drains, face drains.

AD.1.4.4.1 Embankment cracks, bulging, and sliding; condition of abutment and embankment junctions; and vertical and horizontal alignment of the embankment or structure crest, slope, or toe area.

AD.1.4.4.2 Unusual movement or cracking at or beyond the embankment or slope toe.

AD.1.4.4.3 Seepage through or under embankment or abutment slopes.

AD.1.4.4.4 Sloughing, sinkholes, or erosion of embankment or abutment slopes.

AD.1.4.4.5 Condition of riprap, armor or other slope protection.

AD.1.4.4.6 Scour protection stone and below water surface erosion control features.

AD.1.4.4.7 Conditions of relief wells, collector pipes, inspection manholes, or other features of seepage control systems (EM 1110-2-1914 (reference A.79) and ER 1110-2-1942 (reference A.55)).

AD.1.4.4.8 Condition and location of any known embedded utilities, including gas, water, and sewer lines in the embankment, abutments, or toe of the dam.

AD.1.4.4.9 Seepage, depressions, sinkholes, and soft, marshy areas downstream of the dam.

AD.1.4.4.10 Tailrace area, for muddy flows.

AD.1.4.4.11 Vegetation management at the dam site will be evaluated in accordance with the guidance in Appendix AC of this regulation.

AD.1.4.5 Spillways, spillway buckets and stilling basins and outlet channels including submerged features as necessary.

AD.1.4.6 Conditions of instrumentation, and most recent measurements prior to the inspection

AD.1.4.7 Reservoir rim conditions.

AD.1.5 Checklist. A detailed site specific checklist of elements relative to the structural stability and operational adequacy of the project must be developed for each structural component of the project in order to ensure adequate examination coverage for each feature. The facility's instrumentation must be included in the checklist to ensure that data are regularly collected and analyzed and to ascertain whether the instruments are in proper operating condition.

AD.1.6 Photographs. In order to more accurately portray conditions and changes in conditions of surfaces and structural details, high resolution digital color photographs are highly recommended. In addition to photographs, video is encouraged for use in monitoring areas of concern. This is especially useful for comparing movement, water leakages, wave action, etc.

AD.1.7 Examination of Deteriorated Concrete Structures. If the inspection reveals the need for any type of in-depth evaluation to determine the cause of deterioration or malfunction and to make sound recommendations for remediation, the need for the investigation must be stated in the PI/PA report. Guidance on repair of concrete is given in EM 1110-2-2002 (reference A.80).

AD.1.8 Structures. Steel structures must be visually inspected for structural and operational adequacy. The inspection must be sufficient to identify major defects such as visible cracks. Those structures involved directly in the safety of the project must receive special consideration. Fracture critical members, where failure would result in probable loss of life, must initially be inspected by additional means, such as ultrasonic or other nondestructive testing. HSS inspection reports must be prepared in accordance with ER 1110-2-8157 (reference A.58) and must be included in the PI/PA report. Reference EM 1110-2-6054 (reference A.94) for additional information on these structures.

AD.1.9 Emergency Stockpiles. The quantity, size, and location of riprap, sand, gravel, clay, sand bags, geotextiles, and other related materials and available equipment required to place these materials under any weather conditions must be stated. Material sources that have unsatisfactory performance records must be identified, reported, and eliminated from further use.

AD.2 Composition and Qualifications of the Inspection and District Quality Control Review Teams.

AD.2.1 Inspection team and District Quality Control Review team personnel must consist of individuals qualified by experience and training in the design, construction, inspection, and operation of the project, and of individuals with appropriate specialized knowledge in structural, mechanical, electrical, hydraulic, geotechnical (embankment design), geology, concrete materials, and construction procedures, as required. The team leaders (DSPMs or personnel selected from the Districts to Lead the Periodic Inspection teams) must be registered professional engineers or engineering geologists with dam safety experience.

AD2.2 A representative(s) of the sponsor and the state dam safety agency must be invited to be part of this team. Also, if the dam includes hydropower, representatives of the FERC must be invited to be part of this team. The inspection team qualifications and composition may vary with the complexity of the facility and with the level of inspection, but at a minimum will include the disciplines of geotechnical, structural, and hydraulic engineering and Operations are required at all inspections.

AD2.3 All team members must receive training in the inspection procedures and personal safety during the inspection, including the use of personal protective equipment. Training Aids for Dam Safety (TADS) modules are recommended as a minimum for each team member, as well as a thorough understanding of this regulation.

Where appropriate, inspection personnel must be trained for confined space entry. The Dam Safety Officer of each district is responsible for scheduling this training.

AD.3 O&M Dam Safety Recommendations. Recommendations, except for the routine maintenance type that can be performed by project personnel, should include the priority level for the recommended action in accordance with the following Table AD.1. DSMPT priority codes 1 thru 6 must be assigned to each recommendation and input into the deficiency spreadsheet module of the DSPMT software so the assigned priority can be tracked over time.

Table AD.1 - O&M Dam Safety Work Item Funding Priority Levels and Description

Priority Funding Level	DSPMT Code	Descriptions
CFY	1	Serious dam safety deficiency exists that needs remediation immediately. If not corrected, item has an unacceptable dam safety risk. May require operational restrictions placed on the project. Reprogramming funds is appropriate.
CFY + 1	2	Remediation should be initiated within 12 months. May require operational restrictions placed on the project. Reprogramming funds is appropriate.
CFY + 2	3	Study and remediation (as applicable) should be initiated within 24 months. The funds are currently being budgeted.
CFY + 3	4	Study and remediation (as applicable) should be initiated within next budget cycle or 36 months. Used for tracking and monitoring.
CFY + 4	5	Study and remediation (as applicable) should be initiated within next budget cycle or 48 months. Used for tracking and monitoring.
CFY + 5	6	Needs to be resolved within 5 years. This work will probably not get funded unless the deficiency worsens. Monitoring is appropriate.

Notes: DSPMT codes are determined by setting the Current Fiscal Year from 1 Oct to 30 Sept with a priority code value = 1. For successive years add the number of fiscal years to 1 to get priority code.

AD.3.1 Ensure prioritization of WORK CATEGORY CODES 61130, 61230, 61330, and 61630 as these are the primary work categories to be designated for correction of dam safety deficiencies using O&M funds. Other routine dam safety and maintenance requirements in the WCC 61XXX and 60XXX series may also be prioritized in DSMPT. Ensure coordination of all budgetary requirements with the

Operations Manager, Business Line Manager(s) for your district and the Risk Assessment team in or visiting with your district.

AD.3.2 See the current Budget EC for full definitions of all WORK CATEGORY CODES and specific requirements for Dam Safety Program activities.

AD.4 Project Documentation. All engineering data relating to project structures inspected must be collected and permanently retained in appropriate files at the project site for availability to the inspection team and readily accessible for emergency response. PI/PA reports must indicate which items are not available, and describe attempts to locate such records or documents. Project engineering data must also be retained at the district office. In the absence of storage space at the district office, the data must be retained at the nearest field office. These documents and drawings must be considered as permanent engineering data, subject to retirement or disposal only upon termination of operation of the project. These data must consist of, but not be limited to, the items listed below.

AD.4.1 All previous Periodic Inspection and Periodic Assessment Reports.

AD.4.2 Records of inspections by project personnel and interim/special event inspections by district personnel.

AD.4.3 Design Memoranda, Design Documentation Reports, Evaluation for compliance with essential USACE guidelines, or Dam Safety Deficiency Reports to include principle design assumptions, stability and stress analyses, slope stability, seepage and settlement analyses, consolidation, shear, permeability, compaction, classification tests or summaries thereof, contract plans and specifications, and the results of the project evaluation for compliance with the applicable essential guidelines.

AD.4.4 As built plans, elevation, and sections.

AD.4.5 As built drawings of important project features, to include details such as instrumentation, internal drainage, transition zones, or relief wells, and reports of any special investigations.

AD.4.6 Foundation data and geological features, including boring profiles, foundation mapping, foundation reports, and final logs of subsurface exploration.

AD.4.7 Location of borrow areas and identification of embankment, filter, riprap, large stone sources.

AD.4.8 Laboratory Reports including:

AD.4.8.1 As built properties of foundation and embankment materials, such as shear strength, unit weight, and water content and classification. The number of control tests and undisturbed record sample tests must be included.

AD.4.8.2 Physical, chemical, and thermal properties of concrete and concrete-making materials.

AD.4.8.3 Summary of concrete mixture proportions and control procedures.

AD.4.9 Project Geotechnical and Concrete Materials Completion Report.

AD.4.10 Construction history records, construction photographs, construction videos, construction anomalies (piping, settlement, etc.) including diversion schemes and construction sequences shown on appropriate drawings.

AD.4.11. Details of the overall instrumentation program to include predicted performance and record of actual observations, and annual updated evaluations.

AD.4.12 Operations and Maintenance Manual.

AD.4.13 Water Control Manual.

AD.4.14 Copy of PCA.

AD.4.15 Dam Safety Information:

AD.4.15.1 Project copy of "Federal Guidelines for Dam Safety" (reference A.114).

AD.4.15.2 Emergency Action Plan.

AD.4.15.3 Records of dam safety training for project personnel.

AD.4.15.4 Surveillance plan of the project that includes any special/significant events and threshold reservoir levels that initiate observations and/or inspections and reporting procedures.

AD.4.15.5 List of local contractors and construction materials available for use in emergency situations.

AD.4.15.6 Site-specific security and rapid recovery plans.

AD.4.16 Manufacturers’ data for purchased items.

Annex 1 to Appendix AD

EXAMPLE CHECKLIST FOR PERIODIC INSPECTIONS

CHECKLIST FOR THE
??TH PERIODIC INSPECTION
OF XYZ DAM
Name of the River, State Name

Day/Month/Year

Date of Inspection: Day/Month/Year

Conditions:

Pool Elevation:
Date (DD/MM/YYYY) – _____________ (Datum) at ____(Time)

Date (DD/MM/YYYY) – _____________ (Datum) at ____(Time)

Tailwater Elevation:
Date (DD/MM/YYYY) – _____________ (Datum) at ____(Time)

Date (DD/MM/YYYY) – _____________ (Datum) at ____(Time)

Outflow:
Date (DD/MM/YYYY) – __________ CFS
Gate Openings/Generating Units: ______________________________

Date (DD/MM/YYYY) – __________ CFS
Gate Openings/Generating Units: ______________________________

Weather:
Date (DD/MM/YYYY) – high temperature _º F at ____(Time)
Conditions: ____________________

Date (DD/MM/YYYY) – high temperature _º F at ____(Time)
Conditions: ____________________

Inspection Team:

Name of the Inspection Coordinator

List the names of personnel participating/positions on the inspection.

Table AD-1.1 - Operational Condition Assessment Rating Scale and Definitions

Condition Rating	Definitions
A (Excellent)	1) Component is fully functional, 2) No documented critical design flaw in terms of structural/operational capacity or functionality, 3) No documented or observed deficiencies by definition, 5) No indication of wear.
B (Good)	1) Component is fully functional, 2) No documented critical design flaw in terms of structural/operational capacity or functionality, 3) Documentation, testimonies and/or observations concluded that a deficiency by definition exists, 4) A clear mode of failure cannot be confirmed, 5) The components performance is not affected by the deficiency, 6) The feature mission requirement(s) (i.e. flood control, water quality, water supply, etc.) are not affected by the deficiency, 7) Normal operating procedures and routine maintenance requirements are not affected by the deficiency, 8) Safety of personnel and end users are not affected by the deficiency, 9) There is indication of normal wear as documented, reported or observed.
C (Poor)	1) Component is fully functional, 2) A critical design flaw potentially exist in terms of structural/operational capacity or functionality, but must be further substantiated by owning District, 3) Documentation, testimonies and/or observations conclude that a deficiency by definition exists, 4) Documentation, testimonies, and/or observation can confirm a progressing degradation of the components condition, 5) A clear mode of failure cannot be confirmed, 6) The components performance is not presently affected by the deficiency, but is likely due to the substantiated progress in degradation, 7) The feature mission requirement(s) (i.e. flood control, water quality, water supply, etc.) are not presently affected by the deficiency, but likely due to the substantiated progress in degradation,

Table AD-1.1 - Operational Condition Assessment Rating Scale and Definitions (Continued)

Condition Rating	Definitions
C (Poor) (Continued)	8) Normal operating procedures and routine maintenance requirement are not presently affected by the deficiency, but likely due to the substantiated progress in degradation, 9) Safety of personnel and end users not presently affected by the deficiency.
D (Inadequate)	1) Component is functional, 2) Documentation, testimonies and/or observations conclude that a deficiency by definition exists, 3) Documentation, testimonies, and/or observation can confirm that the deficiency is significant by any of the following criteria: a. A clear mode of failure exists, b. The components performance is presently affected, c. Feature mission requirement(s) (i.e. flood control, water quality, water supply, etc.) are presently affected, d. Normal operating procedures are presently affected, e. Routine maintenance requirements are presently affected, 4) A recent unsatisfactory performance or failure of service due to the deficiency cannot be confirmed by documentation or testimonies, 5) It is not likely that an imminent failure of the component will occur, 6) A critical life safety concern to personnel or end users does not exist.
F (Failed)	Failing: 1) Component is functional, 2) Documentation, testimonies and/or observations conclude that a deficiency by definition exists, 3) Documentation, testimonies, and/or observation can confirm that the deficiency is significant by any of the following criteria: a. A clear mode of failure exists, b. The components performance is presently affected, c. Feature mission requirement(s) (i.e. flood control, water quality, water supply, etc.) are presently affected, d. Normal operating procedures are presently affected, e. Routine maintenance requirements are presently affected, 4) In addition to the affect the deficiency has on performance and operation, a recent unsatisfactory performance or failure of service due to the deficiency can be confirmed by documentation or testimonies, 5) In addition to the affect the deficiency has on performance and operation, it is likely that an imminent failure of the component will occur, 6) In addition to the affect the deficiency has on performance and operation, a critical life safety concern to personnel or end users exists.
	Failed: Component is presently out of service or not functional.

Reference: Operational Condition Assessment Process for Flood Risk Management Projects, Guidelines and Instruction Manual, Version 1.1, March 2012 Page 3-8.

Table AD-1.2 Action Priority

DSPMT Code	Definitions	Priority Funding Level
1 (Immediate)	Serious dam safety deficiency exists that needs remediation immediately. If not corrected, item has an unacceptable dam safety risk. May require operational restrictions placed on the project. Reprogramming funds is appropriate.	CY
2 (12 Months)	Remediation should be initiated within 12 months. May require operational restrictions placed on the project. Reprogramming funds is appropriate.	CY+1
3 (24 Months)	Study and remediation (as applicable) should be initiated within 24 months. The funds are currently being budgeted.	CFY + 2
4 (36 Months)	Study and remediation (as applicable) should be initiated within next budget cycle or 36 months. Used for tracking and monitoring.	CFY + 3
5 (48 Months)	Study and remediation (as applicable) should be initiated within next budget cycle or 48 months. Used for tracking and monitoring.	CFY + 4
6 (60 Months)	Needs to be resolved within 5 years. This work will probably not get funded unless the deficiency worsens. Monitoring is appropriate.	CFY + 5

Definitions: CY = Current Fiscal Year
BY = Budget Year, usually CY +2 for O&M,
BY+1 = Budget Year plus one year.

Table AD-1.3 Feature Checklist

In the "Observation" and "Recommendations" portions of the inspection findings document the observed condition and any performance issues noted. For those items where the Operational Condition Classification is assigned specifically document that data used to support determination of the classification.

Note: The "Features" column and the titles for the subsections such as "Instrumentation Evaluation Summary", "Upstream Embankment and Upstream Abutments", etc are to be modified or tailored to fit specific project features, structures, and operating equipment. This example was developed for an embankment dam and will require additions and modification to address locks and dams and concrete dams.

Lead Disciplines: G – Geotechnical, H – Hydraulics, S – Structural, M – Mechanical, E – Electrical, D – Dam Safety

Inspection Findings:

Feature	Lead	Observations	Recommendations	Estimated Cost	Operational Condition Classification (A–F)	Action Priority (1 - 6)
Instrumentation Evaluation Summary						
Alignment – Settlement Pins	G					
Inclinometers	G					
Piezometers	G					
Weirs	G					

Feature	Lead	Observations	Recommendations	Estimated Cost	Operational Condition Classification (A–F)	Action Priority (1 - 6)
Instrumentation Condition						
Monuments	G					
Alignment – Settlement Pins	G					
Inclinometers	G					
Piezometers	G					
Weirs	G					
Reservoir						
Reservoir (IRRM)	H					

Feature	Lead	Observations	Recommendations	Estimated Cost	Operational Condition Classification (A–F)	Action Priority (1 - 6)
Reservoir (bank erosion, slides, etc.)	H/G					
Debris	H					
Sedimentation	H					
Upstream Embankment and Upstream Abutments						
Upstream slope	G					
Upstream Left Abutments and Contacts	G					
Upstream Right Abutments and Contacts	G					
Riprap	G					
Vegetation / Spraying	G					

Feature	Lead	Observations	Recommendations	Estimated Cost	Operational Condition Classification (A–F)	Action Priority (1 - 6)
Clearing Limits	G					
Embankment Crest						
Embankment Crest	G					
Guide Rails and Utility Poles	G					
Roadway Pavement	G					
Downstream Embankment and Downstream Abutments						
Downstream Embankment Slope	G					
Vegetation on Downstream Slope	G					
Downstream Clearing Limits	G					
Downstream Left Abutment	G					
Downstream Left Abutment Rock Drain	G					

Feature	Lead	Observations	Recommendations	Estimated Cost	Operational Condition Classification (A–F)	Action Priority (1 - 6)
Downstream Left Natural Hillside and sinkholes / wet areas	G					
Downstream Right Abutment	G					
Downstream Right Abutment Ditch	G					
Downstream Toe Area						
Downstream Toe Area	G					
Clearing Limits	G					
Service Bridge and Pier						
Abutment, Pier and Deck Concrete	S					
Service Bridge Paint	S					
Bridge Inspection Report	S	[include date of most recent inspection report and summary of recommendations]				

Feature	Lead	Observations	Recommendations	Estimated Cost	Operational Condition Classification (A–F)	Action Priority (1 - 6)
Bridge abutment	S					
Control Tower						
Control Tower	S					
Bulkheads						
Flood Control Sluice Bulkhead	S					
Intake Control Sluice Bulkhead	S					
Gate Chambers and Gates						
Sluice No. 1	S					
Sluice No. 2	S					
Sluice No. 3	S					
Sluice No. 4 (Add additional lines for other gates)	S					

Feature	Lead	Observations	Recommendations	Estimated Cost	Operational Condition Classification (A–F)	Action Priority (1 - 6)
Floor down-stream of liner plate in Sluice Gates	S					
Tunnel						
Tunnel	S					
Monolith Joints	S					
Crack Survey	S					
Stilling Basin						
Stilling Basin	S					
Weep Holes in Right Training Wall	S					
Slope Revetment Concrete Panels	S					
Right Training Wall	S					

Feature	Lead	Observations	Recommendations	Estimated Cost	Operational Condition Classification (A–F)	Action Priority (1 - 6)
Slope above Right Training Wall	G					
Divers' Inspection	H					
Flow Conditions	H					
Outflow Area and Downstream Riverbanks						
Outflow Area	H					
Downstream Riverbanks	G					
Spillway						
Spillway Approach	G					
Spillway	S					
Spillway Side Walls and Weep Holes	S					
Spillway Floor	S					

Feature	Lead	Observations	Recommendations	Estimated Cost	Operational Condition Classification (A–F)	Action Priority (1 - 6)
Slope above Spillway	G					
Debris in Spillway	G					
Flip Bucket	G					
Outlet Channel	G					
Spillway Drain Inspection s	S					
Operating Equipment						
Gate Settings for Inspection	M					
Flood Control Gates Operating Machinery	M					
Flat Wire Ropes	M					
Intake Gates (for Low Flow Discharge Wells and Gates)	M					

Feature	Lead	Observations	Recommendations	Estimated Cost	Operational Condition Classification (A–F)	Action Priority (1 - 6)
Low Flow Gates Operating Machinery	M					
3-Ton Hoist for Main Sluice Bulkhead	M					
2-Ton Hoist for Low Flow Gate Trash Racks and Bulkhead	M					
3-Ton Manual Chain Hoist	M					
Standby Generator and Automatic Transfer Switch	E					
Diesel Fuel Storage Tank	M					
Weir No. 6 House and Pump Station	M					
Gages	H					
Electrical						
Main Electric Power Service	E					

Feature	Lead	Observations	Recommendations	Estimated Cost	Operational Condition Classification (A–F)	Action Priority (1 - 6)
Service Bridge Handrail Grounding	E					
Service Bridge Fence Grounding	E					
Lighting System	E					
Electrical System	E					
Safety						
Safety	ALL					
Stability - Foundation						
Stability	G					

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APPENDIX AE

Periodic Inspection and Periodic Assessment Report Format

AE.1 Format and Responsibilities for the Report.

AE.1.1 This appendix provides guidance on the format and timely completion of the periodic inspection and periodic assessment report. A single report format must be utilized for periodic inspections and periodic assessments as described in this appendix.

AE.1.2 The district is responsible for preparing and assembling the report and appendices. A draft Periodic Assessment report will be completed by the district's PA team and provided to their Dam Safety Program Manager (DSPM) before the team is disbanded and the facilitator leaves the district office. Some of the report documentation will be prepared by the district prior to the PFMA, and some will be prepared by the PA team at the district office following the PFMA and risk assessment. The chapters are prepared in a modular format (i.e., separate files) with minimal formatting to facilitate report assemblage into the district's preferred format.

AE.1.3 In order to complete the Periodic Inspection report in a timely manner and be responsive to Operations Division, it is strongly recommended that the district institute an expedited report preparation method. To do so, the inspection team should be supplemented by at least one skilled technician and one clerical person with sufficient office equipment (computers, scanners, copiers, digital cameras, phones/radios) to be able to generate a 95% complete draft of the PI report to leave at the project site with the Operations personnel. The remaining 5% of the report can be accomplished in the office.

AE.2 Title Page. The title page and title of the report must indicate the name of the project, watercourse, NID identifier, project features, periodic inspection number, periodic assessment number, and date (in that order). Reports of subsequent periodic inspections and periodic assessments will be numbered sequentially. An example of an appropriate title is provided below:

John Redmond Reservoir
Grand (Neosho) River, Kansas
KS00004
Embankment, Spillway, and Hartford Levee
Periodic Inspection No. 11
Periodic Assessment No. 1
March 2011

AE.3 Report Organization. The report will be organized into the following chapters and appendices:

AE.3.1 Table of Contents

AE.3.2 Executive Summary: Overview of incremental and non-breach risk; confidence in the risk assessment and any major uncertainties; periodic inspection findings; major recommendations from the risk assessment and periodic inspection; recommended DSAC and rationale for the recommendation, and incremental and non-breach risk matrices. The length of the executive summary should be limited to 3 pages.

AE.3.3 Chapter 1 (Findings and Recommendations): Recommended DSAC and rationale; discussion of the current risk assessment and results (including incremental and non-breach risk); building the case for the risk-driver likelihood and consequence estimates; major findings and understandings from the risk assessment; status of the project for continued safe operation (including the need for IRRM, operational restrictions, and/or public communications); status of risk management activities (dam safety training, EAP and updates, dam safety exercises, and IRRMP); major uncorrected deficiencies from the previous inspection and explanation for not correcting; statement concerning the current inspection and major findings, including a list of major deficiencies found during the inspection; statement concerning compliance with the applicable essential USACE guidelines and the need for updating the project design parameters (hydraulic, seismic, HSS, etc.), if applicable; recommendations from the PA and PI related to the existing surveillance, monitoring, and inspection plan and/or IRRM plan, additional data, studies, or analyses, O&M, correction of major deficiencies found during the inspection, emergency action plan, training, and other recurrent needs; general schedule including the dates of the previous, current, and next scheduled periodic inspection and periodic assessment of the project.

AE.3.3.1 All recommendations must include the funding priority level using the appropriate DSPMT priority code, except for the routine maintenance type that can be performed by project personnel, and the potential failure mode(s) to which they apply, if appropriate.

AE.3.3.2 If the priority needs to be elevated or if several issues need to be addressed which will likely take some effort to resolve and estimate risks, a recommendation to perform an Issue Evaluation Study using WEDGE funding can be made. A recommendation for an IES must be accompanied by a brief description of the dam safety issue and general scope of the additional data, studies, or analyses necessary to evaluate the issue related to the performance, maintenance, and operation concerns of the project should be provided. The priority for such studies would be determined by the DSAC and other considerations.

AE.3.3.3 While the results of the current inspection may indicate the dam is in good condition, if the dam has been assigned a DSAC 1, 2, or 3, it is not correct to make the statement that the condition of the dam is acceptable because USACE considers the incremental risks for DSAC 1, 2, or 3 dams to be unacceptable except in exceptional circumstances. Considerations for continued safe operation for DSAC 1, 2, or 3 dams include a statement regarding the need for IRRM, operational restrictions, and/or public communications.

AE.3.4 Chapter 2 (Description of Dam and Operations): Authorized project purposes; physical description of the project; hazard potential classification; description of the project operations; brief operational history; summary of past major remedial measures; previous risk assessment findings (including current DSAC); and non-Federal sponsor OMRR&R responsibilities (if applicable). Include an overall photograph of the project.

AE.3.5 Chapter 3 (Periodic Inspection): Inspection results for each project feature including its ability to function as designed; a discussion of the deficiencies, the proposed remedial measures, with sketches if appropriate, related maintenance operations and both the cost estimates and a proposed completion schedule; deficiencies corrected since last inspection; uncorrected deficiencies since last inspection and explanation; and schedule for follow-on inspections. Where appropriate, a technical assessment of the causes of distress, of abnormal conditions, and evaluation of the behavior, movement, deformation, and loading of the structure and its individual components should be included. If such assessment cannot be accomplished within the time allotted to complete the inspection report, a preliminary assessment must be discussed with a plan scheduled to complete the assessment. Views of the non-Federal sponsor on any of the above must be included (if applicable).

AE.3.6 Chapter 4 (Hydrologic Loading): Brief summary of the current PMF and spillway design flood, pool-frequency curve, discharge-frequency curve, pool-duration curve, and tailwater rating curve.

AE.3.7 Chapter 5 (Seismic Loading): Brief summary of the seismic setting, source zones, existing studies and seismic considerations in the original design if available, and seismic hazard curve (from USGS data or site-specific study if available).

AE.3.8 Chapter 6 (Consequences): Brief description of the inundated area downstream of the dam and around the reservoir, selected inundation mapping to demonstrate the extents of inundation and at primary consequence centers, estimated population at risk for breach and non-breach inundation, emergency preparedness (both USACE and local), detection and evacuation issues, and estimated life loss and economic consequences (both flood damages and loss of service) for breach and non-breach inundation.

AE.3.9 Chapter 7 (Risk Assessment): Summary of each potential failure mode judged to drive the incremental risk to include a complete description from initiation to breach, pertinent background and performance data, factors that make the failure mode more or less likely to occur, failure likelihood category and confidence category (including rationale for each), and consequence category and confidence category (including rationale for each).

AE.3.10 Appendices

AE.3.10.1 Appendix A (Excluded Potential Failure Modes): Overview of the failure modes that were considered to be non-risk drivers and the rationale for excluding them from further consideration in the risk assessment.

AE.3.10.2 Appendix B (Pertinent Plates and Drawings): Copies of selected drawings such as layouts and typical sections for the purpose of familiarization with general features of the project; however, extensive reproduction of previously published drawings should be avoided. As a minimum, a location and vicinity map which also shows project access must be included, as well as a general plan that shows each feature discussed in the report. The names and stationing must be consistent on the drawings, narrative, and photograph captions. A reservoir diagram showing Minimum Flood Space, Variable Flood Space and other vital pool elevations, must also be included.

AE.3.10.3 Appendix C (Pertinent Construction Photographs): Photographs should include foundation condition & preparation, major components of the dam, and photos to illustrate the most likely potential failure modes identified in the report.

AE.3.10.4 Appendix D (History of Remedial Measures): Pertinent details of modifications to projects should be included. Depending on the complexity of the remedial measures, pertinent plates and photographs should be included in the appropriate appendices to fully understand the modification to the project(s).

AE.3.10.5 Appendix E (Monitoring and Instrumentation Data): Summarized performance data must have be to support the report discussion, conclusions and recommendations. Reproduce the plan of instrument locations in each report. Where there are design uplift assumptions, cross-sections showing piezometric data must show them along with the current pressure line. When there are piezometers, relief wells or drains, plots of piezometric elevation versus pool elevation and plots of relief well or drain flow versus pool elevation must be included. A summary of analyses of all instrumentation should be set forth. Where possible, threshold values for key instruments should be established. Threshold values should also be entered into the project emergency operations plans. The relevant instrumentation data for a PA should extend at least back to when the dam was constructed and if available groundwater data from pre-construction should be included. Where pertinent, data should include precipitation and tailwater data and be divided into time periods that correspond to key milestones such as end of construction, first filling, major modifications, and changes in operations.

AE.3.10.6 Appendix F (Summary of Intermediate Inspections): Brief summary of intermediate inspections and past performance and problems, with a focus on the new and continuing conditions that affect or may affect the overall safety and operational capability of the structure. This summary must not be merely a reference to a previous report. Include technical summaries of the structural, material, and foundation conditions, and description of reservoir operations procedures, if pertinent. A summary of the project's bridge inspections that may impact project safety or access during emergency conditions must be included.

AE.3.10.7 Appendix G (Current Periodic Inspection Photographs): High resolution digital color photographs with an appropriate caption, including the date taken

AE.3.10.8 Appendix H (Periodic Inspection Notes or Trip Reports)

AE.3.10.9 Appendix I (Dam Safety Fact Sheet): A for Public Release document included as a separable document (see Appendix E for format).

AE.3.10.10 Appendix J (References): A list of references used for the PFMA and risk assessment.

AE.3.10.11 Appendix K (Review Documentation): Certification of DQC review; Periodic Assessment team concurrence and facilitator certification sheet; and documentation of any MSC, DSOG, or consistency review comments and resolution.

AE.3.10.12 Appendix L (Applicable Essential USACE Guidelines and Compliance Review)

AE.3.10.13 Appendix M (Other)

AE.4 Text. All sections and paragraphs must be numbered and must be on 8 1/2 by 11-inch paper with sufficient margin on the left side for binding. Reproduction must be any available process with printing done head-to-head, if possible.

AE.5 Drawings. Drawings or plates should normally be 8 1/2 by 11-inch with sufficient margin on the left for binding. Foldouts should not exceed 11 inches by 17 inches. Drawings and photos may be included in the text or placed entirely in the Exhibits (or Appendices.) However, any figure or drawing in the text must support the written material. All drawings and figures must be dated for ease of reference.

AE.6 Binding and Cover. Hard copies of the reports must have flexible paper or card stock, with fasteners that facilitate removal and insertion of pages and drawings. Information to be on the cover will be sufficient to identify the project report as unique from other reports: name of the project, periodic inspection number, name of the preparing agency, the date of inspection, and date of the report. Electronic copies of the report will be searchable PDF files.

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APPENDIX AF

Management Control

AF.1 Function. The function covered by this checklist is Civil Works Dam Safety Program.

AF.2 Purpose. The purpose of this checklist is to assist the District Safety Officer in evaluating the key management controls listed below. It is not intended to cover all controls.

AF.3 Instructions. Answers must be based on the actual testing of key management controls (e.g., document analysis, direct observation, sampling, simulation, etc.). Answers, which indicate deficiencies, must be explained and corrective action indicated in supporting documentation. These management controls must be evaluated on a two year cycle (or as otherwise required by Army). Certification that this evaluation has been conducted must be accomplished on DA Form 11-2-R (Management Control Evaluation Certification Statement).

AF.4 Test Questions.

AF.4.1 Does the office at each dam have a copy of the Federal Guidelines for Dam Safety – FEMA 93 (reference A.114)?

AF.4.2 Does the office at each dam have a set of the Training Aids for Dam Safety – FEMA 609DVD (reference A.120)?

AF.4.3 Does the office at each dam have a copy of the Safety of Dams Regulation – ER 1110-2-1156?

AF.4.4 Does the office at each dam have a copy of the current Emergency Action Plan for the dam?

AF.4.5 Does the office at each dam have a copy of the latest Periodic Inspection Report and the latest Periodic Assessment Report?

AF.4.6 Does the office at each dam have a copy of the "as-built" plans for the dam?

AF.4.7 Is the Dam Safety Officer appointed on orders by the Commander in accordance with Chapter 4, ER 1110-2-1156?

AF.4.8 Does the Dam Safety Program Manager meet the qualifications requirements established in ER 1110-2-1156?

AF.4.9 Are both the Dam Safety Officer and the Dam Safety Program Manager registered Professional Engineers (or Engineering Geologists) with a current State registration?

AF.4.10 Is the Dam Safety Committee officially established with a list of members by names and does the committee meet on a regular basis?

AF.4.11 Is the data for the Dam Safety Program Management Tools up-to-date for all dams in the district or MSC?

AF.4.12 Are the Periodic Inspections scheduled on a 5 year cycle and Periodic Assessments scheduled on a 10 year cycle and is the schedule current?

AF.4.13 Are periodic inspection reports completed within 90 days of the field inspections and is a draft report left at the dam on the day of the inspections? Are periodic inspection/assessment reports completed within 45 days of the consistency review?

AF.4.14 Are instruments used to monitor the dams in working order and are they read in accordance with the established schedule? Is the data for instrumentation reading processed in 90 days or less for all projects?

AF.4.15 Are emergency exercises held at each dam in accordance with the schedule in ER 1110-2-1156?

AF.4.16 Do all new field employees receive 6 hours of dam safety training within 6 months of being assigned to the dam? Are new contractor employees also trained within 6 months?

AF.4.17 Does each dam (if required) have a current Interim Risk Reduction Measures Plan?

AF.4.18 Does each PDT for a dam safety study have an assigned “Lead Engineer” and is that person a senior level engineer or engineering geologist, with professional engineering registration?

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APPENDIX AG

Example of a Foundation Approval Report

AG.1 Foundation Approval Report Format. Table AG-1 contains the example foundation approval report that is to be used as a model for developing project specific reports to record the final review and approval of the foundation prior to placement of embankment fill or concrete.

Table AG.1 – Example of a Final Foundation Approval Report

FINAL FOUNDATION APPROVAL

Dam XYZ Spillway

REPORT NO. AB-1234

Description of Placement Area: MONOLITH 2, LIFT 1 **Date** 5/15/2013
Slope Face(s): A2, A1-A2, B2, INVERT **Sta:** 2+10.36 **to** 2+58.61
Elevation 3140.34 **to** 3144.87 **Offset** 54.75 R **to** 80.89 R

Purpose: This form shall be completed during the Final Cleanup of a given foundation surface (invert or wall or monolith) as the work progresses. Final Cleanup is defined in Specification Section XX XX XX Paragraph FINAL CLEANUP AND FOUNDATION PREPARATION. Attachments to this form should include photos/sketches showing details of area of cleanup, significant features, and other data for the permanent record. Signatures shall be made to this form at such time that the foundation surface is sufficiently prepared for the placement of structural concrete. Signatories shall have observed the condition of the foundation surface delineated and described herein and concur that the surface has been satisfactorily prepared for the placement of structural concrete. It is understood that requirements of Specification Section xx xx xx Paragraph FINAL CLEANUP AND FOUNDATION PREPARATION shall be enforced to ensure the observed and approved condition is maintained until concrete placement.

Geologic Conditions

Significant Geologic Features

SLIGHTLY TO UNWEATHERED GRANITE WITH PERVASIVE JOINTING. SURFACE TOPOGRAPHY FLATTENED BY HOE-RAMMING IN MOST AREAS, WITH SMALLER AREAS OF JOINT-CONTROLLED BLOCKY TOPOGRAPHY. VERY LITTLE SURFACE WEATHERING ON JOINT SURFACES. MINOR PYRITE MINERALIZATION LOCALLY.

Water Inflow (Source, Estimated Rate)

MINOR FLOW (<1 GPM) INTO AREA FROM JOINT-CONTROLLED SEEPAGE OUT OF A2/A1-A2/B2 FACES. NO SEEPAGE ORIGINATING @ INVERT.

Additional Remarks:

Final Preparation

Description of Removal of/Modification to in-place Slope Support Materials

NONE

Description of Scaling, Washing, Cleaning, etc.

WASHING PERFORMED USING AIR/WATER JETS, WITH FLOW CONTROLLED BY OPERATOR. MUCK REMOVED BY KAISER X4M (SPIDER), THEN HAND TOOLS (SHOVELS/TROWELS), AND FINALLY VACUUMS USED TO REMOVE FINES LOOSENED BY BRUSHING. WATER REMOVED BY PUMPING AND VACUUMING.

Description of Dental Treatment Applied (Concrete/Mortar/Lean Mix)

~25 LOCAL AREAS WERE IDENTIFIED FOR DENTAL MORTAR ON 5/14/12. TREATMENT WAS APPLIED DURING SECOND SHIFT ON 5/14/12. FINISHED DENTAL TREATMENT WAS INSPECTED ON 5/15/12 AND DEEMED SATISFACTORY.

Description of Groundwater Seepage Mitigation and Control of Standing/Flowing Water

STANDING WATER IS PUMPED FROM CASTS/DEPRESSIONS IN THE FOUNDATION, AND MUCK IS REMOVED AND THE AREA SCRUBBED/VACUUMED. CLEANLINESS OF CASTS/DEPRESSIONS IS ASSURED BY FIELD STAFF

Additional Remarks

USACE FIELD STAFF IDENTIFIED BLOCKS TO BE SCALED. NEED FOR SCALING WAS IDENTIFIED BASED ON DRUMMINESS AND/OR LOOSENESS OF BLOCKS. BLAST DAMAGE WAS OBSERVED IN SEVERAL LOCATIONS (RADIAL FRACTURING, OPENED JOINTS). REMOVABLE BLOCKS RESULTING FROM BLAST DAMAGE WERE MARKED AND REMOVED.

CC: USACE XXX-ED, USACE XXX- (Tech Lead), USACE XXX- (Resident Engineer)

Page 1 of 1

Table AG.1 – Example of a Final Foundation Approval Report (Page 2)

FINAL FOUNDATION APPROVAL

Dam XYZ Spillway

REPORT NO. AB-1234

Description of Placement Area: MONOLITH 2, LIFT 1 **Date** 5/15/2013
Slope Face(s): A2, A1-A2, B2, INVERT **Sta:** 2+10.36 **to** 2+58.61
Elevation 3140.34 **to** 3144.87 **Offset** 54.75 R **to** 80.89 R

Final Remarks

Signatures: The undersigned have observed the condition of the foundation surface delineated and described herein and certify that the surface has been satisfactorily prepared for the placement of structural concrete. The requirements of Specification Section 31 60 00 Paragraph FINAL CLEANUP AND FOUNDATION PREPARATION shall be enforced to ensure the observed and approved condition is maintained until concrete placement.

Name	Signature	Date

USACE Engineering Division Geology/Geotech

Name	Signature	Date

USACE Engineering Division Technical Lead

Name	Signature	Date

USACE Resident Engineer

CC: USACE XXX-ED, USACE XXX- (Tech Lead), USACE XXX- (Resident Engineer)

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APPENDIX AH

Notification of Non-Federal Entities Regarding Water Supply in United Sates Army Corps of Engineers (USACE) Reservoirs

AH.1 General. This appendix provides suggested language for letters to non-Federal entities regarding water supply storage in USACE reservoirs, where there are dam safety concerns.

AH.1.1 This language is provided to assist district commanders in preparing letters to non-Federal entities as required in Chapter 24 of this regulation. Each letter should be tailored to address specific situations and circumstances regarding the status of the dam and any remediation planned or underway.

AH.1.2 Letters should be sent to non-Federal entities prior to initiation of studies or assessments. For completed studies or studies underway, the letter may be modified to inform non-Federal entities of changed conditions or a change in DSAC classification.

AH.2 Opening Paragraph. The opening paragraph should be chosen from one of the following suggested paragraphs based on the type of water storage request.

AH.2.1 For requests for Permanent Storage:

> You have requested storage space in [Name of Project] for water supply uses. Such storage may be available, subject to preparation and approval of a report and compliance with applicable Federal and state laws and regulations. Before proceeding, however, we must inform you of the status of the dam at [Name of Project] and the potential impacts on water supply storage.

AH.2.2 For requests for Use of Surplus Water or Interim-use Water for Irrigation:

> You have requested [the use of surplus water] [the interim use of water] in [Name of Project] for [water supply] [irrigation] purposes. Storage for such use may be available, subject to preparation and approval of a report and compliance with applicable Federal and state laws and regulations. Before proceeding, however, we must inform you of the status of the dam at [Name of Project] and the potential impacts on water supply storage.

AH.2.3 For requests for Emergency Withdrawals:

> [You have requested] [We have approved] the use of water in [Name of Project] for emergency purposes. We want to inform you of the status of the dam at [Name of Project] and the potential impacts on water supply storage.

AH.2.4 For Existing Agreements:

You have been provided [storage space] [surplus water] [interim-use water] in [Name of Project] for [water supply] [irrigation] purposes. We wish to provide [information] [updated information] regarding the status of the dam and the potential impacts on water supply storage.

AH.3 Second and Third Paragraphs. These paragraphs provide general information about the DSAC.

While USACE recognizes the numerous public benefits of providing storage in its reservoirs for water supply purposes, USACE also recognizes its responsibility to provide storage in a safe, secure and reliable environment. USACE continually evaluates its dams and determines if remediation may be necessary to meet and maintain current USACE safety standards.

USACE is totally committed to the safety of its dams. USACE dams are classified through a risk assessment process into five Dam Safety Action Classes (DSAC) which represent varying levels of urgency of action and incremental flood risk.

AH.4 Fourth and/or Fifth Paragraphs. These paragraphs provide specific project information based on the DSAC for the dam. Chose the appropriate paragraph(s) that best fit the specific dam from the following paragraphs.

AH.4.1 For DSAC 1, 2, or 3 dams:

The dam at [Name of Project] has been classified DSAC [1 - Very High Urgency] [2 - High Urgency] [3 - Moderate Urgency]. As a result, USACE [may implement] [plans to implement] [is implementing] interim or long-range measures to remediate the conditions which led to the dam's DSAC assignment. These measures may impact the storage in the reservoir for water supply purposes, such that the amount of storage available for water supply could be reduced. USACE water supply storage agreements require non-Federal users to share the costs of remediation in proportion to the storage space that has been provided to each user.

In the interests of public safety, USACE water supply policy does not allow the conservation pool to be raised at projects where dams are classified DSAC 1, 2 or 3. Therefore, only storage within the existing conservation pool may be considered for water supply purposes. [Note: Do include this paragraph when the non-federal entity is only requesting surplus water, interim-use water for irrigation, or water for emergency uses].

AH.4.2 For DSAC 4 dams:

The dam at [Name of Project] has been classified DSAC 4 - Low Urgency in that there is low incremental risk, but it does not meet all USACE safety standards. As a result, USACE will conduct elevated monitoring and evaluation of the dam. In the event the DSAC assignment is elevated to a higher level of urgency, USACE may implement interim or long-range measures to remediate the conditions which led to the new DSAC assignment. These measures may impact the storage in the reservoir for water supply purposes, such that the amount of storage available for water supply could be reduced. Remediation is cost shared with water supply users in proportion to the storage space that has been provided to each user.

AH.4.3 For DSAC 5 dams:

The dam at [Name of Project] has been classified DSAC 5 - Normal Urgency (in that the incremental risk is very low and is considered tolerable and the dam meets essential guidelines). However, because a dam is a structure that changes over time, the DSAC assignment may be elevated to a higher level of urgency of action if conditions change. In such cases, USACE may implement interim or long-range measures to remediate the conditions which led to the elevated risk. These measures may impact the storage in the reservoir for water supply purposes, such that the amount of storage available for water supply could be reduced. Remediation is cost shared with water supply users in proportion to the storage space that has been provided to each user.

AH.5 Final Closing Paragraph. This paragraph provides closure to the letter and the name and contact information for future use by the non-Federal entity.

We will continue to work with you in your efforts to meet your present and future water needs. To this end, we continually review our projects for effectiveness, efficiency and safety. If you have questions about any matters addressed in this letter, or wish to learn more about USACE's commitment to dam safety, please contact [Mr. or Ms] [Insert Name of District Contact Team Member] at [provide telephone number and email address].

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GLOSSARY

Abbreviations and Terms

Abbreviations.

AIS .... Automated Information System

ALARP .... As Low As Reasonably Practicable

AALL .... Average Annual Life loss

ANCOLD .... Australian National Committee on Large Dams

APF .... Annual Probability of Failure

ASA(CW)................ Assistant Secretary of the Army for Civil Works

ASDSO................... Association of State Dam Safety Officials

ATR........................ Agency Technical Review

BCOE .... Bidability, Constructability, Operability and Environmental review

BCOES................... Bidability, Constructability, Operability, Environmental, and Sustainability review

BCR........................ Benefit Cost Ratio

CE .... Constructability evaluation

CIPR....................... Critical Infrastructure Protection and Resilience

CoP .... Community of Practice

CQC .... Contractor Quality Control

CSSL...................... Cost to save a statistical life

CX .... Center of Expertise

DA .... Department of the Army

DCE........................ Design Construction Evaluation

DDR .... Design Documentation Report

DHS........................ Department of Homeland Security

DQC .... District Quality Control

DSAC .... Dam Safety Action Classification

DSADS.................... Dam Safety Action Decision Summary

DSMMCX .... Dam Safety Modification Mandatory Center of Expertise

DSMR...................... Dam Safety Modification Report

DSMS...................... Dam Safety Modification Study

DSPC .... Dam Safety Production Center

DSPCMG .... Dam Safety Production Center Management Group

DSPCSC .... Dam Safety Production Center Steering Committee

DSO .... Dam Safety Officer

DSOG...................... Dam Senior Oversight Group

DSPM...................... Dam Safety Program Manager

DSPMT.................... Dam Safety Program Management Tools

DSPPM .... Dam Safety Program Performance Measures

DSSC .... Dam Safety Steering Committee

EAP .... Emergency Action Plan

EMA .... Emergency Management Agencies

ERDC .... Engineer Research and Development Center

EIS .... Environmental Impact Statement

ESA .... Endangered Species Act

FCCSET .... Federal Coordinating Council for Science, Engineering, and Technology

FC, MR&T .... Flood Control, Mississippi River and Tributaries

FCSA...................... Feasibility Cost Sharing Agreement

FEMA .... Federal Emergency Management Agency

FERC .... Federal Energy Regulatory Commission

FONSI……………... Finding of No Significant Impact

FOUO..................... For Official Use Only

FPA…………………Federal Power Act

GIS .... Geographical Information Systems

H H & C .... Hydraulics Hydrology and Coastal

H & H...................... Hydraulics and Hydrology

HQUSACE .... Headquarters, U.S. Army Corps of Engineers

HSE........................ Health Safety Executive, United Kingdom

HSEEP .... Homeland Security Exercise and Evaluation Program

HSS........................ Hydraulic Steel Structures

HTRW .... Hazardous, Toxic and Radioactive Waste

ICODS.................... Interagency Committee on Dam Safety

ICOLD .... International Commission on Large Dams

ICW .... Inspection of Completed Works

IDF .... Inflow Design Flood

IEPR....................... Independent External Peer Review

IFP.......................... Initial Reservoir Filling Plan

IES .... Issue Evaluation Study

IESSF..................... Issue Evaluation Study Summary of Findings

IRRM...................... Interim Risk Reduction Measure

IRRMP.................... Interim Risk Reduction Measures Plan

IPMP .... Initial Project Management Plan

IR............................ Individual Risk

IRC .... Issue Resolution Conference

ITR .... Independent technical review

IWR .... Institute for Water Resources

LCA .... Local Cooperation Agreement

MCACES .... Micro Computer Aided Cost Engineering System

MCE .... Maximum Credible Earthquake

MDE .... Maximum Design Earthquake

MMC....................... Modeling, Mapping, and Consequences Production Center

MMCSC.................. Modeling, Mapping, and Consequence Production Center Steering Committee

MSC .... Major Subordinate Commands

NAVD .... North American Vertical Datum

NDSRB................... National Dam Safety Review Board

NED........................ National Economic Development

NEPA .... National Environmental Policy Act

NID .... National Inventory of Dams

NSW DSC .... New South Wales Dam Safety Committee

NWS....................... National Weather Service

O&M .... Operation and Maintenance

OBE........................ Operating Basis Earthquake

OMB .... Office of Management and Budget

OMRR&R .... Operation, Maintenance, Repair, Replacement and Rehabilitation

PA .... Periodic Assessment

PAO........................ Public Affairs Office

P&S........................ Plans and Specifications

P&G........................ Principles and Guidelines

PCA........................ Project Cooperation Agreement

PCCR..................... Policy Compliance & Criteria Review

PDT........................ Project Delivery Team

PED........................ Preconstruction Engineering and Design

PFM........................ Potential Failure Modes

PFMA..................... Potential Failure Modes Analysis

PGM....................... Project Guidance Memo

PI............................ Periodic Inspection

PIE .... Post-Implementation Evaluation

PMA .... Power Marketing Agency

PMF........................ Probable Maximum Flood

PMP .... Probable Maximum Precipitation

PMP .... Project Management Plan

PPMD..................... Programs and Project Management Division

PROSPECT .... Proponent-Sponsored Engineer Corps Training

QCC .... Quality Control and Consistency Review

QA.......................... Quality Assurance

RA .... Risk Assessment

RADS II .... Risk Assessment for Dam Safety II web site

REMR..................... Repair, Evaluation, Maintenance, and Rehabilitation

RMC .... Risk Management Center

RMO....................... Review Management Organization

RP .... Review Plan

SDF .... Spillway Design Flood

SEE .... Safety Evaluation Earthquake

SEF .... Safety Evaluation Flood

SES .... Senior Executive Service

SET .... Standard Engineering Technology

SPRA .... Screening for Portfolio Risk Analysis

TADS...................... Training Aids for Dam Safety

TF........................... Threshold Flood

TRC........................ Technical Review Conference

USACE................... United States Army Corps of Engineers

USCOLD .... U.S. Committee on Large Dams
(Renamed United States Society on Dams, USSD)

USDOT................... United States Department of Transportation

USSD .... United States Society on Dams

VE .... Value Engineering

WCC....................... Work Cost Category

WRDA .... Water Resources Development Act

WTP .... Willingness-to-pay-to-prevent-a-statistical-fatality

Terms

Abutment – That part of the valley side against which the dam is constructed. An artificial abutment is sometimes constructed as a concrete gravity section to take the thrust of an arch dam where there is no suitable natural abutment. The left and right abutments of dams are defined with the observer viewing the dam looking in the downstream direction, unless otherwise indicated.

Acceptable Risk – A risk, for the purposes of life or work, everyone who might be impacted is prepared to accept assuming no changes in risk control mechanisms. Such risk is regarded as insignificant and adequately controlled. Action to further reduce such risk is usually not required.

Acre-foot – A unit of volumetric measure that would cover 1 acre to a depth of 1 foot. It is equal to 43,560 cubic feet. This is approximately 325,851.4 U.S. gallons.

Adit – A nearly horizontal underground excavation in an abutment having an opening in only one end, such as an opening in the face of a dam for access to galleries or operating chambers.

Adverse Consequences – The outcome of the failure of a dam or its appurtenances, including immediate, short and long-term, direct and indirect losses and effects. Loss may include human casualties, project benefits, monetary and economic damages, and environmental impact (Adapted from USACE).

Agency Technical Review (ATR) – An independent in-depth review designed to ensure the proper application of clearly established criteria, regulations, laws, codes, principles and professional practices. The ATR team reviews the various work products and assures that all the parts fit together in a coherent whole.

ATR Team – For dam safety studies, the ATR team must include members from and be coordinated with the RMC as well as recognized experts (internal and external to USACE) in the field of risk assessment. The ATR team findings will be vetted with the MSC DSO, Risk Management Center, and HQUSACE.

Annual Inspections – Inspections conducted annually by the Operating Project staff with technical experts from Engineering or Operations (reference ER 1130-2-500 (reference A.60)). The goal is to monitor the performance of the dam and note any evidence of changes in performance or needed dam safety related maintenance. Findings must be documented and reviewed in support of Periodic Inspections (PI's) and Periodic Assessments (PA's).

Annual Probability of Failure (APF) – For dams the combined estimated annual probability of failure from all failure modes associated with all loading or initiating event types that result in an unintentional release of the reservoir.

Appurtenant structure – Ancillary features of a dam such as inlet and outlet works, spillways, tunnels, or power plants.

As-Low-As-Reasonably-Practicable (ALARP) – That principle which states that risks, lower than the limit of tolerability, are tolerable only if risk reduction is impracticable or if the next increment of risk reduction is not cost effective compared to the improvement gained.

Automatically Operated System – An automatically operated system is where operation is determined by automated means based on instrumentation data without requiring direct input from personnel.

Average Annual Life Lost (AALL) – As used in the f-N plot, the expected value (average) of potential life loss of the probability distribution of potential life loss from dam failure.

Axis of dam – The vertical plane or curved surface, chosen by a designer, which appears as a line, in plan, or in cross-section, from which the horizontal dimensions of the dam are referenced.

Baffle block – A block, usually of concrete, constructed in a channel or stilling basin to dissipate the energy of water flowing at high velocity.

Base thickness – Also referred to as base width. The maximum thickness or width of the dam measured horizontally between upstream and downstream faces and normal to the axis of the dam, but excluding projections for outlets, or other appurtenant structures.

Batter – Angle of inclination from the vertical.

Bedrock – The consolidated body of natural solid mineral matter which underlies the overburden soils.

Berm – A nearly horizontal step in the sloping profile of an embankment dam. Also a step in a rock or earth cut.

Borrow Area – The area from which natural materials, such as rock, gravel or soil, used for construction purposes is excavated.

Breach – An opening through a dam that allows the uncontrolled draining of a reservoir. A controlled breach is a constructed opening. An uncontrolled breach is an unintentional opening caused by discharge from the reservoir. A breach is generally associated with the partial or total failure of the dam.

Broadly Acceptable Risk – "Risks falling into this region are generally regarded as insignificant and adequately controlled. The levels of risk characterizing this region are comparable to those that people regard as insignificant or trivial in their daily lives. They are typical of the risk from activities that are inherently not very hazardous or from hazardous activities that can be, and are, readily controlled to produce very low risks" (HSE, 2001 reference A.145). By the nature of the hazard that dams pose it is inappropriate to attempt to manage them as a broadly acceptable risk and therefore the concept of the broadly acceptable risk level or limit does not apply to dams.

Caretaker Status – Real or personal property at a project site, in part or in whole, which currently is not utilized or occupied for current program authorized purposes. This may also include property that is "Inactive" (Not currently being used but may have a future need) or "Excess" (Formally identified as having no further program use including pending disposition actions). This does not include property placed in “Mothball” status. Caretaker status is defined at the project or project site level, not the feature level."

Catastrophe – A sudden and great disaster causing misfortune, destruction, or irreplaceable loss extensive enough to cripple activities in an area.

Channel – A general term for any natural or artificial facility for conveying water.

Combined Annual Probability of all Failure Modes – Combined estimated annual probability of failure from all failure modes associated with all loading or initiating event types.

Cofferdam – A temporary structure enclosing all or part of the construction area so that construction can proceed in the dry. A diversion cofferdam diverts a river into a pipe, channel, or tunnel.

Compaction – Mechanical action, which increases the density by reducing the voids in a material.

Component Risks – Estimates of risk contributed by the physical components of a dam undergoing failure mode analysis for a remediation alternative.

Conditional Load Response Probabilities – Response probabilities (of failure) corresponding to the conditional load type and scenario under investigation.

Conditional System Response Probability Estimates – System response probabilities that are conditional on the specific loading condition analyzed (over the range of loading conditions to be studied).

Conduit – A closed channel to convey water through, around, or under a dam.

Confirmed (Unconfirmed) – Through investigation or other means, Dam Safety issue is firmly established as of concern or not. Unconfirmed – not confirmed.

Confirmed Dam Safety Issues – Manifested or obvious issues are those impacting the safe operation of a dam. Examples of confirmed issues can be described as performance concerns - lack of spillway or seismic capacity, or deficiencies that are demonstrated by signs of seepage and boils, obvious flaws or defects, component distress or malfunction, unusual settlement, unsatisfactory instrument readings, etc. that can be specifically linked to one or more potential failure modes.

Conservation Pool – The permanent pool that lies just below the flood storage pool in a reservoir.

Constructability evaluation (CE) –A project review that concentrates on schedule, cost, constructability, and risks that may be inherent to the construction of a project. This review is performed and documented by a team designated by the DSMMCX/DSPC. A CE report is prepared, briefed to the project PDT and approved by the DSPC. A CE will be performed at least during the steps of evaluation and comparison of alternatives in the plan formulation process and during PED prior to final design.

Construction Joint – The interface between two successive placings or pours of concrete where bond, and not permanent separation, is intended.

Contact Grouting – Filling, with cement grout, any voids existing at the contact of two zones of different materials, e.g., between a concrete tunnel lining and the surrounding rock.

Contractor Quality Control (CQC) – The construction contractor's system to manage, control, and document his own, his supplier's, and his subcontractor's activities to comply with contract requirements.

Core – A zone of low permeability material in an embankment dam. The core is sometimes referred to as central core, inclined core, puddle clay core, rolled clay core, or impervious zone.

Core Wall – A wall built of relatively impervious material, usually of concrete or asphaltic concrete, in the body of an embankment dam to prevent seepage.

Cost-to-Save-a-Statistical-Life (CSSL) – CSSL is the ratio of the cost of a proposed risk reduction measure divided by the consequent estimate of 'Statistical Lives Saved'.

Credible "Existing and Future Without Federal Action" Risk Estimate – Occurs when the conditional load response probabilities and consequences used to estimate the residual project risk (incremental and non-breach) are supported by sufficient data, analysis, and performance history. The need for additional information, studies, and investigations to determine or resolve uncertainty should be determined after parametric studies are completed and insight is gained as to improvement in the confidence of the risk estimate by more accurately predicting conditional load response probabilities or life loss estimates. Typically, risk estimates for confirmed issues can be established with

existing data and performance history because the physical manifestations are visual and measurable. Unconfirmed issues may require the collection of additional data if the concerns are less obvious or cannot be linked to a specific failure mode or observation.
Credible Failure Mode – A physically plausible failure mode.

Crest of dam – See top of dam.

Critical feature – For Seismic Evaluation – Critical features are the engineered structures, natural site conditions, or operating equipment and utilities at high hazard projects whose failure during or immediately following an earthquake could result in loss of life.

Critically near failure – Failure sequence has been initiated and continues under normal loading. Without intervention (e.g., interim risk reduction measures or remediation), dam is expected to fail.

Cross section – An elevation view of a dam formed by passing a plane through the dam perpendicular to the axis.

Cutoff trench – A foundation excavation later to be filled with impervious material so as to limit seepage beneath a dam.

Cutoff wall – A wall of impervious material usually of concrete, asphaltic concrete, or steel sheet piling constructed in the foundation and abutments to reduce seepage beneath and adjacent to the dam.

Dam – An artificial barrier, including appurtenant works, constructed for the purpose of storage, control, or diversion of water, and which (1) is twenty-five feet or more in height from the natural bed of the stream or watercourse measured at the downstream toe of the barrier or from the lowest elevation of the outside limit of the barrier if it is not across a stream channel or watercourse, to the maximum water storage elevation or (2) has an impounding capacity at maximum water storage elevation of fifty acre-feet or more. Any such barrier which is under six feet in height regardless of storage capacity, or which has a storage capacity at maximum water storage elevation not in excess of fifteen acre-feet regardless of height is not considered a dam. This lower size limitation should be waived if there is a potentially significant downstream hazard. This definition applies whether the dam has a permanent reservoir or is a detention dam for temporary storage of floodwaters. The impounding capacity at maximum water storage elevation includes storage of floodwaters above the normal full storage elevation. Various types of dams include the following:

a. Afterbay dam. See regulating dam.

b. Ambursen dam. A buttress dam in which the upstream part is a relatively thin flat slab usually made of reinforced concrete.

c. Arch dam. A concrete or masonry dam, which is curved upstream so as to transmit the major part of the water load to the abutments.

d. Buttress dam. A dam consisting of a watertight part supported at intervals on the downstream side by a series of buttresses. A buttress dam can take many forms, such as a flat slab or a massive head buttress.

e. Cofferdam. A temporary structure enclosing all or part of the construction area so that construction can proceed in the dry. A diversion cofferdam diverts a stream into a pipe, channel, tunnel, or other watercourse.

f. Crib dam. A gravity dam built up of boxes, crossed timbers, or gabions filled with earth or rock.

g. Diversion dam. A dam built to divert water from a waterway or stream into a different watercourse.

h. Double curvature arch dam. An arch dam, which is curved vertically as well as horizontally.

i. Earth dam. An embankment dam in which more than 50 percent of the total volume is formed of compacted earth material generally smaller than 3-inch size.

j. Embankment dam. Any dam constructed of excavated natural materials or of industrial waste materials.

k. Gravity dam. A dam constructed of concrete and/or masonry, which relies on its weight and internal strength for stability.

l. Hollow gravity dam. A dam constructed of concrete and/or masonry on the outside but having a hollow interior and relying on its weight for stability.

m. Hydraulic fill dam. An earth dam constructed of materials, often dredged, which are conveyed and placed by suspension in flowing water.

n. Industrial waste dam. An embankment dam, usually built in stages, to create storage for the disposal of waste products from an industrial process. The waste products are conveyed as fine material suspended in water to the reservoir impounded by the embankment. The embankment may be built of conventional materials but sometimes incorporates suitable waste products.

o. Masonry dam. Any dam constructed mainly of stone, brick, or concrete blocks jointed with mortar. A dam having only a masonry facing should not be referred to as a masonry dam.

p. Mine tailings dam. An industrial waste dam in which the waste materials come from mining operations or mineral processing.

q. Multiple arch dam. A buttress dam composed of a series of arches for the upstream face.

r. Overflow dam. A dam designed to be overtopped.

s. Regulating dam. A dam impounding a reservoir from which water is released to regulate the flow downstream.

t. Rockfill dam. An embankment dam in which more than 50 percent of the total volume is composed of compacted or dumped cobbles, boulders, rock fragments, or quarried rock generally larger than 3-inch size.

u. Roller-compacted concrete dam. A concrete gravity dam constructed by the use of a dry mix concrete transported by conventional construction equipment and compacted by rolling, usually with vibratory rollers.

v. Rubble dam. A stone masonry dam in which the stones are unshaped or uncoursed.

w. Saddle dam (or dike). A subsidiary dam of any type constructed across a saddle or low point on the perimeter of a reservoir.

x. Tailings dam. See mine tailings dam.

Dam failure – Failure characterized by the sudden, rapid, and uncontrolled release of impounded water. It is recognized that there are lesser degrees of failure and that any malfunction or abnormality outside the design assumptions and parameters that adversely affect a dam's primary function of impounding water is properly considered a failure. These lesser degrees of failure can lead to loss of services and progressively lead to or heighten the risk of a catastrophic failure.

Dam Safety – Dam safety is the art and science of ensuring the integrity and viability of dams such that they do not present unacceptable risks to the public, property, and the environment. It requires the collective application of engineering principles and experience, and a philosophy of risk management that recognizes that a dam is a structure whose safe functioning is not explicitly determined by its original design and construction. It also includes all actions taken to routinely monitor, evaluate, identify or predict dam safety issues and consequences related to failure including ensuring all reservoir regulation activities are performed in accordance with established water control plans in support of dam safety concerns. These actions are to be performed in concert with activities to document, publicize, and reduce, eliminate, or remediate, to the extent reasonably practicable, any unacceptable risks.

Dam Safety Action Classification (DSAC) System – The Dam Safety Action Classification system is intended to provide consistent and systematic guidelines for appropriate actions to address the dam safety issues and deficiencies of USACE dams. USACE dams are assigned a DSAC class informed by their incremental flood risk considered as a combination of probability of failure and potential life safety, economic, environmental, or other consequences. The DSAC table presents different levels and urgencies of actions that are commensurate with the different levels of incremental flood risk associated with USACE dams. These actions range from immediate recognition of a very high urgency requiring extraordinary and immediate action for dams considered critically near failure or dams with very high incremental flood risk through normal level of urgency for the operations and dam safety activities for dams with very low incremental flood risk and that meet all essential USACE guideline.

Dam Safety Committee – The Dam Safety Committee includes the Dam Safety Officer (DSO) and the Dam Safety Program Manager (DSPM) plus additional members as required. The members should include various technical engineering disciplines from within the district. Other disciplines and areas of expertise may be represented, as required by the DSO or Commander. There is a standing Dam Safety Committee at each level of the decentralized USACE program (districts, divisions, and HQ), who convening regularly to discuss dam safety project and program matters, and advice the Commander on critical dam safety related decisions.

Dam Safety Steering Committee (DSSC) – A committee charged with facilitating and promoting dam safety as a fundamental USACE mission in all levels of the organization, promoting dam safety career development, disseminating pertinent information throughout USACE, and reviewing and evaluating policy, technical criteria and practices, administrative procedures, and regulatory functions to support the USACE dam safety program. The DSSC reviews experience and qualifications of dam safety staffing at all levels within the USACE to assess competency, serves as a resource for sharing information and project specific Lessons Learned, and makes recommendations for future research and development in areas related to dam safety. The team meets as required, and provides advice and information to the Special Assistant for Dam and Levee Safety.

Dam Safety Deficiency – A material defect or load capacity limit that threatens a dam failure.

Dam Safety Issue – Any confirmed or not yet confirmed condition at a dam that could result in intolerable life safety, economic, and environmental risks.

Dam Safety Modification – A Dam Safety Modification is any planning, design, or construction activity whose execution or improper execution could significantly impact the project’s ability to operate as intended. The following activities will normally be considered dam safety modifications: all dam safety modification studies to bring projects within tolerable risks, all drilling and or grouting activities for a dam, replacement of hydraulic steel structures with new or significantly altered designs, installation of relief wells and collector systems, any drilling within or immediately adjacent to the dam, replacement of operating machinery other than like kind and similar activities. The following activities will normally be considered as routine and are not dam safety modifications: routine cleaning of drains, normal maintenance and repair of existing operating machinery, replacement of hydraulic steel structures and operating equipment with like kind components and similar routine activities performed by the district staff.

Dam Safety Modification (DSM) Lead Engineer - The DSM lead engineer for all dam safety modification studies, designs, plans and specification, and engineering during construction must be assigned by the Director of the Dam Safety Production Center in consultation with the district DSO. The DSM lead engineer must be a senior level registered professional engineer (typically a civil, geotechnical, or structural engineer) or engineering geologist with extensive knowledge and skills related to the primary features associated with the project. The engineering geologist is required to be a registered professional engineer.

Dam Safety Modification Risk Assessment – The risk assessment addresses the life safety, economic, and environmental risks associated with the identified potential failure modes and the risk reduction that can be achieved with risk reduction measures, including potential staged implementation options.

Dam Safety Modification Study – The safety case that presents the investigation, documentation, and rationale for modifications for dam safety at completed USACE projects. The report presents the formulation and evaluation for a full range of risk reduction alternatives with preliminary level cost estimates. A detailed risk assessment is required to look at incremental risk reduction alternatives that together meet the tolerable risk guidelines and cost effectiveness of reducing the risk to and below the minimum safety criteria. However, the level of detail should only be what is needed to justify the modification decision. Related NEPA (reference A.6) and ESA (reference A.10) studies will be conducted during the Modification Study, in support of the recommended risk reduction measures. The resultant Dam Safety Modification Decision Document will present a comparison of alternatives and the recommended risk management plan to include actions, components, risk reduction by increments or stages, implementation plan, detailed cost estimate, NEPA, and ESA determinations.

Dam Safety Officer – A registered professional engineer with civil engineering background and with management abilities who is competent in the areas related to the design, construction, operation, inspection or evaluation of dams. They must understand adverse dam incidents and the potential causes and consequences of dam failure. The DSO is the highest-ranking Registered Professional Engineer in each level of USACE responsible for implementing the dam safety program of that organization. The Commander must ensure the DSO meets the technical qualifications and experience. The DSO is the Chair of the Dam Safety Committee.

Dam safety preparedness – The quality or state of being prepared to deal with emergency conditions which endanger the structural integrity of the dam and/or downstream property and human life.

Dam Safety Portfolio Risk Management – The management process shown generally on Figure 2.3 and for USACE in detail on Figure 3.1. It is a risk-informed USACE-wide portfolio perspective process applied to all features of all dams on a continuing basis.
Dam Safety Program – The purposes of a dam safety program are to protect life, property, and the environment by ensuring that all dams are designed, constructed, operated, and maintained as safely and effectively as is reasonably possible. Accomplishing these purposes require commitments to continually inspect, evaluate, and document the design, construction, operations, maintenance, rehabilitation, and emergency preparedness of each dam and the associated public. It also requires the archiving of documents on the inspections and history of dams and the training of personnel who inspect, evaluate, operate, and maintain them. Programs must instill an awareness of dams and the potential hazard that they may present in the owners, the users, the public, and the local and national decision-makers. On both local and national scales, program purposes also include periodic reporting on the degree of program implementation. Key to accomplishing these purposes is to attract, train, and retain a staff proficient in the art and science of dam design.

Dam Safety Program Management Tools – A shared software database, developed and maintained by USACE on behalf of FEMA, used for managing and monitoring Dam Safety Programs. It is used by multiple Federal and State agencies, to track program accomplishments, including entering data for the National Inventory of Dams and preparing the Federal Dam Safety Biennial Report to Congress.

Dam Safety Program Manager (DSPM) – Dam Safety officials at the HQUSACE, MSC, and district level responsible for the overall daily management of the Dam Safety program. These managers normally support and report to the Dam Safety Officer at their respective level.

Dam Senior Oversight Group (DSOG) – Designated USACE dam safety senior headquarters and field staff team that performs an oversight function for the Dam Safety program. The DSOG meets periodically to advise the Dam Safety Officer on key issues related to the program, such as determining Dam Safety Action Classifications. The DSOG generally consists of the following members: Special Assistant for Dam and Levee Safety (Chair); USACE CoP leaders (for Geotechnical, Structural and H&H technical disciplines); Regional representatives determined by Special Assistant for Dam and Levee Safety; USACE Business Line & Program Representatives to include USACE DSPM, Flood Damage Reduction, Navigation, Programs, and Risk Management Center Director; and any other Representatives determined by the Special Assistant for Dam and Levee Safety. The Senior Oversight Group is established to vet the findings of the Regional Risk Cadres and confirm dam safety work priorities based on portfolio risk findings.

Damming Surface – Any surface of the structure that hold back water. In the case of a navigation lock, the damming surface could include the miter gates and lock walls. In the case of a hydropower unit, the damming surface could be the head gates on the penstocks

Design Structural Capacity – The maximum loading condition that the project was planned to withstand, although the project may fail at a lesser loading condition

Design water level – The maximum water elevation including the flood surcharge that a dam is designed to withstand.

Design wind – The most severe wind that is reasonably possible at a particular reservoir for generating wind setup and run-up. The determination will generally include the results of meteorological studies, which combine wind velocity, duration, direction, and seasonal distribution characteristics in a realistic manner.

Diaphragm wall (membrane) – A sheet, thin zone, or facing made of an impervious material such as concrete, steel, wood, or plastic. Also see core wall.

Dike – See Dam, w. saddle dam.

Direct Economic Losses – Direct economic losses are the damage to property located downstream from the dam due to the failure. Items in this category include those commonly computed for the National Economic Development (NED) account in any USACE flood risk management study. These include damage to private and public buildings, contents of buildings, vehicles, public infrastructure such as roads and bridges, public utility infrastructure, agricultural crops, agricultural capital, and erosion losses to land.

Diversion channel, canal, or tunnel – A waterway used to divert water from its natural course. The term is generally applied to a temporary arrangement, e.g., to by-pass water around a dam site during construction. “Channel” is normally used instead of “canal” when the waterway is short.

Drain, blanket – A layer of pervious material placed to facilitate drainage of the foundation and/or embankment.

Drain, chimney – A vertical or inclined layer of pervious material in an embankment to facilitate and control drainage of the embankment fill.

Drain, toe – A system of pipe and/or pervious material along the downstream toe of a dam used to collect seepage from the foundation and embankment and convey it to a free outlet.

Drainage area – The area, which drains to a particular point on a river or stream.

Drainage curtain – Also called drainage wells or relief wells. A line of vertical wells or boreholes placed to facilitate drainage of the foundation and abutments and to reduce water pressure.

Drawdown – The difference between a water level and a lower water level in a reservoir within a particular time. Used as a verb, it is the lowering of the water surface.

DSAC 1 (Very High Urgency) – Dams where progression toward failure is confirmed to be taking place under normal operations and the dam is almost certain to fail under normal operations within a few years without intervention; or the incremental risk – combination of life or economic consequences with likelihood of failure – is very high. USACE considers this level of life-risk to be unacceptable except in extraordinary circumstances.

DSAC 2 (High Urgency) – Dams where failure could begin during normal operations or be initiated by an event. The likelihood of failure from one of these occurrences, prior to remediation, is too high to assure public safety; or the incremental risk – combination of life or economic consequences with likelihood of failure – is high. USACE considers this level of life-risk to be unacceptable except in extraordinary circumstances.

DSAC 3 (Moderate Urgency) – Dams in this class have issues where the incremental risk – combination life, economic, or environmental consequences with likelihood of failure – is moderate. USACE considers this level of life-risk to be unacceptable except in unusual circumstances.

DSAC 4 (Low Urgency) – Dams are inadequate with low incremental risk such that the incremental risk – combination of life, economic, or environmental consequences with a likelihood of failure – is low and the dam may not meet all essential USACE guidelines. USACE considers this level of life-risk to be in the range of tolerability but the dam does not meet all essential USACE guidelines.

DSAC 5 (Normal) – Dams in this class are where the incremental risk - combination life, economic, or environmental consequences with likelihood of failure – is very low and the dam meets all essential USACE guidelines (see Appendix F). USACE considers this Level of life-safety risk to be tolerable.

Earthquake – A sudden motion or trembling in the earth caused by the abrupt release of accumulated stress along a fault.

Earthquake, Maximum Credible (MCE) – The MCE is defined as the greatest earthquake that can reasonably be expected to be generated by a specific source on the basis of seismological and geological evidence. Since a project site may be affected by earthquakes generated by various sources, each with its own fault mechanism, maximum earthquake magnitude, and distance from the site, multiple MCE's may be defined for the site, each with characteristic ground motion parameters and spectral shape. The MCE is determined by a DSHA and input from PSHA when site specific studies are performed.

Earthquake, Maximum Design (MDE) – The MDE is the maximum level of ground motion for which a structure is designed or evaluated. The associated performance requirement is that the project performs without catastrophic failure, such as uncontrolled release of a reservoir, although severe damage or economic loss may be tolerated. For critical features, the MDE is the same as the MCE. For all other features, the MDE must be selected as a minimum of event with a 10% probability of exceedance in 100 years. (This corresponds to an average return period of 975 years). The longer or shorter return period for the non critical features can be use if warranted. The MDE can be characterized as a deterministic or probabilistic event.

Earthquake, Operating Basis (OBE) – The OBE is considered to be an earthquake that has a 50 percent chance of being exceeded in 100 years (or a 144-year return period).

Earthquake, Safety Evaluation (SEE) – The earthquake, expressed in terms of magnitude and closest distance from the dam site or in terms of the characteristics of the time history of free-field ground motions, for which the safety of the dam and critical structures associated with the dam are to be evaluated. In many cases, this earthquake will be the maximum credible earthquake to which the dam will be exposed. However, in other cases where the possible sources of ground motion are not easily apparent, it may be a motion with prescribed characteristics selected on the basis of a probabilistic assessment of the ground motions that may occur in the vicinity of the dam. To be considered safe, it should be demonstrated that the dam can withstand this level of earthquake shaking without release of water from the reservoir.

Earthquake, synthetic – Earthquake time history records developed from mathematical models that use white noise, filtered white noise, and stationary and non-stationary filtered white noise, or theoretical seismic source models of failure in the fault zone. (White noise is random energy containing all frequency components in equal proportions. Stationary white noise is random energy with statistical characteristics that do not vary with time).

Economic Consequences – Direct and indirect losses of the failure of a dam and other economic impacts on the regional or national economy. Part of the direct losses is the damage to property located downstream from the dam due to the failure. Items in this category include those commonly computed for the National Economic Development (NED) account in any USACE flood risk management study.

Economic Damages – These include damage to private and public buildings, contents of buildings, vehicles, public infrastructure such as roads and bridges, public utility infrastructure, agricultural crops, agricultural capital, and erosion losses to land.

Economic Regret – Condition when the costs of making a “wrong” decision are deemed to be high. The basic concept of regret is the difference between the outcome of the "best alternative for a future, uncertain state" and outcome of each alternative evaluated for that state. So it is really the potential costs, if you choose an alternative as the best given some future scenario, and a different future actually happens. All regret values are determined by comparing each alternative to the best (e.g. maximum net benefits) for a scenario. So you end up with a regret matrix with scenarios as column headings and alternatives as row headings. There is nothing in the notion about regret about it being "too high." The minimax principle is usually applied to regret to identify the plan or plans that are robust across multiple future scenarios.

Efficiency – Efficiency is the need for society to distribute and use available resources so as to achieve the greatest benefit. For dam safety investments, this means ensuring that resources and expenditure directed to safety improvements are cost-effective and that an appropriate balance between the monetary and non-monetary benefits and the monetary and non-monetary costs is achieved.

Embankment – A raised structure of earth, rocks, or gravel, usually intended to retain water or carry a roadway.

Emergency – An emergency, in terms of dam operation, is a condition, which develops unexpectedly, endangers the structural integrity of the dam and/or downstream property and human life, and requires immediate action.

Emergency Action Plan (EAP) – An action plan that provides detailed instructions for agencies and individuals for responding to emergencies such as a potential dam failure. Plans typically include threat recognition, emergency action message formulation, message dissemination to authorities and the public, provisions for search and rescue, and early stages of recovery.

Emergency Exercise – Drill – A drill is the lowest level exercise that involves an actual exercise. It tests, develops, or maintains skills in a single emergency response procedure. An example of a drill is an in-house exercise performed to verify the validity of telephone numbers and other means of communication along with the response of the entity responsible for the dam. A drill is considered a necessary part of ongoing training.

Emergency Exercise – Full Scale – The full scale exercise is the most complex level of exercise. It evaluates the operational capability of all facets of the emergency management system (both dam operator and state and local emergency management agencies) interactively in a stressful environment with the actual mobilization of personnel and resources. It includes deployment to and movement in the field of personnel and equipment to demonstrate coordination and response capability. The participants actively "play out" their roles in a dynamic environment that provides the highest degree of realism possible for the simulated event. Actual evacuation of critical residents may be exercised if previously announced to the public.

Emergency Exercise – Functional – The functional exercise is the highest level exercise that does not involve the full activation of the entity responsible for dam operation and state and local emergency management agency field personnel and facilities or test evacuation of residents downstream of the dam. It involves the various levels of the entity responsible for dam operation and state and local emergency management personnel that would be involved in an actual emergency. The functional exercise takes place in a stress-induced environment with time constraints and involves the simulation of a dam failure and other specified events. The participants "act out" their actual roles. The exercise is designed to evaluate both the internal capabilities and responses of the entity responsible for dam operation and the workability of the information in the EAP used by the emergency management officials to carry out their responsibilities. The functional exercise also is designed to evaluate the coordination activities between the entity responsible for dam operation and emergency management personnel.

Emergency Exercise – Orientation Seminar – This exercise is a seminar that involves bringing together those with a role or interest in an EAP, i.e., entity responsible for dam operation and state and local emergency management agencies, to discuss the EAP and initial plans for an annual drill or more in-depth comprehensive exercise. The seminar does not involve an actual exercise of the EAP. Instead, it is a meeting that enables each participant to become familiar with the EAP and the roles, responsibilities, and procedures of those involved. An orientation seminar can also be used to discuss and describe technical matters with involved, non-technical personnel.

Emergency Exercise – Tabletop – The tabletop exercise involves a meeting of the entity responsible for dam operation and the state and local emergency management officials in a conference room environment. The format is usually informal with minimum stress involved. The exercise begins with the description of a simulated event and proceeds with discussions by the participants to evaluate the EAP and response procedures and to resolve concerns regarding coordination and responsibilities.

Endangered Species Act (ESA) – The Endangered Species Act of 1973 (7 U.S.C. § 136, 16 U.S.C. § 1531 et seq.) or ESA is the most wide-ranging of the dozens of United States environmental laws passed in the 1970s (references A.6, A.9, and A.10). As stated in section 2 of the act, it was designed to protect critically imperiled species from extinction as a "consequence of economic growth and development untendered by adequate concern and conservation." See ER 1105-2-100 Appendix C (reference A.39) for detailed discussion.

Energy dissipater – A device constructed in a waterway to reduce the kinetic energy of fast flowing water.

Environmental and other Non-monetary Consequences – Direct and indirect consequences that cannot be measured in monetary terms. These stem from the impacts of the dam failure flood and loss of pool on environmental, cultural, and historic resources. In most cases, the assessment of the impacts of dam failure will be the reporting of area and type of habitat impacted, habitat of threatened and endangered species impacted, number and type of historic sites and the cultural significance areas impacted. An indirect non-monetary consequence could be the exposure of people and the ecosystem to hazardous and toxic material released from landfills, warehouses, and other facilities. An estimate of the locations and quantities should be compiled identifying where significant quantities are concentrated.

Environmental Impact Statement (EIS) – An environmental impact statement, in the United States, is a document that must be filed when the federal government takes a "major Federal action significantly affecting the quality of the human environment." The law requiring this is the National Environmental Policy Act. See ER 200-2-2 (reference A.34) and ER 1105-2-100, Appendix C (reference A.39), for details on preparation of EIS.

Epicenter – The point on the earth's surface located vertically above the point of origin of an earthquake.

Equity in Risk Management – Equity, in the risk management context, is the right of individuals and society to be protected, and the right that the interests of all are treated with fairness, placing all members of society on a (more) equal footing in terms of levels of risk faced. The equity objective is addressed by requiring that all risks higher than a limit value be brought down below the limit, except in extraordinary circumstances.

Essential Agency Guidelines – The state-of-practice for design, construction, operation, and maintenance of USACE dams as documented in current USACE regulations. The requirements specified in these USACE regulations must be met for a dam to achieve DSAC 5 (Normal) classification status. These regulations include: Engineer Circulars, Engineer Regulations, Engineer Manuals, Engineer Pamphlets and Engineer Technical Letters; and Engineering and Construction Bulletins, and other official HQUSACE dam safety-related Policy Letters and guidance. Current state-of-practice guidance is summarized in Appendix F.

Event Tree(s) – An event tree serves as a model of the physical dam system in which each node represents an identifiable behavior of the dam or its physical components and each event should be something that happens in space or time (Hartford and Baecher, 2004). An event tree begins with a single initiating branch on the left hand side and progress toward more detailed events to the right hand side. Starting with an initiating event branch (e.g. a severe flood, an earthquake or other natural or human caused hazards), each node is divided at various nodes to generate all possible subsequent events. Each node is an origin of possible subsequent events and each branch is a possible event that is a logical consequence of the one before it, and a necessary precursor of the one that follows. As the number of events increases, structure fans outs like the branches of a tree until each event tree chain comes to a terminal branch. Terminal branches are the system outcome or system effect of an initiating event which leads to adverse consequences or failure of the system completely or partially. The tree may be extended to represent the economic damages and life loss consequences associated with the terminal branches.

Existing Condition Component Risk Estimates – An Estimate of risk contributed by an individual credible failure mode that is associated with a dam for given load combinations.

Existing and Future Condition Without Federal Action Consequence Analysis – Analysis of existing and future without Federal remediation project consequences.

Existing Condition Risk Estimate – The risk estimate at a point in time.

Exposure Assessment – Exposure occurs when a susceptible asset comes in contact with a hazard. An exposure assessment, then, is the determination or estimation (which may be qualitative or quantitative) of the magnitude, frequency, or duration, and route of exposure.

Failure Mode – A way that failure can occur, described by the means by which element or component failures must occur to cause loss of the sub-system or system function of a dam that could result in failure.

Failure of a Water Control System – A water control system failure is any condition that results in the uncontrolled release or discharge of water. This might include misoperation involving improper or unintended opening or closing of gates, valves, operation of pumps, etc. Misoperation leading to systems not operating when needed or intended (i.e. gates fail to open on demand) might also lead to failure. Another example could be structural failure involving partial or total collapse of a gate.

Fault – A fracture or fracture zone in the earth crust along which there has been displacement of the two sides relative to one another.

Fault, active – A fault which, because of its present tectonic setting, can undergo movement from time to time in the immediate geologic future.

Fault, capable – An active fault that is judged capable of producing macro earthquakes and exhibits one or more of the following characteristics:

a. Movement at or near the ground surface at least once within the past 35,000 years.

b. Macroseismicity (3.5 magnitude Richter or greater) instrumentally determined with records of sufficient precision to demonstrate a direct relationship with the fault.

c. A structural relationship to a capable fault such that movement on one fault could be reasonably expected to cause movement on the other.

d. Established patterns of microseismicity, which define a fault, with historic macroseismicity that can reasonably, be associated with the fault.

Fetch – The straight-line distance across a body of water subject to wind forces. The fetch is one of the factors used in calculating wave heights in a reservoir.

Filter (filter zone) – One or more layers of granular material graded (either naturally or by selection) so as to allow seepage through or within the layers while preventing the migration of material from adjacent zones.

Flashboards – Structural members of timber, concrete, or steel placed in channels or on the crest of a spillway to raise the reservoir water level but that may be quickly removed in the event of a flood.

Flip bucket – An energy dissipater located at the downstream end of a spillway and shaped so that water flowing at a high velocity is deflected upwards in a trajectory away from the foundation of the spillway.

Flood – A general and temporary condition of partial or complete inundation of two or more acres of normally dry land area or of two or more properties from: (1) overflow of inland or tidal waters; (2) unusual and rapid accumulation or runoff of surface waters from any source; (3) mudflow; or (4) collapse or subsidence of land along the shore of a lake or similar body of water as a result of erosion or undermining caused by waves or currents of water exceeding anticipated cyclical levels that result in a flood as defined above. The four terms below are used to further define flooding and efforts to prevent flooding.

a. Flood Level. The size of a flood may be expressed in terms of probability, of exceedance per year such as one percent chance flood or expressed as a fraction of the probable maximum flood or other reference flood.

b. Flood Control. The Flood Control Act of 1936 declared that flood control was a national priority since floods constituted a menace to the national welfare. This act authorized the construction of levees, floodwalls, channel improvements, and reservoirs to control flooding.

c. Flood Damage Reduction. The term flood damage reduction was adopted in recognition that the structures built for flood control only reduced the level of flooding and did not totally control all floods. Projects developed for flood damage reduction also include non-structural elements.

d. Flood Risk Management. This term recognizes that there are different levels of risks in flood control works and in flood damage reduction activities. Since all flood management structures and other features have a risk of failure, the current practice is to seek to reduce the risk to a tolerable level that the public is willing to accept.

Flood routing – A process of determining progressively over time the amplitude of a flood wave as it moves past a dam or downstream to successive points along a river or stream.

Flood, antecedent – A flood or series of floods assumed to occur prior to the occurrence of an inflow design flood.

Flood, base safety standard (BSS) – The inflow design flood where there is no significant increase in adverse consequences from dam failure compared to non-failure adverse consequences.

Flood, Safety Evaluation (SEF) – The largest flood for which the safety of a dam and appurtenant structure is to be evaluated.

Flood, Inflow Design (IDF) – The flood used in the design of a dam and its appurtenant works particularly for sizing the spillway and outlet works, and for determining maximum temporary storage and height of dam requirements.

Flood, Probable Maximum (PMF) – The most severe flood that is considered reasonably possible at a site as a result of meteorological and hydrologic conditions.

Floodplain – An area adjoining a body of water or natural stream that has been or may be covered by floodwater.

F-N chart (plot) – This chart is a plot of the annual probability of exceedance (greater than or equal to) of potential life loss (F) vs. incremental potential loss of life (N) due to failure compared to the no failure condition. Thus, the F-N chart displays the entire estimated probability distribution of life loss for a reservoir encompassing all failure modes and all population exposure scenarios for a particular reservoir. See figure 5.4.b.

Freeboard – Vertical distance between the design water level and the top of dam.

Full pool – The reservoir level that would be attained when the reservoir is fully utilized for all project purposes, including flood control.

Future Without Federal Action Condition – The condition, data, or other representations of the topic of interest to be used for comparison of changes which may occur without intervention or as a result of a remediation alternative remediation. It is comprised of the existing conditions and such future projected conditions as chosen to be relevant for the comparison.

Gallery – A passageway in the body of a dam used for inspection, foundation grouting, and/or drainage.

Gantry crane – A fixed or traveling bent-supported crane for handling heavy equipment.

Gate – A movable, watertight barrier for the control of water in a waterway. Types of gate include the following:

a. Bascule gate. See flap gate.

b. Bulkhead gate. A gate used either for temporary closure of a channel or conduit before dewatering it for inspection or maintenance or for closure against flowing water when the head difference is small, e.g., for diversion tunnel closure.

c. Crest gate (spillway gate). A gate on the crest of a spillway to control the discharge or reservoir water level.

d. Drum gate. A type of spillway gate consisting of a long hollow drum. The drum may be held in its raised position by the water pressure in a flotation chamber beneath the dam.

e. Emergency gate. A standby or auxiliary gate used when the normal means of water control is not available. Sometimes referred to as guard gate.

f. Fixed wheel gate (fixed roller gate or fixed axle gate). A gate having wheels or rollers mounted on the end posts of the gate. The wheels bear against rails fixed in side grooves or gate guides.

g. Flap gate. A gate hinged along one edge, usually either the top or bottom edge. Examples of bottom-hinged flap gates are tilting gates and fish belly gates so called from their shape in cross section.

h. Flood gate. A gate to control flood release from a reservoir.

i. Outlet gate. A gate controlling the flow of water through a reservoir outlet.

j. Radial gate (tainter gate). A gate with a curved upstream plate and radial arms hinged to piers or other supporting structure.

k. Regulating gate (regulating valve). A gate or valve that operates under full pressure flow conditions to regulate the rate of discharge.

l. Roller drum gate. See drum gate.

m. Roller gate (stoney gate). A gate for large openings that bears on a train of rollers in each gate guide.

n. Skimmer gate. A gate at the spillway crest whose prime purpose is to control the release of debris and logs with a limited amount of water. It is usually a bottom hinged flap or Bascule gate.

o. Slide gate (sluice gate). A gate that can be opened or closed by sliding in supporting guides.

Gate chamber – Also called valve chamber. A room from which a gate or valve can be operated, or sometimes in which the gate is located.

Geotextiles – Any fabric or textile (natural or synthetic) when used as an engineering material in conjunction with soil, foundations, or rock. Geotextiles have the following uses: drainage, filtration, separation of materials, reinforcement, moisture barriers, and erosion protection.

Groin – The area along the contact (or intersection) of the face of a dam with the abutments.

Grout – A fluidized material that is injected into soil, rock, concrete, or other construction material to seal openings and to lower the permeability and/or provide additional structural strength. There are four major types of grouting materials: chemical, cement, clay, and bitumen.

Grout curtain – One or more zones, usually thin, in the foundation into which grout is injected to reduce seepage under or around a dam.

Grout blanket – An area of the foundation systematically grouted to a uniform shallow depth.

Grout cap – A concrete pad constructed to facilitate subsequent pressure grouting of the grout curtain.

Hazard – Hazard is anything that is a potential source of harm to a valued asset (human, animal, natural, economic, social).

Hazard Characterization – Hazard Characterization is the qualitative and/or quantitative evaluation of the nature of the adverse effects associated with the identified hazard(s), which may be present in the situation of interest.

Hazard Identification – Hazard Identification identifies all biological, chemical, social, economic, and physical agents or natural/anthropogenic events capable of causing adverse effects on people, property, economy, culture, social structure, or environment.

Hazard potential classification – The rating for a dam based on the potential consequences of failure. The rating is based on potential for loss of life and damage to property that failure of that dam could cause. Such classification is related to the amount of development downstream of a dam.

HAZUS – A database and software system sponsored by the Federal Emergency Management Agency (FEMA) for performing a range of hazard analysis, including flood loss and impacts, for a variety of levels of detail regional wherein analysis supported by national databases; and site specific wherein local data be substituted for data that would come from national databases.

Head, static – The vertical distance between two points in a fluid.

Head, velocity – The vertical distance that would statically result from the velocity of a moving fluid.

Headrace – A free-flow tunnel or open channel that conveys water to the upper end of a penstock; hence, the terms “headrace tunnel” and ‘headrace Canal.”

Heel – The junction of the upstream face of a gravity or arch dam with the ground surface. For an embankment dam the junction is referred to as the upstream toe of the dam.

Height, above ground – The maximum height from natural ground surface to the top of a dam.

Height, dam – The dam height is the vertical distance between the lowest point on the crest of the dam and the lowest point in the original streambed.

Height, hydraulic – The vertical difference between the maximum design water level and the lowest point in the original streambed.

Height, structural – The vertical distance between the lowest point of the excavated foundation to the top of the dam.

Incident – An event occurrence at a dam that could potentially result in a dam safety issue, such as a spillway flood, seismic event, gate operation failure, etc. that should be documented and trigger an investigation.

Inclinometer – An instrument, usually consisting of a metal or plastic tube inserted in a drill hole and a sensitized monitor either lowered into the tube or fixed within the tube. This measures at different points the tube’s inclination to the vertical. By integration, the lateral position at different Levels of the tube may be found relative to a point, usually the top or bottom of the tube, assumed to be fixed. The system may be used to measure settlement during embankment construction (Bartholomew, Murray, and Goins 1987). A reference benchmark is used to establish the top of the inclinometer casing. The instrument probe is lowered to each slip joint in the casing, and the depth to each joint is read directly off the tape. Settlement measurements are made as each section of casing is added during embankment construction.

Incremental consequences – Incremental consequences are associated with a failure of the project to provide the planned level of public protection plus any additional risk created by the project due to dam failure. Incremental consequences = (Consequences associated with the estimated performance of the project including failure) - (Consequence associated with the estimated performance of the project hypothetically without failure).

Independent External Peer Review Team – A team of experts selected in accordance with Section 2034 and/ Section 2035 of the Water Resources Development Act of 2007 (Public Law 110-114) to review proposed Civil Works projects and projects under construction.

Independent Technical Review (ITR) – A comprehensive independent review of a technical product (design and construction documents). .The ITR was replaced by an ATR level of review in 2009.

Indirect Economic Impacts – Impacts associated with the destruction of property and the displacement of people due to the failure. The destruction due to the failure flood can have significant impacts on the local and regional economy as businesses at least temporarily close resulting in loss of employment and income. Similarly, economic activity linked to the services provided by the dam will also have consequences. All these indirect losses then have ripple or multiplier effects in the rest of the regional and national economy due to the resulting reduction in spending on goods and services in the region. These losses are the increment to flood losses above those that would have would have occurred had the dam not failed.

Individual incremental life safety tolerable risk guideline (ANCOLD) – For existing dams, the individual risk to the person or group, which is most at risk, should be less than a limit value of 1 in 10,000 per year, except in extraordinary circumstances, following the ANCOLD (2003) (reference A.130) individual life safety risk guideline. For new dams or major augmentations , the individual risk to the person or group, which is most at risk, should be less than a limit value of 1 in 100,000 per year, except in extraordinary circumstances, following the ANCOLD (2003) (reference A.130) individual life safety risk guideline. In the case of existing dams and new dams or major augmentations, individual risks are to be lower than the limit values to an extent determined in accordance with the ALARP principle.

Individual Risk – The increment of risk imposed on a particular individual by the existence of a hazardous facility. This increment of risk is an addition to the background risk to life, which the person would live with on a daily basis if the facility did not exist. (ANCOLD October 2003) (reference A.130).

Initial reservoir filling – A deliberate impoundment to meet project purposes (a continuing process as successively higher pools are attained for flood control projects).

Institute for Water Resources – The U.S. Army Engineer Institute for Water Resources (IWR) was formed to provide forward-looking analysis and research in developing planning methodologies to aid the Civil Works program. Since its beginnings in 1969, the Institute was envisioned to provide USACE with long-range planning capabilities to assist in improving the civil works planning process. Today the Institute continues to provide the Civil Works program with a variety of products to enhance the U.S. Army Engineer Institute for Water Resources development planning. IWR is comprised of several semi-independent Centers, and a senior staff of planning and policy experts. See http://www.iwr.usace.army.mil.

Instrumentation – An arrangement of devices installed into or near dams (i.e., piezometers, inclinometers, strain gages, measurement points, etc.), which provide for measurements that can be used to evaluate the structural behavior and performance parameters of the structure.

Intake – Any structure in a reservoir, dam, or river through which water can be discharged. Placed at the beginning of an outlet-works waterway (power conduit, water supply conduit), the intake establishes the ultimate drawdown level of the reservoir by the position and size of its opening(s) to the outlet works. The intake may be vertical or inclined towers, drop inlets, or submerged, box-shaped structures.

Intangible Consequences – These are consequences that have no directly observable physical dimensions but exist in the minds, individually and collectively, of those affected. Such consequences are real and can support decisions. Intangible consequences identified in ANCOLD (2003) (reference A.130) include such things as: the grief and loss suffered by relatives and friends of those who die; the impact of multiple deaths on the psyche of the community in which they lived; the stress involved in arranging alternative accommodations and income; the sense of loss by those who enjoyed the natural landscape destroyed; and the fear of lost status and reputation of the dam owning organization and its technical staff (see discussion at paragraph 5.3.10.3 and ANCOLD (2003) (reference A-130). The affect of these intangible consequences can be observed more tangibly in terms of increased mental health expenditures and increased suicides.

Interagency Committee on Dam Safety – The Interagency Committee on Dam Safety (ICODS) is comprised of a representative of each of the Department of Agriculture, the Department of Defense, the Department of Energy, the Department of the Interior, the Department of Labor, the Federal Emergency Management Agency, the Federal Energy Regulatory Commission, the Nuclear Regulatory Commission, the Tennessee Valley Authority, and the United States Section of the International Boundary Commission. ICODS encourages the establishment and maintenance of effective Federal programs, policies, and guidelines intended to enhance dam safety for the protection of human life and property through coordination and information exchange among Federal agencies concerning implementation of the Federal Guidelines for Dam Safety (reference A.114).

Interim Risk Reduction Measure (IRRM) – Dam Safety Risk Reduction Measures that are to be formulated and undertaken for dams that are not considered to be tolerably safe and are intended as interim until more permanent remediation measures are implemented. Increased monitoring and reservoir restrictions are examples of interim measures that can be taken at a project.

Interim Risk Reduction Measures Plans (IRRMP) – Plans prepared by the districts for all DSAC Class I, 2, and 3 dams. The urgency of submittal corresponds to the DSAC Class. In general, the plans will describe the project and area, dam safety issues, failure modes and analysis, interim risk reduction plans, consequences with and without the plan, schedule, cost, coordination and review documentation, updated emergency action plan, and communications plan.

Interlock – A device for preventing a mechanism from being set in motion when another mechanism is in such a position that the two operating simultaneously might produce undesirable results.

Interlock – A device for preventing a mechanism from being set in motion when another mechanism is in such a position that the two operating simultaneously might produce undesirable results.

Internal Erosion: Removal of soil particles within an embankment dam or its foundation by seepage or leakage. Internal erosion development leading to dam failure can be represented by four phases: initiation, continuation, progression, and breach.

Intervention – An action taken during the sequence of any failure mechanism either when failure has been initiated or later to prevent or delay completion of failure progression.

Inundation map – Inundation Map: A map showing either the actual or predicted extent of flood water within a study area for future pre-determined flood events, ongoing flood events, or past flood events. For dams, a map showing the predicted extent of inundation from controlled or uncontrolled reservoir releases for a pre-determined event scenario or scenarios. Releases may be a result of normal reservoir operation, a result of structural failure or a result of misoperation. An example of a controlled release is flood-inducing spillway discharge. An example of an uncontrolled release is overtopping and/or structural failure. For levees, a map showing the predicted extent of leveed area inundation due to breach of the levee system prior to or during overtopping, levee overtopping without breach, or misoperation of a levee system component for a pre-determined event scenario. An inundation map is sometimes referred to as a flood inundation map. The policy on release of inundation maps is provided in EC 1165-2-215 (reference A.97).

Issue Evaluation Studies – Issue Evaluation studies for dams classified in DSAC Classes 2, 3, and 4 are studies to better determine the nature of the dam safety issue and the degree of urgency for action within the context of the full USACE inventory of dams. The intent of an Issue Evaluation Study is to perform a more robust and detailed level of risk assessment, than used in the SPRA that will enable informed decisions about the need for further investigations, the DSAC classification, and interim risk reduction measures implementation. However the level of detail should only be what is needed to justify the decision to pursue or not to pursue a dam safety modification study.

Leakage – Concentrated flow through preferential paths (e.g., crack in cohesive soil, open rock defect).

Lead Engineer – A registered professional engineer (typically a civil, geotechnical, or structural engineer) or engineering geologist qualified through appropriate technical training and experience, assigned the responsibility to lead the technical team members of a product delivery team. The engineering geologist is required to be a registered professional engineer. The lead engineer is responsible for working closely with the Project Manager and insuring that all technical requirements are addressed in the Project Management Plan (PMP). The lead engineer insure that the necessary field investigations are completed during the study and design phases; that plans and specifications are reviewed; that the technical comments on the design are properly addressed; and that engineers on the PDT visit the project during the construction phase. When possible the same individual should function as the lead engineer from the start of the studies until the completion of the project. (See Dam Safety Modification Lead Engineer definition for dam safety modification projects.)

Length of dam – The length along the top of the dam. This also includes the spillway, power plant, navigation lock, fish pass, etc., where these form part of the length of the dam. If detached from the dam these structures should not be included.

Levee – An embankment whose primary purpose is to furnish flood protection from seasonal high water. Embankments that are subject to water loading for prolonged periods or permanently should be designed in accordance with earth dam criteria.

Life Loss Consequences – This includes the determination of the population at risk, threaten population, and the estimated potential loss of life.

Life Loss Estimates – Estimate of potential life loss using approved life loss estimating methodology. May be for individual failure modes, or combined for a set of potential failure modes for specified loading scenario(s).

Life Safety Tolerable Risk Guidelines – Three types of life safety tolerable risk guidelines will be used under the USACE tolerable risk guidelines. Individual incremental life safety risk using probability of life loss and Societal incremental life safety risk express in two different ways - Probability distribution of potential life loss (F-N chart); and the f-$\bar{N}$ with average annual Life Loss (AALL).

Lifelines -- The public facilities and systems that provide basic life support services such as water, energy, sanitation, communications and transportation.

Lifeline Systems – Public works and utilities such as electrical power, gas and liquid fuels, telecommunications, transportation, and water and sewer systems.

Likelihood – Used as a qualitative description of probability and frequency. (ICOLD) A description of the occurrence chance of a particular event.

Limit Line for Life Safety – Tolerable Risk Limit Line is depicted in Figures 5.4 and 5.5 of Chapter 5, Tolerable Risk Guidelines. It defines the limit line separating unacceptable risk from tolerable risk on f-$\bar{N}$ and F-N diagram.

Limit of Tolerability – Limit of Tolerability as depicted on Figure 5.1 of Chapter 5. It defines the limit line separating Intolerable Residual Risk from Tolerable Residual Risk within the range of tolerability conceptually depicting the ALARP principle.

Liquefaction – A condition whereby soil undergoes continued deformation at a constant low residual stress or with low residual resistance, due to the buildup and maintenance of high pore water pressures, which reduces the effective confining pressure to a very low value. Pore pressure buildup leading to liquefaction may be due either to static or cyclic stress applications and the possibility of its occurrence will depend on the void ratio or relative density of a cohesionless or slightly cohesive soil and the confining pressure.

Locally Controlled System – A locally controlled system is a system where operation is made by personnel physically located at the project site using controls that are physically located at the structure being operated.

Logboom – A chain of logs, drums, or pontoons secured end-to-end and floating on the surface of a reservoir so as to divert floating debris, trash, and logs.

Maximum flood control level – The highest elevation of the flood control storage.

Maximum pool – The highest pool elevation resulting from the inflow design flood.

Maximum wave – The highest wave in a wave group.

Minimum operating level – The lowest level to which the reservoir is drawn down under normal operating conditions.

National Dam Safety Review Board – The National Dam Safety Review Board provides the Director of FEMA with advice in setting national dam safety priorities and considers the effects of national policy issues affecting dam safety. Review Board members include FEMA, the Chair of the Board; representatives from four federal agencies that serve on the Interagency Committee on Dam Safety (ICODS); five state dam safety officials; and one member from the private sector.

National Environmental Policy Act (NEPA) – The National Environmental Policy Act (NEPA) (reference A.6) requires federal agencies to integrate environmental values into their decision making processes by considering the environmental impacts of their proposed actions and reasonable alternatives to those actions. To meet NEPA requirements federal agencies prepare a detailed statement known as an Environmental Impact Statement (EIS). EPA reviews and comments on EIS's prepared by other federal agencies, maintains a national filing system for all EIS's, and assures that its own actions comply with NEPA.

National Inventory of Dams – The National Inventory of Dams (NID) contains information on approximately 84,000 dams throughout the U.S. that are more than 25 feet high, hold more than 50 acre-feet of water, or are considered a significant hazard if they fail. The NID is maintained and published by USACE with information from all 50 states, Puerto Rico, and 16 Federal agencies. The NID is available on the web at http://geo.usace.army.mil/pgis/f?p=397:12:0

Non-Structural Risk Reduction – Risk reduction by measures that do not require structural modification or construction related to the dam and its appurtenant works.

Normal Operations – Loading on the dam resulting from day-to-day pool operations to achieve authorized purposes. (For the purposes of a screening analysis for dry dams, or where pool elevations fluctuate widely and no historical normal pool elevation has been established, the normal loading is usually correlated to a 1 to 10 year return period.)

Observation well – A hole used to observe the groundwater surface at atmospheric pressure within soil or rock.

Operation restrictions – Changes to operating pool levels and durations, or reduced lockages, power generation, water supply, or conservation operations.

Outlet – An opening through which water can be freely discharged from a reservoir to the river for a particular purpose.

Outlet works – A dam appurtenance that provides release of water (generally controlled) from a reservoir.

Parametric Studies – Parametric studies execute one application many times with different sets of input parameters. Such studies are in-effect, systematic, carefully controlled sensitivity studies.

Parapet wall – A solid wall built along the top of a dam (upstream or downstream edge) used for ornamentation, for safety of vehicles and pedestrians, or to prevent overtopping caused by wave run-up.

Peer Review – Peer review is a form of deliberation involving an exchange of judgments about the appropriateness of methods and the strength of the author's inferences. Peer review involves the review of a draft product for quality by specialists in the field who were not involved in producing the draft.

Peer Review Panel – A panel of peer experts, usually formed by a district, to review and to advise on particular difficult or controversial technical issues related to a dam safety study. The peer group may be from inside or outside USACE, or whatever combination of experts is judged to best fit the need.

Penstock – A pressurized pipeline or shaft between the reservoir and hydraulic machinery.

Performance Evaluation – Description of how the dam and appurtenant structures have performed over the years since construction.

Performance Uncertainty – Performance uncertainty refers to the situation in which more rigorous and detailed studies are needed to more accurately predict the system response probabilities within each applicable failure mode.

Periodic Assessments (PA) – The periodic assessment will consist of a site visit, typically associated with a periodic inspection, a potential failure modes analysis, and a semi- quantitative risk assessment based on existing data and limited development of estimated consequence data developed by the Modeling, Mapping, and Consequence Production Center. The primary purposes of the Periodic Assessment are as follows: Evaluate the project vulnerabilities and associated risks, including non-breach risks; Reevaluate the DSAC of a project and recommend a change, if necessary; Review and if necessary revise the IRRMP; Identify the need for issue evaluation studies and provide data to prioritize issue evaluation studies; Identify and prioritize any data collection, analyses, and study needs; Identify operations and maintenance, monitoring, emergency action plan, training and other recurrent needs ; and Provide a better understanding of vulnerabilities and a basis for future dam safety inspections and activities.

Periodic Inspections (PI) – The recurrent engineering inspections conducted at dams and other civil works structures whose failure or partial failure could jeopardize the operational integrity of the project, endanger the lives and safety of the public or cause substantial property damage must be periodically inspected and evaluated to ensure their structural stability, safety, and operational adequacy.

Phreatic surface – The free surface of water seeping at atmospheric pressure through soil or rock.

Piezometer – An instrument used for measuring fluid pressure (air or water) within soil, rock, or concrete.

Piping – A mechanism of internal erosion which progresses backward in the opposite direction of seepage flow.

Plunge pool – A natural or artificially created pool that dissipates the energy of free falling water.

Population at Risk – The population downstream of a dam that would be subject to risk from flooding in the instance of a potential dam failure; usually documented in numbers of persons at risk.

Pore water pressure – The interstitial water pressure within a mass of soil, rock, or concrete.

Portfolio Risk Management Process – The management process shown generally on Figure 2.3 and in detail for USACE Figure 3.1. It is a risk-informed USACE-wide portfolio perspective process applied to all features of all dams on a continuing basis. Same definition as 'Dam Safety Portfolio Risk Management Process" above.

Potential Failure Mode (PFM) – The chain of events leading to dam failure or a portion there of that could lead to dam failure. The dam does not have to completely fail in the sense of a complete release of the impounded water.

Potential Failure Mode Analysis (PFMA) – A PFMA is an examination of "potential" failure modes for an existing dam by a team of persons who are qualified either by experience and\or education to evaluate dams. It is based on a review of existing data and information, first hand input from field and operational personnel, site inspection, completed engineering analyses, discussion of dam characteristics, failure causes and an understanding of the consequences of failure. The PFMA is intended to provide enhanced understanding and insight on the risk exposure associated with the dam or levee.

Probability – A measure, of the likelihood, chance, or degree of belief that a particular outcome or consequence will occur. A probability provides a quantitative description of the likelihood of occurrence of a particular event. This is expressed as a value between 0 and 1. (USACE)

Probability of Failure – The probability that a component of a dam or the dam will fail, given a specified load, leading to sudden, rapid, and uncontrolled release of impounded water.

Probability of Individual Life Loss – The probability of individual life loss, which is used in the evaluation of Individual incremental life safety risk, is not necessarily the same as the probability of failure that is used in the evaluation of Reclamation's APF guideline. The probability of life loss is based on the probability of failure and a consideration of exposure factors such as day-night differences in PAR and evaluation and the seasonal presence of people in campgrounds. The level of detail that is appropriate for characterizing exposure factors should be “decision driven”, although it is noted that FEMA’s HAZUS data base provides opportunity for some level of automation in capturing information on exposure factors. The distinction between probability of failure and probability of life loss is particularly important for navigation dams, but can also have a significant effect on the evaluation of life safety for other types of dams. It applies to societal risk as well as to individual risk.

Probable Maximum Precipitation (PMP) – Theoretically, the greatest depth of precipitation for a given duration that is physically possible over a given size storm area at a particular geographical location.

Pumped storage reservoir – A reservoir filled entirely or mainly with water pumped from outside its natural drainage area.
Quality (as related to construction) – Conformance to properly developed requirements.

Quality Assurance (QA) – The procedure by which the Government fulfills its responsibility to be certain the contractors’ quality control is functioning and the specified end product is realized.

Quality Management – All control and assurance activities instituted to achieve the product quality established by the contract requirements

Rapid Consequence Analysis/Estimate – The rapid consequence estimate requires a very limited detail, unsteady-flow hydraulic model to reproduce various, with and without, dam failure scenarios. These failure scenarios would include sunny day, Probably Maximum Flood (PMF) and several intermediate load cases between these extremes for both the with and without dam failure condition.

Redundancy – The duplication of critical components of a system with the intention of increasing reliability of the system, usually in the case of a backup or fail-safe.

Regional Cadres – Teams of technical specialists and analysts (cadre) assembled to conduct project specific risk evaluations, such as PFMAs, based on expert knowledge of the geology, hydrology, structural integrity, soils, consequences, and other relevant factors.

Regulation Design Capacity – The maximum hydrologic loading condition (flood hydrograph) above which the project no longer has storage capacity to reduce flow that would provide flood damage reduction benefits. The regulation design capacity is typically the reservoir storage capacity (and attendant operation rules and policies) that are authorized for a flood damage reduction reservoir project. This will always be a hydrologic loading level less than the loading levels used as the structural design capacity.

Reliability – For gate and mechanical systems reliability is defined as the likelihood of successful performance of a given project element. It may be measured on an annual basis or for some specified time period of interest or, for example, in the case of spillway gates, on a per demand basis. Mathematically, Reliability = 1 - Probability of unsatisfactory operation.

Remediation – Implementation of long-term structural and non-structural risk reduction measures to resolve Dam Safety issues.

Remotely Controlled System - A remotely controlled system is a system where operation is made by personnel who are physically located at the project site using remote controls that are not physically at the structure being operated.

Remotely Operated System - A remotely operated system is a system where operation is made by personnel who are not physically located at the project site using remote controls that are not physically located at the structure being operated.

Reservoir – A body of water impounded by a dam and in which water can be stored.

Reservoir regulation (or operating) procedure – Operating procedures that govern reservoir storage and releases.

Reservoir surface area – The area covered by a reservoir when filled to a specified level.

Residual Risk – The remaining level of risk at any time before, during and after a program of risk mitigation measures has been taken.

Resilience – The ability to avoid, minimize, withstand, and recover from the effects of adversity, whether natural or manmade, under all circumstances of use.

Riprap – A layer of large uncoursed stone, precast blocks, bags of cement, or other suitable material, generally placed on the upstream slopes of an embankment or along a watercourse as protection against wave action, erosion, or scour. Riprap is usually placed by dumping or other mechanical methods and in some cases is hand placed. It consists of pieces of relatively large size as distinguished from a gravel blanket. Also known as stone slope protection.

Risk – A measure of the probability and severity of undesirable consequences or outcome.

Risk assessment – Risk assessment is a broad term that encompasses a variety of analytic techniques that are used in different situations, depending upon the nature of the risk, the available data, and needs of decision makers. A risk assessment is a systematic, evidence based approach for quantifying and describing the nature, likelihood, and magnitude of risk associated with the current condition and the same values resulting from a changed condition due to some action. Risk assessment includes explicit acknowledgment of the uncertainties in the risk. As applied to dam safety, the process of identifying the likelihood and consequences of dam failure to provide the basis for informed decisions on a course of action.

Risk Characterization – Risk characterization is the qualitative or quantitative description of the nature, magnitude and likelihood of the adverse effects associated with a hazard with and without a risk management action. A risk characterization often includes: one or more estimates of risk; risk descriptions; evaluations of risk management options; economic and other evaluations; estimates of changes in risk attributable to the management options.

Risk Communication – Risk communication is the open, two-way exchange of information and opinion about hazards and risks leading to a better understanding of the risks and better risk management decisions.

Risk Engine – Software and computational algorithms either commercially available or under development by USACE that is used to construct an event tree for a plausible failure mode and automatically calculate the estimated risk.

Risk Estimate – The end result risk evaluation generated by application of a risk engine to the credible failure mode under study.

Risk Exposure – The population, infrastructure, and other assets and valued resources that would be adversely impact from a dam failure.

Risk-informed – Risk information will play a key role in decisions related to dam safety but will not be the only information to influence the final decisions.

Risk management – Risk management is the process of problem finding and initiating action to identify, evaluate, select, implement, monitor and modify actions taken to alter levels of risk, as compared to taking no action. The purpose of risk management is to choose and prioritize work required to reduce risk.

Risk Management Center (RMC) – An independent USACE Center assigned to the Institute for Water Resources, which is responsible for development and implementation of dam and levee safety policy, prioritization of national dam and levee safety projects and technical consistency of dam and levee safety products. The Center utilizes a combination of in-situ and virtual resources (district, contract, the Modeling, Mapping, and Consequence Production Center, and Policy and Procedures workgroups) to manage the program.

Risk Reduction Measure – Actions formulated and undertaken to reduce risk.

Risk to Tolerable Levels – In context, this refers to implementing dam safety risk reduction measures such that the resulting risk is 'tolerable' as shown graphically in figure 5.1. Generally is the outcome of application of the ALARP (As Low As Reasonably Possible) considerations.

Robustness – Robustness is the ability of a system to continue to operate correctly across a wide range of operational conditions, with minimal damage, alteration or loss of functionality, and to fail gracefully outside of that range. The wider the range of conditions included, the more robust the system.

Rock anchor – A steel rod or cable placed in a hole drilled in rock, held in position by grout, mechanical means, or both. In principle, the same as a rock bolt, but usually the rock anchor is more than 4 meters long.

Rock bolt – A steel rod placed in a hole drilled in rock, held in position by grout, mechanical means, or both. A rock bolt can be tensioned.

Run-up – The vertical distance above the setup that the rush of water reaches when a wave breaks on the dam embankment.

Safe (Unsafe) – Involving little or no chance of dam failure. Meets all required USACE guidelines and criteria.

Safety – Safety is thought of as the condition of being free from danger, risk, or injury. However, safety is not something that can be absolutely achieved or guaranteed. Instead safety is the condition to which risks are managed to acceptable levels. Therefore, safety is a subjective concept based on individual perceptions of risks and their tolerability

Safety Assurance Review Team – Section 2035, Safety assurance review team, Public Law 110-114, the Water Resource Development Act of 2007, requires a safety assurance review of the design and construction of work effecting public safety. This review team is formed at the time pre-construction engineering and design starts and stays with the project until the completion of construction.

Screening for Portfolio Risk Analysis (SPRA) – This analysis screened projects based on available information, to expeditiously identify the highest risk dams requiring urgent and compelling action (Dam Safety Action Classification 1 and 2 Dams) with low chance of missing any such dams Also, the SPRA is to provide information for preliminary classification of the remainder of the USACE dams into Dam Safety Action Classes 3 - 4. SPRA does not provide sufficient information to confirm whether a dam can be placed in Dam Safety Action Classification Class 5. SPRA will be performed only once for every dam in the USACE inventory. Risk estimates that are computed from SPRA are a relative measure only to compare dams across the USACE portfolio. Decisions and actions relative to tolerable risk cannot be made solely from SPRA results.

Section 1203 - Dam Safety Assurance Cost Sharing – Section 1203, WRDA, 1986 (reference A.12) provides for special cost-sharing for modification of completed USACE dam projects that are potential safety hazards in light of current engineering standards and criteria. The problems that meet the criteria of Section 1203 fall into three main categories: hydrologic, seismic, and change in state-of-the-art. (Modifications required on a project due to state-of-the-art changes, but not related to hydrologic or seismic deficiencies, must be decided on a case-by-case basis by the ASA(CW). Costs incurred in modifications for dam safety assurance must be recovered in accordance with provisions of the statute.

Seepage – Flow through porous media.

Significant Failure Modes – Significant failure modes are a subset of credible failure modes (i.e. physically possible). The term “significant” should be judged in the context of the purpose of the risk assessment and the decisions that it will inform. Factors to consider include Dam Safety Action Classification, comparisons with tolerable risk guidelines, scoping the next level of study, portfolio roll-up of the risk estimates, the level of confidence in risk estimates, representation of uncertainty in estimates, and prioritization for next phase of work. For example credible failure mode should be considered significant if the probability of failure and associated consequences approach closely or exceed a tolerable risk limit guideline.

Significant wave height – The average height of the one-third highest waves of a given wave group.

Sill – A submerged structure across a river to control the water level upstream. The crest of a spillway. A horizontal gate seating, made of wood, stone, concrete, or metal at the invert of any opening or gap in a structure; hence, the expressions “gate sill” and “stoplog sill.”

Slope – Inclination from the horizontal. Sometimes referred to as batter when measured from vertical.

Sluice – An opening for releasing water from below the static head elevation.

Societal incremental life safety tolerable risk guideline – For existing dams, the societal risk should be less than the limit line shown in the chart of societal risk guideline for existing dams, except in extraordinary circumstances, following an adaptation of the ANCOLD (2003) (reference A.130) and NSW(2006) (reference A.147) societal life safety risk guideline. For new dams or Section 216 major modifications (reference A.7), the societal risk should be less than the limit line shown in the chart for societal risk guideline for new dams and Section 216 major modifications (reference A.7), except in extraordinary circumstances, following an adaptation of the ANCOLD (2003) (reference A.130) and NSW (2006) (reference A.147) societal life safety risk guideline. Societal risks are to be lower than the limit lines to an extent determined in accordance with the ALARP principle.

Societal Risk – The risk of widespread or large scale detriment from the realization of a defined risk, the implication being that the consequence would be on such a scale as to provoke a socio/political response, and/or that the risk (that is, the likelihood combined with the consequence) provokes public discussion and is effectively regulated by society as a whole through its political processes and regulatory mechanisms. Such large risks are typically unevenly distributed, as are their attendant benefits. Thus the construction of a dam represents a risk to those close by and a benefit to those further off, or a process may harm some future generation more than the present one. The distribution and balancing of such major costs and benefits is a classic function of Government, subject to public discussion and discussion (HSE, 1995 reference A.144) and (ANCOLD October 2003) (reference A.130).

Special Assistant for Dam and Levee Safety – Acts for the USACE DSO in the execution of daily program activities and serves as Chairman of the DSSC and the DSOG. The Special Assistant must be a registered professional civil engineer with management abilities, be competent in the areas related to the design, construction, or evaluation of dams and understand adverse dam incidents and the potential causes and consequences of dam failure. The Special Assistant works for and reports directly to the USACE DSO and represents the USACE DSO in the development of the budget submission, working with the appropriate Business Line Managers and the RMC to ensure that dam safety priorities are addressed. The Special Assistant serves as the Department of Defense and/or USACE representative on various national teams as directed by the USACE DSO.

Spillway – A structure over or through which flow is discharged from a reservoir. If the rate of flow is controlled by mechanical means such as gates, it is considered a controlled spillway. If the geometry of the spillway is the only control, it is considered an uncontrolled spillway.

Spillway, auxiliary – Any secondary spillway, which is designed to be operated very infrequently and possibly in anticipation of some degree of structural damage or erosion to the spillway during operation.

Spillway, primary (or service) – A spillway designed to provide continuous or frequent releases from a reservoir without significant damage to either the dam or its appurtenant structures.

Spillway Design Flood (SDF) – See Flood, Inflow Design.

Spillway channel – An open channel or closed conduit conveying water from the spillway inlet downstream.

Spillway chute – A steeply sloping spillway channel that conveys discharges at supercritical velocities.

Spillway crest – The lowest level at which water can flow over or through the spillway.

Spillway, fuse plug – A form of auxiliary spillway consisting of a low embankment designed to be overtopped and washed away during an exceptionally large flood.

Spillway, shaft – A vertical or inclined shaft into which water spills and then is conveyed through, under, or around a dam by means of a conduit or tunnel. If the upper part of the shaft is splayed cut and terminates in a circular horizontal weir, it is termed a bellmouth or morning glory spillway.

Stakeholders – Elected, and agency officials, public and private individuals and groups that have a direct stake in the subject matter under consideration.
Stilling basin – A basin constructed to dissipate the energy of rapidly flowing water, e.g., from a spillway or outlet, and to protect the riverbed from erosion.

Stoplogs – Large logs, timbers, metal beams, or metal frames placed on top of each other with their ends held in guides on each side of a channel or conduit so as to provide a cheaper or more easily handled means of temporary closure than a bulkhead gate.

Storage – The retention of water or delay of runoff either by planned operation, as in a reservoir, or by temporary filling of overflow areas, as in the progression of a flood wave through a natural stream channel. Definitions of specific types of storage in reservoirs are:

a. Dead storage. The storage that lies below the invert of the lowest outlet and that, therefore, cannot readily be withdrawn from the reservoir.

b. Inactive storage. The storage volume of a reservoir between the crest of the invert of the lowest outlet and the minimum operating level.

c. Active storage. The volume of the reservoir that is available for some use such as power generation, irrigation, flood control, or water supply. The bottom elevation is the minimum operating level.

d. Live storage. The sum of the active and the inactive storage.

e. Reservoir capacity. The sum of the dead and live storage of the reservoir.

f. Flood surcharge. The storage volume between the top of the active storage and the design water level.

Surcharge – Any storage above the full pool.

Tailrace – The tunnel, channel, or conduit that conveys the discharge from the turbine to the river; hence, the terms “tailrace tunnel” and “tailrace canal.”

Tailwater level – The level of water in the tailrace at the nearest free surface to the turbine or in the discharge channel immediately downstream of the dam.

Threshold Flood – The flood that fully utilizes the existing dam, i.e., the flood that just exceeds the design maximum water surface elevation at the dam.

Thrust block – A massive block of concrete built to withstand a thrust or pull.

Toe of dam – The junction of the face of a dam with the ground surface. For concrete dams, see heel.

Tolerable Risk – A risk within a range that society can live with so as to secure the benefits provided by the dam. It is a range of risk that we do not regard as negligible or as something we might ignore, but rather as something we need to keep under review and reduce it still further if and as we can (HSE, 1999 reference A.145). In addition to the tolerable risk limit the ALARP considerations will be applied to determine tolerable risk.

Tolerable Risk Guidelines – Tolerable risk guidelines are used in risk management to guide the process of examining and judging the significance of estimated risks obtained using risk assessment. The outcomes of risk assessment are inputs to the risk management decision process along with other considerations. Meeting or achieving the tolerable risk guidelines is the goal for all risk reduction measures including permanent and interim measures.

Tolerable Risk Limit – Tolerable risk limit, as depicted on Figure 5.1, defines the limit separating the unacceptable risk region from the range of tolerability.

Top of dam – The elevation of the uppermost surface of a dam, usually a road or walkway excluding any parapet wall, railing, etc.

Trashrack – A device located at an intake to prevent floating or submerged debris from entering the intake.

Tunnel – A long underground excavation with two or more openings to the surface, usually having a uniform cross section used for access, conveying flows, etc.

Type I IEPR – An Independent External Peer Review conducted for feasibility, reevaluation, modification, and assessment reports with an EIS and managed by an outside eligible organization (OEO) that is described in Internal Revenue Code Section 501(c) (3); as exempt from Federal tax under section 501(a), of the Internal Revenue Code of 1986; as independent; as free from conflicts of interest; does not carry out or advocate for or against Federal water resources projects; and has experience in establishing and administering IEPR panels. These reviews are exempt from the Federal Advisory Committees Act (FACA). The scope of review will address all the underlying planning, engineering, including safety assurance, economics, and environmental analyses performed, not just one aspect of the project.

Type II IEPR – A Safety Assurance Review (SAR) of design and construction activities for flood damage reduction or coastal storm damage reduction projects or for other activities that affect public safety, and will also be conducted for reviewing the relevancy and effectiveness of USACE inspection of completed works and safety programs in promoting safety and competent performance. They are not required to be managed by OEO's and may be managed by USACE, MSC, or by an outside organization. While all aspects of the project may be included in the review, it will focus on the public safety aspects.

Unacceptable Level of Risk – The risk cannot be justified except under extraordinary circumstances.

Unacceptable Risk Region – The region within the risk range shown in figure 5.1 that is above the zone referred to as the 'Range of Tolerability'. In the 'Unacceptable Region' the risk is considered unacceptable and cannot be justified except in extraordinary circumstance HSE (2001) (reference A.146)

Uncertainty – Uncertainty is the result of imperfect knowledge concerning the present or future state of a system, event, situation, or (sub) population under consideration. The level of uncertainty governs the confidence in predictions, inferences, or conclusions.

Unsafe – Unacceptable chance of a dam failure.

Uplift – The uplift pressure in the pores of a material (interstitial pressure) or on the base of a structure.

Upstream blanket – An impervious blanket placed on the reservoir floor and abutments upstream of a dam. For an embankment dam, the blanket may be connected to the core.

Valve – A device fitted to a pipeline or orifice in which the closure member is either rotated or moved transversely or longitudinally in the waterway so as to control or stop the flow.

a. Hollow jet valve. A device for regulating high-pressure outlets. Essentially, it is half a needle valve in which the needle closure member moves upstream toward the inlet end of the valve to shut off flow. As there is no convergence at the outlet end, the flow emerges in the form of an annular cylinder, segmented by several splitter ribs for admitting air into the jet interior to prevent jet instability.

b. Regulating sleeve valve. A valve for regulating high-pressure outlets and ensuring energy dissipation. Inside the valve there is a fixed-cone, pointed upstream, which ensures dispersion of the jet. Outside the valve a cylindrical sleeve moves downstream to shut off flow by sealing on the periphery of the cone.

Variability – One of two components often thought of as comprising ‘uncertainty’. Epistemic or 'knowledge uncertainty' that is possible to reduce with additional data and study; and aleatory or 'natural variability' that reflects a process that is random but uncertainty in its magnitude and values may not be reduced with additional data and study. Annual stream flow is an example of 'natural variability.'

Volume of dam – The total space occupied by the materials forming the dam structure computed between abutments and from top to bottom of dam. No deduction is made for small openings such as galleries, adits, tunnels, and operating chambers within the dam structure. Portions of powerplants, locks, spillway, etc., should be included only if they are necessary for the structural stability of the dam.

Water Control System – Any structure or group of structures and its appurtenant components that is used as part of a system to control or modify the conveyance of water such as gates, pumps, valves, motors, controls, power supply, etc.

Watershed divide – The divide or boundary between catchment areas (or drainage areas).

Waterstop – A strip of metal, rubber, or other material used to prevent leakage through joints between adjacent sections of concrete.

Wave run-up – Vertical height above the stillwater level to which water from a specific wave will run up the face of a structure or embankment.

WEDGE Fund – A special line item in the Construction Remaining items entitled Dam Safety Assurance and Seepage Stability Correction Program. Funding is provided to a project for investigation (study and report) and the start of construction for a dam safety modification while waiting for the current budget cycle project funding to become available.

Weir – A notch of regular form through which water flows.

a. Weir, broad-crested. An overflow structure on which the nape is supported for an appreciable length in the direction of flow.

b. Weir, measuring. A device for measuring the rate of flow of water. It generally consists of a rectangular, trapezoidal, triangular, or other shaped notch, located in a vertical, thin plate over which water flows. The height of water above the weir crest is used to determine the rate of flow.

c. Weir, ogee. A reverse curve, shaped like an elongated letter “S.” The downstream faces of overflow spillways are often made to this shape.

Willingness-to-Pay-to-Prevent-a-Statistical-Fatality – This is defined as the economic principle that attempts to place a value on a potential life lost by determining the willingness of society to pay to prevent a statistical fatality. Such values are determined from studies of court cases involving involuntary death, from Federal and other agency studies of establishing regulatory standards for public safety.

Wind setup – The vertical rise in the stillwater level at the face of a structure or embankment caused by wind stresses on the surface of the water.

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