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	Engineering and Design SAFETY OF DAMS – POLICY AND PROCEDURES	
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28 October 2011

US Army Corps
of Engineers

ENGINEERING AND DESIGN

SAFETY OF DAMS - POLICY AND PROCEDURES

ENGINEER REGULATION

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Engineering and Design
SAFETY OF DAMS – POLICY AND PROCEDURES

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This regulation supersedes ETL 1110-2-231 dated 30 March 1979, EP 1110-2-13 dated 28 June 1996, ER 1110-2-50 dated 22 August 1975, ER 1110-2-100 dated 1 December 1998, ER 1110-2-101 dated 31 January 1993, ER 1110-2-110 dated 8 July 1985, ER 1110-2-1155 dated 12 September 1997, and ER 1110-2-1156 dated 31 July 1992.

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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 the Corps of Engineers implement and maintain a strong dam safety program in compliance with *"Federal Guidelines for Dam Safety"* (reference A.71). 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, and the Engineer Research and Development Center (ERDC), 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. Required 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 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, and to document, publicize, and reduce, eliminate, or remediate, to the extent reasonably practicable, any unacceptable risks.

1.7 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 practicable. The Corps 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.81).

1.8 Dam Safety Officers. To comply with the Federal Guidelines for Dam Safety (Reference A.71), the Chief of Engineers has designated a USACE Dam Safety Officer 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.

1.9 Transition to a Risk Informed Dam Safety Program. USACE is moving 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.80).

1.10 Principles for Dam Safety Portfolio Risk Management. The following guiding principles, which represent a paradigm shift for USACE, have been established for the USACE Dam Safety Portfolio Risk Management process:

1.10.1 Life Safety is Paramount. 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.

1.10.2 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, emergency or permanent construction, or a temporary or permanent change in regulation schedules would not result in the dam safety being compromised at any point in time or during measure implementation.

1.10.3 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.

1.10.4 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.

1.10.5 Risk Communications. 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.

1.10.6 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.

1.10.7 Formulation and Prioritization of Risk Management Measures. Where practical, risk reduction 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.

1.10.8 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.

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

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

1.11 <u>Principles for Implementing Interim Risk Reduction Measures at High Risk Dams</u>.

1.11.1 Public Safety. 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 tolerable risk guidelines are met that other purposes and objectives will be considered. Dam Safety Officers are the designated advisors and advocates for life safety decisions.

1.11.2 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 result in the dam safety being compromised at any point in time or during IRRM implementation.

1.11.3 Risk-Informed – Not Risk Based. Decisions should be 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. (We no longer refer to risk-based decisions because of the inappropriate implication that life-safety decisions can be reduced to simple, numerical solutions).

1.11.4 Congressional Authorizations. Our projects provide us with 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 our projects are adequately safe from catastrophic failure that results in uncontrolled release of the water in the reservoir. We have specific public safety responsibility, when a project has known safety issues, to take appropriate interim risk reduction measures - including reservoir releases - to assure safety of the project and to protect the public. Our statutory responsibilities do not give us authority to operate our 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. We manage risks of flood waters, we do not control them. Our projects do not have unlimited operational capacity to control extreme floods, as Mother Nature can always up the ante. Our 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 high risk (unsafe or conditionally unsafe) 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 Interim Risk Reduction Measure Plan. The IRRMP, including the supporting Water Control Plan (modified by approved temporary deviations as necessary), is the key document that frames operational decision making for unsafe dams (DSAC I, II, and III). This plan establishes the specific threshold events, decision points, and actions required. As such, the IRRM Plans set the sideboards for decision making, including changes in the regulation schedule from that of the approved Water Control Manual. The IRRM Plan should recognize the need for two primary water control management controls.

1.11.8.1 A recommended safe operating reservoir level that is maintained for the vast majority of time through non damaging releases.

1.11.8.2 A threshold event for which emergency measures such as rapid reservoir drawdown and recommendations on evacuation must occur.

1.11.8.3 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.

1.11.9 In the centrally-led and decentrally-executed USACE Dam Safety Program, responsibilities and decision making for Interim Risk Reduction Measures are vertically distributed:

1.11.9.1 Districts develop IRRM Plans, coordinate plans, and execute all IRRM plans for DSAC III dams.

1.11.9.2 Divisions coordinate, review, and approve plans for DSAC Class I, II, and III dams. In particular, divisions are critical in assuring system and watershed issues are considered and coordinated.

1.11.9.3 Headquarters in consultation with the RMC establishes DSAC class for all dams, reviews and concurs on IRRM Plans for DSAC class I, II, and III dams, and aligns investment strategies for all unsafe dams.

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

1.13 Federal Guidelines for Dam Safety. A summary of the guidelines is provided in Appendix C. The guidelines are referenced at A.71.

1.14 Levels of USACE Responsibility for Dam Safety. 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.

CHAPTER 2

Dam Safety Program Framework

2.1 Scope. This chapter presents the guiding principles and policy for implementation of risk-informed dam safety program within the United States Army, Corps of Engineers (USACE), Office of Management and Budget (OMB) principles for risk analysis, a generalized dam safety framework based on the OMB principles with an elaboration of the concepts of risk assessment, risk management, and risk communication, and the presentation of a generalized dam safety portfolio risk management process.

2.2 OMB Risk Analysis Principles.

2.2.1 Risk is a measure of the probability and severity of undesirable consequences. In 1995 (Principles for Risk Assessment, Management, and Communication, January 12, 1995 (reference A.82) and again in September 2007 (Updated Risk Principles (M07-24), September 19, 2007 (reference A.84) the Office of Management and Budget (OMB) set forth a set of principles to guide policymakers in assessing, managing, and communicating policies to address environmental, health, and safety risk. The OMB intent in presenting these principles was "to provide a general policy framework for evaluating and reducing risk." Evaluating and reducing risk requires a decision-making 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 risk 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, risk analysis comprises three tasks: risk assessment, risk management, and risk communication.

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

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 current condition 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. Here we distinguish uncertainty that results from a lack of knowledge from variability, although many consider variability 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.

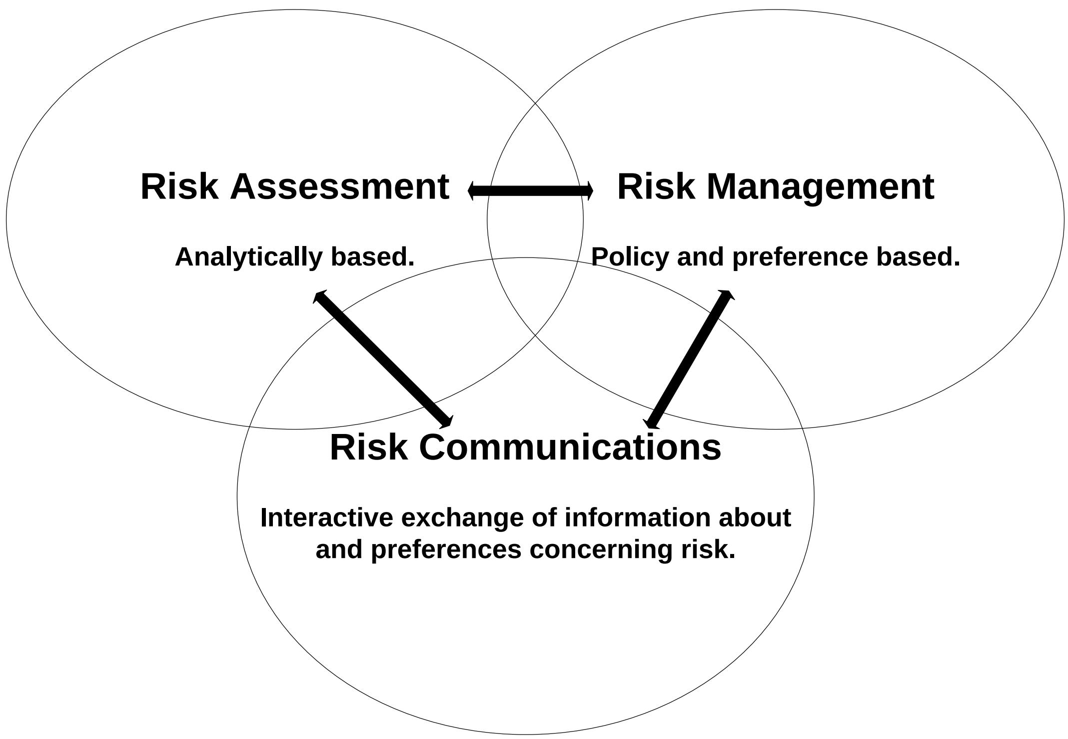


Figure 2.1 OMB Risk Analysis Principles

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 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, 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 OMB stated, "In choosing among alternative approaches to reducing risk, agencies should seek to 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)." (OMB 2007 memorandum, Subject: Updated Principles for Risk Analysis, Page 10 (reference A.84)).

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 to below the limit, except in exceptional 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 below limit values in tolerable risk guidelines.

2.2.5 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 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. 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.

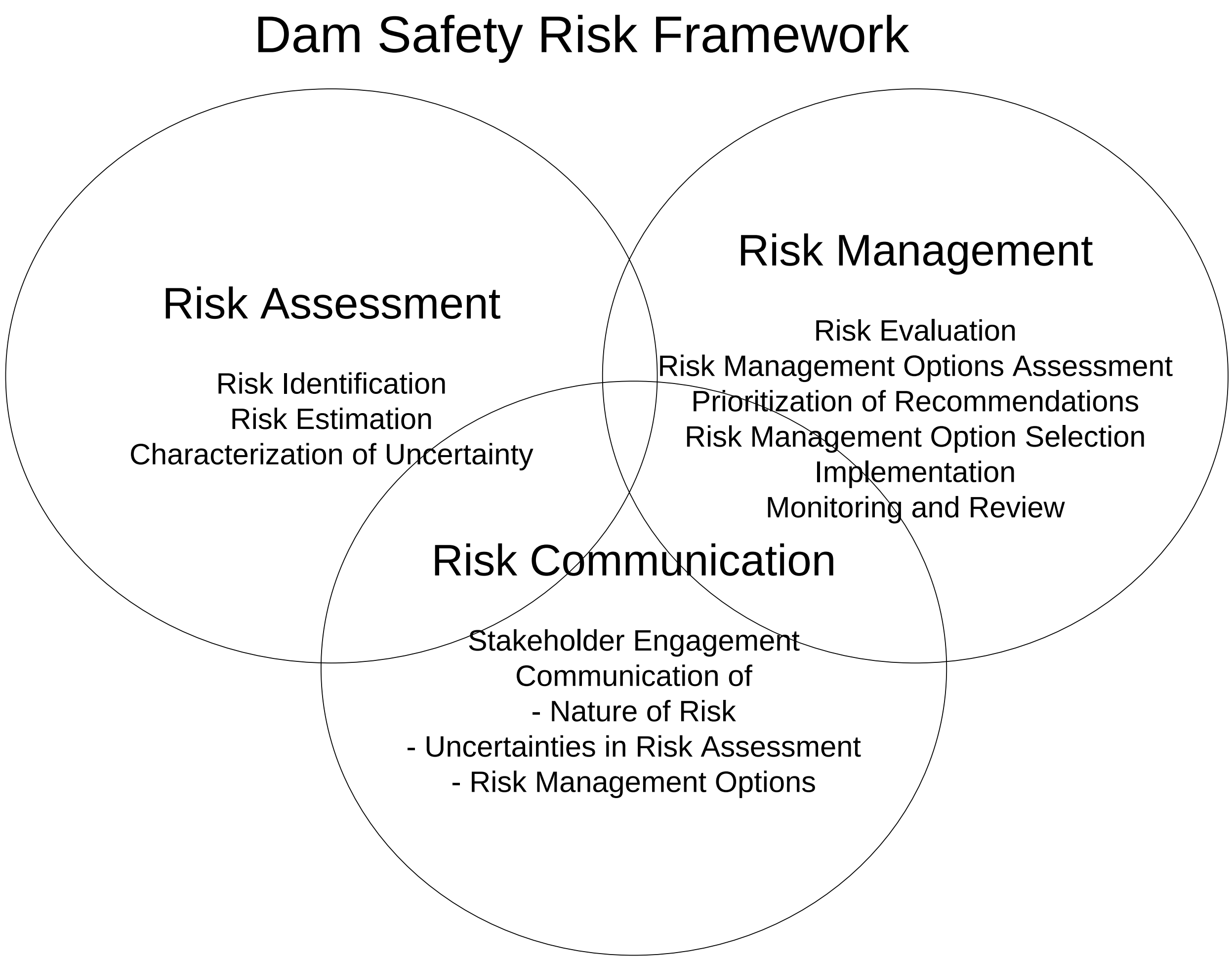


Figure 2.2 – Dam Safety Risk Framework

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?

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.83) 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* (the so-called "Redbook") (reference A.91) 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, 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.

2.5 Risk Management – An Elaboration.

2.5.1 Risk management may be understood as 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 sum, 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 2.3 shows a generalized risk management process for dams developed to describe a common approach proposed for use by the Corps of Engineers, Bureau of Reclamation, and the Federal Energy Regulatory Commission. The risk management process emphasizes its ongoing and iterative nature and the usefulness of adapting to new information.

2.5.3 Thinking of risk management as part of risk analysis, some broad categories of risk management activities can be identified as described below.

2.5.3.1 Assess Risk Management Options. Options assessment activities include the process of identifying (optioneering), 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 means deciding the level of risk that is tolerable including the consideration of the costs and other consequences of different risk reduction 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.84)

2.6 <u>Risk Communication – An Elaboration</u>.

2.6.1 Beginning with an informal definition, 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 Effective two-way risk communication has both internal and external communication components. Internal risk communication requires early and continuing communication, coordination, and collaboration among risk assessors and agency officials throughout the decision making process.

2.6.3 Stakeholder Engagement.

2.6.3.1 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.

2.6.3.2 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 irresponsible and dangerous not to engage stakeholders in meaningful input and feedback opportunities in the risk management process.

2.6.3.3 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 Constituents and 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 the probability 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.

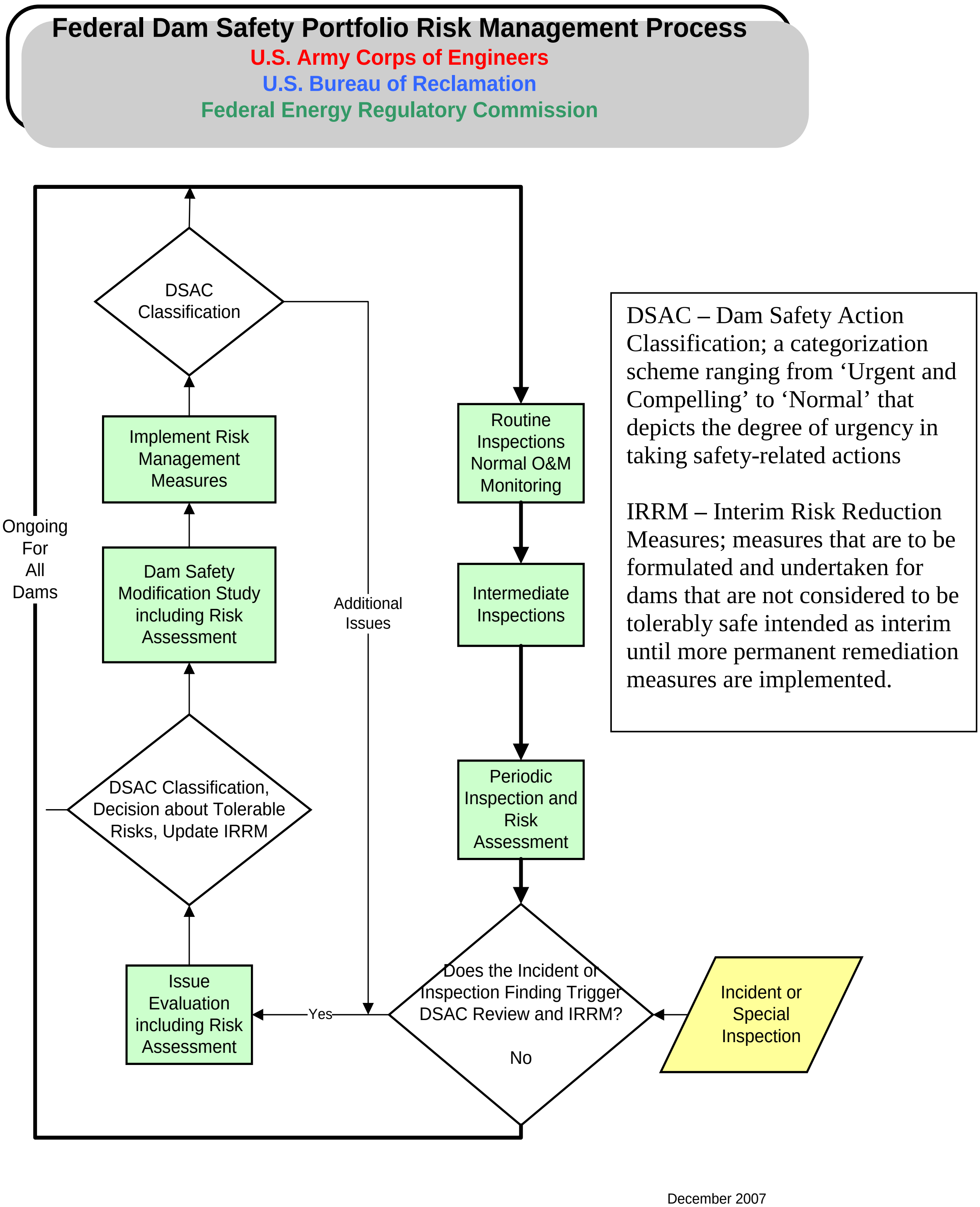


Figure 2.3 – Proposed Generalized Federal Dam Safety Portfolio Risk Management Process

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 safety case for justifying 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.

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 (DSAC), 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 Portfolio Risk Assessment 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 Dam Safety Action Classification system provides consistent and systematic guidelines for appropriate actions to address the dam safety issues and deficiencies of USACE dams. USACE dams are placed into a Dam Safety Action Classification (DSAC) class based on their probability of failure or the individual dam safety risk estimate considered as a combination of probability of failure and potential life safety, economic, environmental, or other consequences. Until fully evaluated no dam will be considered a DSAC class V, therefore all dams will initially be assigned to classes I - IV. The intent is that the classification of a dam is dynamic over time, changing 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 an urgent and compelling situation requiring extraordinary and immediate action for unsafe dams through normal operations and dam safety activities for adequate safe dams.

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 Classes. 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 adequately safe. 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 Class I (Urgent and Compelling). Class I 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 time frame from immediately to within a few years without intervention; or, the combination of life or economic consequences with probability of failure is extremely high.

3.2.4.2 Class II (Urgent). Class II 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 combination of life or economic consequences with probability of failure is very high.

3.2.4.3 Class III (High Priority). Class III dams have issues where the dam is significantly inadequate or the combination of life, economic, or environmental consequences with probability of failure is moderate to high.

3.2.4.4 Class IV (Priority). Class IV dams are inadequate with low risk such that the combination of life, economic, or environmental consequences with a probability of failure is low and the dam may not meet all essential USACE guidelines.

3.2.4.5 Class V (Normal). Class V is for dams considered adequately safe, meeting all essential agency guidelines (see Appendix E) and the residual risk is considered tolerable.

3.2.4.6 Background information on the USACE Dam Safety Action Classification System along with examples of dams in the various classes in provided in Appendix F.

3.3 <u>Dam Safety Portfolio Risk Management Process</u>.

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. Exceptions are dams found to have insignificant or no consequences should they fail. At this time, such structures are to be tagged as exceptions and are exempt from the portfolio management process. These dams will be later considered for decommissioning or transfer.

3.3.2 DSAC Class 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 Classification (DSAC) classes as presented in Table 3.1. Note that dams in each DSAC class are managed in accordance with their safety status as reflected by their assigned DSAC class.

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 Corps of Engineers 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 justified 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. DSAC classification.

3.3.4.2.2 Decision Point D 1c. Reclassification as a result of an Issue Evaluation Study where the dam can be reclassified to any of the other classes.

3.3.4.2.3 Decision Point D 1d. Incident triggers DSAC review.

3.3.4.2.4 Decision Point D 1e. Post implementation DSAC review and modification of DSAC class as appropriate. Review IRRM plan and modify as appropriate.

3.3.4.3 Decisions dealing with the implementation of IRRM recommendations for DSAC I, II and III dams are located at Decision Point D 2a. The decision related to heighten monitoring for Class IV dams is located at Decision Point D 2b.

3.3.4.4 Decision Point D 3 relates to the determination of the justification of Dam Safety Modification studies for DSAC II, III and IV dams.

3.3.4.5 Decision Point D 4 deals with the approval of Dam Safety Modification study reports.

3.3.5 Screening. Initially, all dams in the USACE inventory will be subjected to a screening level risk assessment called the Screening Portfolio Risk Assessments (SPRA), defined later, and assigned a DSAC class 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), potential incident identification, review and update of the Dam Safety Program Management Tools data (See Appendix G), and review of the DSAC class. All USACE dams are in the outer loop regardless of their DSAC class. 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 V and therefore they are only in the outer loop of the Dam Safety Portfolio Risk Management process diagram.

3.3.6.2 Periodic Assessments and Periodic Inspections. All USACE dams will undergo PA on a routine and systematic schedule not to exceed ten years. Periodic Assessments include a revised Periodic Inspections (PI) process (details in Chapter 11) and baseline risk assessment, including potential failure mode analysis. The PI will occur more frequently than PA, typically not more than five year intervals. 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 assessments are described in more detail later in chapter 11.

3.3.7 Interim Risk Reduction Measures Plans and Implementation. Interim Risk Reduction Measure (IRRM) plans will be developed for all DSAC I, II, and III 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 Class I Expedited Process. Because of their urgent and compelling safety issues, dams in DSAC Class I are immediately processed through several key steps to formulate, approve (Decision Point D 2a), and implement interim risk reduction measures. At Decision Point D 2a the USACE Dam Safety senior oversight group (SOG) will review DSAC documentation and make a recommendation to the USACE senior leadership that the agency does or does not accept the DSAC I classification for that dam. The IRRM plan should be developed and implemented as quickly as possible for DSAC I dams. For DSAC I 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 reduction measures. Once the approved risk reduction measures are implemented the DSAC class 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 use of approved incremental risk reduction measures may not move a dam from a DSAC I class all the way to a DSAC V.

3.3.9 DSAC Classes II and III Process. All dams placed into DSAC II and III (Decision Point 1a) will have IRRM plans developed and implemented. The IRRM plans identify the risk reduction 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 II and III 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 I, it will then be addressed using the DSAC I Expedited Process. If a dam is in DSAC II, III, or IV it will be reviewed to determine if a Dam Safety Modification study is justified (Decision Point D 3). If the determination is that a Dam Safety Modification study is justified, 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 I dams.

3.3.10 DSAC IV Process. For DSAC IV class 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 IV class dam as it is for a DSAC II or III class dam.

3.3.11 DSAC V Process. To place a dam in the DSAC V class requires a risk assessment estimate with as low as reasonably practicable (ALARP) considerations included to determine residual risk and an evaluation of compliance with all essential USACE guidelines with no unconfirmed dam safety issues. The risk assessment to determine residual risk and the evaluation of essential guideline compliance can be performed either at the time of the periodic assessment or after the approved risk reduction measures from the DSM report are implemented. The latter should just entail an evaluation of the performance of the risk reduction measures to assure that the risk reduction measures meet the prescribed performance levels and guidelines as outlined in the DSM report.

3.3.12 Baseline risk estimate. The baseline risk estimate is the risk estimate at a point in time. It may change based on changes in: a) information; b) the condition of the dam; c) factors affecting the consequences, or d) from proposed implementation of risk reduction measures. Incorporating any of these changes or a change in the scope, purpose, or decision to be made will result in a new baseline risk estimate.

3.3.12.1 Baseline risk estimates shall encompass all significant failure modes and factors affecting the consequences of failure (*e.g. exposure conditions*). Significant failure modes are a subset of credible failure modes (*i.e. physically possible*). The number of significant failure modes to be considered in a risk assessment should be judged in the context of the purpose of the risk assessment and the decisions that it will inform. The cumulative effect of multiple low risk failure modes shall be considered on the baseline risk estimate. It is important to identify and list all credible failure modes and factors affecting consequences that are not considered “significant” for a risk assessment. These failure modes may be justified as significant in a subsequent risk assessment.

3.3.12.2 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.

3.3.12.3 Periodic Assessments (PA) and Phase 1 Issue Evaluation Study (IES) baseline 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. Additional information and analysis to reduce uncertainty and increase confidence in the baseline risk estimate may be justified to support the Phase 2 IES and the Dam Safety Modification study. In all cases the baseline risk estimate should be obtained with the minimum expenditure of time and resources. The scope of the risk assessment shall be determined on the basis of the decisions to be made.

3.3.13 Issue Evaluation Studies. Issue Evaluation studies (IES) for dams classified in DSAC Classes II, III, and IV 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 intent of an Issue Evaluation Study is to perform a more robust and detailed level of risk assessment, than used in the SPRA and possibly more robust than the risk assessment used in a periodic assessment, that will enable informed decisions about the need for a Dam Safety Modification study, further investigations, the DSAC reclassification, 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. Based on the results of previous or current investigations and an Issue Evaluation Study, a dam could be reclassified as DSAC Class I and thus warrant the expedited process for a DSAC Class I dam as shown on the left side of Figure 3.1. The report documenting the Issue Evaluation Study will have an Agency Technical Review (ATR) performed to include Dam Safety Risk Management Center representatives. The IES report presents the rationale and the justification for a Dam Safety 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.

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 reduction alternatives with preliminary level cost estimates will be performed at this time. A detailed risk assessment is required and will look at incremental risk reduction alternatives that together meet the tolerable risk guidelines (details in Chapter 5) and cost effectiveness of additional risk reduction 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 justify the modification decision. Related NEPA and ESA 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, 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.53), National Environmental Policy Act (NEPA) (reference A.109), and the Endangered Species Act (ESA) determinations). This document will have an ATR performed to include Risk Management Center representatives. Dam Safety Modification Studies process, content, and the approval process are discussed in detail in Chapter 9.

3.3.15 Dams Exempt from the Dam Safety Portfolio Risk Management Process. The Corps 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. 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 resolution of a dam safety deficiency will cost less than the major rehabilitation threshold funding cap (see annual budget guidance Engineering Circular) or the work can be accomplished in one construction season. If this is the case 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 Operations and Maintenance funds. If significant risk reduction can be made at high risk dams for amounts less than the major rehabilitation threshold funding cap districts should coordinate with the MSC and HQ dam safety program managers and the O&M appropriation program managers to determine if Operations and Maintenance funds are available.

3.4 Scope of Risk Assessments in Support of Dam Safety Evaluations. There are five specific instances of evaluations in the process- Screening Portfolio Risk Assessment (SPRA), Interim Risk Reduction Measures Plans (IRRMP), Periodic Assessments, Issue Evaluation Studies, and Dam Safety Modification Studies. The USACE Dam Safety Portfolio Risk Management process uses risk assessments in each of the five 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. Table 3.2 shows the relationships of the primary and secondary uses of the outcomes of the risk assessments with the purpose of the various studies or evaluations. However, in all cases the level of detail should only be what is needed to justify the decision(s) that will be informed by the risk assessment.

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

3.4.1.1 Potential failure mode analysis;

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; and

3.4.1.7 Compare to the USACE tolerable risk guidelines.

3.4.2 Screening for Portfolio Risk Assessment (SPRA). This assessment screens projects to expeditiously identify the dams requiring urgent and compelling action (Dam Safety Action Classification Classes I and II 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 III – IV. SPRA does not provide sufficient information to confirm a dam can be placed in Dam Safety Action Classification Class V. The intent is that SPRA will be performed only once for every dam in the USACE inventory. Once all dams are screened using SPRA, the SPRA DSAC rating will remain the official rating unless a more detailed assessment leads to a reclassification. The SPRA process is described in Appendix I.

3.4.3 Interim Risk Reduction Measures Plans (IRRMP). The risk assessment supporting the IRRM plan will use existing information and easily obtained consequence data. The primary purpose is to support and justify 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 dams on a 10 year cycle, but more frequently as justified. The periodic assessment will consist of a periodic inspection, a potential failure modes analysis, and a risk assessment based on existing data and limited analyses to estimate consequences. The primary purposes of the Periodic Assessment are as follows.

3.4.4.1 Confirm or revise the DSAC classification of a project;

3.4.4.2 Justify interim risk reduction measures;

3.4.4.3 Provide initial input for quantitative risk reporting;

3.4.4.4 Identify needed issue evaluation studies;

3.4.4.5 Provide data to prioritize issue evaluation studies;

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

3.4.4.7 Develop or update the baseline risk and confirm that essential USACE dam safety guidelines are or are not met.

3.4.5 Issue Evaluation Study. Risk assessments in support of the Issue Evaluation studies (IES) are conducted for the 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 justified.

3.4.5.2 Secondary.

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

3.4.5.2.2 Determine if a dam should be reclassified as DSAC I and thus warrants the expedited process for a DSAC I dam as shown on the left side of Figure 3.1;

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 studies; and

3.4.5.2.5 Develop or update the baseline risk estimate.

3.4.5.3 The methodology of this risk assessment/study must be more rigorous than the SPRA methodology. The IES risk assessment is intended to achieve a defensible, risk informed justification for initiating Dam Safety Modification studies with the minimal expenditure of time and resources. This risk assessment will use the USACE dam safety risk assessment and evaluation tools.

3.4.6 Dam Safety Modification Study. The risk assessment supporting the Dam Safety Modification study leads to definitive decisions and documentation to justify dam safety actions to achieve reduction in life, economic, and environmental risk. Additional data will be gathered as justified by the decision to be made. The Dam Safety Modification study will use the USACE dam safety risk assessment and evaluation tools which provide results of increased robustness of and confidence in the risk assessment over the Issue Evaluation Study due to an increase in the level of confidence in the input data used in the study. The primary purposes of the Dam Safety Modification study are the determination or update of the baseline risk estimate; identification, evaluation, justification, and recommendation of long-term risk reduction remedial measures; and the estimation of the residual risk of the remediated project. The risk assessment shall be updated after implementation of the risk reduction remedial measures and evaluated to determine if the risk reduction objectives were achieved.

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

3.5.1 SPRA ratings and findings,

3.5.2 Current DSAC Classification,

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 of last PA and PI,

3.5.9 Results of the essential agency guidelines (Appendix E) evaluation,

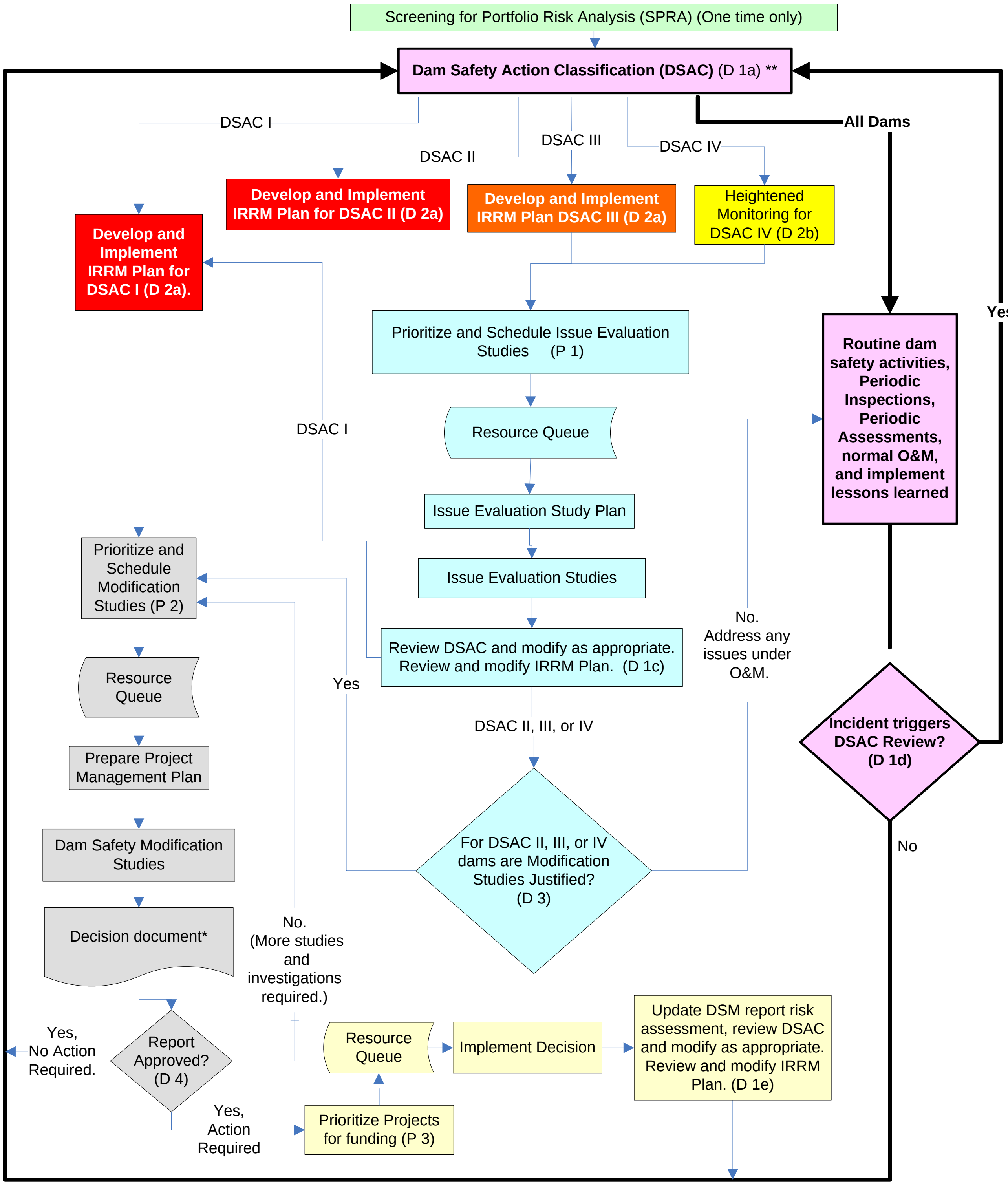
3.5.10 Consequences - list estimated consequences related to the identified potential failure modes,

3.5.11 Issue Evaluation Study results, recommendations and final decisions, and

3.5.12 Dam Safety Modification study results, recommendation, and final decisions.

3.6 Water Storage and Risk Reduction 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 I, II, or III. (See EC 1165-2-210 for further guidance, Reference A.6)

Figure 3.1 -- Corps of Engineers Dam Safety Portfolio Risk Management Process



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 the Dam Safety Modification chapter.**
**** 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.**

Table 3.1 – USACE Dam Safety Action Classification Table*			
Dam Safety Action Class		**Characteristics of this class**	**Actions for dams in this class**
I **URGENT AND COMPELLING** (Unsafe)	(red)	**CRITICALLY NEAR FAILURE** Progression toward failure is confirmed to be taking place under normal operations. Almost certain to fail under normal operations from immediately to within a few years without intervention. **OR EXTREMELY HIGH RISK** Combination of life or economic consequences with probability of failure is extremely high.	Take immediate action to avoid failure. Implement interim risk reduction measures, including operational restrictions, ensure that emergency action plan is current, and functionally tested for initiating event. Conduct heightened monitoring and evaluation. Expedite investigations to support justification for remediation using all resources and funding necessary. Initiate intensive management and situation reports.
II **URGENT** (Unsafe or Potentially Unsafe)	(red)	**FAILURE INITIATION FORESEEN** For confirmed (unsafe) and unconfirmed (potentially unsafe) 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 RISK** The combination of life or economic consequences with probability of failure is very high.	Implement interim risk reduction measures, including operational restrictions as justified, and ensure that 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 justification for remediation.
III **HIGH PRIORITY** (Conditionally Unsafe)	(orange)	**SIGNIFICANTLY INADEQUATE** **OR MODERATE TO HIGH RISK** For confirmed and unconfirmed dam safety issues, the combination of life, economic, or environmental consequences with probability of failure is moderate to high.	Implement interim risk reduction measures, including operational restrictions as justified, ensure that emergency action plan is current, and functionally tested for initiating event. Conduct heightened monitoring and evaluation. Prioritize for investigations to support justification for remediation considering consequences and other factors.
IV **PRIORITY** (Marginally Safe)	(yellow)	**INADEQUATE WITH LOW RISK** For confirmed and unconfirmed dam safety issues, the combination of life, economic, or environmental consequences with probability of failure is low and may not meet all essential USACE guidelines.	Conduct elevated monitoring and evaluation. Give normal priority to investigations to validate classification, but no plan for risk reduction measures at this time.
V **NORMAL** (Adequately Safe)	(green)	**ADEQUATELY SAFE** Dam is considered adequately safe, meeting all essential USACE guidelines with no unconfirmed dam safety issues, **AND RESIDUAL RISK IS CONSIDERED TOLERABLE**.	Continue routine dam safety activities, normal operation, and maintenance.

* At any time for specific events a dam, from any action class, can become an emergency requiring activation of the emergency plan

Table 3.2 – Primary and Secondary Use of Risk Assessment Outcomes

Use of the Outcomes from Risk Assessment	Screening	Interim Risk Reduction Measures	Periodic Assessment	Issue Evaluation Study	Modification Study
Identify DSAC I & II with low chance of missing any such dams	P				
Preliminary classification of DSAC III - IV	P				
IRRM Decisions including justification		P	s	s	s
DSAC Confirmation or Reclassification			P	s	s
Initial Portfolio Input for quantitative risk reporting			P	s	s
Portfolio Update			P	s	s
Identify all potential failure modes		s	P	s	P
Develop baseline risk estimate			P	s	P
Identify needed Issue Evaluation Studies	P		P		
Identify O&M, monitoring, EAP, and staff training and other recurrent needs		P	P	s	s
Prioritization of Issue Evaluation Studies	s	s	P		
Tolerable risk evaluation for existing dam			P	s	P
Identify representative, potential long term risk reduction measures (incremental)					P
Prioritization of Dam Safety Modification Studies (incremental)				P	
Confirmation that all essential USACE Dam Safety guidelines are met and residual risk is considered tolerable for an existing dam (DSAC V confirmation)			P		P
Tolerable risk evaluation for Modification Alternatives					P
Modification decision and justification					P
Prioritization of projects for funding			s	P	P

P = Primary s = Secondary

CHAPTER 4

Management of Corps of Engineers Dam Safety Program

4.1 General. The Corps of Engineers maintains a three-level decentralized organization, HQUSACE, MSC (Regional) and district. Each level shall 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 shall have a Dam Safety Officer (DSO) with supporting organization as outlined in this chapter. The Corps of Engineers 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 and the Senior Oversight Group, 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 Senior Oversight Group and Special Assistant for Dam Safety. Routine day-to-day operation, maintenance and safety evaluations of dams shall remain the primary responsibility of the district command. Periodic assessments of dams are accomplished with assistance from regional and national risk and reliability cadres and the RMC.

4.2 Overall Responsibility for Dam Safety Program. The Commanders at each level of the Corps of Engineers have the ultimate responsibility for dam safety within their commands. Each District Commander having responsibility for dams shall ensure that the organization has a dam safety program which complies with Corps of Engineers policy and criteria, assuring compliance with the “Federal Guidelines for Dam Safety” (reference A.71). Commanders exercise this responsibility through officially designated Dam Safety Officers 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 (discussed in subsequent chapters as well as ER 1130-2-530 (reference A.63)).

4.2.1 For the Corps of Engineers 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 Dam Safety Officer 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 Dam Safety Officer. 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 shall 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.

4.3 <u>Headquarters, US Army Corps of Engineers</u>.

4.3.1 Organization. The Corps of Engineers 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. A Special Assistant for Dam Safety and the Corps Dam Safety Program Manager support the Corps DSO. The Corps of Engineers Dam Safety Steering Committee (DSSC) and the HQUSACE Dam Safety Committee provide additional advice and support to the Corps DSO concerning the program. The Corps Dam Safety Committee includes the Senior Oversight Group (SOG), Corps DSO, the National Inventory of Dams (NID) Program Manager, and other members with extensive knowledge and expertise in the programming, planning, design, construction, operations, and maintenance of dams. Other individuals from the various communities of practice within the Corps of Engineers may be included as members of the committee.

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.79).

4.3.2.1 Corps of Engineers Dam Safety Officer: The Corps (DSO) shall 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 Corps DSO, this individual is responsible directly to the Chief of Engineers for all dam safety activities and shall be appointed by written order of the Chief of Engineers. The Corps DSO coordinates dam safety activities with the various elements of the Directorate of Civil Works and informs the Director concerning the condition of Corps dams. The Corps DSO is responsible for ensuring that the Corps of Engineers maintains a proactive dam safety program, implementing all practices and procedures outlined in the "Federal Guidelines for Dam Safety" (reference A.71). The Corps DSO is responsible for establishing policy and technical criteria for dam safety, and prioritizing dam safety related work. The Corps DSO or designated representative(s) shall represent the Department of Defense on the National Dam Safety Review Board (NDSRB) and Interagency Committee on Dam Safety (ICODS). The Corps DSO ensures that programs to implement dam safety needs and to monitor the activities at the various levels of the Corps are established. The Corps DSO serves as chair of the Corps Dam Safety Committee. The Corps DSO shall assess the Corps 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 Corps DSO in the execution of daily program activities and serves as Chairman of the Corps of Engineers DSSC and the SOG. The Special Assistant shall 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 works for and reports directly to the Corps DSO. The director of the RMC shall report directly to the Special Assistant. The Special Assistant represents the Corps 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 Corps of Engineers representative on various national teams as directed by the Corps DSO.

4.3.2.3 Corps Dam Safety Program Manager. The Corps Dam Safety Program Manager (DSPM) shall be a registered professional engineer with civil engineering background (or registered professional 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 DSPM conducts the daily activities of the overall dam safety program. The DSPM coordinates the HQ review of dam safety reports and prepares Corps-wide dam safety budget submissions in coordination with the DSSC and the RMC, and works in close coordination with the Special Assistant for Dam Safety. The DSPM serves as the Department of Defense and/or Corps of Engineers representative on various national teams as directed by the Corps DSO or the Special Assistant. The Corps DSPM shall maintain an updated membership list of the Corps Dam Safety Committee, the Corps of Engineers DSSC, the SOG, and all USACE DSOs and DSPMs.

4.3.2.4 Risk Management Center: The Corps of Engineers is currently transitioning to risk-informed dam safety program management to more effectively evaluate, prioritize and justify 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 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 shall 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 shall have knowledge of risk management concepts and implementation.

4.3.2.4.2 Specific functions performed by the RMC in support of HQUSACE dam safety program management:

4.3.2.4.2.1 Maintains the 10-year plan for Periodic Assessments and Inspections of dams and pertinent structures in coordination with the MSC DSPM's.

4.3.2.4.2.2 Manages the resource queues (see the Dam Safety Portfolio Risk Management Process Chart, figure 3.1).

4.3.2.4.2.3 Supports the Agency Technical Review (ATR) and Independent External Peer Review (IEPR) (EC 1165-2-209) (Reference A.5) process, as applicable, for Dam Safety Modification Reports. The RMC shall be the Review Management Organization (RMO) for Dam Safety Modification Reports and perform the RMO functions required in EC 1165-2-209 (reference A.5). The RMC may be consulted for the names of qualified individuals who have worked with the national risk cadres and are experienced in the needed area to serve on ATR teams. The RMC shall manage the IEPR process for all dam safety modification reports.

4.3.2.4.2.4 Supports the Corps DSPM in the development of annual budget requests. The RMC communicates directly with districts and MSCs on program planning, priorities, funding and implementation. It provides workload input/commitments to resource providers regarding the future year program.

4.3.2.4.2.5 Plans and evaluates dam safety-related risk activities for all phases of the life-cycle of a project.

4.3.2.4.2.6 Manages the documentation, maintenance and publication of the Corps Dam Safety Portfolio Risk Rankings and DSAC.

4.3.2.4.2.7 Integrates dam safety portfolio risk management activities with other asset management activities.

4.3.2.4.2.8 Represents Dam Safety on the Civil Works Research and Development team.

4.3.2.4.2.9 Maintains dam safety standard engineering technology (SET) programs, and automated information systems (AIS) to include reviewing usage by various districts of the programs within SET. Reviews requests for additions to and deletions from SET and makes recommendations to the SOG.

4.3.2.4.2.10 Performs metrics roll up and interpretation of Corps-wide Dam Safety Program Performance Measures (DSPPM) and the dam safety scorecard (Appendix G) using Dam Safety Program Management Tools (DSPMT) and other dam safety AIS tools.

4.3.2.4.2.11 Assists DOD member participation on the National Dam Safety Review Board (NDSRB) and the Interagency Committee on Dam Safety (ICODS), including nominating individuals for various tasks and work groups.

4.3.2.4.2.12 Provides an individual to participate as a member of the Senior Oversight Group, Dam Safety Steering Committee, and other Ad Hoc Groups as deemed necessary.

4.3.2.4.2.13 Manages national level external peer review panels and their reports for DSAC I dams.

4.3.2.4.2.14 Coordinates special Working Groups in the Risk Management Center such as the Methodology (interim) and Policy and Procedures Work Groups (interim). It coordinates the work between RMC and Regional Cadres to include scheduling and budgeting. Other activities include assisting Dam Safety policy development and guiding Dam Safety Risk and Reliability Training Management with RA and RA facilitation. Maintains updated membership list of the cadres and other national teams.

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 Corps, and reviewing and evaluating policy, technical criteria and practices, administrative procedures, and regulatory functions to support the dam safety program. The DSSC shall also review experience and qualifications of dam safety staffing at all levels within the Corps 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 team shall meet as required, and shall provide advice and information to the Special Assistant for Dam and Levee Safety.

4.3.2.5.1 The DSSC shall be composed of the following members: Special Assistant for Dam Safety (Lead), Corps DSPM, one member each from HQUSACE Operations, Planning, and Program Integration Division (the Corps Operations, Planning, and Program Integration Division Chiefs may designate individuals from one of the MSCs to represent their community of practice in lieu of a member of their staff), each MSC DSPM, one ERDC individual appointed by the ERDC Director, a representative from the RMC, and four (4) district representatives with experience in the safety of dams who shall be nominated by the DSSC as at-large members with final selection by the Corps DSO. At least one of the district representatives shall be from an operating element, one should be a DSPM and one should be a DSO. Public Affairs Office (PAO), Emergency Management, and Homeland Security Office representatives should be invited to the DSSC meetings. Additional information on the DSSC is provided in Appendix J.

4.3.2.6 The Senior Oversight Group (SOG) generally consists of the following members: Special Assistant for Dam Safety (Chair); CoP & Regional Representatives to include Geotechnical and Materials CoP Leader, Structural CoP Leader, Hydraulics and Hydrologic CoP Leader, Planning CoP Leader, and Construction CoP Leader; Regional representatives determined by Special Assistant for Dam Safety; Corps Business Line & Program Representatives to include DSPM, Flood Damage Reduction, Navigation, Programs, and Director, Risk Management Center; and any other Representatives determined by the Special Assistant for Dam Safety. A current list of members and charter will be posted on the USACE Technical Excellence Network (TEN). The Corps Dam Safety Program Manager shall serve as recording secretary. The SOG shall elect a Vice Chair.

4.3.2.6.1 The SOG will review Dam Safety Action Classifications (DSAC), dam safety risk assessment reports prepared by the RA cadres and other decision documents, confirm dam safety work priorities based on portfolio risk findings, and make recommendations on dam safety modifications to the Special Assistant for Dam Safety and the Corps DSO.

4.3.2.6.2 The Special Assistant may assign additional ad hoc members to act as reviewers for the SOG 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 reduction measures.

4.3.2.7 The Modeling, Mapping, and Consequences (MMC) Production Center 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, Economist, 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 supplemented by a USACE wide virtual staff. The MMC Program Manager receives guidance from the MMC Steering Committee.

4.3.2.7.1 The Modeling, Mapping, and Consequence Production Center (MMC) Steering Committee 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 shall also review experience and qualifications to assess agency competency in the areas of dam failure modeling, inundation mapping, and consequence estimating. The committee shall provide input to the scope, cost, schedule, and priority of MMC activities including an overall review of resource requirements. The committee shall meet as required and shall provide advice and information to the Risk Management Center Director.

4.3.2.7.2 As a minimum, the MMC steering committee shall be composed of the following members: Special Assistant for Dam Safety, HH&C CoP Lead, Planning CoP Lead, GIS 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.

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.79).

4.4.1.1 MSC Dam Safety Officer (DSO). The MSC DSO shall 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 shall ensure the DSO meets the technical qualifications and experience. The MSC DSO shall 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 shall be forwarded to the Corps DSO. The DSO shall serve as the Chair of the MSC Dam Safety Committee.

4.4.1.2 MSC Dam Safety Committee. The MSC Dam Safety Committee shall include 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 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 shall be appointed by the MSC DSO. The DSPM shall 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 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 DSPM works with the programs budget managers to ensure that dam safety requirements are included and properly prioritized in budget submissions. The DSPM serves on various national teams as requested by the Corps DSO and on the DSSC. The DSPM shall maintain an updated membership list of the MSC Dam Safety Committee. The MSC DSPM shall report directly to the MSC DSO on dam safety matters.

4.4.2 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, in technically complex cases, that the project development team includes members from the MSC and RMC starting early in the process to ensure that the analytical methods and processes used by the district 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 Corps dams and DSPMT.

4.4.2.10 Monitoring and participating in 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 SOG for consistency.

4.4.2.13 Monitoring the performance of district dam safety programs including DSPMT, upward reporting, and submitting data to HQ for 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 District Commands.

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.79).

4.5.1.1 District Dam Safety Officer (DSO). The District Dam Safety Officer (DSO) shall 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 shall generally be the chief of the engineering organization. The Commander shall ensure the DSO meets the technical qualifications and experience. The District DSO shall 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 DSO shall be forwarded to the Corps DSO and the MSC DSO. The DSO shall serve as the Chair of the District Dam Safety Committee.

4.5.1.2 District Dam Safety Committee. The District Dam Safety Committee shall include 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.

4.5.1.3 District Dam Safety Program Manager (DSPM). The District Dam Safety Program Manager (DSPM) shall be appointed in writing by the District DSO. The DSPM shall 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 DSPM conducts the daily activities for the District dam safety program and coordinates the review of dam safety reports. The DSPM works with the programs budget managers to ensure that dam safety requirements are included and properly prioritized in budget submissions. The DSPM shall maintain an updated membership list of the District Dam Safety Committee. The District DSPM shall report directly to the District DSO on dam safety matters.

4.5.2 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 shall 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 remedial measures when necessary. Collecting 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 G.

4.5.2.3 Establishing priorities for dam safety related work. The DSO, as a member of the district Corporate Board, shall defend 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 shall 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 evaluating 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 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-35) and ER 1110-2-1150 (reference A-51). A Project Delivery Team (PDT) consists of a project manager and 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 shall designate a "lead engineer". 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 Issue Evaluation Study phase. The lead engineer may change as the project moves through the different phases of development, however continuity is important and changes should only be made after careful consideration. Because of the complexity and life safety implications of dam safety projects it is vitally important that the district DSO ensures that qualified registered professional engineer or engineering geologist are assigned as the lead engineer. In addition, they shall 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.

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 of this ER. Maintaining emergency notification procedures for utilization in a dam safety emergency situation and for use during dam safety exercises. 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 that the security program and the dam safety program activities and initiatives are coordinated.

4.5.2.16 Monitoring 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 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 Ensure structural and operational modifications to Corps-owned dam projects do not diminish factors of safety or limit the ability to make flood releases.

4.6 Professional Registration. Dam Safety Officers, Dam Safety Program Managers, and various other positions providing final approval of engineering products and services to ensure the protection of life, property and the environment, are required by ER 690-1-1212 (reference A.41) 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 geologist as the DSPM when filling the position. Persons holding a Dam Safety Program Manager position without appropriate professional registration at the time this regulation takes effect 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 shall 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.

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 Corps DSO at HQUSACE 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 Corps DSO will review the recommendation, request comments from the other MSC DSOs across the Corps, 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 Corps 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 Corps DSO at least twice annually.

4.7.3 Process for Designation of Corps (HQUSACE) Dam Safety Officer. The SOG, with input from MSC DSO's, will review the qualifications of candidates at HQUSACE and furnish a recommendation through the Special Assistant for Dam 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 SOG Chair shall coordinate the assignment of the Corps DSO duties to an MSC DSO on an interim basis.

4.7.3.2 The SOG 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 SOG at least twice annually.

4.7.4 An example of a Dam Safety Officer Appointment order is provided in Figure 4.1. This format may also be used to appoint interim or temporary DSO's.

Example Dam Safety Officer Appointment Order
Figure 4.1

DEPARTMENT OF THE ARMY
U.S. Army Corps Of Engineers
WASHINGTON DC 20314-1000

REPLY TO
ATTENTION OF
CECG

SEP 0 9 2009

MEMORANDUM FOR Chief, Engineering and Construction, ATTN: Mr. James C. Dalton, P.E.

SUBJECT: Appointment of Dam Safety Officer

1. Effective 1 October 2009, you are appointed as the U.S. Army Corps of Engineers Dam Safety Officer (DSO) in accordance with the Federal Guidelines for Dam Safety (FEMA 93).

2. As DSO you will report directly to the Chief of Engineers on Dam Safety matters. The duties of the DSO are as published in the following guidance.

a. Federal Guidelines for Dam Safety, FEMA 93, June 1979

b. ER 1110-2-1155, Dam Safety - Organization, Responsibilities, and Activities, 31 July 1992

3. This appointment is effective until rescinded.

R. L. VAN ANTWERP
Lieutenant General, USA
Commanding

CF: Mr. Steven L. Stockton

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CHAPTER 5

Tolerable Risk Guidelines

5.1 Introduction.

5.1.1 The 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 risk to public safety.)

5.1.2 Development of Tolerable Risk Guidelines for The Corps of Engineers. USACE is working with the Bureau of Reclamation (Reclamation) 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.100), which were originally issued as interim guidance in 1997 and subsequently in final form in 2003. 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.80). 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 2003 Reclamation public protection guidelines and the risk evaluation guidelines published by Australian National Committee On Larger Dams (ANCOLD) in 2003 (reference A.80) 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.106).

5.1.4 Definition of an “Adequately Safe” Dam. USACE will use the concept that a dam is considered adequately safe (DSAC Class V) when residual risk is considered tolerable and it meets all essential USACE guidelines with no dam safety issues.

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 (broadly acceptable) or something it might ignore;

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.105).

5.2.2 Definition of Broadly Acceptable Risk. “Broadly acceptable risk” is contrasted with tolerable risk. "Risks falling into this 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.105). 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.

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 extraordinary circumstance, and broadly acceptable, where the risk is regarded as negligible (Adapted from HSE, 2001) (reference A.105). This figure illustrates the point at which the residual risk for a specific dam is tolerable within the general range of tolerability as defined by meeting the as-low-as-reasonably-practicable (ALARP) considerations.

5.2.4 Equity and Efficiency.

5.2.4.1 Two fundamental principles, from which tolerability of risk guidelines are derived, are described as follows in ICOLD (2005) (reference A.101):

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; and

5.2.4.1.2 Efficiency. Efficiency is the need for society to distribute and use available resources so as to achieve the greatest benefit.

5.2.4.2 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 marginal benefits equal or exceed the marginal cost. Equity requires that a tolerable risk limit should be met regardless of the lack of economic justification or the magnitude of the cost. Equity implies the need for this limit even if efficiency does not support reducing risks to meet the maximum 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, creating a socio-political response. In contrast, society tends to be less averse to risks that result from many individual small loss accidents involving only one or two fatalities, even if the total loss from the sum of 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.

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 concept for the use of ALARP considerations is that risks lower than the tolerable risk limit are tolerable only if further risk reduction is impracticable or if the cost is grossly disproportional to the risk reduction. The related concept of disproportionality is related to the legal obligation of the owner of a hazard to protect life and property from the risks associated with a hazard. ALARP only has meaning in evaluating risk reduction measures: it cannot be applied to an existing risk without considering the options to reduce that risk. ALARP is an explicit consideration under ANCOLD (2003) (reference A.80) and NSW DSC (2006) (reference A.106) 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.106):

5.2.5.1 The level of risk in relation to the tolerable risk limit and the broadly acceptable risk level (not applicable to dams);

5.2.5.2 The disproportion between the sacrifice (money, time, trouble and effort) in implementing the risk reduction measures and the subsequent risk reduction achieved;

5.2.5.3 The cost-effectiveness of the risk reduction measures;

5.2.5.4 Any relevant recognized good practice; and

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

5.3 <u>USACE Tolerable Risk Guidelines</u>.

5.3.1 Risk Measurement. Four risk measures will be evaluated under the USACE tolerable risk guidelines:

5.3.1.1 Annual probability of failure

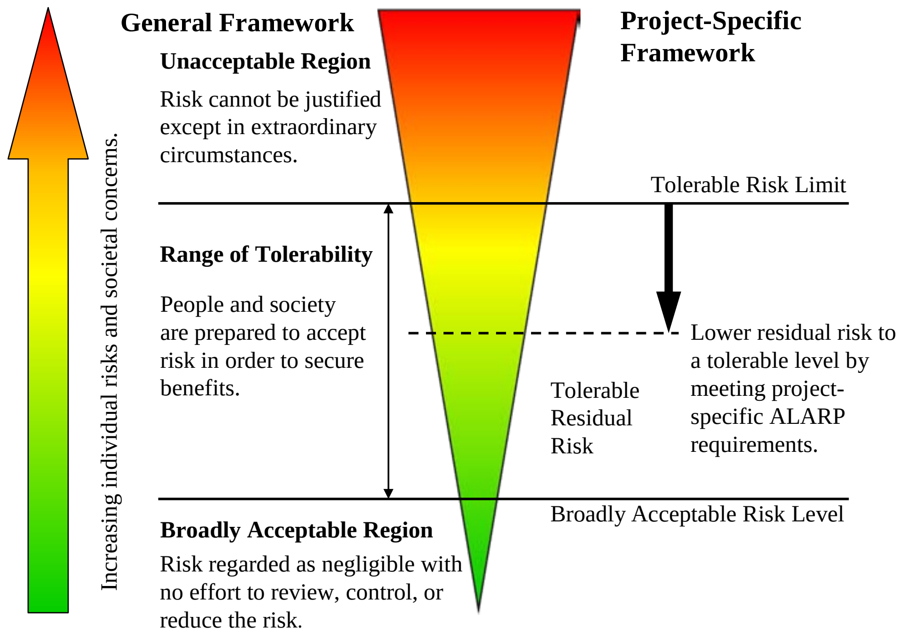

Figure 5.1 - Generalized and Project Specific Tolerability of Risk Framework (Adapted from HSE, 2001) (Reference A.105)

5.3.1.2 Life safety risk

5.3.1.3 Economic risk

5.3.1.4 Environment and other non-monetary risk

5.3.2 Additional Considerations. In addition to the tolerable risk limit guidelines, the ALARP considerations will be applied to determine when the risk is considered to be tolerable. All of these measures together will be considered when evaluating a dam and making risk management decisions; but life safety risk and the annual probability of failure will be given preference, with economic and environmental risk 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 risk in making risk management decisions.

5.3.3 Incremental Consequences. In applying these tolerable risk guidelines, the incremental consequences will be considered. Incremental consequences are defined as follows:

Incremental consequences	=	Consequences associated with the estimated performance of the project with *failure*	-	Consequence associated with the estimated performance of the project *without failure*

5.3.3.1 This definition, when applied to flood-induced failure, is illustrated in Figure 5.2 and distinguishes between the following:

5.3.3.1.1 The structural design capacity, which is the maximum loading condition that the project was planned to withstand (original design loads), although the project may fail at a lesser loading condition; and

5.3.3.1.2 The flood regulation design capacity, which is the maximum loading condition above which the project no longer provides any flood damage reduction benefits, defined as a reduction in flood levels in the area protected by the project at loading levels below the structural design capacity.

5.3.3.2 Figure 5.2 also distinguishes between the following:

5.3.3.2.1 The planned or intended condition, for which failure does not occur until the loading level exceeds the structural design capacity (vertical line shading); and

5.3.3.2.2 The condition that failure may occur at loading levels less than the structural design capacity (diagonal line shading).

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

5.3.4 Annual Probability of Failure Guideline.

5.3.4.1 Annual probability of failure will be evaluated based on Reclamation's value for its annual probability of failure (APF) Public Protection Guideline applied to the total estimated annual probability of failure from all failure modes associated with all loading or initiating event types. For a detailed discussion on the Reclamation's process see Appendix K. Although only the total annual probability of failure is to be evaluated against this guideline, it is important that the contributions to the total 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 total annual probability of failure. It can also provide insights that can lead to the identification of both structural and non-structural risk reduction measures, including interim measures.
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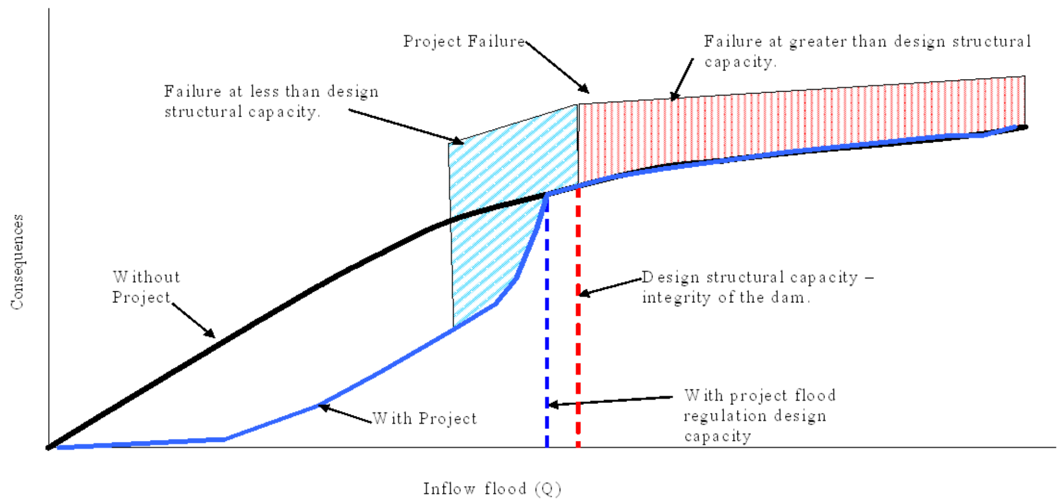

Figure 5.2 – Abstract Illustration of Incremental Consequences for Flood Induced Dam Failure

5.3.4.2 The policy for the estimated APF under USACE tolerable risk guidelines is:

5.3.4.2.1 APF > 1 in 10,000 (0.0001) Per Year. Annual probability of failure in this range is unacceptable except in exceptional circumstances. Reclamation states, "The justification to implement risk reduction actions increases as the estimates become greater than 0.0001 per year. Actions considered reasonable and prudent should be considered for implementation when the annual probability of failure estimate is in this range" (Reclamation 2003) (Reference A.100).

5.3.4.2.2 APF < 1 in 10,000 (0.0001) Per Year. Annual probability of failure in this range will be considered tolerable provided the other tolerable risk guidelines are met. Reclamation states, "The justification to implement risk reduction actions diminishes as the estimates become smaller than 0.0001 per year. Risk reduction action costs, uncertainties in the risk estimates, scope of consequences, operational and other water resources management issues play an increased role in decision-making. Actions considered reasonable and prudent should be considered for implementation when the annual probability of failure is in this range" (Reclamation 2003) (Reference A.100).

5.3.4.3 This guideline is illustrated in Figure 5.3 as the horizontal dashed line at 1×10^{-4} per year.

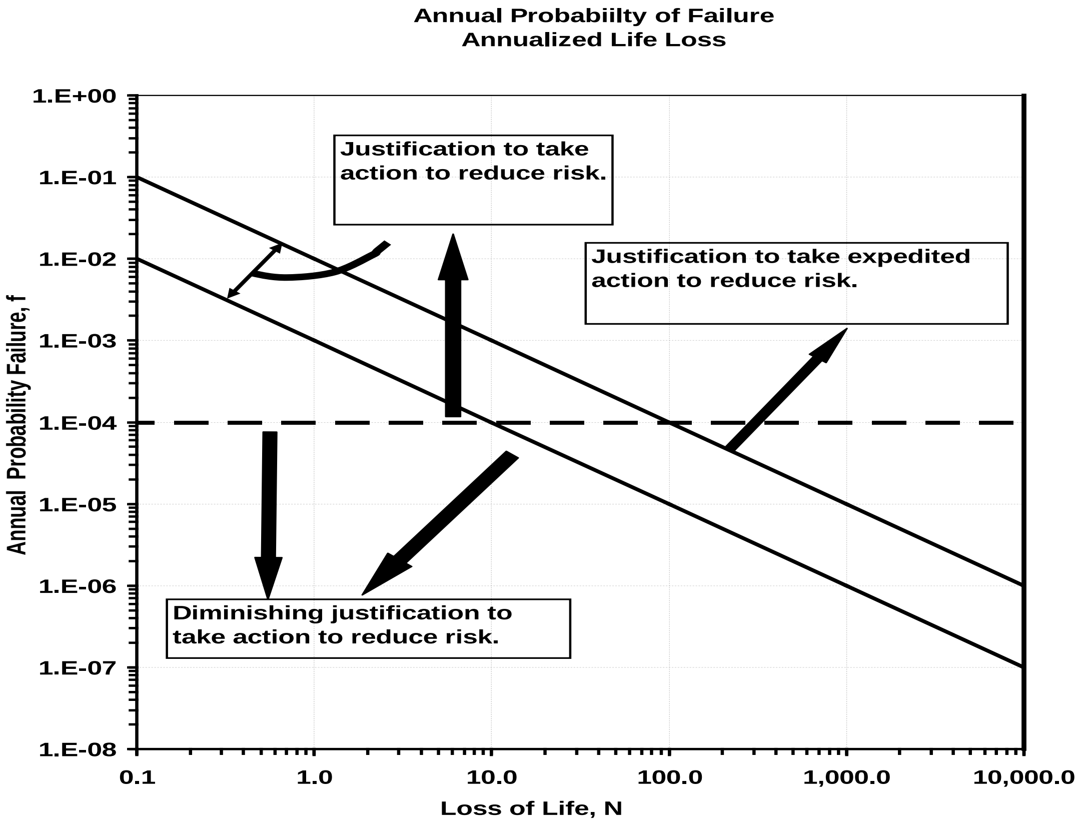

Figure 5.3 – f-N Chart for Displaying Annual Probability of Failure and Annualized Life Loss

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 risk using probability of life loss

5.3.5.1.2 Societal incremental life safety risk expressed in two different ways –

5.3.5.1.2.1 Probability distribution of potential life loss (F-N chart as discussed in the section on *Probability Distribution of Potential Life Loss)*

5.3.5.1.2.2 Annualized Life Loss (ALL)

5.3.5.2 Evaluation of Total Life Safety Risk. As with APF, it is the total life safety risk that is to be evaluated against the life safety guidelines. However, it is important that the contributions to the total from all individual failure modes, loading types, loading ranges, exposure conditions, subpopulations at risk, etc, are analyzed. This analysis can lead to an improved understanding of the failure modes and the exposure conditions that affect the total 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 measures.

5.3.5.3 Individual Incremental Life Safety Tolerable Risk Guideline. The individual risk is represented by the probability of life loss for the identifiable person or group by location that is most at risk. This is combined over all modes of failure with due regard for non-mutually exclusive failure modes, for the purpose of tolerable risk evaluation.

5.3.5.3.1 Existing Dams. For existing dams, the individual 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 exceptional circumstances. This follows the ANCOLD (2003) (reference A.80) individual life safety risk guideline. The individual life risk is computed from all failure modes associated with all loading or initiating events, with due regard for non-mutually exclusive failure modes (Figure 5.4.a).

5.3.5.3.2 New Dams and Major Modifications. For new dams or major modifications under Section 216 (reference A.94)[1], 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 exceptional circumstances, following the ANCOLD (2003) (reference A.80) individual life safety risk guideline (Figure 5.5.a). Application of the new dam tolerable risk guidelines for major modifications will be decided on an individual project basis in coordination with HQUSACE.

5.3.5.3.3 All Dams. For existing dams, new dams, or Section 216 modifications (reference A.94), individual risks are to be lower than the limit values to an extent determined in accordance with the ALARP considerations. NWS DSC (2006) states that if individual risk is below 1 in 1,000,000 per annum there is no need to pursue further risk reduction. However, it is USACE policy to consider ALARP below 1 in 1,000,000 per annum although it is unlikely to justify further risk reduction.

5.3.5.3.4 Multiple Dams. Individual risk should be checked below the main and each auxiliary dam to verify that the person or group, which is most at risk, is provided a level of protection that satisfies this individual incremental life safety tolerable risk guideline.

5.3.5.3.5 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, a consideration of exposure factors to

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

characterize the day-night, seasonal, 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 characterizing exposure factors should be "decision driven."

5.3.5.4 Probability Distribution of Potential Life Loss. The societal risk is represented by a distribution of the estimated annual probability of potential life loss from dam failure 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)[2] due to failure compared to the no failure condition. 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.

5.3.5.4.1 Existing Dams. For existing dams, the societal risk should be less than the tolerable risk limit line shown in Figure 5.4.b, except in exceptional circumstances, following an adaptation of the ANCOLD (2003) (reference A.80) and NSW (2006) (Reference A.106) 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.94), the societal risk should be less than the tolerable risk limit line shown in Figure 5.5.b, except in exceptional circumstances, following an adaptation of the ANCOLD (2003) (reference A.80) and NSW (2006) (Reference A.106) societal life safety risk guideline. Application of the new dam tolerable risk guidelines for major modifications will be decided on an individual project basis in coordination with HQUSACE.

5.3.5.4.3 All Dams. For existing dams, new dams, or major modifications under Section 216 (reference A.94), societal risk are to be lower than the tolerable risk limit lines to an extent determined in accordance with the ALARP considerations.

5.3.5.4.4 Dams with Unacceptable Level of Risk. Dams with failure risks that plot above a tolerable risk limit on an F-N chart are considered to have an unacceptable level of risk. As with the individual tolerable risk limit, risks should be reduced to the tolerable risk limit regardless of cost considerations and then further until ALARP is satisfied, except in exceptional circumstances.

5.3.5.4.5 Special Evaluation of the Tolerability of Risk. If incremental life loss is estimated to exceed 1,000 lives or is above the minus 1 sloping limit line the evaluation of the tolerability of risk shall be based on an official review of the benefits and risks as described in the "Except in Exceptional Circumstances" section (paragraph5.3.6).

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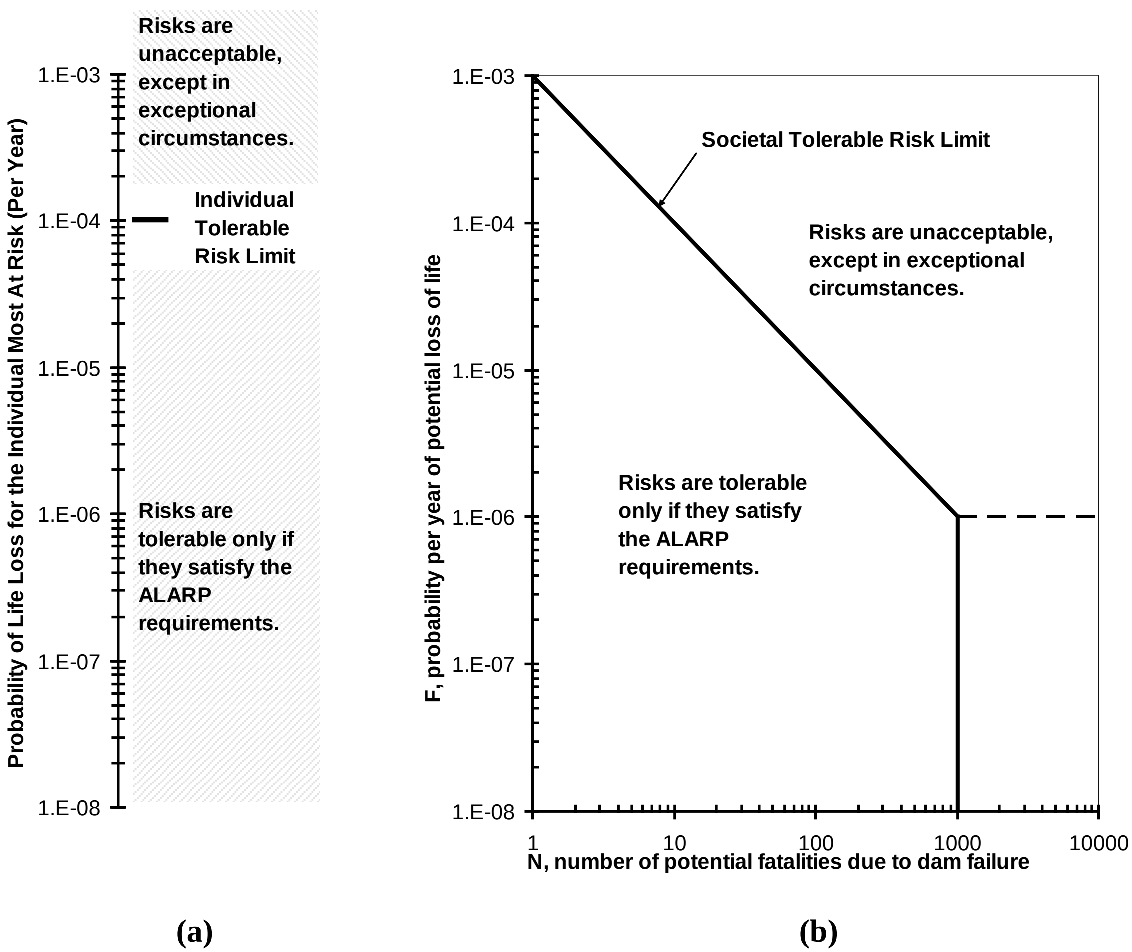
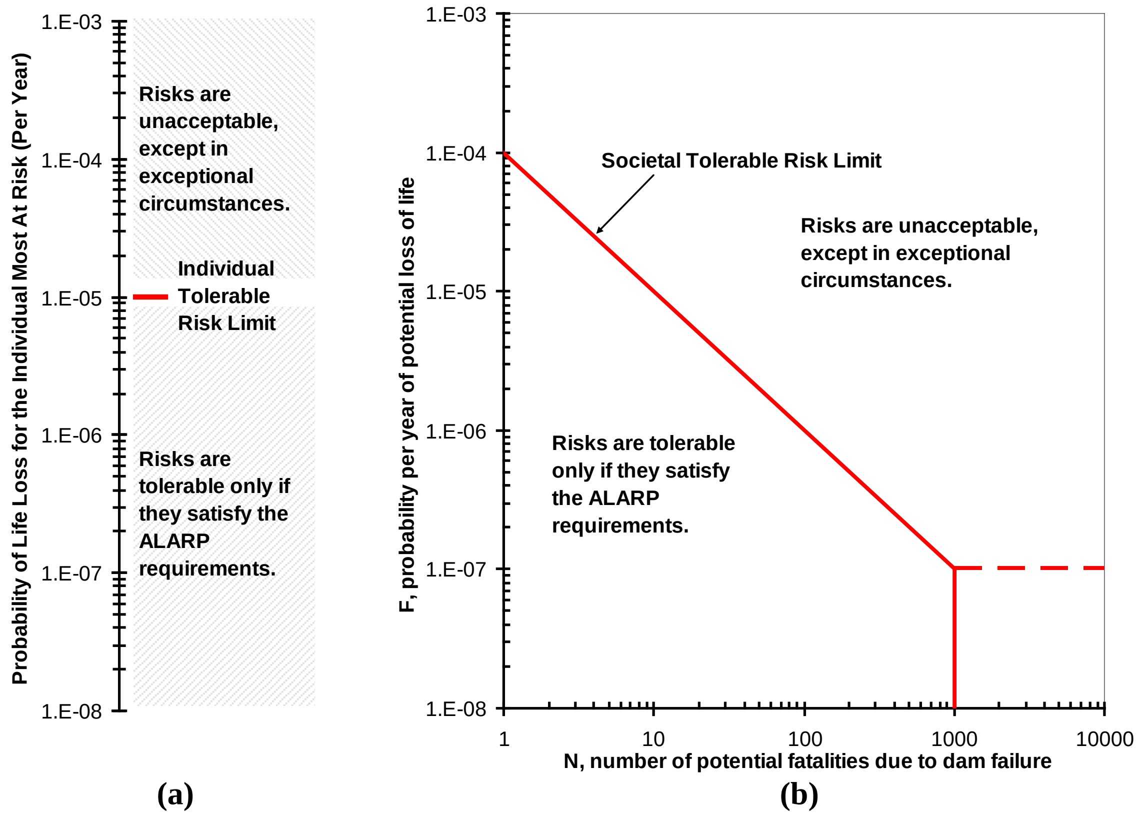
[2] In probability textbooks a cumulative (probability) distribution function (CDF) is defined to have probability "less than or equal to" on the vertical axis and a complementary cumulative (probability) distribution function (CCDF) is defined to have probability "greater than" on the vertical axis. 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.

5.3.6 Except in Exceptional Circumstances. The qualifier “except in exceptional 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 special benefits that “the dam brings to society at large”. "The justification for tolerating



Figures 5.4.a – Individual Risk Guidelines for Existing Dams
and 5.4.b – Societal Risk Guidelines for Existing Dams

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.80). 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 are deemed to outweigh the increased residual risk. This exception might be made where the residual potential life loss and economic consequences are large, but where the probability of failure is very low and state of the practice risk reduction measures have been implemented. For dams in this area on Figures 5.4.b and 5.5.b USACE will look critically at the confidence in the estimate of the risk. Full compliance with essential guidelines will be expected. The adequacy of potential failure modes analysis and risk assessment will be carefully examined. The USACE is to demonstrate that risks are ALARP. HQUSACE would reach a decision based on the merits of the case.



Figures 5.5.a – Individual Risk Guideline for New Dams and Major Modification Under Section 216
and 5.5.b -- Societal Risk Guideline for New Dams and Major Modification Under Section 216

5.3.7 Annualized Incremental Life Loss (ALL) Public Protection Guideline. Annualized Life Loss (ALL) guideline is the expected value (average annual) of incremental potential life loss resulting from dam failure as shown in the f-N chart.

5.3.7.1 Annualized Incremental Societal Life Loss. Annualized incremental societal life loss will be evaluated based on the limit values as shown in the ALL guideline (Figure 5.3). This should be applied to the total estimated annualized incremental life loss from all failure modes associated with all loading or initiating event types and considering all exposure conditions associated with life loss.

5.3.7.2 Policy for Estimating ALL. The policy for the estimated ALL under the USACE tolerable risk guidelines is:

5.3.7.2.1 ALL > 0.01 Lives/Year. ALL risk in this range is unacceptable except in exceptional circumstances and is reason for urgent actions to reduce risk. Reclamation states, "… there is justification for taking expedited action to reduce risk." This is represented by the upper minus 1 sloping line in Figure 5.3 (Reclamation 2003) (reference A.100).

5.3.7.2.2 ALL Between 0.01 and 0.001 Lives/Year. ALL risk in this range is unacceptable except in exceptional circumstances and is reason for actions taken to reduce risk. Reclamation states, "…there is justification for taking action to reduce risk." This is represented by the area between the two minus 1 sloping lines in Figure 5.3 (Reclamation 2003) (reference A.100).

5.3.7.2.3 ALL < 0.001 Lives/Year. ALL risk in this range may be considered tolerable provided the other tolerable risk guidelines are met. Reclamation states, "The justification to implement risk reduction actions or conduct additional studies diminishes as estimated risks become smaller than 0.001 lives/year. Risk reduction action costs, uncertainties in the risk estimates, scope of consequences, operational and other water resources management issues play an increased role in decision making. Actions considered reasonable and prudent should be considered for implementation when the risk is in this range" (Reclamation 2003) (reference A.100).

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

5.3.8.1 The ANCOLD (2003) (reference A.80) individual and societal risk guidelines include an important consideration that the risk is to be lower than the limit values to an extent determined in accordance with the ALARP considerations. Reclamation's Public Protection Guidelines do not specifically address ALARP. The ANCOLD (2003) (reference A.80) 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 risks are ALARP, the USACE shall take the following into account: the level of risk in relation to the tolerable risk limit and the broadly acceptable risk level (not applicable to dams); the disproportion between the sacrifice (money, time, trouble and effort) in implementing the risk reduction measures and the subsequent risk reduction achieved; 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 risk in relation to the tolerable risk limit. When the estimated life safety 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 ALARP justification for further risk reductions.

5.3.8.2.2 The cost-effectiveness of the risk reduction measures.

5.3.8.2.3 The disproportion between the sacrifice (money, time, trouble and effort) in implementing the risk reduction measures and the subsequent risk reduction achieved.

5.3.8.2.3.1 Disproportionality is used as a justification to reduce the risk below the tolerable risk limit. The disproportion between the sacrifice (money, time, trouble and effort) in implementing the risk reduction measures and the subsequent risk reduction achieved is to be evaluated using the disproportionality between the sacrifice and the risk reduction achieved. 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 (OMB 2003) and other federal agencies as the "value-of-statistical-life" (VSL). VSL is used by OMB, the United States Department of Transportation (USDOT) (references A.110 and A.111), and other federal agencies to evaluate the case for regulating risk or investing in life-saving risk reduction measures. The risk measure for disproportionality is the ratio of the CSSL divided by WTP. The quantitative ANCOLD (2003) (reference A.80) guidance is based on estimating the incremental CSSL for any risk reduction options that could reduce the risk below the limit values, starting at or below the limit values, and assigning a “strength of ALARP justification” to proceed with the risk reduction measure based on the magnitude of the estimated CSSL. This approach has it roots in work by the Health Safety Executive, United Kingdom (HSE 2001) (reference A.105) and by Bowles and Anderson (2003) (Reference A.85). CSSL calculations are shown in Appendix L.

5.3.8.2.3.2 The ANCOLD approach has been adapted for application to USACE dams as represented in Tables 5.1 and 5.2 that show the disproportionality ratio of the CSSL to the WTP.

$$\text{Disproportionality ratio} = \text{CSSL} / \text{WTP}$$

5.3.8.2.3.3 The value to use for WTP in USACE dam safety risk assessments will be the current value used by USDOT. As of January 2009 USDOT (2008) uses a value for WTP of US$5.8M with a standard deviation of US$2.6M or a range of US$3.2M - US$8.4M, which is equivalent to a range of plus and minus one standard deviation. (Reference A.110 and A.111)

5.3.8.2.3.4 The disproportionality ratios in Tables 5.1 and 5.2[3] have been calculated from the ANCOLD CSSL values using a WTP of $5M/statistical fatality prevented. The

[3] Tables 5.1 and 5.2 refer to the tolerable risk limit and broadly acceptable region, respectively. Based on their original use by HSE, the tolerable risk limit for individual risk may be considered to be 1 in 10,000 per year and the broadly acceptable limit may be considered to be 1 in 1,000,000 per year. However, the concept of broadly acceptable risk does not apply to dams as discussed elsewhere in this paper.

disproportionality ratio will be calculated, as described in the next paragraph, for each risk reduction alternative and compared with the ANCOLD values below for illustrative purposes.

5.3.8.2.4 Compliance with Essential USACE Guidelines. The dam will be evaluated on its ability to meet essential USACE guidelines. The USACE essential guidelines list will be developed from the published and draft design criteria documented in the USACE engineering regulations and engineering manuals. The evaluation will be

Table 5.1 – Guidance on ALARP Justification for
Risks just below the Tolerable Risk Limit

ALARP Justification Rating	Range of Disproportionality Ratios	
	Greater than or equal to	Less than
Very Strong	Zero	1
Strong	1	4
Moderate	4	20
Poor	20	

Table 5.2 – Guidance on ALARP Justification for
Risks just above the Broadly Acceptable Region

ALARP Justification Rating	Range of Disproportionality Ratios	
	Greater than or equal to	Less than
Very Strong	Zero	0.3
Strong	0.3	1
Moderate	1	6
Poor	6	

presented as pass, apparent pass, apparent no pass, or no pass tabulation with a detailed evaluation for apparent pass, apparent no pass, or no pass ratings.

5.3.8.2.5 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 Consequences.

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 the 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: 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. 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 Consequences.

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.80) 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.

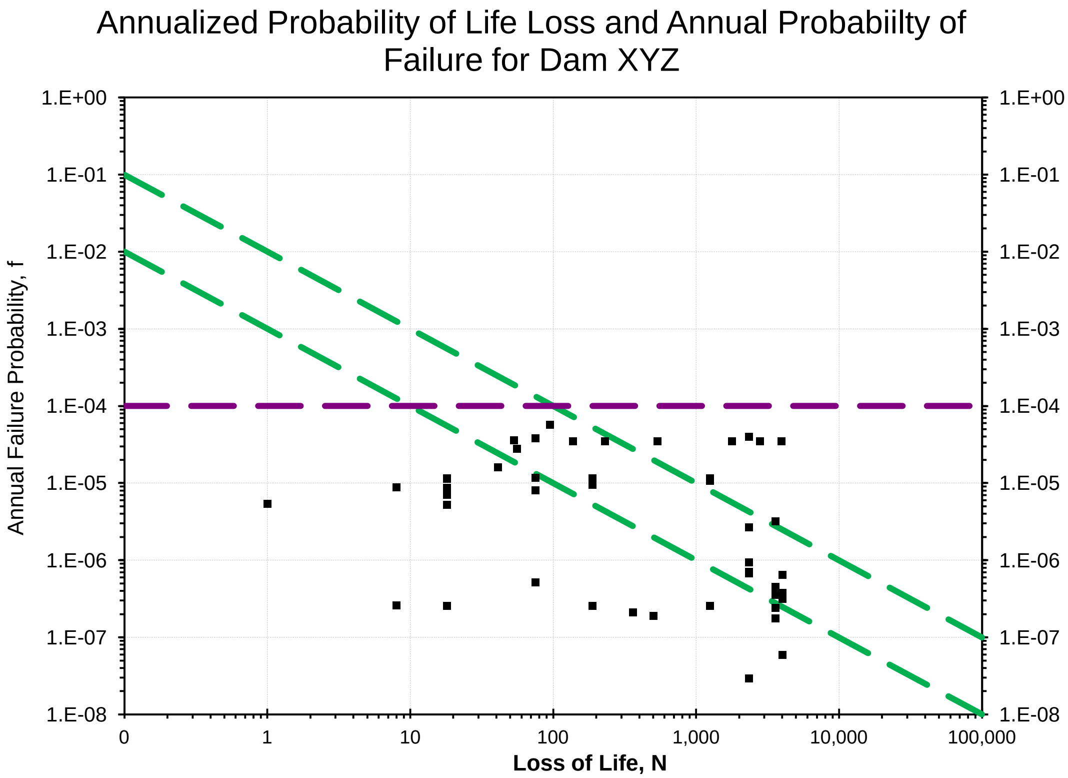
5.4 <u>Considerations in Risk Estimation for Risk Assessment and Risk Evaluation</u>.

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. 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 analysis 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.

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 justifies 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.

5.5 Example Presentations of USACE Tolerable Risk Guidelines. An example set of f-N data points are used in the figures below. Figure 5.6 illustrates the plotting of data using the annual probability of failure and ALL guidelines on the f-N chart. In addition the expected life loss is plotted versus sum of the APF for all failure modes and exposure scenarios are shown as a single data point on the chart. Figure 5.7 illustrates plotting the same f-N data pairs on the societal risk guideline F-N or probability distribution chart.



Expected life loss plotted versus the sum of APF for all failure modes and exposure scenarios

f-N pairs

Figure 5.6 – Plot of f-N Data Pairs for Individual Failure Modes and Exposure Scenarios on the Annualized Life Loss and Annual Probability of Failure Tolerable Risk Guidelines Format

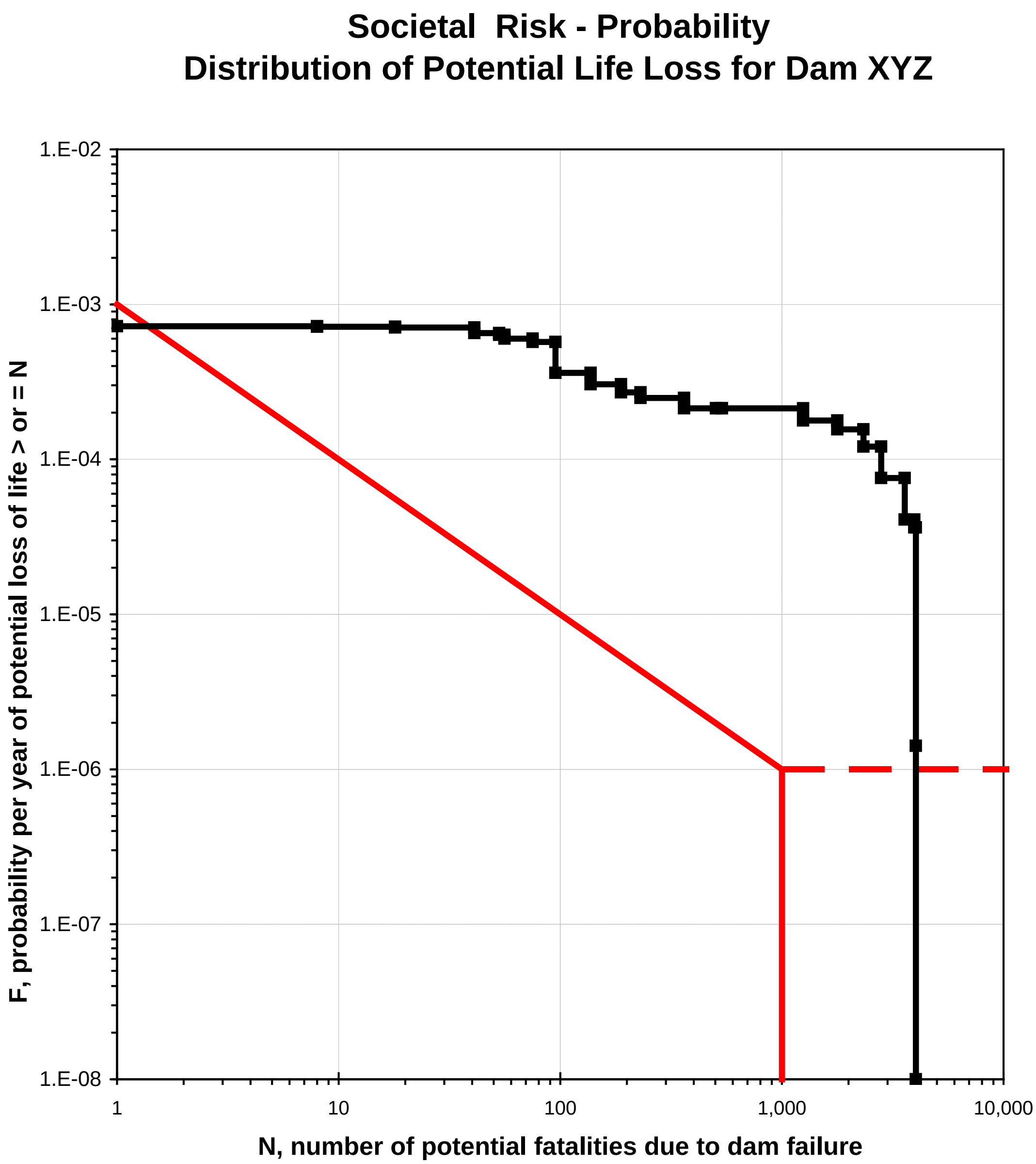


Figure 5.7 – Example Illustrating the Plotting of the Same f-N Data Pairs for Individual Failure Modes and Exposure Scenarios in a Probability Distribution of Potential Life Loss f-N Chart

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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 Dam Safety Risk Management Center, in coordination with the Senior Oversight Group (SOG), will assist the HQUSACE dam safety officer with the prioritization of Issue Evaluation Studies (IES) and Dam Safety Modification Studies (DSM), and the implementation of Risk Reduction 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 Class, Priority, and Urgency.

6.3.2.1 DSAC I dams have been determined to have a confirmed urgent and compelling issue that requires taking immediate and expedited actions to reduce and manage the risk. Therefore, DSAC I dams will automatically be given first priority for DSM studies and will not require an issue evaluation study.

6.3.2.2 Dams will be prioritized within their DSAC class. For example not all DSAC II 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 class dams.

6.3.2.4 With the exception of DSAC I dams, prioritization decisions for Issue Evaluation Studies (P1) and 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 Factors. Significant weight will be given to the quantitative tolerable risk guidelines, but other non-quantitative considerations, including ALARP, will also be used to provide a more complete basis for prioritization of the queues.

6.3.3.1 Quantitative Factors.

6.3.3.1.1 The level of risk in relation to the tolerable risk limit. The greater the estimated annual probability of failure and the further the estimated life risk is above the tolerable risk limit the greater the urgency to act. The more cost-effective a risk management plan is in reducing the annual probability of failure and the life safety risk below the tolerable limit, the greater the justification to select that plan;

6.3.3.1.2 The disproportion between the sacrifice (money, time, trouble and effort) in implementing the risk reduction measures and the subsequent risk reduction achieved (the lower the ratio for a given measure that reduces the life safety risk below tolerable risk limits the greater justification to implement those risk reduction measures);

6.3.3.1.3 The cost-effectiveness of the risk reduction; (the project with lower overall cost for the same level of risk reduction would be given higher priority);

6.3.3.1.4 Net benefits achieved;

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

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

6.3.3.2 Non-Monetary Considerations.

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

6.3.3.2.2 Impacts on any facilities critical to national security and well being, 6.3.3.2.3 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 Consequences' (5.3.9) and 'Environment and Other Non-Monetary Consequences' (5.3.10).

6.4 Prioritization Queues and Related Issues.

6.4.1 Issue Evaluation Studies Queue (P1).

6.4.1.1 Within the Issue Evaluation study queue are those projects awaiting approval to begin the Issue Evaluation study (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 Issue Evaluation Study. 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 Issue Evaluation study, if evidence is obtained that justifies an ‘urgent and compelling’ need for action, the dam should be promptly recommended for reclassification as a DSAC I and moved to the expedited process that is associated with a DSAC I dam.(See Figure 3.1)

6.4.1.3 Phase 1 IES are 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 analysis 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 shall be considered, if available, for use in prioritizing dams for IES includes:

6.4.1.4.1 Information developed in the Screening 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 USACE essential 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 (DSM) will be performed for all dams that do not satisfy the tolerable risk limits as determined by the issue evaluation study, unless the dam has been classified as a DSAC I dam. In general DSAC I dams, except those with low life risk, are given the highest priority for starting the DSM studies. DSAC I dams are prioritized based on available data such as the SPRA report, incident report, the External Peer Review report, and periodic assessment report (if available). DSM studies for the DSAC II, III and IV dams are prioritized based on information available from Issue Evaluation studies 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 reduction actions from the DSM studies are prioritized for Construction funding. The ultimate decision to fund implementation of the DSM study recommendation shall be based on the results of the DSM studies and the priorities of the USACE DSO considering all approved DSM reports. 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 class. Estimates of the reduction in annual probability of failure, reduction in the estimated life safety risk, evaluations of risk reduction measures against tolerable risk guidelines, disproportionality ratio for the recommended risk reduction alternatives, and the cost effectiveness of risk reduction alternatives will be available from the DSM report. Staged risk reduction alternatives should be developed in DSM studies, where appropriate and practicable. These staged risk reduction 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 DSM report recommendations, the district will commence pre-construction engineering and design (PED) and construction once design is completed.

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 DSM study	DSAC class SPRA evaluations and ratings if no PA or IRRM PFMA or risk assessment is available. From a PA use the APF for individual failure modes and total APF of all failure modes, individual life risk, and the societal life risk for the credible PFMs. Critical infrastructure, economic and environmental aspects of the estimated 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 class For the issue(s) being evaluated: the APF, individual life safety risk, and the societal life safety risk for the credible PFMs. Sensitivity analysis to identify the effect of current uncertainty on DSAC and risk evaluations. Critical infrastructure, economic and environmental aspects of the estimated consequences and risk. Recommendations from the RA team	Phase I IES risk assessment

Prioritization Queue	What is being prioritized?	Prioritization Factors	RA and other information available for Prioritization
P2) Dam Safety Modification (DSM) studies	Studies and other work required to support completion of a DSM report	DSAC class From the IES or PA report use the APF for individual failure modes and total APF of all failure modes, individual life safety risk, and the societal life safety risk for the credible PFMs. Consideration of the range of uncertainty in baseline risk estimates. Critical infrastructure, economic and environmental aspects of the estimated consequences and risk. Recommendations from the RA team	IES report PA risk assessment (if done) For a DSAC I dam - SPRA report, incident report, and other available information.
P3) Risk Reduction Projects	Funding of design and implementation of risk reduction measures	DSAC class Total and individual PFM estimated baseline risk showing APF, individual life safety risk, and societal life safety risk Magnitude of the reduction in and the residual total and individual PFM risk showing APF, individual life safety risk, and societal life safety risk Cost-effectiveness as measured by the Cost of a Statistical Life Saved. Disproportionality ratio Benefit cost ratio (BCR) Critical infrastructure, economic and environmental aspects of the estimated consequences and risk.	DSM study report

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 I, II, and III 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 remedial measures are pursued.

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

7.2.1 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 result in the dam safety being compromised 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. We no longer refer to 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 provide specific Congressional authorizations and legal responsibilities that often cover a broad array of purposes and objectives. The public safety responsibility is critical to informing how we implement these statutory responsibilities and requires USACE to assure projects are adequately safe from catastrophic failure 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. We manage risks of flood waters, we do not control them. Our projects do not have unlimited operational capacity to control extreme floods. Our 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 Unique Projects 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 consider these complexities and be modified as required over time.

7.2.7 Loss of Life Versus Economic Damages. The operations of a high risk (unsafe or conditionally unsafe) dam during flood conditions can create a conflict between the potential for loss of life and economic damages resulting from an uncontrolled release due to failure and 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 planned, controlled release of the pool than with the case of unplanned, uncontrolled release resulting from failure of the project.

7.2.8 Interim Risk Reduction Measure Plan. The Interim Risk Reduction Measure (IRRM) Plan, including changes to the supporting Water Control Plan, is the key document that frames operational decision making for DSAC I, II, and III dams. This plan establishes the specific threshold events, decision points, and actions required. The IRRM Plan should recognize the need for two primary water control management objectives.

7.2.8.1 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.

7.2.8.2 A plan for which emergency measures such as rapid reservoir drawdown and recommendations on evacuation of the reservoir storage must occur.

7.2.8.3 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.

7.2.9 Centrally Led – Decentrally Executed Program. In the centrally led and decentrally executed USACE Dam Safety Program, responsibilities and decision making for Interim Risk Reduction Measures are vertically distributed.

7.2.9.1 Districts. Develop IRRM Plans, coordinate plans, and execute all plans.

7.2.9.2 Divisions. Coordinate, review, and approve plans for DSAC I, II and III dams. In particular, divisions are critical in assuring system and watershed issues are considered and coordinated.

7.2.9.3 HQS. Establishes, in consultation with the RMC, the DSAC class for all dams, reviews and concurs on IRRM Plans for DSAC class I and II dams, and aligns investment strategies for all unsafe dams.

7.2.10 Risk Communications. Familiarity with IRRM Plan is the key to effective risk communications. It is important that managers and leaders discuss issues consistently and openly with affected stakeholders.

7.3 General. IRRMs shall be established for DSAC I, II and III dams. The DSAC Table (Table 3.1) provides the characteristics and actions for each DSAC, including preparation of an Interim Risk Reduction Measures Plan (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 IRRM plans. 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 IRRM, the prevention of loss of life is the first and foremost objective, followed by prevention of catastrophic economic or environmental losses. The process of identifying and evaluating IRRM shall be conducted as expeditiously as possible and shall be a collaborative effort between all district elements as well as technical experts within the MSC, RMC, and HQUSACE. 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 (e.g., project sponsors, project beneficiaries, local emergency response agencies, power marketing agencies, etc.) will be established with the goal of coordinating support for the IRRM. 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 IRRM plan to justify significant restrictions in project storage and release regulation schedules. 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 I, DSAC II and DSAC III dams is from the O&M account (or the Maintenance portion of the MR&T account). Funding for IRRMP implementation for DSAC I, DSAC II and DSAC III 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 Assurance and Seepage/Stability Correction Program. For example, Program funds can be used for inundation maps since that will provide information to advance the Dam Safety Modification study. Design and implementation of permanent risk reduction measures described in the Dam Safety Modification Report are funded from the Construction account, beginning with the Dam Safety Assurance and Seepage/Stability Correction Program until line-item Construction funds become available. 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. For the Construction account, use category class subclass code (CCS) 240, 540, or 640 based on the type project. Construction funds will not be used for maintenance repairs, IRRMP, or IRRM. O&M funds will not be used for the Dam Safety Modification study or implementation. The Mapping, Modeling, and Consequence Production Center (MMC) has overall responsibility for developing dam failure, inundation mapping, and consequence models for USACE dams in support of the IRRMP. Districts must seek O&M funds, through the budget process and/or reprogramming, for IRRMP and IRRM. HQUSACE will seek Construction funds for the Dam Safety Assurance and Seepage/Stability Correction Program and will allocate Program funds among projects for Issue Evaluation Studies and Dam Safety Modification work.

7.5 Interim Risk Reduction Measures Plan (IRRMP). Districts with DSAC I, II, and III dams shall develop and submit to the MSC Dam Safety Officer (MSC DSO an IRRMP outlining the proposed risk reduction measures for approval. IRRMP's for DSAC I dams shall be submitted within a 60-day period after being designated as DSAC I , or within 90 days after being designated as a DSAC II, or within 120 days after being designated as a DSAC III. Prior to submission of the IRRMP, the plan shall 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 M). Stakeholders should also be engaged in developing the plan to the extent possible. Submission of the IRRMP shall include a formal briefing to the HQ DSO for DSAC I, II and III 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 consequences associated with the failure modes (reservoir pool restrictions, modification of reservoir regulation plan and updating of EAPs must always be included as an option that is addressed).

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 justification 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 current EAP which reflects site specific risks, and which includes emergency exercises for DSAC I, II, and III 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 Dam Safety Action Classification (DSAC) rating and hazard potential of the project. The completion of these exercises should be incorporated into the official Interim Risk Reduction Measures Plan 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 Long-term life-safety tolerable risk guidelines should be met by IRRMs wherever available non-structural and appropriate structural options exist to do so. Because life safety is paramount, this implies that the economic and other impacts of IRRMs will not influence meeting long-term life-safety tolerable risk guidelines except in exceptional circumstances. The life safety tolerable risk guideline is intended to influence only the speed with which IRRMs are developed and implemented and not to be a lower level of public safety for short- and medium-term exposure to dam safety risks. See Chapter 5 for more information on tolerable risk guidelines.

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 Dam Safety Officer (DSO). IRRMP and associated decisions require MSC approval and require 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.

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 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) shall be uploaded to the Risk Management Center's centralized data repository at the time of review copy submittal. A copy of the final IRRMP reflecting all updates and revisions required from the review process shall be uploaded after IRRMP approval.

Table 7.1
Decision Levels for Interim Risk Reduction Actions

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

7.7.6 An annual review of all DSAC I and II IRRMP's is required unless some event occurs that would trigger an earlier review, e.g., rise in piezometers readings, completion of a remediation phase, etc.

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

7.8 Interim Risk Reduction Measures (IRRM).

7.8.1 Types of IRRM that should be considered include, but are not limited to, the items listed below. 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 imperative objective is to reduce the probability of catastrophic failure and associated consequences to the maximum extent reasonably practicable while long-term remedial 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. IRRMPs are mandatory for DSAC I, II, and III dams. IRRMP development timeline guidance outlining development, review, and implementation requirements is detailed in Table M.1 in Appendix M. Seepage and internal erosion have been identified as the primary failure mode governing risk for the USACE' dam inventory. Seepage and internal erosion can be a lengthy failure continuum (progressive failure) which may lead to catastrophic loss of pool with little or no warning. An example of a seepage failure development continuum is shown in Figure O.1 in Appendix O. 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 Interim risk reduction measures are not intended to be the process for permanently remediating dam safety concerns. The following principles (and associated questions) can be used to determine if a proposed interim risk reduction measure is appropriate.

7.8.2.1 Timely. Will the measure be implemented in a timely manner 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 No New Risk. Does the measure increase the overall risk from the dam to the downstream public? 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. An action done during a response to a dam safety emergency is not an interim risk reduction measure.

7.8.3 Examples of non-structural Interim Risk Reduction Measures.

7.8.3.1 Reservoir pool restrictions or change in water control plan the district should begin immediate action to update the water control plan to reflect the operational change or pool restriction.

7.8.3.1.1 Guidance is provided in ER 1110-2-240, Water Control Management (Reference A.49) 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.

7.8.3.1.2 Annual command level reviews of IRRM implementation are required for DSAC I, II, and III 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.

7.8.3.2 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 Emergency Action Plan 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 Consequence Production Center (MMC) has overall responsibility for developing dam failure, inundation mapping, and consequence models for USACE dams in support of the EAP.

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. Refer to Chapter 16 for guidance on the appropriate type and frequency of exercises.

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.

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 evacuation percentage and time.

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 damages and potential loss of life from a potential dam failure or other IRRM.

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.

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 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 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, 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 shall 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. Approval of the IRRMP for DSAC I, II, and III dams shall be by the MSC DSO with 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 <u>Purpose of Issue Evaluation Studies (IES)</u>.

8.1.1 This chapter provides guidance and procedures for developing the IES report that presents the risk assessment, documentation, and justification for conducting a Dam Safety Modification study at completed USACE projects. In addition, this chapter provides guidance for completing Issue Evaluation Study plans, Issue Evaluation studies, and Issue Evaluation Study reports. Figure 8.1 is a graphical representation that shows the work flow process for Issue Evaluation Studies. Figure 8.2 shows how the Issue Evaluation Study and Periodic Assessments fit into the overall portfolio risk management process for dam safety.

8.1.2 Issue Evaluation Studies for dams rated as DSAC II, III and, IV are studies to determine the nature of a safety issue or concern, and the degree of urgency for action within the context of the entire USACE inventory of dams. The purpose of an Issue Evaluation Study (IES) is to focus on significant potential failure modes when evaluating risk, verify the current DSAC rating, guide the selection and gauge the effectiveness of interim risk reduction measures, and justify the need to pursue or not pursue Dam Safety Modification studies. Issue Evaluation Study 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 <u>Objectives of Issue Evaluation Studies</u>**.** 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 justifies 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.

8.2.1 Confirmed Dam Safety Issues. Confirmed issues are those that pose a significant risk (approaching or exceeding tolerable risk limits) with a high level of confidence (due regard for uncertainty) such that additional studies and investigations are not likely to change the decision that dam safety modifications are justified. 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 seepage and piping, 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 I 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 a high probability of unsatisfactory performance, 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 justified to further investigate the dam safety issue prior to finalizing the risk estimate.

8.2.3 Scope of Issue Evaluation Studies. The scope and level of rigor required for a 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 using existing data, analyses, and performance history. As the risk management process develops over time, a baseline risk estimate will be prepared for every dam in the portfolio either through a Periodic Assessment, or through other risk informed studies. For projects where a baseline risk estimate has been prepared during a previous Periodic Assessment or other risk informed study, the risk estimate should be updated to address the current issue or concern. For projects where a baseline risk estimate has not been performed, an initial risk estimate for issue evaluation will be prepared to determine if the issues of concern approach or exceed the tolerable risk limits.

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

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

8.2.4.2 Verify or reclassify the current DSAC rating based on these findings;

8.2.4.3 Determine if a dam should be reclassified as DSAC I and thus warrants the expedited process for a DSAC I dam as shown on the left side of Figure 8.2;

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

8.2.4.5 Use the Issue Evaluation Study results to develop effective risk management plans, identify data deficiencies, develop study plans, and prioritize dam safety modification studies; and

8.2.4.6 Determine if there is justification (or not) to proceed to a Dam Safety Modification study.

8.3 Issue Evaluation Study Plan. The Issue Evaluation Study Plan shall 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 rating;

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 risk estimates 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 IRRMP's, Issue Evaluation studies, Periodic Assessments, etc.;

8.3.6 A description of the proposed work plan/scope of work and funding estimate for the district to complete the Issue Evaluation Study. The district will coordinated with the RMC and obtain RMC concurrence of the scope of work prior to the development of the plan. The 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 Issue Evaluation Study, the district 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 Phase 1 study plan examples from other USACE projects are available upon request by contacting the Risk Management Center.

8.4 Funding for Issue Evaluation Study Plans. The preparation of Issue Evaluation study plans will be funded from Dam Safety Assurance, Seepage/Stability Correction Program ("Wedge Funds"). The 5 to 7 page Issue Evaluation Study 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 Issue Evaluation Studies.

8.5 Schedules for Submittal of Issue Evaluation Study Plans. Preparation of Issue Evaluation Study plans for DSAC II, III, & IV dams shall begin when the project receives a priority rating and the district is notified by the RMC/HQUSACE to proceed with preparation of the IES Study plan. The plan study plan shall be submitted to the MSC DSO within 60 days after such notification.

8.6 Approval Authority. Issue Evaluation Study Plans for Phase 1 and addendums to Phase 1 plans for Phase 2 studies shall be prepared by the district and approved by the district's dam safety officer. The study plan will contain a District Quality Control plan as per EC 1165-2-209 (reference A.5). The need for Phase 2 studies will be determined by the vertical team based on findings documented in the IES draft report. The execution strategy for incremental Phase 2 efforts must be formulated during a collaborative meeting between the risk assessment 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, Phase 2 work scope must be approved by the Risk Management Center, and the funding request will require budgetary approval for Wedge Funds from the HQUSACE Dam Safety Program Manager. Table 8.1 depicts a summary of the principal participants in the decisions involving the development, review, and approval of study plans.

<table>
<tr><th colspan="6">Table 8.1 Issue Evaluation Study Plan - Review & Approval Requirements</th></tr>
<tr><th>Study Phase</th><th>DSAC II, III, & IV</th><th>District</th><th>MSC</th><th>RMC</th><th>HQ-DSO</th></tr>
<tr><td rowspan="2">Issue Evaluation Study Plan</td><td rowspan="2">Phase 1</td><td>Study Plan Approval by DSO</td><td>Concurrent Quality Assurance Review</td><td>Concurrent Risk Cadre Review</td><td>Concurrent Policy & Compliance Review</td></tr>
<tr><td colspan="3">District will coordinate with the RMC and obtain RMC concurrence on the scope of work prior to development of the study plan.</td><td></td></tr>
<tr><td rowspan="2">Issue Evaluation Study Plan</td><td rowspan="2">Phase 2</td><td>Addendum to Study Plan Approval by DSO</td><td>Concurrent Quality Assurance Review</td><td>Concurrent Risk Cadre Review

Approval of Work Scope</td><td rowspan="2">Concurrent Policy & Compliance Review

HQ DSPM Budgetary Approval</td></tr>
<tr><td colspan="3">Collaborative meeting with Risk Assessment Cadre, and joint approval of work scope with RMC is required for incremental Phase 2 efforts</td></tr>
</table>

8.7 Submittal Requirements. Issue Evaluation Study plans shall be submitted electronically to the MSC DSO, HQ USACE DSPM, and the Dam Safety Risk Management Center. An electronic copy of the study plan (review copy) shall be uploaded to the Risk Management Center'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 shall be uploaded after approval.

8.8 Issue Evaluation Studies - Phase 1.

8.8.1 Risk Estimates. Risk estimates in support of the Issue Evaluation Studies (IES) are conducted to determine if the total project risk approaches or exceeds the Corp's tolerable risk limits, and if Dam Safety Modification (DSM) studies are justified. Phase 1 efforts utilize existing data and information. The risk estimate resulting from an issue evaluation study is used to verify or reclassify the current DSAC, guide the selection and gauge the effectiveness of interim risk reduction measure requirements, and provide information to support prioritization of Dam Safety Modification Studies from a national portfolio level.

8.8.2 Scope of Risk Estimates. The scope of the risk estimate must be more rigorous than the level of detail executed in SPRA estimates, may be more or less rigorous than a Periodic Assessment, and is intended to achieve a defensible, risk informed justification for initiating Dam Safety Modification Studies. 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 missing data required to assess performance is not available or cannot be linked to a specific failure mode or observation.

8.8.3 Data for Risk Estimates. For dams with no baseline risk estimate (see Chapter 3) the IES risk estimate should be conducted using existing data and should include as many significant failure modes as are necessary to determine that the estimated risk justifies going on to a DSM study. For dams where a previous risk estimate has been calculated from a Periodic Assessment or other dam safety study, 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.

8.8.4 Finding of Urgent and Compelling. At anytime during the conduct of an Issue Evaluation Study, if a finding of major concern or evidence is identified requiring an ‘urgent and compelling’ need for action, such as if the dam is judged to be in the failure continuum, the project should immediately be moved to the expedited process as outlined in Chapter 9, Dam Safety Modification Studies and Documentation.

8.8.5 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:

8.8.5.1 Perform a facilitated Potential Failure Mode Analysis.

8.8.5.2 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.

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

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

8.8.5.5 Utilize consequence estimates provided by the Modeling, Mapping, and Consequence Production Center (MMC).

8.8.5.6 Prepare a risk estimate for issue evaluation (that typically addresses four or five significant failure modes), and determine if the issues of concern approach or exceed the tolerable risk limits.

8.8.6 Dam Safety Risk Assessment Tools. Corps of Engineers Dam Safety Risk Assessment Tools along with Expert Elicitation can be used to calculate load-frequency and load-response probabilities for all potential failure modes included in the risk estimate. The Risk Management Center will provide guidance on selection of the most appropriate risk estimating tools and methodologies to be employed, prior to the start of the Issue Evaluation Study.

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 Phase 2 Justifications. 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 DSM study. Phase 2 studies are justified when it can be clearly demonstrated that additional reductions in uncertainty or a greater level of confidence can be achieved in the IES risk estimate from the additional time, resources, investigations, and analyses that are proposed. Phase 2 efforts will be incrementally funded to support increasing levels of rigor until the uncertainties are sufficiently minimized. Figure 8.2 of the Issue Evaluation Study process shows the incremental approach and decision making process as the levels of rigor are increased.

8.9.3 Study Plan Addendums. Study plan addendums for Phase 2 efforts shall be prepared and submitted to the Risk Management Center 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 the likelihood of better defining an issue, and determine if it is a problem or not, with a high degree of confidence or certainty with the additional studies, analyses, and investigation efforts. 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 risk estimate in an Issue Evaluation Study will assist the vertical team in determining what additional actions are justified and the urgency of such actions.

8.10.2 Projects with an approved Issue Evaluation Study that concludes that the estimated risk exceeds the USACE tolerable risk limits will undergo a DSAC review and be recommended for a Dam Safety Modification study. The project will be prioritized, scheduled, and moved into the resource queue for funding.

8.10.3 If the Issue Evaluation Study concludes that the risk estimate is significantly below the tolerable risk limits, the study should recommend that an evaluation of the tolerability of the residual risk and compliance with Essential Agency Guidelines be conducted accordance with Chapter 5. The DSAC reclassification 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 total annual probability of all failure modes;

8.10.4.2 The incremental risk estimate above the limit line for life safety; and

8.10.4.3 The total annualized (mean) 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 shall be called Issue Evaluation Study report. The IES report will be used to present information that confirms the dam safety issues and support the need for a dam safety modification study (DSM), or states the case to revise the current DSAC rating. Therefore the dam safety issue or issues must be clearly defined and supported by the related risk estimate. In the event that a Dam Safety Modification study is not justified, or a determination is made at any point during the study that the issues can be remediated under the major rehabilitation threshold funding cap , the Issue Evaluation Study is stopped and documented, and project is assigned to the routine O&M processes as defined in Figure 3.1. At the minimum a potential failure mode analysis will be conducted. The IES document shall include 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 justified.

8.11.2 Organization and Scope. The IES report shall consist of two separate documents, the Issue Evaluation Study Summary of Findings (IESSF) report, and the IES Report. These documents shall be prepared in a standardized modular format to allow for relative ease of assembly and updating. This approach allows for the district to provide concise and consistent reports to the MSC, RMC, SOG, and HQ and allows for studies to be easily prioritized on a national level. This will also support rapid reevaluation of a project if adverse incidents occur or criteria changes at a later date that would warrant review of the risk estimate and the priority given the dam.

8.11.2.1 The IESSF for an Issue Evaluation Study is intended to be a stand-alone component of the IES report that provides information to senior USACE officials to make dam safety decisions. The IESSF for an Issue Evaluation Study is an internal working document and not intended for public release.

8.11.2.2 The IESSF for an Issue Evaluation Study concisely summarizes the following: The USACE dam safety program; 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 Issue Evaluation Study shall contain all background data, risk computations, findings, conclusions, and recommendations, and supporting documentation. It will act as the technical reference and supporting document for the IESSF Report.

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

8.12 Roles and Responsibilities.

8.12.1 Risk Management Center (RMC). The Risk Management Center will provide support to the HQUSACE DSO and the Senior Oversight Group (SOG) 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 SOG, MSC, and district offices to prioritize the Issue Evaluation and Dam Safety Modification Studies from a national perspective. The RMC will schedule and budget all centralized resources needed for the execution of Issue Evaluation Studies based on the SOG's prioritization and assign facilitators and regional cadre members to perform the PFMA and risk estimate. The Risk Management Center will also assign a separate risk assessment cadre to assist with the agency technical review requirements. Risk assessment cadre members shall not be assigned to work on projects that are located within the boundaries of their home district.

8.12.2. Risk Assessment Cadre. A risk assessment cadre and an approved PFMA facilitator, with support from the district, will be responsible for conducting the potential failure mode analysis and performing the risk estimate. The regional cadre will provide the district with recommendations on implementing or revising Interim Risk Reduction Measures, 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 Assessment 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 assessment 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 Issue Evaluation Studies. This includes formation and management of an Issue Evaluation Study Product Delivery Team as directed in ER 5-1-11 (reference A.35). The PDT will coordinate the development of the IES plan scope of work with the RMC; prepare and submit the Issue Evaluation Study 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; funds requests addendums; and schedule the various work efforts required to complete the Issue Evaluation Study. 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 Issue Evaluation Study 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 ER 1110-2-1150 (reference A.51). 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.

8.12.4 Agency Technical Review. The Risk Management Center is responsible for coordinating and managing agency technical review of the IES reports in accordance with EC 1165-2-209 (reference A.5).

8.13 Funding. Issue Evaluation Studies 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.

8.14 Schedule. The schedule for completion of an Issue Evaluation Study 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 Issue Evaluation Study plan. Phase 1 Issue Evaluation Studies should be completed within 6 months from receipt of funds. For projects where Phase 1 efforts find that a Phase 2 study is justified, the study should be executed in accordance with the approved study plan addendum for the Phase 2 efforts.

8.15 Decision Process; Submittal, Review, and Approvals of IES.

8.15.1 Decision Process. The decision process: submittal, review and approvals of IES involve 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. The dam safety program will follow the policy review process described in EC 1165-2-209, Civil Works Review Policy. 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. A Quality Control and Consistency (QCC) review will be conducted including the district, MSC, and RMC. The district and the risk assessment cadre present the IES risk assessment, IES findings, conclusions, and recommendations for review. After resolution of QCC review comments, the MSC and HQUSACE will complete quality assurance and policy compliance review. Then the district will present the report findings and recommendations to the Senior Oversight Group (SOG). Once any SOG comments are resolved the district DSO, MSC DSO, and the SOG Chair will sign a joint memorandum approving the findings and recommendations of the IES report. By formal memorandum the SOG Chair will notify the USACE DSO and the MSC commander that the IES report is approved. (See Figure 8.3)

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

Table 8.2 Issue Evaluation Study Report - Review and Approval

Study Phase	For DSAC II, III, & IV	District	MSC	RMC	HQUSACE DSO
Issue Evaluation Study Report	Includes: Report, Appendices, to include Risk Estimate	ATR w/Risk Assessment Cadre Cert Joint Approval by DSO	Quality Assurance Review Joint Approval by DSO	QCC Risk Cadre Review & Approval of Risk Estimate Concurrence with Recommendations	Policy & Compliance Review Joint Approval by SOG Chairman

8.15.3. Report submittal requirements are as follows:

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

An electronic copy of the IES report (review copy) shall 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 IES Report reflecting all updates and revisions required from the review process shall be uploaded after report approval.

8.15.4 Following joint approval of the Issue Evaluation Study, the RMC, MSC, and district will be notified, and the project will be placed in the national priority queue for Dam Safety Modification study funds.

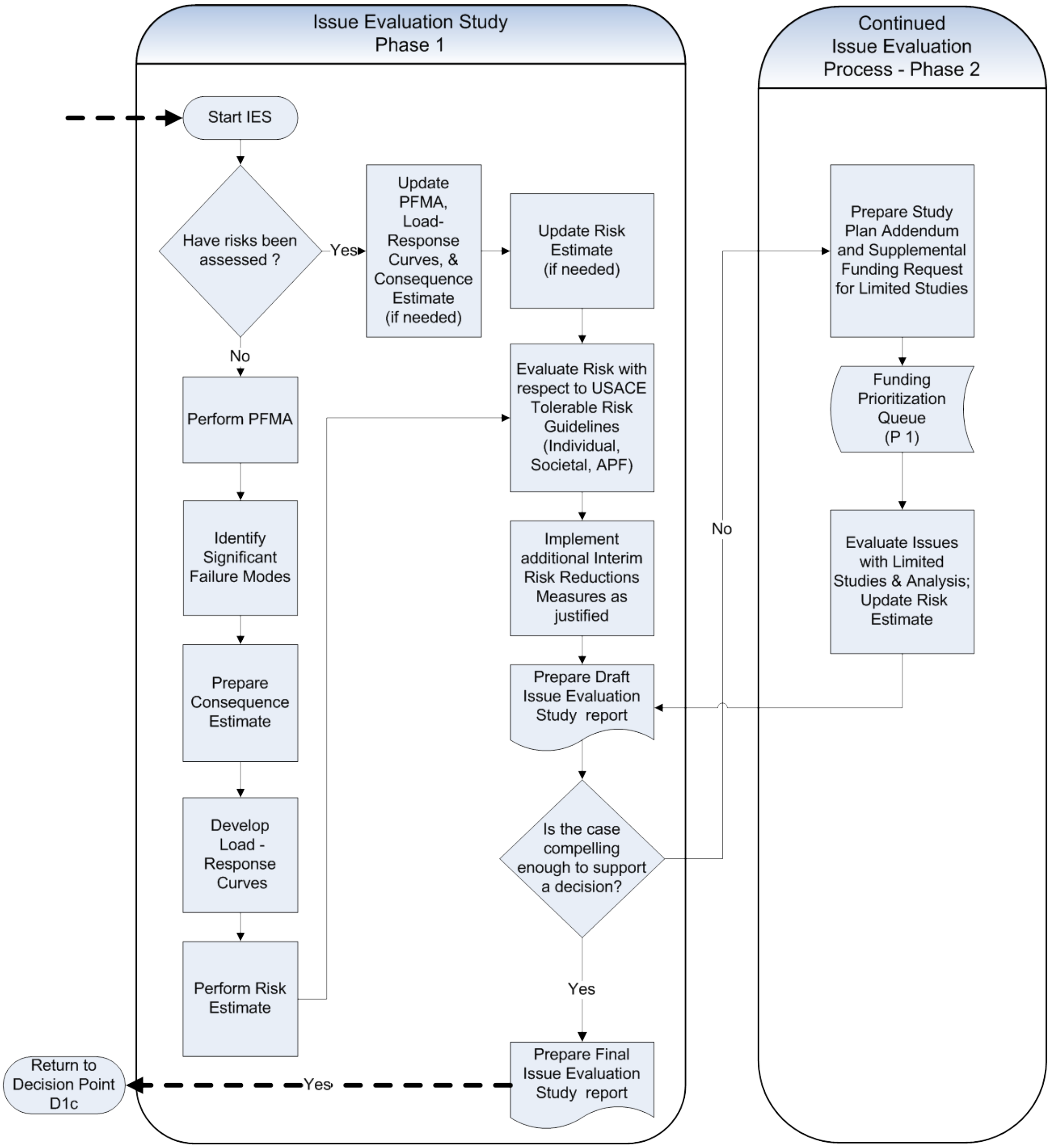
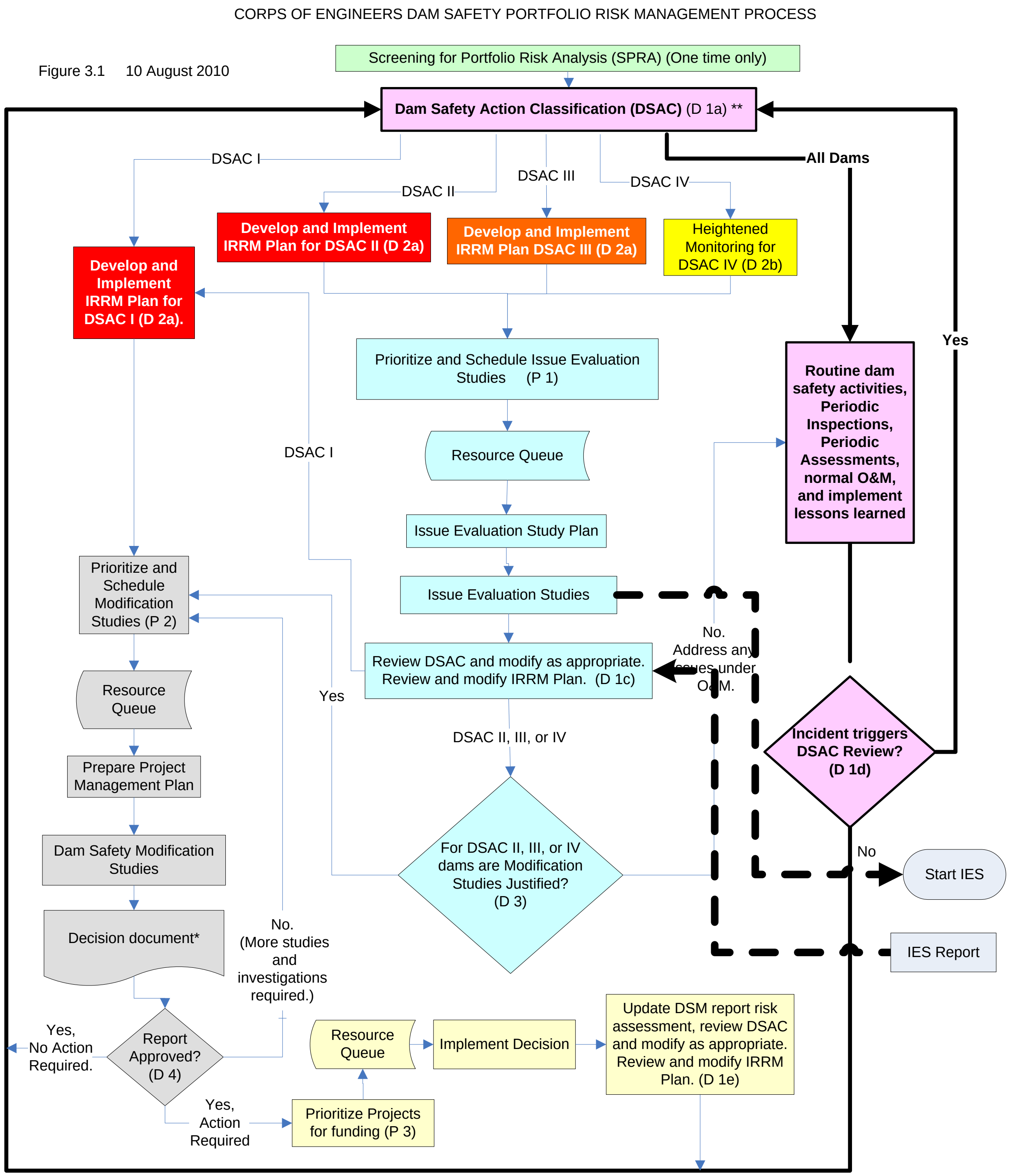


Figure 8.1 - Graphical Representation that Shows the Work Flow Process for Issue Evaluation Studies



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 the Dam Safety Modification chapter.**
**** 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 8.2 - How the Issue Evaluation Study Fits Into the Overall Portfolio Risk Management Process

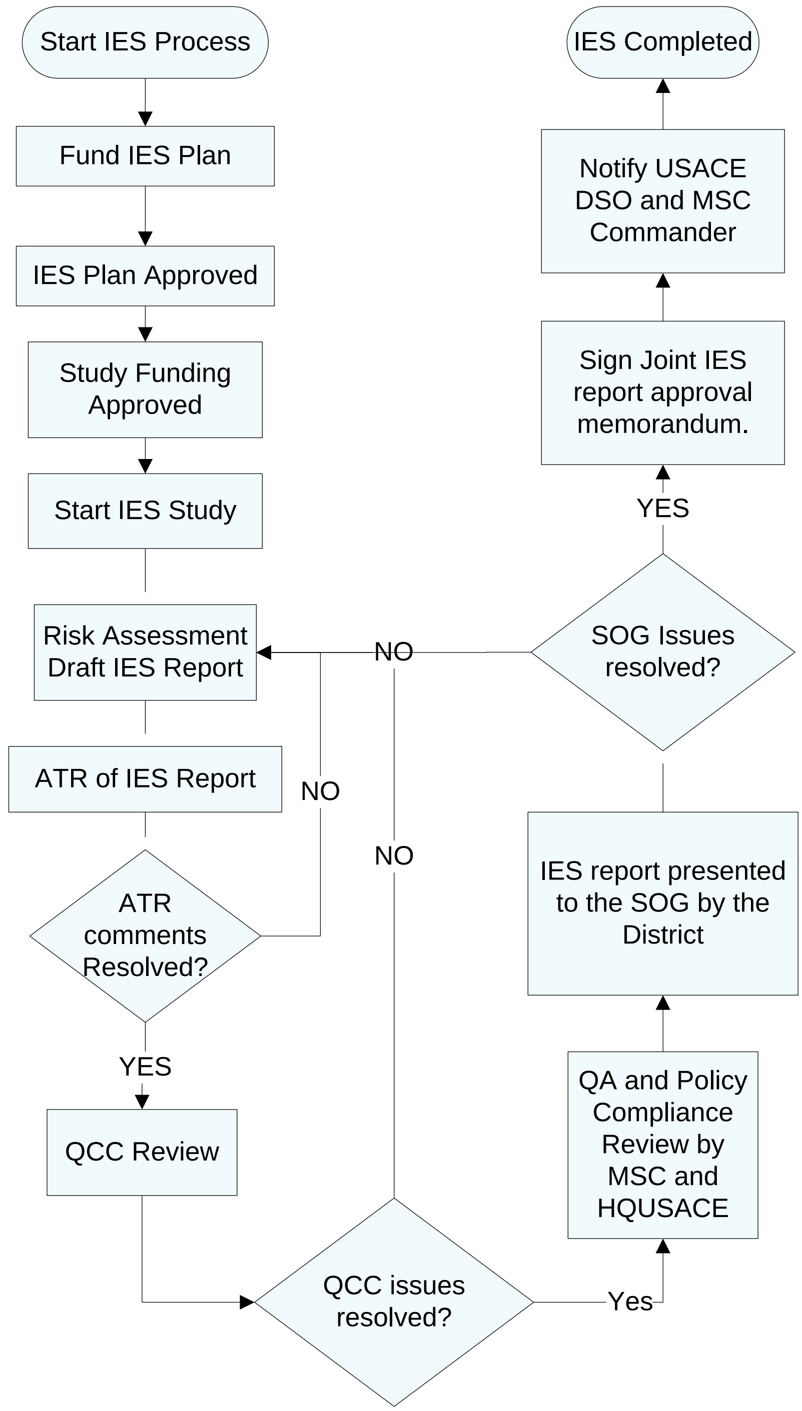


Figure 8.3 – Flowchart of the IES Decision, Review, and Approval Process

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 justification of 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 (DSM) report – will be used for all dam safety modification projects not requiring additional authorization by Congress. The DSM report shall be prepared for any Dam Safety Action Classification (DSAC) Class I, II, III, and IV dams upon the approval of the Dam Safety Senior Oversight Group (SOG) in accordance with national priorities. Figure 3.1, Corps of Engineers 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 DSM study, review, decision and approval process flowchart. The DSM report shall include 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. The risk assessment in support of the Dam Safety Modification study shall 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. The report format and additional technical guidance is contained in Appendix Q.

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 (ER 1110-2-1155, “Dam Safety Assurance Program” (reference A.52); and ER 1130-2-500, “Project Operations - Partners and Support (Work Management Policies)” (reference A.62). Note - for projects with currently approved Dam Safety Assurance reports or major rehabilitation reports a DSM report 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 DSM Report. 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 SOG, based on an assessment of risk, shall be funded to go through the DSM study process. The decision to modify a dam should be based upon the magnitude of existing life, economic, and environmental risks; the effectiveness of the proposed alternatives to reduce the 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, the modifications must be within the Chief of Engineers' discretionary authority to operate and maintain the dam. Guidance that will assist in making this determination is contained in ER 1110-2-240 “Water Control Management” dated 8 October 1982. 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.’

9.3.1.2 At such time during execution of the DSM study that it is determined that the likely recommended alternative will significantly impact authorized purposes, the study process should transition to “Additional Authorization” as described in paragraph 9.3.2 below. A DSM report will be used to approve projects to be funded with Construction appropriation funding. A DSM study 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). Once a DSM report 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.

9.3.2 Additional Authorization. Project modifications that require additional authorization should be studied under the authority of Section 216 of the Rivers and Harbors Act of 1970 (reference A.94), following the guidance in Chapter 2 of ER 1105-2-100 (reference A.42).

9.4 DSM Study Objectives. The objective of a dam safety modification study is to identify and recommend an alternative 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, comply with applicable laws, and satisfy applicable tolerable risk and 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 guidelines in Chapter 5 on an individual failure mode basis, including considerations for ALARP. The intent is to achieve a complete remediation of those individual failure mode(s) being addressed by the plan to support the ultimate goal of having an adequately safe dam where the dam meets essential USACE guidelines and the total residual risk for the dam is considered tolerable (DSAC V). 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.

9.4.1 DSAC I and II Dams.

9.4.1.1 The DSM report for DSAC I and II dams will support expedited risk reduction for urgent dam safety issues. The objective is to identify and recommend an alternative risk management plan that addresses all failure modes that contribute to the DSAC I or II classification such that the failure modes being addressed would be completely remediated and the dam would be reclassified after implementation of the plan.

9.4.1.2 The DSM study for DSAC I and II dams will focus on those individual failure mode(s) that collectively contribute to the DSAC I or II classification. Other significant failure modes should be included in the study if they can be expeditiously and cost effectively addressed at the same time without impacting the schedule for completion of the study and the timeframe for implementation of the alternative risk management plan. All significant failure modes still need to be identified during the PFMA and quantified for the baseline risk estimate even though they may not be addressed by an alternative risk management plan. Resources allocated to the evaluation of failure modes that will not be part of an alternative risk management plan should be kept to a minimum relying primarily on existing information.

9.4.1.3 After implementation of the alternative risk management plan, the dam will be reclassified and inserted back into the portfolio risk management process at the appropriate location for national prioritization of any remaining dam safety issues.

9.4.2 DSAC III and IV. The DSM report for DSAC III and IV dams will support risk reduction for priority dam safety issues. The objective is to identify and recommend an alternative risk management plan that addresses all failure modes that contribute to the DSAC III or IV classification such that the failure modes being addressed would be completely remediated and the dam would be reclassified after implementation of the plan. All significant failure modes need to be identified during the PFMA, quantified for the baseline risk estimate, and addressed by the alternative risk management plan. The intent is to achieve a complete remediation of those individual failure mode(s) being addressed by the plan to support the ultimate goal of having an adequately safe dam (DSAC V).

9.5 Basic Approach and Principles for Execution of a DSM Study.

9.5.1 DSM studies will be undertaken following the six step framework of civil works planning presented in ER 1105-2-100 "Planning Guidance Notebook" (reference A.42) as adapted herein for addressing dam safety issues.

9.5.1.1 Identify dam safety issues and opportunities;

9.5.1.2 Estimate baseline risk condition;

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 generally 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 measures (IRRM) studies, Issue Evaluation studies (IES), and periodic assessments (PA) completed under Chapters 7, 8, and 11 shall form the beginnings of the DSM study.

9.5.1.8. Environmental Compliance. DSM studies and modifications should be in compliance with all applicable Federal environmental statutes and regulations and with applicable State laws and regulations where the Federal government has clearly waived sovereign immunity. The National Environmental Policy Act (NEPA) 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 impacts to those ecological, cultural, and aesthetic resources identified and investigated. Involvement by resource agencies and the general public during the study process is also required. USACE NEPA guidance can be found in ER 200-2-2. The NEPA process will be integrated with the USACE six step planning process. This should also include all measures required for compliance with other applicable environmental statutes, such as the Endangered Species Act, the Clean Air Act, the Clean Water Act, the Fish and Wildlife Coordination Act, and the Historic Preservation Act, among others. (See ER 1105-2-100, Appendix C for compliance requirements.) This integration is intended to reduce process overlap and duplication. The integrated process will help assure that well-defined study conditions and well-researched, thorough assessments of the environmental, social, and economic resources affected by the proposed dam safety activity are incorporated into dam safety decisions.

9.5.2 Identify Dam safety issues and opportunities (Step 1). Dam safety issues and opportunities 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 engineering guidelines. Issues and opportunities should be defined in a manner that does not preclude the consideration of all potential alternatives to resolve the dam safety issues. Problems and opportunities statements will generally encompass just 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.) as well if they are expected to be significantly different from the current conditions and thus be relevant to ‘fix’ decisions and risk characterization. Thus, they can be, and usually are, re-evaluated and modified in subsequent steps and iterations of the DSM study process.

9.5.2.1 Properly defined statements of dam safety issues and 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 opportunities (risk management measures) are the foundation for scoping the DSM study process.

9.5.2.2 Once the dam safety issues and opportunities are properly defined, the next task is to define the DSM study risk reduction objectives and the constraints that will guide efforts to resolve these safety issues and achieve these opportunities. Dam safety risk reduction objectives are statements that describe the desired results of the DSM study 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 essential USACE guidelines.

9.5.2.3 Constraints are restrictions that limit the DSM study process. Constraints are unique to each DSM study. Some general types of constraints that need to be considered are resource constraints and 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, money and time. Legal and policy constraints are those defined by law, USACE policy and guidance. Plans should be formulated to meet the DSM study risk reduction objectives and to avoid violating the constraints. Thus, a clear definition of risk reduction objectives and constraints is essential to the success of the DSM study process.

9.5.3 Estimate Baseline risk condition (Step 2). A quantitative and qualitative description is made, for both current and, in selected instances, future risk conditions that become the baseline conditions. A vital activity during this step is to identify all key assumptions and sources of uncertainty in defining this baseline risk condition. These activities would include the potential failure mode analysis (PFMA) and detailed risk assessment of current and where important, future, without modification, conditions. Existing conditions are those at the time the study is conducted and most often constitute the baseline risk condition. The baseline risk condition provides the basis from which alternative plans are formulated and their impacts are assessed. Since impact assessment is the basis for plan evaluation, comparison and selection, clear definition and full documentation of the baseline condition are essential. Consequence analysis will consider existing and future population at risk and threatened population for fatality estimates. All dam safety issues (significant failure modes) will undergo a risk assessment to determine the baseline risk and for each subsequent risk reduction alternative. Each potential failure mode must be shown to lead to a plausible failure of the dam. These steps are accomplished with the risk assessment that establishes the baseline risk estimate on a without IRRM condition. Permanent structural IRRM and permanent changes to the water control manual are to be included in the baseline risk condition.

9.5.4 Formulating alternative risk management plans (Step 3). Alternative risk management plans shall be formulated to identify specific ways to achieve dam safety objectives within constraints, so as to resolve the dam safety issues and realize the opportunities that were identified in step 1. 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 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). 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 shall 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 shall 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. As a general rule alternatives must be formulated to contribute to achieving the tolerable risk and essential USACE engineering guidelines, and reflect the ALARP considerations.

9.5.4.1.1 Required alternatives are:

9.5.4.1.1.1 No action alternative (current condition baseline risk);

9.5.4.1.1.2 Meeting risk reduction objectives for the DSAC class of the dam (Refer to Section 9.4);

9.5.4.1.1.3 Achieving only tolerable risk limit for life safety;

9.5.4.1.1.4 Make IRRM permanent,

9.5.4.1.1.5 Remove structure, and

9.5.4.1.1.6 Replace structure.

9.5.4.1.2 Each alternative risk management plan shall be formulated in consideration of four criteria described in the Principles and Guidelines (P&G): completeness, efficiency, effectiveness, and acceptability.

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 DSM study 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 shall be an integral component of each alternative risk management plan.

9.5.4.2 Non-structural measures shall be considered as means for addressing dam safety issues and opportunities. 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 shall receive equal consideration in the alternative development process to structural risk management measures.

9.5.5 Evaluating alternative risk management plans (Step 4). The evaluation of effects is a comparison of the with-risk reduction condition to the without IRRM condition (baseline condition) for each risk management alternative. This necessitates risk assessment be performed for all alternatives. Considering the IRRM as an alternative for permanent implementation should be considered in the formulation process.

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. Each with-risk reduction condition will describe the same critical variables included in the baseline condition developed in step 2 (risk evaluation factors of annual probability of failure, life safety and economic and environmental consequences, and costs and benefits). Criteria to evaluate the alternative plans include all significant resources, outputs and plan effects. They also include contributions to the dam safety risk management objectives, compliance with environmental protection requirements, the P&G's four evaluation criteria (completeness, effectiveness, efficiency and acceptability) and comparison with tolerable risk and essential engineering guidelines.

9.5.5.1.2 The second task is to compare each with-risk reduction condition to the baseline condition and document the differences between the two.

9.5.5.1.3 The third task is to characterize the beneficial and adverse effects by magnitude, location, timing and duration. Beneficial and adverse effects of each plan must be compared. Special care shall be taken to insure that the plan will not result in the risks being increased by the plan instead of lowered. These include monetary and non-monetary benefits and costs. 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. The comparison step can be defined as a reiteration of the evaluation step, with the exception that in this step each plan (including the no action plan) is compared against each other and not against the without-project condition. The output of the comparison step shall be a ranking of plans.

9.5.5.1.4 The fourth task identifies the plans that will be further considered, dropped or reformulated in the DSM study 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 tolerable risk guidelines and essential USACE guidelines.

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 justified by the cost of the plan components being analyzed. The steps abbreviated and the reason for abbreviation shall be documented in the study reports.

9.5.6 Comparing alternative risk management plans (Step 5). In this step, plans (including the no permanent risk reduction action plan) are compared against each other, with emphasis on the outputs and effects 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. A comparison of the outputs of the various plans must be made. The no action plan is to be based on a without IRRM condition. 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 no permanent risk reduction action plan) is compared against each other and not against the baseline condition. The output of the comparison step shall be a ranking of plans.

9.5.7 Selecting a risk management plan (Step 6). A single risk management plan will be selected for recommendation from among all alternative plans that have been considered, including the no 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 tolerable risk guidelines, ALARP considerations, and essential USACE guidelines form the basis for plan selection. Beneficial and adverse effects of each plan must be compared. Other considerations, such as economic and environmental, might be used in selecting a risk management plan must be fully documented and justified. The DSM study risk assessment shall be updated after implementation of the risk reduction remedial measures and evaluated to determine if the risk reduction objectives were achieved.

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 shall be the assignment of a project manager, a lead engineer, creation of a vertical project delivery team, and 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.35) and ER 1110-2-1150, *Engineering and Design of Civil Works Projects* (reference A.51). The PDT consists of personnel from engineering, planning, operations, public affairs office, and others necessary to develop the project.

9.6.1.2. A copy of the final DSM PMP reflecting all updates and revisions required from the review process shall be uploaded after PMP approval.

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

9.6.3 Vertical team meetings.

9.6.3.1 Kickoff Meeting. The district will hold a kickoff meeting with HQUSACE, Risk Management Center, MSC 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 DSM 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 DSM study PMP (review copy) shall be uploaded to the Risk Management Center's centralized data repository at the time of review copy submittal.

9.6.3.2 Alternative Scoping Meeting. After step 2 (Estimate baseline risk condition) a vertical team meeting shall be held to brainstorm and identify the risk management measures to be used in the development of the risk management alternatives.

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

Activity/Document	District	MSC	HQ	
			RMC*	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

9.6.3.3 Risk Management Plan Formulation Briefing. After step 3 (Formulate alternative risk management plans) there shall be a vertical team meeting where the various alternatives will be presented and discussed. The outcome of this meeting will be agreement on those alternatives that will be carried forward to steps 4, 5, and 6, and the level of design and cost estimate 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.

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. This is not the independent external peer review discussed later in this chapter.

9.6.5 Study Schedule and Cost Estimate. Based on the study scope, a study schedule and cost estimate shall be developed. Copies of the schedule and cost estimate shall be included in the PMP and provided to the MSC and HQUSACE DSO.

9.6.6 Investigations and Studies.

9.6.6.1 Detailed field investigations and office studies shall be scoped based on the need for a full baseline risk assessment of the dam.

9.6.6.2 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 Baseline Risk Estimate. One of the first major tasks of a DSM study is to perform a baseline risk assessment to ensure that all credible potential failure modes that contribute significant risk to the total risk of the dam are evaluated and their associated risk estimated for the baseline risk estimate. All risk assessments done up to this point are to be reviewed and considered for use in this full risk assessment of the dam.

9.6.8 Product Review.

9.6.8.1 Review Plan (RP). District will prepare a review plan per EC 1165-2-209 (reference A.5). The Risk Management Center is the RMO. This plan includes all levels of review: District Quality Control (DQC), Agency Technical Review (ATR), Quality Control and Consistency (QCC) review, quality assurance and policy compliance review, SOG 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. If a particular level of review is not anticipated, the RP will document the risk-informed decision not to perform that level of review. Note that DSM reports that recommend the ‘no action’ alternative are to be reviewed in the same manner as DSM reports that recommend an action alternative.

9.6.8.2 Quality Control and Consistency Review. Quality Control and Consistency (QCC) review will be conducted including the district, MSC, and RMC. The district and the risk assessment cadre present the baseline risk assessment, risk management alternatives considered, and the recommended risk management plan for review.

9.6.8.3 SOG Review. The district presents the baseline risk assessment, risk management alternatives considered, and the recommended risk management plan to the dam safety senior oversight group prior to the IEPR.

9.6.8.4 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 EC 1165-2-209 (reference A.5). This review must be completed before the DSM report is approved. EC 1165-2-209, Water Resources Policies and Authorities, Civil Works Review Policy (reference A.5), 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 I and II dams or the project will go forward without the review being completed due to life safety concerns.

9.6.9 IRRM Plan. After completion of the DSM baseline risk estimate review the IRRM plan and update as appropriate.

9.6.10 Post Implementation Risk Assessment. The PMP shall include the task of updating the DSM study risk assessment after implementation of the risk management remedial measures. The dam shall be evaluated to determine if the risk management objectives were achieved.

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 shall be called a Dam Safety Modification Report (DSM Report) and shall 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 DSM report will include a Dam Safety Action Decision Summary (DSADS) which is intended to be an extractable, stand alone component of the DSM report that meets 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.

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

9.7.2 Reports for DSAC I and II Dams. When a project is placed in DSAC Class I and II, an expedited process shall be followed in the preparation of the DSM Report. This expedited process can be 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 shall 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.37) and real estate processes (Reference A.38) shall start as early as possible. While the report must be expedited, it should still follow the format outlined in Appendix Q. 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. An M-CACES cost estimate is required for the recommended risk management plan. Cost estimates shall include a cost risk analysis showing the uncertainty per ER 1110-2-1302, Civil Works

Cost Engineering (reference A.53). 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 Present the results of the economic cost analysis and the total project cost for the recommended risk management plan.

9.8 Submittal, Policy Compliance Review, and Approval Process.

9.8.1 Submittal. The district DSO shall submit the DSM report package including a cover letter requesting policy compliance review in preparation for approval to the MSC DSO, Risk Management Center, and HQUSACE in the number listed in Table 9.2. Two complete copies and 6 copies of the main report without appendices shall be transmitted directly by the district to the USACE DSO at HQUSACE, ATTN: CECW-CE for concurrent review. The transmittals shall include the completed review checklists as given in Appendix S - Dam Safety Modification Report Issue Checklist and Appendix T - Post-Authorization Decision Document Checklist. Once the report is transmitted, further work on the project shall be accomplished only after consultation with the MSC and the USACE DSOs and their concurrence is obtained. An electronic copy of the DSM Report (review copy) shall be uploaded to the Risk Management Center's centralized data repository at the time of hard copy submittal. A copy of the final DSM Report reflecting all updates and revisions required from the review process shall 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
HQ USACE RIT and DSPM	2	6	8
Dam Safety Risk Management Center	2	-	8

* The HQUSACE 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 DSM report is approved. Guidance is provided in ER 1110-2-240, Water Control Management (reference A.49).

9.8.1.2 For DSAC I and II 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. An appropriate level of communications is recommended for DSAC Class III and IV projects.

9.8.2 Policy Compliance Review. The MSC and HQ will conduct agency policy compliance review. The Risk Management Center will review the risk estimate and verify that risk estimate is in compliance with the current policy for dam safety risk estimates. The Risk Management Center will review the risk management recommendations and verify the estimated risk reductions.

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

9.8.3.1 The USACE DSO has been delegated approving authority from the Assistant Secretary of the Army (ASA) (Civil Works) and is the responsible approval official for Dam Safety Modification Reports submitted in accordance with this regulation.

9.8.3.2 The district DSO, MSC DSO, and the Chairman, HQUSACE Dam Safety Senior Oversight Group will sign the memorandum recommending approval once the review process is completed. This memorandum will state that all agency requirements, certifications, and reviews have been completed and all NEPA and ESA documentation has been satisfactorily completed.

9.8.3.3 The report will then be sent to the USACE DSO for approval. The USACE DSO will then notify the USACE commander and the MSC commander that the DSM report has been approved.

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

9.9 <u>ASA(CW) Notification and Concurrence with Construction</u>. The USACE DSO shall notify ASA (CW) of report approvals and the start of the design phase of the project. Two copies of the approved and final reports shall 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 <u>Supplemental DSM Decision Documents</u>.

9.10.1 Past experience has shown that during the design or the construction phase large changes in the scope of the modifications or increases in construction effort occur increasing the cost of risk management measures. Whenever such changes occur, for whatever reason, a supplemental to the DSM report will be prepared and processed for approval in accordance with the guidance for the decision report. The supplement will be prepared and submitted for approval when new information increases the original cost estimate by 20 per cent.

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

Phase	DSAC I, II, III, & IV	District	MSC	HQ	
				RMC	DSO
Dam Safety Modification Report	Includes: Report, Appendices, & Risk Estimate.	ATR Cert* IEPR Joint recommen-dation for approval by District DSO	Quality Assurance and Policy Compliance Review Joint recommen-dation for approval by MSC DSO	QCC Review Concurrence with Report Recommendations	Policy Compliance Review Joint recommen-dation for approval by SOG Chairman** Approval by USACE DSO
		Coordination and collaboration of report findings, conclusions, and recommendations, and joint approval of the Dam Safety Modification Report, are required for the development of a unified path forward.			
*Risk Cadre must be included on ATR Team ** Dam Safety Senior Oversight Group Chairman is the HQUSACE, Special Assistant for Dam Safety					

9.10.2 A supplement to the DSM study scope will be submitted for approval if additional significant failure modes are identified after the DSM report is approved or to address the failure modes that were not addressed in the original DSM report for DSAC I and II dams as per paragraph 9.4.1.

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 Assurance 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 should submit requests 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

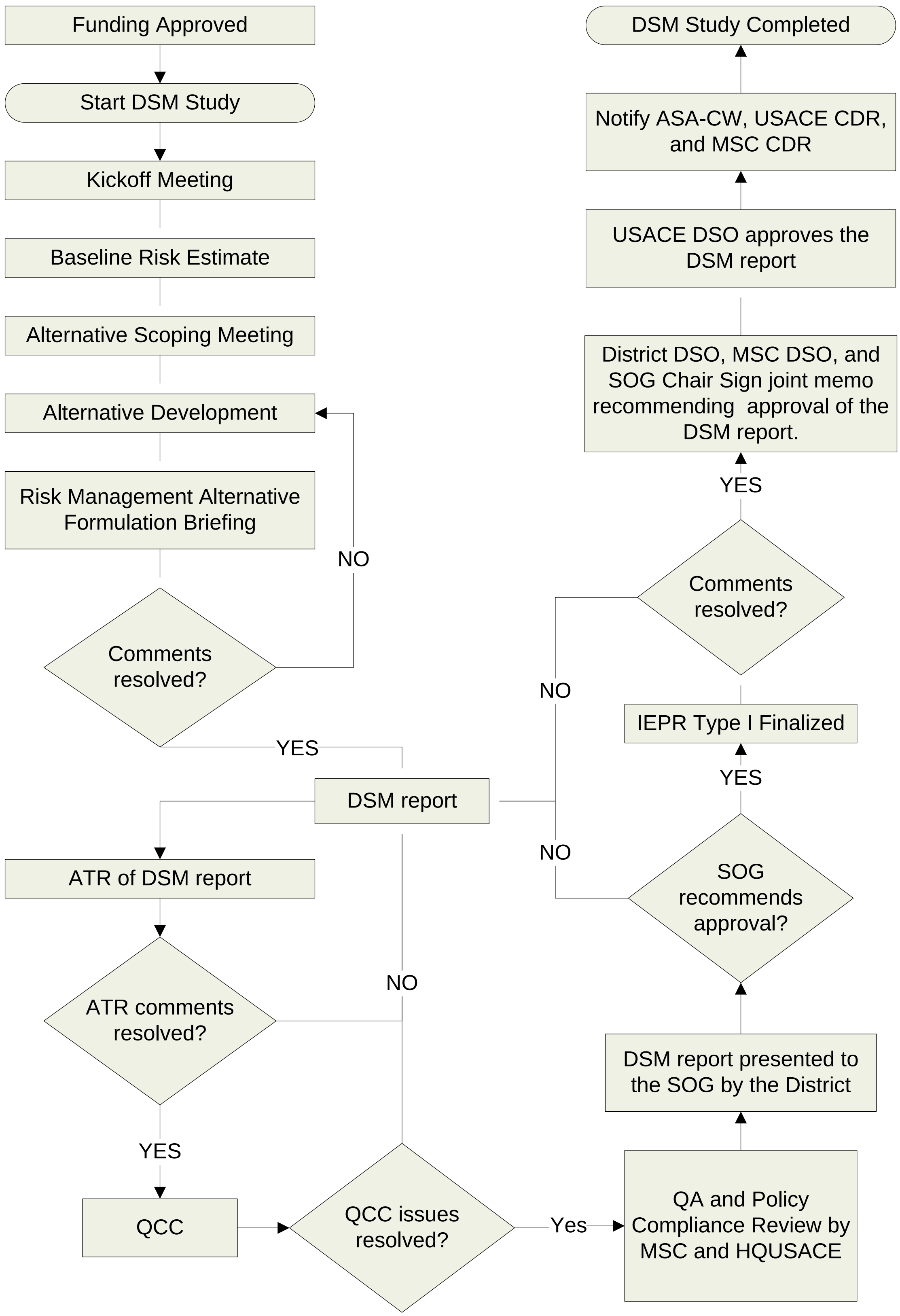


Figure 9.1 DSM Study, Review, Decision and Approval Process

newly identified problem, especially for expediting risk reduction to DSAC I 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 shall 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 shall recommend budgeting for follow on Construction funds 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 ultimate decision to fund construction shall be 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 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 management measures. See chapter 6, Dam Safety Risk Management Prioritization, for further details on the prioritization guidance.

9.11.3.1 A district shall request funding for the construction of an approved dam safety project in accordance with current budget guidance from HQUSACE as a line item project.

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 Assurance 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.

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 I and some DSAC II 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, serious 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) and 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 dam safety program managers to determine if Operation and Maintenance funds are available.

9.12 Cost Sharing Requirements. Dam Safety Modifications shall be cost shared in accordance with the following policies.

9.12.1 Section 1203 of WRDA 1986: Section 1203, WRDA, 1986 (reference A-103) 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 shall 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) shall be addressed through the Major Rehabilitation 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 shall 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, maintainence, 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, maintainence, 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.

9.12.1.1 In accordance with Section 1203 of WRDA 1986 (reference A-103) and the Army policy specified above, costs incurred for modifications for dam safety assurance (i.e., strictly limited to new hydrologic or seismic data) shall be recovered in accordance with provisions of the statute. Repayment of the local share of costs, except for irrigation, may be made, with interest, over a period not to exceed 30 years in accordance with provisions of subsection (a)(2) of the legislation. Costs assigned to irrigation shall be recovered by the Secretary of Interior in accordance with Public Law 98-404 (reference A-97).

9.12.1.2 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.

9.12.1.2.1 Projects with a Formal Cost Allocation. In this case, 15% of the cost of the modification for dam safety assurance shall 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.

9.12.1.2.1.1 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.

9.12.1.2.1.1.1 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.

9.12.1.2.1.1.2 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].

9.12.1.2.1.1.3 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.

9.12.1.2.1.1.4 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.

9.12.1.2.1.2 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].

9.12.1.2.2 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.

9.12.1.2.2.1 For projects with this type of agreement, 15% of the cost of the dam safety modification shall 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.

9.12.1.2.2.2 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].

9.12.1.2.3 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).

9.12.1.2.3.1 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.

9.12.1.2.3.2 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].

9.12.1.2.4 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.

9.12.2 Seepage/Stability Corrections do not qualify under Section 1203, WRDA 1986 (reference A-103). Therefore, 100% of the modifications shall be cost shared in accordance with current cost sharing policy as defined below.

9.12.2.1 Projects with a formal agreement with a non-Federal sponsor that identifies the cost sharing percentages for major rehabilitation or dam safety modifications shall be cost shared in accordance with the current agreement (contract).

9.12.2.2 Projects without a formal agreement will be cost shared at the same ratio as the original cost sharing for the project.

9.12.3 Special Cost Sharing for Navigation and Hydropower.

9.12.3.1 For navigation projects, dam safety modifications shall be cost shared by the Inland Waterways Trust fund or the Harbor Maintenance Trust Fund in accordance with WRDA 1986 as amended (reference A.99).

9.12.3.2 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.

9.12.3.3 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 sponsorship, and the identification of non-Federal sponsors shall 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 on cost sharing, an interpretation on the need for sponsorship and the application of the generic guidance contained in this regulation shall be forwarded to HQUSACE, ATTN: Dam Safety Officer for information. This should occur within 60 days after the DSM is started and study funding is received.

9.13.1 Reports shall include documentation of substantive involvement and coordination with non-Federal sponsors, and expressions of their willingness to cost share in the dam safety assurance work when required

9.13.2 On projects classified as DSAC I or II, the lack of sponsor identification shall not delay completion of the report. When a sponsor cannot be identified, the district shall notify HQUSACE, ATTN: Dam Safety Officer, and request that project work continue without cost sharing due to the risk to public safety. Efforts shall 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, shall be considered in lieu of the dam safety modification in those cases where a non-Federal sponsor is unwilling or unable to participated 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. 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 the USACE to integrate risk communication into routine dam safety program activities, and develop communication strategies when conducting dam safety evaluations and risk reduction actions. Key points are use of the Dam Safety Action Classification System, the Dam Safety Portfolio Risk Management for the USACE portfolio of dams using the principles outlined in Chapters 2 and 3, and the importance of internal PDT communications on a "typical" dam safety project.

10.2 USACE Dam Safety Risk Communication Philosophy.

10.2.1 Risk communication is a management/leadership process and responsibility. It involves more than only the public affairs staff.

10.2.2 Risk communication is an open, honest, genuine, sincere exchange of information with affected stakeholders. It requires planning, practice and preparation. It helps USACE focus on its mission, build better relationships with stakeholders and drives better risk management decisions.

10.2.3 Communication about risk is equally important as the steps taken to determine the risks associated with a project. An informed public is safer because individuals are able to make risk-informed decisions about their personal safety. Communicating risk to the public is a shared responsibility among federal, state, local agencies and local stakeholders.

10.2.3.1 For example, USACE works closely with respective state and local emergency officials to ensure they have the information they need to fulfill their emergency management responsibilities to protect public health, safety and welfare.

10.2.3.2 Concerning the public affected by a high-risk project, information security must be balanced with information essential for individuals to make informed decisions about their safety. There are no simple solutions to communicating risk, but open and honest dialogue, along with diligent efforts at the local level, have proven successful when informing stakeholders about USACE highest risk projects.

10.2.4 USACE is responsible to protect public safety by effectively communicating risks associated with USACE-owned dams, while also protecting security interests.

10.2.5 A dam is adequately safe when it meets all essential USACE engineering guidelines and the residual risk is considered tolerable.

10.2.6 While risk communication is necessary when confirmed unsafe dam safety issues are identified, it is equally important when unconfirmed or potentially unsafe dam safety issues are present that could have life safety, economic, or environmental consequences.

10.3 Understanding Tolerable Risks.

10.3.1 USACE operates more than 600 dams that range in age from less than 10 years old to more than 100 years old. These projects serve multiple purposes and span the range of construction methods and materials, and geographic settings, etc. USACE has a responsibility to educate internal and external stakeholders that the USACE dams are well constructed based on the state of practice and best science at that time, and have generally performed well. However, these structures do not have an indefinite life cycle and individual dams vary in their condition and risk potential. The public may falsely perceive that they are “safe” for a wide range of conditions, but the results of the USACE Screening for Portfolio Risk Analysis (SPRA) initiative conducted from 2005-2010 and risk assessments of specific dams have told us otherwise. These findings support the agency’s transition to a risk informed dam safety program and related decision making. More important to the longer term implementation of our dam safety program, however, are the lessons learned about how to continually adjust and refine the program. We are a learning organization and have recognized the need to build upon changes and improvements to the state of the practice in all aspects of flood risk management, which allows better assessment of risk and uncertainty, and therefore reduce public safety and economic risks.

10.3.2 The key to assessing safety is whether the residual risk for an individual dam is tolerable and that the dam meets essential USACE safety guidelines. An informed public better understands risk and can contribute to discussions of deciding how far to lower the risk and take on some degree of responsibility for their safety.

10.3.2.1 Tolerable Risk. ‘Tolerable’ does not mean ‘acceptable’. Tolerable refers to a willingness to live with a risk to secure certain benefits and with confidence that it is being properly managed. Tolerable risk is not regarded as negligible or something to ignore. It must, however be kept under review and reduced further if possible. For a risk to be ‘broadly acceptable’ on the other hand means that "for purposes of life or work, we are prepared to take it pretty well as it is." (HSE 1992) (Reference A.102) (See Chapter 5 of this regulation for more details).

10.3.2.2 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. Reference is made to Chapters 2, 5, 6 and 8 for additional information.

10.3.3 Communication Shapes Risk-Informed Decisions. Risk communication is integral to decisions on interim and permanent risk reduction actions. Risk communication ensures that decision makers, stakeholders, and affected publics understand potential short term and long term impacts and risks. Some may be willing to temporarily accept risks that exceed USACE tolerable risk guidelines and do not meet essential guidelines, if operating the dam serves a significant benefit or benefits. For example, the level of a reservoir operating restriction may be refined based on stakeholder and public feedback. Knowing their degree of risk allows people who feel they are not adequately protected to make individual decisions about their personal safety. This includes taking actions such as purchasing weather alert radios and developing evacuation plans.

10.4 Communication Planning. Dam safety issues must be coordinated within USACE and with the public and affected stakeholders. Examples of stakeholders requiring identification include but not limited to**,** neighboring dam owners, emergency managers, recreation partners, hydropower marketing agencies, irrigators, water supply contractors, and Dam Safety Regulating agencies.

10.4.1 Districts must clarify roles and responsibilities when organizing meetings and coordinating media events and will develop a detailed communication plan with a roles and responsibilities matrix to synchronize communication efforts.

10.4.2 Dam safety risk communication may also be required for routine project activities, such as dewatering, inspections and maintenance work, and for non-routine remediation work and responses to unusual or emergency events, such as floods or earthquakes. Because each project has different characteristics, the level of detail and methodology of communication effort should be commensurate with the overall risk posed by the project. Minimally, the communication planning team shall include the Operating Project Manager, the Dam Safety Program Manager, and the Public Affairs Officer.

10.5 Communication of the USACE Dam Safety Action Classifications.

10.5.1 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 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 significant issues or extremely high risk.

10.5.2 The USACE Dam Safety Action Classification is the framework by which USACE provides consistent and systematic guidelines for appropriate actions to address the dam safety issues and deficiencies of USACE dams. MSCs and districts may not reinterpret or redefine the Dam Safety Action Classification or project assignments. DSAC values should only be used in conducting internal communications with USACE staff. However, in coordinating with the public, the descriptions assigned to each class (Urgent and Compelling, Urgent, High Priority, Priority and Normal), as well as the safety designations should be used, in lieu of the terms “DSAC I”, “DSAC II,” etc.

10.5.3 Appendix F provides information on the DSAC system. Appendix U includes examples of Frequently Asked Questions and Answers that may be useful in preparing for internal and external communication.

10.5.4 Risk-informed decision making, which drives action for IRRM and remediation, includes public communication about an unsafe project. Clearly communicating risks to the public is challenging, but necessary. In many cases the public perceives safety as being related only to probability of failure, regardless of consequences. We should not, however, miss the opportunity to discuss what is driving some of the risks and the very important responsibility and role the public and local governments have in managing their risks (consequence management).

10.5.5 DSAC ratings have the potential to cause concern among uninformed district staff and affected communities near the dam. Districts shall initiate notification planning shortly after receiving project specific DSAC rating. The Operating Project Manager should collaborate with the Dam Safety Program Manager, Dam Safety Officer, and the Public Affairs Officer to craft a strategy.

10.5.6 District leadership should brief district personnel prior to providing information to the public. The MSC and HQUSACE Dam Safety Officers must also be engaged for high risk, controversial, or locally sensitive issues. Leaders shall explain the situation and assure employees that appropriate details will be shared with the public. Any message to employees delivered prior to public communication should be delivered as FOUO.

10.6 DSAC I and II Communication Strategies.

10.6.1 Districts shall develop timely communication plans for DSAC I and II projects to inform key community leaders and affected stakeholders.

10.6.2 Engagement, awareness and understanding of the communication plan at all levels of district and MSC leadership are imperative to ensure adequate opportunity for full understanding of input and guidance. MSCs must also coordinate with HQUSACE to ensure consistency of key messages and strategies.

10.6.3 Districts shall not conduct external coordination prior to approval of the project specific Interim Risk Reduction Measures (IRRM) Plans, which shall include a Communication Plan unless, coordinated with the vertical team. Per Chapter 7, IRRM Plans for DSAC I and II projects are approved by the MSC Dam Safety Officer

10.7 Public Meetings and Stakeholder Involvement.

10.7.1 For security reasons, numerical risk results and aggregate lists of the Dam Safety Action classifications shall not be released to the public. Regional and project specific information may be shared with stakeholders, adjacent and potentially impacted dam owners, emergency responders and Congressional interests, designated as For Official Use Only. The HQUSACE Dam Safety Special Assistant and HQUSACE Homeland Security Office must approve release of aggregate information and FOUO reports, on a case by case basis. Release of inundation maps and information will be in accordance with Interim USACE Policy on Release of Inundation Maps, dated 10 May 2007 (reference A.77).

10.7.2 Prior to external coordination, fact sheets, press releases, and other informational products will be furnished to the MSC and HQ Public Affairs and Dam Safety Officers, applicable State Dam Safety Officials, and neighboring dam owners who may receive media inquiries.

10.7.3 It is extremely important that community leadership understands the issue when/if the public asks questions. Similarly, the district must ensure that USACE is the primary release of information to the public about its respective project dam safety risks. USACE has an obligation to educate and inform affected stakeholders about the risks associated with its projects. Withholding information because of potential embarrassment is not appropriate.

10.7.4 Dam safety is an extremely technical subject and it is important that information presented is understandable. Visual aids, such as physical models, drawings or cut-a-ways of the dam to help explain the technical issues during briefings may be particularly useful.

10.7.5 When scheduling external briefings, recommend using normal meetings/coordination opportunities, unless the project is a DSAC Class I or II dam where immediate risk reduction actions are required, such as operating restriction.

10.8 Emergency Risk Communications.

10.8.1 Local authorities, counties, and states may have plans for multiple disasters or for a specific disaster such as a dam failure. These plans provide detailed instructions for agencies and individuals for responding to emergencies and may include threat recognition, emergency action message formulation, message dissemination to authorities and the public, provisions for search and rescue, and early stages of recovery.

10.8.2 During a dam safety emergency, Reporting of Distress within USACE shall be conducted in accordance with Chapter 13. The district Dam Safety Officer shall take immediate actions to notify the USACE Dam Safety Officer, through the Chain of

Command, and mobilize a team to expediently develop a communication plan, including notifying key stakeholders and Congressional interests, and issuing press releases.

10.8.3 It is important that USACE field personnel establish relationships with downstream officials and stakeholders, and maintain accurate lists of contacts in preparation for emergency events.

10.8.4 Notification lists for emergency action plans shall be updated annually. Face-to-face interaction with the local emergency response entities is also strongly encouraged. Copies of the emergency action plans shall be furnished to appropriate emergency response agencies. Release shall be considered as FOUO. Emergency action plans and corresponding inundation mapping can be furnished to the public or media in accordance with Interim USACE Policy on Release of Inundation Maps, dated 10 May 2007 (reference A-80).

10.8.5 Preparation for real time emergency notifications can be greatly enhanced by including local officials and emergency response agencies at emergency exercises and project specific dam safety training sessions.

10.9 Internal PDT Communications. As outlined above, proper external communication of risk is a key component to ensure the success of a dam safety project. Equally important is the proper internal communication within the PDT as a project moves through its various phases (issue identification and analysis, planning, E&D, and construction). 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, stakeholders, etc…) throughout a project's life. For this reason it is vital that team members are selected who possess a solid combination of both technical and communication skills - particularly the lead engineer and project manager positions.

CHAPTER 11

Periodic Inspection, Periodic Assessment and Continuing Evaluation

11.1 Applicability and Policy. This chapter on Periodic Inspection, Periodic Assessment, and Continuing Evaluation is applicable to Civil Works structures including dams, navigation structures, and other water control facilities.

11.1.1 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.

11.1.2 Periodic Assessments consist of a periodic inspection, a potential failure modes analysis, and a risk assessment based on existing data and a minimum development of limited consequence data.

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. 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 shall 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 should be done with licensed Professional Engineers 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 imply the necessity for 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 the management 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 shall be periodically inspected and assessed to ensure structural stability, safety, and operational adequacy. 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 shall 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 shall be dispatched to 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 shall be prepared and documented in a memorandum with copy furnished to the MSC for information within 14 days after the event. Evaluation reports shall provide a basis for initiating timely remedial or rehabilitation measures.

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 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 shall 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) shall be related 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) shall include in the Operation and Maintenance (O&M) manual, a requirement that USACE conducts inspections/assessments in accordance with this regulation. These inspections are to ensure design/construction quality. USACE is responsible for the first and second periodic inspections. See Policy Guidance Letter No. 39, dated 13 November 1992 (reference A.77) for USACE and sponsor responsibilities.

11.3.3 Under the authority of ER 1130-2-530 (reference A.63), USACE shall 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 shall 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 shall inspect and/or assess using risk and reliability tools, 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 shall obtain and review the current comprehensive inspection report, such as a Federal Energy Regulatory Commission (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 shall coordinate with the owner and the regulatory authority to have the dam inspected. Every effort shall 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.73).

11.3.6 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. Requests are to be coordinated with HQUSACE DSPM. This policy extends to non-federally owned dams on a military installation where the safety of life and Federal property are in jeopardy from probability of a failure. These inspections and assessments shall be performed and documented in the same manner as the inspections of USACE dams, except that the reports should be forwarded to the Installation Management Agency and to the owner of the dam if not owned by the installation.

11.4 Program Implementation. A periodic and comprehensive inspection and assessment schedule shall be established based on the project size, importance, and hazard/risk potential. Other inspections, including intermediate, informal, and annual 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/Assessments of all water control facilities shall 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 preclude the surveillance plan for the initial filling of USACE reservoirs as prescribed by ER 1110-2-1150 (reference A.51) and chapter 17 of this regulation.

11.4.1.1.1 Initial Periodic Inspection. The first periodic inspection and evaluation of a dam shall be carried out prior to impoundment of the pool; however, if involuntary impoundment occurs before the first inspection is accomplished; the inspection shall be performed at that time. This inspection will be funded using Construction funds. The initial periodic inspection of navigation locks shall be made immediately prior to flooding of cofferdams, culverts or chambers.

11.4.1.1.2 Subsequent Periodic Inspections. A second periodic inspection for new dams shall be performed no later than one year after impoundment is initiated. The 3rd and 4th periodic inspections shall also be performed at one-year intervals. The 5th and 6th periodic inspections shall be performed at two-year intervals. Subsequent periodic inspection intervals may then be extended to a maximum of five years with a periodic assessment, which includes the periodic inspection, held at intervals not to exceed ten years, i.e., at alternating periodic inspections. Inspection intervals more frequent than indicated above shall 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.

11.4.1.1.3 Special Inspections. Special inspections should be performed 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.

11.4.1.1.4 Periodic Assessments. Periodic Assessment (PA) of projects shall be conducted as determined by risk factors, but they shall not exceed a ten-year interval. 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 reports. The periodic assessment will generally be accomplished in conjunction with a periodic inspection. The district will coordinate schedule and resources for initial periodic assessments with the Risk Management Center.

11.4.1.1.5 Intermediate Inspections. For projects on five-year alternating cycle of periodic inspections and periodic assessments, an intermediate inspection of all or some of the features may be scheduled, if warranted. Selection shall be based on consequences of failure, age, degree of routine observation, performance record and history of remedial measures. Intermediate inspections shall also be made of any portion of a project exposed during dewatering that could not be accomplished during the scheduled periodic inspection. Completion of dam modifications, e.g., major rehabilitations, addition of appurtenance structures, addition of hydropower, etc., requires a series of intermediate inspections to determine effect and performance of new work. A summary of the findings from intermediate inspections is to be included in the next periodic inspection report. Annual inspections performed by Operations personnel, in accordance with ER 1130-2-530 (reference A.63), are mandatory for all high hazard potential dams, shall include district dam safety personnel, and are considered intermediate inspections for reporting purposes. As per Federal Guidelines for Dam Safety (reference A.71), 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.

11.4.1.1.6 Informal Inspections. Appropriate employees at the project shall make frequent observations of the dam and appurtenant structures. 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 shall 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

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, shall also have inspection intervals defined in the O&M manual.

11.4.1.3 Hydraulic Steel Structures (HSS). ER 1110-2-8157 (reference A.60) requires fracture critical members to be inspected every five years and that all HSS be inspected not to exceed 25 years, even if dewatering is required. Based on the baseline and/or subsequent Periodic Assessment, a frequency shorter than every five, or 25 years 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 shall be included in the next subsequent periodic inspection report.

11.4.1.4 Stilling basins. When feasible, stilling basins shall 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

Dam Safety Officer may require 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-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 shall be dewatered for a special inspection or an underwater inspection shall be performed immediately after the event.

11.4.2 Report. A formal technical report of periodic inspections and periodic assessments shall be prepared for permanent record and for reference for needed remedial work. These reports shall 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 of failure. A summary of findings from intermediate inspections shall be included in an appendix. See Appendices V and W for report content and format of PI reports and PA reports, respectively, and Appendix X for details on PFMA procedures and documentation.

11.4.2.1 Inspections or routine observations indicating that the safety of a structure is in jeopardy shall be reported in accordance with Chapter 13 of this regulation.

11.4.2.2 Inspections/assessments indicating necessity for project modifications, major repairs, rehabilitation, replacement or need for further study beyond the scope of normal maintenance shall be reported to the MSC Dam Safety Officer in the memorandum transmitting the report. Reports of conditions requiring modification shall contain a statement as to whether studies shall be pursued under Operations and Maintenance Program or Dam Safety Modification Program.

11.4.2.3 The Executive Summary of the reports shall be provided electronically to HQUSACE Dam Safety Program Manager (HQ-DamSafety@usace.army.mil) and the MSC Dam Safety Program Manager within 90 days of completion of the periodic inspection, or assessment. See Appendix V of this regulation for information on preparing and submitting the Executive Summary. The Executive Summary shall also be entered into the Dam Safety Program Management Tools (DSPMT) database within 90 days.

11.4.3 Report Completion and Submittal Schedule. Two printed copies of the reports shall be submitted by the district to the MSC Dam Safety Officer within 90 days after the inspection. The district shall establish completion and tracking standards for the review of periodic inspection and periodic assessment reports (District Quality Control Review for Periodic Inspection reports and Agency Technical Review for Periodic Assessment reports.) The submission shall include all review comments and the resolution of the comments. The district Dam Safety Officer shall certify the review and the reports prior to submittal to the MSC Dam Safety Officer. At least two printed copies shall be retained at the district and one printed copy submitted to ERDC. Reports Control Symbol (RCS) is exempt based on AR 335-15 (reference A.3). Each printed copy of the report shall also contain an electronic version of the report in the appropriate media (CD or DVD).

11.4.4 Report Approval. The MSC Dam Safety Officer is responsible for approval of all the inspection and assessment reports on dams operated and maintained by the USACE.

11.4.5 Distribution of Approved Inspection Reports.

11.4.5.1 Library Copy. Upon approval of the inspection report, one printed copy together with a copy of all correspondence bound under the front cover 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 shall 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, shall be furnished to the co-owner. The district Dam Safety Officer shall 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-112). Owners and operators of such FERC licensed facilities shall be advised that the information made available by USACE shall 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 Instrumentation. Instrumentation shall be continually monitored and data analyzed in a timely manner by a qualified engineer between periodic inspections to detect changing conditions in the facility. Plots and written assessments and evaluations of the instrumentation data shall be included in pre-inspection/assessment packets, and in periodic inspection reports.

11.6 Responsibilities.

11.6.1 District Dam Safety Officer. The district Dam Safety Officer shall be 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 Dam Safety Officer, and the USACE Dam Safety Officer 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.71).

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 shall be invited to participate. A representative(s) of the sponsor and the appropriate State Dam Safety official(s) shall also be invited to attend the inspection. If hydropower is a feature of the project, the regional FERC office and any licensee shall be invited to the inspection.

11.6.1.5 Forwarding the approved periodic reports to the district Operations Division for implementation of any routine recommendations. The Dam Safety Officer shall coordinate with PPPMD 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 shall 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 V 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 screen 4.5 of the Dam Safety Program Management Tool software and assigning the DSPMT 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 NID/DSPMT.

11.6.1.9 Performing annual program review, see paragraph 11.7.

11.6.2 District Operations Division. The district Operations Division shall be 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 shall 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 shall 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 shall require, if possible, the maximum power demand expected under emergency conditions. Additional details and requirements are described in Appendix V.

11.6.2.3 Performing required preliminary 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 table in Appendix V.

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. The Programs and Project Management Division shall be responsible for:

11.6.3.1 Supporting the program with proper funding and shall coordinate and cooperate 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.108).

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 Dam Safety Officer shall provide quality assurance, oversight and management for this program. As a minimum, the MSC Dam Safety Officer shall:

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. Intervals in excess of 10 years require written request and approval by USACE Dam Safety Officer.

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.

11.7 Program Review. At the end of each fiscal year, the district Dam Safety Officer shall review and set priorities for the recommended remedial actions for the next budget submission.

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 Dam Safety activities and reports preparation shall be budgeted in the minimum funding level of the district's fiscal year budget request for project operation and maintenance. Periodic inspections are considered routine, recurring actions that are budgetable in the initial O&M increment for each project. Costs incurred by HQUSACE and MSC personnel shall 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 shall 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 shall be under Appropriation 96X3123, Operation and Maintenance, General. Funding for periodic assessments shall be included in the minimum program of the Operations and Maintenance budget submission.

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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 control 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.16). Operations and maintenance policies for flood control operations are covered in ER 1130-2-530 (reference A.63).

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, probable failure modes, a history of problems, and how those problems could adversely affect the structure under stress. The O&M manual shall be prepared during the construction phase and shall be 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.44) 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, shall be identified, scheduled, and resourced in the Project Management Plan (PMP). The information and data in this document shall 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 shall facilitate accurate, timely inspections and performance evaluations, and serve 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 expected to furnish data on structural behavior for application to future designs. Each dam or other water control structure shall have instrumentation to measure hydrostatic pressure, embankment and abutment seepage, foundation under seepage, and displacement of major elements of the structure. Strong motion accelerometers are to be installed in structures located in designated seismic regions in accordance with ER 1110-2-103 (reference A.46). After a project is operational for several years, scheduled maintenance, repair, and replacement of instrumentation shall be part of the normal plan of operation. Instrumentation shall be properly maintained or replaced, as necessary, in order to obtain accurate and timely data. Readings shall be made at scheduled frequency and shall be properly recorded and analyzed. Detailed information on instrumentation for earth and rock fill dams is given in EM 1110-2-2300 (reference A.25) and EM 1110-2-1908 (reference A.15). Information on instrumentation for concrete dams is given in EM 1110-2-2200 (reference A.23) and EM 1110-2-4300 (reference A.30). Full reliance shall 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.90). Project personnel shall 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.

12.5.1 General. Evidence of distress in dams, and other water control structures shall be immediately reported to the district Dam Safety Officer. If an engineering evaluation of the evidence of distress indicates the need for immediate remedial action, the Dam Safety Officer shall immediately report such conditions through command channels to the USACE Dam Safety Officer. The USACE Dam Safety Officer shall notify the Director of Civil Works and the USACE Commander, if necessary.

12.5.2 Procedures. When evidence of distress is reported to the district Dam Safety Officer, the DSO shall confirm the situation and determine if an engineering evaluation of the condition is needed or remedial measures are required. Initial notification shall be made by telephone (or e-mail for minor distress) to the MSC Dam Safety Officer and Dam Safety Program Manager. The MSC DSO shall notify USACE DSO. If the USACE Dam Safety Officer cannot be contacted, the reporting office shall follow the notification sequence shown in HQUSACE Dam Safety Notification Plan. A narrative summary, with appropriate photographs, endorsed by the MSC Dam Safety Officer shall follow the initial notification. After actions report shall be prepared and submitted to the MSC and HQUSACE. A post distress inspection shall be performed to evaluate damages or changes caused by any event listed in Chapter 13 of this regulation. If the distress is significant enough to require operational restrictions, the implementation of restrictions shall be reported as well.

12.5.3 HQUSACE Dam Safety Notification Plan. The Corps Dam Safety Program Manager shall maintain and periodically publish an official HQUSACE Dam Safety Notification Plan. This plan shall be distributed electronically to all DSO's and DSPM's.

It shall be updated each January, 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 HQUSACE Operations Center should be notified at (202) 761-1001.

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 that does not qualify for funding under either the Dam Safety Assurance Program or the Major Rehabilitation Program shall be funded under the regular O&M Program. Work recommended in the Periodic Inspection Report shall 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.

12.6.2.2 Major Maintenance for Dam Safety includes non-routine major repairs that exceed $2,000,000. 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.67), 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 Y.

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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 shall 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 shall, as soon as practical, report such conditions through command channels to the USACE Dam Safety Officer. Actions that could impact life safety shall take precedence over notifications to command. The USACE Dam Safety Officer shall 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 situational 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, 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 Dam Safety Officer, the DSO shall confirm the situation and determine if an engineering evaluation of the condition is needed or remedial measures are required. Initial notification shall 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 shall notify USACE DSO. If the USACE Dam Safety Officer cannot be contacted, the reporting office shall 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 shall follow the initial notification to the HQUSACE DSO and be recorded in the Dam Safety Program Management Tools (DSPMT). The DSPMT software contains a built-in mechanism to enter details of the observed distress. The use of DSPMT is encouraged because it has the capability to generate a report that can be promptly and simply attached to an e-mail.

13.4.2 After action reports shall be prepared and submitted to the MSC and HQUSACE. A post-distress field inspection, and if necessary, a periodic assessment of risk shall 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 shall immediately be coordinated with the Special Assistant for Dam Safety. See Chapter 7 for guidance on interim risk reduction measures.

13.4.3 HQUSACE Dam Safety Notification Plan. The USACE Dam Safety Program Manager shall maintain and periodically publish an official HQUSACE Dam Safety Notification Plan. This plan shall be distributed electronically to all DSOs and DSPMs. It shall be updated each January, 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 HQUSACE Operations Center should be notified at (202) 761-1001.

13.5 Signs of Distress. Typical examples of distress are:

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 of 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.

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.55).

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 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 having broken strands or deformed, worn, or severely corroded links.

13.5.19 Frequent power interruptions.

13.5.20 Excessive movement of penstock flexible couplings.

13.5.21 Penstocks or turbine spiral cases that show signs of distress such as deformation or cracking.

13.5.22 Failure of major mechanical or electrical equipment at locks and dams or local flood protection projects.

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 Dam Safety Officer. The report should include what is believed to have lead 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 Risk Management Center will maintain a record of these reports to help in identifying trends and/or reoccurring problems. The DSO shall ensure that this information is promptly communicated through command channels (MSC and HQUSACE) so that appropriate decisions regarding the project's DSAC rating and national priority can be made. HQUSACE will ensure proper coordination and involvement of the Risk Management Center.

CHAPTER 14

Instrumentation for Safety Evaluations of Civil Works Structures

14.1 Policy. All Civil Works water control projects shall have an adequate level of instrumentation 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.

14.1.1 The District Dam Safety Officer is responsible to ensure projects are adequately monitored and shall 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 shall be elevated to the Dam Safety Officer for resolution with District Senior leadership.

14.1.2 Appropriate instrumentation and monitoring frequency shall be based on that Dam's 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 shall 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 establishes performance that is uniquely characteristic to the structure and provides a basis for predicting future behavior.

14.2.1 The number of instruments, locations, types, and frequency of readings shall be commensurate with the risk classification and dominant failure modes identified for each project. 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 shall 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 shall be performed in conjunction with unusual loading events, such as high reservoir levels or following earthquakes. Specific devices and frequency of readings shall be documented in project specific surveillance plans and be 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 construction phase work may not be critical for the operations phase. The number and locations of instruments shall 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 information, particularly when investigating and analyzing performance conditions that require frequent, and/or difficult access for obtaining measurements. Automated instrumentation must be periodically calibrated and verified manually. Further guidance for instrument automation is available through ER 1110-1-8158 (reference A.45). Automation should augment field visual inspection and not take the place of it. It is not recommended that automation be accomplished for all instrument requirements, but only to achieve those monitoring objectives that require automation.

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 meets design safety thresholds. Data anomalies in critical areas must be promptly evaluated by experienced technical staff and may include but not limited to verification readings, verification of calibration and collection methods, visual observation of area and instrument for damage or distress of structure, and comparison with redundant instrumentation if available.

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 shall be incorporated into the planning of instrumentation systems and programs to ensure that the concerns 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 evaluate the parameters. Generally, the types of measurements are as follows;

14.3.1.1 Horizontal and vertical movement,

14.3.1.2 Alignment and plumb,

14.3.1.3 Stresses and strains in soil and rock-fill,

14.3.1.4 Pore pressure,

14.3.1.5 Uplift pressure,

14.3.1.6 Phreatic surfaces,

14.3.1.7 Seismic effects,

14.3.1.8 Seepage clarity and quantity.

14.3.2 References. ER 1110-2-103 (reference A.46) gives guidance on instrumentation for seismic effects, including instrumentation, automation, and determination of performance parameters. EM 1110-1-1005 (reference A.8) gives guidance on monitoring horizontal and vertical movements. EM 1110-2-2300 (reference A.25) provides information on design and construction of earth and rock-fill embankments. EM 1110-2-4300 (reference A.30) provides information on instrumentation requirements for concrete structures. EM 1110-2-1908 (reference A.15) provides detailed information on all aspects of instrumentation, including staffing qualifications, data management, analysis and long-term reassessments. EM 1110-2-1901 (reference A.12) provides information on analysis of seepage.

14.3.3 Instrumentation System Requirements. Baseline readings for all instrument data must be generated. Statistical and graphical methods are simple ways to establish this baseline. In all circumstances, background information that may affect the validity of the data or the analysis of the performance shall 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 should maintain the ability to be read manually or as appropriate have adjacent redundant manual system to verify automated data.

14.3.3.2 Each instrument shall have the capability to be read at the site in addition to upload to the network via satellite / radio / or other.

14.3.3.3 A backup communication link to the district shall be provided for the data transmission to allow redundancy for data acquisition.

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. 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 The automated system does not relieve or replace the normal visual inspection schedule of the project features to include the instrumentation. Rather, automation should supplement those critical activities.

14.3.3.6 In addition to these primary automation requirements, consideration shall 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 shall be included in the design phase, during construction, and throughout the life of the project as conditions warrant. After a project has been operational for several years, 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.

14.4.2 Existing Projects. Existing projects shall 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 shall 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. Changes to the instrumentation should be budgeted through normal operations and maintenance funding procedures.

14.5 Data Collection, Interpretation and Evaluation.

14.5.1 Collection 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 shall be obtained to ensure that a reliable database is available to facilitate subsequent comparisons. The subsequent reading frequency of instruments during construction and operating conditions shall be based on an anticipated rate of loading or changes in reservoir levels to be determined by a dam safety engineer familiar with the design and performance parameters of the project.

14.5.2 Data Interpretation. The timely reduction and interpretation of instrumentation data is essential for a responsive safety evaluation of the project. For all USACE projects, this reduction and interpretation shall occur as soon as conditions warrant from the time that the data was obtained. The evaluation of the data shall follow immediately. As a minimum, all data shall be plotted as instrument response with respect to time, as well as to reservoir level or other range of loading. All instrumentation data shall be reviewed monthly and evaluated not less than annually. More frequent readings may be required when operating under Dam Safety Action Classification (DSAC) –based Interim Risk Reduction Measures (IRRM) or other critical Dam Safety events such as surcharge pool or near record pool. The district shall document instruments critical for monitoring during IRRM in an addendum to the project specific surveillance plan. High risk conditions will require more frequent and intensive scrutiny of instrumentation data in accordance with established plans.

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, and the appropriate factors of safety shall be utilized to determine the desired threshold limits for each performance parameter. Quantitative values shall be established for these limits that can be accurately translated into measurements that are easily and 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 shall be presented in the design documentation report (DDR) for new or modified features. The threshold limits along with the predicted performance levels shall 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 shall be documented to aid response to future exceeded thresholds. Exceeded thresholds shall trigger increased scrutiny and analysis of structural integrity and shall not be relied upon for sole basis of evacuation requests.

14.5.4 Monitoring Plans. Monitoring plans should remain adaptive to real time events and accelerate as appropriate to conditions. Data collection, reduction, and evaluation methods should be assessed routinely to try to shorten the process as appropriate to monitoring frequencies. If resources limit data collection / reduction / evaluation, priority shall be given to gather and assess data associated with high risk project features, based on a PFMA or detailed risk assessment. More detailed guidance for data acquisition, interpretation and presentation can be found in EM 1110-2-1908 (reference A.15) and EM 1100-2-4300 (reference A.30).

14.6 Reporting.

14.6.1 Upon completion of new projects or significant modifications to projects, the instrumentation data along with the written evaluation shall be consolidated and submitted to the MSC Dam Safety Officer in accordance with ER 1110-1-1901 (reference A.44). Written evaluation should also be incorporated in the subsequent periodic inspection reports.

14.6.2 The District Dam Safety Officer shall provide a written summary and evaluation of the district's instrumentation program annually to the MSC Dam Safety Officer. This annual program review shall include a specific write up on the performance of high risk (DSAC I and II) dams. The project information obtained annually shall be included in the periodic inspection report of the project. Instrumentation program records shall 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.) shall be utilized to accomplish the level of instrumentation outlined in this regulation. Funding for maintenance of instrumentation, data collection, data analysis, and reporting shall be included in the minimum routine program of the annual Operations and Maintenance budget submission. New or replacement instruments shall be programmed in the annual budget submissions as non-routine work items, and prioritized based on criticality. The DSAC rating and risk based failure modes shall be considered in budget prioritization, and coordinated with Operations and Programs staff.

CHAPTER 15

Dam Safety Training

15.1 Overview. The Corps of Engineers 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. The Corps of Engineers has a training course on “Dam Safety in the Corps of Engineers” and has supported the development of the Training Aids for Dam Safety (TADS) Program. In 1991, the Federal Energy Regulatory Commission initiated a training course on “Emergency Action Plan”. ASDSO maintains a list of currently scheduled dam safety training courses on the web site at http://www.damsafety.org.

15.2 Corps of Engineers Training Course on Dam Safety. The Corps of Engineers Proponent Sponsored Engineer Corps Training (PROSPECT) program offers a course titled “Dam Safety in the Corps of Engineers”. 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). The scope and implementation details of the Dam Safety Assurance 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 Corps of Engineers dams.

15.3 National Dam Safety Conferences. National dam safety conferences, such as the Association of State Dam Safety Officials annual conference, the United States Society on Dams annual conference, the Corps of Engineers Infrastructure 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 the Corps of Engineers. Participation in these conferences can be valuable training in dam safety activities.

15.4 Exchange Training – District to District. Participation in other 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.

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 shall have a minimum of 6 hours training shortly after starting duty and at least 6 hours refresher training every five years.

15.5.3 Records. The Operations Project Manager shall document all formal training. These records shall be kept on file at the employee's project office and shall 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.

15.6 Sample Dam Safety Training Course Outline for Project Personnel.

15.6.1 Purpose of Training Program. 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 Corps of Engineer offices to emergency conditions, and alerting police and local civil defense groups to emergency conditions.

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 Bureau of Reclamation has a dam safety training course for their personnel. In some cases it is more cost effective for Corps 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 Corps personnel in dam safety.

15.7.1.2 *Training Aids for Dam Safety*.

15.7.1.2.1 Background. In 1986, the Corps of Engineers, along with 13 other Federal Agencies, all members of the Interagency Committee on Dam Safety, joined forces to develop a professionally prepared TADS Program. The TADS materials are arranged in three components that cover dam safety inspections, dam safety awareness and program development, and evaluations and remedial actions (references A.72 and A.78).

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 offers a standardized approach to dam safety training. The Corps of Engineers, as one of the primary sponsors of the TADS Program, distributes the TADS materials to each Corps of Engineers field office through the Engineering and Construction, Directorate of Civil Works, HQUSACE. All MSC's and districts shall maintain a complete set of modules including the videotape supplements.

15.8 Risk Assessment Training. The Risk Management Center 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 Modeling, Mapping, and Consequence Center (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 presenting HEC-FIA (Flood Impact Analysis - the most common tool used for estimating consequences in support of dam safety risk assessments) will be available starting in FY 2012. 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 downstream 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 the Corps of Engineers 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.95).

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.96).

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.97).

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.98).

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

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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.”).

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.

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.71) 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 specific federal guidelines related to emergency action planning. The final document was published in 2004 and is entitled “Federal Guidelines for Dam Safety: Emergency Action Planning for Dam Owners” (reference A.74). This document is intended to serve as the over-arching guidance which governs the content, structure, and implementation of EAPs for the U.S. Army Corps of Engineers.

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 Corps of Engineers Dams, including appurtenant structures having separate consequences from the main dam**.** This 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, you may want to have one EAP for the system with different call sheet for each project. For dams classified as low hazard, 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 still 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 scenarios: 1) Sunny day with dam failure, 2) Flood with dam failure, and 3) Flood without dam failure. Coordination with the Risk Management Center 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. 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 Z. That is, the lower the DSAC rating the more frequently exercises should be conducted. As a minimum the EAP exercise schedule listed in table 16.1, Emergency Exercise Frequency, shall 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 years, it is recommended to start with a table top exercise and work up to the level appropriate for the DSAC. Low hazard potential projects, regardless of DSAC rating, require only an annual orientation seminar or drill. 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 I and High Hazard Potential		Year 1, 3, 5, etc….	Year 2, 4, 6, etc….	At DSO discretion
DSAC II or III and High Hazard Potential	Year 1, 3, 5, etc…	Year 2, 4, 6, etc	At DSO discretion	At DSO discretion
DSAC IV or V Significant Hazard Potential	Year 1 – 4 and 6 - 9. etc….	Year 5, 10, etc…	At DSO discretion	At DSO discretion
Low Hazard Potential	At DSO discretion			

*Orientation Seminars shall be held for all new dams and whenever new information is developed.

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. HSEEP Policy and Guidance is presented in detail in HSEEP Volumes 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 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 Consequence Center. 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 Mapping, Modeling, and Consequence Center has been established as a virtual asset under the Risk Management Center. The mission of this virtual center (comprised of H&H, GIS, and economist professionals from across the Corps) 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 Corps 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 the Corps. 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 the Corps to Principal Local Officials.

16.6.1.3 Notifications from the Corps to Other Federal Officials.

16.6.1.4 Distribution of Warnings. Distribution of warnings from the Corps 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 the Corps 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 shall include information to help guide the dam owner in making immediate operational decisions in the event of various types of emergencies. Information shall 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 the Corps. 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 Risk Management Center 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.

CHAPTER 17

Reservoir Filling Plans

17.1 Applicability. This regulation applies to all new and existing flood damage reduction dams and to all new navigation dams.

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 shall be established on a dam-by-dam basis for all reservoirs which are new, 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 Class (DSAC) rating 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.

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 that must be made to meet project 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 shall consider all of the items listed above and shall 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 shall be tied to the identified significant potential failure modes associated with the dam. A visual inspection checklist shall be developed to facilitate the effectiveness of the surveillance efforts and the reporting of results. Specific distress indicators for various failure modes shall 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 shall 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 shall be tied to specific responses in the event of readings outside the prescribed range. Reference EM 1110-2-2300 (Appendix E) (reference A.25) 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 shall 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 shall have been 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 Dam Safety Action Class (DSAC) rating. Because of their higher level of assigned risk, projects designated as DSAC I, II and III 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 shall 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 Plan Approval. Reservoir filling plans shall be prepared by the District, approved by the District Dam Safety Officer and furnished to the MSC Dam Safety Officer for informational purposes.

17.5 Performance Report. A performance report shall 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 Dam Safety Officer within 2 weeks of the event.

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CHAPTER 18

Risk Assessment Methodology

18.1 General.

18.1.1 The Risk Management Center (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 has been developed jointly with the United States Bureau of Reclamation (USBR) as the top level 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 procedures outlined in EC 1105-2-410 as good practice. Occasionally, a dam safety study will involve significant environmental concerns and the study will necessarily need a certified environmental model. If an existing certified model does not exist, it may be necessary to fund certification of the model with dam safety modification study funds.

18.2 Philosophy and Approach.

18.2.1 The methodology contained in the best practices manual and supporting toolboxes provide a suite of scalable assessment approaches that provide information to promote critical thinking and guide a risk assessor's judgment. These methods can be tailored and used 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 be credible.

18.2.2 Risk assessment cadres and others implementing the methodology are accountable for understanding what is happening inside 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 cadre will always decide the final answer, not the methodology. This may require some judgment and expert elicitation to translate the results obtained from the toolboxes to the risk estimate. Analysts must use understanding of the failure mode, key factors, uncertainty, and sensitivity 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 they will 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. An intervention is 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. This includes routine, non-routine, and heroic actions. 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 plotted 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. 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 a limit state (i.e. factor of safety less than one) is not the same as probability of failure. Limit state exceedance is only one of several potential branches of a fully developed failure mode event tree. Similarly, the probability of a serious incident is not the same as probability of failure. An incident only addresses a portion of a fully developed failure mode event tree.

18.3 Best Practices. The Best Practices manual shall be maintained and updated on an as needed basis by the RMC. The current version of the Best Practices Manual may be obtained from the RMC. The risk assessment cadres shall use the 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, whether completed by a team or by an individual, 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 become complex, some simplifications can be applied to situations commonly seen when evaluating risks for dams. The Best Practices Manual 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 IES or the DSM study. 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 risk category, and whether additional exploration, investigation, or analysis has a reasonable likelihood of changing the perceived risk such that if falls in a different category. 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.

18.5.2 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, there may be justification 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 Qualitative and Semi-Quantitative Risk Assessments. Qualitative or semi-quantitative risk assessments can be desirable in some cases such where it is desired to apply risk assessment principles to the decision making without the time, cost, and data/assessment requirements associated with a full blown 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 the public to a high degree whereby those involved are more likely to understand qualitative assessments than full blown 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.

CHAPTER 19

Program Administration and Funding Process

19.1 Purpose. The Dam Safety Officer (DSO) and the Dam Safety Program Manager (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 three year cycle (or as otherwise required by Army), the Dam Safety Officers 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 AA 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 until February FY-1. 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 Corps 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 level.

CHAPTER 20

Asset Management and Condition Assessments

20.1 Purpose. This chapter describes the direction of the Corps Asset Management (AM) Program and how it relates to the Corps Dam Safety Program. It includes information on the Asset Management Program vision and approach for the coordination of Dam Safety and Asset Management. The chapter is subject to modification as the Corps Asset Management program continues to mature.

20.2 General. USACE Asset Management vision is to incorporate a holistic and integrated approach that embraces a risk informed life-cycle watershed portfolio management perspective. This enhanced AM outlook will enable risk-informed, life-cycle investment decisions to include an assessment of sustainment, restoration, modernization, and disposition projects, as well as portfolio trade-offs. AM is the unifying catalyst to ensure integration of business lines, major programs, and initiatives to improve communication and collaboration. AM will leverage resources, eliminate duplication, evaluate economic and other consequential trade-offs, adapt to new and anticipated requirements, and benefit from synergy. This life-cycle watershed portfolio management approach is asset based and recognizes the multi-business line purpose, risk, and consequence in meeting the various mission requirements.

20.3 Policy. It is the policy of USACE Asset Management to corporately determine condition of the assets and components. Pursuant to this approach are the development (if required) and/or use of existing nationally consistent condition assessment and inspection processes and procedures to meet overall portfolio investment requirements.

20.3.1 Asset Management broadly uses the “feature codes” found in the Finance and Accounting regulations as the “primary constructed asset categories” that support the water resource mission portfolio. These codes are the two digit account numbers found in Appendix A, Chapter 14 of ER 37-1-30, “Financial Administration: Accounting and Reporting” (reference A.36) and as shown in Table 20.1 below.

20.3.2 Reference Memorandum for MSC Commanders dated 16 October 2009, subject “Interim Guidance – Operational Condition Assessments for Inland Navigation” co-signed by the Chiefs of Engineering and Construction and Operations and Regulatory (reference A.78). It is recognized that these baseline operational condition assessments require a similar skill set and experience utilized in the Dam Safety Periodic Inspections as discussed in Chapter 11, “Periodic Inspection, Periodic Assessment and Continuing Evaluation.” MSC’s should plan to transition the baseline operational condition assessments to coincide with the 5-year Periodic Inspection schedule. If the MSC determines that a more aggressive condition assessment schedule is required, they may supplement the 5-year schedule as necessary.

Table 20.1 – Applicable Feature Codes

Feature Code	Title
01	Land
02	N/A
03	Reservoirs
04	Dams
05	Locks
06	Fish and Wildlife
07	Power Plants
08	Roads, Railroads, and Bridges
09	Channels and Canals
10	Breakwaters and Seawalls
11	Levees and Floodwalls
12	Navigation Ports and Harbors
13	Pumping Plants
14	Recreation
15	Floodway Control and Diversion Structures
16	Bank Stabilization
17	Beach Replenishment
18	Cultural Resource Preservation
19	Buildings, Grounds, and Utilities
20	Permanent Operating Equipment

20.3.3. It is also the policy of Asset Management to eventually integrate and use the Facilities and Equipment Maintenance (FEM) day-to-day work maintenance records and other applicable data where applicable to inform and adjust the condition for critical components that may lead to mission interruption.

CHAPTER 21

Dam Safety Policy for Planning and Design

21.1 Purpose and Status. This chapter provides guidance on incorporating USACE dam safety policy into the planning and design of new dams and modification of existing dams through the Civil Works and Dam Safety Portfolio Risk Management processes. It applies to all structures that meet the definition of a dam in the National Dam Safety Program. It encompasses the dam safety requirements from WRDA ’86 for new projects (reference A.99).

21.2 General. The civil works planning and design process for a new dam or for modification of an existing facility 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 or modification of an existing dam for non-dam safety reasons are reconnaissance, feasibility, pre-construction engineering and design (PED), construction, operation and maintenance[5], and finally decommissioning and removal. Detailed guidance on each phase is given in ER 1110-2-1150 (reference A.51). For modification of an existing dam due to dam safety issues the phases are issue evaluation study (Chapter 8), dam safety modification study (Chapter 9), PED (ER 1110-2-1150)(reference A.51), implementation of the risk reduction measures, and post implementation risk assessment (See Figure 3.1).

21.3 Project Delivery Team. A Project Delivery Team (PDT) is established for all projects in accordance with ER 5-1-11 (reference A-35). 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 shall designate a "lead engineer." 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 Issue Evaluation Study phase. The lead engineer may change as the project moves through the different phases of development, however continuity is very important and changes should only be made after careful consideration. At each phase of a project it is also vitally important that team members (in particular the PM and lead engineer) possess a solid combination of both technical and communication skills. External communication with the public and stakeholders is a certainty on dam safety projects and guidance on how to properly communicate risk is covered in Chapter 10. Equally important is the internal communications aspect as it frequently involves team members from within the district, the MSC, HQUSACE, and the Risk Management Center to name just a few. 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 design of a

[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)”

project and our partners are key members of the PDT. Partnering shall occur in all phases of project development (ER 1110-2-1150) (reference A-51).

21.4 Dam Safety Items for the Planning Phase.

21.4.1 Reconnaissance. During the reconnaissance phase, the Project Delivery Team (PDT) develops a Management Plan. At this phase the documentation requirements shall be identified, scheduled, and resourced in coordination between the PDT and the Dam Safety Officer or his representatives. Those documents generally include all 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.

21.4.2 Feasibility. During the feasibility phase, the Project Delivery Team (PDT) develops a Management Plan. The feasibility study shall address the following items related to Dam Safety.

21.4.2.1 Project OMRR&R and dam safety requirements shall be identified and discussed with the sponsor and State. The local sponsor shall be informed that they shall be expected to comply with all State and Federal dam safety requirements. A turnover plan for non-Federally operated dams must be prepared to establish definite turnover criteria or date to the sponsor and to identify funding for the first and second periodic inspections. This information shall be documented in the Feasibility Report.

21.4.2.2 Project Cooperation Agreement. 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.92). When the Project Cooperation Agreement is developed during the feasibility phase, the Dam Safety Officer or his representative shall ensure that all dam safety requirements are included in the agreement.

21.4.2.3 Consequence and Failure Mode Analysis and Preventative Measures. All reports to be submitted to Congress for authorization of water impoundment facilities shall 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.99) and ER 1105-2-100, *Planning Guidance Notebook, Appendix G* (reference A.42)). 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 to identified, the associated failure mode described, and present the design steps taken to prevent the failure from occurring. 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 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.54).

21.4.2.5 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. Specific guidance on this issue is found in Chapter 12 of this regulation.

21.5 Dam Safety Items for the PED Phase. During the PED phase the Dam Safety Officer, or his representative, shall ensure that the design criteria include the most current dam safety requirements and that the design is 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 shall be used on all federally funded designs. When the design is being prepared for a sponsor on a cost-reimbursable basis, the district Dam Safety Officer may consider use of state criteria. Deviations from Corps criteria require written concurrence from the USACE Dam Safety Officer.

21.5.2 Public Safety Awareness. A policy of public safety awareness shall be adhered to in all phases of design and operation of dam and lake projects to ensure adequate protection for the general public.

21.5.3 Downstream Lands. See section 21.4.2.4 Downstream Lands.

21.5.4 Low-level Discharge Facilities. See section 21.4.2.5 Low-level Discharge Facilities.

21.5.5 Instrumentation and Monitoring. An adequate instrumentation and monitoring system is required by the “Federal Guidelines for Dam Safety” (reference A.71) as well as by good engineering practice.

21.5.5.1 Purpose. The purposes of the instrumentation are the following:

21.5.5.1.1 To provide data to validate design assumptions, 21.5.5.1.2 To provide information on the continuing behavior of the water control structure,

21.5.5.1.3 To observe the performance of critical features, and
21.5.5.1.4 To advance the state-of-the-art of dam engineering.

21.5.5.2 The rationale for the instrumentation shall be justified 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.

21.5.5.3 The instrumentation plan shall 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 shall 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 of this regulation.

21.5.6 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.59)). A risk assessment should be used to inform the selection of the construction options and the results should influence the options selected.

21.5.7 Initial Reservoir Filling Plan. The Initial Reservoir Filling Plan (IFP) shall be prepared prior to construction, modified during construction to reflect the as built conditions, and documented in the DDR. As a minimum, the documentation on initial reservoir filling shall include:

21.5.7.1 The preferred filling rate and the available options to control the rate of reservoir rise.

21.5.7.2 The surveillance necessary to detect the most likely occurring failure modes.

21.5.7.3 A plan and schedule for reading the instruments and evaluating the data.

21.5.7.4 A plan and schedule for inspecting the dam and downstream areas.

21.5.7.5 Instructions for observers on observed conditions or instrumentation readings requiring immediate attention of personnel authorized to make emergency decisions.

21.5.7.6 An emergency plan listing responsibilities, name and/or positions, telephone numbers, and radio frequencies to be used (as appropriate).

21.5.8 Surveillance Plan. The Surveillance Plan shall be prepared during construction. The plan will address the routine and non-routine surveillance of the dam after the initial reservoir filling.

21.5.8.1 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 shall be addressed in this plan.

21.5.8.2 The surveillance necessary to detect most likely occurring failure modes.

21.5.8.3 A plan and schedule for reading the instruments and evaluating the data.

21.5.8.4 A plan and schedule for inspecting the dam and downstream areas.

21.5.8.5 Instructions for observers on observed conditions or instrumentation readings requiring immediate attention of personnel authorized to make emergency decisions.

21.5.9 O&M Manual. The O&M (or OMRR&R) Manual shall be prepared during construction. Specific guidance for preparation of the manual is given in ER 1110-2-401 (reference A.50) and ER 1130-2-500, (reference A.62).

21.5.10 Emergency Action Plan. The EAP shall be prepared during construction. Specific guidance for preparation of the EAP is given in ER 1130-2-530 (reference A.63), and in Chapter 16 of this regulation.

21.5.11. Water Control Plan. The Water Control Plan (Operational) shall be prepared during construction. Guidance on water control management is available in ER 1110-2-240 (reference A.49).

21.6 Consulting with State Dam Safety Officials. The district shall 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.

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CHAPTER 22

Dam Safety During Construction (Remediation and New Dams)

22.1 Purpose. Construction (design implementation) is a crucial phase in achieving an adequately safe dam. The objective for construction management is always to deliver a quality project in a timely manner at a reasonable cost. This is considered commensurate with the importance of the project to the Corps and all stakeholders. During construction, the entire project team (particularly the on-site construction staff) is required to assure the design is compatible with actual conditions encountered. 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 Corps regulations. The intent of this chapter is simply to supplement those regulations and provide a perspective of their application from a dam safety perspective.

22.2 Design/Pre-Construction Phase. Involvement of construction personnel in the design phase of a project is vital to assure the development of a technical product of the highest quality. 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, biddability, etc… are invaluable in assuring the project meets technical requirements while at the same time limiting government contractual risk (reference A.39)

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.35). This entire team shall be involved in the project from planning, design, and through completion of construction. This includes not only the technical elements within a district (planners, designers, constructors, PMs, etc…) but also the involvement of vertical elements such as the regional/HQ staff and the Risk Management Center (RMC). While the day-to-day execution of a project remains the responsibility of a district, the RMC is able to bring an agency-wide perspective to the project to ensure uniformity and adoption of best practices from across USACE. 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 construction staff be part 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 and that all construction-related risks are fully identified and mitigated to an acceptable level. For the preferred alternative, a construction risk assessment may be required if the perceived risks during construction are significant. While restoring a dam to a fully functional condition so that it can safely 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 to name just a few. Analysis of the instrumentation data and inspection results as it relates to the expected behavior of the dam must be done by the Lead Engineer or his designated PDT representative throughout the construction period.

22.2.3 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 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 "Engineering Considerations for Field Personnel" prepared by the PDT during the PED phase in accordance with Appendix G of ER 1110-2-1150 (reference A.51). 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 should be reviewed and revised, as necessary, as the project progresses through design and 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 To ensure dam safety risks are adequately addressed by the designs, Districts shall form a Biddability, Constructability, Operability, and Environmental (BCOE) team in accordance ER 415-1-11 (reference A.39) with emphasis on reviewing the designs from the standpoint of constructability. Conducting a BCOE review in the latter stages of design development is an effective method to achieve a quality, cost effective and operations and maintenance (O&M) efficient design. The guiding principle for the BCOE team shall be to act much like a contractor preparing a bid or proposal and look for flaws or defects in the technical specifications. The Lead Engineer/PDT may need to brief the BCOE team on the potential failure modes mitigated by construction and on potential failure modes that may be present during construction activities. In addition to the list of items contained in ER 415-1-11 (reference A.39), the following constructability issues should also be reviewed and discussed if applicable:

22.2.5.1 Borrow area locations, ownership, and access

22.2.5.2 Borrow areas with respect to flooding

22.2.5.3 Borrow materials characteristics in relation to processing requirements

22.2.5.4 In situ moisture conditions

22.2.5.5 Unwatering and dewatering requirements

22.2.5.6 Waste and stockpile issues

22.2.5.7 Zoning

22.2.5.8 Protection of work from flooding

22.2.5.9 Reservoir operations and associated construction constraints

22.2.5.10 Availability of equipment and materials, delivery times, and their sources

22.2.5.11 User deliveries and special needs

22.2.5.12 Climatic effects on construction schedules

22.2.5.13 Available right of way

22.2.5.14 Expected acquisition times

22.2.5.15 Road relocations

22.2.5.16 Material utilization

22.2.6 Construction personnel shall assist the Lead Engineer/ 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.

22.2.7 During the construction period the emergency action plan (EAP) shall 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.

22.2.8 During the PED phase the Lead Engineer/PDT shall identify those submittals that require review and comment by a specific engineering discipline. Once a submittal is received, comments shall 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 shall 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- 35) and ER 1110-1-12 (reference A.43).

22.3.1 Quality Assurance Plan (QAP). The construction staff shall prepare a project-specific Quality Assurance Plan (QAP) that is consistent with the scope and complexity of the work. It shall be in accordance with the specific requirements in ER 1180-1-6 (reference A.66). The plan shall 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 as it is important to help establish the complete project picture. It should be updated as required as the project scope is modified. The QAP should be included in the DDR/Plans and Specification package and be subjected to ATR and RMC/HQ review and approval.

22.3.2 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 Lead Engineer/PDT shall 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 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 Lead Engineer shall 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.

22.3.3 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.

22.3.4 Performance of Quality Assurance

22.3.4.1 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 shall 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 shall be in accordance with ER 1180-1-6 (reference A.66).

22.3.5 A communication/ information protocol flow chart for the dissemination of information between the Resident Engineer and the contractor shall 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.

22.3.6 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. The design of these features must be reviewed and approved by the project Lead Engineer.

22.3.7 When a project includes the installation or modification of major electrical or mechanical equipment, special inspections shall be performed at the place of manufacture, upon delivery to the site, during installation, and during acceptance testing.

22.3.8 The Lead Engineer/PDT shall be actively involved in the confirmation of design assumptions during construction. Frequent and mandatory inspections shall 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 Lead Engineer and the command chain, including the Dam Safety Officer. In accordance with ER 1110-2-112 (reference A.43), key design members of the PDT (with appropriate support of management) shall 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.

22.3.9 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.16) shall 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 shall 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 shall be developed. This plan shall 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 shall 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.7) shall be enforced as applicable.

22.3.10 All cleanup, treatment, and support (bolts, mesh, shotcrete, etc.) of dam or structure foundations and excavated slopes (temporary or permanent) shall 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.

22.3.11 All foundation surfaces that are to be covered by fill and/or concrete shall be formally inspected and approved by the Lead Engineer or their designated representatives. No foundation surface shall be covered until this formal review is completed. The specifications should include the following:

22.3.11.1 A specific period of contract time for geologic mapping by USACE personnel.

22.3.11.2 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.

22.3.11.3 A specific notification period and specific period of contract time for foundation inspection by USACE personnel.

22.3.12 In order to effectively accomplish this critical task, the Lead Engineer/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:

22.3.12.1 Describe an adequate and inadequate foundation.

22.3.12.2 Measures to be considered where an inadequate foundation is identified.

22.3.12.3 Measures to ensure the integrity of an adequate foundation once it has been prepared and prior to placing the structure on the foundation.

22.3.12.4 Procedures to be used when inspection and approval are made onsite.

22.3.12.5 Procedure to be used when inspection is made by field personnel and approval made via telephone.

22.3.12.6 Identify appropriate field testing to be conducted prior to, or during, foundation inspections.

22.3.12.7 Preparation of a foundation inspection checklist which should be used by field personnel.

22.3.13 Formal approval shall be documented in a "Foundation Approval Memorandum" including photographs and geologic maps. Multiple memorandums may be utilized depending on the construction schedule/sequence. These shall be included in the final project geotechnical report (reference paragraph 22.4.4).

22.3.14 Engineering representatives from RMC and MSC office are an integral part of the PDT 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.48). This includes their participation in the latter stages of construction (prior to final acceptance). This shall be accomplished through a regular project update prepared by the Project Manager and distributed to the entire vertical/horizontal team. This update shall highlight current construction progress, issues (both funding and technical), and a 30 to 90 day look-ahead.

22.3.15 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) shall assemble and conduct a brainstorming session in order to capture lessons learned from both the design and construction phases of the project. The Lead Engineer and Resident Engineer shall 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 shall 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 shall 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 shall be prepared during the construction phase and shall 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.44), 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. 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.

22.4.4.1 This report shall be identified, scheduled, and resourced in the Project Management Plan (PMP). The information and data in this document shall 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 shall facilitate accurate, timely inspections and performance assessments, and serve 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.

22.4.5 Post Implementation Risk Assessment. Review and update the DSM study risk assessment after implementation of the risk management remedial measures. The dam shall be evaluated to determine if the risk management objectives were achieved.

CHAPTER 23

Physical Security for Dams

23.1 Purpose and Status. The purpose of this chapter is to provide references and other information to guide dam safety personnel on physical security issues and facilitate in their coordination with security personnel and first responders.

23.2 Policy. All dams within USACE shall 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 shall 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 for project physical security. The engineering chief and the security chief provide technical support to the operations chief in execution of their responsibility. The District Engineer is ultimately responsible for the security of the project site and personnel within in the area of responsibility (AOR).

23.3 General. It shall be realized that the normal security posture will vary from project to project. The determination of the recommended steady-state security posture for USACE dams should 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. Normal and enhanced security postures should 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 Physical Security Program. All USACE dams shall implement an appropriate physical security program designed to ensure effective and efficient uses of resources, meeting the needs of the command in protecting its assets against aggressors that are a threat to the project critical assets and hostile intelligence operations. The physical security program is required to include a project specific physical security plan, physical security inspections, and security systems designed and constructed in accordance with the appropriate chapters of AR 190-11 (reference A.1) and AR 190-13 (reference A.2).

23.5 Antiterrorism. All USACE dams shall have a viable, project specific Antiterrorism and Force Protection Plan in place and in accordance with Department of Defense (DoD) Directive Number 2000.12 “DoD Antiterrorism (AT) Program,” (18AUG03) (reference A.70), DoD Instruction Number 2000.16, “DoD Antiterrorism Standards,” (14JUN01) (reference A.69), and DoD O-2000.12-H, “Protection of DoD Personnel and Activities Against Acts of Terrorism and Political Turbulence,” (19FEB93) (reference A.68) that allows for the elevation and decrease of Force Protection Condition Measures as detailed in Chapter B, AR 525-13 (reference A.4).

23.6 Security Portfolio Prioritization. Consequence-based prioritization constitutes the first practical step towards implementation of a security risk management framework. The Consequence-Based Top Screen (CTS) methodology is used to identify the most critical facilities within a given 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 input data is developed by the USACE Modeling, Mapping, and Consequence (MMC) Production Center, which has overall responsibility for developing dam break failure modeling, flood inundation mapping, and consequence estimation studies for USACE dams.

23.7 Security Risk Assessment. At a minimum, a security risk assessment should be conducted every five years in conjunction with the project's periodic inspection or periodic assessment.

23.7.1 The results of the security risk assessment should be documented with the periodic inspection or 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 "change" at the project (threat, construction, mission, criticality of a project asset, condition of security systems, project operation, 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.

23.7.2 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 methods and scenarios. The threat should be estimated as the likelihood that the adversary would attempt a given attack method against the target. The vulnerability assessment component of the methodology should develop estimates of the likelihood of an adversary's success for each attack scenario, accounting for any protective measures in place and considering law enforcement response capabilities. For a given attack scenario, the vulnerability should be defined as the probability of attacker's success, given that an attack is attempted. The Common Risk Model for Dams (CRM-D) risk assessment methodology and the tools and templates for implementing CRM-D, are available through the HQUSACE Office of Homeland Security. CRM-D meet the assessment criteria.

23.8 Security Training and Resources. The following training courses and resources are available to project personnel with security responsibilities:

23.8.1 The web-based training module "IS-870 Dams Sector: Crisis Management" 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.

23.8.2 The web-based training module "IS-871 Dams Sector: Security Awareness" 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.

23.8.3 The web-based training module "IS-872 Dams Sector: Protective Measures" 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.

23.8.4. 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.

FOR THE COMMANDER:

29 Appendices
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DIONYSIOS ANNINOS
Colonel, Corps of Engineers
Chief of Staff

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APPENDIX A

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APPENDIX B

Dam Safety in The Corps of Engineers

B.1 Background.

B.1.1 Corps Dam Safety. The safety of dams has been a major concern of the Corps of Engineers 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 Corps started a multiple level of review requirements for dam design. This is currently being performed by an Agency technical review at the district level. 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 Corps 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 Corps to adhere to the highest design standards and comprehensive inspection and testing for construction. The Corps 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.71) due to its early, comprehensive and effective program.

B.1.2 Federal Dam Safety Action. As a result of several dam failures in the mid 1970's, none of which were Corps' 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. 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.71) 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. 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. The Corps of Engineers is the Department of Defense representative on ICODS.

B.1.3 Corps Dam Safety Officer. On 7 February 1980, the Chief of Engineers appointed the Chief of the Engineering Division, Directorate of Civil Works, as the HQUSACE Dam Safety Officer. This appointment also required that the Dam Safety Officer 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 the Corps of Engineers. The Dam Safety Officer is advisory to the Chief of Engineers, through the Director of Civil Works. The HQUSACE Dam Safety Officer is now Chief, Engineering and Construction.

B.2 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.86, A.88, A.89, and A.91).

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 Corps of Engineers' 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. "The Reclamation Safety of Dams Act" in 1977 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.71).

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 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.59); (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 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.

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 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.71)) are

C.2.1 Establish a Dam Safety Officer 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.71) 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 Dam Safety Officer by General Order. This regulation further defines the requirements and responsibilities of the Dam Safety Officers 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 that retain permanent 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 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.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).

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.

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.8.1 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.8.2 Responsibilities. USACE has no responsibility for dam safety.

APPENDIX E

Essential Agency Guidelines

E.1 Policy. Essential Agency Guidelines are 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 V (Adequately Safe) 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 USACE guidance reflecting the state-of-practice guidance is summarized in following paragraphs.

E.2 Hydrology and Hydraulics Minimum Requirements.

E.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.61). In order to be classified as DSAC V, 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.

E.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 V, 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.

E.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 V, 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.

E.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 V classification. If a gate reliability is a potential failure mechanism, the classification should reflect that deficiency.

E.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 V 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.

E.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 V classification an assessment of the gage availability and operational availability of critical gages must be provided. If there are gaging shortfalls and/or gages are not dependable during extreme flood events, the classification should reflect that deficiency.

E.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 V classification, a qualitative 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.

E.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.54). In order to receive a DSAC V classification, 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.54). 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.

E.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 V classification, 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.)

E.3 Geotechnical and Materials Minimum Requirements.

E.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 host geology and the materials employed in the built structure. In order to be classified as DSAC V, 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.51), 1110-2-1806 (reference A.56), and 1110-2-1925 (reference A.57), through procedures described in numerous Engineering Manuals, including, but not limited to Engineer Manuals 1110-1-

1804 (reference A.9), 1110-1-2907 (reference A.10), 1110-1-2908 (reference A.11), 1110-2-1902 (reference A.13), 1110-2-1906 (reference A.14), 1110-2-1908 (reference A.15), 1110-2-1911 (reference A.16), 1110-2-2006 (reference A.19), 1110-2-2200 (reference A.23), and 1110-2-2201 (reference A.24).

E.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.

E.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 piping 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 may serve to justify changing the assignment of DSAC V to DSAC IV.

E.3.4 Drainage Features. Relief wells, 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 V unless and until such contamination is cleared and surveillance reveals that contamination is not recurrent. This infers that a DSAC V 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.

E.3.5 Filters. Piping 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; the absence of these filter zones precludes assignment as a DSAC V 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 V 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 V dam, unless the causative mechanism is fully determined and permanently resolved.

E.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 0.2 g. 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 V designation. Hydraulic fill embankments, which are placed without engineering consideration other than expedience of constructability, should not be assigned as DSAC V unless dynamic seismic analysis indicates satisfactory performance.

E.3.7 Summary. If loads less than or equal to the design loads create critical distress (unsatisfactory performance that leads to loss of pool or loss of function that leads to loss of life or large economic consequences), the classification must reflect the deficiency.

E.4 Structural Minimum Requirements.

E.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.

E.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.

E.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.20) and EM 1110-2-6053 (reference A.31) 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.

E.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.21). Guidance for hydraulic steel structures is contained in EM 1110-2-2105 (reference A.22). Additional guidance for specific structure types is included in EM 1110-2-2200 (reference A.23) for gravity dams, EM 1110-2-2201 (reference A.24) for arch dams, EM 1110-2-2400 (reference A.26) for outlet works, EM 1110-2-2701 (reference A.27) for vertical lift gates, EM 1110-2-2702 (reference A.28) for tainter gates, and EM 1110-2-2703 (reference A.29) for lock 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.

APPENDIX F

Background Information on the USACE Dam Safety Action Classification System

F.1 Policy.

F.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) based on their individual Dam Safety risk considered as probability of failure and potential failure consequences. Consequences of the dam failure considered are lives lost, economic, environmental, and other impacts. All dams will be evaluated with a screening assessment and classified according to the DSAC. Dams will be reclassified as new dam safety related 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.

F.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 for safe dams.

F.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 risk, which warrant heightened actions that are not provided for in the current business-as-usual procedures. Three action classes are termed “unsafe” and two are termed “safe”. The choice of three “unsafe” action classes is to provide adequate separation in the range of levels of actions. These five action classes are now included in the USACE Dam Safety program and summarized in the DSAC table. At the top, DSAC I is for those dams considered to be critically near failure and for which urgent actions are needed to avoid catastrophe in the near-term. DSAC II is for dams with confirmed (unsafe) and unconfirmed (potentially unsafe) 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. DSAC III is for dams with confirmed and unconfirmed dam safety issues where the combination of life or economic consequences with probability of failure is moderate to high. DSAC IV is for dams that are not declared safe because they don’t meet current guidelines, but which are not considered unsafe enough to warrant heightened attention and for which remediation is considered to be quite low priority, although investigations to confirm their DSAC classification should be given normal priority. At the bottom is DSAC V for dams that are determined to be safe. Examples of Dam Safety Action Classifications are given in following sections of this appendix.

F.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 placed into Dam Safety Action Classes (DSAC) based on their individual Dam Safety risk considered as probability of failure and potential failure consequences.

F.2.1 DSAC I – Urgent and Compelling (Unsafe).

F.2.1.1 Characteristics. Dams in this class are CRICTICALLY NEAR FAILURE OR EXTREMELY HIGH RISK under normal operations. These dams are ones where progression toward failure is confirmed to be taking place and are almost certain to fail under normal operations any time within a few years without intervention**;** or the dams have Extremely High Risk with a combination of life or economic consequences with high probability of failure.

F.2.1.2 Actions. A summary of the actions to be considered and pursued by the district for this class of dams are:

F.2.1.2.1 Take immediate action to avoid failure.

F.2.1.2.2 Validate classification through an external peer review.

F.2.1.2.3 Implement interim risk reduction measures, including operational restrictions, and ensure that emergency action plan is current and functionally tested for initiating event.

F.2.1.2.4 Conduct heightened monitoring and evaluation.

F.2.1.2.5 Expedite investigations to support justification for remediation using all resources and funding necessary.

F.2.1.2.6 Initiate intensive management and situation reports.

F.2.1.3 Examples of Critically Near Failure Dams.

F.2.1.3.1 Dam A. Dam A is experiencing foundation, abutment, and embankment piping or internal erosion due to seepage through these features under normal pool elevations. All of the seepage items may lead to the formation of piping, 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.

F.2.1.3.2 Dam B. Dam B is experiencing foundation and abutment seepage and piping, and embankment piping along the conduit during all pool elevations. 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 piping of the embankment. The left abutment is composed of granular glacial deposits and has experienced significant seepage during Normal pool events. The project has had several test fillings and subsequent 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. The most likely mode of failure for this project is seepage and piping of foundation or abutment materials which may rapidly progress to breaching of the dam.

F.2.1.4 Example of Extremely High Risk Dam. Dam C. Items of concern include foundation and abutment seepage and piping under the embankment. 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. This project is considered to have extremely high risk.

F.2.2 DSAC II – Urgent (Unsafe or Potentially Unsafe).

F.2.2.1 Characteristics. Dams in this class are considered to have Failure Initiation Foreseen in that, for confirmed (unsafe) and unconfirmed (potentially unsafe) dam safety issues, failure could be initiated during normal operations or from a hydrologic or seismic event. The likelihood of failure from one of these occurrences, prior to remediation, is too high to assure public safety. Or, dams in this class have Very High Risk in that the combination of life or economic consequences with probability of failure is very high.

F.2.2.2 Actions. A summary of the actions to be considered and pursued by the district for this class of dams are:

F.2.2.2.1 Implement interim risk reduction measures, including operational restrictions as justified, and ensure that emergency action plan is current and functionally tested for initiating event.

F.2.2.2.2 Conduct heightened monitoring and evaluation.

F.2.2.2.3 Expedite confirmation of classification.

F.2.2.2.4 Give very high priority for investigations to support justification for remediation.

F.2.2.3 Examples of Failure Initiation Foreseen Condition.

F.2.2.3.1 Dam D. The most likely mode of failure for this project is breaching of the dam by erosion or piping through cracks in the core caused by significant displacements of the upstream shell during an Operating Basis Earthquake (OBE) or greater earthquake. Foundation seepage may lead to the formation of piping, which can quickly progress to rapid breaching of the embankment. 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. This will result in piping of the remaining dam embankment and will quickly progress to breach. 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.

F.2.2.3.2 Dam E. The most likely failure mode is embankment, abutment, and foundation seepage and piping. Deficiencies in the design and construction techniques contribute to a condition of active piping at moderately high pools – 0.05 to 0.01 pool frequency. 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 caused by seepage. It is possible that seepage through the lift joints in the concrete section may be entering embankment materials.

F.2.2.4 Example of Very High Risk Condition. 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.

F.2.3 DSAC III – High Priority (Conditionally unsafe).

F.2.3.1 Characteristics. Dams in this class, for confirmed and unconfirmed Dam Safety issues, are considered to be Significantly Inadequate or have Moderate to High Risk in that the combination of life or economic consequences with probability of failure is moderate to high.

F.2.3.2 Actions. A summary of the actions to be considered and pursued by the district for this class of dams are:

F.2.3.2.1 Implement interim risk reduction measures, including operational restrictions as justified, and ensure that emergency action plan is current and functionally tested for initiating event.

F.2.3.2.2 Conduct heightened monitoring and evaluation.

F.2.3.2.3 Prioritize for investigations to support justification for remediation considering consequences and other factors.

F.2.3.3 Example of Significantly Inadequate Dam. Dam H. Two failure modes have been identified for this dam - overtopping and piping. The most probable is a piping failure of 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. Dam is estimated to be overtopped by several feet by the probable maximum flood and the embankment is breached by erosion. 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.

F.2.3.4 Example of a Moderate to High Risk Dam. 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.

F.2.4 DSAC IV. Priority (Marginally Safe).

F.2.4.1 Characteristics. Dams in this class are considered to be inadequate with low risk. For confirmed and unconfirmed Dam Safety issues, the combination of life or economic consequences with probability of failure is low and may not meet all essential USACE guidelines.

F.2.4.2 Actions. A summary of the actions to be considered and pursued by the district for this class of dams are:

F.2.4.2.1 Conduct elevated monitoring and evaluation.

F.2.4.2.2 Give normal priority to investigations to validate classification, but no plan for interim risk reduction measures at this time.

F.2.4.3 Examples of Inadequate With Low Risk condition Dams.

F.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 piping 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 the 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 an Extreme event. 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.

F.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.

F.2.5 DSAC V – Normal (Safe).

F.2.5.1 Characteristics. Dams in this class are considered to be adequately safe, meeting all essential USACE guidelines with no unconfirmed Dam Safety issues such that the residual risk is considered tolerable.

F.2.5.2 Actions. Continue routine Dam Safety activities, normal operation and maintenance.

F.2.5.3 Example of an Adequately Safe Dam. Dam L. Dam meets the requirements for hydrologic capacity to pass the most current inflow design flood (IDF), there is no known seepage and piping issue 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, and 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 residual 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 residual risk associated with any dam with the goal to keep the residual risk at or below the that which is considered tolerable for the respective dam.

F.3 Actions. The actions listed are an executive summary of the actions that a district Dam Safety officer should pursue based on the action classification assigned to each dam. The basic concept is that dams in classes I, II, and III shall be treated as unsafe until confirmed safe.

F.4 Documentation**.** It is recommended that a district document their decision for assigning a class to a given dam using a short fact sheet that addresses the available information in summary form to include the failure modes of concern, the loading conditions of concern, the probability of failure, the consequences, and DSAC assignment.

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APPENDIX G

Dam Safety Program Management Tools

G.1 Purpose. The purpose for the Dam Safety Program Management Tools (DSPMT) is to facilitate agency wide data collection and monitoring of the USACE dam safety program and to track compliance against the "Federal Guidelines for Dam Safety" (reference A.71) and USACE criteria.

G.2 Introduction.

G.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:

G.2.1.1 Documenting the condition of the Agency's dams

G.2.1.2 Tracking the status and progress of the MSC's and District's dam safety programs

G.2.1.3 Reporting information regarding the Agency's inventory of dams periodically to the National Inventory of Dams (NID) and Congress.

G.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.

G.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:

G.2.3.1 How well are our dam safety programs being implemented?

G.2.3.2 Are we doing too much in some areas and not enough in others?

G.2.3.3 Are we spending our scarce resources in the right places?

G.2.3.4 Are we improving?

G.2.4 The DSPMT consists of a set of interactive software programs which provide a resource to the dam safety data owners, managers, and data providers. The software is under continual development and is evolving as needs are expressed by users. The DSPMT includes two distinct, complementary, and interoperable software programs:

G.2.4.1 The Dam Safety Program Performance Measures (DSPPM).

G.2.4.2 The National Inventory of Dams (NID) Electronic Submittal Workflow

G.2.5 Each of these programs 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.

G.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.

G.3.1 The vision is to eventually achieve:

G.3.1.1 One-time data entry for programs targeted at the different aspects of dam safety;

G.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;

G.3.1.3 Automated error checking and identification of conflicting data;

G.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

G.3.1.5 Updating and reporting of inventory, performance measure, and incident information as frequently as desired.

G.3.2 The objectives of the DSPPM are also to provide simple, unbiased, quantitative data that are useful separately and/or collectively as metrics to help users:

G.3.2.1 Evaluate how well their dam safety programs are being implemented;

G.3.2.2 Determine whether they accomplished what they set out to accomplish;

G.3.2.3 Proactively “tell” their dam safety stories to others, both internal and external to their organizations; and

G.3.2.4 Encourage uniform and consistent application of laws, policies, and regulations.

G.4 DSPMT Overview.

G.4.1 DSPPM. The DSPPM is currently divided into seven subject areas:

G.4.1.1 Dam Safety Program Management Authorities and Practices,

G.4.1.2 Dam Safety Staff Size and Relevant Experience,

G.4.1.3 Inspections and Evaluations,

G.4.1.4 Identification and Remediation of Deficient Dams,

G.4.1.5 Project Response Preparedness,

G.4.1.6 Agency and Public Response Preparedness, and

G.4.1.7 Unscheduled Dam Safety Program Actions.

G.4.1.8 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:

G.4.1.8.1 Staffing Spreadsheet

G.4.1.8.2 Deficiencies and Budgeting Prioritization Spreadsheet

G.4.1.8.3 Documentation Spreadsheet

G.4.1.9 These spreadsheets allow graphics of data to be generated that provide insight into the capabilities and challenges faced by the organization.

G.4.2 NID Submittal Workflow.

G.4.2.1 The NID electronic submittal software provides tools for State and Federal data owners to efficiently collect, access, and manage NID data. The workflow starts by importing a State or Federal agency's local inventory of dams, which can be in a variety of database formats. Interactive graphical tools provided by the DSPMT are then utilized to check for data errors in numeric values and spelling errors or inconsistencies in text values. The NID inclusion rules are then applied. The data submittal is checked for differences between the candidate and the current NID, and is then electronically sent to USACE for review and incorporation into the NID.

G.4.2.2 By performing data submittal workflows at the state and agency level, those most familiar with the data and most qualified to make any changes, specifically the data owners, managers, and data providers, are kept in the loop by the program as it highlights areas in the data that potentially need attention, modification, or double-checking. By performing these workflows at the state and agency level, and by using the original data from the day-to-day dam inventory management tools, the data quality and accuracy of the submittal is significantly enhanced.

G.5 USACE DSPMT Implementation Specifics. Since the Dam Safety Program Managers at the district level should be most familiar with the details of the individual projects in their inventory, they shall have the primary burden of maintaining up-to-date information on the dams in the database.

G.5.1 DSPMT databases shall be fully updated quarterly prior to HQ quarterly review. As inspections are completed, the DSPMT shall be updated to include any modifications to NID 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.

G.5.2 The MSC shall be 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 shall not be corrected or modified at the division level or HQ level. It shall be the district responsibility to resolve the question or implement the correction in the district database.

G.6 Dam Safety Scorecard for Routine Dam Safety. For several years now, we have been collectively building an unbiased dam safety database within the Dam Safety Program Management Tools (DSPMT). Progress of the program is being tracked using Dam Safety Program Performance Measures (DSPPM). Selected performance measures which represent key routine activities are utilized to export in the form of the Dam Safety Scorecard. The Dam Safety Score Card provides a numerical and graphical report of the implementation of routine dam safety activities on a per dam basis. The score card is not used to be an indicator of the dam's condition or to determine the dam safety action class (DSAC). It does, however, provide 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 Dam Safety Program Management Tools as an output on a per dam basis, or it can be rolled up for dams in a district, a division, or HQUSACE. The Dam Safety Scorecard will be reviewed approximately quarterly in forums such as the HQ Dam Safety Committee meetings and Civil Works DMRs.

G.6.1 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, adjusted accordingly, and as data is collected, in time the scorecard index value will be a reasonable, recognizable, and accepted index of a routine dam safety program implementation.

G.6.2 The data used to populate the scorecard is retrieved from information that the districts provide in their DSPMT databases. The scores, verbal 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.

G.6.3 Districts should include discussions of their scorecards in their dam safety committee meetings and for briefing their DSAC I and II dams at PRBS. 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.

G.7 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 assistance 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 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 3.3.1 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.34).

H.2.2 ER 200-2-2, Procedures for Implementing NEPA (reference A.37).

H.2.3 ER 405-1-12, 27 Oct 80, Real Estate Handbook, Chapter 11, Disposal (reference A.38).

H.2.4 ER 1105-2-100, Planning Guidance Notebook, Appendix G, Section IV (reference A.42).

H.2.5 ER 1165-2-119, Modifications to Completed Projects (reference A.64).

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 based on 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 justified, 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 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 the Corps ‘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’ – Reference A.37. 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 Dam Safety Officer. The copy of the memorandum is to be furnished to the Corps Dam Safety Officer and the Director, Dam Safety Risk Management Center. 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.64). 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.38)), 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.64).

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.99) 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.64) 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

Screening Portfolio Risk Assessment Process

I.1 SPRA Process. The SPRA process includes having an independent regional cadre comprised of various disciplines including geotechnical, geology, structural, hydrologic, economic, and mechanical visit the district with dams to be screened. In one day, the cadre has a district presentation on the dam and reviews existing reports to estimate the consequences and engineering ratings to be entered in the SPRA spreadsheet. A SPRA report is prepared to document the range of the load cases considered, the engineering ratings, and consequences estimated from the existing data.

I.2 SPRA Spreadsheet. The SPRA spreadsheet provides information in the form of annualized risk in terms of potential loss of life and economic damages as well a probability of failure. These items are used to determine the appropriate DSAC for each dam. The methodology used for determining the appropriate DSAC (DSAC dam binning) has evolved over time. The current procedure plots the annualized potential loss of life (for Flood Damage Reduction (FDR) structures) or annualized economic damages (for Navigation (NAV) structures) after being divided by the resulting failure probability for the dam as rated. This operation results in an "average" potential loss of life or economic damage for a single dam failure. These values are plotted on the x-axis as shown in Figures I.1.a and I.1.b. The y-axis plots the probability of failure for the dam as rated by the regional cadre divided by the probability for a baseline dam. The baseline dam probability of failure is for a dam meeting all current guidelines. For example all features were rated "Adequate". The y-axis then represents how many more times likely the dam (as rated) is to fail than a baseline dam or a dam meeting all current guidance. Navigation structures with potential for loss of life are plotted on both charts and the appropriate DSAC rating used.

I.3 SPRA Methodology. SPRA methodology does calculate a probability of failure, but the methodology in the SPRA calculations includes modifiers of 1, 10, 100, and 1000 for engineering ratings of Adequate, Probably Adequate, Probably Inadequate, and Inadequate respectively. These modifiers are multiplied times the baseline probability of failure for each feature and therefore result in a probability of failure that is comparable only to results of other dams using the SPRA spreadsheet. SPRA results represent more of a "relative comparison" system and the data is not compatible with the tolerable risk guidelines. DSAC V determinations cannot be made based on SPRA data since it is not compatible with tolerable risk guidelines.

I.4 DSAC Binning. The DSAC binning chart has "bounding" lines based on an interpretation of the DSAC descriptions for DSAC I, II, III and IV. These "bounding" lines are not finite lines and cannot be described by simple bounding limits. The basic limits for these bounding lines are shown in Table I.1.a, but should not be considered as absolute values as there is considerable uncertainty in the SPRA estimates. This requires the dam values to be plotted on the chart to determine the initial estimate of the DSAC for the dam. Once plotted, the initial estimate is the beginning point that is reviewed for other factors to determine if the rating should be adjusted higher or lower

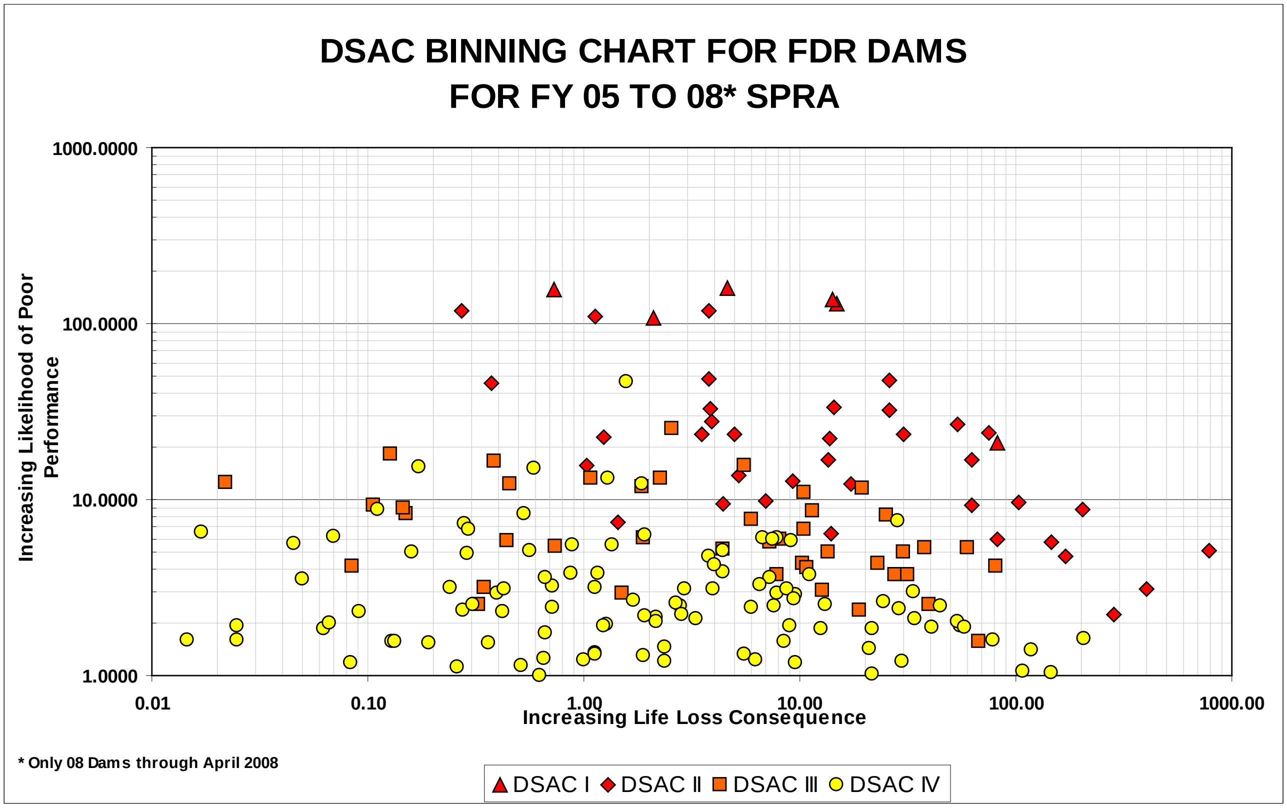

Figure I.1.a

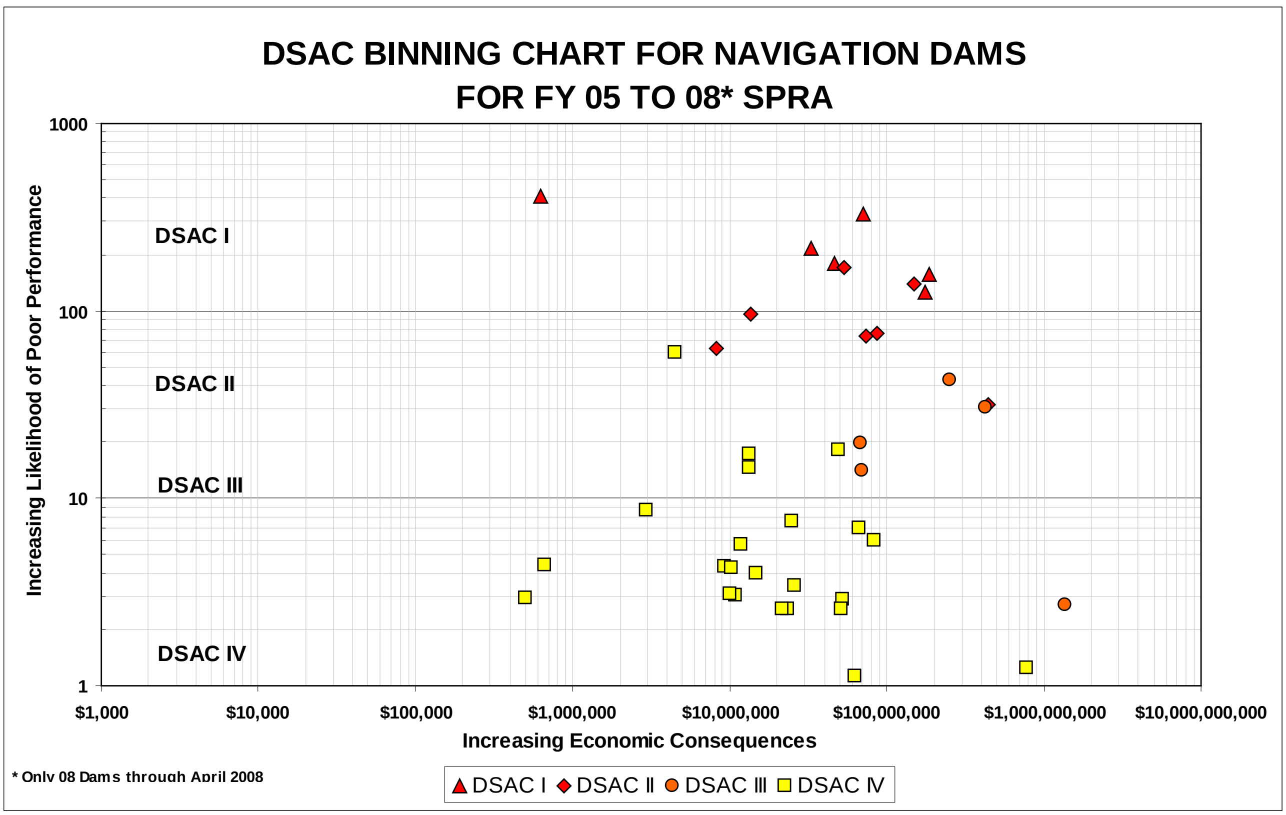

Figure I.1.b

Table I.1.a Guidelines for determining USACE Dam Safety Action Classification using SPRA		
Dam Safety Action Class		SPRA Classification Criteria
I **URGENT AND COMPELLING** (Unsafe)	(red)	Life Risk Index > 40 and Performance Index > 100 or Economic Risk > $3B
II **URGENT** (Unsafe or Potentially Unsafe)	(red)	20 < Life Risk Index < 40 or $300M < Economic Risk < $3B or 20< Performance Index < 100
III **HIGH PRIORITY** (Conditionally Unsafe)	(orange)	5 < Life Risk Index <20 or $50M < Economic Risk < $300M or 6 < Performance Index < 20
IV **PRIORITY** (Marginally Safe)	(yellow)	Life Risk Index < 5 or Economic Risk < $50M or Performance Index < 6
V **NORMAL** (Adequately Safe)	(green)	Cannot be determined using SPRA

as shown in Table I.1.b. The DSAC rating is then determined for dam with a brief justification for keeping or changing the initial DSAC for the dam.

I.5 Rating and Review of Rating. The initial DSAC rating is determined by the regional cadre following the district visit. The SPRA ratings, consequences, and DSAC determination go through two levels of review prior to being finalized.

I.5.1 The first level of review is completed by a group of quality control personnel including past regional cadre members and the Engineering Risk and Reliability Directorate (ERRDX) and the cadre lead responsible for the dam. The review consists of reviewing the district presentation, SPRA report, and SPRA spreadsheet. Based on the information presented, questions are asked about various SPRA items including engineering ratings, consequences, breach release severity parameters, justifications, and DSAC determination. These items are recorded and provided to the regional cadre to vet back with the entire cadre. The cadre considers the comments and either makes the recommended changes or documents why they are not changed. A follow-up discussion is held if the changes could potentially impact the agreed upon DSAC determination. From this effort a presentation summarizing the results of the screening are prepared for the next review.

Table I.1.b
Dam Safety Action Class Adjustment Guidelines

Dam Safety Action Class	Reasons to adjust Dam Safety Action Class	
I **URGENT AND COMPELLING** (Unsafe)	To Class II • External Peer Review does not support DSAC. • Studies and Investigations do not support suspected defect or failure mode. Extreme risk is not supported	
II **URGENT** (Unsafe or Potentially Unsafe)	To Class I • Progression toward failure is confirmed or supported by field observations (boils, excessive seepage, deformation, sink holes, etc)	Class III • Primary deficiency is in the extreme loading events. • History to indicate good performance at unusual loading range.
III **HIGH PRIORITY** (Conditionally Unsafe)	Class II • 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.	Class IV • Deficiencies are at extreme loading events • Low component risk
IV **PRIORITY** (Marginally Safe)	To Class IV • Increasing piezometric pressure over time	
V **NORMAL** (Adequately Safe)	N/A	

I.5.2 The second level of review is completed by the Senior Oversight Group (SOG). The summary presentation is made by the cadre lead. SOG members have access to the district presentation, SPRA report, and the summary presentation prepared by the cadre lead. Based on the presentation questions, recommendations, and comments are made for the cadre lead to answer or address later. If the recommendations or comments may impact the proposed DSAC rating, the determination of the DSAC is withheld until addressed. If the recommendations would not change the DSAC rating, the SOG reviews the recommended rating and votes on the final DSAC determination.

I.5.3 Following the SOG meeting, any needed changes to SPRA reports and spreadsheets are made. The final DSAC recommendation is included in the SPRA report. Once finalized, the reports are finalized and distributed to the division DSPM.

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APPENDIX J

Corps of Engineers Dam Safety Community of Practice Steering Committee (DSSC)

J.1 Authority and Responsibilities. The Steering Committee is empowered to develop and implement a strategic plan and a long-range plan for the USACE Dam Safety Program, including a mission statement, goals, objectives, and performance measures. The Steering Committee shall establish USACE Dam Safety Standards and monitor district compliance with these standards. The Steering Committee shall function in accordance with requirements of the Project Management Business Process (PMBP).

J.2 Objectives and Goals. The objective of the Steering Committee is to provide a formal USACE structure to develop policies, practices, and relationships to effectively facilitate dam safety practices and accomplishments. The Steering Committee maintains a consistent and accountable nationwide dam safety program. The Steering Committee works with other agencies to improve the USACE Dam Safety Program. The Steering Committee affirms accountability for dam safety to all elements within the command chain, monitors performance, and inculcates dam safety as a fundamental USACE mission. The goals of the Steering Committee are:

J.2.1 Participating in development of USACE-wide guidance when requested by the HQUSACE Dam Safety Officer (DSO),

J.2.2 Making recommendations to HQUSACE Dam Safety Officer for studies, investigations, and research designed to improve the safety of dams,

J.2.3 Rendering consulting service and advice on specific safety of dams issues and problems as requested by various elements of USACE or other agencies,

J.2.4 Maintaining a continuing evaluation of the state-of-the-art for the safety of dams,

J.2.5 Serving as a liaison for the dam safety process between HQUSACE and MSC/districts and disseminate pertinent information throughout USACE, and

J.2.6 Promoting dam safety engineering career development.

J.3 Scope of Steering Committee Activities. The Steering Committee will provide recommendations to the HQUSACE DSO on all topics in the areas of safety of dams such as roles and responsibilities, training, career development, automated systems and software, guide specifications, uniformity of project specifications, uniformity of process, research and development, and interface with other elements within USACE, other agencies, and professional organizations.

J.4 Composition. The steering committee members are full-time civilian employees of USACE. The Steering Committee shall seek 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 posted on the Corps of Engineers Technical Excellence Network (TEN). The steering committee officers shall be steering committee leader, alternate steering committee leader, and recording secretary. The Special Assistant for Dam Safety shall serve as the steering committee leader. The HQUSACE Dam Safety Program Manager shall serve as recording secretary. The Steering Committee shall elect an alternate steering committee leader. The Steering Committee shall be composed of seventeen (17) members as listed below.

J.4.1 HQUSACE Members. Four (4) HQUSACE individuals, who will be the Special Assistant for Dam Safety (CECW-CE), the Dam Safety Program Manager (CECW-CE), one member from Operations (CECW-CO), and one member from Program Integration Division (CECW-IP).

J.4.2 Major Subordinate Command (MSC) Members. Eight (8) individuals comprised of the Dam Safety Program Manager from each MSC.

J.4.3 Engineering Research and Development Center (ERDC) Member. One (1) ERDC individual appointed by the ERDC Director.

J.4.4 District Members. Four (4) district representatives, with experience in the safety of dams, shall be nominated by the Steering Committee as at-large members with final selection by the Corps DSO. At least one of the district representatives shall be from an operating element, one should be a DSPM, and one should be a DSO.

J.4.5 Alternate Members. In the event that a member of the Steering Committee cannot attend a Steering Committee meeting, the member may designate an alternate to serve in his capacity. The member shall provide the name of the alternate to the steering committee leader prior to the meeting.

J.5 General. The Steering Committee will carry out its objective in accordance with the following:

J.5.1 Oversight. The Steering Committee functions under the general direction of the USACE DSO.

J.5.2 Meetings. The steering committee leader will call meetings as required to carry out the Steering Committee's objective; normally meetings will be held semi-annually. Advance notice, agenda, and minutes of each meeting will be furnished to steering committee members and pertinent USACE commands.

J.5.3 Funding. HQUSACE, MSC, and ERDC members will be funded by their respective organizations for steering committee activities. District members' salary, travel and per diem expenses may be funded by HQUSACE for steering committee activities based on the availability of funds.

APPENDIX K

Observations on How Reclamation Uses Their Guidelines

K.1 Basis for Decision Making.

K.1.1 Decisions regarding the safety of the facility are made using two perspectives; the numerical risk estimate and the case made to justify the risk estimate. Reclamation has many levels of detail for the risk estimates it generates relative to the significance of the corresponding decision. Some evaluations are simplified and scripted, some are determined after several team evaluations and consultant reviews.

K.1.2 For any level of risk estimate, a technical report of findings is developed to justify the numbers that are generated. It also includes the primary factors that led to the risk estimate, a description of the uncertainties, and the strengths and weaknesses behind the numbers. These pieces of information are used to “make the case” to the advisory panel and the decision makers. This is a critical component that is intended to give the decision makers enough information to make an informed decision.

K.2 Risk Estimates Related to Tolerable Risks. Reclamation uses the tolerable risk guidelines as goals for achieving public protection, as shown in Figure K.1 (reference A.100). They are also thresholds, shown below, used to justify expending funds to reduce risks. They are not the sole piece of information used to judge the absolute safety of a structure, but they are the primary means to judge the relative safety of a structure. When considering these guidelines, Reclamation generally averages over the distribution of uncertainty to obtain the mean estimate of risk for an individual failure mode in comparison to the threshold values. Graphical depiction of this is shown in the f-N diagram in Figure K.2. Each point on the plot represents the mean risk estimate for an individual failure mode. The lines near the two axes represent the uncertainty associated with each estimate. Uncertainty is also considered in the decision process, and will be discussed in a later section. The primary focus of the dam safety program is life safety. As such, the thresholds are listed below in order of importance.

K.2.1 Expedited Public Protection.

K.2.1.1 Reclamation considers that there is justification for taking expedited action to reduce risk when the mean estimate of the annualized life loss for an individual failure mode exceeds 0.01 lives per year or the total risk of all failure modes for the project exceeds 0.01 lives per year. While there is a full range of possible risk reduction actions that can be taken, Reclamation focuses on those that can quickly reduce risk or improve understanding of the uncertainties associated with the risk. As confidence increases that the risk is in this range, actions concentrate more on reducing the risk than reducing the uncertainties. Every effort is made to take actions to reduce risks and complete any reassessment within 90 days of determining the need for expedited risk reduction action.

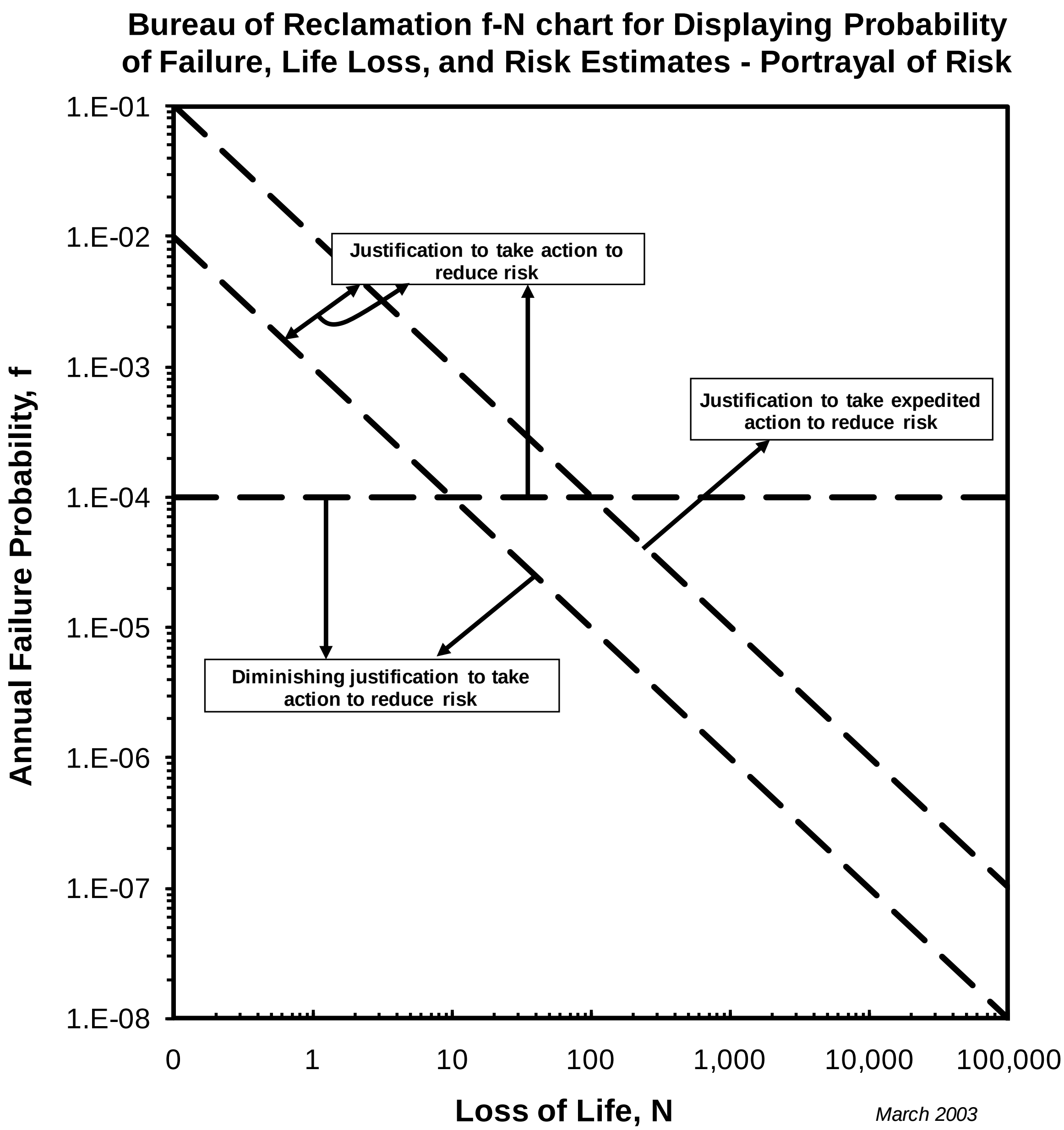

Figure K.1 - Reclamation’s Public Protection Guidelines

K.2.1.2 The purpose of the “expedited guideline” is to reinforce the importance of reducing risks in an expedited fashion. In general, *identified risks* are addressed more rapidly the higher they plot in relation to the guidelines. In many occasions, risks that result in an expedited action are a result of an incident or observed change in structural behavior. In these cases, every effort is made to reduce risks on an interim basis while the magnitude of the problem is evaluated.

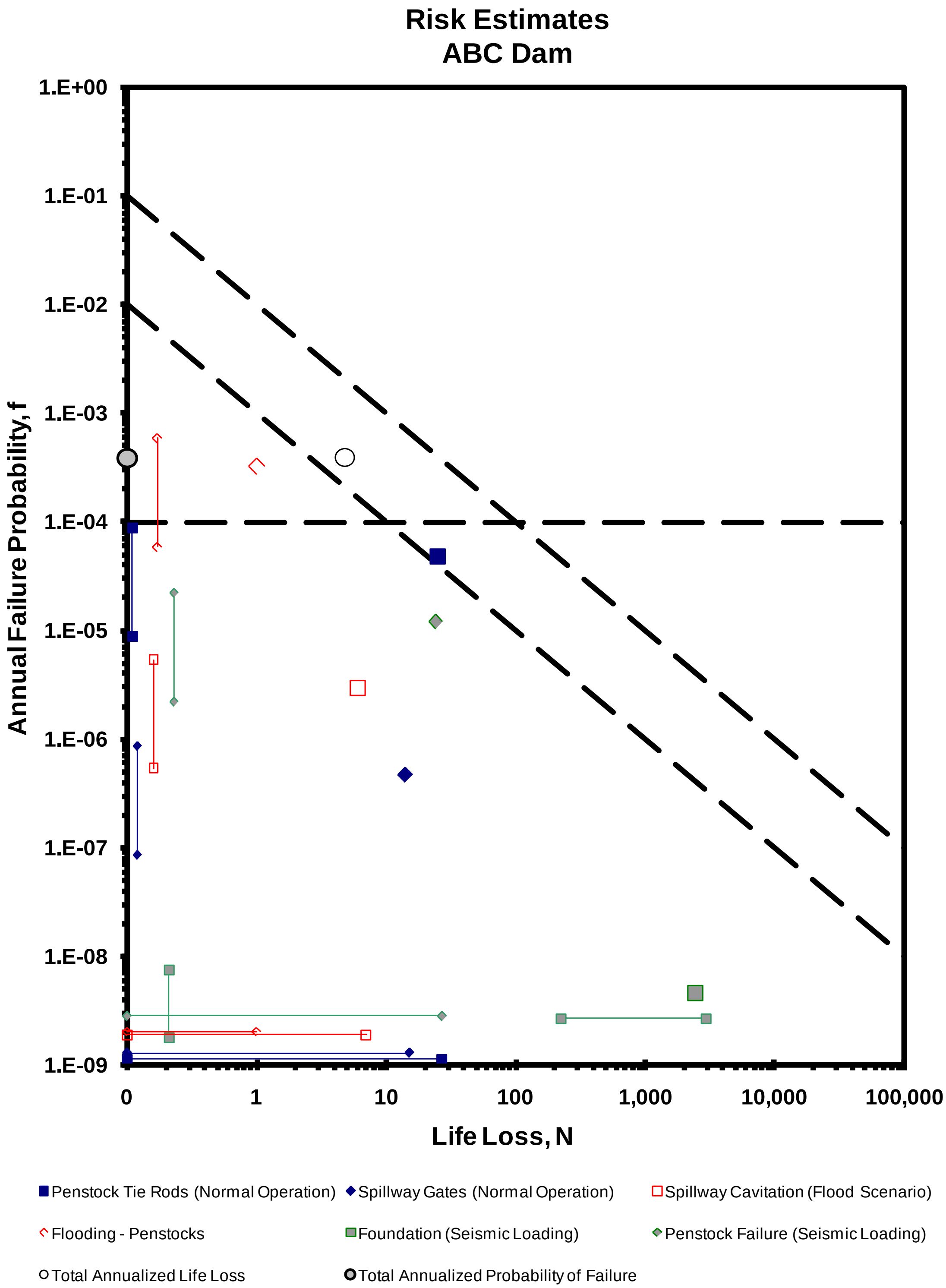

Figure K.2 - Example of an f-N Diagram for a Facility

K.2.2 Long-term Public Protection.

K.2.2.1 Reclamation considers that there is increasing justification for taking action to reduce risk when the mean estimate of the annualized life loss for an individual failure mode exceeds 0.001 lives per year or the total risk of all failure modes for the project exceeds 0.001 lives per year. When risk estimates exceed this value, there are a wide variety of possible actions which may be appropriate. The actions are scheduled into the dam safety program and coordinated with other needs at the facility and at other facilities. Actions to reduce risks are implemented on a schedule that is consistent with budgeting and appropriations processes. Typically, risk reduction should be accomplished within 7 years of a decision that identifies a need to reduce risk.

K.2.2.2 The purpose of the 'long-term' guidelines is to identify a threshold where actions are important, but not necessarily urgent. In this area, risks are managed in a more detailed and conscious manner while awaiting further evaluation or structural modifications. Interim actions are considered but not required. Decisions related to interim actions are constantly re-evaluated acknowledging that structures and conditions change over time and new information may influence the original decision.

K.2.3 Public Trust.

K.2.3.1 The justification to implement risk reduction actions increases as the mean estimate of the annual probability of failure for an individual failure mode exceeds 0.0001 per year or the total probability of failure for all failure modes for the project exceeds 0.0001 per year. Reasonable and prudent actions should be considered for implementation when the annual probability of failure estimate exceeds this value. A variety of possible actions may be appropriate.

K.2.3.2 The purpose of the public trust guidelines is to reinforce the idea that safety is important, even for facilities with low consequences.

K.2.4 Total Risk.

K.2.4.1 Figure K.3 illustrates the risk profile for one of Reclamation's five regions. Each point represents the total risk for an individual facility. In Reclamation, remediation decisions are made using the *mean estimate of risk for an individual failure mode*, whereas studies are prioritized based on the *sum of the mean risk estimates for an individual facility*.

K.2.4.2 Occasionally facilities with lower risk are worked on due to stakeholder requests or project requirements. Occasionally facilities with higher risk or probability of failure are delayed either intentionally or by circumstance. As Figure K.3 illustrates, most of the high-risk facilities in this particular region are currently being studied or modified.

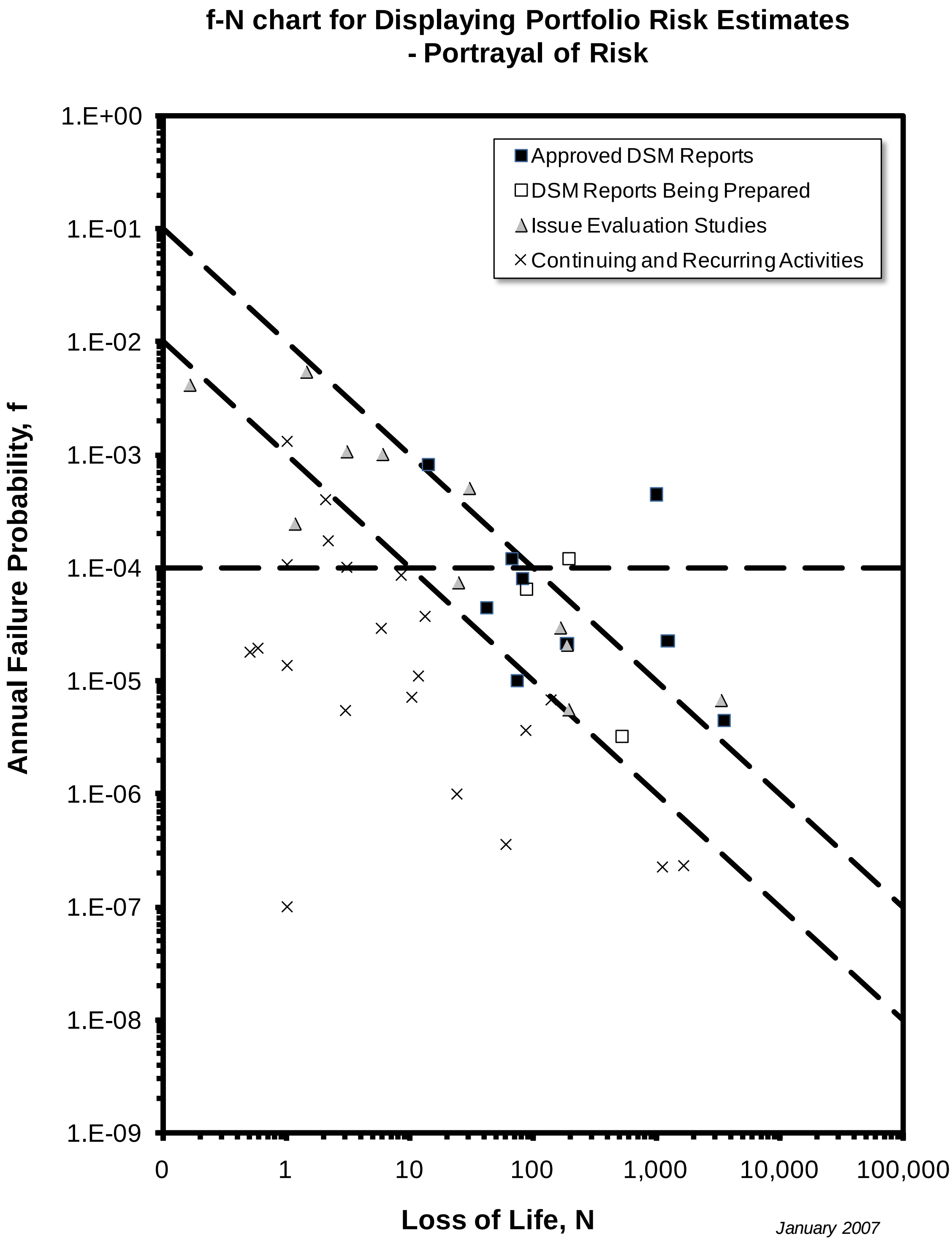

Figure K.3 - The Risk Profile for One Region in Reclamation

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APPENDIX L

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

Two variants of CSSL are calculated – unadjusted CSSL(U) and adjusted CSSL(A).

The adjusted CSSL(A) is calculated as follows:

$$CSSL(A) = \frac{C_A - (E[R:e] - E[E:pr]) - ([O:e] - [O:pr])}{E[L:e] - E[L:pr]}$$

Where CSSL(A) = adjusted cost-to-save-a-statistical-life, with the proviso that a negative value is taken as zero

C_A= ANNUALIZED cost of implementing risk reduction measure, dollars per annum

E[R:e] = existing expected value of risk cost (failure probability times monetary losses to the owner) for existing dam, dollar per annum

E[R:pr] = expected value of risk cost post-risk reduction, dollars per annum

E[L:e] = expected value of life loss for existing dam, lives per annum

E[L:pr] = expected value of life loss post-risk reduction, lives per annum

O:e = existing operating costs per annum

O:pr = post-risk reduction operating costs per annum

The "unadjusted" CSSL is calculated as follows:

$$CSSL(U) = \frac{C_A}{E[L:e] - E[L:pr]}$$

Reference: ANCOLD 2003 (reference A.80)

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APPENDIX M

Interim Risk Reduction Management Plan Development Sequence

M.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 I, II, and III Dams.

M.2 Development Sequence. The following table describes the sequence for IRRM development.

Table M.1 – Interim Risk Reduction Measures
Development Sequence

Item	Process	Notes
1	Designate dam as DSAC I, II, or III	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 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 HQ DSO

Item	Process	Notes
11	Approval of IRRMP by MSC DSO	Concurrence of approval by HQ DSO
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	

M.3 Submission and Approval. IRRMPs for DSAC I dams shall be submitted to the MSC DSO within 60 days after being designated as a DSAC I, or within 90 days after being designated as a DSAC II, or within 120 days after being designated as a DSAC III. A formal IRRMP is not required for DSAC IV dams, and remedial actions may follow more routine processes.

APPENDIX N

Interim Risk Reduction Management Plan Review Checklist

N.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.

N.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.

N.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.).

N.4 Structural and Nonstructural IRRM Alternatives. Alternatives considered to reduce the probability 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).

N.4.1 Reservoir Restrictions. If a reservoir restriction or pool deviation has been ruled out, very specific reasons should be included as to why.

N.4.2 Non-Structural IRRM. Non-structural measures such as increased monitoring and surveillance, stockpiling materials, help to reduce probability 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.

N.4.3 Structural IRRM. These measures typically improve the system response which will reduce the probability of failure.

N.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.

N.5 Discussion of Probability of Failure and Consequences. A general discussion of how predicted reduction in risk (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 is provided. This will help reviewers discern if the cost of the IRRM is clearly justified based on its estimated risk reduction.

N.5.1 NOTE. Analysis does not reduce risk – just reduces the uncertainty associated with the risk estimate.

N.5.2 Has NEPA coordination been started and continued throughout the process?

N.6 Recommendations and Risk-Informed Justification for IRRM to be Implemented. Each justification should include an estimate of the risk reduction from the IRRM implementation. Address potential for reduction in probability 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.

N.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 shall consider the expediency of implementing the IRRM. Resources, funding, capability, execution time, and the time to complete the dam remediation shall 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.

N.8 Estimate of Benefits and Costs for IRRM (DSAC I 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 I dams where significant and urgent risk reduction is necessary.

N.9 ATR Comments and Comment Resolutions. Review shall 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.

N.10 Updated EAP. The IRRMP should include updating the EAP to reflect site specific risks, and include emergency exercises for DSAC I, II, and III dams conducted in manners that are appropriate for the risk involved. Specifically it should include the local emergency managers for DSAC I, II, and III dams.

N.11 Communication Plan (Internal and External). Verify communication plan is in place and way of handling media, stockholders, and public is addressed. Check for schedule for media training based on DSAC rating, and discussion of how plan will be updated as the study progresses.

N.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.

N.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 O

Seepage Failure Mode Continuum

O.1 The Seepage Failure Mode Continuum. The Continuum (Figure O.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:

O.1.1 Stages of a seepage erosion/piping failure development, and

O.1.2 Corresponding risk reduction strategies that can be considered for implementation as the failure mode is progressing toward breach formation.

O.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.87), and the US Bureau of Reclamation (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 O.1 illustrates these as two distinct and separate stages in the development of the failure mode as described further below.

O.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.

O.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.

O.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.

O.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.

O.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).

O.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.

O.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.

O.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

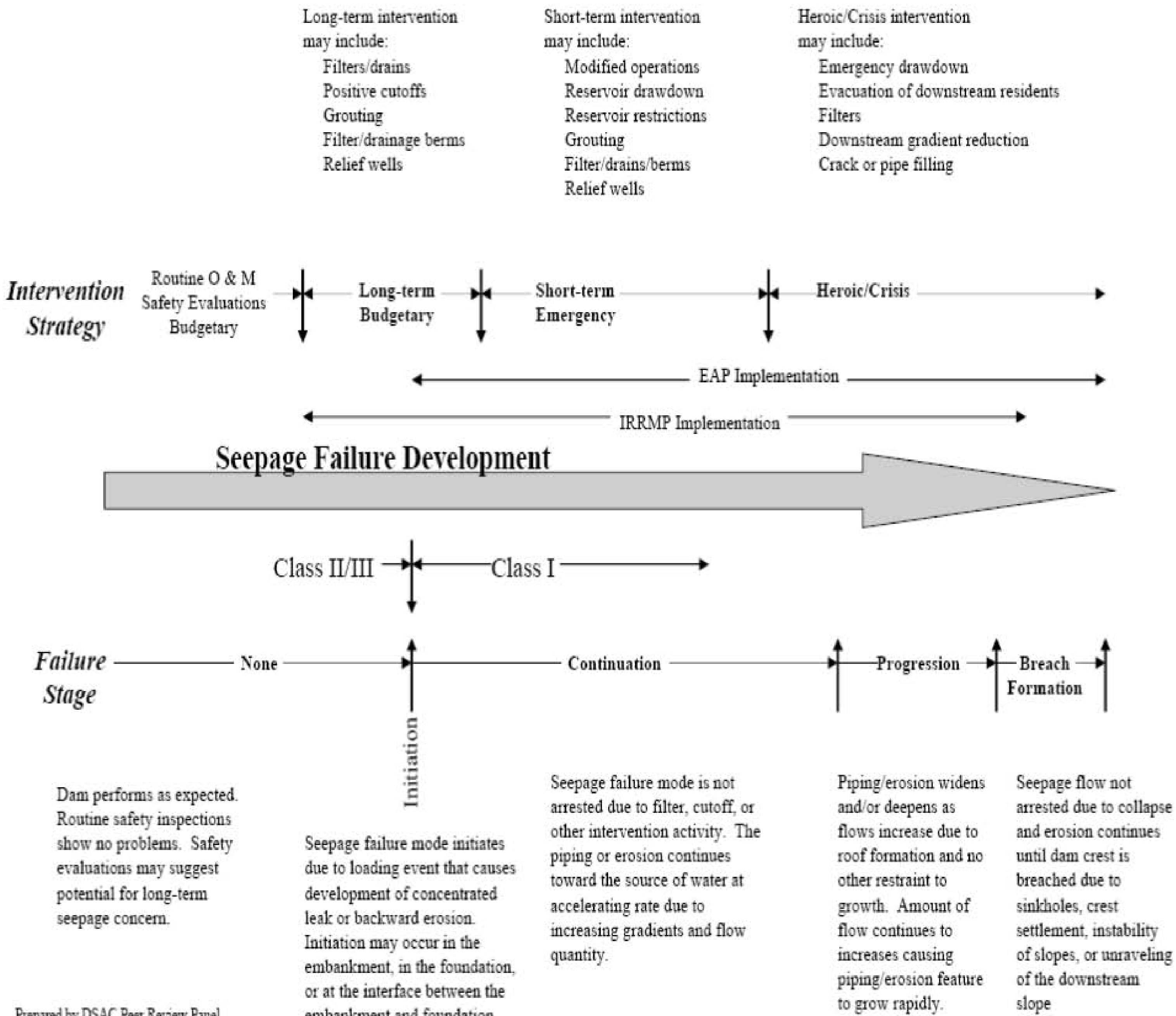

Figure O.1 – Seepage Failure Mode Development Continuum
DSAC Peer Review Panel. December 14. 2006

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 P

Format and Content for Issue Evaluation Study Documents

P.1 Issue Evaluation Study Summary of Findings (IESSF). This portion of the appendix describes the format and content of the IESSF.

P.1.1 Title Page. Include the following items on the title page:

P.1.1.1 Issue Evaluation Study Summary of Findings - Issue Evaluation Study

P.1.1.2 Dam Name

P.1.1.3 Location (river, city, state)

P.1.1.4 USACE District and USACE Division

P.1.1.5 Date

P.1.2 Approval Certification Sheet. Signature sheet in accordance with the approval requirements outlined in Table 8.2.

P.1.3 IESSF Section 1. Dam Safety Portfolio Risk Management Process. For Section 1 use the standard text (boiler plate) provided in Table P.1. Fill in the blanks at the end of the text.

P.1.4 IESSF Section 2. Summary History of Dam Safety-related Actions. Summarize, using text, diagrams, and photographs (as appropriate), the dam-safety-related issues and actions that might have arisen during design, construction, and operation continuing to the present. The information to be presented should include the following safety issues identified; remediation proposed and adopted; and a brief assessment of the degree of success of the remediation. A time-line diagram of major safety-related events and actions is a powerful way of presenting such history. Include the appropriate charts and diagrams.

P.1.5 IESSF Section 3. Guiding Principles and Key Concepts. For Section 3 use the standard text (boiler plate) provided in Table P.2.

P.1.6 IESSF Section 4. The following questions are to be answered in a narrative manner that succinctly communicates the essential dam safety issues, failure modes and risk assessment, and the recommended action(s). Tables, illustrations, and graphs are to be used as appropriate to summarize information and support the narrative.

P.1.6.1 Current Dam Safety Action Classification (DSAC). What is the existing DSAC classification, and what are the significant dam safety issues that have lead to this classification? (Include a summary listing of physical manifestations or PFM's.)

Table P.1 – Standard Text for IESSF Section 1
The overall Dam Safety Portfolio Risk Management Process is a series of hierarchical activities used to assess, classify, and manage the risks associated with the USACE inventory of dams. Dam Safety Action Classification (DSAC). The DSAC classification system provides consistent and systematic guidelines for appropriate dam safety actions, which are designed to address the dam safety issues and deficiencies of USACE dams and which are commensurate with the level of the dam failure risk. USACE dams are placed into a DSAC class based on their probability of failure or the individual dam safety risk estimate considered as a combination of probability of failure and potential life safety, economic, environmental, or other consequences. The intent is that the classification of a dam is dynamic over time, being revised as project characteristics are modified or more refined information becomes available affecting the loading, probability of failure, or consequences of failure. Portfolio Risk Management Process. The portfolio risk management process defines and documents the USACE risk assessment and risk management action decisions for each dam and facilitates risk communication. The actions and documents that reflect the process include normal operations and maintenance (O&M) activities and the documents generated through the portfolio risk management process to address dam safety issues. These documents are principally the Screening Portfolio Risk Assessment report, the Interim Risk Reduction Measures report, the Issue Evaluation Study report, and the Dam Safety Modification report. See ER 1110-2-1156 Chapter 3 for a detailed description of the process. Dam <*insert name*> is presently classified <*Insert dam's DSAC class*> and is poised at decision point <*Insert decision point ID*>. Prior dam safety actions for this dam are summarized in the following section.

P.1.6.2 Description of Potential Failure Mode(s) Judged to be Significant. List each significant PFM separately, (PFM-1, PFM-2, PFM-3, etc) and answer the following questions for each PFM:

P.1.6.2.1 Dam Safety Issue for PFM

P.1.6.2.1.1 What is the Dam Safety Issue?

P.1.6.2.1.2 What instigated the safety concern?

P.1.6.2.1.3 What physical evidence or project performance indicates that there is a problem or that a problem cannot be ruled out?

P.1.6.2.1.4 Why are these issues significant?

Table P.2 – Standard Text for IESSF Section 3
Assessments of the safety of USACE dams are conducted using a risk assessment approach which provides input to risk informed decision making. The approach combines the evaluation of dam safety against engineering guidelines, and evaluates the risk posed by USACE dams compared to tolerable risk guidelines. The former focuses on satisfying essential USACE guidelines for a wide range of engineering considerations (for an Issue Evaluation Study risk estimate this evaluation against engineering guidelines is very limited if done at all, and if done, is only done for those potential failure modes assessed in the IES). The latter involves identifying all credible and significant failure modes for a specific dam, quantifying their probabilities of occurrence and associated consequences, and evaluating their estimated risk of dam failure against the USACE tolerable risk guidelines. The tolerable risk guidelines address the probability of failure, risk to the public (life loss), economic risk and environmental risk. For a particular USACE dam, by combining the two evaluation approaches and the breadth of understanding gained from both, well-reasoned recommendations are made for reducing risks to tolerable levels and to meet essential USACE guidelines. Achieving and maintaining tolerably low risk levels for USACE dams requires structural measures in concert with an effective safety management regime, including staff training, operation and maintain, monitoring and surveillance, and emergency action planning. Since each USACE dam is part of a large portfolio of dams, risk management decisions viewed from a national perspective will be made centrally by HQUSACE. Therefore, the evaluation of dam safety for a particular dam must be made in a consistent manner such that the information obtained from these evaluations can be used to prioritize risk reduction actions across the portfolio of USACE dams. In addition, the Dam Safety Action Classification (DSAC) system is designed and used to maintain the appropriate degree of urgency for addressing safety issues at individual dams. It is recognized that both the engineering guidelines approach and the risk-informed approach are subject to limitations based on the available information, understanding about dam safety issues and failure modes, and limitations in the state-of-the-practice of dam safety engineering. Thus it is important that the degree of confidence in quantitative analyses be considered in both engineering analyses and risk assessments for each dam. Hence USACE does not consider tolerable risk guidelines as strict criteria, and it does not rely solely on these guidelines to demonstrate adequate dam safety, but rather USACE uses the entirety of the information available to support the recommendations made to take a particular risk management action. The IESSF presents a balanced and professional distillation of the risk assessment in support of the recommended risk informed decision.

P.1.6.2.2 Estimation of Risk Conditions for PFMA.

P.1.6.2.2.1 What is the estimated risk condition?

P.1.6.2.2.2 What are the major contributors of the risk condition? Provide a summary on the likelihood of the initiating event, the conditional probability of failure, and the exposure of people, property, and environment, given this failure, and the ultimate loses due to the failure. Discuss the nature of the flooding, the nature of the warning, the ease of evacuation, and size of the population at risk from a best case to a worst case evaluation.

P.1.6.2.2.3 What physical evidence or project performance metrics support that there is or could be a significant failure mode and what is the confidence in its existence?

P.1.6.2.2.4 What are the estimated probabilities of failure and consequences for the identified significant failure mode and the degree of confidence in these estimates?

P.1.6.2.2.5 Can the confidence in the risk estimates be increased and if so, how?

P.1.6.3 Evaluation of Risk Condition

P.1.6.3.1 Tolerable Risk Guidelines

P.1.6.3.1.1 What order of magnitude above or below the tolerable risk limit is the estimated risk, with respect to:

P.1.6.3.1.1.1 APF - total annual probability of failure and

P.1.6.3.1.1.2 ALL - annualized incremental societal risk.

P.1.6.3.1.2 What is the estimated individual risk (IR)?

P.1.6.3.1.3 Does the probability distribution of potential life loss exceed the societal (F-N) tolerable risk limit?

P.1.6.3.1.4 How does uncertainty impact the evaluation of the estimated risk in relation to the tolerable risk guidelines?

P.1.6.3.2 Recommended Dam Safety Action Classification (DSAC) – Do the results of the risk assessment justify a change in the DSAC classification? IESSF

P.1.6.3.3 Dam Safety Modification Study – Is a dam study modification study justified? If so, what is the rationale?

P.1.6.3.4 Interim Risk Reduction Measures.

P.1.6.3.4.1 Are changes in the interim risk reduction measures indicated by the risk assessment in support of the IES?

P.1.6.3.4.2 Are there minor dam safety issues or loss of service issues that should be addressed by operation and maintenance? If so, what is the rationale?

P.2 IES Report. This portion of the appendix describes the format and content of the IES Report.

P.2.1 Chapter 1 – Introduction. Overall project authority, purposes, location, and descriptions of pertinent project features.

P.2.2 Chapter 2 – Background. Discussion of past performance and key observations, Include summary of the dam features and components, foundation conditions, seepage control features, unique design considerations, and construction methods.

P.2.3 Chapter 3 – Current Assessment. Overview from the results of any past SPRA or PA findings and the reasons for the current DSAC rating. The current assessment shall 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).

P.2.4 Chapter 4 – Interim Risk Reduction Measures. Summary of the IRRMP implementation, and the benefits and impacts of the corresponding interim risk reduction measures.

P.2.5 Chapter 5 – Potential Failure Modes. Summary of the facilitated PFMA results with a listing of the significant and credible failure modes, the impacts if failure was to occur, and corresponding opportunities for risk reductions.

P.2.6 Chapter 6 – Hydrologic and Hydraulic Analysis. A discussion of the hydrologic loading events and frequency for the project as well as hydraulic modeling efforts.

P.2.7 Chapter 7 – Seismic Loading. A discussion of the seismic loading events and frequency for the project shall be included in this chapter. The overall seismic analysis process is provided in Appendices AB and AC.

P.2.8 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.).

P.2.9 Chapter 9 – Risk Estimate.

P.2.9.1 Methodology. A description of the methodology and risk estimating tools, used to estimate the risk.

P.2.9.2 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.

P.2.9.3 Summary of risk estimates. Discussion of the risk estimates based upon current tolerable risk guidelines. Plot the risk estimate results on the tolerable risk guideline charts. The summary shall provide a tabular summary of results that includes the Annual Probability of Failure, the estimated Life Loss (Mean Value), the Annualized Life Loss, and economic risk for each failure mode analyzed (see Chapter 5).

P.2.10 Chapter 10 – Conclusions and Recommendations. This section should include the findings and conclusions of the risk estimate, recommendations, and risk-informed justification for more detailed study. This section should also include a discussion on future data needs required to reduce unacceptable uncertainty at the next level of study.

P.2.11 Chapter 11 – Interim Risk Management Plan. A comprehensive discussion on the significant dam safety deficiencies identified by the risk analysis, the short and long term efficiency, effectiveness, and potential impacts of current and proposed IRRMs, the justification 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.

P.2.12 Chapter 12 – Risk Communications Plan. A summary of efforts and actions the district intends or has implemented in accordance with chapters 7 and 10.

P.2.13 Supporting Documentation. Supporting documentation shall be included in the following Appendices:

P.2.13.1 Appendix A – References.

P.2.13.2 Appendix B – PFMA Documentation.

P.2.13.3 Appendix C – Initiating Events.

P.2.13.4 Appendix D – System Response.

P.2.13.5 Appendix E – Consequence Documentation.

P.2.13.6 Appendix F – Risk Engine Results.

P.2.13.7 Appendix G – Pertinent Project Data used in Risk Estimates.

P.2.13.8 Appendix H – Agency Technical Review.

P.2.13.9 Appendix I – IRRM Supporting Documentation.

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APPENDIX Q

Dam Safety Modification Investigations, Studies, and Reports

Q.1 Format of Dam Safety Modification Report. Each report shall include the requirements contained in the following paragraphs and the report format shall follow the order as presented below.

Q.2 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 Part 1, IES.) 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 R.

Q.3 Executive Summary. The Executive Summary will include project location, description, and DSAC; dam safety issues and significant potential failure modes; baseline 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.”

Q.4 Background.

Q.4.1 Project Authorization 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.

Q.4.2 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.

Q.4.3 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.

Q.4.4 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 and what impact the proposed modifications for dam safety will have on the project’s capability to do so. Provide supporting data, as available from USACE or non-USACE sources.

Q.5 DSM Study Findings and Recommendations. This section presents a summary of the investigations, analysis, studies, and decision process for the recommended risk management plan.

Q.5.1 Identify Dam Safety Issues and Opportunities (Chapter 9, Section 9.5.2). Problems and opportunities statements will be framed in terms of the USACE dam safety program objectives, identified dam safety issues, and life safety tolerable risk and essential USACE engineering guidelines.

Q.5.2 Estimate Baseline Risk Condition (Chapter 9, Section 9.5.3). The baseline 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 baseline 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. A risk assessment for each subsequent risk management alternative will be done to determine the estimated risk reduction.

Q.5.2.1 Provide a narrative description of the investigations and studies used to support the baseline risk estimate.

Q.5.2.2 Present any investigations and studies and explain how they improved the quality and reduce uncertainty of the baseline risk estimate and 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.

Q.5.2.3 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.

Q.5.2.4 Baseline 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.

Q.5.2.4.1 Baseline Life Loss Consequences. This shall include the estimate of the population at risk; threatened population, and the potential loss of life.

Q.5.2.4.2 Baseline Economic Consequences. This shall 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.

Q.5.2.4.3 Baseline Environmental and Other Consequences. This shall include the estimated environmental damages (i.e., acres of habitat destroyed, threatened or endangered species impacted.) and HTRW contamination from contaminates either within the reservoir or in the downstream inundation area. Other consequences that cannot be quantified shall be qualitatively described.

Q.5.3 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.

Q.5.3.1 At least one proposed risk management alternative must be shown to reduce the risk to the levels defined in the tolerable risk guidelines.

Q.5.3.2 Other alternatives to be considered include:

Q.5.3.2.1 Do nothing – continue project as is;

Q.5.3.2.2 Removal of dam;

Q.5.3.2.3 Replacement of dam;

Q.5.3.2.4 Plan formulated with full ALARP considerations;

Q.5.3.2.5 Only achieving tolerable risk limit for life safety; and

Q.5.3.2.6 Make Interim Risk Reduction Measures permanent.

Q.5.4 Evaluating 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 baseline condition for each risk management alternative.

Q.5.4.1 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.

Q.5.4.1.1 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.

Q.5.4.1.2 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.

Q.5.4.1.3 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.

Q.5.4.2 Alternative Cost Estimates. Provide a preliminary cost/economic analysis for each alternative included in the report.

Q.5.5 Comparing Alternative Risk Management Plans (Chapter 9, Section 9.5.5). In this step, plans (including the no permanent risk management action plan) are compared against each other, with emphasis on the outputs and effects 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.

Q.5.5.1 At a minimum for each alternative show the estimated probably of failure for the baseline condition and the with-risk reduction 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 baseline condition and with-risk reduction condition estimated risk, show the reduction in total estimated risk and estimated risk for each failure mode, list the ALARP considerations to indicate the residual risk is tolerable, and the estimated cost for the alternative.

Q.5.5.2 Under the ALARP considerations present the disproportionality ratio, 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

Q.5.6 Selection of a Risk Management Plan (Chapter 9, Section 9.5.6). 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.

Q.5.6.1 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 shall be presented, pending the outcome of the proposed investigations.

Q.5.6.2 Present the justification for any aspect of the recommended plan that requires additional project authorization.

Q.5.6.3 Provide a narrative description of how the dam currently (no risk management measures implemented) deviates from current essential USACE guidelines.

Q.5.6.4 Provide a narrative on the cost to fully meet current standards based criteria. A discussion of the baseline risk, 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 shall include a cost risk analysis showing the uncertainty per ER 1110-2-1302, (reference A.53).

Q.6 Cost Sharing Considerations.

Q.6.1 For risk assessment and decision document approval this dam safety regulation treats the dam safety assurance work (Section 1203 cost sharing) and major rehabilitation work for seepage and stability (regular cost sharing) the same way. Each dam safety issue shall be discussed and alternatives reviewed in light of all potential failure modes. For cost sharing purposes this section of the report shall 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 cost sharing guidance – the cost sharing is failure mode dependent.

Q.6.2 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 shall 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.

Q.7 Real Estate Plan(s). Present a summary of any real estate requirements. The Real Estate Plan shall 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 shall so document that finding.

Q.8. 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 and the Fish and Wildlife Coordination Act Reports, in addition to NEPA documents. In accordance with ER 200-2-2, 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-42)

Q.9 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.)

Q.10 Dam Safety Modification Report Appendices.

Q.10.1 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 analysis.

Q.10.2 Life Loss Consequences. Include all approaches, data sources, description of models, and model results for all life loss evaluations conducted to estimate the baseline condition 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.

Q.10.3 Economic Evaluation and Economic Consequences. Include all approaches, data sources, description of models, and model results for all economic evaluations conducted to estimate the baseline condition 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.

Q.10.4 M-CACES Estimate for Recommended Plan. A Micro Computer Aided Cost Engineering System (MCACES) baseline feasibility estimate (ER 1110-2-1302 (reference A.53)) in the Civil Works/HTRW Work Breakdown Structure will be prepared for the recommended plan. Cost estimates shall 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.” The level of the cost detail will vary with the design information available to support the project scope, but shall 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 baseline cost estimate. Although this baseline estimate is not subject to reauthorization if the Section 902 limit (WRDA 86) (reference A.99) 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 shall be prepared following the current cost engineering policy. Include a summary and the full detail M-CACES estimate for the recommended plan.

Q.10.5 Environmental Documentation.

Q.10.5.1 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.

Q.10.5.2 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.37) (e.g., EA, FONSI, EIS, or Supplement) and/or Section 404(1)(b) evaluation.

Q.10.5.3 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.

Q.10.6 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.

Q.10.7 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.

Q.10.8 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.

Q.10.9 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.

Q.10.10 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.

Q.10.11 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.

Q.10.11.1 Hydraulic or Hydrologic. Evaluate the ability to pass the spillway design flood in accordance with current policy.

Q.10.11.2 Seismic. Evaluate the ability to withstand seismic loads in accordance with current policy.

Q.10.11.3 Static stability. Evaluate the ability to withstand static pool loads in accordance with current policy. (e.g., seepage and piping, static stability)

Q.10.11.4 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)

Q.10.11.5 Spillway Gate Operations. Evaluate the ability to operate within the full range of design loads in accordance with current policy.

Q.10.11.6 Evaluate other conditions not meeting current design or construction criteria or seriously affecting project performance.

Q.10.11.7 Recommended Plan Drawings. Provide summary drawings for the recommended plan for use in review and presentation of the recommended plan.

Q.10.12 Real Estate Plan (including relocations). A Real Estate Plan shall 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 shall so state. Provide the background details concerning the Real Estate requirements for the recommended plan.

Q.10.13 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 EC 1165-2-209, Water Resources Policies and Authorities, Review of Decision Documents will be contained in this appendix.

Q.10.14 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.

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APPENDIX R

Instructions for the "Dam Safety Action Decision Summary for a Dam Safety Modification Study"

R.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 is a public document with unrestricted distribution but it is not designed as a public communications product. DSADS concisely summarizes the following the USACE dam safety program; the history and status of safety issues and actions for the subject dam; the risk management alternatives considered; 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.

R.2 Document Content. The DSADS consists of:

R.2.1 Title page – Dam Safety Action Decision Summary. The title page shall include Dam Safety Modification Study, name of the dam, location, name of the USACE district and division, and date of the decision summary.

R.2.2 Section 1. Overview of USACE dam safety portfolio risk management process (*standardized text (boiler plate)*) (Table R.1), concluding with identifying the current stage of the dam in that process.

R.2.3 Section 2. Dam safety action summary for the dam.

R.2.4 Section 3. Principles and key concepts that guided the synthesis of the data, analyses and evaluations that provided the basis for action recommendations (*standardized text (boiler plate)*) (Table R.2).

R.2.5 Section 4. Succinct answers to the required standard set of questions posed in this guidance that encompass the scope of issues, investigations, alternatives, and consequences, and that substantiate the recommendations.

R.3 DSADS Instructions. The instructions for the DSADS content are presented in this attachment.

R.3.1 Title Page. Dam name, location (river, city, state), USACE district, USACE division.

R.3.2 Section 1 –"Dam Safety Portfolio Risk Management Process". For Section 1 use the standard text (boiler plate) provided in Table R.1. Fill in the blanks at the end of the text. Include a copy of Figure 3.1 and Table 3.1 in the DSADS at this point.

Table R.1 – Standard Text for DSADS Section 1
The overall Dam Safety Portfolio Risk Management Process is a series of hierarchical activities used to assess, classify, and manage the risks associated with the USACE inventory of dams. Dam Safety Action Classification (DSAC). The DSAC classification system provides consistent and systematic guidelines for appropriate dam safety actions, which are designed to address the dam safety issues and deficiencies of USACE dams and which are commensurate with the level of the dam failure risk. USACE dams are placed into a DSAC class based on their probability of failure or the individual dam safety risk estimate considered as a combination of probability of failure and potential life safety, economic, environmental, or other consequences. The intent is that the classification of a dam is dynamic over time, being revised as project characteristics are modified or more refined information becomes available affecting the loading, probability of failure, or consequences of failure. Portfolio Risk Management Process. The portfolio risk management process defines and documents the USACE risk assessment and risk management action decisions for each dam and facilitates risk communication. The actions and documents that reflect the process include normal operations and maintenance (O&M) activities and the documents generated through the portfolio risk management process to address dam safety issues. These documents are principally the Screening Portfolio Risk Assessment report, the Interim Risk Reduction Measures report, the Issue Evaluation Study report, and the Dam Safety Modification report. Portfolio Risk Management Process Graphic Depictions. Table 3.1 contains the definition of the USACE dam safety action classification system. Figure 3.1 is a flow chart of the USACE dam safety portfolio risk management process. Chapter 3 of the Safety of Dams regulation provides a detailed description of the process and discussion of the figures. Dam <*insert name*> is presently classified <*Insert dam's DSAC class*> and is poised at decision point <*Insert decision point ID*>. Prior dam safety actions for this dam are summarized in the following section.

R.3.3 Section 2 – Summary History of Dam Safety-Related Actions. Summarize, using text, diagrams, and photographs (as appropriate), the dam-safety-related issues and actions that might have arisen during design, construction, and operation continuing to the present. The information to be presented should include the following safety issues identified; remediation proposed and adopted; and a brief assessment of the degree of success of the remediation. A time-line diagram of major safety-related events and actions is a powerful way of presenting such history. Include the appropriate charts and diagrams.

R.3.4 Section 3 –"Guiding Principles and Key Concepts". For Section 3 use the standard text (boiler plate) provided in Table R.2.

Table R.2 – Standard Text for DSADS Section 3
Assessments of the safety of USACE dams are conducted using a risk assessment approach which provides input to risk informed decision making. The approach combines the evaluation of dam safety against engineering guidelines, and evaluates the risk posed by USACE dams compared to tolerable risk guidelines. The former focuses on satisfying essential USACE guidelines for a wide range of engineering considerations. The latter involves identifying all credible and significant failure modes for a specific dam, quantifying their probabilities of occurrence and associated consequences, and evaluating their estimated risk of dam failure against the USACE tolerable risk guidelines. The tolerable risk guidelines address the probability of failure, risk to the public, economic risk and environmental risk. For a particular USACE dam, by combining the two evaluation approaches and the breadth of understanding gained from both, well-reasoned recommendations are made for reducing risks to tolerable levels and to meet essential USACE guidelines. Achieving and maintaining tolerably low risk levels for USACE dams requires structural measures in concert with an effective safety management regime, including staff training, operation and maintain, monitoring and surveillance, and emergency action planning. Since each USACE dam is part of a large portfolio of dams, risk management decisions viewed from a national perspective will be made centrally by HQUSACE. Therefore, the evaluation of dam safety for a particular dam must be made in a consistent manner such that the information obtained from these evaluations can be used to prioritize risk reduction actions across the portfolio of USACE dams. In addition, the Dam Safety Action Classification (DSAC) system is designed and used to maintain the appropriate degree of urgency for addressing safety issues at individual dams. To appropriately manage the prioritization and urgency of risk reduction for each individual dam across the entire portfolio, opportunities for staging risk reduction actions using logically separable construction packages are considered in the dam safety modification studies. It is recognized that both the engineering guidelines approach and the risk-informed approach are subject to limitations based on the available information, understanding about dam safety issues and failure modes, and limitations in the state-of-the-practice of dam safety engineering. Thus it is important that the degree of confidence in quantitative analyses be considered in both engineering analyses and risk assessments for each dam. Hence USACE does not consider tolerable risk guidelines as strict criteria, and it does not rely solely on these guidelines to demonstrate adequate dam safety, but rather USACE uses the entirety of the information available to support the recommendations made to take a particular risk management action. The DSADS presents a balanced and professional distillation of the risk assessment in support of the recommended risk informed decision.

R.3.5 Section 4. The following questions are to be answered in a narrative manner that succinctly communicates the essential dam safety issues, failure modes and risk assessment, alternatives formulated and analyzed, estimated risk reduction for each alternative, the recommended risk reduction action(s), and potential remaining dam safety issues. Tables, illustrations, and graphs are to be used as appropriate to summarize information and support the narrative. The questions are grouped consistent with the investigation structure presented in Chapter 9, paragraph 9.5.

R.3.5.1 Identification of the dam safety issues, risk reduction objectives, limitations and opportunities

R.3.5.1.1 What are the dam safety issues?

R.3.5.1.2 What instigated the safety concern?

R.3.5.1.3 What physical evidence or project performance indicates that there is a problem or that a problem cannot be ruled out?

R.3.5.1.4 Why are these issues significant?

R.3.5.1.5 What is the existing DSAC classification and what are the significant dam safety issues that have lead to this classification?

R.3.5.1.6 What are the dam safety risk reduction objectives?

R.3.5.1.7 What tolerable risk guidelines are being used for performance objectives – life safety, economic, and environmental?

R.3.5.1.8 What essential USACE guidelines are pertinent for this dam and why?

R.3.5.1.9 Is the ALARP principle to be applied and how?

R.3.5.1.10 What are the potential constraints on risk reduction actions that need to be addressed?

R.3.5.1.11 Are there physical site constraints and if so, what are they?

R.3.5.1.12 Are there resource constraints such as institutional, people, funding and if so, what are they?

R.3.5.1.13 Are there policy and legal constraints that must be considered, and if so, what are they?

R.3.5.2 Estimation of baseline risk conditions

R.3.5.2.1 What is the estimated baseline risk condition?

R.3.5.2.2 What are the major contributors of the baseline risk condition? And what is the likelihood of the initiating event; conditional probability of failure; exposure of people, property, and environment given this failure; and the ultimate losses due to the failure?

R.3.5.2.3 Was it necessary to consider future risk conditions (changes in consequences or deterioration in condition) and if so, what are they?

R.3.5.2.4 What physical evidence or project performance metrics support that there is or could be a significant failure mode and what is the confidence in its existence?

R.3.5.2.5 What are the estimated probabilities of failure and consequences for each significant failure mode and the degree of confidence in these estimates?

R.3.5.2.6 Can the confidence in the risk estimates be increased and if so, how?

R.3.5.2.7 Which essential USACE guidelines are not met?

R.3.5.2.8 Which tolerable risk guidelines are not met for baseline conditions, and what is the confidence in these assessments?

R.3.5.2.9 What is the risk estimates for with and without intervention scenarios? What are the interventions considered?

R.3.5.3 Formulation of alternative risk management plans

R.3.5.3.1 What risk reduction measures were considered in formulating the alternative plans?

R.3.5.3.2 How were the measures grouped to form the initial set of alternative plans?

R.3.5.3.3 What specifically are the alternative plans proposed for evaluation?

R.3.5.3.4 Does the set of alternatives formulated address all credible and significant dam safety issues?

R.3.5.3.5 How have staging of construction phases for remediation action been considered in the alternative plans?

R.3.5.3.6 Are there stakeholders or other interested parties promoting or objecting to one or more of the alternatives and why?

R.3.5.4 Evaluation of alternative risk management plans

R.3.5.4.1 What is the risk (hazard, probability of failure, and consequences) estimate for each failure mode for each alternative?

R.3.5.4.2 Which essential USACE guidelines remain unmet, if any, for each alternative risk reduction plan?

R.3.5.4.3 What are the costs, any changes in benefits, and tolerable risk evaluations, including benefit/cost, ALARP and disproportionality considerations, for each alternative plan and the degree of confidence in these?

R.3.5.4.4 How is the implementation of each alternative expected to affect the Interim Risk Reduction Measures that currently exist?

R.3.5.4.5 Are there any opportunities for increased project benefits (integrating remediation with enhancing other purposes) for each alternative plan and what are the incremental costs? Is additional congressional authorization required for these plans that increase benefits?

R.3.5.4.6 What would be the effect of staging implementation of selected components of the alternatives?

R.3.5.5 Comparison of alternative risk management plans

R.3.5.5.1 How much does each alternative plan reduce risk in comparison with the baseline risk, and what is the cost of the alternative?

R.3.5.5.2 How does each alterative plan compare in terms of meeting essential USACE guidelines?

R.3.5.5.3 What are the changes in relation to the tolerable risk evaluations, including ALARP (to include disproportionality) for each alternative plan?

R.3.5.5.4 What are the potential negative aspects of each alternative plan, such as reduction in benefits, increased cost to users, impact on the environment, and can they be mitigated?

R.3.5.6 Selection of the recommended risk management plan

R.3.5.6.1 What is the recommended risk management plan?

R.3.5.6.2 Are all dam safety issues (credible and significant failure modes) addressed by the recommended plan and if not, which are not addressed and what is the rationale?

R.3.5.6.3 Does the recommended risk management plan achieve the desired objectives including tolerable risk guidelines, ALARP, cost effectiveness, and essential USACE guidelines.

R.3.5.6.4 What is the expected DSAC class after implementation of the recommended risk management plan?

R.3.5.6.5 What would be the effect of delaying implementation of the recommended plan?

R.3.5.6.6 What are the consequences of not implementing, or delaying implementation of the recommended risk management plan?

R.3.5.6.7 Is there consensus on the recommended plan by principal stakeholders and other interested parties and who are they?

R.3.5.6.8 Are there opposing views and what are they and how were differences addressed?

R.3.5.7 Cost Sharing

R.3.5.7.1 What are the cost sharing requirements?

R.3.5.7.2 If there are no cost sharing requirements, what would the cost sharing requirements be under modern day legislation and policies?

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APPENDIX S

Dam Safety Modification Report Issue Checklist

S.1 Sensitive Policy Areas. Areas which require vertical team coordination with MSC/HQUSACE to Washington: ______________________________

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S.2 General Project Information.

S.2.1 Project Name. (State, County, River Basin/Waterbody under Study)

S.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.)

S.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)

S.3 General Questions.

S.3.1 Has a NEPA document been completed?

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.

S.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:

S.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:

S.3.4 Is ESA coordination complete?

Response: YES ______ NO _____*

Remarks:

S.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:

S.3.6 Is the proposed project consistent with the ROD/FONSI?

Response: YES ______ NO _____*

Remarks:

S.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 status for the project area…going from attainment to non-attainment]

Response: YES _____* NO ______

Remarks:

S.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.]

S.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:

S.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:

S.3.11 Does the project involve HTRW clean-up?

Response: YES _____* NO ______

Remarks:

S.3.12 Does the work involve CERCLA covered materials?

Response: YES _____* NO ______

Remarks:

S.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:

S.3.14 Are there any proposed scope changes to the authorized project? [Reference: ER 1105-2-100 (reference A.42)]

Response: YES _____* NO ______

Remarks: [Describe the authority that would enable the project to proceed without additional Congressional modification]

S.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:

S.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:

S.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.65)]. 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:

S.3.18 Is an 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:

S.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:

S.3.20 Was a standard accepted USACE methodology/model used to calculate NED benefits?

Response: YES ______ NO _____*

Remarks:

S.3.21 Are there non-standard benefit categories? [Reference ER 1105-2-100 (reference A.42)].

Response: YES ______ NO _____*

Remarks:

S.3.22 Is there a flood damage reduction component in the project?

Response: YES ______ NO ______
(If Yes, answer following question)

S.3.23 Are reallocation studies likely to change the existing allocated storage in lake projects?

Response: YES _____* NO ______

Remarks:

S.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 T

Post-Authorization Decision Document Checklist

T.1 Basic Information.

T.1.1 Name of Authorized Project: ____

T.1.2 Name of Separable Element: ____

T.1.3 PWI Number: ____

T.1.4 Authorizing Document: ____

T.1.5 Law/Section/Date of Project Authorization: ____________________________
(Note: attach copy to checklist)

T.1.6 Laws/Sections/Dates of Any Post-Authorization Modification: _____________

T.1.7 Non-Federal Sponsor(s): ____

T.1.8 Project/Separable Element Purpose(s): _______________________________

T.1.9 Congressional Interests (Senator(s), Representative(s) and District(s)): _____

____

T.2 Project Documents.

T.2.1 Type of Decision Document: ____

T.2.2 Approval Authority of Decision Document: ______________________________

T.2.3 Project Management Plan Approval Date: ______________________________

T.2.4 Agency Technical Review (ATR) Approval Date: _________________________

T.2.5 Independent External Peer Review (IEPR) Completion Date: ______________

T.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)

T.2.7 Current M-CACES Estimate: $ ____

Date Prepared and Price Level: ____

T.2.8 Date of Latest Economic Analysis: ______________

T.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						

T.3.1 Projected Credit for Section 215 Work and Date Section 215 Agreement

Signed: ____

T.3.2 Projected Credit for Section 104 or Other Authorized Creditable Work and Date Work Approved by ASA(CW) or Agreement Addressing Work Signed: __________

____

T.3.3 Annual Non-Fed OMRR&R Costs (1 Oct FY_____ Price Levels): ___________

T.4 Funding History. Appropriations History for Project/Separable Element (include Wedge Funding)

Fiscal Year	Budget Amount	Appropriated Amount
____________	__________________	__________________
____________	__________________	__________________
____________	__________________	__________________
____________	__________________	__________________

T.5 Certification For Delegated Decision Documents. You must answer “Yes” to all of the following questions to approve the decision document under delegated authority.

T.5.1 Project Plan.

T.5.1.1 Has the project study issue checklist been completed and all issues resolved?

___Yes ___No

T.5.1.2 Does the non-Federal sponsor concur in the project plan as submitted?

___Yes ___No

T.5.1.3 Has project plan as submitted been reviewed and concurred with by the non-Federal sponsor’s counsel?

___ Yes ___ No

T.5.2 Authority –

T.5.2.1 Has the Dam Safety Officer at each level approved the project report?

___Yes ___No

T.5.2.2 Is authority adequate to complete the project as proposed?

___ Yes ___ No

T.5.3 Policy/Legal/Technical Compliance

T.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

T.5.3.2 Have all aspects of ATR and IEPR have been completed with no unresolved issues remaining?

_____Yes _____No

T.5.3.3 Has the District Dam Safety Officer documented policy/legal/technical compliance of the decision document?

_____Yes _____No

T.5.3.4 Has the MSC Dam Safety Officer certified the policy/legal/technical compliance of the decision document?

_____Yes _____No

T.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 U

Dam Safety Communication

U.1 Sample Frequently Asked Questions and Answers.

U.1.1 Question. Am I safe?

Answer. While we cannot completely eliminate risk, we can reduce risk. Our safety 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 industry dam safety 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 repairs. 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 actions for suspected high risk conditions, until we have adequate information to confirm risks are acceptable.

U.1.2 Question. What is risk?

Answer. Risk is the 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.

U.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.

U.1.4 Question. Why do the DSAC categories emphasize the "unsafe" term? What does unsafe mean?

Answer. DSAC classifications are based upon confirmed and unconfirmed dam safety issues, the probability of failure and life or economic consequences. USACE will only designate a dam normal or safe when there are no unconfirmed dam safety issues.

U.1.5 Question. Is this (are these) dam(s) at risk of failing?

Answer. (For DSAC I projects) Our screening and classification of _____________Dam identified this project as urgent and compelling. A dam with this classification is critically near failure or extremely high risk under normal operations. Critically near failure means we have confirmed failure is taking place and it is almost certain to fail under normal operations any time within a few years without intervention. Extremely high risk means that the dam poses a combination of life or economic consequences with a high probability of failure. Modification studies for DSAC I dams are funded immediately. We are taking the following interim risk reduction measures __________.

Answer. (For DSAC II projects) Our screening and classification of _____________Dam identified this project as urgent. A dam with this classification is considered to have failure initiation foreseen or very high risk. Foreseen failure initiation means the dam has confirmed and/or unconfirmed safety issues and failure could begin during normal operations or from a hydrologic or seismic event. Very high risk means that the dam poses a combination of life or economic consequences with a high probability of failure. We are taking the following interim risk reduction measures __________.

Answer. (For DSAC III projects) Our screening and classification of _______________Dam identified this project as a high priority. A dam with this classification is considered significantly inadequate or moderate to high risk. Significantly inadequate means the dam has confirmed and/or unconfirmed safety issues. Moderate to high risk means that the dam poses a combination of life or economic consequences with moderate to high probability of failure. 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.

U.1.6 Question. May we have copies of your risk analysis 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 Corps has posted information on District websites that can be accessed by the public.

U.1.7 Question. If there are Classification I dams, are there other classifications? What are they and how are they defined?

Answer. The five Dam Safety Action Classes are:

DSAC I – URGENT AND COMPELLING (Unsafe)

DSAC II – URGENT (Unsafe or Potentially Unsafe)

DSAC III – HIGH PRIORITY (Conditionally Unsafe)

DSAC IV – PRIORITY (Marginally Safe)

DSAC V – NORMAL (Safe)

U.1.8 Question. What are interim risk reduction measures?

Answer. Interim risk reduction measures are a short-term approach 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.

U.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 American Recovery and Reinvestment Act and emergency authorities.

U.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 I and II dams has been prioritized Corps wide, to allow us to advance work on the highest risk dams first. Studies are required to identify permanent repair options. The Corps of Engineers has updated our criteria on how to conduct dam safety evaluations. Projects that pose significant public safety risks are our top priority.

Routine Operations and Maintenance funds will be used for DSAC III projects, unless new information changes the risk classification.

The Corps has also set up a new organization, called our Risk Management Center, and has assigned our best engineering experts to work on dam and levee projects.

U.1.11 Question. Is there funding available to make permanent construction repairs?

Answer. Funding for DSAC I and II projects already in construction receive high budgeting DSAC ratings are being used to set national construction repair priorities. Projects classified as DSAC III and IV will not receive funding until the higher risk DSAC I and II projects are addressed. Districts may elect to make partial repairs for DSAC III and IV projects with O&M funds.

USACE will continue to request funding for DSAC I and II projects, and transition to fund future studies and repairs for DSAC III projects as the repairs on the DSAC I and II dams are completed.

U.1.12 Question. Why is my dam now at high risk, when it has been here for many years?

Answer. In 2005 we began evaluating the risks at Corps operated dams. This was in response to recommendations a Peer Review of the USACE Dam Safety program conducted in 2001 by the Association of State Dam Safety Officials (ASDSO). 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. USACE began an approach to consistently take appropriate actions to address our dam safety issues.

Following the first three years of risk-informed screening in 2005, 2006 and 2007, USACE categorized dams into Dam Safety Action Classes (DSAC) based on their individual dam safety risk considered as probability of failure and potential failure consequences.

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.

U.1.13 Question. How long has the USACE known these dams were unsafe?

Answer. The dams validated as 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 decisions.

U.1.14 Question. What will we do with the findings?

Answer. USACE will use DSAC information to set dam safety remediation priorities in its annual budget requests and to implement IRRM. The overall objective is to reduce the risks to public safety.

U.1.15 Question. How did USACE 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 established the DSAC for each dam.

U.1.16 Question. What criteria did USACE use?

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.

U.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 indicates settlement of the dam is occurring on a small scale. Instrumentation which monitors the water pressure in and beneath the embankment also indicates 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 that have shown up on the downstream face of a dam are indications that the condition at this dam is worsening over time.

U.1.18 Question. If the dam fails, how do I find out if my home and business will be impacted?

Answer. The Corps 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 maps are not routinely posted for public use, because this information may expose a vulnerability that could be an operational security concern.

Information on high risk (DSAC I and II dams) will be shared with communities via public meetings. Property owners are encouraged to attend these meetings, to assess how their homes and businesses could be impacted.

Additionally, the local District office can provide site specific flood elevation information when contacted by individual home and business owners. In cases where public safety issues outweigh Security concerns, the local District may request a waiver from the Corps of Engineers HQ, and provide the maps to landowners.

U.1.19 Question. How do I prepare to make sure my family is safe?

Answer. Safety is a shared responsibility. The Corps has the responsibility to coordinate with local officials and communicate with the public on the condition of Corps operated dams. Private individuals are encouraged to become educated and aware of local conditions. Personal planning is encouraged, such as purchasing weather alert radios, keeping emergency supplies on hand, and determining personal evacuation routes.

U.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, immediate action is necessary.

U.1.21 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 which is developed in accordance with FEMA Publication 333, Hazard Potential Classification System for Dams. This system ranks a dam as Low, Significant, or High Hazard Potential based on the damages 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) which 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 2005-2007, USACE conducted an initial risk-informed screening of approximately 202 dams and the remaining dams operated by USACE will be screened in the next two years.

U.1.22 Question. Are External Peer Reviews Required?

Answer. HQUSACE is sponsoring External Peer Reviews by nationally known dam safety experts. These reviews are being conducted for the DSAC I Flood Damage Reduction dams. 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.

U.1.23 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 analysis.

U.1.24 Question. Why does it take the Corps so long to fix a dam?

Answer. That is a good question. Given the multiple purposes of our dams and the long term benefits they provide we require through analysis 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 dams. In some cases a dam may have multiple deficiencies that require correction which increases the time required to start the fixes.

We also take great effort to comply with the National Environmental Protection Act and the Endangered Species Act 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 V

Periodic Inspection Program – Inspection and Evaluation Procedures

V.1 Periodic Inspection Program.

V.1.1 Initial Pre-Inspection Brochure. A technical brochure shall be prepared in advance of the first project inspection to familiarize inspection team members with general project features. This brochure shall 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 shall also include appropriate pertinent project data, project layout and typical section drawings, Federal and non-Federal responsibilities for OMRR&R, summaries of sub-surface soil profiles and boring logs, brief construction history and construction description, and the checklist developed for conducting the inspection. Pre-inspection brochures shall be completed and distributed to inspection team members at least 30 days prior to the inspection date.

V.1.2 Pre-Inspection Packets. A technical pre-inspection packet shall be prepared in advance of all subsequent project inspections to familiarize inspection team members with general project features and history. Pre-inspection packets shall 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 shall include:

V.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.

V.1.2.2 A written evaluation and plots of all instrumentation data, including settlement monuments shall be prepared along with the location of the instruments.

V.1.2.3 Project data, layout and typical section drawings, Federal and non-Federal responsibilities for OMRR&R, sub-surface 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.

V.1.2.4 Findings of annual inspections since the last periodic inspection and the status of recommended action items shall be reviewed and included in the packet.

V.1.2.5 A section discussing the need for updating the project design parameters (hydraulic, seismic, HSS, etc.) shall be prepared, if applicable.

V.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.

V.1.2.7 A summary of the project's bridge inspections that may impact project safety or access during emergency conditions shall be included.

V.1.2.8 Status of seismic re-evaluations, per ER 1110-2-1806 (reference A.56) shall be included in the packet.

V.1.2.9 Status of Hydrologic re-evaluations shall be included in the packet.

V.1.3 Inspection Procedures. A systematic inspection plan, based on the most recent risk informed methodology assessment from a Portfolio Risk Assessment (SPRA/PRA), 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. 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 shall be tested under load on more frequent intervals to maintain their integrity. In addition, standby emergency generating systems shall 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 shall 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 shall be conducted during the scheduled inspection. The inspection of the remaining features may be conducted any time prior to completion of the inspection 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., shall 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.

V.1.4. Inspection Plan. The risk-informed systematic inspection plan shall assure adequate coverage of the project 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 95% complete draft of the PI report. The plan and

Site Specific Checklist shall complement each other. The plan shall provide, as appropriate, the examination and the operation of, but not be limited to, the following features and conditions:

V.1.4.1 Hydraulic Steel Structures (HSS), as defined and required in ER 1110-2-8157 (reference A.52), 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.

V.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.

V.1.4.2.1 Structural features.

V.1.4.2.2 Concrete surfaces.

V.1.4.2.3 Structural cracking and deterioration of material.

V.1.4.2.4 Joints and joint materials, including relative movement at joints between structures or portions of structures.

V.1.4.3 Water passages.

V.1.4.4 Embankments including foundation drains, joint drains, face drains.

V.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.

V.1.4.4.2 Unusual movement or cracking at or beyond the embankment or slope toe.

V.1.4.4.3 Seepage through or under embankment or abutment slopes.

V.1.4.4.4 Sloughing, sinkholes, or erosion of embankment or abutment slopes.

V.1.4.4.5 Condition of riprap, armor or other slope protection.

V.1.4.4.6 Scour protection stone and below water surface erosion control features.

V.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.14) and ER 1110-2-1942 (reference A.50)).

V.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.

V.1.4.4.9 Seepage, depressions, sinkholes, and soft, marshy areas downstream of the dam.

V.1.4.4.10 Tailrace area, for muddy flows.

V.1.4.5 Spillways, spillway buckets and stilling basins and outlet channels including submerged features as necessary.

V.1.4.6 Conditions of instrumentation, and most recent measurements prior to the inspection

V.1.4.7 Reservoir rim conditions. (This can be limited to areas impacting the operation or stability of the dam).

V.1.5 Checklist. A detailed site specific checklist of elements relative to the structural stability and operational adequacy of the project shall be developed for each structural component of the project in order to ensure adequate examination coverage for each feature. The facility's instrumentation shall 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.

V.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.

V.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 shall be stated in the periodic inspection report. Guidance on repair of concrete is given in EM 1110-2-2002 (Reference A.15).

V.1.8 Structures. Steel structures shall be visually inspected for structural and operational adequacy. The inspection shall be sufficient to identify major defects such as visible cracks. Those structures involved directly in the safety of the project shall receive special consideration. Fracture critical members, where failure would result in probable loss of life, shall initially be inspected by additional means, such as ultrasonic or other nondestructive testing. HSS inspection reports shall be prepared in accordance with ER 1110-2-8157 (reference A.52) and shall be included in the Periodic Inspection Report. Reference EM 1110-2-6054 (reference A.32) for additional information on these structures.

V.1.9 Riprap. 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 shall be stated. Material sources that have unsatisfactory performance records shall be identified, reported, and eliminated from further use.

V.2 Composition and Qualifications of the Inspection and District Quality Control Review Teams.

V.2.1 Inspection team and District Quality Control Review team personnel shall 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. Team leaders shall be registered professional engineers or geologists with dam safety experience. A representative(s) of the sponsor and the state dam safety agency shall be invited to be part of this team. Also, if the dam includes hydropower, representatives of the Federal Energy Regulatory Commission (FERC) shall 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. All team members shall 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 shall be trained for confined space entry. The Dam Safety Officer of each district is responsible for scheduling this training.

V.2.2 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.

V.3 Executive Summary and Content. The district shall submit an electronic Executive Summary of each Periodic Inspection Report to HQ-DamSafety@usace.army.mil within 90 days of the completion of the formal inspection. The Executive Summary shall also be entered into the Dam Safety Program Management Tools (DSPMT) database at the district level. The electronic executive summary should be limited in length to two to four pages and shall contain the following information.

V.3.1 Brief description of the project that was inspected.

V.3.2 Statement concerning the current inspection and major findings.

V.3.3 Statement regarding the project's safety status for continued operation.

V.3.4 General periodic inspection schedule including the dates of the previous, current, and next scheduled inspections of the project.

V.3.5 Statement concerning any major uncorrected deficiencies from the previous inspection.

V.3.6 List of major deficiencies found during the inspection and recommendations to correct the deficiencies.

V.3.7 Summary of conclusions from the periodic inspection report.

V.4 Inspection Report Content. The periodic inspection report shall present the results of each project inspection. The title of this report shall indicate the name of the project, watercourse, NID identifier, project features, and inspection number and date, in that order. An example of an appropriate title is "Beech Fork Lake Project; Twelvepole Creek, WV09903; Dam, Outlet Works and Spillway; Periodic Inspection Report No. 1, September 1992". Report No. 1 (report of initial inspection) shall provide a general project description and present the results of the initial inspection. Reports of subsequent inspections shall be supplementary to the initial report and will be numbered sequentially with the initial report; i.e., Report No. 2 would describe inspection number 2, etc.

V.4.1 Initial Periodic Inspection Report. To the extent possible, major elements of this report are:

V.4.1.1 An executive summary of the major items found in the inspection, including a statement regarding the project's ability to continue acceptable and safe operation.

V.4.1.2 A general project description including statement on hazard potential classification, layouts and typical section for the purpose of familiarization with general features of the project, and Federal and non-Federal responsibilities for OMRR&R.

V.4.1.3 List of project documents and engineering data that identifies the status and location of the project documents.

V.4.1.4 Discussion of dam safety training, emergency action plan and updates, and exercises.

V.4.1.5 Results of examination for each feature, including a statement as to its ability to function as designed.

V.4.1.6 Evaluation and summaries of the observations and inspection of instrumentation (Chapter 14 of this regulation) and relief wells with comparison to design predictions and actual conditions that signal changes in the structure's performance.

V.4.1.7 Where appropriate, statements, or exhibits summarizing the duration and frequency of spillway and control gate operations, including heads or velocities, and number of lock filling and emptying operations.

V.4.1.8 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. If such assessment cannot be accomplished within the time allotted to complete the inspection report, a preliminary assessment shall be discussed with a plan scheduled to complete the assessment.

V.4.1.9 High resolution digital color photographs with an appropriate caption, including the date taken.

V.4.1.10 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.

V.4.1.11 A discussion of the overall structural and individual project components stability, safety, and operational adequacy compared to its intended purpose(s) for the conditions with and without the recommended remedial measures. The DSMPT priority code 1 thru 6 assigned to each recommendation should be updated in the deficiency spreadsheet module screen 4.5 of the Dam Safety Program Management Tool software so the assigned priority can be tracked over time.

V.4.1.12 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 V.1.

V.4.1.12.1 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.

Table V.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: Priority 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.

V.4.1.12.2 See the current Budget EC for full definitions of all WORK CATEGORY CODES and specific requirements for Dam Safety Program activities.

V.4.1.13 Views of the non-Federal sponsor on any of the above shall be included (if applicable).

V.4.1.14 Exhibits (or Appendices) shall include, as appropriate trip reports; plots of instrumentation data; completed inspection checklist; summaries of crack surveys; correspondence that documents the performance of the project; the results of special investigations; a summary table/spreadsheet for documenting deficiencies, repair/evaluation recommendations, estimated costs, schedules, responsible office, and current status; district Quality Control Review Comments and Resolutions; and the status and location of the project documents required by this document and ER 1130-2-530 (reference A.55). For the initial inspection report, the Pre-Inspection Brochure shall also be an Exhibit (or Appendix).

V.4.1.15 A discussion of the need for updating the project design parameters (hydraulic, seismic, HSS, etc.), if applicable.

V.4.1.16 Copies of selected drawings and boring logs.

V.4.2 Subsequent Reports. Subsequent reports shall generally include the items stated in paragraph V.4.1 above and shall follow the requirements of paragraph V.5 below, however they shall also include:

V.4.2.1 Brief summary of intermediate inspections and past performance and problems, and concentrate on the new and continuing conditions that affect or may affect the overall safety and operational capability of the structure. This summary shall 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.

V.4.2.2 A discussion on maintenance and remedial activities to include materials used, application techniques, and performance.

V.4.2.3 A discussion on recommended remedial measures not completed since the previous inspection report, as well as a proposed schedule to accomplish the remedial measures.

V.4.2.4 Copies of selected drawings; however, extensive reproduction of previously published drawings shall be avoided. As a minimum, a location and vicinity map which also shows project access shall be included, as well as a general plan that shows each feature discussed in the report. The names and stationing shall be consistent on the drawings, narrative, and photograph captions.

V.4.2.5 A summary of the project's bridge inspections that may impact project safety or access during emergency conditions shall be included. ER 1110-2-111 (reference A.40) provides guidance on bridge inspections.

V.5 Inspection Report Format. The following paragraphs describe the requirements for hard-copy reports. Reports may be submitted electronically, as approved by the respective MSC, and shall be prepared in the same format as stated herein; however, at least two hard copies shall be retained at the district and at least two hard copies submitted to the MSC.

V.5.1 Organization. Reports shall generally be organized as follows:

V.5.1.1 Table of Contents

V.5.1.2 Executive Summary in accordance with Paragraph V.3, along with a Certification of district Quality Control Review.

V.5.1.3 General Statement of Inspection Program.

V.5.1.4 Description of the Project.

V.5.1.5 Brief Project Summary and History.

V.5.1.5.1 Construction history and construction description.

V.5.1.5.2 Project characteristics.

V.5.1.5.3 Description of past major remedial measures.

V.5.1.5.4 Deficiencies corrected since last inspection.

V.5.1.5.5 Past deficiencies not yet corrected, and explanation for not correcting.

V.5.1.5.6 Non-Federal sponsor OMRR&R responsibilities (if applicable).

V.5.1.5.7 Emergency Preparedness—Status of Dam Safety training (ER 1130-2-530 (reference A.55)) and status of Emergency Action Plans and their updates.

V.5.1.6 Inspection Results.

V.5.1.7 Recommendations, including date of next inspection.

V.5.1.8 Exhibits (or Appendices)

V.5.1.8.1 Figures (including Construction Plates, and other drawings that describe the project).

V.5.1.8.2 History of Remedial Measures.

V.5.1.8.3 Photographs (from current and previous inspections).

V.5.1.8.4 Inspection Checklist.

V.5.1.8.5 Summary of Inspection Notes.

V.5.1.8.6 Summary of Intermediate Inspection Reports

V.5.1.8.7 Instrumentation Data and/or Plots. Data shall contain all figures since the last inspection and have sufficient background data to support the report discussion, conclusions and recommendations. Reproduce the plan of instrument locations in each report. Where appropriate, cross-sections showing piezometric data shall show design uplift assumptions along with the current pressure line. Plots of piezometric elevation versus pool elevation and plots of relief well or drain flow versus pool elevation shall be included. In each case, upper limit correlation lines should be drawn (to help eliminate time lag effects) and when possible, extrapolations should be made to maximum possible pool elevations. 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.

V.5.1.8.8 Summary of Crack Surveys.

V.5.1.8.9 Project Documentation.

V.5.1.8.10 District Quality Control Review Comments and Resolutions.

V.5.2 Text. All sections and paragraphs shall be numbered and shall be on 8 1/2 by 11-inch paper with sufficient margin on the left side for binding. Reproduction shall be any available process with printing done head-to-head, if possible.

V.5.3 Drawings. Drawings or plates shall normally be 8 1/2 by 11-inch with sufficient margin on the left for binding. Foldouts normally shall not exceed 11 inches by 17 inches. Drawings and photos may be included in the text or placed entirely in the Exhibit (or Appendix.) However, any figure or drawing in the text shall support the written material. All drawings and figures will be dated for ease of reference.

V.5.4 Binding and Cover. Reports shall have flexible paper or card stock, hidden hinge covers 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, and the date of inspection, and date of the report.

V.6 Project Documentation. All engineering data relating to project structures inspected shall be collected and permanently retained in appropriate files at the project site for availability to the inspection team and readily accessible for emergency response. Periodic Inspection Reports shall indicate which items are not available, and describe attempts to locate such records or documents. Project engineering data shall also be retained at the district office. In the absence of storage space at the district office, the data shall be retained at the nearest field office. These documents and drawings shall be considered as permanent engineering data, subject to retirement or disposal only upon termination of operation of the project. These data shall consist of, but not be limited to, the items listed below.

V.6.1 All previous Periodic Inspection and Periodic Assessment Reports.

V.6.2 Records of inspections by project personnel and interim/special event inspections by district personnel.

V.6.3 Design Memoranda, Design Documentation Reports, 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, and contract plans and specifications.

V.6.4 As built plans, elevation, and sections.

V.6.5 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.

V.6.6 Foundation data and geological features, including boring profiles, foundation mapping, foundation reports, and final logs of subsurface exploration.

V.6.7 Location of borrow areas and identification of embankment, filter, riprap, large stone sources.

V.6.8 Laboratory Reports including:

V.6.8.1 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 shall be included.

V.6.8.2 Physical, chemical, and thermal properties of concrete and concrete-making materials.

V.6.8.3 Summary of concrete mixture proportions and control procedures.

V.6.9 Project Geotechnical and Concrete Materials Completion Report.

V.6.10 Construction history records, construction photographs, construction videos, construction anomalies (piping, settlement, etc.) including diversion schemes and construction sequences shown on appropriate drawings.

V.6.11. Details of the overall instrumentation program to include predicted performance and record of actual observations, and annual updated evaluations.

V.6.12 Operations and Maintenance Manual.

V.6.13 Water Control Manual.

V.6.14 Copy of PCA.

V.6.15 Dam Safety Information:

V.6.15.1 Project copy of "Federal Guidelines for Dam Safety" (reference A.71).

V.6.15.2 Emergency Action Plan.

V.6.15.3 Records of dam safety training for project personnel.

V.6.15.4 Surveillance plan of the project that includes any special/significant events and threshold reservoir levels that initiate observations and/or inspections and reporting procedures.

V.6.15.5 List of local contractors and construction materials available for use in emergency situations.

V.6.15.6 Site-specific security and rapid recovery plans.

V.6.16 Manufacturers' data for purchased items.

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APPENDIX W

Periodic Assessments

W.1 Periodic Assessment Purpose.

W.1.1 USACE risk management process resulted in assignment of a DSAC for each project. In many cases, the data used for initial classification may have been preliminary or incomplete or information used in the Screening Portfolio Risk Analysis (SPRA) process. The Periodic Assessment (PA) applies a higher level of rigor to further identify and refine project risks.

W.1.2 The PA is a Periodic Inspection (PI) with a facilitated Potential Failure Mode Analysis (PFMA), updated project consequences and evaluation of significant project risk drivers by a risk cadre working in tandem with district personnel. The normal field inspection activities for both the PI and PA will be maintained every five years. The PFMA and risk assessment will be completed prior to the traditional field inspection. The PA will be performed once every ten years.

W.1.3 The primary purposes of the PA are to:

W.1.3.1 Verify\re-evaluate the DSAC classification of a project;

W.1.3.2 Justify and revise interim risk reduction measures if needed;

W.1.3.3 Evaluate\revise the project risk assessment;

W.1.3.4 Identify operations and maintenance, monitoring, emergency action plan, training and other recurrent needs;

W.1.3.5 Confirm essential USACE dam safety guidelines are met and determine if the current risk is tolerable; and

W.1.3.6 Identify and prioritize any issue evaluation study needs.

W.1.4 Specific steps included in the PA that differ from a PI are:

W.1.4.1 Compilation of existing historic documents from design, analysis, and construction photos and records for the PFMA session.

W.1.4.2 Compilation and evaluation of project performance, instrumentation readings, and any recent remediation or improvements for the PFMA session.

W.1.4.3 Cursory site visit by the PFMA team. (Risk cadre and select district personnel)

W.1.4.4 District participation of a facilitated PFMA. (Documented by the risk cadre)

W.1.4.5 Update of project consequences by a regional cadre production pool.

W.1.4.6 District integration of a risk assessment report prepared by the risk cadre.

W.1.5 Completed PA reports will also serve as a “blue print” for districts 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.

W.2 Periodic Assessment Report. The Periodic Assessment report ties existing information, field inspections, and the risk assessment together and provides engineering recommendations to decision makers. The report format is closely aligned to the Issue Evaluation Study (IES) and will have fifteen chapters and associated appendices as follows:

W.2.1 Executive Summary

W.2.2 Summary of All Dam Safety Recommendations (old\new compiled together)[1]

W.2.3 Introduction and Description of Dam and Operations

W.2.4 Current DSAC Assessment[1]

W.2.5 Evaluation of Foundation Materials and Construction Methods

W.2.6 Observed Project Past Performance Evaluation

W.2.7 Engineer’s Inspection Report (PI field inspection)

W.2.8 H&H Analysis - Hydrologic Loading and Duration[2]

W.2.9 Seismic Loadings[2]

W.2.10 Consequences of Failure[2]

W.2.11 Potential Failure Mode Analysis[2]

W.2.12 Risk Assessment[2]

W.2.13 Future Performance Monitoring\Risk Management Practice[1]

Notes: [1] = New district report sections from traditional PI.
[2] = Prepared by regional risk cadre.

W.2.14 Compliance with USACE Engineering Criteria[1]

W.2.15 Conclusions and Recommendations[1]

W.2.16 Report Appendices:

W.2.16.1 O&M History of Remedial Measures

W.2.16.2 Instrumentation Review

W.2.16.3 EIR Photos

W.2.16.4 EIR Field Notes

W.2.16.5 Intermediate Inspections (AI, Bulkheads, Conduit, Bridge Inspections)

W.2.16.6 Conduit Inspection

W.2.16.7 Supporting H&H Data[2]

W.2.16.8 Supporting Consequence Data[2]

W.2.16.9 Potential Failure Modes Analysis Report[2]

W.2.16.10 Support Risk Assessment Data[2]

W.2.16.11 Quality Control (ATR) Documentation

Notes: [1] = New district report sections from traditional PI.
[2] = Prepared by regional risk cadre.

W.3 Overall Workflow for PA. Proper scheduling and sequencing of the PA activities will be critical due to the need to engage the regional cadre, the engineering staff, the site operations staff, and MSC personnel. The general PA procedure is summarized in the following subsections.

W.3.1 The Risk Management Center will identify dams for Periodic Assessment and assign a PFMA Facilitator.

W.3.2 The district team shall compile all available design documentation reports including As-Built Drawings, construction records and photographs, foundation completion reports, Design Memoranda, Seismic Studies, Special Investigations, Periodic Inspection Reports, Water Control Manual, EAP, etc. for the PFMA and risk assessment. This activity should ideally be completed in the 1st and 2nd quarter of the fiscal year.

W.3.3 The Facilitator and Regional Cadre will be required to review the project design, construction, and performance records, prior to PFMA session.

W.3.4 A site visit shall be completed prior to the Potential Failure Modes Analysis session. All team members shall attend the cursory site visit and PFMA session.

W.3.5 The assigned regional cadre team will take the results from the PFMA and develop Event Trees for each plausible failure mode of concern using DAMRAE. System response curves will be estimated using available information and toolboxes and entered into the risk engine as well.

W.3.6 The district Team will perform the traditional field inspection and finalize a draft PA report.

W.3.7 An ATR will be performed by an independent regional cadre.

W.3.8 The Risk Management Center will review the final PA risk assessment and finalize any changes required to the DSAC ratings and prioritize funding of studies for the budget.

W.4 PA District Versus Risk Cadre Responsibilities. The initial PA will involve a greater level of effort due to the data gathering and documentation requirements. Once completed, this information will be available for future risk assessments as will additional data and performance history data collected following the initial PA. In addition, the PFMA and risk assessment within the PA will serve as a living document for ongoing district judgments required to manage normal O&M tasks within the program such as instrumentation replacement priorities, adjustments to surveillance and monitoring programs, etc.

W.4.1 For the PA, additional effort will be required by the district. These tasks will include:

W.4.1.1 The district will select a team leader (coordinator) to collect and organize a variety of documents and other information to support the PFMA, risk assessment, and compliance to USACE engineering criteria verification. The district will organize and summarize this information in preparation for the PFMA.

W.4.1.2 Appropriate in-house experts from engineering and operations including field personnel will participate in the PFMA process, which will include a cursory site visit and follow-on PFMA session.

W.4.1.3 Engineering and operations will collaborate in follow-up data for system loading events and system response for the risk assessment.

W.4.1.4 District personnel shall prepare the PA report including incorporating chapters supplied by the regional cadre.

W.4.2 The risk cadre will perform the following activities for the PA.

W.4.2.1 The regional cadre facilitator will verify proper district and regional cadre participants are assigned to the PA team.

W.4.2.2 Prepare updated consequences.

W.4.2.3 Conduct site visit and PFMA session and fully document findings.

W.4.2.4 Complete risk analysis system response curves using the latest methodologies.

W.4.2.5 Risk facilitator will assemble risk assessment portion of report and submit to district POC.

W.4.2.6 Risk cadre will help educate district personnel with the PFMA and risk assessment process. The district is encouraged to use this process to educate their technical staff on how to complete the PFMA and risk assessment portions of the PA.

W.4.2.7 Communicate the draft results from the baseline risk estimation process with district personnel.

W.4.3 The following subsections provide more detail on the risk cadre activities outlined above.

W.5 Updated Consequences.

W.5.1 For the PA, the regional cadre H&H engineer will work with regional consequence production pool members and district personnel to generate models and data needed to complete updated consequences.

W.5.2 The rapid consequence estimate requires a very limited detail unsteady model to reproduce various with and without dam failure scenarios including sunny day, PMF and several interim load cases in between all for with and without dam failure condition. Using GIS tools, the unsteady model results will be used to generate flood inundation mapping downstream as well as travel time and other values. This data will be used to interface with appropriate downstream data such as HAZUS to calculate population at risk, economic damages, potential for loss of life, and other consequence data. In addition, loss of function from a dam breach will need to be estimated such as hydropower, recreation, flood control, etc.

W.5.3 All of this data will be aggregated to allow consequences to be estimated for the risk assessment.

W.6 Potential Failure Modes Analysis (PFMA) Session. A PFMA chapter will be prepared by the regional cadre. The report records the thought process behind the derivation and justification of significant PFMs to be carried forward or excluded from the PA. More detailed information on the overall Potential Failure Modes Analysis process in Appendix X.

W.7 PA Risk Assessment. This risk assessment effort include identifying significant PFMs and critical O&M features from the PFMA session and develop system response curves for each PFM using the latest risk methodologies (toolboxes). Once these tasks are complete, the facilitator will generate the risk engine using DAMRAE to develop component and total project risk and compare of the overall and component risks with tolerable risk guidelines. Preparation of the related risk assessment chapters will incorporate the risk assessment findings.

W.8 Quality Control. The draft PA report will be prepared by the district and submitted to the facilitator for an ATR review. The ATR of the draft PA will be completed by another regional cadre not involved in the risk assessment process.

W.9 Periodic Assessment Schedule. The overall duration for the Periodic Assessment will depend on the level of complexity of the project. In some cases significant preparation may be needed for some sites while other project may have much of the data needed for the PA already on hand from the SPRA process. Regardless, 30 days before the scheduled PFMA site visit, the collected data should be transferred to the assign risk facilitator. The site visit and Potential Failure Modes Analysis will be completed in 1 week for most dams. The risk assessment will be completed by the regional cadre 45 days after completion of the PFMA session. PFMA and risk assessment activities should ideally be completed prior traditional field inspection such that findings can be used for targeted and more comprehensive engineering inspection of the project features. A draft of the PA report should be left “at the door” at the conclusion of the field inspection. The draft PA report should be submitted to the independent regional cadre for ATR 30 days after completion of field activities. The regional cadre shall complete review of the PA in 30 days. After which the final PA report shall be submitted to MSC 30 days after ATR is complete.

W.10 Periodic Assessment Funding. The district will budget for the expense of the Periodic Assessment through normal O&M processes. The cost of the regional cadre and facilitator will be funded by the Risk Management Center.

W.11 Approval Process of Periodic Assessment Report. The Periodic Assessment Report would be submitted to the district Dam Safety Officer for approval and sent to the MSC Dam Safety Officer for concurrence. A copy of the report will be sent to Risk Management Center.

APPENDIX X

Potential Failure Mode Analysis (PFMA) for Dams

X.1 Purpose/Applicability. Guidance for determination of potential failure modes for use in risk assessments of dams.

X.2 PFMA Overview.

X.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.

X.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.

X.3 Outcomes. The PFMA outcomes will include the following:

X.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.

X.3.2 Classify PFM as not credible, credible and significant.

X.3.3 Major findings and understandings

X.3.4 Initial event tree development for each PFM to be carried forward in the next step of the risk assessment.

X.3.5 Review and update routine dam safety activities.

X.3.6 Identify needed additional investigations, analysis, testing, data, etc. for each PFM with unresolved issues.

X.3.7 PFMA documentation.

X.3.8 Plan for the risk assessment effort.

X.3.9 Review and update IRRM plan.

X.4 PFMA Process Description. The following is a brief overview of the steps required to perform a PFMA.

X.4.1 Step 1. Dam Safety Risk Management Center designates the PFMA facilitator and the facilitator coordinates with the district to assign PFMA participants.

X.4.2 Step 2. Collect and summarize background information, (requires assignment in the district).

X.4.3 Step 3. Perform a site visit/review (all members of the PFMA team should participate in the site visit).

X.4.4 Step 4. Review background information on the dam (by PFMA team)

X.4.5 Step 5. Conduct the PFMA.

X.4.6 Step 6. Generate final PFMA report.

X.5 Subject Matter Expert Facilitator Requirements /Corps Qualifications.

X.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 Dam Safety Risk Management Center and USACE Dam Safety Program Manager shall approve PFMA facilitators.

X.5.2 Typical requirements to be an approved PFMA facilitator are:

X.5.2.1 Be a licensed engineer or a licensed engineering geologist/geologist with a minimum of ten years of experience in the design, construction, or operations of dams.

X.5.2.2 Be experienced in dam safety and related risk assessments.

X.5.2.3 Participate in a PFMA for at least one for embankment dam and one concrete structure PFMA for projects operated/regulated by USACE or USBR.

X.5.2.4 Complete the USACE facilitator training course.

X.5.2.5 Shall have consolidated data and written the report from at least one the PFMA session.

X.5.2.6 Successfully facilitated at least two PFMA sessions observed by an experienced facilitator with associated formal feedback and endorsement.

X.5.2.7 Possess good communication and group leadership skills.

X.6 Development of Supporting Data for PFMA. 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).

X.7 Identifying and Describing Potential Failure Modes. 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.

X.7.1 To ensure the PFMA team has a common understanding of the failure mode.

X.7.2 To document PFM for future reference and use.

X.7.3 To facilitate subsequent development of an event tree.

X.8 Evaluating a Potential Failure Mode. 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.

X.9 Performance Monitoring Enhancements, Data Collection Needs, Analyses, and Risk Reduction Measures. 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.

X.10 Major Findings and Understandings. The knowledge gained from the PFMA and a determination whether or not USACE essential guidelines are met should be documented in the form of "Major Findings and Understandings" in the PFMA report. Below are examples of a major finding and understanding.

X.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.

X.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, 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.9).

X.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.

X.11 Documentation. The results of the PFMA will be documented using the following outline.

X.11.1 Introduction and Background including a summary of the last risk assessment completed (SPRA, Periodic Assessment, Issue Evaluation, etc.)

X.11.2 Current Assessment Effort (include a list of participants in this section)

X.11.3 Description of Project

X.11.4 Major Findings and Understandings

X.11.5 Potential Failure Modes Identified.

X.11.6 Credible Potential Failure Modes

X.11.7 Significant Potential Failure Modes

X.11.8 Potential Failure Modes with Unresolved Issues

X.11.9 Not credible Failure Modes

X.11.10 Summary and Conclusions

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APPENDIX Y

Dam Safety Vegetation Management

Y.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.67), this guidance establishes minimum requirements for maintenance/control of vegetation at USACE-owned dams, abutments, spillways, inlet/outlet channels, and other appurtenances.

Y.2 References.

Y.2.1 ETL 1110-2-571, "Guidelines for Landscape Planting and Vegetation Management at Levees, Floodwalls, Embankment Dams, and Appurtenant Structures" (reference A.67).

Y.2.2 Federal Emergency Management Agency, (2005), "Technical Manual for Dam Owners: Impacts of Plants", FEMA Document 534, Washington, DC (reference A.75).

Y.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.

Y.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.

Y.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.

Y.3.2.1 Structural instability can occur due to falling/decaying tree/woody vegetation and root system 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.

Y.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.

Y.4 Policy.

Y.4.1 The following areas shall remain free of trees and other woody vegetation such as shrubs and vines:

Y.4.1.1 The dam and dam toe area

Y.4.1.2 In or around seepage monitoring systems or critical areas for seepage observation

Y.4.1.3 Abutments and groins

Y.4.1.4 Emergency spillways and regulating outlet channels, including channel floors, side slopes and approaches

Y.4.1.5 Outlet works discharge channels

Y.4.2 All areas of dam projects must be inspected according to Chapter 11 of this regulation and ER 1130-2-530 (reference A.63). 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 shall be part of each annual and formal periodic inspection for each project and shall be discussed in the respective reports.

Y.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.

Y.4.4 Design and construction of landscape plantings, including irrigation systems, must be carefully devaluated and reviewed from a Dam Safety perspective, comply with ETL 1110-2-571 (reference A.67), and approved by dam safety experts.

Y.4.5 Trees, brush, and weeds in spillways and inlet and outlet channels shall 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.

Y.5 Implementation.

Y.5.1 Mowing/ clearing limits for each dam shall be identified by dam safety personnel within Engineering Division and documented on aerial photographs or plan drawings, as part of the project Operations and Maintenance Manual. The limits shall be site-specific and shall take into consideration the topography, phreatic surfaces within the structure and abutments, foundation characteristics and any historical problems with the structure.

Y.5.2 The horizontal limits of clearing shall not be less than the entrance width of the spillway. In the vertical direction, no encroachment by woody vegetation of any kind can be tolerated up to the elevation of the inflow design flood profile. Dam safety personnel within Engineering Division shall establish specific clearing limits for spillways based on project hydrological characteristics, and they shall be permanently and clearly marked in the field.

Y.5.3 Riprap in all areas shall be maintained free of vegetation. This includes embankment slopes, discharge channel slopes, and emergency rock stockpiles.

Y.6 Remediation Procedures.

Y.6.1 Undesirable woody vegetation identified by Dam Safety personnel shall 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.

Y.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 shall be placed in the excavation and properly compacted to the dam remediation design limits. Backfill shall be similar to the in-situ embankment fill material and shall be compacted. Installing a slope protection system is recommended to reduce the potential for wave and surface runoff erosion.

Y.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.

Y.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.

Y.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:

Y.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;

Y.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;

Y.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;

Y.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.

Y.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.

Y.7 Establishment of Vegetation. All disturbed areas must be protected by seeding and mulching. Timing must be considered to allow seed to germinate and develop roots prior to winter or heavy precipitation seasons.

Y.8 Waivers. Waivers to allow additional vegetation or alternate remediation techniques must be submitted in writing to the district Dam Safety Officer. A multi-discipline team shall review the proposed change, assess potential dam safety impacts, and provide a written recommendation to either approve or decline by the Dam Safety Officer.

APPENDIX Z

Hazard Potential Classification

Z.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.

Z.2 Classification System. Table Z.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:

Z.2.1 Loss of Life. “Federal Guidelines for Dam Safety: Hazard Potential Classification System for Dams” (reference A.76) 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 mis-operation, 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.

Z.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:

Z.2.2.1 Loss of power generation capability at the failed dam (or at an inundated powerhouse downstream).

Z.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).

Z.2.2.3 Loss of water supply due to a reservoir emptied by a failed dam.

Z.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.

Z.2.4 Environmental Losses. Damage to the environment caused by project failure or operation can result in the need for mitigative measures, or can cause irreparable damage to the environment. Environmental damage estimates shall 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 shall be attributed to project failure or operation. Some other examples of environmental impacts are:

Z.2.4.1 Environmental damage caused by the release of a reservoir contaminated by toxic or hazardous mine waste.

Z.2.4.2 Environmental damage caused by sediment released by a reservoir.

Z.3 Classification Table. See Table Z.1 for guidance in classifying Civil Works projects as low, significant, or high hazard potential.

Table Z.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 project performance and do not apply 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 shall 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 AA

Management Control

AA.1 Function. The function covered by this checklist is Civil Works Dam Safety Program.

AA.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.

AA.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 at least once every five years and may be evaluated as often as very project. Certification that this evaluation has been conducted must be accomplished on DA Form 11-2-R (Management Control Evaluation Certification Statement).

AA.4 Test Questions.

AA.4.1 Does the office at each dam have a copy of the Federal Guidelines for Dam Safety – FEMA 93?

AA.4.2 Does the office at each dam have a set of the Training Aids for Dam Safety – FEMA 609DVD?

AA.4.3 Does the office at each dam have a copy of the Safety of Dams Regulation – ER 1110-2-1156?

AA.4.4 Does the office at each dam have a copy of the current Emergency Action Plan for the dam?

AA.4.5 Does the office at each dam have a copy of the latest Periodic Inspection Report and the latest Periodic Assessment Report?

AA.4.6 Does the office at each dam have a copy of the “as-built” plans for the dam?

AA.4.7 Is the Dam Safety Officer appointed on orders by the Commander in accordance with Chapter 4, ER 1110-2-1156?

AA.4.8 Does the Dam Safety Program Manager meet the qualifications requirements established in ER 1110-2-1156?

AA.4.9 Are both the Dam Safety Officer and the Dam Safety Program Manager registered Professional Engineers (or Geologists) with a current State registration?

AA.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?

AA.4.11 Is the data for the Dam Safety Program Management Tools up-to-date for all dams in the district or MSC?

AA.4.12 Are the Periodic Inspections and Periodic Assessments scheduled on a 10 year cycle and is the schedule current?

AA.4.13 Are inspection and assessment reports completed within 90 days of the field inspections and is a draft report left at the dam on the day of the inspections?

AA.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?

AA.4.15 Are emergency exercises held at each dam in accordance with the schedule in ER 1110-2-1156?

AA.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?

AA.4.17 Does each dam (if required) have a current Interim Risk Reduction Plan?

AA.4.18 Does each PDT for a dam safety study have an assigned “Lead Engineer”?

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APPENDIX AB

Seismic Safety Evaluation Process for Embankment Dams and Foundations

AB.1 Introduction.

AB.1.1 This Annex provides detailed guidance for evaluating the seismic safety of existing USACE embankment dams and foundations. The process ensures:

AB.1.1.1 That seismic evaluations/re-evaluations for embankment dams and foundations are accurately identified and conducted with minimum expenditure of project funds, manpower or delay and

AB.1.1.2 That embankment dams and/or foundations not requiring modifications are accurately identified and removed from further study at the earliest possible point in the evaluation process.

AB.1.2 This guidance is to be used in evaluating the seismic safety of existing USACE Civil Works embankment dams in accordance with the provisions of the Dam Safety Program as defined in the main text of this regulation.

AB.1.3 The seismic safety of many existing embankment dams must be evaluated or re-evaluated in accordance with the requirements in ER 1110-2-1806. Seismic safety evaluation of major civil works projects, particularly embankment dams, is typically a complex, multi-stage process. It generally requires progressively more detailed definition of certain project characteristics and analysis of project response to the design earthquake ground motions at each subsequent stage. This process can be expensive and manpower intensive, and may take many months to several years to complete.

AB.2 Seismic Safety Evaluation Process.

AB.2.1 Evaluation Process. Stages of the seismic safety evaluation process are designated as:

AB.2.1.1 Seismic Safety Review,

AB.2.1.2 Phase I Special Studies, and

AB.2.1.3 Phase II Special Studies

AB.2.1.4 A flow chart illustrating the process is shown at Figure AB.1.

AB.2.2 The evaluation process is structured to validate technical conclusions and policy compliance as an integral part of each stage of the process. This is accomplished during appropriately timed Policy Compliance & Criteria Reviews (PCCR). These reviews eliminate the need for several report submission and approval cycles preceding the development of an official decision document. The evaluation process leads either to negative findings (i.e., that critical project features are likely to perform in an acceptable manner during and following the design earthquake) resulting in removal of the dam from further evaluation, or to the conclusion that modifications are required to the embankment dam and/or its foundation to ensure acceptable performance when subjected to the design earthquake. Negative conclusions at any stage beyond the initial screening at the Seismic Safety Review stage require validation during a PCCR. Negative conclusions at any stage of evaluation require only minimal formal documentation. Conclusions which indicate additional studies are required or that the project requires some form of remediation or modification must be validated during a PCCR. Additionally, the evaluation process and resultant conclusions must be documented for record prior to proceeding into the next phase. If studies through the Phase II level lead to the conclusion that some form of remediation is required, the results of the evaluation process, recommended remediation or modifications and justification are presented in the Dam Safety Modification Report (DSMR).

AB.2.3 The Dam Safety Modification Studies and Documentation are described in Chapter 9 of this regulation.

AB.2.4 Phase III/Detailed Design. Following official approval of the DSMR, Phase III work should precede in accordance with the approved schedule. This includes detailed design for the seismic modifications approved in the DSMR as well as preparation of the plans and specifications for those measures.

AB.3 Funding. The Seismic Safety Review should be a recurring review has part of the Periodic Assessment of the dam and is funded with project O&M funds. The Phase I Special Studies are included in the Initial Evaluation Study (IES). The Phase II Special Studies are included in the Dam Safety Modification Study (DSMS). Both the IES and the DSMS are funded with Construction funds.

AB.4 Seismic Safety Review.

AB.4.1 A Seismic Safety Review (SSR) is required when certain conditions exist as described in ER 1110-2-1806. The SSR should be considered as a part of each Periodic Assessment (PA).

AB.4.2 The purpose of the SSR is to review and document conclusions about the seismic safety of embankment dams and foundations for civil works projects in accordance with ER 1110-2-1806. This review will conclude whether or not a Phase I Special Study is required. The SSR is normally limited to office examination and screening of available data and the results of the most recent PI and/or PA. In this review, available information, such as geologic maps, boring logs, seismic zone maps, acceleration contour maps, existing field investigation reports, as-built project records, and previous seismic evaluation reports, should be used. If the initial screening indicates that the embankment dam and/or its foundation may require remediation/modification for seismic adequacy, then limited, simple preliminary analyses using existing available data should be performed as part of the SSR. If these analyses indicate that there is potential for sudden, uncontrolled loss of reservoir pool or other form of unacceptable performance which causes loss of life as a result of the project being subjected to the design earthquake, then a Phase I Special Study should be recommended. Where specialized expertise is needed, subject matter experts, either USACE or external, should participate in the examination and analysis as early as practical in the evaluation process.

AB.4.3 The level of effort to accomplish the SSR should be the minimum required to resolve whether or not seismic safety issues exist which require a Phase I Special Study. (The level of effort and associated cost are estimated to be on the order of a few man-weeks of office effort with costs in the range of $25-50K.)

AB.4.4 Seismic Safety Issues. Issues that are relevant to the determination of seismic safety and the need for further investigations may include some or all of the following:

AB.4.4.1 Project Hazard Potential Classification, which reflects the criticality of the project in terms of threat to public safety in the event of failure. It is USACE policy that seismic safety of USACE embankment dams, where failure would result in loss of life, must be assured. For embankment dams and other features for which the consequences of failure are economic and no loss of life is expected, the decisions about further investigations or other actions should be justified on an economic basis.

AB.4.4.2 Adequacy of past seismic evaluations, if any; including the adequacy of procedures used in selection of design ground motions and the appropriateness and adequacy of methods of analysis used, in light of the present state-of-the-practice.

AB.4.4.3 Proximity to seismic source zones

AB.4.4.4 Changes in the state of knowledge of regional or local seismicity since the last review.

AB.4.4.5 Existence of soils that are potentially unstable due to buildup of excess residual pore pressures or degradation of strength from cyclic loading in either the embankment or foundation.

AB.4.4.6 Existence of slopes that may be seismically unstable, including embankment slopes, the abutments or the reservoir rims.

AB.4.4.7 Existence of project features that may become critical to safety after small deformations of the embankment dam (i.e., outlet works becoming nonoperational or thin filter zones within the embankment being disrupted).

AB.4.4.8 A Policy Compliance & Criteria Review (PCCR) should be held after 95% completion of the technical examination and analysis for the SSR, but prior to forwarding a recommendation to the District Dam Officer. The PCCR should include geotechnical representatives from the RMC and the MSC as well as District representatives including representatives from Engineering and Operations. A PCCR is not needed if the results of the SSR indicate that the dam is seismically adequate. The PCCR should summarize the examination and screening and should provide a recommendation with justification for the initiation of Phase I studies. Supporting documentation should be presented. If a Phase I study is recommended, then a scope of work, cost estimate and schedule for the Phase I study should be presented. If the SSR is done in conjunction with a periodic assessment, the results of the SSR should be incorporated into the Periodic Assessment Report. As a minimum, the District should document the SSR as well as the results and conclusions of the PCCR in a memorandum for record to project files. No formal report or documentation is required to be submitted to the MSC or HQUSACE for review and approval; the PCCR replaces the MSC and HQUSACE review and approval process for the SSR. An information copy of the memorandum for record must be provided to both the MSC and HQUSACE (CECW-CE).

AB.5 Phase I Special Study.

AB.5.1 A Phase I Special Study is necessary when the PCCR for the SSR concludes that potential deficiencies exist in an embankment dam or foundation which could lead to sudden, uncontrolled loss of reservoir pool or other form of unacceptable performance likely to cause loss of life if the project were subjected to the Maximum Credible Earthquake (MCE), as defined in ER 1110-2-1806, or a lesser event.

AB.5.2 The purpose of Phase I study is as shown below. The Phase I study should be part of an overall risk-informed IES for the dam.

AB.5.2.1 Develop site specific ground motions appropriate for seismic evaluation of all project features to be evaluated,

AB.5.2.2 Perform limited field investigations and laboratory studies, and,

AB.5.2.3 Perform preliminary analyses, based on the ground motions, field data and laboratory testing results, to determine the response of the dam to seismic loading and to identify potential problem areas which may need more detailed analyses.

AB.5.3 The type and level of study required in the Phase I study will be project dependent; however, the content of a Phase I study normally includes the following:

AB.5.3.1 Project Description. Provide a brief description of the project, including type of dam, major structures or other critical feature. Provide tabulated pertinent project data. Describe design and current project operations. Identify key operational pool levels such as conservation pool, power pool, seasonal pool levels, spillway crest, flood pool and maximum pool. Other relevant pool information should include reservoir pool history elevation versus time, average yearly maximum pool, and the reservoir pool elevation versus frequency relationship based on historical data supplemented with flood routing analyses for less frequent flood events as required.

AB.5.3.2 Purpose and Scope. Describe the purpose and scope of the study and the deficiency(s) identified in the SSR. (Estimating the level of effort and cost to perform a Phase I study is difficult to address on other than a project specific basis but are likely to range from many man-months to a few man-years of effort and involve expenditures in the range of $300-800K. Phase I duration should be limited to the shortest possible time period consistent with project complexity, manpower, funding and quality considerations.)

AB.5.3.3 Site Characterization. Perform limited field and laboratory investigations to define the soil and rock stratigraphy and to further clarify location and extent of potential problem areas. These investigations should be sufficient to develop preliminary soil and rock cross sections of the dam and foundation in areas which have potentially unstable soils. These investigations may include Standard Penetration Tests (SPT), Cone Penetration Tests (CPT), shear wave velocity, permeability, Becker Penetration Tests (BPT), conventional undisturbed sampling, and trenching in areas of much lateral heterogeneity or anisotropy.

AB.5.3.4 Seismotectonic Evaluation. Develop a detailed evaluation of the geology, tectonics and seismic history of the area, and the proximity of the dam to active seismic zones. Provide fault study and related field investigations and laboratory testing where necessary.

AB.5.3.5 Seismicity and Ground Motions. Select the final design earthquake ground motions and develop the ground motion parameters to which the project could be subjected. For all critical projects or features, these input ground motions will be obtained from a deterministic analysis of historic seismicity and active fault systems or seismic source zones and their activity. Develop several accelerograms for site response computations. The accelerograms should contain energy, frequency and duration components appropriate for the source, the region and the feature being evaluated. Caution is advised to avoid undue conservatism in selection of ground motions for use in analyses. Selection of specific accelerograms or the manipulation of accelerograms to generate records with specific time histories not representative of the characteristic ground motion records within the region of the project should be strongly justified and well documented. Of particular concern is that accelerograms be developed with energy content and occurrence of the peak energy representative of the seismological setting of the feature(s) being evaluated. For effective stress analyses, where site permeability profiles and boundaries are accurately known and seismic generated residual excess pore water pressures will be simultaneously dissipated, input motion time histories should not be manipulated to shift the energy content to the end of shaking to minimize pore pressure dissipation and thereby maximize excess residual pore pressures during modeling of post earthquake response unless justified from seismological investigations and by expert seismologists. Selection of ground motions should be made with input from qualified seismologists, geologists and geotechnical engineers.

AB.5.3.6 Seismic Evaluations and Analyses.

AB.5.3.6.1 Liquefaction Potential. Evaluate the potential for liquefaction or development of excess pore pressure in soils of the embankment and foundation using standard methods. This should consist of using an appropriate empirical method linking documented field performance with site characteristics using field investigations. Use a 1-D analysis, such as SHAKE, to model propagation of earthquake induced rock motions through the foundation and the embankment.

AB.5.3.6.2 Post Earthquake Stability. Evaluate post earthquake limit equilibrium slope stability for the reach(es) of the embankment where liquefaction of the embankment and/or foundation is indicated. Post-earthquake shear strengths for zones not indicated to liquefy should be estimated taking into account residual excess pore pressures. Post-earthquake shear strengths for zones which are indicated to liquefy should be selected based on residual strengths back calculated for well documented liquefaction induced failures. The further reduction in shear resistance below the residual level is not justified.

AB.5.3.7 Post Earthquake Deformed Shape. Assess the shape and amount of deformation in the embankment after sliding or slumping for the cross section where inadequate factors of safety are indicated by limit equilibrium slope stability analyses. Similar cautions noted for selection of strength and pore pressure values in evaluating limit equilibrium stability are to be observed in evaluating the post earthquake deformed shape of an embankment or other slope.

AB.5.3.8 Conclusions and Recommendations. Develop conclusions and recommendations on the need for a Phase II seismic evaluation or departure from requirements of ER 1110-2- 1806.

AB.5.3.9 Cost Estimate and Schedule. If Phase II studies are recommended, develop a detailed scope, cost estimate and schedule for the proposed Phase II studies.

AB.5.3.10 Phase I PCCR. Conduct a PCCR for the Phase I study.

AB.6 Phase II Special Study.

AB.6.1 A Phase II Special Study is necessary when the PCCR for the Phase I concludes that potential deficiencies exist in an embankment dam or foundation which could lead to sudden, uncontrolled loss of reservoir pool or other form of unacceptable performance likely to cause loss of life if the project were subjected to the design earthquake. The Phase II study should be detailed and sufficiently comprehensive such that conclusions reached concerning the seismic adequacy of the dam in question are definitive and constitute the basis for selection, detailed design and construction of modifications or other form of remediation required to ensure seismic safety of the project.

AB.6.2 The purpose and scope of Phase II study are as follows:

AB.6.2.1 Perform comprehensive detailed analyses to evaluate performance of the critical project features when subjected to the ground motions identified in Phase I.

AB.6.2.2 Determine if the dam is seismically adequate or if remediation/modifications are required to ensure acceptable seismic performance.

AB.6.2.3 Establish remediation requirements.

AB.6.2.4 Evaluate various alternative remedial techniques and select the most appropriate alternative.

AB.6.2.5 Prepare cost estimates, scope, and schedule for design documentation, plans and specifications, and construction.

AB.6.3 Methods of Analysis. The recommended engineering approach to analysis of an embankment dam and foundation for seismic stability generally consists of assessing both post earthquake static limit equilibrium slope stability and deformation response of the dam using, as appropriate, detailed 2D and 3D numerical analyses. The steps involved in a Phase II seismic analyses for earth dams normally include:

AB.6.3.1 Use the recommended design earthquake ground motions and accelerograms developed in the Phase I study for site response computations. For all critical projects or features, these input ground motions will be obtained from a deterministic analysis. The selected accelerograms should be used in the application of an appropriate, validated dynamic finite element program used for modeling the deformation process in response to an imposed earthquake ground motion time history.

AB.6.3.2 Perform detailed field investigations which may include SPT, BPT, CPT, field vane shear tests, field permeability, ground water observation wells, conventional undisturbed sampling, geophysical evaluations, and laboratory testing, to develop a detailed understanding of site conditions, including stratigraphy, geometry, hydrology, material properties and their variability, and the areal extent of potential problem zones.

AB.6.3.3 Determine the preearthquake vertical effective shear stresses, and the initial static shear stresses on horizontal planes throughout the dam and its foundation.

AB.6.3.4 Determine the dynamic shear moduli of the soils in the dam and foundation.

AB.6.3.5 Using an appropriate dynamic finite element analysis procedure, determine the stresses induced in the embankment and foundation when subjected to the accelerograms selected for the design earthquake. Pore water pressure dissipation should be properly accounted for in determining pore pressure behavior during shaking and residual excess pore pressure level after shaking stops. Consider relevant soil properties and stratigraphy including permeabilities in soil layers adjacent to the liquefiable soil layer, which restricts pore pressure dissipation.

AB.6.3.6 Determine the liquefaction resistance of the embankment and foundation soils and the maximum potential residual excess pore water pressure that can be generated by the earthquake using corrected penetration data from in-situ tests such as SPT, CPT, BPT, and laboratory index tests.

AB.6.3.7 Map the areal extent of all suspect materials. Determine post earthquake shear strength of relevant soils. Prepare several generalized cross sections of the dam and foundation for final analysis to determine seismic response.

AB.6.3.8 Perform static limit equilibrium slope stability analyses of the generalized cross sections to assess post earthquake stability and to identify potential zones of the dam and foundation which may require remediation.

AB.6.3.9 Estimate the deformation response of the embankment dam and the post earthquake shape of the embankment by using an appropriate 2D and/or 3D finite element or other appropriate deformation analysis program.

AB.6.3.10 Remediation should be recommended when the embankment dam is

AB.6.3.10.1 found to have inadequate limit equilibrium slope stability factors of safety and/or

AB.6.3.10.2 projected to experience unacceptable deformations when subjected to the design earthquake and it is concluded that either situation would result in sudden, uncontrolled loss of the reservoir pool and loss of life.

AB.6.3.10.3 If remedial measures are recommended, establish the remediation requirements, evaluate various remediation alternatives, and select the most appropriate alternative.

AB.6.3.11 Perform additional post earthquake limit equilibrium slope stability and finite element analysis to determine preliminary remediation needs such as extent and location of remediation required, strength/resistance required and to determine the level of protection to be obtained by remediation.

AB.6.3.12 Evaluate various preliminary remediation alternatives and select the most appropriate alternatives for cost estimating purposes.

AB.6.3.13 Perform additional finite element deformation analyses to determine expected deformations in both remediated and non-remediated sections of the dam. Determine overall dam response and differential deformation.

AB.6.3.14 Develop detailed scope, cost, and schedule for PED phase (Preconstruction Engineering and Design) which includes preparation of design documentation and plans and specifications (P&S).

AB.6.3.15 Conduct a PCCR for the Phase II study.

AB.6.3.16 Prepare the Phase II study summary. This is the basis for a technical appendix to the DSMR. The suggested format and content for the Phase II summary is described in Paragraph AB.6.4 below.

AB.6.4 Phase II Study Documentation. A detailed summary of the entire evaluation process including the Phase II study must be included as a Technical Appendix to the IES Report. To facilitate the Phase II PCCR, a summary should be developed and presented at the PCCR in the general format and scope indicated as follows:

AB.6.4.1 Introduction

AB.6.4.1.1 Authorization

AB.6.4.1.2 Purpose

AB.6.4.1.3 Project Description

AB.6.4.1.4 Method of Analysis

AB.6.4.2 Static Stress Analyses

AB.6.4.2.1 General

AB.6.4.2.2 Development of Static Properties of the Dam

AB.6.4.2.3 Results of Static Stress Analyses

AB.6.4.3 Design Earthquake Motions

AB.6.4.3.1 General

AB.6.4.3.2 Design Earthquake and Ground Motions

AB.6.4.3.2.1 Response Spectra

AB.6.4.3.2.2 Time Histories

AB.6.4.4 Dynamic Response Analyses

AB.6.4.4.1 General

AB.6.4.4.2 Field and Laboratory Tests and Results

AB.6.4.4.3 Development of Dynamic Properties

AB.6.4.4.4 Dynamic Analyses

AB.6.4.4.5 Dynamic Response

AB.6.4.5 Seismic Stability Assessment

AB.6.4.5.1 Evaluation of Dynamic Strengths

AB.6.4.5.1.1 Laboratory Data

AB.6.4.5.1.2 Field Data

AB.6.4.5.2 Dynamic Response and Stability

AB.6.4.5.3 Earthquake Induced Deformation Analyses

AB.6.4.6 Post Earthquake Stability Analyses

AB.6.4.6.1 General

AB.6.4.6.2 Post Earthquake Strength Properties

AB.6.4.6.3 Slope Stability

AB.6.4.6.4 Post Earthquake Deformed Condition

AB.6.4.7 Deformation Response Analyses

AB.6.4.7.1 General

AB.6.4.7.2 Deformation analyses of Remediated Sections

AB.6.4.7.3 Deformation Analyses of Unremediated Sections

AB.6.4.8 Remediation Alternatives

AB.6.4.8.1 General

AB.6.4.8.2 Potential Remediation Alternatives

AB.6.4.8.3 Cost Estimates for Potential Remediation Alternatives

AB.6.4.8.4 Estimated Construction Sequence, Schedule, Duration for Alternatives

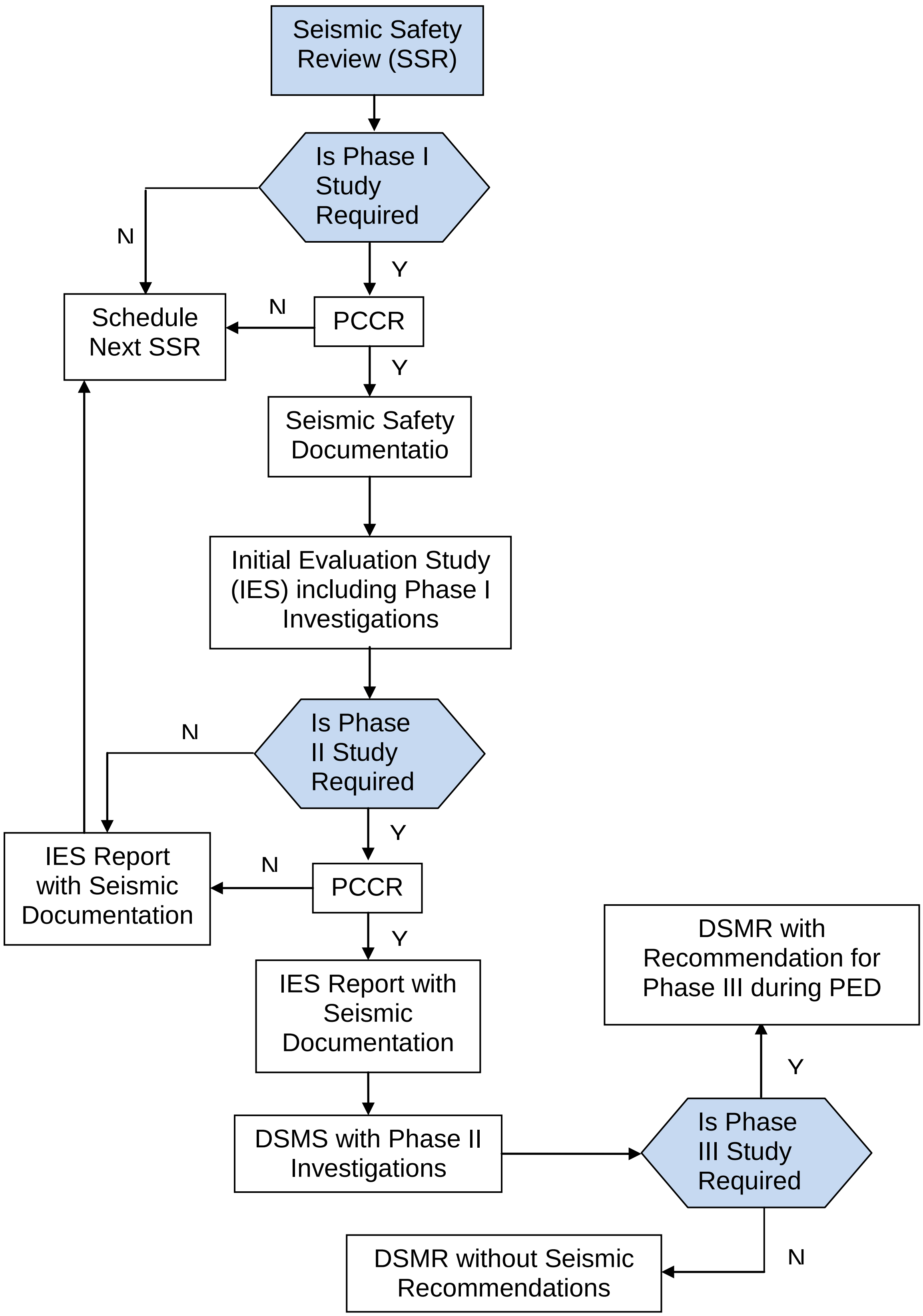
AB.6.4.9 Summary

AB.6.4.10 Conclusions and Recommendations

AB.6.4.11 References

AB.6.4.12 Attachments

Figure AB.1 – Seismic Analysis Process



APPENDIX AC

Seismic Safety Evaluation Process for Concrete Structures and Foundations

AC.1 Seismic Safety Review.

AC.1.1 General.

AC.1.1.1 Types and levels of programs for seismic evaluation of concrete dams needed at various times and for various purposes start with a Seismic Safety Review (SSR) and may be followed by special studies consisting of preliminary seismologic investigations coupled with simplified seismic evaluations (Phase I), full seismologic investigations and dynamic analysis of the project (Phase II), and preparation of design documents, plans and specifications (Phase III). Flexible guidelines, consistent with the policy in paragraph 5.b.of ER 1110-2-1806 are needed to permit experienced investigators to do the best practical and economical job for each specific situation.

AC.1.1.2 A review is required to identify specific problem areas and establish priorities for further study. Generally, Seismic Safety Reviews are based on evaluations of available pertinent data and surface inspections. Seldom do SSR level investigations include extensive exploratory or testing provisions.

AC.1.2 Project Description. Briefly describe the project, including type of dam or major structure and seismic zone. Enclose a location map and the tabulated pertinent project data. Describe design and current project operations.

AC.1.3 Geology/Seismicity. Describe site specific geology and provide current detailed seismicity of the site including faulting, seismic evaluation parameters used in the design and changes or experienced shaking at site based on a search of existing project files and current professional literature. Describe site specific ground motion data.

AC.1.4 Structural Investigations. Summarize structural design and results of recent analyses, if available. Describe those analyses used to conduct the evaluation.

AC.1.5 Evaluation. Provide diagnostic seismic evaluation of the structure and foundation based on the data presented. Evaluate post-seismic stability. Develop a basis for decision on the need for and justification of additional studies or departure from further studies of risk assessment based on probabilities of occurrence of earthquakes, operating pool elevations and structural failure.

AC.1.6 E&D Cost Estimate and Schedule. Provide scope of recommended studies and associated study costs and schedule.

AC.1.7 Conclusions and Recommendations. Provide conclusions and specific recommendations based on existing data evaluations. Schedule and conduct PCCR.

AC.2 Phase I – Special Study Content.

AC.2.1 Project Authorization. Reference the Project Guidance Memo (PGM) from the Policy Compliance & Criteria Review (PCCR) of the SSR for the project.

AC.2.2 Project Description. Briefly describe the project, including type of structures. Provide tabulated pertinent project data. Describe design and current project operations.

AC.2.3 Purpose and Scope. Describe the purpose of the study, scope, and deficiency identified in the SSR.

AC.2.4 Seismologic Investigations. Provide detailed seismologic study results, including fault study investigations, related field investigations, and laboratory studies.

AC.2.5 Seismicity. Develop design earthquakes in relation to active fault systems and their activity.

AC.2.6 Seismic Evaluation. Provide seismic evaluation of features subjected to design earthquakes. Provide basis for selection of parameters, method of analysis, and rationale for the decision on seismic assessment of the project.

AC.2.7 Conclusions and Recommendations. Develop conclusions and recommendations for terminating the study or proceeding to a Phase II seismic evaluation in accordance with the requirements of ER 1110-2-1806.

AC.2.8 Cost Estimate and Schedule. Provide scope, cost estimate, and schedule of recommended Phase II studies. Conduct the PCCR.

AC.3 Phase II – Special Study Guidelines for Dynamic Analysis of Concrete Structures.

AC.3.1 Design Earthquakes and Ground Motions. Design earthquakes and ground motions for the seismic evaluations of concrete dams and appurtenant structures shall be determined in accordance with ER 1110-2-1806, paragraphs 5.h., 6 and 8.f. The study scope shall be consistent with the PGM for the Phase I PCCR.

AC.3.2 Dynamic Analyses of Existing Structures and Proposed Remedial Alternatives.

AC.3.2.1 Review the candidate earthquake, location, and ground motions for most severe conditions to concrete structures.

AC.3.2.2 Select design response spectra.

AC.3.2.3 Select appropriate acceleration-time history records compatible with the design response spectra.

AC.3.2.4 Select dynamic properties for the concrete and foundation.

AC.3.2.5 Analyze and evaluate any cracking.

AC.3.2.6 Follow guidance in the current technical guidance and EM appropriate for that concrete structure.

AC.3.3 Conclusions and Recommendations. Discuss remedial alternatives in the DSMR and selection of remediation plan to be developed in Phase III Plans and Specifications. Provide a summary of the Phase II studies in the DSMR

AC.4 Phase II – Special Study Content.

AC.4.1 Introduction.

AC.4.1.1 Authorization

AC.4.1.2 Purpose

AC.4.1.3 Project Description

AC.4.1.4 Method of Analysis

AC.4.2 Static Finite Element Analysis.

AC.4.2.1 General

AC.4.2.2 Development of Static Properties

AC.4.2.3 Results of Static FEM Analyses

AC.4.3 Design Earthquake Motions

AC.4.3.1 General

AC.4.3.2 Design Earthquake and Ground Motions

AC.4.3.3 Response Spectra

AC.4.3.4 Time Histories

AC.4.4 Dynamic Finite Element Analyses

AC.4.4.1 General

AC.4.7.3 Cost

AC.4.8 Summary

AC.4.9 Conclusions and Recommendations

AC.4.10 References

AC.4.11 Attachments

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GLOSSARY

Abbreviations and Terms

Abbreviations.

ADAS .... Automated Data Acquisition System

AIS .... Automated Information System

ALARP .... As Low as Reasonably Possible

ALL......................... Annualized life loss

ANCOLD .... Australian National Committee on Large Dams

APF .... Annual Probability of Failure

ASA........................ Assistant Secretary of the Army for Civil Works

ASDSO................... Association of State Dam Safety Officials

ATR........................ Agency Technical Review

BCR........................ Benefit Cost Ratio

BOR .... Bureau of Reclamation

BPA........................ Blanket Purchase Agreement

BSC........................ Base Safety Condition

CCS........................ Category Class Subclass

CG.......................... Construction General Funds

CIPR....................... Critical Infrastructure Protection and Resilience

COE .... Corps of Engineers

CoP .... Community of Practice

CQC .... Contractor Quality Control

CSSL...................... Cost to save a statistical life

DA .... Department of the Army

DDR .... Design Documentation Report

DHS........................ Department of Homeland Security

DQC .... District Quality Control

DSAC .... Dam Safety Action Classification

DSADS................... Dam Safety Action Decision Summary

DSAP .... Dam Safety Assurance Program

DSDMR .... Dam Safety Deficiency Modification Report

DSM .... Dam Safety Modification Study

DSO .... Dam Safety Officer

DSPM..................... Dam Safety Program Manager

DSPMT................... Dam Safety Program Management Tools

DSPPM .... Dam Safety Program Performance Measures

DSSC .... Dam Safety Steering Committee

DX .... District Center of Expertise

EAP........................ Emergency Action Plan

EMA .... Emergency management Agencies

ERDC..................... Engineer Research and Development Center

EIS .... Environmental Impact Statement

EPRI....................... Electric Power Research Institute

ERRDX................... Engineering Risk and Reliability Directory of Expertise

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

FOUO..................... For Official Use Only

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

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

IRRM...................... Interim Risk Reduction Measure

IRRMP.................... Interim Risk Reduction Measures Plan

IPMP .... Initial Project Management Plan

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....................... Mapping Modeling and Consequence Production Center

MSC .... Major Subordinate Commands

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

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

QA .... Quality Assurance

RA .... Risk Assessment

RADS II .... Risk Assessment For Dam Safety web site

REMR .... Repair, Evaluation, Maintenance, and Rehabilitation

RMC .... Risk Management Center

RMO .... Review Management Organization

RP .... Review Plan

RRDX .... Risk and Reliability Center

SDF .... Spillway Design Flood

SEE .... Safety Evaluation Earthquake

SEF .... Safety Evaluation Flood

SES .... Senior Executive Service

SET .... Standard Engineering Technology

SOG .... Senior Oversight Group

SPRA .... Screening Portfolio Risk Assessment

SSR .... Seismic Safety Review

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

WPSF .... Willingness-to-pay-to-prevent-a-statistical-fatality

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.

Adequately Safe Dam – A dam is adequately safe when the dam meets all essential USACE engineering guidelines and the residual risk is considered tolerable.

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 shall include members from and be coordinated with the Dam Safety Risk Management Center (DSRMC) as well as recognized experts in the field of risk assessment outside of the DSRMC. The ATR team findings will be vetted with the MSC DSO, Dam Safety 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.62)). 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 shall be documented and reviewed in support of Periodic Inspections (PI’s) and Periodic Assessments (PA’s).

Annual Probability of Failure (APF) – For dams the total 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.

Annualized Life Lost (ALL) – 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.

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 its cost is grossly disproportional (depending on the level of risk) to the improvement gained.

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.

Baseline – The condition, data, or other representations of the topic of interest that will be used for comparison of 1) changes that may occur without intervention or as a result of a remediation alternative remediation and 2) changes and impacts estimated to result from intervention or remediation alternative. It is comprised of the existing conditions and such future projected conditions as chosen to be relevant for the comparison.

Baseline Component Risk Estimates – An Estimate of risk contributed by an individual credible failure mode that associated with the dam for given load combinations.

Baseline Consequence Analysis – Analysis of existing and future without remediation project consequences.

Baseline Risk Estimate – The baseline risk estimate is the risk estimate at a point in time.

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.105). 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.

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.

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.

Concept of Disproportionality – Entails the use of two measures associated with the 'statistical life' concept. The first is the cost effectiveness measure called, "cost-to-save-a-statistical-life" (CSSL). The second measure is the "willingness-to-pay-to-prevent-a-statistical fatality" (WPSF) or as sometimes used in the United States "the value to save a life" (VSL). The characterization of the sacrifice is based in part on the ratio of the CSSL estimate for a risk reduction measure to the WPSF value as an approximate efficiency measure.

Conditional Load Response Probabilities – Response probabilities (of failure) corresponding to the conditional load type and scenario under investigation.

Conditionally Unsafe – Assertion that the existence or occurrence of one thing or event (e.g., initiation of dam failure) depends on the existence or occurrence of another thing or event (e.g., extreme flood or extreme seismic event).

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.

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 Baseline Risk Estimate – Occurs when the conditional load response probabilities and consequences used to estimate the total project risk 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.

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 c*oncrete 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 identify or predict deficiencies and consequences related to failure, and to document, publicize, and reduce, eliminate, or remediate to the extent reasonably possible 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 placed into a Dam Safety Action Classification (DSAC) class based on their individual dam safety 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 classes of the safety status of USACE dams. These actions range from immediate recognition of an urgent and compelling situation requiring extraordinary and immediate action for unsafe dams through normal operations and dam safety activities for safe dams.

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 Community of Practice 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 shall meet as required, and shall provide 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 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 justification of modifications for dam safety at completed Corps of Engineers 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 additional risk reduction 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.109) and ESA 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, implementation plan, detailed cost estimate, NEPA, and ESA determinations.

Dam Safety Officer – A registered professional civil engineer 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 the Corps of Engineers responsible for implementing the dam safety program of that organization. The Commander shall 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) – The DSPM is a Dam Safety official 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 Safety Senior Oversight Group (SOG) – Designated USACE Dam Safety senior headquarters and field staff team that performs an oversight function for the Dam Safety program. The SOG meets periodically to advise the Dam Safety Officer on key issues related to the program, such as determining Dam Safety Action Classifications. The SOG 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 Dam Safety 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.

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.

Disproportionality Ratio – See definition for 'Concept of Disproportionality'.

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 Class I (Urgent and Compelling) – 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 time frame from immediately to within a few years without intervention; or, the combination of life or economic consequences with probability of failure is extremely high.

DSAC Class II (Urgent) – Dams where 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, the combination of life or economic consequences with probability of failure is very high.

DSAC Class III (High Priority) – Dams that have issues where the dam is significantly inadequate or the combination of life, economic, or environmental consequences with probability of failure is moderate to high.

DSAC Class IV (Priority) – Dams are inadequate with low risk such that the combination of life, economic, or environmental consequences with a probability of failure is low and the dam may not meet all essential USACE engineering guidelines.

DSAC Class V (Normal) – Dams considered adequately safe, meeting all essential agency guidelines and the residual risk is considered 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 most severe earthquake that can be expected to occur at a given site on the basis of geologic and seismological evidence.

Earthquake, Maximum Design (MDE) – A postulated seismic event, specified in terms of specific bedrock motion parameters at a given site, which is used to evaluate the seismic resistance of man-made structures or other features at the site.

Earthquake, Operating Basis (OBE) – The earthquake(s) for which the structure is designed to resist and remain operational. It reflects the level of earthquake protection desired for operational or economic reasons and may be determined on a probabilistic basis considering the regional and local geology and seismology.

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. 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.42) 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 h

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.37) and ER 1105-2-100, Appendix C (reference A.42), 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 to below the limit, except in exceptional 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 V (Adequately Safe) 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 E.

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.

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.

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 floodwave 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.

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 exceptional circumstances, following the ANCOLD (2003) (reference A.80) 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 exceptional circumstances, following the ANCOLD (2003) (reference A.80) 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.80).

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 the Corps 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.80) 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-83). 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.71).

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, II, and III 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.

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 – A map showing areas that would be affected by flooding from releases from a dam’s reservoir. The flooding may be from either controlled or uncontrolled releases or as a result of a dam failure.

Issue Evaluation Studies – Issue Evaluation studies for dams classified in DSAC Classes II, III, and IV 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.

Lead Engineer – A professional engineer, engineering geologist, or geologist, qualified through appropriate technical training and experience, assigned the responsibility to lead the technical team members of a product delivery team. 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 dam safety studies until the completion of the modifications to the dam. (This definition is specifically for the dam safety program.)

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 shall include 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 total for specified loading scenario.

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); Annualized Life Loss (ALL).

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 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-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.

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.

Marginally safe – Safe with reservations, barely within the lowest standards or limits of safety.

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.109) 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 79,000 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 the U.S. Army Corps of Engineers with information from all 50 states, Puerto Rico, and 16 Federal agencies. The NID is available on the web at https://rsgis.crrel.usace.army.mil/apex/f?p=397:12:854569765989113.

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 periodic inspection, a potential failure modes analysis, and a risk assessment based on existing data and a minimum development of limited consequence data. The primary purposes of the Periodic Assessment are to: Confirm the DSAC classification of a project; Justify interim risk reduction measures; Provide initial input for quantitative risk reporting; Identify needed issue evaluation studies; Prioritize issue evaluation studies; Identify operations and maintenance, monitoring, emergency action plan, training and other recurrent needs; and Confirm essential USACE dam safety guidelines are met and determine if the current baseline risk is tolerable to confirm a DSAC class V.

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 shall 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 – The progressive development of internal erosion by seepage.

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 annualized 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.

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 Analysis – Risk analysis is a decision-making framework that comprises three tasks: risk assessment, risk management, and risk communication

Risk Analysis Framework – In 1995 and again in September 2007 the US Office of Management and Budget (OMB) published a memorandum (references A.82 and A.84) setting forth a set of principles (framework) to guide policymakers in assessing, managing, and communicating risk policies.

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, and Risk and Reliability Directory of Expertise, 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 Portfolio Risk Analysis (SPRA) – This analysis screens projects based on available information, to expeditiously identify the highest risk dams requiring urgent and compelling action (Dam Safety Action Classification Classes I and II 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 III – IV. SPRA does not provide sufficient information to confirm whether a dam can be placed in Dam Safety Action Classification Class V. 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.99) provides for special cost-sharing for modification of completed Corps of Engineers 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, shall be decided on a case-by-case basis by the ASA(CW). Costs incurred in modifications for dam safety assurance shall be recovered in accordance with provisions of the statute.

Seepage – The interstitial movement of water that may take place through a dam, its foundation, or its abutments.

Senior Oversight Group (SOG) – See Dam Safety Senior Oversight Group

Significant Failure Mode – 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 exceptional circumstances, following an adaptation of the ANCOLD (2003) (reference A.80) and NSW(2006) (Reference A.106) societal life safety risk guideline. For new dams or Section 216 major modifications (reference A.93), 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-97), except in exceptional circumstances, following an adaptation of the ANCOLD (2003) (reference A.80) and NSW (2006) (Reference A.106) 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.103) and (ANCOLD October 2003) (Reference A.80).

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 HQUSACE DSSC and the SOG. The Special Assistant shall 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 DSRMC 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.104). 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.

Total Annual Probability of all Failure Modes – Total estimated annual probability of failure from all failure modes associated with all loading or initiating event types.

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 the Corps 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 the Corps 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.105)

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.

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. See also definition for 'Concept of Disproportionality' for further insight.

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.