



US Army Corps  
of Engineers®

# ENGINEERING AND CONSTRUCTION BULLETIN

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## Subject: Periodic Assessments for Dam Safety

**Applicability:** Directive and Guidance. The US Army Corps of Engineers (USACE) will use this as an interim directive and guidance for Periodic Assessments as required on Civil Works structures including dams, navigation structures and other water control facilities. Content of this Engineering and Construction Bulletin (ECB) will be incorporated in a revision of Appendix W and to a lesser extent in Chapter 11 of the Safety of Dams – Policy and Procedures (ER 1110-2-1156).

### 1. Introduction

The ongoing routine dam safety activities form the cornerstone of the USACE dam safety program. This includes normal day to day monitoring and maintenance as well as periodic in-depth inspections and assessments. An important part of these activities is an assessment of risks, which occurs during the Periodic Assessments (PA). These will normally be conducted on a 10-year cycle. Given the large number of projects to be assessed and the limited budgets and resources to conduct these assessments, a more efficient streamlined process has been developed and vetted using a pilot PA program.

The guiding principles for the PA process are as follows:

- Apply a higher level of rigor to further identify and refine project risks, assess the Dam Safety Action Classification (DSAC), and help prioritize activities within a given DSAC.
- Perform the PA in conjunction with a Periodic Inspection (PI), where possible, for economy.
- Perform the majority of work on-site or at the district office.
- The district provides a PA team leader and a PA team that will be facilitated by an RMC-approved facilitator (i.e., this is a district not a “cadre” activity).
- Assess risks in a qualitative or semi-quantitative manner.
- Prepare a complete, concise and focused draft report before the facilitator leaves the site or district office (approximately 7 to 8 days on-site).

Life safety is the primary focus of the PA consequence evaluations. However, economic, environmental, and other consequences will be discussed. This will be particularly important for navigation projects where loss of navigation could have significant economic consequences.

The FY 2012 PA's using this streamlined process have been selected. An RMC Program Manager will work with the district on what projects will have PA's done in FY 2013 and beyond. Part of the PA process in FY 2012-13 will be the development of enough facilitators, through classroom and on-the-job training, to be able to begin completing approximately 1/10<sup>th</sup> of the Civil Works Structures requiring PA's in FY 2014.

## 2. Purpose

The USACE risk management process resulted in assignment of a DSAC for each project. In many cases, the data used for initial classification came from the Screening Portfolio Risk Analysis (SPRA) process. The SPRA was an efficient approach to initially assess the large USACE portfolio, but was quick and limited. The PA applies a higher level of rigor to further identify and refine project risks.

The PA consists of a PI, a Potential Failure Mode Analysis (PFMA), and a risk assessment. The risk assessment is based on existing data and limited development of estimated consequences. It is completed by a facilitated team consisting mostly of district personnel. The PA is a chance to evaluate the design, analysis, construction, and condition of a dam project, and the results of SPRA or previous risk assessments results in more detail. The outcome and purpose of the evaluation is as follows:

- Evaluate the project vulnerabilities and associated risks, including non-breach risks.
- Reevaluate and verify or recommend a change to the DSAC.
- Review and revise the Interim Risk Reduction Measures (IRRM), if necessary.
- Identify O&M, monitoring, emergency management, training, and other ongoing needs.
- Identify and prioritize any data collection, analyses, and study needs.
- Provide a better understanding of vulnerabilities and a basis for future dam safety inspections and activities.

## 3. Report

The district is responsible for preparing and assembling the report and appendices. A draft report will be provided by the district's PA team to their Dam Safety Program Manager (DSPM) before the team is disbanded and the facilitator leaves the district office. Some of the report documentation will be prepared by the district prior to the PFMA, and some will be prepared by the PA team at the district office following the PFMA and risk assessment. The chapters are prepared in a modular format (i.e., separate files) with minimal formatting to facilitate report assemblage into the district's preferred format. The report will be organized into the following chapters and appendices:

- Chapter 1 (Major Findings): Recommended DSAC and justification, risk assessment results, significant findings, as well as the traditional PI findings (e.g., uncorrected deficiencies from previous PI, project condition based on PI results, major PI findings, and PI schedule), and non-breach risks.
- Chapter 2 (Description of Dam and Operations): Authorized project purposes, physical description of the project, and reservoir operations.
- Chapter 3 (Previous Risk Assessments): Summary of the existing DSAC and previous risk assessment findings.
- Chapter 4 (Periodic Inspection): Traditional periodic inspection findings.
- Chapter 5 (Hydrologic Hazard): Brief summary of the current PMF and spillway design flood, pool-frequency curve, pool-duration curve, tailwater rating curve, etc.

- Chapter 6 (Seismic Hazard): Brief summary of the seismic setting, source zones, seismic hazard curve (from USGS or site-specific if available), PHA for common return periods up to an AEP of 1E-04/year, etc.
- Chapter 7 (Consequences): Brief description of the downstream impacted area, population estimates, existing inundation mapping, issues related to detection and evacuation, existing evaluations of population at risk, estimated life loss and economic consequences based on information provided by the MMC Production Center, etc.
- Chapter 8 (Risk-Driver Potential Failure Modes): Summary of each potential failure mode judged to be a risk-driver, in which the following information is documented: complete description from initiation to breach; pertinent background and performance data; factors that make the failure mode more or less likely to occur; failure likelihood category, rationale, and confidence; and consequence category, rationale, and confidence.
- Chapter 9 (Conclusions and Recommendations): Complete list of findings and understandings, recommendations (e.g., modifications to the existing surveillance, monitoring, and inspection plan and/or IRRM plan and additional data, studies, or analyses), and traditional PI recommendations (e.g., O&M, monitoring, emergency action plan, training, and other recurrent needs); a numbered list of all recommendations and an indication whether they would be O&M or Wedge funded. O&M recommendations should also be prioritized according to the DSPMT priority code.
- Appendix A (Excluded Potential Failure Modes): Overview of the failure modes that were considered to be non-risk drivers and the rationale for excluding them from further consideration in the risk assessment.
- Appendix B (Monitoring and Instrumentation Data): The instrumentation data for a PA should extend at least back to when the dam was constructed and if available groundwater data from pre-construction should be included. The data should include precipitation and tailwater data and be parsed according to time periods that correspond to key milestones such as end of construction, first filling, major modifications, and changes in operations. Further guidance on the presentation of monitoring data is provided on the RMC website.
- Appendix C (Summary of Intermediate Inspections)
- Appendix D (Periodic Inspection Photographs)
- Appendix E (Periodic Inspection Notes or Trip Reports)
- Appendix F (References)
- Appendix G (DQC and RMC Review Documentation)
- Appendix H (Other)

PA implementation guidance will include example report chapters and reference tools provided to the facilitators and districts' PA teams and to assist with the report preparation. In addition, a non-FOUO releasable Dam Safety Inundation Fact Sheet will be prepared by the district to summarize the results.

#### 4. Overall Workflow

Proper scheduling and sequencing of the PA activities by the PA team lead will be critical due to the need to engage the facilitator, the engineering staff, the site operations staff, and MSC personnel. The general PA workflow is summarized in the following paragraphs.

Advanced preparation by the district is required to collect all background data and prepare draft versions of some of the chapters of the PA report. The district's PA 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, PI reports, Water Control Manual, Emergency Action Plan (EAP), etc. Scanning all background data and uploading to RADS II is required for electronic archival purposes. Filenames should be descriptive and indicative of the content. A reference list of all background data needs to be prepared by the district. Chapters 2, 3, 5, 6, and 7 of the PA report shall be prepared by the district based on existing data. The facilitator and district's PA team members will review the project design, construction, and performance records, previous risk assessments, flood and earthquake loading, and estimated consequences prior to the PFMA and risk assessment.

A site visit by the district's PA team and facilitator is required for the PFMA and risk assessment. Therefore, the PA will generally be accomplished in conjunction with a PI for economy. In these cases, there is no additional cost for the site visit. The facilitator and accompanying specialists will spend a few hours visiting locations associated with potential vulnerabilities but typically will not walk the entire dam from toe to toe, which will be done during the inspection by the PI team. Because the duration of the PI and proximity of the projects to the district office can vary greatly, it may not be practical to schedule the site visit, PFMA, and risk assessment in conjunction with the PI. In addition, it is envisioned that some PA's will be performed outside the normal PI schedule to accommodate unusual performance issues or other issues that need to be evaluated further to verify or re-establish priorities.

Typically the facilitator and district's PA team will spend some time at the site or district office reviewing hard-copy files of background data before starting the PFMA. The district's PA team will then participate in facilitated PFMA and risk assessment. After the risk assessment is complete, the PA team will re-evaluate the DSAC rating and justification, develop recommendations for further studies based on DSAC rating, re-evaluate IRRM's, and prioritize routine recommendations. Before the facilitator departs the district, the PA team will prepare portions of the other sections of the draft PA report (Chapters 1, 8, 9, and Appendix A) that do not require additional time to complete by the district. The district will be responsible for incorporating the results of the field inspection into Chapter 4. The following sections provide more details on the responsibilities and procedures for each step listed above.

#### 5. Responsibilities

District's PA Team Leader: The district will select a team leader (coordinator) to lead the PA team and coordinate with the facilitator and any other experts needed from outside the district to accomplish the completion of a PA according to this guidance document. The PA team leader will also coordinate the DQC review.

District's PA Team: The district's PA team will consist of appropriate in-house experts from engineering and operations including field personnel who will participate in the facilitated PFMA and risk assessment. Other dam experts from outside the district may also be called upon to participate. The team shall compile

all background data and upload it to the RADS II website. The team shall prepare draft versions of some of the chapters of the PA report and review the background data prior to the PFMA, participate in the PFMA and risk assessment, and prepare the remaining report sections upon completion of the risk assessment.

Modeling, Mapping, and Consequence (MMC) Production Center: The MMC Production Center shall provide baseline consequence estimates, warning time sensitivities for life loss estimates, and inundation mapping products.

Risk Management Center (RMC): The RMC will help identify dams for PA's each year, coordinate with the MMC Production Center to develop breach and on-breach consequence estimates, and assign facilitators. The RMC shall coordinate a consistency review in which all PA reports completed between Senior Oversight Group (SOG) meetings are reviewed concurrently for consistency with respect to their evaluations, recommendations, and documentation before presenting the results to the SOG. A member of the consistency review panel will typically present results from all PA's reviewed at that time to the SOG. The RMC will also prioritize the non-routine recommendations from the PA's related to Wedge funding on a national level considering DSAC rating as well as other important factors.

Facilitator: The RMC-approved facilitator will verify appropriate district staff is assigned to the PA team. The RMC may provide additional technical specialists if needed. The facilitator will coordinate with the district's team lead on logistics and scheduling of the site visit, PFMA, and risk assessment. The facilitator shall facilitate the PFMA and risk assessment, participate in the District Quality Control (DQC) review; and certify the report to document the PA team's concurrence.

District Dam Safety Officer (DSO): The district DSO shall approve the PA report and may present the results to SOG in controversial cases. The district DSO approves of the PA recommendation on the DSAC. The DSAC decision is responsibility of the HQ DSO. The district DSO shall coordinate with PPPMD and Operations Divisions to develop schedules and any funding prioritization for routine recommendations. The DSO should coordinate with the RMC, who is responsible for prioritization of Wedge funded activities, for the schedule and funding of non-routine recommendations. The DSO shall assure this process is used to educate their technical staff on how to complete the PFMA and risk assessment portions of the PA.

## **6. Consequences**

Dam failure consequences include life loss, destruction of downstream property, loss of project benefits, environmental damage, and socio-economic impacts. For PA's, the focus will be on the potential for life loss, with the idea that the broader socio-economic, environmental, and property damages would be generally commensurate. Consequences related to loss of navigation will also be considered and described for navigation projects. Information from the MMC Production Center will be used to estimate breach and non-breach consequences.

## **7. Potential Failure Mode Analysis**

The first, and perhaps the most critical, step in any dam safety risk assessment involves identifying and fully describing potential failure modes based on an evaluation of a dam's vulnerabilities. If this first step is not done in a diligent and thorough manner, it doesn't matter what is done for the rest of the risk

assessment. The results will have significantly less value, and may even lead to incorrect or unsubstantiated conclusions.

A facilitator will guide the team members in developing the potential failure modes, based on the team's understanding of the project vulnerabilities resulting from the data review and current field conditions. After the list of credible potential failure modes has been developed, a key step for the PA team is to identify the potential failure modes that are considered to be risk-drivers. These are the potential failure modes that the team judges will have the highest risk. Identifying the risk-drivers requires that the team critically compare all of the vulnerabilities identified in the data review and observed in the site visit. This step optimizes efficiency by having the team focus its efforts in the risk assessment on the more important potential failure modes. All identified potential failure modes and their evaluation will be documented in the report or appendix. More details will be provided in the PA implementation guidance.

## **8. Risk Assessment**

For PA's, failure will be defined in general as an uncontrolled, potentially life-threatening release of the reservoir. Breach of many navigation projects may not result in life-threatening flows. Therefore, loss of navigation will be considered for these projects, along with life-threatening flows if the hazard potential classification is high.

A risk assessment will be performed for the potential failure modes judged to be risk-drivers. For breach considerations, the incremental risk (due to breach) includes a consideration of both failure likelihood and consequences. The likelihood of failure is a function of both the likelihood of the loading condition that could lead to the failure and the likelihood of failure given the loading condition. During the risk assessment, a failure likelihood category (which includes the likelihood of the loading), and a consequence category (based on estimated consequences provided by MMC Production Center and the team's judgment) were assigned to each risk-driver potential failure mode. The evaluation of each risk-driver potential failure mode was documented as well as the team's confidence in the selected categories. The failure likelihood and consequence categories were used in an attempt to delineate the potential failure mode relative to the tolerable risk guidelines. This information will be used to help justify the recommended DSAC rating.

The risk assessment will also identify and portray the non-breach risks associated with normal operational releases. This generally involves identification of releases that would exceed the downstream channel capacity, overtop any downstream levees (assuming no breach), maximum releases and freeboard that would occur during the Inflow Design Flood (IDF) if the dam is not overtopped or the threshold flood prior to overtopping if the IDF cannot be passed. The frequency of the flood and the estimated consequences associated with the aforementioned non-breach releases were evaluated. The frequency of the flood drives the likelihood category. The consequence category is based on estimated consequences provided by MMC Production Center and the team's judgment.

More detailed information on the categorization of the likelihood of failure and estimated consequences as well as on capturing the confidence the team in the selected categories will be provided in the PA implementation guidance document. This guidance will also include details on portrayal of the incremental risk (due to breach) and non-breach risk estimates.

## 9. **Quality Control**

The report shall be subjected to a District Quality Control (DQC) review. The facilitator will be included in this review and their review can be performed concurrently with the DQC. An additional signature sheet will be used to document the PA team's concurrence and the facilitator's certification. Upon completion of the QC review, the report will be submitted to the district's Dam Safety Officer (DSO) for approval and sent to the MSC DSO for concurrence. A consistency review will be coordinated by the RMC in which all PA reports completed between Senior Oversight Group (SOG) meetings are reviewed concurrently for consistency with respect to their evaluations, recommendations, and documentation before presenting the results to the SOG. This may result in the need to amend the report in some cases. A member of the consistency review panel will typically present results from all PA's reviewed at that time to the SOG. The DSO is welcome to present results to SOG in controversial cases.

## 10. **Schedule**

Generally, a PA will be performed once every 10 years unless the MSC DSO in coordination with the RMC recommends a more frequent schedule. Projects that have an active Issue Evaluation Study (IES) or Dam Safety Modification Study (DSMS) in progress may be excluded from the PA process until 10 years after approval of the IES or DSMS report. Intervals in excess of 10 years require approval by the USACE DSO. Dams which are under construction for risk-reduction actions may be excluded from a PA until modifications are complete. Additional intermediate inspections are required on such dams.

Scanning all background data, uploading to RADS II, and preparation of Chapters 2, 3, 5, 6, and 7 of the draft PA report shall be prepared by the district at least 30 days prior to the site visit. The overall on-site duration of the PA will depend on the level of complexity of the project. The PA team and facilitator will likely spend 7 to 8 days at the site or district office completing the PFMA, risk assessment, and draft PA report.

Scheduling PA's and facilitators will be a challenge. Therefore, it is essential that districts keep their PI and PA schedules updated in the Dam Safety Project Management Tool (DSPMT) software, as this will be used for scheduling projects and facilitators.

## 11. **Funding of PA's and Resulting Recommendations**

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. The PA will require additional effort by the district (when compared to a PI) as highlighted in this document.

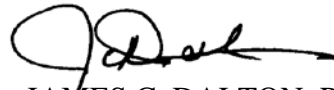
The district will budget for the expense of the PA through normal O&M processes. The cost of the facilitator will be funded by the RMC. The cost of the PA will vary depending upon the quality of existing data, district preparation, and complexity of the project. The estimated costs shown below are provided for consideration in the development of budget submissions for PA's to be done in FY 2014. They exclude the costs associated with a traditional PI and assume the site visit will be performed in conjunction with the PI. Larger costs are typically associated with additional travel costs when the site is distant from the district office.

Typical Budget Request for PA-portion (excludes traditional PI costs)

Background Data	\$5,000	to	\$10,000
Report Preparation (Chapters 2, 3, 5, 6, and 7)	\$5,000	to	\$10,000
PFMA and Qualitative Risk Assessment (Chapter 8, portions of Chapters 1 & 9, Appendix A)	\$15,000	to	\$45,000
Technical Review	\$1,000	to	\$6,000
Total	\$26,000	to	\$71,000

Approved PA reports will be forwarded to district Operations Divisions for implementation of any routine recommendations. The district DSO shall coordinate with PPPMD and Operations Divisions to develop schedules and any funding prioritization for routine recommendations. The district DSO should coordinate with the RMC, who is responsible for prioritization of Wedge funded activities, for the schedule and funding of non-routine recommendations.

12. The implementation point-of-contact for this action is the district DSPM. The HQ technical proponent is Travis Tutka, Acting HQUSACE DSPM, 202-761-4643.



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