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	Engineering and Design  DAM SAFETY ASSURANCE PROGRAM	
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Regulation  
No. 1110-2-1155

12 September 1997

Engineering and Design  
DAM SAFETY ASSURANCE PROGRAM

## 1. Purpose

This regulation provides guidance and procedures for the investigation and justification of modifications for dam safety assurance at completed Corps of Engineers projects, under the authority of Section 1203 of the Water Resources Development Act of 1986 (P.L.99-662).

## 2. Applicability

This regulation applies to HQUSACE elements, major subordinate commands (MSC), districts, and field operating activities having responsibility for civil works projects.

## 3. References

See Appendix A for references.

## 4. Distribution

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## 5. Program Parameters

a. The Dam Safety Assurance Program provides for modification of completed Corps of Engineers dams and

related facilities, when deemed necessary for safety purposes due to new hydrologic or seismic data or changes in the state-of-the-art design or construction criteria.

b. In order to qualify, the modifications must be within the Chief of Engineers' discretionary authority to rectify plus meet the eligibility requirements described below. Projects approved under the Dam Safety Assurance Program will require a Dam Safety Assurance Program Evaluation Report, budget justification and other supporting data in accordance with the annual budget Engineer Circular as described in ER 5-7-1(FR). Generally, existing project authorities are considered sufficient to permit improvements to the project for safety purposes, if such improvements do not alter the scope or function of the project or substantially change any of its specifically authorized purposes.

c. Project modifications that will require additional authorization may be studied under the authority of Section 216 of the Rivers and Harbors Act of 1970, following the

guidance in Chapter 2 of reference 8. Modifications to project features, which do not qualify under this regulation, will continue to be accomplished under the programs funded by the Operations and Maintenance, General, or Flood Control, Mississippi River and Tributaries (FC,MR&T) appropriations, respectively.

## 6. Eligibility

a. Examples of project features eligible for modification under this program follow:

(1) Modifying existing or constructing new facilities to provide stable and adequate discharge capability to safely pass the Inflow Design Flood (IDF), as defined in ER 1110-8-2(FR), reference 18.

(2) Raising the dam height to prevent overtopping during occurrence of the IDF.

(3) Increasing structural stability of the dam, foundation, abutments, and equipment support or other structures to withstand hydrologic, hydraulic, and/or seismic loading.

b. Dams designed and/or constructed by the Corps of Engineers and turned over to others for operations and maintenance may be modified under this program.

c. Modifications to projects may be proposed for

inclusion in the Dam Safety Assurance Program by submitting a letter report requesting that the project be placed on the HQUSACE high priority list if all of the below conditions exist. The request should include a brief write-up describing the dam safety problem and a summary of the proposed remedial measures and a pertinent data sheet.

(1) The work is required for continued safe operation of the project for its authorized purposes.

(2) The work does not include additions or betterments which constitute a change in project scope, function or authorized purposes.

(3) The work meets applicable criteria, as specified for dam safety assurance projects in the budget EC, for the budget year in which it is to be initiated.

d. The total average annual benefits of the existing project should be greater than the annual costs of the modification plus additional operation, maintenance, repair, replacement and rehabilitation (OMRR&R), if any. In the event that the benefits do not exceed the costs, consideration will be given to breaching the dam and the rationale for not selecting the breaching option will be

provided if improvement is recommended.

## 7. Policy on Hydrologic Criteria

The following policy is used as a basis to make decisions on the merits of dam safety modifications to meet current hydrologic criteria:

a. *General.* Dam safety modifications related to hydrologic deficiencies should be recommended to meet or exceed the Base Safety Condition (BSC). The BSC is met when a dam failure related to hydrologic capacity will result in no increase in downstream hazard over the hazard that would have existed if the dam had not failed. Recommendations for any modifications that would accommodate floods larger than the flood identified as the BSC must be supported by an analysis that presents the incremental costs and benefits of the enhanced design in a manner that demonstrates the merits of the recommendation.

### b. *Discussion.*

(1) Planning for dam safety assurance program modifications will consider combinations of structural design modifications as well as nonstructural measures, including downstream actions and changes in water control plans. The recommended plan, except when circumstances noted in paragraph 7c(3) below apply, should be for the dam

safety modification which meets or exceeds the BSC. Recommendations for modifications that would accommodate floods larger than the flood identified as the BSC will require additional analysis as described in paragraph 7b(3)(b) and 7c(2) below.

(2) Determination of the flood that identifies the BSC will require definition of the relationship between flood flows and adverse impacts with and without dam failure for a range of floods that fully utilizes the existing structure up to the Probable Maximum Flood (PMF). Selection of a BSC predicated on the hazard to life from dam failure requires supporting information to demonstrate that the safety of the population would actually be threatened. The evaluation should distinguish between total population downstream of a dam and the population that would likely be in a life threatening situation given the extent of prefailure flooding, warning time available, evacuation opportunities and other factors that might affect the occupancy of the incrementally inundated area at the time the failure occurs. Appropriate freeboard necessary to accommodate potential wind and wave conditions will be included for all flood evaluations.

(3) The evaluation consists of two phases.

(a) Phase I is a comparative hazard analysis in which the Threshold Flood (TF) and the BSC are established. The TF is the flood that fully utilizes the existing dam, i.e., the flood that just exceeds the design maximum water surface elevation at the dam (top of the dam minus freeboard). The BSC is determined by comparing the loss of life for various floods, expressed as percentages of the PMF, with and without dam failure. PMF is determined in accordance with standard hydrometeorological procedures. The flood, expressed as a percentage of PMF, for which loss of life is not different for with and without dam failure conditions, is the BSC, but should never be more than 100% of the PMF.

(b) Phase II is the risk-cost analysis required if modifications for a flood greater than the BSC are recommended. This is the more traditional risk analysis where the costs of making the improvements are balanced against the economic losses expected from collapse of the structure. Those losses include the cost of additional downstream damage, the cost of repairing the dam, and the cost associated with the loss of project services.

c. *Policy Implementation.*

(1) A detailed description of the Phase I analysis, including examples,

is given in reference 23. The organization and display of the data is a vital component of this "comparative hazard analysis" phase, enabling a comprehensive overview of the key considerations and decision variables.

(2) The Phase II risk analysis is like a multi-objective decision problem. The justification for increasing the level of dam safety beyond the BSC as a design criterion will be based on a more subjective weighing and trading off of a number of intangibles and engineering reliability and social factors. These may include, but are not limited to, unique location and population concentration factors, and unique national interest of the specific area that would be affected. The justification for increments of additional safety beyond the BSC requires that the additional risk reduction be explicitly balanced against increased costs. It is imperative that the display of data and weighing rationale is clear so that others in the decision chain can reach an independent conclusion.

(3) Selection of a recommended level of modification should also reflect traditional concerns for economy. Modification costs in the vicinity of the scale of improvement identified as the BSC should be examined for sudden increases in the cost/scale of

improvement relationship. This type of change could occur, for instance, when a costly highway relocation is encountered near the scale of improvement identified as the BSC. An adjustment in the level of fix recommended may be warranted under these conditions. On the other hand, the large increase in costs may be justified if a significant reduction in the hazard with versus without dam failure is achieved.

(4) Conduct of the analysis will require careful application of professional judgement for determining those parameters where data and modeling capability are limited. Therefore, the importance of documenting the logic of the assumptions that are critical to the conclusions and recommendations drawn from the analysis cannot be overemphasized. Also, the evaluation will produce a significant amount of information that can be used throughout the decision-making process, particularly in those cases where it is appropriate to proceed beyond the BSC. The information should be displayed in a format that assists the decision maker when evaluating the important trade-offs involved.

#### 8. Policy on Seismic Criteria

The following policy will be used to make decisions on the merits of dam safety modifications related to

current earthquake design criteria:

a. *General.* Projects that retain or have the potential to retain a pool, failure of which would result in loss of life, substantial property damage, or indirect loss such as the loss of essential emergency services provided by the dam, are required to survive and remain safe during and following the maximum credible earthquake (MCE) event. Such projects must also be capable of remaining operational with only minor repair during and after an operating basis earthquake (OBE). Minor repair is that which can be accomplished within operation and maintenance limitations. In those instances where a combination of events is required before failure would occur (e.g., both an earthquake and a flood), a combined risk analysis should be prepared.

#### b. *Discussion.*

(1) Technical requirements for selecting seismic design values and performing design analyses are periodically updated in Engineering Circulars. These criteria, along with current state-of-the-art techniques, are intended to be used in such studies and analyses. Criteria levels, safety factors, and design methods are the same as that for new projects unless specifically noted as being different in

technical guidance documents or by written direction from HQUSACE.

(2) Since judgement of ground motion parameters for design is based on geologic and seismic history, future strong seismic events may raise the design values against which stability is analyzed. Should such a situation occur, the district, if convinced that the ground motion parameters have changed significantly enough to affect safety of the project, shall prepare an evaluation report as provided for in paragraph 11 and Appendix B or Appendix F of this regulation.

(3) Strong motion accelerometers placed on or around Corps dams are intended to record ground motion at the site and verify the seismic design of the structure. If these instruments record ground motion parameters that (after analysis) are found to be below the values used in design, but yet the structure received damage, the occurrence and recommendations for action need to be documented. If no action is recommended, a letter report will be prepared and submitted through the MSC to HQUSACE, ATTN: CECW-E. If action is anticipated, an evaluation report will be prepared and submitted IAW the guidance herein.

(4) Seismic stability of auxiliary structures and devices, such as regulating

outlets, regulating outlet towers, spillway gates, retaining walls, hydraulic equipment, and electric supply, both permanent and standby, shall be analyzed and modified in accordance with ER 1110-2-1806, where necessary to provide for the dam safety policy of subparagraph 8a above, including requirements for dams to remain operational following the OBE. Auxiliary structures that do not affect dam or operational safety, shall be judged for modification on economic or other grounds.

(5) Seismic stability assessment for dam safety may also involve reservoir rim slides, critical retaining walls, foundation or abutment changes, or any other feature that might contribute to dam failure.

#### 9. Policy on Changes in State-of-the-Art Design or Construction Criteria

Modifications required on a project due to State-of-the-Art changes, but not related to hydrologic or seismic deficiencies as discussed in paragraphs 7 and 8 above will be decided on a case-by-case basis. Correction of seepage through an embankment, or an inadequate structural feature will be submitted under the Major Rehabilitation Program or the Operation and Maintenance Program.

#### 10. Policy on Cost Sharing

a. *Legislation.* Section 1203 of WRDA 1986 requires that costs incurred in modifications for dam safety assurance shall be recovered in accordance with provisions of the statute. Repayment 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 will be recovered by the Secretary of Interior in accordance with Public Law 98-404.

b. *Sponsor Identification.*

(1) Requirements for cost sharing sponsorship, and the identification of non-Federal sponsors must occur early in the study process, to insure that the non-Federal interests are willing cost sharing partners. Uncertainty about sponsorship and lack of meaningful sponsor involvement in the scope and extent of dam safety repairs will delay dam safety assurance 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 must be forwarded to HQUSACE, ATTN: CECW-A, for approval.

(2) Dam safety assurance evaluation reports will 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.

c. Fifteen percent of the cost of the dam safety modification will be allocated among purposes and shared with the appropriate project sponsors. General procedures for determining the amount of sponsor cost are outlined in the following subparagraphs:

(1) Projects with a Formal Cost Allocation. In this case, 15% of the cost of the modification for dam safety assurance will be allocated among project purposes in the same percent as the construction expenditures in joint-use facilities are allocated in the cost allocation currently in effect. 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. 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. 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  $[(\$15,000,000 \times 0.15) \times 0.45]$ . If there was no sharing of the initial construction costs allocated to flood control, all of the modification costs assigned to flood control would be Federal. If a sponsor shared in the initial construction costs allocated to flood control, the dam safety costs assigned to flood control would be shared on the same percentage basis. In cases where storage is reallocated from flood control 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  $[(\$15,000,000 \times 0.15) \times 0.015]$ .

(2) Projects without a Formal Cost Allocation, but with a Signed Project or Local Cooperation Agreement. A cooperation agreement for the initial project construction may contain an allocation or assignment of costs among project purposes. For projects with this type of agreement, 15% of the cost of the dam safety modification will be assigned to project purposes in the same manner as costs were allocated for the project or local cooperation 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 percent of total cost. As before, assume a dam safety modification of \$15,000,000; a local cooperation 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  $[(\$15,000,000 \times 0.15) \times 0.05]$ .

(3) Projects without a Formal Cost Allocation or a Signed Project or Local Cooperation Agreement. In most cases where there is no signed agreement, there was some sort of a letter of intent at the time of construction which indicated what local interests would provide, such as lands, easements, rights-of-way or

relocations. These projects will require a review of letters of intent or other documentation of arrangements for provision of relocations, etc., 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 a cash contribution, the value of the work or the contribution should be converted to a percent of total project initial cost. Fifteen percent of the cost of dam safety modification will be shared in the same percentage as the percentage of total project initial 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 costs of construction, if available. For example, if the actual construction cost was \$50,000,000, and non-Federal interests contributed LERRD (Lands, easements, rights-of-way, relocations and disposal areas) 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  $[(\$15,000,000 \times 0.15) \times 0.01]$ .

(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.

d. *Cost Recovery.*

Recovery of the non-Federal share of the dam safety assurance modification cost will be determined by the current arrangement for project cost recovery. For costs which are reimbursable through the sale of power, the share of dam safety cost will be reported to the power marketing agency for recovery in the same manner as major rehabilitation costs. For cost sharing based on a project cooperation agreement which 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. Where the project cost sharing was based on a letter of intent, an agreement will be negotiated with the sponsor. 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. If no current agreement addresses this cost, the sponsor may elect to repay the cost, with interest, over a period up to 30 years in accordance with 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.

#### 11. Reporting Requirements.

In order to identify and process work under the Dam Safety Assurance Program, a report must be prepared that documents the analysis and evaluation processes that were made for those work items meeting the policy requirements of this regulation. The content of the report is set forth in the following subparagraphs:

a. *Report.* The report will be called Dam Safety Assurance Program Evaluation Report. It will be prepared following the format shown in Appendix C. This report is the decision document that must be approved by HQUSACE before initiation of detailed design leading to the preparation of the plans and specifications.

The procedure and contents of the geotechnical investigation for embankment dams will be conducted in accordance with Appendix B. The structural section will be prepared in accordance with Appendix F. Both will be appended to the report. Detailed field investigations and office studies will be limited to those necessary to evaluate the need to modify a dam and related facilities, and to recommend further action. The report should be designed to develop a basis for decision on: (1) the need for and justification of the proposed modification for dam safety; (2) the appropriateness of funding under the Dam Safety Assurance Program; (3) whether the work requires additional authorization; (4) whether the work is subject to cost-sharing, and identification of the cost sharing partner, and the potential sponsor's willingness to cost share; (5) the scope and cost of design requirements; and (6) the estimated cost for construction. In those instances where there is need for a special engineering investigation required by detailed design effort, i.e., hydraulic modeling, structural modeling and testing, they should be identified in the report. A plan of study and cost estimate for these special efforts should be included. See paragraph 15a for funding guidance on the evaluation investigation and report preparation.

b. *Engineering Investigations.* Engineering investigations required to support the proposed modification for dam safety are set forth in the following subparagraphs:

(1) *Hydrologic/Hydraulic Investigations.* Hydrologic/hydraulic investigations are accomplished to determine the design that will meet the dam safety requirements. Investigations generally include hydrologic modeling, hydrograph routings, determination of the probable maximum flood and base safety condition, freeboard design requirements and other site specific hydrologic/hydraulic investigations. Documentation of these investigations will be included in the Hydrologic and Hydraulic Section of the report.

(2) *Geotechnical/Structural Investigations.* In order to provide a rational, cost-effective approach to the requirements of ER 1110-2-1806, a study is performed in three parts consistent with the regulation. Phases I and II will be included as subsequent appendices to the Dam Safety Assurance Evaluation Report and performed with Operations and Maintenance funds. Phase III study activities are normally performed with Operations and Maintenance funds after approval of the Report, as part of detailed engineering and design activities leading to the

preparation of the plans and specifications. The Phase I report develops information needed to assess the potential for seismic instability and to provide a basis for requesting approval to continue with a detailed study of seismic stability (Phase II) using state-of-the-art dynamic methods. Phase III consists of preparing design documents, plans and specifications for remedial measures, if warranted.

12. Transmittal and Review of the Dam Safety Assurance Program Evaluation Report.

a. Ten copies of the report will be transmitted by the district, after a rigorous technical review, to HQUSACE (CECW-AR) for policy compliance review and approval. One copy of this decision package will also be sent to the HQUSACE Dam Safety Officer (CECW-E) and one copy to the MSC Dam Safety Officer. Once the report is transmitted, further work on the project may be accomplished only upon approval from HQUSACE.

b. The HQUSACE Dam Safety Officer has approval authority on these reports. The Dam Safety Officer will notify OASA(CW) of report approvals.

c. Following report approval, the district may use available Operation and Maintenance (O&M), General funds to proceed with engineering and design activities, which will begin

with the preparation of a design memorandum. The district may also budget for construction new start funds under the Construction, General appropriation. Refer to paragraph 15 for additional funding guidance, including information on the Mississippi River and Tributaries account.

13. Design Memorandum.

Preparation of DMs will follow the guidance in reference 11. The format of the DM should be in accordance with Appendix D.

14. Plans and Specifications.

Plans and specifications will be prepared in accordance with the requirements of reference 11.

15. Funding.

a. *Evaluation Reports.* Charges for preparation of the evaluation report may be made in two ways; against the Dam Safety Assurance Studies feature in the O&M, General account or the maintenance portion of the Flood Control, Mississippi River and Tributaries (FC,MR&T) account: (1) under the specific project name for projects maintained by the Corps of Engineers; and (2) under the category of Inspection of Completed Works for projects designed and/or constructed by the Corps of Engineers but turned over to others for operation and maintenance.

b. *Engineering Investigations.* All Phase I

and II investigations will be funded in the same manner described above.

c. *Design and Plans and Specifications.* Following approval, and based on the schedule of recommended work in the evaluation report, the O&M, General account or the maintenance portion of the FC, MR&T account may be used to continue design, and complete plans and specifications (Phase III for structural/seismic investigations) prior to receipt of construction funds.

d. *Construction.* A district will request funding for the new construction start of an approved dam safety project through the normal budgetary process. Construction or land acquisition may not commence until the DM has been approved, construction funds have been specifically allocated for the required work, and a project cooperation agreement or amendment has been executed. Dam Safety Assurance Program construction projects will be funded under the Construction, General appropriation title or the construction portion of the FC,MR&T account.

16. Hazard Potential Classification.

Appendix E shows the hydrologic hazard potential (low, significant, high) losses posed by dams to life, property, lifeline, and the environment.

FOR THE COMMANDER:



OTIS WILLIAMS  
Colonel, Corps of Engineers  
Chief of Staff

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