

D.10. U.S. Fish and Wildlife Service



FEMA

**FISH AND WILDLIFE SERVICE
ENGINEERING AND CONSTRUCTION**

Engineering and Construction

Part 361 Dam Safety

Chapter 1 Policy and Responsibilities for Dam Safety

361 FW 1

1.1 What is the purpose of this chapter? This chapter describes the policy and division of responsibilities for managing the Fish and Wildlife Service's (Service) Dam Safety Program.

1.2 What is the Service policy? Our policy is to:

- A.** Ensure that no dam creates an unacceptable risk to public safety and welfare, property, the environment, or cultural resources, and
- B.** Maintain high standards in the practices and procedures we use for planning, engineering design, construction, repairs, operation, maintenance, emergency preparedness, and evaluation of existing dams.

1.3 What are the authorities for the Dam Safety Program?

- A.** National Dam Inspection Act of 1972 (Public Law 92-367).
- B.** Executive Order 12148, Federal Emergency Management, July 20, 1979.
- C.** Water Resources Development Act, Dam Safety Act of 1986 (Public Law. 99-662).
- D.** Water Resources Development Act of 1996 (Public Law. 104-303).
- E.** Federal Guidelines for Selecting and Accommodating Inflow Design Floods for Dams, Federal Emergency Management Agency 97, Interagency Committee on Dam Safety, October 1998.
- F.** Recommended Guidelines for Dam Safety--Inspection of Dams, Corps of Engineers, 1974.
- G.** The Dam Safety Act of 2006 (Public Law 109-460).
- H.** Federal Guidelines for Dam Safety, Federal Emergency Management Agency 93, April 2004.
- I.** 753 DM, Dam Safety and Security Program.

1.4 Who is responsible for the Dam Safety Program?

A. The **Director** ensures there are resources and policy in place to implement our Dam Safety Program.

B. The **Assistant Director – Business Management and Operations** is responsible for the overall integrity of our Dam Safety Program.

C. Regional Directors are responsible for:

(1) The safety and operation of facilities in their Regions, including dams, dikes, levees, and other water diversion and control structures.

(2) Budget requests for maintenance funding for dams, including routine annual maintenance and correcting Priority 1 and Priority 2 deficiencies identified in the Safety Evaluation of Existing Dams (SEED) inspections.

(3) Appointing a Regional Dam Safety Officer.

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D. The Chief, Division of Engineering is responsible for:

- (1) Managing our Dam Safety Program,
- (2) Developing and interpreting dam safety policy, and
- (3) Appointing the Service Dam Safety Officer.

E. The Service Dam Safety Officer (SDSO) is responsible for:

(1) Developing and recommending plans, technical guidelines, standards, and procedures for our Dam Safety Program.

(2) Ensuring that our Dam Safety Program complies with applicable laws, policies, and technical recommendations governing Federal dam safety activities.

(3) Preparing technical guidelines and standards for and implementing the SEED inspection and rehabilitation programs by:

(a) Performing periodic SEED inspections and notifying the Project Leader of the inspection findings,

(b) Managing and maintaining an inventory and a comprehensive database on all Service dams, and

(c) Serving as a liaison with other Service programs for dam inspections and rehabilitation.

(4) For high and significant hazard dams:

(a) Preparing budget requests for:

(i) Project planning,

(ii) Engineering design,

(iii) Analysis and studies,

(iv) Construction management for emergency repairs, and

(v) Safety rehabilitation and construction.

(b) Developing Standing Operating Procedures (SOPs) and Emergency Action Plans (EAPs) and updating them for major repairs or rehabilitation.

(c) Project planning, design, and construction for new dams and for rehabilitation, modification, or emergency repairs to existing dams.

(5) For low hazard dams, providing independent review of project planning, engineering design, and construction management for dam safety rehabilitation and construction.

(6) Serving as the Service's representative on:

(a) Dam safety technical committees,

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- (b) Departmental working groups, and
- (c) As liaison with other Government agencies.
- (7) Assisting Regional Dam Safety Officers in implementing SOPs and Emergency Action Plans.
- (8) Performing periodic Emergency Action Plan exercises (see [361 FW 2](#)).
- (9) Providing technical engineering support and expertise to the Regions.
- (10) Providing dam safety training to the Regions, Project Leaders, and dam operating staff.

F. At the discretion of the Regional Director, **Assistant Regional Directors – Budget and Administration** are responsible for providing advice and guidance to the Regional Engineers and the Regional Dam Safety Officers in their Regions in exercising their dam safety responsibilities.

G. At the discretion of the Regional Director and working through the Assistant Regional Director – Budget and Administration, **Regional Engineers** are responsible for:

- (1) Implementation and oversight of the Region's Dam Safety Program and designation and supervision of the Regional Dam Safety Officer.
- (2) Technical support and assistance to the Regional Director, Regional office supervisors, and Project Leaders for the operation and maintenance of dams within the Region.
- (3) Assisting the Regional Dam Safety Officer in developing and implementing SOPs and Emergency Action Plans.

H. Regional Dam Safety Officers (RDSO):

- (1) Must have experience in and knowledge of the planning, design, construction, safety inspection, and operation of dams.
- (2) Are responsible for:
 - (a) Providing technical support to the Regional Director to ensure that the Region's dam safety program complies with applicable laws, policies, and technical recommendations governing Federal dam safety activities.
 - (b) Providing technical assistance to Project Leaders for dam operation and maintenance.
 - (c) Assisting the Service Dam Safety Officer in developing and updating SOPs and Emergency Action Plans and assisting Project Leaders to implement them.
- (3) Are the designated emergency planning officers, who:
 - (a) Annually test, verify, update and certify Emergency Action Plans, and
 - (b) Provide technical and decisionmaking support to Project Leaders during unusual or emergency events.

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(4) Provide technical leadership and oversight of project planning, engineering design, and construction management for dam safety for low hazard inventory and non-inventory dam:

- (a) Rehabilitation,
- (b) Modifications,
- (c) Emergency repairs, and
- (d) New construction.

(5) Review observation and instrumentation data from dams, and contact the Division of Engineering and the Service Dam Safety Officer to request consultation.

I. Project Leaders are responsible for:

- (1) Operating, maintaining, and keeping the dams for which they are responsible safe.
- (2) Sending to the Regional Director funding requests for:
 - (a) Routine annual and regular maintenance,
 - (b) Operations and monitoring, and
 - (c) Priority 1 and Priority 2 recommendations identified in SEED inspections (see 361 FW 2 for more information about SEED inspections).
- (3) Ensuring operating staff are adequately trained on all relevant dam safety matters.
- (4) Ensuring the safety of employees and visitors who may be impacted by dam failure or misoperation.
- (5) Implementing Emergency Action Plans, security plans, and SOPs.
- (6) Ensuring that all of the monitoring and recording of dam instrumentation data is complete and sent to the Regional Dam Safety Officer and the Service Dam Safety Officer in accordance with SOPs.
- (7) Performing periodic informal inspections in accordance with SOPs.


DIRECTOR

Acting

Date: September 12, 2008

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2.1 What is the purpose of this chapter? This chapter describes the standards and requirements of our Dam Safety Program.

2.2 What terms do you need to know to understand this chapter?

A. Cross-dike or interior dike. A cross-dike or interior dike:

(1) Is an artificial embankment constructed to subdivide a reservoir or provide vehicular access across a reservoir,

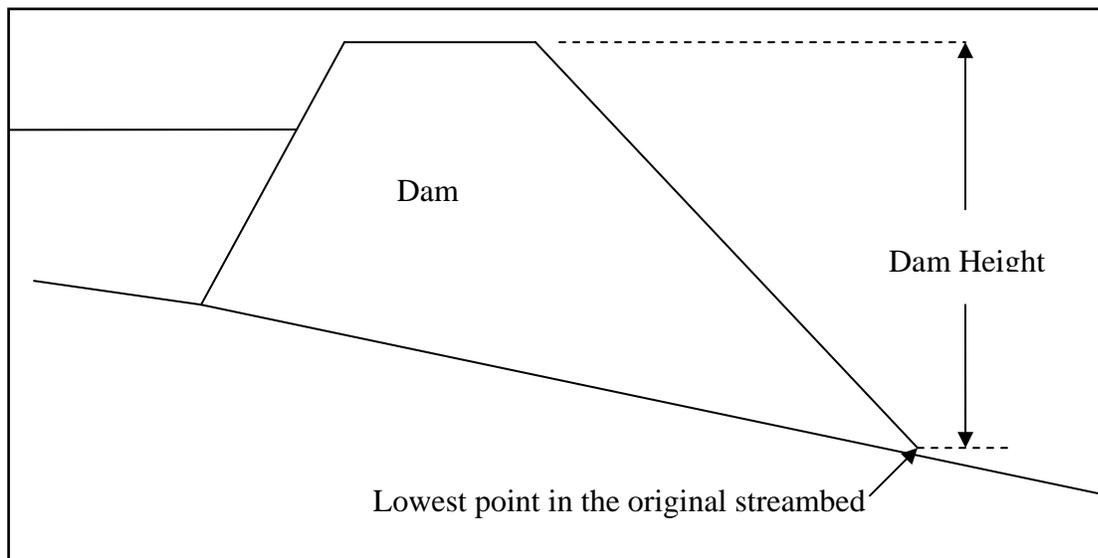
(2) Does not provide any additional water storage above the maximum storage of the dam that creates the reservoir, and

(3) May be considered a dam if the difference in the water surface elevation from upstream to downstream of the dike can be more than 3 feet.

B. Dam. A dam is an artificial barrier, including appurtenant works, constructed to impound water for permanent storage or flood control storage.

C. Dam Height. A dam's height is the vertical distance between the lowest point on the dam crest and the lowest point in the original streambed measured at the toe of the dam (see Figure 1).

Figure 1: Dam Height



D. Hazard Classification. Hazard classification is a rating based on the potential loss of life or property damage downstream of a dam if the dam were to fail or be misoperated. We do not determine hazard classification based on the existing condition of a dam and its appurtenant structures.

E. Hydraulic Height. A dam's hydraulic height is the vertical distance between the maximum design water level and the lowest point in the original streambed measured at the toe of the dam.

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F. Inflow Design Flood. The Inflow Design Flood is the rate of water coming into the reservoir over time that the dam must be able to safely pass through a combination of spillway and outlet works and attendant surcharge storage.

G. Inventory Dam. We include a dam in the Service Inventory of Dams and the National Inventory of Dams if it meets the following criteria:

- (1) It has a storage capacity at maximum water storage elevation in excess of 15 acre-feet, and:
 - (a) It exceeds 25 feet in height from the natural bed of the stream (or a watercourse) to the maximum water storage elevation measured at the downstream toe of the dam, or
 - (b) If it is not across a stream channel or watercourse, it exceeds 25 feet in height measured from the lowest elevation of the outside limit of the dam, to the maximum water storage elevation; or
- (2) It exceeds an impounding capacity at maximum water storage elevation of 50 acre-feet **and** a height measured as section 2.2 G(1) above describes in excess of 6 feet; and
- (3) It has a high or significant hazard classification.

H. Maximum Water Storage Elevation. The maximum water storage elevation is the highest elevation of water that the dam can impound, including temporary storage of flood water.

I. Maximum Design Water Level. The maximum design water level is the highest elevation of water determined as a result of safely passing the Inflow Design Flood (see section 2.15A).

J. Noninventory Dam. Noninventory dams are:

- (1) Low hazard dams that do not meet the criteria in section 2.2G, and
- (2) Interior dikes or cross dikes located within an impoundment.

K. Probable Maximum Flood (PMF). The Probable Maximum Flood is the runoff flow of water that we expect from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in a drainage area under study.

L. Structural Height. The structural height of a dam is the vertical distance between the lowest point on the crest of the dam and the lowest point of the excavated foundation.

2.3 How does the Service classify dams? We classify dams based on hazard potential and a dam's size.

A. Hazard Classification. The hazard classification for a dam gives us the minimum requirements for security, investigation, design, and construction.

- (1) The Regional Dam Safety Officer (RDSO) or a member of the Service's Dam Safety inspection team provides a preliminary hazard classification recommendation.
- (2) The Division of Engineering analyzes the hazard classification, when appropriate, in accordance with the latest version of the Federal Emergency Management Agency (FEMA) 333, Department of the Interior (753 DM), and the Bureau of Reclamation (BOR) guidelines, (i.e., Downstream Hazard Classification

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Guidelines, Assistant Commissioner Engineering and Research (ACER) Technical Memorandum (TM) #11).

(3) A hazard classification panel assigns a formal hazard classification to all Service dams by using the RDSO's preliminary hazard classification recommendation, the Division of Engineering's hazard classification analysis, and other data.

(a) The panel consists of a Service Dam Safety Officer (SDSO) designee(s), the affected RDSO and an RDSO from another Region. The panel provides a written determination to the SDSO.

(i) A majority vote of the panel is required to classify new dams, and

(ii) A unanimous vote of the panel is required to change the hazard classification of existing dams.

(b) The hazard classification panel determines the formal classification of a dam in accordance with the guidelines in section 2.3A(2).

(4) The RDSO reviews the hazard classification of low hazard inventory dams and noninventory dams at least every 6 years.

(5) The RDSO or the SDSO may request the reclassification of a dam.

B. Size Classification. The RDSO or a member of the Service's Dam Safety inspection team determines the size classification of a dam. They use the dam height or the water storage capacity at maximum water storage elevation, whichever yields the larger size classification, to determine the size of a dam.

(1) Small dams are structures that are less than 40 feet high or that impound less than 1,000 acre-feet of water.

(2) Intermediate dams are structures that are 40 to 100 feet high or that impound 1,000 to 50,000 acre-feet of water.

(3) Large dams are structures that are more than 100 feet high or that impound more than 50,000 acre-feet of water.

2.4 What is the Service's Safety Evaluation of Existing Dams (SEED) inspection program?

A. The SEED Inspection program.

(1) Purpose. The purpose of the SEED Program is to ensure protection of life and property and to assure the integrity of our inventory dams and appurtenant structures (also see The Federal Guidelines for Dam Safety FEMA 93, 2004). Periodic inspections disclose conditions that might disrupt operation or threaten dam safety.

(2) Correction of Deficiencies. We must correct any deficiencies noted as a result of inspections. The Division of Engineering will set priorities and completion dates to correct deficiencies in accordance with the relative level of failure potential and downstream consequences. To determine priorities for maintenance, repair, or removal, the Division of Engineering looks at the adequacy of structures and facilities to continue serving the purpose for which they were constructed and identifies the extent of deterioration.

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B. Types of Inspections. There are four types of inspections:

(1) Informal inspections are visual examinations carried out during day-to-day operations. They provide frequent surveillance of the general appearance and functioning of the dam and its appurtenances to identify, as soon as possible, any readily observable changes. For each high and significant hazard dam, Project Leaders and staff perform these inspections in accordance with the dam's Standing Operating Procedures (see section 2.5).

(2) Formal SEED inspections assess the safety and integrity of all aspects of a dam. Formal inspections are comprehensive searches for evidence of deterioration of materials, developing weaknesses, and unsafe hydraulic or structural conditions. Engineers perform these inspections which include:

(a) Field examinations,

(b) Photographic or video recording of all physical features,

(c) Examination of any adjacent endangering conditions,

(d) Review and evaluation of all recorded performance data, including engineering loadings, analytical methods, instrumentation and spillway discharge measurements,

(e) Evaluation of the performance of the dam and a comparison of the long-term examination record with current conditions,

(f) An overall condition rating, and

(g) Recommendations to maintain or improve the integrity of the dam.

(3) Intermediate SEED inspections are visual site investigations conducted to identify deterioration of materials, developing weaknesses, and unsafe hydraulic or structural conditions.

(a) Engineers perform these inspections which consist of:

(i) Field examinations,

(ii) Photographic or video recording of all physical features, and

(iii) Examination of any adjacent endangering conditions.

(b) Intermediate inspections do not include a comprehensive evaluation of the engineering loadings and analytical methods to predict dam performance.

(4) Special inspections are made following (or during, if possible) unusual floods, significant earthquakes, mishaps, or the appearance of unexpected dam performance. These inspections determine the extent of any damage and the need for emergency repair or other action.

C. Frequency of Inspections.

(1) Project Leaders and dam operators perform informal inspections routinely during day-to-day operations in accordance with SOPs.

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(2) The frequency of formal and intermediate inspections is based on the hazard classification of the dam.

(a) High and significant hazard dams are inspected every 3 years, alternating between a formal SEED inspection and an Intermediate SEED inspection.

(b) Low hazard dams are inspected every 6 years, alternating between a formal SEED inspection and an Intermediate SEED inspection. (The SDSO may change the frequency based on size and condition of the dam.)

(3) The frequency of special inspections depends on the occurrence of an unusual event (e.g., seepage through the dam has become turbid). Those responsible for the dam must be alert to identify situations or events that may require special inspections.

D. Reporting Dangerous or Unusual Conditions.

(1) The SEED Inspector must immediately report dangerous or unusual conditions to the Project Leader and the RDSO.

(2) In response to a dangerous or unusual condition, the RDSO must immediately:

(a) Initiate appropriate response in accordance with the dam's Emergency Action Plan (see section 2.6 and 361 FW 3), and

(b) Contact the SDSO and the Regional Safety Manager if an inspection indicates imminent danger or threat of serious injury or significant property damage.

E. Inspection Reports.

(1) Use written checklists for informal inspection reports. They contain enough information to determine whether or not further action is necessary and may be obtained from the SDSO or the RDSO.

(2) Formal and intermediate inspection reports are written reports prepared in a format consistent with established Service guidelines.

F. Inspectors.

(1) **Inspectors for Informal Inspections:** These inspectors:

(a) May be Project Leaders, dam operators, and other Service personnel who are in the vicinity of the dam in the course of their regular activities. The RDSO may request an individual to conduct informal inspections of a dam.

(b) Should have a basic knowledge of dams so they can recognize unusual conditions, abrupt changes from previous conditions, and obvious new defects such as seepage, cracks, and displacements.

(2) **Inspectors for Formal, Intermediate, and Special Inspections:**

(a) **High and Significant Hazard Dams:** Staff from the Division of Engineering, RDSOs, or consultants perform SEED inspections for high and significant hazard dams. Members of the inspection team must include a Registered Professional Engineer trained in the safety inspection of dams.

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(b) Low Hazard Dams: Staff from the Division of Engineering, RDSOs, or consultants perform SEED inspections for low hazard dams. Dam safety professionals must perform the inspections under the direct supervision of a Registered Professional Engineer trained in the safety inspection of dams.

2.5 What are the requirements for writing Standing Operating Procedures (SOPs)?

A. The SDSO must:

- (1)** Prepare SOPs for all high and significant hazard dams using the Service format.
- (2)** Update SOPs associated with major repair or rehabilitation to high and significant hazard dams.

B. The RDSO must annually review and update, as appropriate, the SOPs for each high and significant hazard dam within the Region.

2.6 What are the requirements for writing and implementing Emergency Action Plans? The SDSO must prepare Emergency Action Plans for all high and significant hazard dams (see 361 FW 3 for more information about Emergency Action Plans).

A. The RDSO:

(1) Must annually review the Emergency Action Plan for each high and significant hazard dam within the Region in accordance with procedures outlined in the Emergency Action Plans.

(2) Is responsible for:

- (a)** Annual testing, verification, and certification of Emergency Action Plans by November 1st.
- (b)** Submitting a verification statement, in accordance with the SOPs, along with any revisions to the Emergency Action Plans, to the SDSO annually on or before November 30th.
- (c)** Distributing revisions of the Emergency Action Plan to the plan holders.

B. The SDSO is responsible for:

- (1)** Performing Emergency Action Plan periodic tests every 6 years concurrent with Formal SEED inspections and tabletop exercises concurrent with Intermediate SEED inspections, and
- (2)** Updating Emergency Action Plans associated with major repair or rehabilitation to high and significant hazard dams.

2.7 What is the approval process and procedure for building new dams?

A. Review and Approval. Table 2-1 shows who must review and approve or decline to approve all plans, designs, drawings, and construction specifications for Service dams by performing a Qualified Engineering Review and Approval:

Table 2-1: Who Must Review and Approve Plans, Designs, Drawings, and Specifications	
Type of Dam	Approving Official(s)
Noninventory dams	The RDSO

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Table 2-1: Who Must Review and Approve Plans, Designs, Drawings, and Specifications	
Type of Dam	Approving Official(s)
Low hazard inventory dams	The RDSO and SDSO
High and significant hazard dams	The SDSO (The SDSO must also obtain an independent review by an outside organization, such as the Bureau of Reclamation, the Army Corps of Engineers, or a consultant.)

B. Project Planning, Design, and Construction.

(1) The SDSO or a designee serves as the project manager for planning (including environmental impacts), design, permitting and construction of high and significant hazard dams.

(2) The Regional Engineer designates the RDSO or another qualified engineering staff person to be the project manager for planning (including environmental impacts), design, permitting and construction of all low hazard, inventory dams, and noninventory dams.

(3) The RDSO classifies all new dams as either inventory or noninventory dams. The RDSO sends this determination, along with the vital statistics of the dam, to the SDSO. The SDSO adds the dam to the Service inventory, if appropriate.

2.8 How does the Service address newly acquired dams? Before acquiring new lands, we must identify any dams being conveyed with the property. We must inspect and classify the dams and clearly identify any needed rehabilitation or repair costs before we acquire the land.

A. The RDSO must ensure that a SEED inspection is performed as part of the Engineering Assessment we conduct for all proposed land acquisitions (see 341 FW 2). See section 2.4 for more information about the SEED inspection program

(1) The SEED inspection should describe:

(a) The condition of the dam,

(b) The cost of any work required to bring the dam up to Service safety standards, and

(c) Future costs and liabilities associated with the dam.

(2) The RDSO must review the SEED report and approve it before it can be included with the Engineering Assessment. The Engineering Assessment must clearly state any significant deficiencies and costs associated with the dam(s) and must be included in the Decision Document the Region's Engineering Division gives to the Regional Director for approval (see 341 FW 1).

B. The RDSO must ensure that SEED II studies are performed on all newly acquired dams. The SEED II study is a detailed assessment of the design and condition of the dam and normally includes hydrologic and hydraulic, structural, and geotechnical analyses (stability, seepage, liquefaction, etc).

C. The acquisition contract or other legally enforceable agreement should include the cost associated with work required to bring the dam up to Service safety standards, including modifications, repairs, and development of Emergency Action Plans and SOPs. Land acquisition budget requests should include the costs for SEED inspections and SEED II studies (see 341 FW 3).

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2.9 What is the process for rehabilitating, modifying, or repairing an inventory dam?

A. We must follow the same approval process and procedures for major rehabilitation, modification, or emergency repair of inventory dams as for new dams (see section 2.7).

B. Major rehabilitation or modification may include:

- (1) Raising a dam crest,
- (2) Enlarging or replacing spillways and outlets, and
- (3) Constructing auxiliary or emergency spillways.

C. Major rehabilitation, modification, or emergency repair does not include annual operation and maintenance work such as repairs to gates, repair of erosion on embankments, simple concrete repair, etc.

2.10 How do Project Leaders request funding for safety modifications, operations and monitoring, and rehabilitation of dams? Table 2-2 shows who should request funding for modifying and operating dams.

Table 2-2 Requesting Funding		
Type of Project	Responsible Official(s)	How Requested
A. Routine maintenance, operations and monitoring and minor repairs of high and significant and low hazard dams	Project Leaders and Regional Service Asset Maintenance Management System (SAMMS) Coordinators	Resource Management funds through SAMMS
B. Priority 1 and 2* recommendations except recommendations for engineering studies or major repair or rehabilitation	Project Leaders and Regional SAMMS Coordinators	Resource Management funds through SAMMS the year they are identified in SEED inspections
C. Planning, design, and construction of major rehabilitation or modification to low hazard dams and appurtenances and noninventory dams	Project Leader, in consultation with the RDSO and the Regional Engineer	Resource Management or Construction funds through SAMMS or the Construction 5-year Plan
D. Planning, design, and construction of major rehabilitation or modification to high and significant hazard dams and appurtenances	SDSO, through the Chief, Division of Engineering	Construction funds through the Construction 5-year Plan

*P1 Recommendations indicate that the normal condition of the structure is impaired and the safety of the structure is in jeopardy.

P2 Recommendations are mainly maintenance deficiencies.

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2.11 How does the Service coordinate with State Dam Safety Programs? We consult on the design and safety of dams with the Dam Safety Program officials in the States in which we own, operate, or propose to construct a dam. We also invite State officials to participate in safety inspections and Emergency Action Plan exercises.

2.12 What are the requirements for privately funded dams on Service property?

A. To allow construction of a privately funded dam on Service property the proposed dam must satisfy the requirements in section 2.7, and the SDSO must review and approve a Professional Engineer's certification of the dam. The Professional Engineer must be licensed by the State in which the dam will be located.

B. The certification must at least attest to the following:

(1) The hazard and size classification of the dam;

(2) The proposed project has been designed by a Professional Engineer, qualified in dam design and construction, to meet Federal standards for dam design, construction, and rehabilitation including, but not limited to, the Federal Guidelines for Dam Safety (FEMA 93, 2004) and Service design standards;

(3) The project design and specifications have been reviewed and approved by the State dam safety program staff;

(4) There is a dedicated funding source for future operation, inspection, maintenance, and repairs of the dam;

(5) If the dam is a high or significant hazard dam, there is an Emergency Action Plan in effect for the dam that meets the requirements of Emergency Action Planning for Dam Owners (FEMA 64, 2004); and

(6) Federal and State permits will be obtained prior to construction.

2.13 How are privately owned dams on Service property inspected?

A. The non-Federal entity who owns the dam or lessee is responsible for ensuring the dam complies with State regulations and the Federal Guidelines for Dam Safety (FEMA 93 April, 2004). Although Service inspection teams do not inspect private dams, the SDSO maintains a list of the dams.

B. Responsibilities for dam safety must be identified in the Memorandum of Understanding or lease agreement that authorizes use of Service lands. Responsibilities should include ensuring the owner/lessee contacts the Project Leader and the RDSO if significant dam safety deficiencies or unusual circumstances are identified on a private dam on Service property.

2.14 What are the requirements for State dam projects to which the Service provides funding?

A. We may provide funds to supplement approved State dam safety projects on a cost-sharing basis through the Federal Aid Program.

B. For all inventory dams for which we provide funds (see section 2.2G), we must obtain:

(1) Reasonable assurances that the State has a dedicated funding source to safely operate and maintain the dam and that there is an Emergency Action Plan for any high and significant hazard dams, and

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(2) Certification from the State Dam Safety Official, signed by a Registered Professional Engineer licensed in the requesting State, that proposed projects involving the construction, enlargement, or rehabilitation of any dam (including appurtenant works) satisfies the criteria for our inventory and meets Federal requirements. The certification must attest to the following:

- (a)** The hazard and size classification of the dam are correct and its present condition and deficiencies have been accurately identified;
- (b)** The proposed project has been designed by a Professional Engineer, qualified in dam design and construction, to meet Federal standards for dam design, construction, and rehabilitation including, but not limited to, the Federal Guidelines for Dam Safety (FEMA 93, 2004), and any other technical requirements identified in the Federal Aid project agreement documents;
- (c)** A Registered Professional Engineer qualified in the design and construction of dams completed the State's technical review of the project design and specifications;
- (d)** There is a dedicated funding source that will provide for future operation, inspection, maintenance, and repairs of the dam;
- (e)** If the dam is a high and significant hazard dam, there is an Emergency Action Plan in effect for the dam that meets the requirements of Emergency Action Planning for Dam Owners (FEMA 64, 2004); and
- (f)** Federal and State permits will be obtained prior to construction.

C. The requirements in section 2.14B do not apply to noninventory Federal Aid dams.

2.15 What are the technical standards for the Dam Safety Program? The planning, design, construction, and rehabilitation of all inventory dams must follow the technical standards below and in 361 FW 1 and 3.

A. Inflow Design Flood. The Inflow Design Flood is the rate of inflow discharge into the reservoir over time that the dam must be able to safely pass through a combination of spillway and outlet works and attendant surcharge storage.

- (1)** Service inventory dams must meet the Inflow Design Flood standards in Exhibit 1.
- (2)** The Project Leader must obtain a waiver from the Inflow Design Flood standards in Exhibit 1:
 - (a)** For high or significant hazard dams from the Chief, Division of Engineering and the SDSO.
 - (b)** For low hazard inventory dams from the SDSO and the RDSO.
- (3)** Approval of Inflow Design Floods other than those in Exhibit 1 may be granted only after performing an incremental damage assessment or risk-based analysis to determine if a waiver is appropriate.
 - (a)** Studies and mapping must clearly demonstrate that consequences of dam failure at flood flows larger than the selected Inflow Design Flood will not increase projected loss of life and will have no significant incremental increase on property damage. All Inflow Design Floods must follow FEMA 97, Federal Guidelines for Selecting and Accommodating Inflow Design Floods for Dams or a more conservative approach. Analysis must include existing structures and inhabitants and projected inhabitants and structures based on approved planning documents and over at least the next 20 years. The incremental

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increase in property damage versus the potential frequency of floods must be clearly identified in a management decision chart.

(b) The RDSO or the SDSO must provide the proposed Inflow Design Flood using an incremental damage assessment or risk-based analysis to the affected State dam safety office for review and discussion.

(c) The minimum Inflow Design Flood for high and significant hazard dams must at least meet the 100-year flood frequency.

B. Freeboard Requirements. Freeboard is the vertical distance from the water surface to the top of the dam. Freeboard should meet the requirements of ACER TM No. 2, Freeboard Criteria and Guidelines for Computing Freeboard Allowances for Storage Dams, BOR 1992 or the latest revision.

C. Low-Level Outlets. All inventory dams must have a low-level outlet that can evacuate the major portion of the reservoir storage volume by gravity flow.

(1) Only the SDSO may approve waivers to this requirement.

(2) Criteria for reservoir draining should recognize site-specific conditions, economic aspects, and project needs to provide an acceptable balance between costs and rates of draining and filling. Draining times established for a dam reflect downstream channel capacity, level of risk to the dam, and hazard potential to the downstream areas. A low-level outlet works, in conjunction with other release facilities, should meet the requirements in Criteria and Guidelines for Evacuating Storage Reservoirs and Sizing Low-level Outlet Works, ACER TM No. 3, the Department of the Interior, BOR 1990 or the latest revision.

(3) For small low-hazard inventory dams, the low-level outlet works, in conjunction with other release facilities, should be located and sized to draw down the reservoir within 1 to 4 months, at a minimum, to the lower of the following levels:

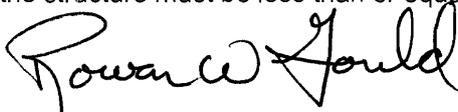
(a) The reservoir level commensurate with a storage capacity that is 10 percent of that at the normal reservoir level, or

(b) The reservoir level with less than 50 percent of the hydraulic height.

D. Risk Analyses: The Division of Engineering may use risk assessments to identify appropriate repair criteria. The assessments predict the annual probability of loss of life and failure probabilities of the structure over a projected 50-year period.

(1) The average annual loss of life probability must be less than or equal to 1 in 1,000.

(2) The annual failure probability of the structure must be less than or equal to 1 in 10,000.

Acting 
DIRECTOR

Date: September 12, 2008

09/12/08

ENGINEERING AND CONSTRUCTION

Supersedes 361 FW 2, FWM 418, 01/31/03

D.11. U.S. Forest Service



FEMA

**FSM 7500 - WATER STORAGE AND TRANSMISSION
CHAPTER ZERO CODE**

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FSM 7500 - WATER STORAGE AND TRANSMISSION CHAPTER ZERO CODE

This title establishes policies, standards, and criteria for the investigation, design, construction, emergency planning and response, maintenance, and operation of water storage and transmission structures administered or permitted by the Forest Service. Water storage structures include class A, B, C, and D dams, including settling ponds and tailing dams. Water transmission structures include ditches, flumes, tunnels and penstocks.

7501 – AUTHORITY

The installation and operation of water storage and transmission facilities on National Forest System lands are carried out under the authorities and limitations of various laws and the regulations of the Secretaries of Agriculture and Army, as well as the Federal Energy Regulatory Commission. Key authorities are as follows:

1. Presidential Memorandum of October 4, 1979, directed Federal Agencies to implement the "Federal Guidelines for Dam Safety" published on June 25, 1979, by the Ad Hoc Interagency Committee on Dam Safety of the Federal Coordinating Council for Science, Engineering, and Technology, Washington, D.C., June 25, 1979, and to report implementation progress to the Federal Emergency Management Agency (FEMA).
2. Departmental Regulation 1043-18 establishes the U.S. Department of Agriculture (USDA) Dam Safety Committee, requires member agencies to name a Dam Safety Officer, assigns the Soil Conservation Service (SCS) Dam Safety Officer as the USDA contact for FEMA, and requires the Forest Service Dam Safety Officer to participate in technical dam safety activities with FEMA.
3. Title 36, Code of Federal Regulations, Part 251 and FSM 2700 establish that, authorized uses of lands managed by the Forest Service include special uses such as reservoirs, canals, ditches, flumes, pipelines and other facilities for the impoundment, storage, transportation, or distribution of water.
4. Title 18, Code of Federal Regulations, Part 4 provide that Federal Energy Regulatory Commission (FERC) regulations related to licenses and permits for dams, pipelines, and other water storage and transmission facilities related to power generation establish authority to require conditions for issuing a FERC license (FSM 2770).
5. Title 33, Code of Federal Regulations, Part 208 establishes that the Army Corps of Engineers has the authority to prescribe regulations for the use of storage allocated for flood control at all reservoirs constructed wholly or in part with Federal funds, with the regulations normally implemented by letters of understanding between the Corps of Engineers and the project owners.
6. Water Resources Development Act of 1992 (33 U.S.C. 2201) directs participation in updating and maintaining of the National Dam Inventory.

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7502 – OBJECTIVES

Manage water storage or transmission structures administered or permitted by the Forest Service to:

1. Prevent sudden failure resulting in loss of life or extensive damage to property or the environment.
2. Efficiently and effectively achieve planned benefits such as fisheries enhancement, improved recreational opportunities, and increased livestock watering.
3. Protect the government's investment and interest in facilities.
4. Minimize the potential liability of the Forest Service from failures of Forest Service owned and permitted dams.

7503 – POLICY

The policies in this section apply with equal force whether the dam has a permanent reservoir or is a detention dam for temporary storage of flood waters. Except for inventory of dams, these standards and criteria may be modified on a case-by-case basis for moderate and low-hazard class D dams. Any dam up to but not more than 6 feet high, regardless of storage capacity, or which has a maximum storage capacity not greater than 15-acre feet, regardless of height, may be excluded from this policy unless there is a potentially significant downstream hazard.

1. Ensure that the design, construction, operation, and maintenance of Forest Service owned dams and dams authorized by special use permits or other instruments meet acceptable standards or withdraw them from service to the degree necessary to safeguard life and property.
2. Use funds from benefiting function(s) for technical work related to dams owned by the Forest Service and authorized under special use permit (FSM 7515).
3. Fully coordinate technical reviews, construction monitoring, and inspections with environmental and resource management review processes.
4. Do not relieve an owner of a dam from the responsibility for providing and maintaining a safe structure.
5. Do not duplicate reviews performed by State and other Federal Agencies, or the Engineer retained by the proponent, if those reviews meet Forest Service objectives and standards.

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6. Use the Memorandum of Understanding with the Soil Conservation Service (SCS) as the basis for coordinating SCS-sponsored projects on National Forest System lands (FSM 1541).

7. Ensure the following conditions are met when existing dams are acquired by the Forest Service:

a. When dams are acquired voluntarily such as through land exchange--

(1) Ensure the overall decisionmaking process includes an engineering study that addresses the structural condition of the dam.

(2) Identify any hazards to existing downstream life and property, and identify potential hazards if future development should occur.

(3) If the dam requires rehabilitation, identify costs of repairs.

(4) Identify long-term costs of maintaining and operating the dam.

(5) Identify any benefiting functions (FSM 7515).

b. If a dam is acquired involuntarily, such as by abandonment, ensure proper administrative and legal steps have been followed and that the ownership has been vested in the United States (FSM 2716.4).

8. Comply with the policies on the following aspects of water storage and transmission facilities management identified in the cross-referenced sections of the Forest Service Manual:

a. Facilities located in wilderness areas (FSM 2320.3, 2323.42, 2326).

b. Flood plain management (Executive Order 11988 issued May 24, 1977) (FSM 2527).

c. Wetlands protection (Executive Order 11990, issued May 24, 1977) (FSM 1950, 2527).

d. Special uses management (FSM 2700).

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7504 – RESPONSIBILITY

Exhibit 01 summarizes responsibilities assigned in this chapter.

7504 - Exhibit 01

Summary of Responsibilities

Activity	Chief (DE)	DSO	RF (RDE)	FS
1. Appoint Dam Safety Officer.	O			
2. Advise and update Chief.	X			
3. Represent Forest Service on Interagency Coordinator matters.	X			
4. Establish procedures.		X		
5. Ensure Service-wide coordination.		X		
6. Monitor and report.		X		
7. Review and approve design and safety evaluations, and approve water storage and transmission projects prior to use: a. Class A, B, C, and high hazard D dams. b. Design approval of water transmission and class D moderate and low hazard dams. c. Inspect ALL dams and water transmission projects (A, B, C, and D).			O (RE) X X	 O O
8. Establish policy, standards, and criteria for: a. Dam safety and water transmission b. Design, construction, operation, and maintenance of class D moderate and low hazard dams.			O O	

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7504 - Exhibit 01--Continued

Activity	Chief (DE)	DSO	RF (RDE)	FS
9. Determine that work meets standards for the life of the project.			O	
10. Maintain dams inventory.			O	
11. Monitor and report on quality and effectiveness of dam management program.			O	
12. Provide training and assistance with emergency action plans.			O	
13. Ensure dams are operated and maintained in accordance with guidelines and standards.				X
14. Designate qualified personnel.				X
15. Ensure qualified personnel participate in management of permitted facilities.				X
16. Ensure inspections are completed at designated intervals by qualified personnel.				X
17. Ensure emergency action plans are prepared, maintained, and tested.				X
18. Maintain documents and records.				X

Notes:	X	Delegable
	O	Not Delegable
	DE	Director of Engineering, WO
	DSO	Dam Safety Officer
	RDE	Regional Director of Engineering
	FS	Forest Supervisor

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7504.1 – Chief

The Chief reserves the authority to appoint a Dam Safety Officer for the Forest Service through the Washington Office, Director of Engineering.

7504.2 - Washington Office, Director of Engineering

It is the responsibility of the Director of Engineering to:

1. Advise the Chief of the adequacy of administrative and technical procedures used to manage dams and water transmission structures.
2. Periodically update the Chief on compliance with water storage and transmission objectives through reports such as the Biennial Report on Dams Safety provided to the Federal Emergency Management Agency.
3. Represent the Forest Service on interagency coordination matters within the Department of Agriculture on dams and water transmission structures.

7504.3 - Dam Safety Officer

It is the responsibility of the Dam Safety Officer to:

1. Establish procedures for conducting the dam safety activities of the Forest Service.
2. Coordinate Service-wide engineering aspects of the dam safety activities with other units, agencies, departments, and organizations.
3. Monitor and report on the quality and effectiveness of Regional administrative and technical practices.

7504.4 - Regional Foresters

It is the responsibility of Regional Foresters to:

1. Review and, if appropriate, approve or certify the acceptability of emergency action plans, designs, and safety evaluations for all classes of projects (FSM 7511), and also approve completed water storage and transmission projects prior to their use. This authority may be redelegated only to the Regional Staff Director for engineering activities. Authority for design approval or certification of water transmission and class D moderate- and low-hazard dams and inspections of all projects may be delegated to Forest Supervisors.

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2. Establish policy, standards, and criteria for:
 - a. Dam safety and water transmission activities in the Region.
 - b. Design, construction, operation, and maintenance of class D moderate- and low-hazard dams.
3. To ensure that all construction, reconstruction, or major maintenance works:
 - a. Conform to sound engineering practice and Forest Service standards and criteria.
 - b. Function according to acceptable principles for the life of the structure.
4. Maintain a Regional dams inventory that contains, as a minimum, the elements found in FSM 7515.1.
5. Monitor and report on the quality and effectiveness of Forest administrative and technical engineering practices.
6. Provide training and assistance in preparing, maintaining, and testing emergency action plans by Forest Service and permit holder personnel.

7504.5 - Forest Supervisors

It is the responsibility of Forest Supervisors to:

1. Ensure that all water storage and transmission structures, government-owned or permitted by the Forest Service, are operated and maintained in accordance with the Federal Guidelines For Dam Safety (FSM 7501) and other applicable regulations and standards.
2. Designate qualified personnel to adequately accomplish the construction, operation, inspection, and management of Forest Service-owned dams.
3. Ensure that qualified personnel are participating in the management of permitted dams and water transmission facilities.
4. Ensure that all dams are inspected at designated intervals by qualified people.
5. Ensure that required emergency action plans are prepared and maintained, that personnel are trained, and that plans are tested at the designated intervals.
6. Maintain documentation and records of dams (FSM 7515).

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7505 - DEFINITIONS

(FSM 7520.01 and FSH 7509.11).

Dam. Any artificial barrier, including appurtenant works, which impounds or diverts water.

Dam Height. (Also called Hydraulic Height.) For administrative classification of dams, height is the vertical distance in feet measured from the natural bed of the stream or watercourse at the downstream toe of the barrier or, if not across a stream channel or watercourse, from the lowest elevation of the outside limit of the barrier to the maximum water storage elevation.

Forest Service-owned Dams. Those facilities owned by the Government which are the complete responsibility of the Forest Service; as opposed to facilities owned by the Government but built and maintained by other Federal agencies, or facilities built under special use permit or United States Department of the Interior (USDI) easement.

Holder. The holder of a special-use permit to develop or operate a water storage or transmission facility on National Forest lands.

Independent Review. An engineering review conducted by qualified engineers not directly involved in the design of the project.

Inspect. To view closely and critically to detect errors or to determine quality and condition.

Maximum Storage Capacity. The total storage space, measured in acre-feet, in a reservoir at the maximum water storage elevation including storage of flood waters above the normal full storage elevation.

Maximum Water Storage Elevation. The water surface elevation for the reservoir at the dam face for the inflow design flood (FSM 7524.3).

Monitor. To compare performance with sources of information, and data, for conformance with accepted practice and principles, and to check for reasonable accuracy.

Normal Full Storage Elevation. The elevation of the crest of the lowest uncontrolled spillway (FSM 7523.01).

Qualified Engineer. A person who, by reason of training and experience, is assigned by the Forest Supervisor or Regional Forester to perform certain specific technical functions within the authorizing Line Officer's delegated authority. Technical qualifications should be appropriate for the technical requirements of the functions assigned. Consider the consistency of qualifications with engineers assigned similar work in State and private practice.

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7506 - REFERENCES

1. Interagency Committee on Dam Safety. 1979. Federal Guidelines for Dam Safety. Washington, D.C. 39p.
2. Interagency Committee on Dam Safety. 1985. The Emergency Action Planning Guidelines. Washington, D.C. 39p.
3. Interagency Committee on Dam Safety. 1985. Federal Guidelines for Earthquake Analysis and Design of Dams. Washington, D.C. 45p.
4. Interagency Committee on Dam Safety. 1985. Federal Guidelines for Selecting and Accommodating Inflow Design Floods for Dams. Washington, D.C. 37p.
5. Federal Emergency Management Agency. 1988. Glossary of Terms for Dam Safety. Washington, D.C. 18p.

7509 - HANDBOOKS

7509.1 - Internal Service-wide Handbooks

7509.11 - Dams Management Handbook (FSH)

This Handbook contains procedures and specific information related to the management of existing dams, both Forest Service dams and those authorized by a special use document. The Handbook also outlines procedures for technical administration of special use applications for proposed dams.

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7511 - CLASSIFICATION OF PROPOSED PROJECTS

The potential effect of water storage and transmission structures on the safety and economy of downstream areas varies with the size of the structure and with the amount and value of human-built improvements and natural amenities that exist downstream. The required scope of investigations, precision of design, quality and capacity of components, and subsequent cost vary with the hazard assigned to the dam.

Minimum acceptable criteria for design, operation, maintenance, and monitoring of dams are based on the administrative size and hazard classifications. All factors that might influence the potential hazard classification must be evaluated during the design and design review of the dam. The hazard rating should be consistent with the potential for loss of human life and damage to property that could be caused by a failure of the dam.

7511.1 - Administrative Classification

For administrative purposes, classify dams as follows:

1. Class A Projects. Dams that are 100 feet or higher or impound 50,000 acre-feet or more of water.
2. Class B Projects. Dams that are 40 feet but less than 100 feet high, or impound 1,000 but less than 50,000 acre-feet of water.
3. Class C Projects. Dams that are 25 feet but less than 40 feet high, or impound 50 but less than 1,000 acre-feet of water.
4. Class D Projects. Dams that are less than 25 feet high and impound less than 50 acre-feet of water.

7511.2 - Hazard Assessment Classification

Classify dams according to hazard potential based on the loss of human life or property damage that could occur if the structure failed.

1. Low Hazard. Dams built in undeveloped areas where failure would result in minor environmental or economic loss, damage would be limited to undeveloped or agricultural lands, and significant improvements are not planned in the foreseeable future. Loss of human life would be unlikely.

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2. Moderate Hazard. Dams built in areas where failure would result in serious environmental damage or appreciable economic loss with damage to improvement, such as commercial and industrial structures, public utilities and transportation systems. No urban development and no more than a small number of habitable structures are involved. Loss of human life would be unlikely.

3. High Hazard. Dams built in areas where failure would likely result in loss of human life or excessive economic loss. Generally this would involve urban or community development with more than a small number of habitable structures.

7511.3 - Transmission Structures Classification

Classification of transmission structures such as pipelines and canals is left to the discretion of the Regional Directors of Engineering.

7512 - REVIEW AND APPROVAL OF PROPOSED PROJECTS

Plans and designs for new water storage and transmission projects proposed by the Forest Service or others, or for changes in, or major repair of, existing works must be reviewed and approved by the authorized officer (FSH 2709.11, sec. 53.2, clause B37) prior to construction. Approval shall be based on administrative review (FSM 7512.1) and engineering review (FSM 7512.2).

Coordination with other agencies is required to determine that:

1. Project plans are consistent with policies stated in FSM 7503.
2. Project plans include securing any needed water rights or permits from the State for water development or use (FSM 2540).
3. The projects are compatible with Forest plans.
4. The construction of the project can be effectively coordinated with other National Forest activities.

7512.1 - Environmental Review

Ensure that the scope and intensity of the environmental (FSM 1950) and administrative work for each project is complete and appropriate.

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7512.2 - Regional Engineering Review

The scope and intensity of the engineering review varies with the complexity, extent, and hazard classification of the structures. See FSM 7504 for design review and approval authorities.

Engineering review and approval by the Regional Staff Director for engineering activities are not required for:

1. Water projects authorized by Federal law and under the jurisdiction of the Bureau of Reclamation, Corps of Engineers, or the Federal Energy Regulatory Commission.
2. Watershed-protection and flood-prevention projects (Pub. L. 566), flood-control projects (authorized by the Flood Control Act of 1944), or other projects reviewed and approved by the Soil Conservation Service (FSM 7503).
3. Dams not located on National Forest land even if all or part of the reservoir occupies National Forest land, unless salient features such as flooding of National Forest land require Forest Service involvement as part of the permitting process.

7512.21 - Independent Review

All high hazard dams and moderate hazard dams designated by the Regional Forester shall have an independent engineering review made by a qualified engineer (FSM 7505) not directly involved in the design process.

Independent reviews of special use projects may be accomplished by qualified Forest Service engineers, States or other agencies, or consultants not employed by the primary design firm.

7512.22 - Regional Design Certification

When review indicates the design is adequate, the Regional Staff Director for engineering activities shall certify approval or acceptability of the project drawings and specifications prior to their use by signing them. When drawings are issued in a bound set, the signing of the cover sheet may serve to certify the entire set.

Design changes made after the initial review or during construction must also be approved or certified as acceptable by the Regional Staff Director for engineering activities.

Designs submitted by special use applicants (FSM 2700) will be prepared and signed or stamped by a licensed engineer with professional experience consistent with the requirements for analyzing the size of the structure and the hazard involved.

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Approval of designs prepared by Forest Service units indicates that the design is judged to be adequate from the standpoint of safety, economy, and function.

7512.3 - Washington Office Review

Review by the Washington Office is not required. Requests for assistance in Regional reviews may be made at any stage of design.

The dam safety officer may make design reviews of specific dams for the purpose of monitoring Regional programs.

7513 - SUPERVISION OF PROJECT CONSTRUCTION

Maintain continuing liaison between personnel concerned with project planning, design, construction, and operation. Individuals from each concerned discipline must know and understand the relevant activities of the others to determine technical adequacy.

Qualified engineers are required for:

1. Supervising site investigation work.
2. Designing all dams and water transmission systems.
3. Supervising or monitoring the inspection of construction activities.
4. Supervising or monitoring safety inspections, emergency action plans, and operation and maintenance plans.

7514 - FUNDING AND BUDGETING

Program funding to accomplish the safety requirements for Forest Service-owned dams shall be charged to the appropriate benefiting function(s). Budget for dam safety at the lowest budget level. The most current programming and budget directions for Forest Service dam administration, inspections, maintenance, and development are in each year's Program Budget Instructions. Regions and Forests may use management codes to track dam work in general, or to track by specific project, for example, new structures, modifications, safety repairs, and routine repairs.

Program funding from benefiting functions may be used for technical and safety related work for the administration of special use permits for dams and water transmission structures (FSM 7503, FSM 2720, and FSM 2780).

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7515 - DOCUMENTATION AND RECORDS

Maintain and use the following records to identify and resolve problems with water storage and transmission structures:

1. Dams inventory.
2. Project files.
3. Operation and maintenance (O&M).
4. Inspections.
5. Emergency action plans.

7515.1 - Dams Inventory

The dams inventory provides the primary basis for administration of dams. Each Region shall maintain and update annually an inventory for class A, B, C, and D dams (permitted and Forest Service-owned) located on National Forest System lands (FSM 7504.4 and FSH 7509.11, sec. 11). Other dams owned or licensed by other Federal agencies may be inventoried for information purposes. Data elements for the dam inventory shall be those required to annually update the National Inventory of Dams (Pub. L. 99-662 and FSH 7509.11, sec. 08) maintained for all dams in the United States by the Federal Emergency Management Agency, Priority 1 and Priority 2 maintenance and repair needs and cost estimates for Forest Service-owned dams, and other data elements (FSM 7116) included in the Forest Service inventory for dams.

7515.2 - Project File

Maintain a project file for each Forest Service-owned or permitted dam (FSH 7509.11, ch. 10) or transmission structure. The file should be updated as needed over the life of the project with information on problems encountered, hazard assessment, repairs, operational changes, instrumentation, and inspections.

The responsibility for maintaining a project file for a dam under a special-use permit rests with the owner. However, Forests shall keep a supplemental file for each special use dam for such things as inspections, maintenance performed, and agreements.

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7515.3 - Operation and Maintenance Plans

An operation plan and a maintenance plan are required. The responsibility for preparation of operation and maintenance plans rests with the owner. The plans for new dams shall be prepared during the design phase. The plans may be combined and may cover more than one structure if they are of a similar type (FSH 7509.11, ch. 20).

7515.31 - Operation Plan

Revise an operation plan as required by changes in project status or maintenance condition. Plans should reflect current operating agreements.

7515.31a - Special Use Structures

The authorization holder is responsible for preparation of the operation plan. The plan shall be coordinated with applicable State agencies. It shall be reviewed by a qualified engineer or authorized special-use personnel, as delegated, and approved by the authorized officer (FSM 2705).

A qualified engineer shall monitor each special use structure at least once every 5 years to ensure that it complies with the technical requirements of the permit. High hazard and controversial projects may necessitate more frequent monitoring.

7515.32 - Maintenance Plan

Review and update the maintenance plan annually to determine that current conditions are covered.

7515.32a - Special Use Structures

The authorization holder shall prepare the operating and/or maintenance plan in coordination with applicable State agencies. It shall be reviewed by a qualified engineer or qualified Forest Officer, as delegated, and approved by the authorizing official.

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7515.33 - Maintenance Categories

The categories of maintenance needs are defined as:

1. Priority 1, Emergency. Maintenance needed to correct deficiencies affecting the safety of the structure or the public, or to correct conditions that may become critical to the safety of the structure or the public in the immediate future. Deficiencies in this category shall be corrected as soon as identified or the structure shall be withdrawn from service or the storage decreased to the extent needed to operate within acceptable parameters.
2. Priority 2, Nonemergency. Maintenance needed to restore functional use of the works, correct unsightly conditions, or prevent more costly damage. Integrity of the structure or public safety is not threatened.
3. Routine. Minor housekeeping-type maintenance normally included in the maintenance plan.

7516 – INSPECTIONS

Develop a systematic dam inspection program to identify routine maintenance and disclose conditions which might threaten life and property, so that timely corrective action can be taken (FSH 7509.11, ch. 40).

Some State regulations require State engineering inspection of non-Federal dams located on National Forest System lands. Some local agencies, such as municipal or county water agencies, flood control districts, and irrigation districts, make regularly scheduled inspections of works under their jurisdiction. When the scope and quality of such inspections are comparable to Forest Service requirements, the Regional Forester should work with appropriate State or local agencies to prevent duplication of effort. Such agreements should include provisions for periodic joint inspections.

Do not include in the Forest Service inspection program structures that are operated or inspected regularly by other Federal agencies, such as the Federal Energy Regulatory Commission, Bureau of Reclamation, or Corps of Engineers.

Include three types of inspections in the dam inspection program:

1. Informal and Special Inspections.
2. Operation and Maintenance Inspections.
3. Safety Inspections and Hazard Assessment.

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7516.1 - Informal and Special Inspections

7516.11 - Informal Inspections

When any employees are in the vicinity of a Forest Service or special use dam, they should observe the overall condition and function of the structure. Any unusual conditions that seem critical or dangerous should be reported immediately to the Forest Officer responsible for dams. Particular attention should be given to evidence of (or changes in) leakage, erosion, sinkholes, boils, seepage, slope instability, undue settlement, displacement, tilting, cracking, deterioration, and improper functioning of drains and relief wells.

7516.12 - Special Inspections

Special inspections should be performed immediately after a dam has passed unusually large floods, the occurrence of an earthquake, sabotage, or when unusual events have been reported by operators or in informal inspections.

7516.2 - Operation and Maintenance Inspections

A qualified engineer shall periodically review operation, maintenance, and inspection records, and make a thorough inspection of each structure located on National Forest System land. Prepare a maintenance report for Forest Service dams to aid in scheduling routine maintenance, programming special repairs, and updating the inventory.

Authorizations for special use structures shall include requirements for owner-acquired inspection in accordance with the inspection plan. A qualified engineer (FSM 7505) shall monitor inspection reports to ensure compliance with technical standards (FSM 7504). When inspections are accomplished by State or local agencies under working agreements, the State or local agency report form is normally acceptable.

Compliance with established operation plans sometimes cannot be verified by inspection at the same frequency as inspection of maintenance. For structures which have administrative limitations on storage, reservoir stage, or water release imposed by the State or the Forest Service, operation logs and water stage or metering-device records (when required) should be checked periodically throughout the year.

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7516.21 - Operation and Maintenance Inspection Schedule

Establish a reasonable and workable inspection schedule considering factors such as: type of structure, hazard rating, watershed characteristics, climate, purpose of reservoir, and type of spillway. The schedule should be based on a consideration of: (1) the conditions peculiar to the structure(s) involved, (2) the need for coordinating the work with other Forest inspections and evaluations, and (3) national and Regional guidelines and standards.

As a minimum, structures classed as high hazard (FSM 7511.2) shall be inspected annually, and also following earthquakes and periods of unusually heavy runoff.

7516.22 - Followup Action

When an inspection discloses operation or maintenance deficiencies, the Forest Supervisor shall:

1. For Forest Service structures, establish a reasonable maintenance schedule based on the priority of identified maintenance, and schedule appropriate restoration and repairs.
2. For special use structures, inform the owner promptly by letter and, if applicable, furnish a copy to the State. The notice should:
 - a. Describe the deficiencies, and explain the nature and urgency of needed changes or repairs.
 - b. Require the holder to submit a proposed maintenance schedule.
 - c. Require the holder to certify by letter when the identified maintenance has been completed.

Any dam having deficiencies which seriously affect the integrity of the structure must be promptly repaired, or wholly or partially removed from service until repairs are made (FSM 7503). See FSM 2715 for direction on taking administrative action.

7516.23 - Dams Not Under Forest Service Jurisdiction

When a dam is located on private land or is under the jurisdiction of another Federal agency (and not subject to inspection by the Forest Service), and conditions endangering Forest Service lands are observed, the owner or the agency having jurisdiction over the dam shall be promptly notified. Notify the Regional Director and the Director, Division of Dam Safety, for the Federal Energy Regulating Commission (FERC) of any dams on Forest Service lands that are not under FERC license but appear to be under FERC jurisdiction.

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7516.3 - Safety Inspections and Hazard Assessment

The Federal Guidelines for Dam Safety require the periodic inspection and evaluation of dams for the purpose of protecting human life and property. The documented safety inspection entails a review by highly trained specialists of all pertinent information, including records on design, construction, instrumentation, operation, maintenance, and inspection; and a detailed field inspection of the dam and appurtenant structures. Base the inspection on current design standards and practices. Adjust the effort and degree of detail involved for a safety inspection in accordance with the structure's size and hazard classification.

7516.31 - Inspection and Hazard Assessment Schedule

Prepare a schedule for safety inspection or hazard classification review for each dam. Perform and record safety inspections for high hazard dams at intervals not exceeding 5 years. Some dams may require more frequent safety inspections, depending on experience or project history, such as active seepage on face of dam or active surface erosion.

Perform and document hazard classification reviews at least every 5 years for moderate and low hazard dams.

1. Forest Service Dams. The Forest Service is responsible for safety inspections of Forest Service-owned dams. Safety inspections performed by other responsible agencies or licensed engineers by contract are acceptable.

2. Special Use Dams. The authorization holder is responsible for having safety inspections performed by a qualified engineer at the frequency prescribed in the special use authorization. Safety inspections performed by other responsible federal or State agencies are acceptable.

7516.32 - Report Review and Approval

The Regional Staff Director for engineering activities is responsible for review and approval of safety inspection reports (FSM 7504.3).

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7517 - EMERGENCY ACTION PLANS

Prepare, test, and maintain emergency action plans for all high hazard dams. Emergency action plans, whether prepared by the Forest Service, permit holder, State, or other party should be prepared in a degree of detail commensurate with the hazard and coordinated with local officials. The schedule for personnel training and emergency action plan testing shall be the same as for inspections and hazard assessments (FSM 7516.21). See FSH 7509.11, ch. 50, for procedures and information to be included in a plan and how to test the plan. The emergency action plan will include flood inundation maps.

For new or proposed dams, prepare the emergency action plan during the design stage (FSM 7521.03). The plan must reflect construction activities for new dams and major reconstruction for existing dams.

Plans should be updated promptly after each change in involved personnel or their phone number. Personnel and phone number changes shall be made on the plan annually, as a minimum. A comprehensive review of the emergency action plan shall be made whenever safety inspections and hazard assessments are performed or reviewed (FSM 7516). Any changes in the plan must be provided to all plan holders. The comprehensive review shall include an assessment of the need for training and plan testing.

7517.1 - Forest Service Dams

The Forest Supervisor is responsible for preparing and testing the emergency action plan.

7517.2 - Special Use Dams

The authorization holder is responsible for preparing and testing the plan Emergency Action plan.

7518 - STRUCTURAL FAILURE REPORT

In case of the failure of a dam or a major appurtenant structure, promptly investigate and report the event as required in FSH 7509.11, ch. 60. See FSM 6730 for additional details on independent investigations.

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7521 – SCHEDULING

Schedule management and engineering steps to:

1. Design dam in an effective and economic manner.
2. Ensure compliance with program objectives, environmental concerns, and public safety.

7521.03 – Policy

Ensure that the design of dams complies with the forest plan, feasibility studies, environmental impact assessments, site investigations, and that appropriate coordination and review occurs at all stages of the design process. Final design review and approval by the Regional Office and State and Federal regulatory agencies, as appropriate, must precede construction (FSH 7509.11, sec. 10). Reviews shall be appropriate for the size and hazard classification of the dam. Prepare the emergency action plan during the design phase when required (FSM 7517 and FSH 7509.11, ch. 50).

7522 - DESIGN RECORDS

Keep design records orderly and current to allow efficient review at any stage. Design records must be complete and understandable, since they may form the basis for later actions such as design changes, modification or addition of appurtenant works, investigation of structural deficiencies, periodic safety evaluations, hazard assessment, emergency action plans, and possible litigation. Scope and detail of the design record will vary with the complexity and risk of the project.

Design related correspondence should contain a full presentation of the pertinent facts and discussion, and document progress in selection of alternatives or other matters affecting the design.

A final design summary should provide a permanent record of the design analysis and decisions, and an index to the design records.

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7523 – PLANNING

In the planning stage, consider alternate sites and structure types to meet objectives, minimize project costs, and minimize social and environmental impacts (FSM 1950). Constraints may include minimum stream flow requirements, water rights, forest plan requirements, project funds, the dam hazard class and environmental issues such as wetlands. The environmental analysis process should consider these constraints as well as the benefits of reservoir storage. Consider flood storage for Forest Service-owned dams when the potential benefits exceed additional construction costs.

Gather data needed to assess alternatives and to plan data collection for design from available maps, records, and site reconnaissance. Field surveys and subsurface investigations may be necessary, depending on complexity and risks of the project.

7523.05 - Definitions

(FSM 7505 and FSH 7509.11, sec. 05).

Freeboard. The vertical distance in feet between the maximum water storage level and the top of the dam.

Inflow Design Flood. (IDF). The largest flood, measured in cubic feet per second, that a given project is designed to pass safely. The reservoir inflow-discharge hydrograph used to estimate the spillway discharge capacity requirements, and corresponding maximum surcharge elevation in the reservoir.

Normal Storage. The storage space, measured in acre-feet, in a reservoir as measured from the low point of the upstream toe of the dam or from the inlet invert of the outlet conduit, whichever is lower, up to the crest of the lowest uncontrolled spillway.

Probable Maximum Flood. (PMF). The most severe flood, measured in cubic feet per second, that is considered reasonably possible at a site as a result of meteorological and hydrologic conditions.

7524 - GENERAL DESIGN STANDARDS

The level of design detail increases from preliminary to final design and with increasing size, value, and Forest Service hazard classification of the structure. The level of detail of the investigation, design, design reports, and drawings shall be adequate to construct a safe dam within acceptable factors of safety for the size and hazard classification of the structure. Design standards and procedures of the Soil Conservation Service, Bureau of Reclamation, and the Corps of Engineers are acceptable for water and sediment storage dams on National Forest lands.

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U.S. Bureau of Mines design standards may be most appropriate for tailings dams. Other generally accepted standards and methods may be accepted on a case-by-case basis. Other authorities that have jurisdiction may require additional or more stringent standards.

7524.1 - Hydrology and Flood Routings

Use generally accepted procedures appropriate for the dam site, such as those established by the Soil Conservation Service, the National Weather Service, and the Bureau of Reclamation, for determining the design storm event and sizing the spillway. Consider site specific evaluations for accepting smaller inflow design hydrographs. Several analysis methods and flood routing trials may be required to establish the most appropriate design flood and to size the spillway.

7524.11 - Incremental Damage Analysis

Perform an analysis using one storm event with two flood routing conditions, that is (1) where the dam overtops without failure, and (2) where the dam overtops with failure, to determine flood damage and potential loss of life resulting from the sudden release of water stored in the reservoir. Incremental damage is the "additional" damage resulting from the greater flood stage of routing the flood with dam failure over that expected from routing without dam failure. In addition to flows from the reservoir, consider also flows from the tributaries downstream of the reservoir in the incremental analysis. The flood routings should extend downstream to a point at which no further significant incremental damage will occur.

7524.2 - Hazard Assessment

Determine a high hazard rating, and tentative moderate or low hazard rating, as defined in FSM 7511.2, based on the clear weather breach flood damage from the dam to a point downstream where the flood is contained within the channel banks. Consider the reservoir full to the crest of the uncontrolled spillway, and calculate the realistic time required for complete breach to occur for the type and size of dam. Consider and document reasonably foreseeable downstream development as well as existing development in the assessment.

Check moderate and low hazard ratings for a possible high hazard rating based on "Incremental Damage Analysis" determined by routing the inflow design storm without a dam failure, and with an overtopping dam failure. If analysis indicates that the failure of the dam causes no loss of human life or no additional excessive economic loss when compared to overtopping without failure, then the dam shall not be classified as high hazard (FSM 7524.32, ex. 01).

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7524.3 - Spillway Sizing

7524.31 - Spillway Sizing Standards

Size the spillway to safely pass the inflow design flood shown in exhibit 01.

7524.31 - Exhibit 01

Minimum Required Inflow Design Flood

<u>Hazard Potential</u>	<u>Size Class</u>	<u>Inflow Design Flood</u>
HIGH	A	PMF*
	B	PMF
	C	PMF
	D	PMF
MODERATE	A	3/4 PMF
	B	1/2 PMF
	C	1/2 PMF
	D	1/2 PMF
LOW	A	100 YEAR**
	B	100 YEAR
	C	50 YEAR
	D	50 YEAR

* Probable Maximum Flood

** Return Frequency in Years

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7524.32 - Exceptions to Spillway Sizing Standards

Smaller inflow design floods may be used if documented analysis shows that:

1. Overtopping the dam crest by the appropriate comparison flood as described in FSM 7524.31, exhibit 01 will not cause failure of the dam.
2. Through incremental damage analysis, failure would not cause additional loss of human life, and property damage is less than the cost of building additional spillway capacity.

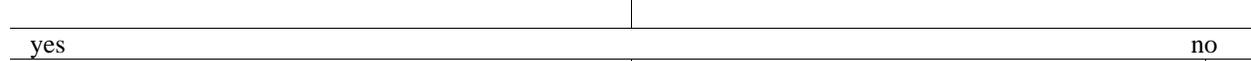
To determine exceptions to spillway sizing standards (FSM 7524.31, exhibit 01), use the decision tree in FSM 7524.32, exhibit 01 for evaluating hazard classification and spillway size requirements based on incremental damage analysis for determining exceptions to FSM 7524.31, exhibit 01.

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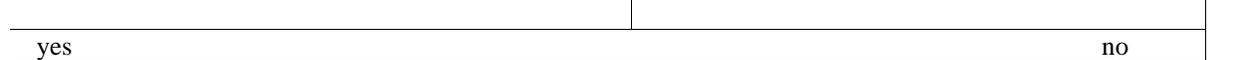
7524.32 - Exhibit 01

Decision Tree For Incremental Analysis

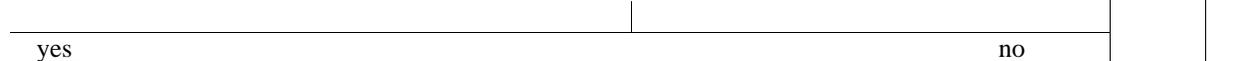
(1) Route a storm causing a full spillway (spillway at design capacity) through the dam without a dam failure. Is there potential loss of human life from this flood?



(2) Route the same storm causing a full spillway through the dam with an overtopping dam failure. Is there potential loss of human life from this flood?



(3) Is the potential loss of human life greater from the flood with an overtopping dam failure than from the flood without a dam failure?



(4) Can a spillway size be found in which the potential loss of human life from the routed store is no greater with dam failure than from the routed storm without a dam failure?



(5) This is a high hazard dam requiring a probable maximum flood size spillway.

(6) Use this storm to evaluate incremental damage, the additional damage that can be expected from the overtopping dam failure above the damage expected from the flood without a dam failure. What is the hazard classification based on incremental damage? Use the higher hazard classification from clear weather breach and incremental damage analysis.



(7) Is the savings from constructing this size spillway in comparison to constructing the spillway required from FSM 7524.31, exhibit 01, less than the incremental loss potential, including the cost of repairing the breached dam?



(8) This size spillway can be constructed.

(9) Use the spillway size from FSM 7524.31, exhibit 01.

Existing dams which can pass at least 75 percent of the design flood will not need to be modified to increase spillway capacity to the 7524.31, exhibit 01 minimums until major reconstruction is implemented.

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7524.33 - Spillway Design

The uncontrolled spillway capacity shall be sufficient to pass the inflow design flood. Flow capacity from unattended gates shall not be included in the design capacity calculation. Flow capacity from automatic gates or resident-attended gates may be included in the spillway design capacity calculation. For a reservoir without a flood pool, start routing the inflow design flood at the lowest uncontrolled spillway crest elevation. For a reservoir with a flood pool, start routing the inflow design flood at the elevation of the water surface that would exist after 10 days of drawdown from the 100-year flood pool.

7524.4 - Investigation and Design Criteria

Apply the site investigations and design criteria of sections 7524.41 through 7524.48 to new dams, enlargement of existing dams, or for dams considered structurally unsafe. Any variance from these criteria must be submitted to the Regional Staff Director for engineering activities for approval.

7524.41 - Site Investigation

Investigate and test a potential dam site to the extent appropriate to the size and hazard of the dam as well as for possible geologic features that influence the risk of failure. Low hazard dams and class C moderate hazard dams require, as a minimum, a field geology report with soil borings or test pits penetrating to bed rock or a distance equal to half the height of the dam. Additionally, class A and B moderate and all high hazard dams require borings that penetrate to bedrock or 1-1/2 times the height of the dam, whichever is shallower, and adequate field and laboratory testing of materials to determine stability and to perform a seepage analysis.

7524.42 - Structure Stability

Soil Conservation Service guidelines may be used to design low hazard earth dam side slopes. Analyze moderate and high hazard dam embankment stability to demonstrate that all pertinent static and dynamic loading conditions will not exceed allowable shearing stresses in the embankment or foundation. Ensure the factors of safety and allowable shear stresses used in the design are appropriate for the construction and operating conditions. In most cases, embankments should be designed for unrestricted rates of reservoir filling and drawdown.

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7524.43 - Earthquake Design

Consider earthquake hazards in site investigation and analysis for all high and moderate hazard dams. Consider also earthquake related concerns such as fault displacement; soil liquefaction; cracking potential; type of structure; structure stability, abutment stability, and reservoir slope stability; overtopping effects; and required defensive measures such as emergency action plans.

7524.44 – Geosynthetics

Geosynthetic fabrics may be used in constructing low hazard dams. Geosynthetic fabrics may be used in moderate and high hazard dams for applications involving the structural stability of the dam (i.e., impermeable membrane cutoffs and internal filter drains) only after consultation with other Federal agencies or private engineering consultants experienced in designing dams and geosynthetic fabric installations.

7524.45 - Outlet Works

All dams except moderate hazard class D and low hazard class C and D dams and debris dams shall have outlet works capable of releasing the top 5 feet of the reservoir capacity within 5 days, and shall also be capable of draining at least two-thirds of the normal storage volume. When selecting minimum pipe diameter, also consider the potential for plugging and ease of inspection. Corrugated metal pipe is restricted to moderate hazard class D and low hazard class C and D dams, unless otherwise approved by the Regional Staff Director for engineering activities. Include the life-cycle cost when considering its use. Locate outlet control works on the upstream side of the dam.

7524.46 – Flashboards

Flashboards with shear pins or failure supports are not permitted in uncontrolled spillways. Other types of flashboards must be approved by the Regional Staff Director for engineering activities.

7524.47 – Access

Provide all weather road access for operation and maintenance of high hazard dams. Moderate hazard dams may be accessible by seasonal roads, and low hazard dams should be accessible for construction equipment. Access to dams in wilderness areas varies with circumstances and will be handled case by case.

7524.48 – Instrumentation

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Where necessary, provide instrumentation for measurement of physical changes that could affect dam safety. Depending on the size, hazard and design of the dam, and the foundation conditions, consider installing an instrumentation system to observe changing conditions in the foundation, embankment, and abutments during construction, initial reservoir filling, and during project operation.

7524.49 - Additional Design Items

In addition to the criteria in FSM 7524.41-7524.48, the following items should be considered in dam design: sediment storage; residual freeboard above design flood stage for wave action; wave erosion protection; slope erosion protection; spillway erosion protection; internal erosion protection; and added embankment height to compensate for settlement. Earthen dam crest width (W) shall be a minimum of 10 feet and increase in width based on dam height (H), $W = (H + 35)/5$. Earthen dams over 100 feet high shall have a minimum crest width of 28 feet. Limit projected frequency of use of unlined earth and vegetated spillways to once in 50 years.

7525 - CHANNEL PLANNING, INVESTIGATION, AND DESIGN

See FSH 7509.11, section 82 for direction on channel layout.

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7530.2 - Objectives

1. To determine that the intent of a project design is met.
2. To ensure that new field information acquired on site during construction is properly incorporated in the design.

7530.3 - Policy

1. Construction inspection personnel shall maintain close coordination with design personnel, especially for design changes, throughout the period of project construction.
2. Forest Service officers shall not permit water to be stored behind a dam or water flow introduced into a canal or similar structure until the requirements outlined in FSM 7531.3 are met.

7530.5 - Definitions

Certificate of Compliance. An affidavit stating that a completed project conforms to the applicable specifications.

Continuous Inspection. The continuous presence of the inspector, or inspectors, at the work site while work is in progress.

Periodic Inspection. The intermittent presence of the inspector during the progress of the work.

7531 - CONSTRUCTION MANAGEMENT

7531.1 – Inspection

Provide inspection by personnel especially trained for, and regularly assigned to, similar work. Ensure continuous or periodic inspection is appropriate for the construction work in progress (FSM 7532).

Where an independent design review team has been established for a project, the team shall be given the latitude for direct contact with construction inspection personnel and for inspecting the project at their discretion.

7531.11 - Special Use Projects

1. Forest Service Monitoring. Monitor special use construction sufficiently to determine that:

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- a. Inspection by the holder's inspector is adequate, effective, and is conducted by qualified personnel.
 - b. The holder's engineer promptly submits planned construction schedules to the Forest Service.
 - c. The holder's engineer keeps the Forest Service informed of construction progress so that any required joint inspection at critical periods can be planned.
 - d. The holder's engineer obtains Forest Service approval of design changes prior to implementing those changes.
 - e. Proper attention is given to protection of adjacent lands and facilities from damage by construction operations.
2. State Coordination. Coordinate Forest Service monitoring and joint inspections with State and other involved agency representatives to promote efficiency and consistent communications.

7531.2 - Records and Reports

7531.21 - Forest Service Projects

Records and reports shall conform to the requirements of FSH 6309.31 and FSH 6309.32.

A final construction report shall be prepared for projects requiring Regional Forester approval (FSM 7504).

Keep the final construction report, including photographs taken during construction, in the project file for reference (FSH 7509.11, ch. 10).

7531.22 - Special Use Projects

Ensure that the holder complies with the terms and conditions of the permit as set out in FSH 2709.11, sec. 53.1, clause B37 to provide the Forest Service required information and record keeping.

7531.3 - Certification of Construction

Ensure that the holder complies with the terms and conditions of the permit as set out in FSH 2709.11, sec. 53.1, clause B37 for inspection of construction of the dam.

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Approval of drawings and specifications does not authorize operation of the completed works. The structure may be operated only after the Regional Staff Director for engineering activities has certified in writing that the structure is acceptable for water storage or transmission, and approval is received from an authorizing official (FSM 7505). Additional construction approvals may be necessary from the State or other involved agencies.

The Regional Staff Director for engineering activities shall take such action as deemed necessary to verify compliance prior to granting approval to operate the structure.

7532 - INSPECTION OF CONSTRUCTION OPERATIONS

The primary responsibility for inspection rests with the party proposing construction. The Forest Service may monitor a special use holder's inspection procedures and documentation to verify adequacy.

7532.1 - Forest Service Inspection of Special Use Projects

1. Continuous Inspections. Continuous inspection is required when the quality of any work cannot be determined accurately by periodic inspection, or the work cannot readily be removed and replaced if rejected. Examples include:

- a. Excavating the foundation when the depth must be determined during the course of the work or when the foundation is under water.
- b. Placing compacted earthfill and filters.
- c. Placing and bedding pipe.
- d. Mixing and placing concrete and pneumatically applied mortar.

2. Periodic Inspections. Periodic inspection may be suitable for certain other types of work depending on the circumstances at the site, the construction schedule, or the contractor's level of ability. Examples include:

- a. Clearing and grubbing.
- b. Stripping or structure removal.
- c. Constructing the forms.
- d. Placing the steel reinforcements.