Forest Service Handbook
National Headquarters – Washington Office
Washington, DC

Forest Service Handbook 7509.11 – Dams Management Handbook
Chapter 40 - Safety Inspections and Hazard Inspections

Amendment: 7509.11-1993-1

Effective date: August 5, 1993

Duration: This amendment is effective until superseded or removed.

Superseded Directive: 1, August 8, 1990; Entire Handbook issued, December 1986

Approved by: F. Dale Robertson, Chief

Date approved:

Responsible Staff:

Explanation of changes: Following is an explanation of the changes throughout the directive by section.

POSTING NOTICE. Amendments are numbered consecutively by Handbook number and calendar year. Post document in numerical order of chapters (1109.12, sec. 4.32, ex. 01). Remove entire national text of the Handbook and replace with this amendment. DO NOT REMOVE SUPPLEMENTS OR INTERIM DIRECTIVES. Retain this transmittal as the first page of this document.

Revises and updates entire Handbook. Significant changes in direction are as follows:

05: Moves select definitions from FSM 7500. Modifies definitions to agree with Glossary of Terms for Dam Safety, prepared by the Interagency Committee for Dam Safety (ICODS), and Federal Emergency Management Agency (FEMA).

08: Updates reference list and adds names and addresses of agencies, associations, and groups publishing reference materials related to dams and dam safety.

10: Changes chapter title from Project Files to Records and Files.

40: Changes chapter title from Safety Evaluation/Hazard Potential to Safety Inspections and Hazard Assessments. Replaces the term "safety evaluation" with "safety inspection" throughout.

42: Replaces the term "Hazard - Potential Evaluations "with" Hazard Assessment."

42.3: Adds hazard classification examples.

53: Adds direction on location of copies of emergency action plans.

54: Adds direction on testing emergency action plans.

62: Revises direction to exclude Regional dam or water resources engineer from serving on a dam failure investigation team in cases of potential or apparent conflict of interest.

70: Changes title from Dam Inventory to Management of Special Use and Other Non-Forest Service Projects. Previous direction contained in this chapter is moved to FSM 7514; moves direction from previous chapter 80 to chapter 70.

80: Changes title from Management of Special-Use and Other Non-Forest Service Projects to Planning and Design.

Completes previously reserved FSM 7520 and incorporates it into
FSH 7509.11.

81: Provides guidance and definitions for four phases in the design schedule.

82: Provides guidance for planning and designing channel layout.

83: Provides guidance for assigning hazard classification.

This Handbook is now available electronically in the National Information Center in the same format as the paper copy. Henceforth, amendments to this Handbook will be issued to Forest Service units electronically on a document basis.

Table of Contents

Safety inspections are necessary for evaluating the safety and integrity of dams and related structures in order to protect human life and property.

Safety inspections differ from routine operation and maintenance inspections in that they may include reanalysis of the structural stability, flood flows, and hydraulic capacity; employ advanced methods and modern design criteria and practices; examine long-term performance patterns revealed by instrumentation and by spillway discharges; and a review of the long-term field examination record and its comparison with current conditions.

40.2 - Objectives

1. To ensure dams are inspected regularly for meeting safety standards.

2. To take followup actions to verify and correct deficiencies noted in the safety inspection.

41 - Safety Evaluations

41.1 - Scope

Perform safety evaluations at intervals not to exceed 5 years (FSM 7516.31). Some dams may require more frequent evaluations based on project history or a recent natural occurrence, such as a major earthquake.

Safety inspections are made by a team of engineers, engineering geologists, and allied technical people, and should include personnel who were involved in recent operation and maintenance inspections. Determine the skills needed to evaluate the dam by considering the type, age, and condition of the dam and select team members with the required skills.

41.2 - Safety Inspection Phase

41.21 - Collection and Review of Existing Data

Collect and review existing data to provide the historical record of the design, construction, and operation of a dam. The results of this step analyzed along with data collected from the site examination will determine whether supplemental data are needed to complete the evaluation. Determine the scope of the supplemental data required.

When the data are collected, all pertinent information should be extracted from each record reviewed.

Records on existing dams vary considerably in completeness, quality, and usefulness. Their existence and character will vary with the age of the facility, the type of ownership, and the project engineer, if there was one. Make a diligent search for all records because the information they contain may be vital, yet unavailable from any other source. In many cases,

records (especially of design and construction) may be fragmentary, inaccurate, or nonexistent. On the other hand, design and construction records may exist but may not be readily available. Consider possible sources of data such as the designer and project engineers (or their heirs), archives of area colleges and universities, State agency files, and other Federal agency records.

Use this information to answer the following questions.

1. General.

    a. When was the dam built?

    b. What are the original and current purposes of the dam?

    c. How were the dam and appurtenant structures designed?

    d. Has the dam ever been rehabilitated or enlarged?

    e. Are there existing as-built drawings?

2. Geotechnical Data.

    a. What are the regional and site geologic conditions?

    b. What are the regional and site seismic characteristics?

    c. What engineering properties were assigned to the construction materials and the foundation for design purposes?

    d. Were the engineering properties based on laboratory and field tests?

    e. Are the engineering properties reliable and representative of the actual conditions encountered during construction?

    f. What criteria were used for design analyses and what were the actual results of analyses? Are the criteria still valid?

3. Hydrologic and Hydraulic Data.

    a. What are the runoff-producing characteristics of the drainage basin?

    b. Are runoff records available?

    c. How was the inflow design flood developed?

d. How does the inflow design flood hydrograph compare with that for similar basins in the Region?

e. What record flows have been recorded at the dam site since construction?

f. What is the elevation of the design pool?

g. What is the reservoir storage capacity?

h. What are the location, type, and size of the spillways?

i. What are the location, type, and size of the outlet works?

j. Can the spillway safely handle the design flood developed by current standards and criteria?

k. What are the effects of a clear weather breach?

l. What are the effects of downstream flooding?

4. Construction Records.

a. What kinds of construction procedures and methods were used?

b. What were the technical provisions of the contract specifications?

c. What were the properties and characteristics of the specified construction materials?

d. How was quality control maintained and measured?

e. How did the material properties, as constructed, compare with the design assumptions?

f. What inspections were made and what records were kept during construction?

g. What were the actual conditions encountered when the foundations were exposed?

h. What design changes were made to conform to those conditions?

5. Operation and Maintenance Records.

a. What has been the performance record to date, as revealed by instrument observations and past surveillance reports?

b. How do the conditions to which the facility has been subjected compare with the most critical conditions anticipated?

c. Are there any trends indicating that performance in recent years has been less favorable than that under like conditions in earlier years?

d. Have any repairs or alterations been necessary? How were they made? When?

e. Have there been any indications of changes in ground water levels at the dam or immediately downstream?

41.22 - Site Examination

In addition to the records on a particular dam, review all available data relating to the area and site, even if they were unavailable or not used in the original work on the dam. Determine how this current knowledge, if any, pertains to the condition of the dam. Study available hydrologic, meteorologic, geologic, and seismic data prior to the field examination to form a frame of reference for the inspection. Determine the scope of the supplemental data required. See chapter 30 for field examination techniques.

41.23 - Supplemental Data Acquisition

Obtain supplemental data not available from the project records or by direct visual observation at this stage of the evaluation. Perform flood routing and inundation mapping if needed. Conduct the subsurface exploration, sample and test material, or install instruments to provide the necessary data to adequately assess the safety and performance of the facility.

41.24 - Data Analyses and Supporting Calculations

Evaluate the safety and performance of the facility at this stage. Use pertinent information revealed by the record, conditions observed at the site, supplemental data, and the results of engineering analyses made by the evaluation team to make the evaluation. Be alert to suspicious calculations, features, or conditions.

41.25 - Formal Report Preparation

Fully document the evaluation process and results in the report. Also include conclusions concerning the safety and performance of the facility as well as recommendations for interim

or permanent modification of operating practices and immediate or future corrective work. Include the following items:

1. A description of how the study was conducted and the personnel involved.

2. A summary of the available records and how they were used.

3. Additional information required and how it was obtained and used.

4. The analyses made and their corresponding assumptions and methods. The discussion should include the engineering properties that were assigned, the results of the analyses, and interpretations.

5. A summary of the project features and the manner in which they were designed and constructed.

6. An assessment of the adequacy of the design and quality of the construction.

7. A summary of the historical structural and hydraulic performance, with emphasis on deficiencies.

8. A description of the present state-of-the-project features, as determined by the onsite examinations.

9. Conclusions concerning the following fundamental safety considerations:

    a. The stability of the dam and its foundation.

    b. The resistance to stresses induced in the dam during impoundment and release of water.

    c. The control of seepage, leakage, and erosion in the dam and foundation.

    d. The condition of materials in the dam and foundation.

    e. The ability of the spillways to transport flood flows.

    f. The hydraulic capabilities of the spillway and the outlet works.

    g. The serviceability and reliability of the discharge control mechanisms for the spillway and outlet works.

10. Recommendations for operational changes, correction of identified deficiencies, changes in hazard classification, and additional testing or analysis needed, if any.

11. Photographs, charts, graphs, tables, sketches, calculations, and drawings.

42 - Hazard Assessments

42.1 - Assessment

Determine the hazard classification for a dam by analyzing the potential effects of structural failure, under certain conditions, on downstream life and property. Definitions and procedures are described in FSM 7511. Breach routing may be required if the effects are not readily evident; for example, where dwellings are located in the valley but above and away from the stream channel.

Do not confuse flood routing required to determine spillway adequacy and its effect on structural safety with the flood routing used to determine the hazard classification, since two different sets of conditions are assumed. Consult FSM 7511 for conditions used to determine hazard potential. Direction on how design floods are used to determine spillway adequacy as a function of the hazard classification and size class is found in FSM 7524.

42.2 - Exceptions to Recommended Spillway Design Flood Criteria

See
FSM 7524 for exceptions to the recommended spillway design flood criteria.

42.3 - Hazard Classification Examples

(FSM 7511).

42.31 - High Hazard

The following are intended to illustrate the minimum amount of damage that would result from failure of a dam with a hazard classification of "high." If the damage would be less severe, check the examples for applicability of moderate hazard classification.

1. The flood wave from a failed dam seriously damages several houses in a community by the stream channel, killing one person. No other damage occurs.

2. A dam fails during a spring rain storm with snow on the ground. The resulting wave of water inundates a downstream campground killing one person. (This dam would be legitimately classified as high hazard only if it has been determined that loss of life is likely, should the dam fail. Such a judgement would result from considerations of flood wave size,

campground occupancy, the time of the year the campground is likely to be used, the time of the year the dam is likely to fail, and so on.)

3. A dam could conceivably cause extensive economic damage without causing loss of life. Such a dam would be classified as high hazard, though a dam with these characteristics is not likely to be on the Forest Service inventory.

42.32 - Moderate Hazard

The following are intended to illustrate the minimum amount of damage that would result in a hazard classification of moderate. If the damage would be less severe, the dam is a low-hazard dam.

1. A dam fails and causes a meadow to flood, doing irreparable damage to a threatened and endangered plant species. No other damage occurs.

2. A dam fails and undermines the foundation of a residence built near the stream channel causing serious structural damage to the house (or similar damage to a moderate-cost bridge or to a large interstate highway fill). The occupants (drivers and passengers in the cases of the bridge and highway fill) would not likely be killed by the flooding. No other damage occurs.

42.33 - Low Hazard

1. A dam fails causing channel scouring to occur for 3 miles downstream of the dam and exposing the root system of several trees and eventually killing them. A double-lane paved county road fill with a culvert or small bridge is washed out. No other damage occurs.

2. A dam fails causing channel scouring and sediment deposition that damages fish spawning habitat for 4 miles downstream of the dam. At the 4-mile point a small earth embankment dam is overtopped and fails. Further stream scour occurs for 2 miles. No other damage occurs.