



## Missouri Department of Natural Resources

### Dam and Reservoir Safety

#### MISSOURI DAM AND RESERVOIR SAFETY STAFF CHECKLIST FOR EVALUATING CONSTRUCTION PERMIT APPLICATIONS FOR MODIFICATIONS TO EXISTING EARTH DAMS

## II. DESIGN REPORT CONSIDERATIONS

If modifications are to the existing spillway facilities or appurtenances, see Parts A, B, C, F, and G. If modifications involve raising the top of dam, changing the water storage elevation or making other geotechnical changes, see parts A, D, E, F, and G.

### A. Description of Proposed Changes

#### 1. Appurtenant Structures.

- a. Description of modifications to the principal and emergency spillways.
- b. Description of modifications to the water withdrawal works, drawdown works, and internal drain outlets.
- c. Description of modifications to the discharge channels.
- d. Description of blasting that will be performed within two (2) miles of the dam.
- e. Describe how the reservoir will be drawn while modifications are constructed.

#### 2. Dam and Foundation

- a. Description of the modification to the height of the dam
- b. Description of modifications to the slopes and dimensions of the dam.
- c. Description of modifications to the internal drainage system.
- d. Description of modifications of the permeability of the dam and foundation by grouting.

### B. Determination of an Environmental Class For Each Dam and Reservoir.

1. For Class I (Go to Part II - C.)

2. For Class II and III only

- a) If a sufficient number of homes are located downstream of a dam, a breach analysis is required to justify a Class II or Class III downstream environmental zone. The following information should be submitted:
  - 1) Topographic map showing: (The most recent USGS Topographic map is minimum acceptable).
    - a) Location of dam and reservoir.
    - b) Location of stream cross sections used in breach analysis.
    - c) Flood plain as derived from breach analysis.
    - d) Verified locations of permanent dwellings, campgrounds or industrial buildings within the dam breach flood plain.
  - 2) Dam failure criteria:
    - a) Final breach configuration (bottom width, top width, side slopes).
    - b) Assumed time of failure.
    - c) Description of the methodology used and the computations performed in the breach analysis.
  - 3) Stream profile showing:
    - a) Water surface elevation created by failure of the dam with the reservoir at the emergency spillway crest elevation.
      - (1) Stream cross section locations.
- b. To show that a structure located in the dam breach flood plain is not inundated by the dam breach flood:
  - 1) Replace cross-section data derived from topographic maps with field survey cross-sections.
  - 2) Compare surveyed first floor elevation of structure to the computed water surface elevation for the dam breach flood.
- c. In a situation where a dam is in very remote location where there are not enough buildings or other structures located downstream of the dam to justify a class I environmental zone, another environmental class may be

used without having to perform a detailed dam breach analysis. Engineers are advised to obtain the approval of the Dam and Reservoir Safety staff before using this option.

C. Evaluation of Spillway Capacity

1. The following data must be included in the application report:

- a. Drainage area (square miles or acres) shown on an up-to-date USGS topo map.
- b. SCS Curve Number for watershed draining into lake.
- c. Time of concentration for runoff draining into reservoir.  
Sufficient documentation should be provided to derive the value used.
- d. Storage (acre-feet) vs. elevation (feet) data for reservoir.

This information should be provided for elevations ranging from the bottom of the reservoir to the final elevation of the dam. Surface area (acres) vs elevation data should also be submitted in support of this information.

- e. Minimum elevation of top of dam exclusive of the spillway(s).  
If the top of dam is not level, a profile of the top of dam is required.
- f. Height of dam (measured in accordance with 10 CSR 22-1.020 (13)).
- g. Length of Dam.
- h. Discharge (cubic feet per second) vs. elevation (feet) data for spillway(s) with backup computations.
- i. The required critical design in-flow hydrograph to the reservoir as determined by taking the appropriate percentage of the PMP as shown in Table 5, 10 CSR 22-3.020.
- j. The probable maximum precipitation values from Hydrometeorological Report No. 51, the duration of the rainfall, and the rainfall distribution pattern used to compute the hydrograph must also be submitted. Sufficient information should be submitted to derive the hydrograph.
- k. The required design storm out-flow hydrograph derived by reservoir routing the required design storm in-flow hydrograph through the spillway.

2. Other items that must be addressed:

- a. The possibility of submergence of the spillway control(s) by backwater conditions in the spillway discharge channel.

- b. The ability of the spillway and discharge channel to withstand the exit velocity expected through them during the required design storm.
- c. The alignment of the spillway discharge channel with respect to the dam and what effect, if any, erosion or overtopping of the discharge channel will have on the dam.

C. Evaluation of Slope Stability

1. General design considerations

- a. Description of drilling and backhoe exploration
- b. Test results
- c. Physical and mechanical properties of construction materials

2. Stability analysis for loading conditions Table (10 CSR 22-3.020)

- a. Identification of all assumptions
- b. Tabulation of the minimum computed factors of safety
- c. Graphical presentation of the maximum dam section showing the configuration of the embankment, foundation and core trench including:
  - 1) The failure surfaces associated with the minimum factors of safety listed above
  - 2) The phreatic surface in the dam and foundation with the appropriate reservoir levels
  - 3) The physical and mechanical properties of the various zones of the embankment and foundation

3. Seismic Analysis (see CSR 22-3.020 (5) and (6))

D. Design of Modifications to the Internal Drain System

- 1. Filter design criteria used
- 2. Size gradation for filters and drains
- 3. Permeability and design capacity of drains

E. Design of New Concrete Structures

1. Discussion of procedures used to design concrete structures
  2. Discuss foundation analysis for these structures
- F. Description of General Work Plan
1. Sequence of work
  2. Monitoring of embankment and seepage
  3. Emergency action plan
  4. Construction start date and time to complete
  5. Location and amount of borrow materials, if required

### **III. CONSTRUCTION DOCUMENTS**

- A. Drawings
1. Certification by experienced Professional Engineer as required by 10 CSR 22-3.040 (1) (A) 13C.
  2. Certification by owner as required by 10 CSR 22-3.040 (1) (A) 13C.
  3. Site plans showing the location of the dam and all proposed modifications.
  4. Plans, profiles, sections, and details sufficient to construct the modifications to the dam.
- B. Specifications (Include only those sections applicable to the modifications being proposed)
1. Location of and protective measures used in conjunction with all drain lines, sewer lines, utilities, or other structures that pass through or under the dam.
  2. Fill Operation
  3. Testing and inspection
    - a. Compaction of earth fill
    - b. Density tests
    - c. Structures
  4. Rip-rap

5. Filter material
6. Pipe construction
7. Concrete
8. Seeding and mulching
9. Record keeping and monitoring