MISSOURI DAM AND RESERVOIR SAFETY STAFF CHECKLIST FOR EVALUATING CONSTRUCTION PERMIT APPLICATIONS FOR INDUSTRIAL WATER RETENTION DAMS

II. DESIGN REPORT CONSIDERATIONS

A. General Information

1. Up-to-date topographic maps showing the location of the proposed dam, the upstream watershed, the reservoir and the downstream environmental zone.

2. Summary of Design

   a. Final height of dam.

   b. Final storage capacity (full reservoir).

   c. Final top of dam elevation (as built maximum).

   d. Final elevation of toe of dam at lowest point at the completion of construction.

   e. Final emergency spillway elevation.

   f. Final maximum water surface elevation.

   g. Expected crest elevation, dam configuration, spillway elevation and configuration of each successive stage of the dam.

   h. Anticipated storage volume of solid or semi-solid materials and of liquids at the completion of the dam.

B. Geologic Exploration

1. Description of drilling and test pits including locations, methods used to collect samples and a geologic description of samples and materials encountered.

2. A geologic report on the dam site which analyzes all available information, discusses cutoff trench requirements, identifies any foundation and/or abutment problems, and describes the available borrow materials for the starter dam.

3. Geologic cross-sections oriented along the axis of the center-line of the dam and along the center-line of the discharge channel of the emergency spillway.

4. Location of surface and underground mine workings with respect to the dam.

C. Geotechnical Investigations and Design

1. General design considerations
   a. Testing records and results with references for test procedures and description of sample handling procedure.

   b. Physical and mechanical properties of foundation and construction materials, description of test or source of properties.

   c. Type and physical properties of the liquid and solid materials to be used in the construction of the dam and the reservoir.

   d. Description of the geotechnical design procedure (referenced).

   e. Description of the system used to deposit tailings on the dam.

2. Settlement Analysis

   a. Test results and assumptions for foundation and embankment.

   b. Elongation and settlement of conduits through or beneath the dam.

3. Seepage Analysis

   a. Discussion of the permeabilities of the embankment zones and foundation.

   b. Determination of the expected seepage rate.

   c. Internal drainage system.

      1) Configuration and size gradation of the drain and filter material.

      2) Permeabilities and design capacity of drains.

4. Seepage and Stability Analysis for the Loading Conditions listed in Table 3 (10 CSR 22-3.0202)

   a. Identification of assumptions

   b. Tabulation of the minimum computed factors of safety.

c. Graphical presentation of the dam cross-section through the maximum section which shows the configuration of the embankment, foundation and core trench and includes:

1) The failure surfaces associated with the minimum factors of safety listed above.

2) The phreatic surface in the dam and foundation and the reservoir level for the loading conditions.

3) The physical and mechanical properties of the various zones of the embankment and foundation.

5. Seismic Analysis

a. Description of active faulting in the area.

b. Design earthquake intensity and bedrock acceleration.

c. Discussion of liquefaction potential of embankment and foundation.

1) Physical and mechanical characteristics of materials.

2) Description and reference of method used to evaluate liquefaction potential and the results of the analysis.

d. Description of slope stability analysis incorporating loss of strength and increased pore pressures due to liquefaction and earthquake induced accelerations.

D. Design of Structures

1. Discussion of procedures used to design concrete structures.

2. Discuss foundation analysis for these structures.

E. Hydrologic/Hydraulic Investigations

1. Determination of an environmental class for each dam and reservoir. This determination should examine the changes in the downstream environmental zone as the dam and reservoir become incrementally larger.

a. For Class I (Go to II. E. 2. below)

b. For Class II and III only

1) 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:

a) Topographic map showing: (The most recent USGS Topographic map is minimum acceptable).

(1) Location of dam and reservoir.

(2) Location of stream cross sections used in breach analysis.

(3) Flood plain as derived from breach analysis.

(4) Verified locations of permanent dwellings, campgrounds or industrial buildings within the dam breach flood plain.

b) Dam failure criteria:

(1) Final breach configuration (bottom width, top width, side slopes).

(2) Assumed time of failure.

(3) Description of the methodology used and the computations performed in the breach analysis.

c) Stream profile showing:

(1) Water surface elevation created by failure of the dam with the reservoir at the emergency spillway crest elevation. State assumptions regarding the flow characteristics of the fine tailings.

(2) Stream cross section locations.

2) To show that a structure located in the dam breach flood plain is not inundated by the dam breach flood:

a) Replace cross-section data derived from topographic maps with field survey cross-sections.

d) Compare surveyed first floor elevation of structure to the computed water surface elevation for the dam breach flood.

3) 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.

4) Address the changes occurring in the downstream environment zone as the dam and reservoir become incrementally larger.

2. Evaluation of Spillway Capacity

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

1. Drainage area (square miles or acres) shown on an up-to-date USGS topo map.

2. SCS Curve Number for watershed draining into lake.

3. Time of concentration for runoff draining into reservoir.

Sufficient documentation should be provided to derive the value used.

4. Storage (acre-feet) vs. elevation (feet) data for reservoir at each stage of construction.

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.

5. 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.

6. Height of dam (measured in accordance with 10 CSR 22-1.020 (13)).

7. Length of Dam.

8. Discharge (cubic feet per second) vs. elevation (feet) data for each temporary spillway and the final spillway with backup computations.

9. 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.

The probable maximum precipitation values from Hydrometerological 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.

10. The required design storm out-flow hydrograph derived by reservoir routing the required design storm in-flow hydrograph through each temporary spillway and the final spillway.

b. Other items that must be addressed:

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

2) The ability of the spillway and discharge channel to withstand the exit velocity expected through them during the required design storm.

3) 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.

F. Discussion of Diversion Channels

1. Location and design of diversions.

2. What effect would failure of the diversion have on the structure.

G. Discussion of Upstream Slope Protection

1. Method of design.

2. Wave run-up

3. Filter gradation.

4. Rip-rap parameters

H. Operation of the Dam after Construction; Discuss the Following:

1. Operating procedures.

2. Maintenance schedule.

3. Monitoring of seepage, water level, or movement of the structures.

4. Sediment storage for the life of the reservoir/dam.

5. Record keeping.

6. Regular inspection.

a. Spigots or cyclones (when active).

b. Decant lines.

c. Position of pool as related to the spillway, decant intake and crest of the dam.

d. Drain outlets checked for flow rate and sediment.

e. Observation of embankment for slides or seepage changes.

f. Spillway for blockage.

7. Emergency actions plans.

II. 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 baselines, centerlines, and other horizontal and vertical control points sufficiently accurate to locate the proposed construction.

4. Plans, profiles, sections, and details sufficient to construct the dam and appurtenances.

B. Specifications

1. Excavation of core trench.

2. Foundation preparation

3. 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.

4. Fill operations

a. Core trench

b. Starter dam

c. Embankment (treat each zone separately)

1) Size gradation standards for cyclone underflow.

2) In-place density standards.

5. Testing and inspection

a. Compaction of embankment and core trench materials…

b. Density tests of all fill.

c. Structures and piping.

6. Rip-rap

7. Filter material

8. Pipe construction

   a. Type of pipe

   b. Type of joints used

   c. Bedding

   d. Construction procedures

   e. Valves

9. Concrete

   a. Mix design

   b. Precast structures

   c. Reinforcing steel

   d. Formwork

10. Seeding and mulching

11. Estimated time to complete construction

    a. Starter dam

    b. Intermediate and final stages

12. Record keeping and monitoring