Rule 50 New Water Storage Dams and Reservoirs

050. New Water Storage Dams and Reservoirs .

The following criteria shall be used by the Director as a basis to evaluate the design of earthen water storage dams in Idaho. These guidelines are intended for a broad range of circumstances, and engineers should not consider them as a restriction to the use of other sound engineering design principles. Exclusion from these established criteria will be considered by the Director on a case-by-case basis during design review of plans and specifications submitted for approval prior to commencing construction. Structures which are or will be constructed of other materials, for example concrete, shall comply with these criteria as found appropriate by the Director and with other engineering design methods, and construction standards of care approved by the Director.

01. Embankment Stability. Slope stability analyses shall determine the appropriate upstream and downstream slopes. Unless a discrete slope stability analysis determines otherwise, the embankment slopes of earthen dams shall resemble the following:

Upstream slope	3:1 or flatter
Downstream slope	2:1 or flatter

a. Water storage dams shall be designed, constructed and maintained to assure stability under static loads and prevent instability due to seepage or uplift forces, rapid drawdown conditions and applied seismic loads.

b. The design analysis shall consider the need for installing filters, filter fabric and/or toe drains to stabilize the fill and protect against piping of the embankment fill material. Transmission of seepage through the embankment, abutments and foundation shall be controlled to prevent internal removal of material and instability where seepage emerges.

c. The minimum factor of safety for a steady state loading condition shall be 1.5. The minimum factor of safety for rapid drawdown loading shall be 1.2. The minimum factor of safety for seismic loading shall be 1.0.

d. Seismic Stability

1. The stability of an embankment subjected to earthquake ground motions can be analyzed by dynamic response or pseudo-static analysis. Pseudo-static analyses are acceptable for embankment dams and foundations composed of non-liquifiable soils that preclude the generation of excess pore water pressures due to shaking. Otherwise the stability analysis shall employ a dynamic response method.
2. Slope deformation analyses are required for structures that are constructed of cohesionless soils and/or on foundations that may be subject to liquefaction
3. The design analyses for large water storage dams shall include a geologic and seismic report. The seismic report shall identify the location of faults, evaluate landslide potential, and include a history of seismicity.
4. The design engineer shall include in the stability analysis peak ground accelerations

obtained from published U.S.G.S. Seismic Hazard Maps using as a minimum a 2 percent probability of exceedance in 50 years, or as determined by the Director.

e. Where in the opinion of the Director, embankment design or conditions warrant, instrumentation of the embankment and/or foundation will be required.

02. Top Width.

The minimum top width for any dam is twelve (12) feet to allow safe access by wheeled vehicles or tracked equipment for maintenance or repair.

03. Cutoff Trenches or Walls. Cutoff trenches shall be excavated through competent foundation material to bear on an approved stratum or zone.

a. The cutoff trench shall be backfilled with suitable material free from organic matter and debris and compacted to the specified moisture and density. The cutoff trench shall extend up the sides of both abutments to the design maximum storage elevation.

b. Cutoff trenches shall be wide enough to allow the free movement of excavation and compaction equipment. To provide for proper compaction side slopes shall be no steeper than one to one (1:1) for shallow depths up to twelve (12) feet, and no steeper than one and one half to one (1.5:1) for greater depths. Flatter slopes may be required for safety and stability.

c. Concrete cutoff walls may be used in a similar manner as cutoff trenches, with the base firmly entrenched in the underlying foundation material.. Where suitable bedrock is encountered, concrete cutoff walls shall be doweled with steel rebar into rock a minimum depth of twelve (12) inches with a maximum spacing of eighteen (18) inches . Concrete walls shall have a minimum vertical projection above the rock surface of three (3) feet, oriented perpendicular to the rock surface, and shall have a minimum thickness of twelve (12) inches. Reinforcement of the concrete may be required, as determined by the Director.

04. Impervious Core Material. Soils used to construct the inner sectional core of a water storage dam shall consist of relatively impervious cohesive materials approved by the engineer, and compacted in strict accordance with the approved plans and specifications. . A minimum ninety-five percent (95%) maximum dry density compacted in accordance with ASTM D-698 is required. The use of other relatively impermeable non-cohesive material is subject to approval by the Director on a case-by-case basis.

05. Drains. Toe, blanket, or chimney drains consisting of approved free draining material shall be installed where necessary to maintain the phreatic line at or near the design level(s) within the embankment.

a. Filter design for toe, blanket or chimney drains shall be included in the design plans and specifications submitted by the engineer for review and approval by the Director.

d. Blanket drains and chimney drains shall have a minimum thickness of twelve (12) inches or thicker, as determined by the Director and the dimensional size of the equipment used to place the material. The maximum particle size is one (1) inch, but may be increased with increasing thickness of the filter however, never to exceed three (3) inches. Each zone of filter comprising the drain must not be less than twelve (12) inches thick per each zone. The lay-down width of granular filters shall not be less than the width of the installation equipment unless the plans and specifications include construction procedures adequate to ensure the integrity of a narrower width.

e. Perforated and slotted drain pipes must be four (4) inches diameter or greater, and shall be surrounded on all sides by a thickness of drain material equal to or greater than the outside pipe diameter. The maximum particle size of the drain material shall reside between one-half (1/2) inch to three-fourths (3/4) inch Underdrains and collection pipes must be constructed of noncorrosive material, taking care to ensure slots and perforations are appropriately sized to avoid long-term migration of the drain material into the pipe.

06. Freeboard. The elevation of the top of the embankment shall be constructed and maintained above the design flood surcharge level, including the vertical height of wind generated waves estimated for the greatest distance of open water measured perpendicular to the major axis of the dam. . Camber shall be included in the design and incorporated in the construction of the top of the embankment, unless waived by the Director.

a. The minimum freeboard shall be two (2) feet plus wave height as calculated for the design spillway flow capacity during passage of the one percent (1%) flood, or greater to equal the surcharge elevation of the reservoir during passage of the inflow design flood.

07. Riprap. All dams which are subject to erosion on either the upstream and downstream slope(s) shall be protected using riprap or other approved material. Pipes, cables, brush, tree growth, dead growth, logs, or floating debris are not acceptable substitutes for approved riprap. The design engineer, with approval of the Director, shall determine the extent of slope protection as deemed necessary for existing site, seasonal, and operating conditions.

a. Where rock riprap or other approved material is used for erosion protection on the upstream slope, it shall be placed on an approved thickness of well-graded and free-draining granular bedding material. Riprap or other approved erosion protection material shall extend up the slope, from three (3) feet below the normal minimum operating level of the reservoir to the top of the dam.

08. Outlet Conduits. All reservoirs shall be provided with an outlet conduit of sufficient capacity to prevent interference with natural streamflow through the reservoir to the injury of downstream appropriators, unless waived by the Director. In addition to any natural flow releases, the outlet conduit should be of sufficient capacity to pass at the same time, the maximum water requirement of the owner. A larger outlet conduit may be required to provide adequate release capability as determined by the Director.

a. Outlet conduits shall be laid on a firm and stable foundation material to avoid the likelihood of differential settlement or excessive consolidation that could cause separation or misalignment of the pipe. Outlet conduits shall be encased on all sides by concrete of approved compressive strength a minimum thickness of twelve (12) inches. During construction outlet conduits shall be properly aligned on an established grade and adequately supported to prevent movement or damage caused by compaction equipment.

b. Unless otherwise required, the outlet conduit shall have a minimum inside diameter of twelve (12) inches. The conduits shall consist of approved material and composition as approved by the Director. Exceptions may be made only where conditions warrant, but in no case shall the reasonable life expectancy of the pipe be less than the design life of the dam.

c. The use of multiple conduits that penetrate the embankment beneath the maximum reservoir level is allowed only upon the written approval of the Director.

09. Gates.

a. All conduits shall be gated on the upstream end to avoid pressurizing the conduit internal to the embankment. Unless otherwise approved by the Director, all conduits shall be fitted with either a vertical or an inclined gate.

b. All conduits shall be vented directly behind the gate unless otherwise determined by the Director.

c. All gate stem pedestals shall be made of concrete.

d. At least one (1) of the sides of the inlet structure shall be open to allow water to flow into the outlet conduit and shall be covered with a trash rack.

e. Trash racks should be designed with bars primarily in one (1) direction so they can be cleaned. If fish screens are used, they shall be placed over the trash rack and shall be removable for cleaning, or of the self-cleaning type, as approved by the Director.

10. Outlet Controls. Outlet controls shall be installed at a stable location, on the crest or on an elevated platform, or within an enclosure when required, which is readily accessible, but secured to prevent unauthorized operation. Reservoirs storing water during the winter and subject to severe ice conditions shall have inclined gate stems or other controlling mechanical or hydraulic features enclosed in a protective sleeve which is buried beneath the upstream slope to suitable depth.

11. Emergency Spillway Flow Capacity Based on the size of the dam and on the downstream hazard classification assigned by the Director, the release capability of a dam shall equal or exceed the inflow design flood. The minimum flow capacity of the emergency spillway(s) shall be sized using the one-percent (1%) rate of flow (cfs) calculated for the contributing watershed upstream from the dam (aka Q100), plus two (2) feet of freeboard

Hazard Classification	Size Classification	Inflow Design Flood
Low	All Sizes	Q100
Significant	Small	Q100
	Intermediate	Q100 to Q500
	Large	Q500
High	Small	Q100
	Intermediate	Q100 to Q500
	Large	Q500 to PMF

a. All spillways shall be stabilized for the discharge of flow by the use of concrete, masonry, riprap or sod, or as approved by the Director if not constructed in resistant rock.

b. Where site conditions allow, the spillway shall be constructed independent of embankment dams. The spillway(s) shall guide the discharge of water away from the dam embankment so as not to erode or otherwise endanger the structure.

c. The minimum base width of an open-channel spillway shall be ten (10) feet, or greater to allow access by mechanical equipment. Siphon pipes or pumps are not acceptable substitutes for an open-channel spillway.

d. The effective flow capacity of spillways shall be undiminished by bridges, fences, pipelines or other obstructions.

e. Unless a part of an approved design and included as an integral part of an operation plan, stop logs or flashboards shall not be installed in spillways.

12. **Reservoir Site**. Prior to filling the reservoir, the site shall be cleared of all woody material, growth or debris that is large enough to lodge in the spillway, or outlet works, except as otherwise approved by the Director.

13. **Inspection and Completion Reports**. As construction proceeds, it is the responsibility of the engineer to submit test reports (e.g. soil material analyses, density tests, concrete strength tests) along with periodic inspection and progress reports to the Director.

a. Upon completion of construction the owner or his engineer shall provide the Director a written narrative account of all items of construction. Record drawings (aka asbuilts) and revised specifications shall be submitted to the Director to accurately reflect the as-constructed, completed project

b. The engineer, acting on behalf of and representing the owner, shall certify that construction or reconstruction or enlargement or replacement or repair of the dam and appurtenances was completed in accordance with the record drawings and specifications.