4.20 Dam Safety

4.20.1 Introduction

The factors associated with dam safety relative to the proposed changes in system operations include:

Resource Issues
▶ Reservoir-triggered seismicity
▶ Dam stability
▶ Leakage from dams

- Effects on reservoir-triggered seismicity (RTS) due to changes in filling or drawdown rates, or higher than normal reservoir levels;

- Effects on dam stability of changes in seismicity, higher reservoir levels, filling or drawdown rates; and,

- Leakage from dams in response to higher reservoir levels in areas of carbonate rocks with karst development.

Potential impacts on these key elements of dam safety are all indirect effects of the policy alternatives.

4.20.2 Regulatory Programs and TVA Management Activities

The Federal Guidelines for Dam Safety require that dams with a direct federal interest, which includes all dams in the TVA's system, must be designed, inspected, and maintained throughout their operating life to verify and protect the structural integrity of the dam and appurtenant structures to ensure protection of human life and property.

The requirements for design floods for dams that are the responsibility of federal agencies are contained in the following documents:

- Federal Guidelines for Dam Safety, Federal Emergency Management Agency Publication FEMA 93, November 1998.

- Federal Guidelines for Dam Safety: Selecting and Accommodating Inflow Design Floods for Dams, Federal Emergency Management Agency Publication FEMA 94, October 1998.

4.20.3 Seismology

Existing Conditions

Reservoir-triggered seismicity is the initiation of earthquakes by the impoundment or operation of a reservoir. Reservoir-triggered earthquakes can be identified by a change in the pattern of earthquake activity in the immediate vicinity of a reservoir that usually begins during or shortly after (days to a few years) initial filling of the reservoir. Rapid reservoir elevation changes can also trigger earthquakes.

The mechanisms that control RTS—primarily increased pore pressures in fractured rock surrounding or beneath the reservoir and increased load due to water volume—are generally agreed upon. The relative importance of these mechanisms on a site-specific basis and whether individual reservoirs exhibit RTS are not as clear.

While at least four reservoirs in the Southeastern United States exhibit RTS, the evidence for RTS at TVA reservoirs is weak at best. Many of the TVA reservoirs are located within the Southern Appalachian Seismic Zone, a zone that was active before the introduction of TVA reservoirs and continues to be active today (Reinbold and Johnston 1987). Earthquakes typically associated with RTS are more shallow than most southern Appalachian earthquakes. There have been a few instances of small, shallow earthquakes near TVA reservoirs (e.g., the February 1990 sequence of earthquakes near Tellico Reservoir); there have also been similar sequences of shallow earthquakes in the Southern Appalachians well removed from reservoirs (e.g., Bristol, Virginia in February 1988 and Greeneville, Tennessee in March 1995).

If TVA reservoirs do exhibit RTS, it appears to be rare and would be difficult to confirm. To determine whether RTS is occurring or has occurred at any TVA reservoir, detailed seismic activity records would be required in the vicinity of all reservoirs for a few years before and for several years after the initial filling of the reservoirs. This type of seismic documentation is not available. The question of RTS at TVA reservoirs cannot be answered with confidence. If RTS does occur, however, it is not obvious based on earthquake data collected over the past 20 years (Chapman and Mathena 2001).

Future Trends

No trends have been identified relative to RTS; therefore, future trends are expected to be the same as existing conditions.

4.20.4 Reservoir Levels

Existing Conditions

Water levels at TVA reservoirs fluctuate under normal operations (see Section 2.2). In addition to the normal operating levels, the reservoirs are designed to withstand forces associated with a flood condition. All TVA dams classified as either high or significant hazard potential are capable of passing the applicable inflow design flood (IDF) as required by the federal guidelines with the exception of Chickamauga. Dams classified as high hazard potential are those dams where failure or improper operation probably would cause loss of human life. Dams classified as significant hazard potential dams are those dams where failure or improper operation would result in no probable loss of human life but could cause economic loss, environmental damage, disruption of lifeline facilities, or could affect other concerns. Dams that are classified as significant hazard potential are often located in predominantly rural or agricultural areas but could be located in areas with higher population and significant infrastructure. The hydrologic design for Chickamauga is under review to determine the applicable IDF and needed modifications, if any.

Future Trends

Reservoirs levels are variable year to year but fall within the flood guides for each reservoir. Levels would not be allowed to fluctuate such that dam safety was compromised.

4.20.5 Reservoir Drawdown Rates

Existing Conditions

Water pressure from a reservoir causes water to gradually infiltrate the surrounding reservoir rimrock, soil embankments, or foundations. Over time, internal pressures, called pore pressures, are created within the surrounding area. These pressures increase until the surrounding area reaches equilibrium. If the reservoir is rapidly drawn down after pore pressures are established, they may create unstable conditions in the surrounding rim that can cause slides or sloughing of the rim material.

The structures that surround reservoirs that are subject to fill and drawdown cycles are designed to withstand the expected fluctuations of external water pressures and internal pore pressures. The design is based on an upper limit on the allowable rate of drawdown. Table 4.20-01 lists the maximum allowable drawdown rates necessary to ensure the stability of the dams within the scope of the EIS.

Future Trends

Under the existing operations policy, future drawdown rates would continue to be maintained within present limits.

4.20.6 Leakage

Existing Conditions

Some leakage, or unintended flow, is expected to occur at all dams either through structural joints, earthen embankments, reservoir rims, or foundation materials. Any leakage is evaluated during periodic dam inspections and a determination is made as to whether the volume, rate of change, and sediment content (if any) of the leak poses structural concerns. When necessary, the leakage is periodically measured and recorded so that trends can be defined. Changes in these trends can indicate that a more detailed evaluation of the seepage is warranted.

Table 4.20-01 Drawdown Limits for Tributary Reservoirs

Project[1]	Description	Drawdown Limits[2]
Apalachia	Concrete	3 feet per day not to exceed 12 feet per week
Blue Ridge	Hydraulic fill	2 feet per day not to exceed 7 feet per week for 28 feet, then 3 feet per week
Chatuge	Impervious rolled fill	2 feet per day not to exceed 7 feet per week for 28 feet, then 3 feet per week
Cherokee	Concrete and impervious rolled fill	2 feet per day not to exceed 7 feet per week for 28 feet, then 3 feet per week
Douglas	Concrete and impervious rolled fill	2 feet per day not to exceed 7 feet per week for 28 feet, then 3 feet per week
Fontana	Concrete	2 feet per day not to exceed 7 feet per week for 28 feet, then 3 feet per day not to exceed 12 feet per week
Great Falls	Concrete	2 feet per day not to exceed 12 feet per week
Hiwassee	Concrete	2 feet per day not to exceed 7 feet per week
Norris	Concrete and earth fill	2 feet per day not to exceed 7 feet per week for 28 feet, then 3 feet per week
Nottely	Impervious rolled fill	2 feet per day not to exceed 7 feet per week for 28 feet, then 3 feet per week
South Holston	Impervious rolled fill	2 feet per day not to exceed 7 feet per week for 28 feet, then 3 feet per week
Watauga	Impervious rolled fill	2 feet per day not to exceed 7 feet per week for 28 feet, then 3 feet per week

1 For those reservoirs not shown, the drawdown rate would follow the rate shown for Blue Ridge.
2 Restrictions are based on dam safety and slope stability considerations.
Source: TVA files - Dam Safety Group 2003.

Table 4.20-02 details TVA reservoirs within the scope of the EIS that have been monitored for leakage. This table also indicates whether the amount of leakage would increase as the reservoir headwater elevation increases and, where known, describes the cause of the leakage. The data are reviewed periodically to assess the leakage and ensure the continued safety of the structures. Periodically, an Instrumentation Project Performance Report is issued, which reviews the history of the project, evaluates the appropriateness of the instrumentation and frequency of observation, identifies conditions that might threaten dam safety, and evaluates the structural and geotechnical performance of the dam.

Table 4.20-02 Leakage Monitored at Non-Power and Power Projects

Project	Leakage Increases with Increasing Headwater	Bedrock	Leakage Mechanism
Non-Power Projects			
Bear Creek	Yes	Limestone and shale	Karst
Cedar Creek	No, seasonal	Sandstone	Unknown
Little Bear Creek	No, seasonal	Limestone and shale	Karst
Normandy	Yes	Limestone	Karst
Tellico	No, seasonal	Limestone and shale	Karst
Upper Bear Creek	No, seasonal	Sandstone, shale and conglomerate	Unknown
Power Projects			
Blue Ridge	Yes	Schist and metagraywacke	Spring along abutment/ embankment interface
Chatuge	Yes	Biotite Gneiss	Unknown
Douglas (Dandridge Dike)	Yes	Unknown	Foundation of dike
Fort Patrick Henry	Inconclusive	Limestone, dolomite, shale	Unknown
Great Falls	Yes	Limestone and chert	Karst
Guntersville	No	Limestone	Karst
Melton Hill	Yes	Dolomite	Karst
Norris	Yes	Dolomite	Karst
Nottely	Yes	Schist, metagraywacke, metaconglomerate	Unknown
Tims Ford	Yes	Limestone and shale	Karst
Wheeler	Yes	Limestone	Karst
Wilson	No, seasonal	Limestone	Karst

Source: TVA files - Dam Safety Group 2003.

Future Trends

The trends exhibited by the leakage observed at TVA dams are shown in Table 4.20-02. These trends are expected to continue through 2030 due to the continued operation of TVA reservoirs under the existing reservoir operations policy.

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