Tennessee Valley Authority, Post Office Box 2000, Soddy-Daisy, Tennessee 37384-2000

May 22, 2003

TVA-SQN-TS-03-02 10 CFR 50.90

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D. C. 20555

Gentlemen:

In the Matter of) Docket Nos. 50-327
Tennessee Valley Authority) 50-328

SEQUOYAH NUCLEAR PLANT (SQN) - UNITS 1 AND 2 - TECHNICAL SPECIFICATION (TS) CHANGE 03-02, "REVISION OF ULTIMATE HEAT SINK (UHS) TEMPERATURE AND ELEVATION REQUIREMENTS"

Reference: TVA letter to NRC, dated September 10, 2002, "Sequoyah Nuclear Plant (SQN) - TVA Withdrawal of TS Change 01-07, SQN Ultimate Heat Sink (UHS)"

Pursuant to 10 CFR 50.90, TVA is submitting a request for a TS change (TS 03-02) to licenses DPR-77 and DPR-79 for SQN Units 1 and 2. The proposed TS change will revise the limiting condition for operation for TS Section 3.7.5, "Ultimate Heat Sink." This revision will modify the minimum required UHS water elevation in TS 3.7.5.a from 670 feet to 674 feet. The maximum emergency raw cooling water (ERCW) temperature requirement in TS 3.7.5.b will be increased from 83 degrees Fahrenheit (°F) to 87°F. The conditional requirements in TS 3.7.5.c are no longer required and are deleted by the proposed change. This change will also delete a temporary footnote that allows a limited time increase in the ERCW temperature requirements. These proposed changes are based on recent evaluations of the ERCW system and the UHS functions and maximum temperatures and minimum river elevations that will satisfy the associated safety functions.

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This request is similar to the approved license amendment request by Nebraska Public Power District, Cooper Nuclear Station, Amendment No. 193, issued July 22, 2002; Consumers Energy Company, Palisades Plant, Amendment No. 202, issued June 4, 2001; and Commonwealth Edison Company, Braidwood Station, Amendment Nos. 107 and 107 for Units 1 and 2, respectively, issued June 13, 2000. These requests proposed and received NRC approval for an increase in a single maximum UHS temperature limit. However, these efforts did not include a change in the UHS elevation limit as proposed in this request for SQN.

TVA has determined that there are no significant hazards considerations associated with the proposed change and that the TS change qualifies for categorical exclusion from environmental review pursuant to the provisions of 10 CFR 51.22(c)(9). Additionally, in accordance with 10 CFR 50.91(b)(1), TVA is sending a copy of this letter and enclosures to the Tennessee State Department of Public Health.

Enclosure 1 to this letter provides the description and evaluation of the proposed change. This includes TVA's determination that the proposed change does not involve a significant hazards consideration, and is exempt from environmental review. Enclosure 2 contains copies of the appropriate TS pages from Units 1 and 2 marked-up to show the proposed change. Enclosure 3 contains recession curves for the UHS level resulting from the loss of the downstream dam. Enclosure 4 contains discussions on how TVA moderates the UHS parameters through river management.

The proposed change provides requirements for the UHS function that have been challenged several times in the late summer. This proposed TS change satisfies TVA's plan to submit a permanent request to revise the UHS temperature limit in the referenced letter. At this time TVA does not anticipate any specific schedule need for approval of this request. However, should river temperatures unexpectedly exceed current forecasts such that the proposed changes would be needed for continued operation of the SQN units, TVA will consider escalating the status of this request. TVA requests that the implementation of the revised TS be within 45 days of NRC approval. There are no commitments contained in this submittal. This letter is being sent in accordance with NRC RIS 2001-05, "Guidance on Submitting Documents to the NRC by Electronic Information Exchange, CD-ROM, or Hard Copy."

If you have any questions about this change, please telephone me at (423) 843-7170 or J. D. Smith at (423) 843-6672.

I declare under penalty of perjury that the foregoing is true and correct. Executed on this 22 day of May, 2003.

Sincerely,

Pedro Salas
Licensing and Industry Affairs Manager

Enclosures:
1. TVA Evaluation of the Proposed Changes
2. Proposed Technical Specifications Changes (mark-up)
3. Updated Predictions of Chickamauga Reservoir Recession Resulting from Postulated Failure of the South Embankment at Chickamauga Dam
4. Monitoring and Moderating the Ultimate Heat Sink

JDS:KCW:PMB
Enclosures
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ENCLOSURE 1

TENNESSEE VALLEY AUTHORITY
SEQUOYAH NUCLEAR PLANT (SQN)
UNITS 1 AND 2

TVA Evaluation of the Proposed Change

1. DESCRIPTION

This letter is a request to amend Operating Licenses DPR-77 and DPR-79 for SQN Units 1 and 2. The proposed technical specification (TS) change will revise the limiting condition for operation for TS Section 3.7.5, "Ultimate Heat Sink." This revision will modify the required minimum ultimate heat sink (UHS) water elevation in TS 3.7.5.a from 670 feet to 674 feet. The maximum emergency raw cooling water (ERCW) temperature requirement in TS 3.7.5.b will be increased from 83 degrees Fahrenheit (°F) to 87°F. These proposed changes are based on recent evaluations of the ERCW system and the UHS functions and maximum temperatures and minimum river elevations that will satisfy the associated safety functions. The proposed changes satisfy TVA's intent to propose a permanent TS change that will reduce the challenges to the UHS limit and the need to request enforcement discretion for river conditions.

2. PROPOSED CHANGE

This amendment request will revise the limiting condition for operation for TS Section 3.7.5, "Ultimate Heat Sink." This revision will modify the minimum required UHS water elevation in TS 3.7.5.a from 670 feet to 674 feet. The maximum ERCW temperature requirement in TS 3.7.5.b will be increased from 83°F to 87°F. The conditional requirements in TS 3.7.5.c are no longer required as a result of the proposed changes and are deleted. This change will also delete a temporary footnote that allowed a limited time increase in the ERCW temperature requirements. This footnote expired in 1995 and is no longer applicable. This change is an administrative change to clean-up the TS pages. Another administrative clean-up item is the correction of a typographical error in the heading "Surveillance Requirements." One letter "e" was left out of the word "Requirements" and this proposed revision will correct this omission.

In summary, the maximum temperature and minimum water elevation requirements for the UHS will be revised to be 87°F and 674 feet, respectively. Limiting Condition for Operation requirements that are now obsolete because of the proposed changes are being deleted as well as expired footnote provisions.

3. BACKGROUND

The UHS for a nuclear plant is that complex of water sources, including associated retaining structures, and any canals or conduits connecting the source with, but not including, the intake structures of nuclear reactor units, used to remove waste heat from the plant. Throughout the plant's life, the UHS is designed to perform two principal safety functions: (1) dissipation of residual and auxiliary heat after reactor shutdown, and (2) dissipation of residual and auxiliary heat after an accident. The UHS achieves these functions through the ERCW system by providing the heat sink function for this system. The UHS for SQN is the Tennessee River and is required to be operable in Operating Modes 1, 2, 3, and 4 in accordance with TS Section 3.7.5. If the UHS function cannot be satisfied, unit shutdown is required.

The UHS was designed to comply with the regulatory position in NRC Regulatory Guide 1.27, Revision 0, dated March 23, 1972, as stated below:

1. The ultimate heat sink should be capable of providing sufficient cooling for at least 30 days (a) to permit simultaneous safe shutdown and cooldown of all nuclear reactor units that it serves, and maintain them in a safe shutdown condition, and (b) in the event of an accident in one unit, to permit control of that accident safely and permit simultaneous safe shutdown and cooldown of the remaining units and maintain them in a safe shutdown condition. Procedures for assuring a continued capability after 30 days should be available.

2. The ultimate heat sink should be capable of withstanding the effects of the most severe natural phenomena associated with this location, other applicable site related events, reasonably probable combinations of less severe phenomena or events where this is appropriate to provide a consistent level of conservatism, and a single failure of man-made structural features without loss of the capability specified in Regulatory Position 1 above.

3. The ultimate heat sink should consist of at least two sources of water, including their retaining structures, each with the capability to perform the safety function specified in Regulatory Position 1 above unless it can be demonstrated that there is an extremely low probability of losing the capability of a single source. There should be at least two canals or conduits connecting the source(s) with the intake structures of the nuclear power units, unless it can be

demonstrated that there is extremely low probability that a single canal can fail entirely from natural phenomena. All water sources and their associated canals or conduits should be highly reliable and should be separated and protected such that failure of any one will not induce failure of any other.

4. The technical specifications for the plant should include actions to be taken in the event that conditions threaten partial loss of the capability of the ultimate heat sink or if it temporarily does not satisfy Regulatory Positions 1 and 3 above during operation.

TVA satisfies these requirements as follows:

1. The cooling water requirements for the most demanding accident shutdown and cooldown of the plant's reactors are presented in Updated Final Safety Analysis Report (UFSAR) Subsection 9.2.2. The adequacy of the Tennessee River to provide this amount of water, and therefore to satisfy Regulatory Position 1 is confirmed in UFSAR Subsections 2.4.11.1 and 2.4.11.3.

2. Under the most adverse events expected at the site or a reasonable combination of less severe events and any single failure of a man-made feature, the UHS is designed to retain its capability to perform the specified safety functions. The most severe natural phenomena (including flood, drought, tornado, wind, and earthquake) conceivable to occur at this site are thoroughly discussed in UFSAR Chapter 2. The UHS's safety functions are insured for all of the plant design basis events, including those extreme natural phenomenon credible to occur at this site.

   The ERCW pumps are protected from the design basis flood including the effects of wind waves, and therefore, they will be capable of functioning in all flood conditions up to and including the design basis flood (see UFSAR Subsection 9.2.2). The water intake to the ERCW pumping station and the area outside the station intake was dredged to form a channel that will provide free access to the river. This channel was dredged to a sufficient width eliminating the possibility of channel blockage due to an earth or mud slide. The channel continues to be monitored and dredged as required to maintain free access to the river. Therefore, adequate water will be available to the ERCW pumps at all times, including the loss of downstream dam. The unlikely occurrence of a safe shutdown earthquake (SSE) could significantly affect the UHS only by causing failure of the downstream dam and/or upstream dams. For the resulting low

and/or high water event, water will be available to the intake at all times. A seismically induced disturbance of the rock surfaces could only block a small percentage of the intake channel due to its highly conservative width. Also, a tornado cannot interrupt the ERCW supply to the station.

TVA regulation of the Tennessee River is such that drought will not jeopardize the UHS's capability required in Regulatory Position 1; this is historically confirmed by the data in UFSAR Subsection 2.4.11.3.

The UHS is designed to withstand a 95 miles per hour basic wind or the most severe tornado, including the associated missile spectrum, without loss of the capability to provide an adequate supply of cooling water to the ERCW system.

The most severe combination of events considered credible to occur would be the simultaneous occurrence of the SSE, a loss-of-coolant accident in one unit and shutdown of the other, loss of offsite power, and loss of upstream and/or downstream dams either individually or concurrently. Under this extreme situation, the sink retains the capability of Regulatory Position 1.

3. The Tennessee River is the common supply for all plant cooling water requirements. Total interruption of this supply is incredible. Additionally, the integrity of the river's dams is not essential for safe reactor shutdown and cooldown.

4. The limiting conditions and surveillance requirements for the ERCW System are given in the SQN Technical Specifications. The limiting conditions for the plant's flood protection program are given in the SQN Technical Requirements Manual.

The function of the UHS is described in Section 9.2.5 of the SQN UFSAR.

Past summertime environmental conditions have shown that the UHS river temperature is capable of exceeding 83°F and the higher 84.5°F limit. Adjustments to this temperature has been necessary in the past and has resulted in asking for discretionary enforcement or a permanent or temporary TS change to TS 3.7.5 during several summers as the TS temperature limit was approached. The more notable historical events were:

- In 1988, the temperature limit was revised to 84.5°F as approved by NRC in Amendments 79 and 70 for SQN Units 1 and 2, respectively. Design analysis was based on sensitivity

studies and the minimum summer pool elevation was required to be raised 10 feet based on recession from downstream dam failure. TSs were revised to include both the existing temperature of 83°F at 670 feet and a new temperature peak of 84.5°F with a minimum pool elevation of 680 feet.

- Also in 1988, a special river operations scheme was undertaken. A cold water column was timed and delivered from Norris Lake to the Chickamauga pool with some success but with other non-nuclear consequences to the river system.

- In 1995, an exigent TS change request was made to request permission to exceed the UHS limit (84.5°F) for a six week period. The supporting design analysis was based on sensitivity studies and demonstrated equipment margins. The 87°F TS change was approved by NRC for use through September 1995 in Amendments 210 and 200 for SQN Units 1 and 2, respectively. The ERCW temperature approached but did not exceed 84.5°F as was previously predicted.

- In 1996 no submittal to NRC was made. Standard and special river operations practices were implemented to mix cooler water into the Chickamauga pool. The ERCW temperature climbed to within a few tenths of the 84.5°F limit.

- During the summers of 1997 through 1999, no NRC actions were requested, and no UHS limit was exceeded during this time period. Persistent hot weather and atypical low seasonal runoff (drought conditions) prompted additional nuclear and river operations management evaluation of the costs associated with a higher UHS temperature (87°F). Inconsistencies were noted between the river temperature prediction model and the actual "as seen" conditions. The model is only as accurate as the long-term weather forecast is credible.

- In 2000 and 2001, exigent TS change requests to NRC were made based on the river temperature prediction model results. Information from the 1995 submittal was utilized. Standard river operations practices were implemented, but the UHS temperatures did not exceed 84.5°F. These requests were withdrawn by TVA once the need for the associated relaxation could be verified.

The proposed change to revise the UHS temperature limit is similar to the approved license amendment request by Nebraska Public Power District, Cooper Nuclear Station, Amendment No. 193, issued July 22, 2002; Consumers Energy Company, Palisades Plant, Amendment No. 202, issued June 4, 2001; and Commonwealth Edison Company, Braidwood Station, Amendment Nos. 107 and 107 for Units

1 and 2, respectively, issued June 13, 2000. These requests proposed and received NRC approval for an increase in a single maximum UHS temperature limit. However, these efforts did not include a change in the UHS elevation limit as proposed in this request for SQN.

4. TECHNICAL ANALYSIS

ULTIMATE HEAT SINK OPERATION

SQN is a two unit pressurized water reactor that utilizes the Tennessee River, Chickamauga Lake, as the UHS. SQN is located on Chickamauga Lake at Tennessee River mile (TRM) 484.5. Chickamauga Dam is the downstream dam that provides primary control of Chickamauga Lake (reservoir) level on this portion of the Tennessee River. Watts Bar Dam is the upstream dam that provides primary flow into Chickamauga Lake. Both reservoirs and the contiguous river system are controlled by the TVA, River System Operations & Engineering (RSO&E) organization. Various TVA divisions work together as a whole to provide a seamless river and electric power service to the region. The UHS and river system are discussed in the UFSAR Chapters 2 and 9.

The Tennessee River's water is drawn into the plant as ERCW by a remote pumping lift station located on site at the bank of the river. River elevation is measured at the condenser circulating water pump station. The ERCW intake obtains water from near the bottom of the river bed from a manmade channel that connects between the river bed and the intake structure. The water is pumped through piping to the powerhouse structure where water temperature is measured in the supply headers and recorded in the main control room (MCR).

Minimum river flows through Watts Bar and Chickamauga Dams are discussed in the UFSAR Chapter 2 for both routine, flood, and loss of dam situations. It has been noted that the bulk river temperature can be decreased by running continuous flows through both dams. On a larger scale, river temperatures in the area of Sequoyah can be manipulated by special operations of the larger and cooler upstream reservoirs. Although a scheme of special operations has met with varying success, it can encompass significant operating expenses and coordination difficulties with somewhat unpredictable outcomes and may be influenced by weather conditions. Special operations may also produce hardships on river quality and river usage programs. Continuously controlling pool temperature by reservoir mixing has essentially been abandoned in order to protect and promote the river system as a whole entity. TVA's RSO&E typically maintains at least an 11 foot deep navigable channel in the river system that have locks. Level fluctuations may occur for mosquito control, maintaining

minimum flows, downstream aeration, water quality, land owner/lake partnerships, and recreational needs.

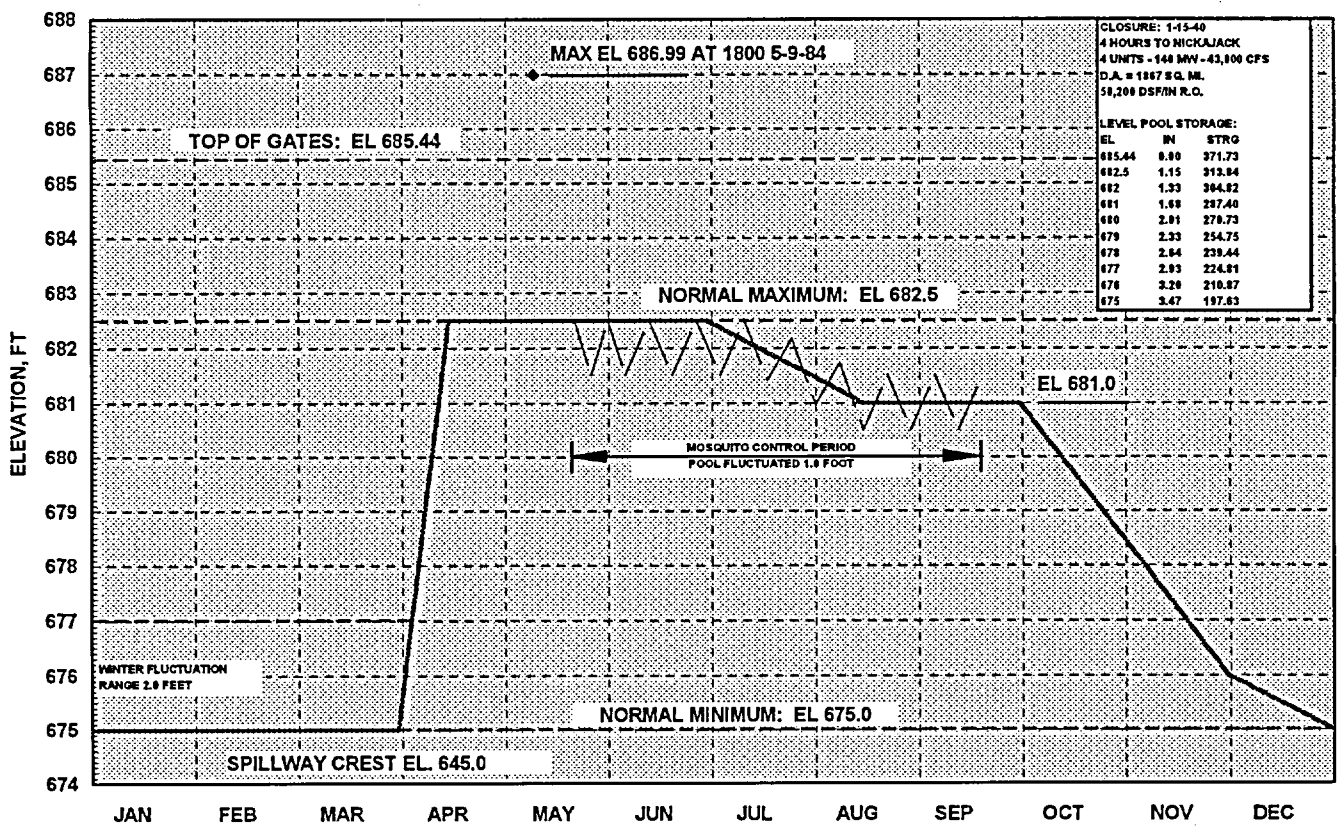
The effect of the proposed UHS increase of 2.5°F to 87°F has been examined in detail on equipment, components, systems, and safety analysis and has been demonstrated to be an acceptable increase to the UHS temperature limit because credit is taken for the available margins in three areas. Specifically, 1) there are margins in the river system water level for loss of downstream dam scenarios and also in the ability to moderate the temperature of the UHS; 2) there are margins to the allowed maximum peak pressure in the containment design due to the previous ice mass increase to 1.916 million pounds (NRC approved Amendments 279 and 270, SQN Units 1 and 2 respectively) and associated containment reanalysis, and 3) there are sufficient margins in the ERCW system flow rates to each affected component. These margins are detailed in the sections to follow.

River System Margins

The use of the river system as the UHS was re-evaluated similarly to that work performed in the 1988 license amendment effort for SQN but with updated resources, technology, and more practical modeling assumptions and sensitivity analysis.

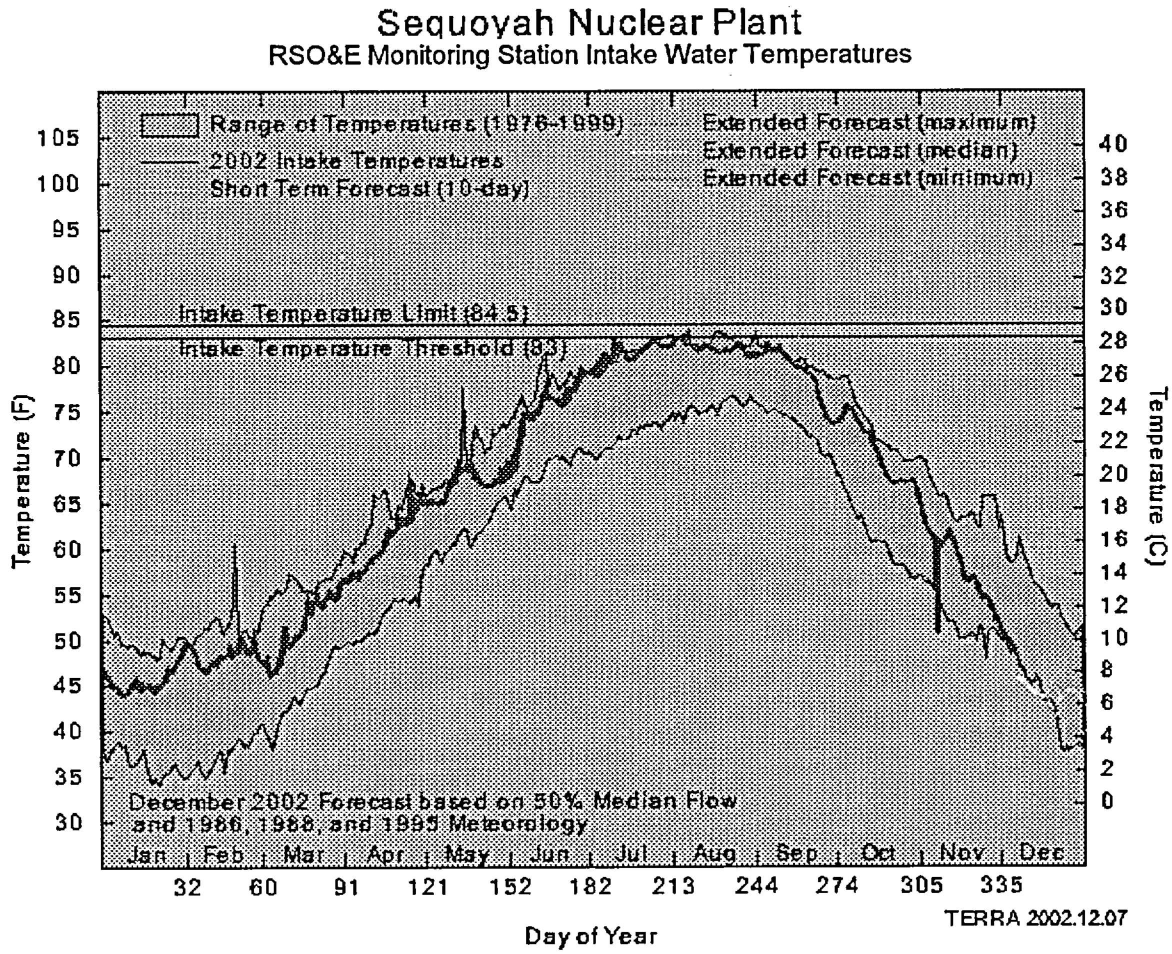
The Chickamauga pool history of averaged operating data (temperature, elevation, season) was also reviewed. An annual operating cycle graph which depicts the pool level verses the months of the year is included below for information.

CHICKAMAUGA OPERATING GUIDE



The solid line curve represents the target lake level and this has not significantly changed since the 1988 amendment effort. It does not represent the maximum or minimum levels but is used as a management tool for planned operation. The months of October, November, and April comprise the transition periods for drawdown or refill. Lake levels at these times can easily exceed the minimum established based on rainfall and severe weather.

For comparison, the following general temperature chart is included. This chart does not plot the UHS TS temperatures as recorded in the ERCW headers at SQN. The temperatures shown are general river temperatures used for environmental compliance. The chart however shows the yearly water temperature pattern and span.



The proposed UHS TS change establishes a single upper temperature limit and a minimum river water elevation limit. The temperature limit has been validated at 87°F. The river water elevation has been validated at elevation 674 feet. See Enclosures 3 and 4 for additional details.

Ice Mass Margins

The containment analysis was not significantly affected based on large gains and margin offsets made from the ice mass increase and other analysis input assumptions. The ice mass increase TS change has already been reviewed, approved, and implemented for SQN. Within that analysis, the limiting UHS temperature of 87°F was utilized as an input. Subsequently, sensitivity analyses have shown acceptable containment performance with the UHS up to and including 90°F.

UFSAR Chapter 6 discusses containment analysis. The results show that the containment integrity is maintained and is within the established safety limits. The resultant pressure increase was

very small. This is due to the SQN ice condenser design and as such, the ERCW cooling to the containment spray heat exchangers does not come into effect until ice melt-out, RWST depletion, and swap over to the containment sump for recirculation.

The containment integrity analysis is based on a double-ended pump suction guillotine break loss of coolant accident (LOCA) assuming minimum ice condenser weight of 1.916 million pounds of ice and minimal emergency core cooling system (ECCS) safeguards. The bulk of the heat energy in containment is eventually transferred outside of containment to the UHS via the ERCW system in the containment spray system heat exchanger and the component cooling system (CCS) and ERCW system in the residual heat removal (RHR) heat exchanger. The resultant containment peak pressure is 11.44 pounds per square inch gauge (psig) and is less than the design pressure of 12 psig. It occurs at approximately 7069 seconds with ice bed meltout at approximately 3363 seconds.

Westinghouse Electric Company sensitivity studies supported the earlier temporary TS change submittals. These earlier studies were not based on the increased ice mass of 1,916,000 pounds. The latest results are presented below:

ERCW Temp. (°F)	Peak Pressure (psig)/Time of Peak (sec)	Peak Steam Pressure (psig)/Time of Peak Steam Temperature (sec)	Time of Ice Bed Melt-out (sec)
85	11.2568 / 6955.45	233.4 / 26.5	3363.52
86	11.3424 / 7009.33	233.4 / 26.5	3362.77
87	11.4422 / 7068.68	233.4 / 26.5	3362.27
90	11.7302 / 7177.47	233.4 / 26.5	3360.52

The containment sub-compartment pressure analysis is not affected by the increase in UHS temperature. The sub-compartment pressure analysis has been revised as part of the Unit 1 steam generator replacement and remains bounding for SQN. The analysis is for the immediate (initial) response to the double-ended break and it does not utilize the UHS as a heat removal source. Likewise, the peak containment temperature analysis is unaffected by the UHS increase. The peak containment temperature results from a main steam line break (MSLB) and this occurs very early in the transient during the initial blowdown from the faulted steam generator. ERCW is utilized later on in the cooldown by the containment spray heat exchangers and in the lower compartment coolers for a MSLB to maintain the containment temperature within the environmental qualification (EQ) limits. Heat release at this time from a MSLB is much less than the initial release at full power operation and it continues to decrease as the reactor coolant system (RCS) is depressurized below 380 psig and placed on RHR system cooldown.

As for long-term containment cooling capability, the analyses and sensitivity studies have shown that an increase to the UHS temperature slightly decreases the rate of cooldown thus extending the duration of the event. The extended duration is a matter of minutes (<10 minutes) and it has no long-term impact on EQ limits. There are no changes affecting on-site or off-site dose rates or consequences. The capacity of the lower compartment coolers for a MSLB is acceptable with ERCW at 87°F and its performance remains well above the minimum required performance for two coolers. Thus the long-term EQ impact in containment remains unchanged.

ERCW Flow Margins

For the ERCW system, the system heat exchanger's log mean temperature difference (LMTD) remained effective; and when coupled with the existing flow margins, it could be demonstrated that the required accident and decay heat loads both short and long term were fully transported via the UHS. The evaluation methodology employed maintaining the process discharge temperatures (ERCW outlet and heat exchanger outlet or air cooler exit) fixed at the values seen previously (UHS at 84.5°F) while increasing ERCW mass flow. The EQ and MCR habitability were not affected or impacted because downstream conditions and room environments remained unchanged. Most components have significant demonstrated ERCW mass flow margins available to do this. The remaining components have sufficient margins and adequate performance at 87°F. Heat exchanger tube plugging allowances and design degraded flows were not credited to show acceptability.

A comparison of the required flows to the demonstrated (1997 base surveillance testing and current 2002 tests) flows ensures that the new design limit is acceptable. Also considered in the UHS temperature evaluation was a review of recent and pending design changes and licensing changes. This included 1.3% power uprate, tritium production, Unit 1 replacement steam generators, proposed condensate storage tank (CST) volume increase, minimum ice weight increase, and other current modifications through Amendment 17 of the UFSAR.

EVALUATION OF PROPOSED UHS TEMPERATURE AND ELEVATION CHANGES

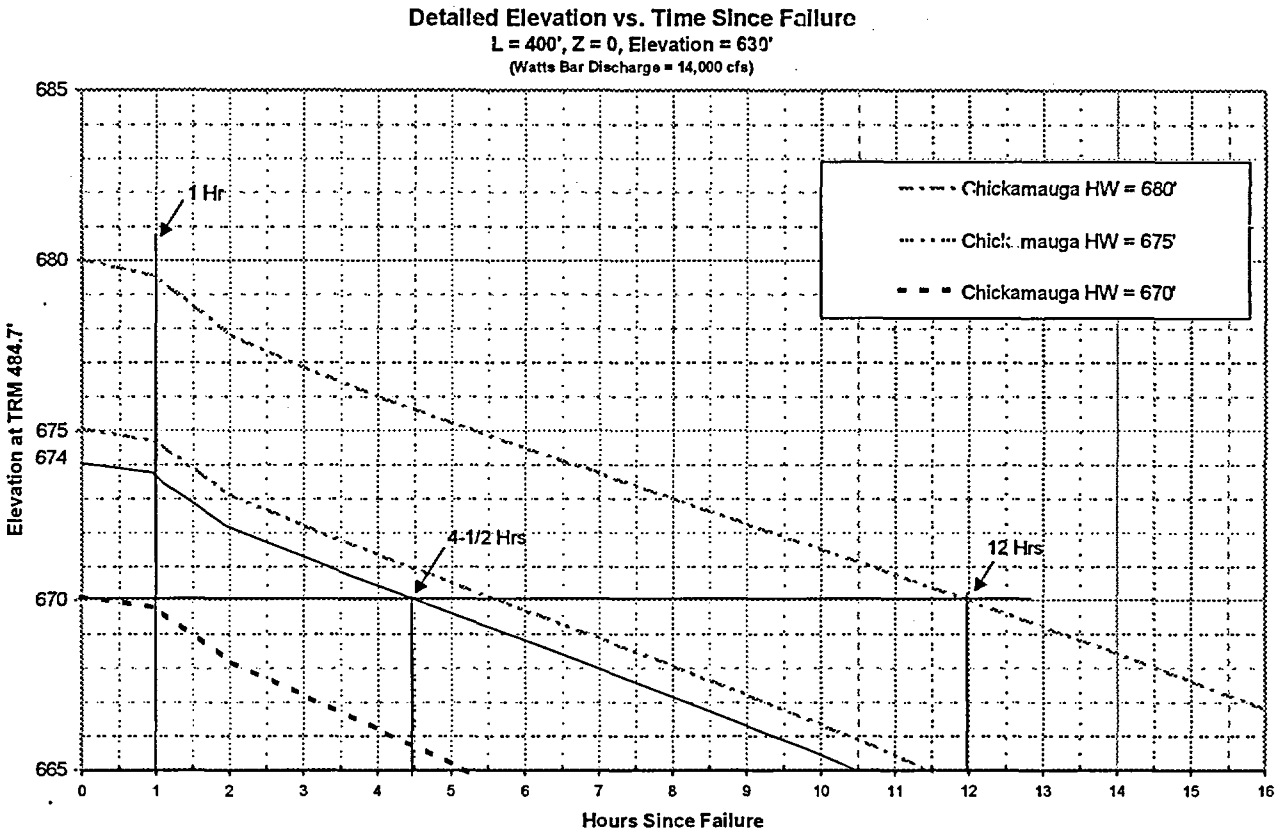
The UHS and ERCW design basis establishes the LOCA-recirculation condition as the most limiting with loss of downstream dam since the UHS and ERCW are not initially relied upon for mitigation of a large break LOCA (LBLOCA). The UHS and ERCW do however provide cooling water to engineered safety feature (ESF) equipment such as room coolers and pump oil coolers during this time. Long term, all accident mitigation heat removal is transferred to the

UHS via the ERCW system. The margin of safety as currently defined by the existing TS and safety analysis is not reduced by this change but has been re-evaluated and re-analyzed in various scenarios in order to demonstrate acceptability.

The first part of the limiting accident (LBLOCA) is the injection phase which uses stored water (refueling and condensate water) and the ice condenser for the initial mitigation. The injection phase lasts about one hour. The short-term minimum river level for analysis and surveillance testing conditions is 670 feet. After the injection phase, the ERCW is required for long-term core cooling and maintenance of the containment building integrity. The long-term minimum river elevation for analysis and surveillance testing conditions is 639 feet assuming the loss of the downstream dam. These elevations remain well above the point were siltation issues might arise. Siltation issues were addressed during the 1988 TS change effort and remain unchanged.

The ERCW system is periodically flow balanced at two states for the UHS level. For equipment related to containment integrity such as containment spray heat exchangers and component cooling heat exchangers that are needed after ice melt-out (about one to two hours), those portions of the ERCW system are balanced to a system configuration with ERCW pumps operating at river elevation 670 feet. The test method establishes that the ERCW pumps are compensated for minimum performance. For the remainder of the ESF equipment tied to the ERCW system, that is needed long term following an accident, the system is balanced to the long-term river elevation 639 feet. The actual long-term river level is 641 feet which is above the low water system balance point of 639 feet.

Should loss of downstream dam occur and result in UHS level below the TS limit, SQN is required by the TSs to be placed in cold shutdown. This can be safely achieved by placing both units into hot standby within 6 hours (the safe licensed shutdown condition) and then taking the units to cold shutdown. Validation curves were created for lake drawdown beginning at various initial pool elevations. At 675 feet, the drawdown time to 641 feet is about 48 hours. Since all cooling water loops are available, the ERCW head reduction to the CCS heat exchangers is not expected to unduly limit their performance. The remainder of the ERCW support components are balanced to 639 feet and are not affected except that the loads should be less severe than the accident loads. A minimum river elevation is established at 674 feet and is conservative thus ensuring that adequate UHS safeguards are established. Note that the minimum elevation of 674 feet is a year-round value.



This chart pictures river elevations vs time at the SQN intake structure for various loss of downstream dam scenarios with different initial pool elevations. The recession curves are based on the validated model. The emphasized time periods of 1 hour, 4-1/2 hours, and 12 hours provide points of comparison for elevations for the different times of year.

For evaluation purposes, one hour bounds the limiting LBLOCA (injection phase and ice condenser melt-out). Note that the existing SQN lower TS limit is river elevation 670 feet. The newly proposed lower TS limit is river elevation 674 feet. The expected minimum UHS water level during summer operation remains at the target value and has not changed. Monitoring (per Surveillance Requirement 4.7.5.1) is not impacted by the UHS at 87°F.

Regulatory Guide 1.27 requires that the UHS and ERCW be available for a minimum of 30 days following the event with procedural guidelines for beyond 30 days. TVA has chosen 100 days for equipment qualification purposes, so the UHS and ERCW system is available for that same duration to ensure that EQ limits are met. Even though there is generally no challenge to the area coolers, it is not reasonable to assume that the UHS will actually remain at 87°F for the entire 100 days or beyond with loss of downstream dam. Extensive environmental heat input is

required to obtain and maintain 87°F ERCW along with low uncontrolled river flows (usually less than 3,500 cubic feet per second [cfs]). The practical duration was considered for both 30 and 100 days. Reasonable margin is also created given the fact that the decay heat loads are a fraction of the initial event at 30 days and 100 days respectively.

Without loss of downstream dam, the pool elevation remains full and the delivered head from the ERCW pumps to the system is at its highest value even with minimum safeguards (single train of on-site power). If considered with loss of downstream dam and loss of off-site power, the local pool is quickly turned-over and replaced by tributary spilling with an outflow of at least 14,000 cfs from the Watts Bar Dam. This minimum sustained flow is above the low flow regime and this can provide a cooling mechanism along with reduced surface area for insolation, however, no credit is taken for the resulting drop in UHS temperature to below 87°F.

MCR habitability is typically considered for just 45 days and can be validated in similar fashion as previously discussed above. The UHS and ERCW is qualified for 30 days but has been expanded to 100 days in accordance with the support function for EQ. UHS, during the summer peak and with RSO&E control of the river, is expected to be at 87° for only 30 days but it continues to provide acceptable performance and cooling similar to above and can be expected to be available to meet the required 45 day minimum operating period for MCR habitability.

The following accidents are not affected by an increase in UHS temperature to 87°F since these are not dependent on UHS heat removal for mitigation or consequences.

- Major or minor secondary system ruptures
- Complete loss of forced RCS flow or single reactor locked rotor
- Rod cluster withdrawal at full power
- Rod cluster control assembly ejection
- Fuel handling accident
- Waste gas decay tank rupture
- Inadvertent loading of a fuel assembly into improper location
- Steam generator tube rupture

ECCS analysis is unaffected since the 10CFR50.46 limits and Appendix K requirements are met in the short term accident mitigation period. ERCW, CCS, and auxiliary feedwater (AFW) piping and supports were evaluated for seismic and thermal stresses at 87°F. All piping and supports remain qualified to seismic Category I and were documented in a TVA calculation.

Impacts on the individual ECCS components and support equipment malfunctions and consequences with ERCW at 87°F were considered and reviewed with acceptable results. The ECCS remains functional and there were no increases in the consequences.

EVALUATION OF UHS THERMAL TRANSPORT IMPACTS

ERCW is the safety related water supply to the AFW system and is used as a backup to the condensate system; ERCW is of low water quality, so the condensate water is the first choice, if available. Should water in the condensate storage tanks (CSTs) be unavailable, ERCW is supplied as feedwater for several events. Adequate net positive suction head is provided by the ERCW system to the motor driven AFW pumps (MDAFWP) following switch-over of the supply from the non-safety grade CSTs to the safety-grade ERCW should it be required. The ERCW supply to the MDAFWP's originates from the ERCW discharge header which may be as warm as 128°F. The steam driven feedwater pump is not affected since it receives water from the supply header up to 87°F. The ERCW pressure supplied to the AFWP's suction is greater than that of the CST in order to preclude continued CST flow when the low tank level is reached. ERCW discharge header water to the MDAFWP's as auxiliary feedwater to the steam generators is not impacted since the maximum design value of 130°F has been previously evaluated by calculations and accepted.

The CCS removes heat from various safety and non-safety related equipment and transfers it to the ERCW system, and then that heat is transferred to the UHS (i.e., the Tennessee River and Chickamauga Reservoir). The CCS closed loop provides an intermediate barrier to contain radioactive or potentially radioactive sources, thus precluding direct leakage of radioactive fluids into the UHS.

The ERCW pump's discharge piping provides a source for the high pressure fire protection water for local fire fighting at the ERCW intake pumping station. There are also some other local components such as the ERCW pump motors that receive cooling water from the pumps or screen wash pumps. These components were not challenged at 87°F. In addition, there were no identified Appendix R impacts.

For flood mode operation, ERCW is connected through temporary spool pieces to provide long-term cooling for various systems that may be inundated. It is argued by engineering judgment that an 87°F bulk river temperature in the Chickamauga pool could not be physically maintained. Unseasonable rainfall coupled with loss of dam(s) would force mixing from many different flow streams and the flow in any arrangement will not be at 87°F.

Unseasonable rainfall and loss of several river system dams would naturally force the bulk river temperature well below 87°F. Flood mode weather conditions are in direct contrast to the low flows and drought conditions needed to spawn high river temperatures. Therefore, there is no impact on flood mode operation.

The spent fuel pool was evaluated to ensure that there were no consequences associated or anticipated with spent fuel handling, cooling, or storage with the increased temperature. Additionally as part of the ERCW and CCS operating modes update and tritium production, spent fuel pool cooling was evaluated with ERCW at 87°F and accepted. Make-up to the pool is available should all cooling flow be lost. Long-term cooling is not challenged and 87°F was validated as an acceptable UHS value.

In summary, the proposed changes for the UHS temperature and water elevation continue to provide adequate heat removal capabilities. Evaluations have been performed which justifies with reasonable assurance that operating 2.5°F above the current UHS design basis temperature limit of 84.5°F (87°F) is safe. Impacts on safety related components and UFSAR Chapters 6 and 15 analyses were reviewed and no consequences were identified. The previous calculation work supporting the temporary TS changes has been superseded.

In all cases, excess ERCW flow is provided to ESF equipment. Sufficient mass flow margins are currently available in the ERCW supply without modifications or adjustment to either the ERCW or the fed component. With exit temperatures held constant, all equipment remains qualified with respect to expected performance, piping analysis, and EQ (10CFR50.49). The equipment remained within its design operating parameters and were not challenged. Therefore, implementation of the proposed TS change will maintain the necessary plant heat sink functions to mitigate the consequences of an accident and will continue to minimize the risk to the health and safety of the public.

5. REGULATORY SAFETY ANALYSIS

The proposed technical specification (TS) change will revise the limiting condition for operation for TS Section 3.7.5, "Ultimate Heat Sink." This revision will modify the required ultimate heat sink (UHS) water elevation in TS 3.7.5.a from 670 feet to 674 feet. The emergency raw cooling water (ERCW) temperature requirement in TS 3.7.5.b will be increased from 83 degrees Fahrenheit (°F) to 87°F. The conditional requirements in TS 3.7.5.c are no longer required and are deleted by the proposed change. This change will also delete a temporary footnote that allowed a limited time increase in the ERCW temperature

requirements. These proposed changes are based on recent evaluations of the ERCW system and the UHS functions and maximum temperatures and minimum river elevations that will satisfy the associated safety functions. The proposed changes will minimize the likelihood of a required dual unit shutdown as a result of high river temperatures in the summer.

5.1 No Significant Hazards Consideration

TVA has evaluated whether or not a significant hazards consideration is involved with the proposed amendment(s) by focusing on the three standards set forth in 10 CFR 50.92, "Issuance of amendment," as discussed below:

1. Does the proposed change involve a significant increase in the probability or consequences of an accident previously evaluated?

   Response: No.

   The proposed change to increase the UHS maximum temperature and the minimum water level does not alter the function, design, or operating practices for plant systems or components. The UHS is utilized to remove heat loads from plant systems during normal and accident conditions. This function is not expected or postulated to result in the generation of any accident and continues to adequately satisfy the associated safety functions with the proposed changes. Therefore, the probability of an accident presently evaluated in the safety analyses will not be increased because the UHS function does not have the potential to be the source of an accident and no plant equipment is altered as a result of this change. The heat loads that the UHS is designed to accommodate have been evaluated for functionality with the higher temperature and elevation requirements. The result of these evaluations is that there is existing margins associated with the systems that utilize the UHS for normal and accident conditions. These margins are sufficient to accommodate the postulated normal and accident heat loads with the proposed changes to the UHS. Since the safety functions of the UHS are maintained, the systems that ensure acceptable offsite dose consequences will continue to operate as designed. Therefore, the proposed changes to TS 3.7.5 will not significantly increase the consequences of an accident previously evaluated based on safety functions continuing to meet their accident mitigation requirements and limiting dose consequences to acceptable levels.

2. Does the proposed change create the possibility of a new or different kind of accident from any accident previously evaluated?

   Response: No.

   The UHS function is not an initiator of any accident and only serves as a heat sink for normal and upset plant conditions. By allowing the proposed change in the UHS temperature and elevation requirements, only the parameters for UHS operation are changed while the safety functions of the UHS and systems that transfer the heat sink capability continue to be maintained. The UHS function provides accident mitigation capabilities and does not reflect the potential for accident generation. Therefore, the possibility for creating a new or different kind of accident is not created because the UHS is only utilized for heat removal functions that are not a potential source for accident generation.

3. Does the proposed change involve a significant reduction in a margin of safety?

   Response: No.

   The proposed change has been evaluated for systems that are needed to support accident mitigation functions as well as normal operational evolutions. Operational margins were found to exist in the systems that utilize the UHS capabilities such that these proposed changes will not result in the loss of any safety function necessary for normal or accident conditions. The ERCW system has excess flow margins that will accommodate the increased flows necessary for the proposed temperature increase. While operating margins have been reduced by the proposed changes, safety margins have been maintained as assumed in the accident analyses for postulated events. Additionally, the proposed changes do not require the modification of component setpoints or operating provisions that are necessary to maintain margins of safety established by the SQN design. Therefore, a significant reduction in the margin to safety is not created by this proposed change.

Based on the above, TVA concludes that the proposed amendment(s) present no significant hazards consideration under the standards set forth in 10 CFR 50.92 (c), and accordingly, a finding of "no significant hazards consideration" is justified.

5.2 Applicable Regulatory Requirements/Criteria

Section 182a of the Atomic Energy Act requires applicants for nuclear power plant operating licenses to include technical specifications (TSs) as part of the license. The Commission's regulatory requirements related to the content of the TS are contained in Title 10, Code of Federal Regulations (10 CFR), Section 50.36. The TS requirements in 10 CFR 50.36 include the following categories: (1) safety limits, limiting safety systems settings and control settings, (2) limiting conditions for operation (LCO), (3) surveillance requirements, (4) design features, and (5) administrative controls. The water temperature and elevation requirements for the ultimate heat sink (UHS) are included in the TS in accordance with 10 CFR 50.36(c)(2), "Limiting Conditions for Operation."

As stated in 10 CFR 50.59(c)(1)(i), a licensee is required to submit a license amendment pursuant to 10 CFR 50.90 if a change to the TS is required. Furthermore, the requirements of 10 CFR 50.59 necessitate that U.S. Nuclear Regulatory Commission (NRC) approve the TS changes before the TS changes are implemented. TVA's submittal meets the requirements of 10 CFR 50.59(c)(1)(i) and 10 CFR 50.90.

Regulatory Guide 1.27 provides an acceptable approach for the design of the UHS. This guidance provides four criteria for an acceptable UHS function. These criteria include recommendations for sufficient cooling capability, integrity during postulated events, function availability and redundancy, and control by the TSs. TVA has evaluated the proposed changes and their impact on the UHS design based on the criteria in Regulatory Guide 1.27 and has determined that these recommendations continue to be met. The cooling ability of the UHS, with the proposed increase in temperature, has been evaluated and verified to satisfy the recommendations for heat removal considerations. The integrity and availability recommendations have not been affected by the proposed changes as the features are not being altered physically. The proposed water elevation change has been evaluated and verified to continue to meet the recommendations for integrity and availability of the UHS. The TS provisions are proposed to be changed but continue to meet the recommendation to provide actions in the event the function of the UHS cannot be satisfied. Therefore, operation of the SQN units with the proposed TS changes will not result in a deviation from the recommendations of Regulatory Guide 1.27.

General Design Criterion 44, "Cooling Water," of Appendix A, "General Design Criteria," to 10 CFR Part 50, provides design

considerations for the UHS. Regulatory Guide 1.27 provides an acceptable approach for satisfying this criteria. The above discussions regarding Regulatory Guide 1.27 compliance demonstrates the ability to meet the recommendations of the regulatory guide and therefore satisfies the requirements of General Design Criterion 44.

Technical Specification Task Force (TSTF)-330 Revision 3 to the Improved Technical Specifications was approved in October 2000. The TSTF provides a methodology that permits averaging the UHS temperature. The TSTF specifies four conditions that form the basis for acceptance of the temperature averaging format. Licensees adopting this change to the Standard Technical Specifications must confirm that these four conditions are satisfied.

TVA has considered the provisions in TSTF-330 as part of this TS change but has concluded that there is no benefit in pursuing these provisions. This conclusion is based on:

1. The current and historical TVA UHS analysis has always provided a single upper UHS temperature limit.
2. There is no intermediate UHS temperature limit (as proposed by the TSTF).
3. The four criteria (required by the TSTF) have not been specifically addressed in this submittal but are generically addressed in part by the existing design and SBO commitments.
4. A temperature averaging scheme (Reference 4) is and has been part of the SQN licensing basis since 1988.
5. Detailed UHS analyses demonstrated that available margins are available to offset the proposed 2.5°F UHS increase.

While the proposed TS change has utilized some of the excess margins associated with heat removal capabilities of the UHS and ERCW functions, there is still sufficient margin within the temperature averaging scheme to accommodate small, short-term temperature peaks above the proposed 87°F UHS temperature limit. This approach is and has been employed since 1988 and it continues to be acceptable as these peaks are of a short duration and the average temperature of 87°F remains within a value that ensures the UHS safety function is maintained. This meets the basis intent of the TSTF. TVA intends to maintain the current licensing basis allowance to use temperature averaging. This allowance is similar to the NRC approved license amendment provisions for the Braidwood Station in Amendments 107 and 107 for Units 1 and 2, respectively, on June 13, 2000.

In conclusion, based on the considerations discussed above, (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, (2) such activities will be conducted in compliance with the Commission's regulations, and (3) the issuance of the amendment will not be inimical to the common defense and security or to the health and safety of the public.

6. ENVIRONMENTAL CONSIDERATION

A review has determined that the proposed amendment would change a requirement with respect to installation or use of a facility component located within the restricted area, as defined in 10 CFR 20, or would change an inspection or surveillance requirement. However, the proposed amendment does not involve (i) a significant hazards consideration, (ii) a significant change in the types or significant increase in the amounts of any effluent that may be released offsite, or (iii) a significant increase in individual or cumulative occupational radiation exposure. Accordingly, the proposed amendment meets the eligibility criterion for categorical exclusion set forth in 10 CFR 51.22(c)(9). Therefore, pursuant to 10 CFR 50.22(b), no environmental impact statement or environmental assessment need be prepared in connection with the proposed amendment.

7. REFERENCES

1. U. S. Nuclear Regulatory Commission Regulatory Guide 1.27, "Ultimate Heat Sink for Nuclear Power Plants," Revision 0, dated March 23, 1972

2. Sequoyah Nuclear Plant, Final Safety Analysis Report (As Updated) Revision 17, Sections 2.4.11.1, 2.4.11.3, 9.2.2, 9.2.5, Chapters 6 and 15, dated November 8, 2002

3. TVA's letter to NRC dated June 20, 1988, "Sequoyah Nuclear Plant (SQN) Units 1 and 2 - Technical Specification (TS) Change 88-21"

4. NRC's letter to TVA dated August 15, 1988, "River Water Level and Temperature (TAC R00375, R00376)(TS 88-21) Sequoyah Nuclear Plant, Units 1 and 2" Amendments 79 and 70 for Units 1 and 2, respectively

5. TVA's letter to NRC dated August 21, 1995, "Sequoyah Nuclear Plant (SQN) - Exigent Technical Specification (TS) Change 95-21, 'Ultimate Heat Sink (UHS)'"

6. NRC's letter to TVA dated September 13, 1995, "Issuance of Amendments (TAC Nos. M93316 and M93317)(TS 95-21)" Amendments 210 and 200 for Units 1 and 2, respectively

7. TVA Calculation MDQ 000 067 2002 0109, "ERCW System Sensitivity Review for 87°F, ESF & HVAC Equipment," Revision 0, dated December 2002

8. TVA Calculation MDQ 000 067 2002 0110, "ERCW System Calculations Review for 87°F," Revision 0, dated February 2003

9. TVA Calculation MDQ 000 067 2002 0136, "Evaluation of ERCW Header Pipe Break(s) in the Turbine Building: Ultimate Heat Sink at 87°F," Revision 0, dated January 2003

10. TVA Calculation MDQ 000 067 2000 0095, "ERCW Flow Balanced Hydraulic Model," Revision 0, dated January 2003

11. TVA Calculation SCG-1S-393, "Essential Raw Cooling Water (ERCW) Intake Sediment Uptake as a Result of Loss of Downstream Dam," Revision 1, dated May 1994

12. Nebraska Public Power District, Cooper Nuclear Station, Amendment No. 193, issued July 22, 2002

13. Consumers Energy Company, Palisades Plant, Amendment No. 202, issued June 4, 2001

14. Commonwealth Edison Company, Braidwood Station, Amendment Nos. 107 and 107 for Units 1 and 2, respectively, issued June 13, 2000

ENCLOSURE 2

TENNESSEE VALLEY AUTHORITY
SEQUOYAH NUCLEAR PLANT (SQN)
UNITS 1 AND 2

Proposed Technical Specification Changes (mark-up)

I. AFFECTED PAGE LIST

Unit 1

3/4 7-14

Unit 2

3/4 7-14

II. MARKED PAGES

See attached.

PLANT SYSTEMS

3/4.7.5 ULTIMATE HEAT SINK

LIMITING CONDITION FOR OPERATION

3.7.5 The ultimate heat sink shall be OPERABLE with: 674

a. A minimum water level at or above elevation ~~670~~ feet mean sea level USGS datum, and 87

b. An average ERCW supply header water temperature of less than ~~or~~ equal to ~~83~~°F~~, and~~ .

~~c. When the water level is above 680 feet mean sea level USGS datum, the average ERCW supply header water temperature may be less than or equal to 84.5°F.*~~

APPLICABILITY: MODES 1, 2, 3 and 4.

ACTION:

With the requirements of the above specification not satisfied, be in at least HOT STANDBY within 6 hours and in COLD SHUTDOWN within ~~the~~ following 30 hours.

E

SURVEILLANCE REQUIRMENTS

4.7.5.1 The ultimate heat sink shall be determined OPERABLE at least once per 24 hours by verifying the average ERCW supply header temperature and water level to be within their limits.

~~*87°F is allowed until September 30, 1995.~~

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ENCLOSURE 3

TENNESSEE VALLEY AUTHORITY
SEQUOYAH NUCLEAR PLANT (SQN)
UNITS 1 AND 2

Updated Predictions of Chickamauga Reservoir Recession Resulting from Postulated Failure of the South Embankment at Chickamauga Dam

TENNESSEE VALLEY AUTHORITY
River System Operations & Environment
River Scheduling

Updated Predictions of Chickamauga Reservoir Recession Resulting from Postulated Failure of the South Embankment at Chickamauga Dam

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Knoxville, Tennessee

November 2002

UPDATED PREDICTIONS OF CHICKAMAUGA RESERVOIR RECESSION RESULTING FROM POSTULATED FAILURE OF THE SOUTH EMBANKMENT AT CHICKAMAUGA DAM

EXECUTIVE SUMMARY

Tennessee Valley Authority Nuclear (TVAN) is performing computations to support a technical specification change allowing Sequoyah Nuclear Plant (SQN) to operate at a higher ultimate heat sink (UHS) temperature. At the request of TVAN, River Scheduling performed a re-analysis of the upstream effects of postulated non-flood failure of Chickamauga Dam. The purpose of this analysis is to ensure that sufficient water surface elevation would be maintained in Chickamauga Reservoir to provide a source of cooling water to safely shut down the nuclear plant in the event of an emergency. The most-likely mechanism of failure for Chickamauga Dam (a combination of concrete and earth structure) is a breach in the earthen dam embankment[1]. The current analysis focused on updating breach parameters consistent with current industry criteria. After a literature review and discussions with TVA Dam Safety staff, a most-likely breach scenario was established and then modeled to simulate water surface elevations and discharges as the water recedes after postulated dam failure. Sensitivity tests were performed on each parameter to validate breach scenario assumptions. All modeling and testing were performed using TVA's Simulated Open Channel Hydraulics (SOCH) computer model[2]. In addition, sub-surface river geometry was examined at the plant and in the 14-mile reach to the dam. The resulting curves show that variation in breach parameters produces little change in the timing of recession from the predictions made previously. Results indicate that after reaching a near steady state 60 hours past failure, water surface elevations at SQN would be entirely dependent on river geometry and outflow from Watts Bar Dam. Thus sufficient water surface elevation can be maintained even after a postulated failure at Chickamauga Dam.

CHOOSING BREACH PREDICTION PARAMETERS

Reservoir recession curves were computed in 1988[3] to support a submittal to the Nuclear Regulatory Commission. Computations supporting those curves assumed:

- Chickamauga Dam fails during a non-flood event,
- Chickamauga Reservoir water surface elevation is 681 feet above mean sea level (ft-msl) at the time of failure,
- An instantaneous failure of a 1000-foot wide breach occurs, and
- The breach has vertical side slopes in the south embankment extending to bottom elevation of 630 ft-msl.

Most research in breach parameter prediction is focused on the size and timing of the downstream flood wave rather than reservoir impacts, with the general assumption that for large capacity reservoirs the size of the breach, length and depth, is the most important parameter upstream. However, the additional breach variables of side slope and time to failure were also examined, as well as variation in starting pool elevation and the impact of tailwater elevation during failure.

A literature search was performed by the TVA Corporate Library for any advances in research beyond those detailed in the Bureau of Reclamation's Dam Safety Office 1998 publication entitled "Prediction of Embankment Dam Breach Parameters: A Literature Review and Needs Assessment"[1]. The multi-database search was unsuccessful in finding any new information to

supplement the 1998 report. Failure criteria in current industry use were also reviewed by TVA Dam Safety staff.

Current industry use and the Bureau of Reclamation Report were in agreement at assuming a maximum postulated breach width at 5 times the dam height. Top of embankment elevation is 706 ft-msl. TVA's 1988 computations used a south embankment bottom elevation of 630 ft-msl, and no compelling reasons emerged during this analysis to alter this assumption. Therefore, dam height is 76 feet and the maximum likely breach width would be around 400 feet. This indicates that based on the latest research, the breach width was overly conservative in the 1988 computations. Narrower or wider widths would be expected to impact the initial hours of rapid water recession. Sensitivity to breach width was tested by comparing breach widths of 300 and 1000 feet. Modeled results showed that during recession the time to reach any given water surface elevation at SQN would be about 4 hours longer for the smaller breach. After 60 hours little water surface elevation difference would be noted.

Vertical side slopes and instantaneous failure were also chosen as reasonably conservative assumptions. Both of these parameters were tested for sensitivity to variation using a side slope range from vertical to 1:1 and a time of breach development range from instantaneous to 1 hour. Both tests showed nearly identical results over the range of variation, confirming the original assumptions.

From an understanding of current industry standards, research, and results of sensitivity analyses, it was concluded that the optimum breach parameters to be used in this analysis should be the following:

- Breach width = 400 feet
- Bottom of Breach = elevation 630 ft-msl
- Time to fail = 0 hours (instantaneous)
- Breach side slopes = vertical

RESERVOIR AND TAILWATER CONDITIONS AT TIME OF FAILURE

The 1988 recession computations assumed an initial reservoir elevation of 681 ft-msl, which is the normal August to September summer level shown on the seasonal guide curves for the Chickamauga Project (see attached operating guide)[4]. In early summer the guide curve shows an elevation of 682.5. However, a more conservative minimum summer operating elevation of 680 ft-msl is consistent with the SQN technical specifications. The reservoir levels are lower at other times of the year, but the ultimate heat sink limit is not approached during these times.

The impact of initial reservoir elevation was tested with the failure scenario above using each of the summer elevations noted above, as well as the minimum winter pool operating elevation of 675 ft-msl. Comparison of results showed that pool levels would drop at a consistent rate regardless of initial elevation with the respective elevation differences holding through the first 36 to 48 hours following failure, but by 60 hours differences would diminish to near zero. To maintain consistency with SQN specifications, summer pool elevation 680 ft-msl was chosen for the failure scenario.

Computation requires the development of an after-failure rating curve relating water surface elevation to discharge. The equation for open channel contraction discharge, as provided earlier[3], is

$$Q = C A [2g (\Delta h + \alpha_1 (V_1^2 / 2g) - h_f)]^{1/2}$$

in which C was assumed to be 0.7, and the term $\alpha_1 (V_1 / 2g)^2 - h_f)$ to be zero.

Where: Q = discharge through the breach
C = a constant
A = breach area (width x depth)
g = acceleration of gravity
Δh = actual head differential (headwater – tailwater)
$\alpha_1 (V_1^2 / 2g)$ = head due to water velocity (V_1) The energy coefficient, α_1, corrects for non-uniform velocity distribution
h_f= head loss due to friction

Therefore, with discharge dependent only on breach width, flow depth, and the changing difference between headwater and tailwater elevations, a discharge rating curve was developed. Current modeling efficiencies allowed the development of a family of tailwater elevations for each of the inflow discharges. Tests were made, then, to compare the impact of using these model-generated tailwater ratings with the single tailwater rating used earlier. Results showed that the predicted water recession using model-generated curves would slightly lag the original 1988 predicted recession. The maximum delay is 2 to 3 hours, occurring between 24 and 36 hours after failure. Using model-generated tailwater relationships also predicts slightly lower (less than 1 foot) steady elevations after 60 hours. This difference would diminish further in the following days.

Therefore, the following conditions were added to the breach scenario above:

- Initial Chickamauga Pool = Elevation 680 ft-msl, and
- Model-Generated Tailwater Rating Curves

SUBSURFACE RIVER GEOMETRY IMPACT ON WATER SURFACE ELEVATIONS

In 1988 the highest streambed point between Chickamauga Dam and SQN was identified as elevation 632 ft-msl at Tennessee River Mile 480. With most of the Chickamauga pool lost late in the breach scenario and river flow quantity directly related to Watts Bar discharge; this point would serve as a control limiting further drawdown. Investigation of current river geometry data[5] showed that this is still the control point, and the elevation has not changed. The precise location of this point, however, has been now updated to Tennessee River mile 479.4.

During construction at SQN an underwater rock dam was placed in the main channel below the condenser water intake and upstream of the discharge diffuser pipes to help maintain an available pool of cooler water during summer months. According to SQN plan drawings[5] the underwater dam has the following characteristics:

- A maximum height of 19 feet above the streambed,
- Natural slopes, and
- A top elevation of 654 ft-msl.

This structure may maintain a pool at a higher elevation than those predicted in this study for a short period of time after Chickamauga failure. However, the dam was constructed of quarry

rock placed by bottom-dump barge. Both the current integrity of the structure and its durability under weir flow conditions are unknown and therefore it was not considered in this evaluation.

UPDATED RECESSION CURVES FOR SQN

River hydraulics at SQN were then modeled using the failure scenario described above and a range of likely discharges from Watts Bar Dam (see attached operating guide), including the possibility of having no discharge for up to 12 hours which is consistent with the Dam Safety Emergency Action Plans and the SQN FSAR. The result is a recession curve for each discharge. Comparing curves shows that in the first 12 hours after failure there would be no distinguishable difference in water surface elevation resulting from any of the Watts Bar discharge conditions confirming the negligible effect of no Watts Bar discharge in this initial period.

In each failure scenario, Chickamauga pool would drop from elevation 680 ft-msl at a nearly linear rate of somewhat under 1 foot per hour. The pool is predicted to reach elevation 660 ft-msl after 24 hours and elevation 650 ft-msl in 36 hours. After 48 hours the water surface recession would begin to diminish and level off at an elevation dependent on upstream inflow. Beyond 60 hours little further recession would occur. It can be seen then, that after rapid recession river elevations at SQN will be determined by the amount of discharge provided from Watts Bar Reservoir.

Results indicate sufficient water surface elevation can be maintained to provide SQN ultimate heat sink even after a postulated failure at Chickamauga Dam. Attachment 1 shows water surface elevation at the plant site vs. time since failure for the updated breach scenario for a range of likely discharges from Watts Bar. The SQN FSAR states that a minimum discharge will be 14,000 cfs.

THE TVA DAM SAFETY PROGRAM

TVA formalized its Dam Safety Program in the early 1980s to ensure consistency with *Federal Guidelines for Dam Safety*. Dam Safety civil engineering general inspections are performed at all projects every 5 years with intermediate inspections performed annually. The 5-year general inspection includes a thorough review of the history, design basis, instrumentation data, and recent maintenance recommendations. The annual inspections are a walk-through review of the project. Thorough mechanical/electrical inspections are performed every 2-1/2 years. The dams are also inspected monthly by plant or site staff using checklists to make any pertinent observations. Copies of reports on all inspections with full documentation, inspection drawings, and data collected are kept with both the Chattanooga and Knoxville Dam Safety offices and are also available through electronic document management systems.

Instrumentation data is continually collected and reviewed to support a continuing assurance of the safety of the dam. 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 which might threaten dam safety, and evaluates the structural and geotechnical performance of the dam.

Emergency Action Plans have also been prepared for each project to minimize potential loss of life and property damage if a failure should occur. In the event of an emergency, Dam Safety staff would evaluate the situation and take appropriate measures to prevent dam failure, if

possible. This would include direct contact with any and all sources to procure emergency equipment, materials, and labor to prevent or lessen the magnitude of a dam failure. Sources for these items have been identified, and are kept current by procurement for each project, as part of the emergency preparedness process.

The focus of TVA's Dam Safety Program is to ensure the integrity of the dam through inspections, monitoring, and maintenance.

References:

1. Wahl, Tony L., "Prediction of Embankment Dam Breach Parameters: A Literature Review and Needs Assessment." U.S. Department of the Interior, Bureau of Reclamation, Dam Safety Office, Water Resources Research Laboratory, DSO-98-004, July 1998.

2. Garrison, J. M., J. P. Granju, and J. T. Price. "Unsteady Flow Simulation in Rivers and Reservoirs," Journal of the Hydraulics Division, American Society of Civil Engineers, Volume 95, Number HY5. Proceedings paper 6771, September 1969, pages 1559-1576.

3. Newton, Donald W., "Sequoyah Nuclear Plant (SNP) – Reservoir Recession Curves – Postulated Failure of Chickamauga Dam." TVA Flood Protection Branch memorandum to Mark Burzynski, TVA Sequoyah Nuclear Plant, June 6, 1988.

4. TVA River Scheduling, "Chickamauga Operating Guide." Unpublished MS Excel file CHICKAMAUGA.XLS dated February 18, 2002.

5. TVA River Scheduling, "SOCH Geometry for Chickamauga Reservoir; Actual Channel Bottoms." Unpublished data file CKNKGT86.GEO dated September 17, 1997.

6. TVA Navigation, SECTION 26a file 2724; Sequoyah Nuclear Plant, Division of Engineering Design, "Condenser Water Supply Units 1 and 2, General Arrangement." Sheet 31N200-1 dated 3/10/70. "Water Supply Units 1 and 2, Concrete Skimmer Wall & Underwater Dam, Outline & Reinf. - Sheet 1." Sheet 31N307-1 dated July 8, 1971.

November 20, 2002

List of Attached Rec-ssion Curves

Sequoyah Nuclear Plant Water Surface Elevation vs. Time Since Chickamauga Failure Curves

Curve 1: Various Watts Bar Discharge with Chickamauga Head Water of 682.5

Curve 2: Various Watts Bar Discharge with Chickamauga Head Water of 681.0

Curve 3: Initial Head Water of 681 Feet, Bottom Breach: L = 1000 Feet, Z = 0, Elevation = 630 Feet

Curve 4: Initial Head Water of 681 Feet, Bottom Breach: L = 300 Feet, Z = 0, Elevation = 630 Feet

Curve 5: Initial Head Water of 681 Feet, Bottom Breach: L = 300 Feet, Z = 0, Elevation = 630 Feet with Chickamauga Discharge Flow

Curve 6: Various Watts Bar Discharge with Chickamauga Head Water of 681.0 with Breach Configuration: L = 400 Feet, Z = 0, Elevation = 630 Feet

Curve 7: Various Watts Bar Discharge with Chickamauga Head Water of 680.0 with Breach Configuration: L = 400 Feet, Z = 0, Elevation = 630 Feet

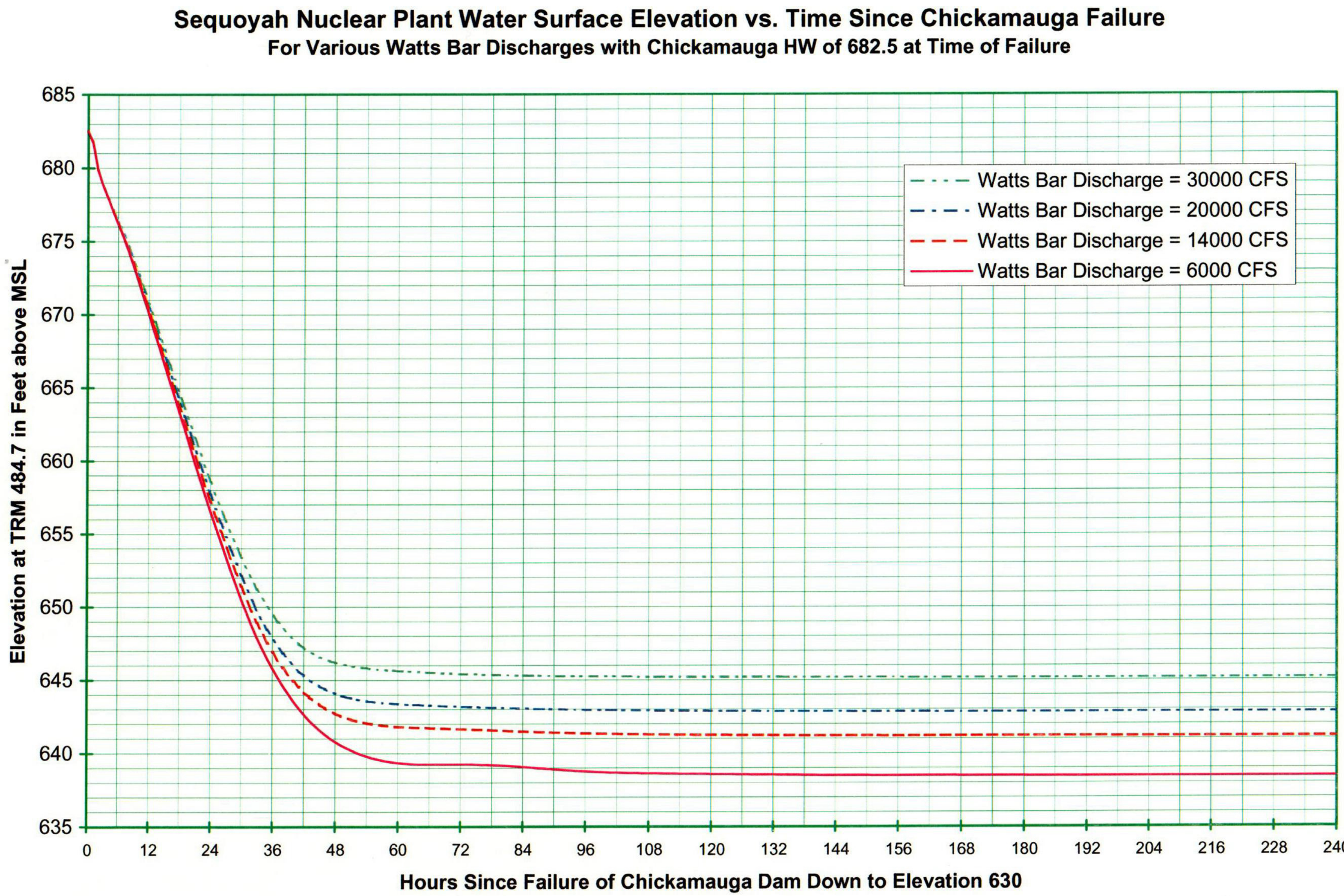
Curve 8: Various Initial Chickamauga Head Water Elevations with Bottom Breach: L = 400 Feet, Z = 0, Elevation = 630 Feet

Curve 9: Initial Head Water of 681 Feet, Side Slope: Z = 1 vs. Z = 0; Bottom Breach: L = 300 Feet, Elevation = 630 Feet

Curve 10: Head Water of 681 Feet with Breach Developing in 1 Hour, Breach Configuration: L = 400 Feet, Z = 0, Elevation = 630 Feet

Chickamauga Tail Water Rating Curve

Curve 1: L = 1000 Feet and 450 Feet Bottom Breaches at Elevation 630 Feet and Side Slopes, Z = 0

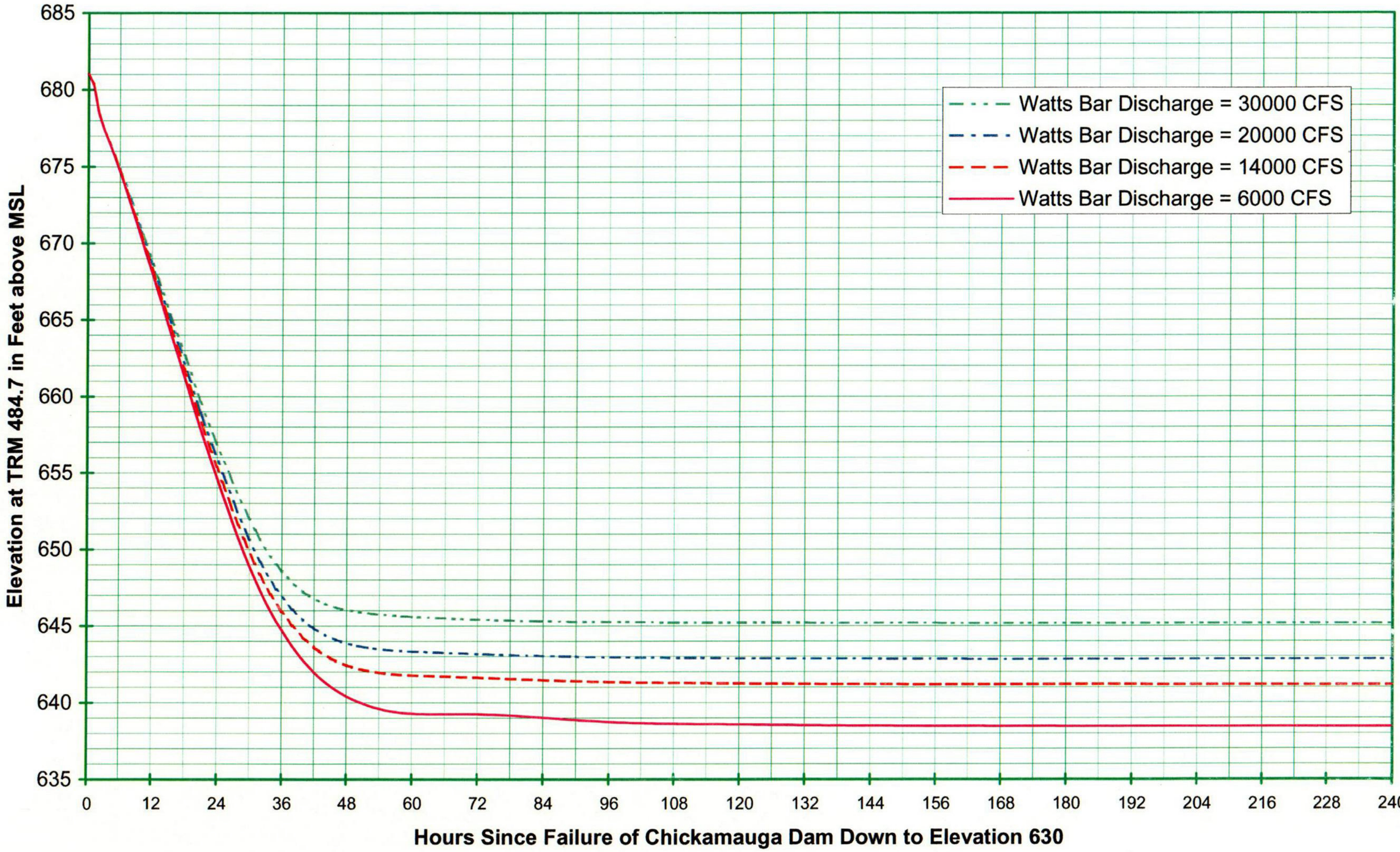


SAL
02/27/2003

C01

Sequoyah Nuclear Plant Water Surface Elevation vs. Time Since Chickamauga Failure

For Various Watts Bar Discharges with Chickamauga HW of 681.0 at Time of Failure



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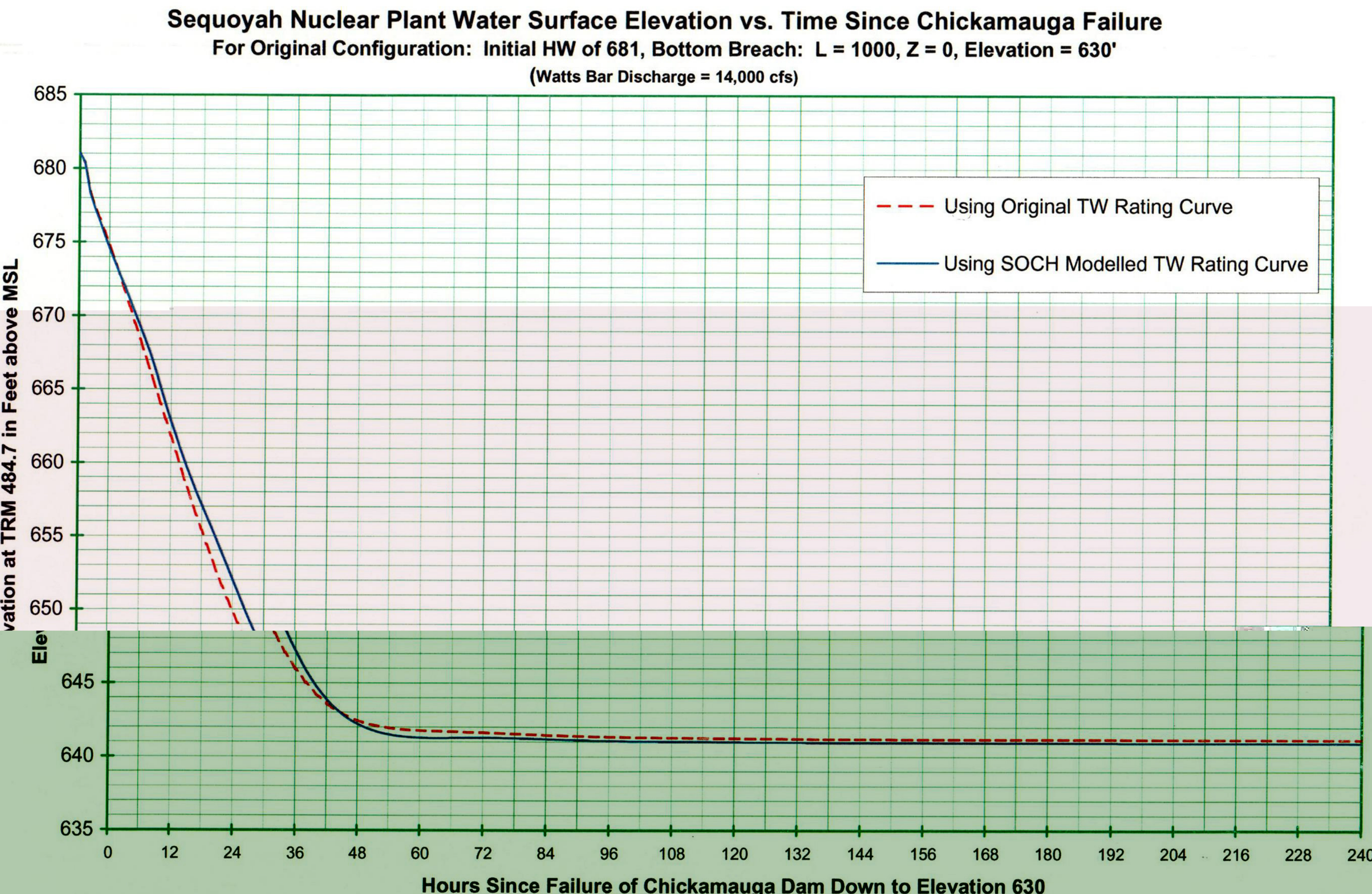

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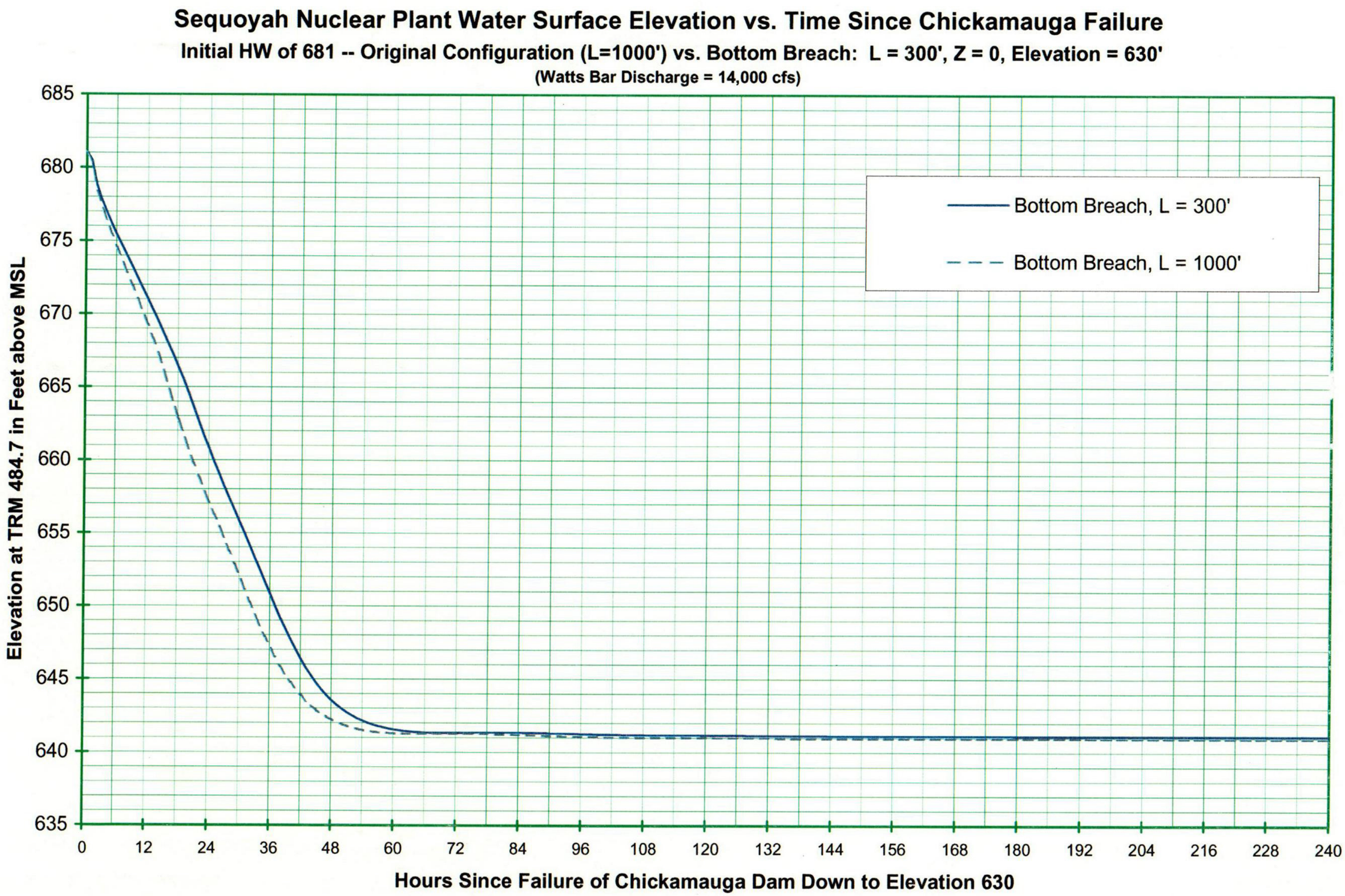

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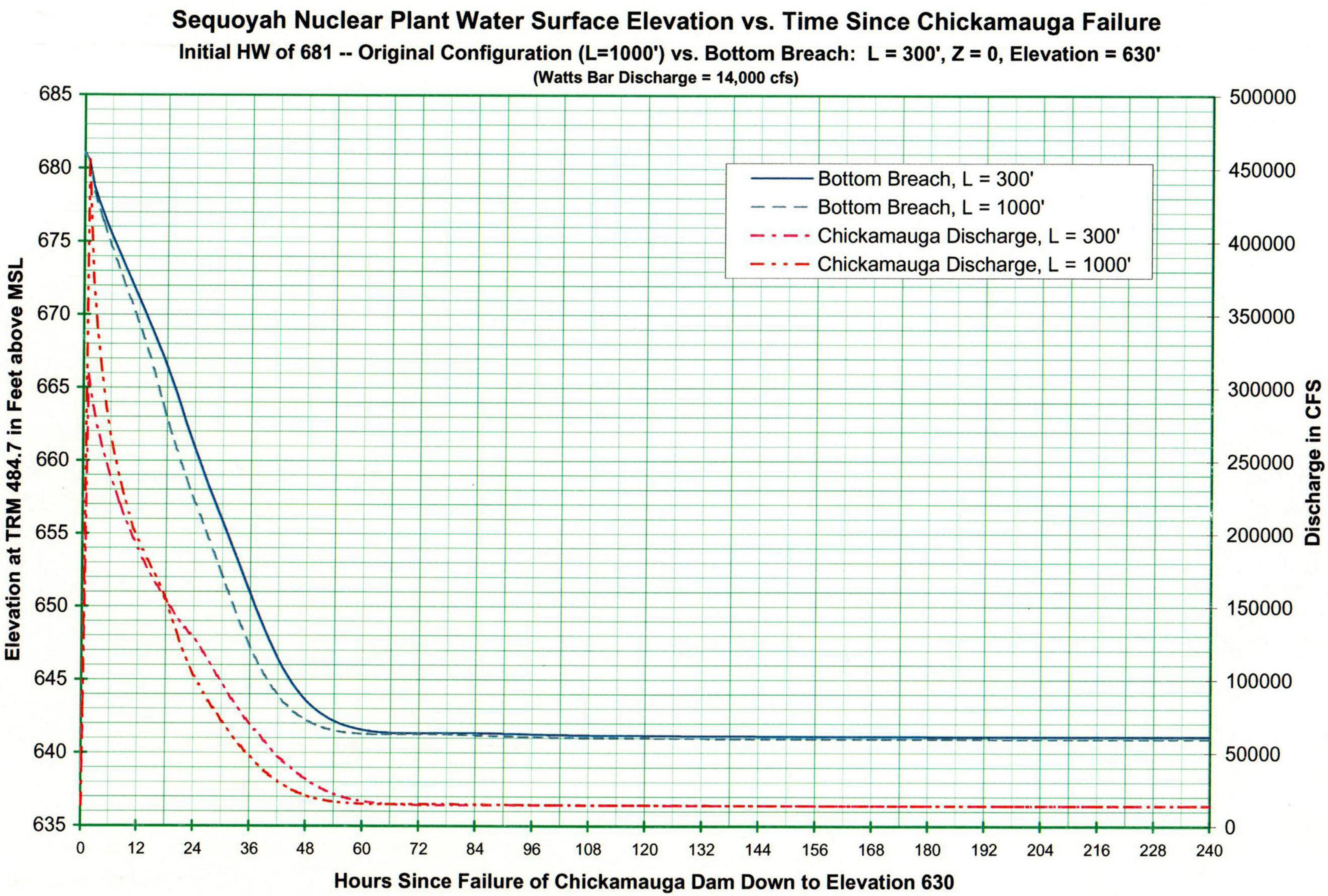

SAL
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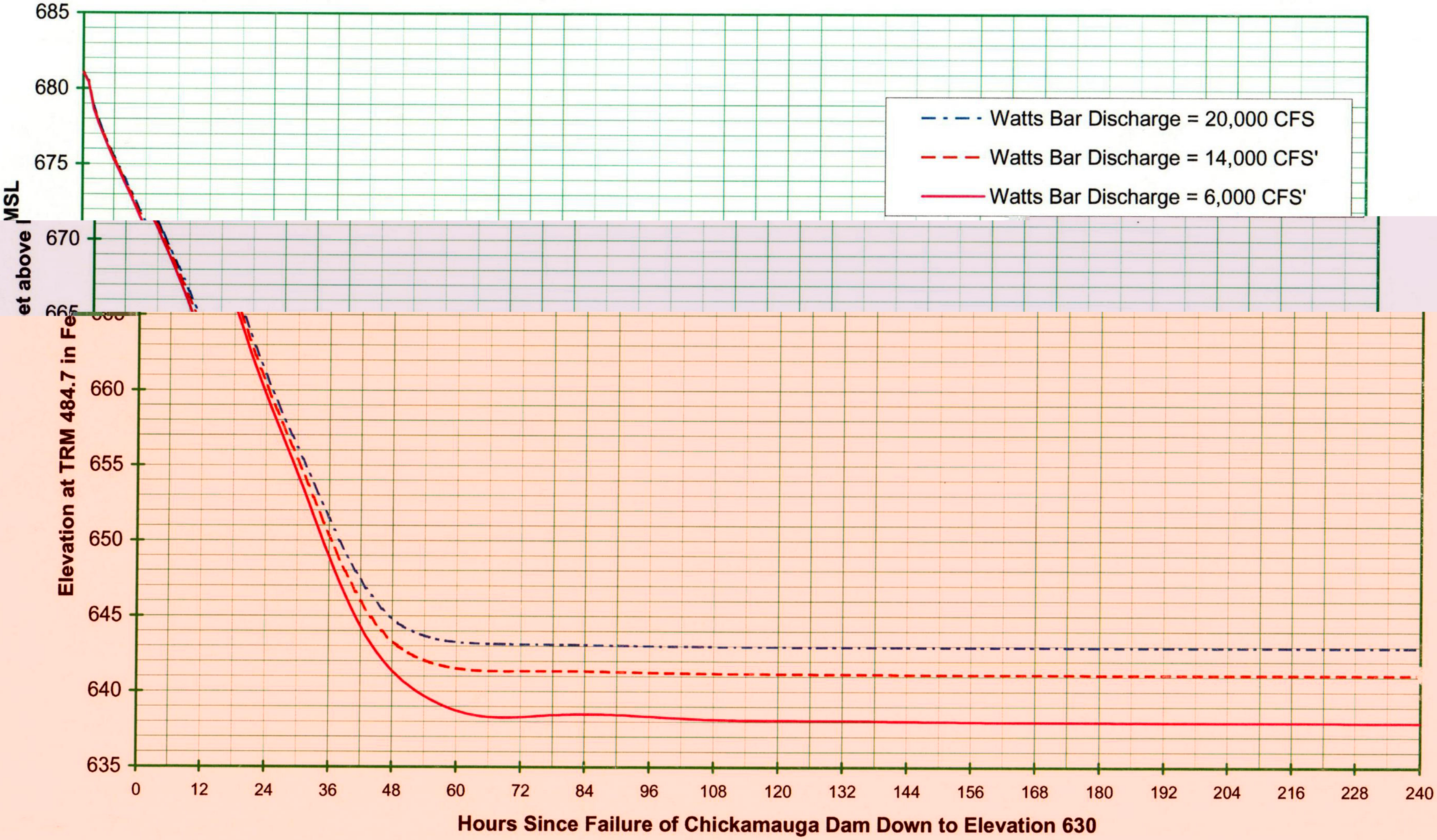
C05

Sequoyah Nuclear Plant Water Surface Elevation vs. Time Since Chickamauga Failure

For HW = 681' and Various Watts Bar Discharges with Breach Configuration: L = 400', Z = 0, Elevation = 630'



SAL
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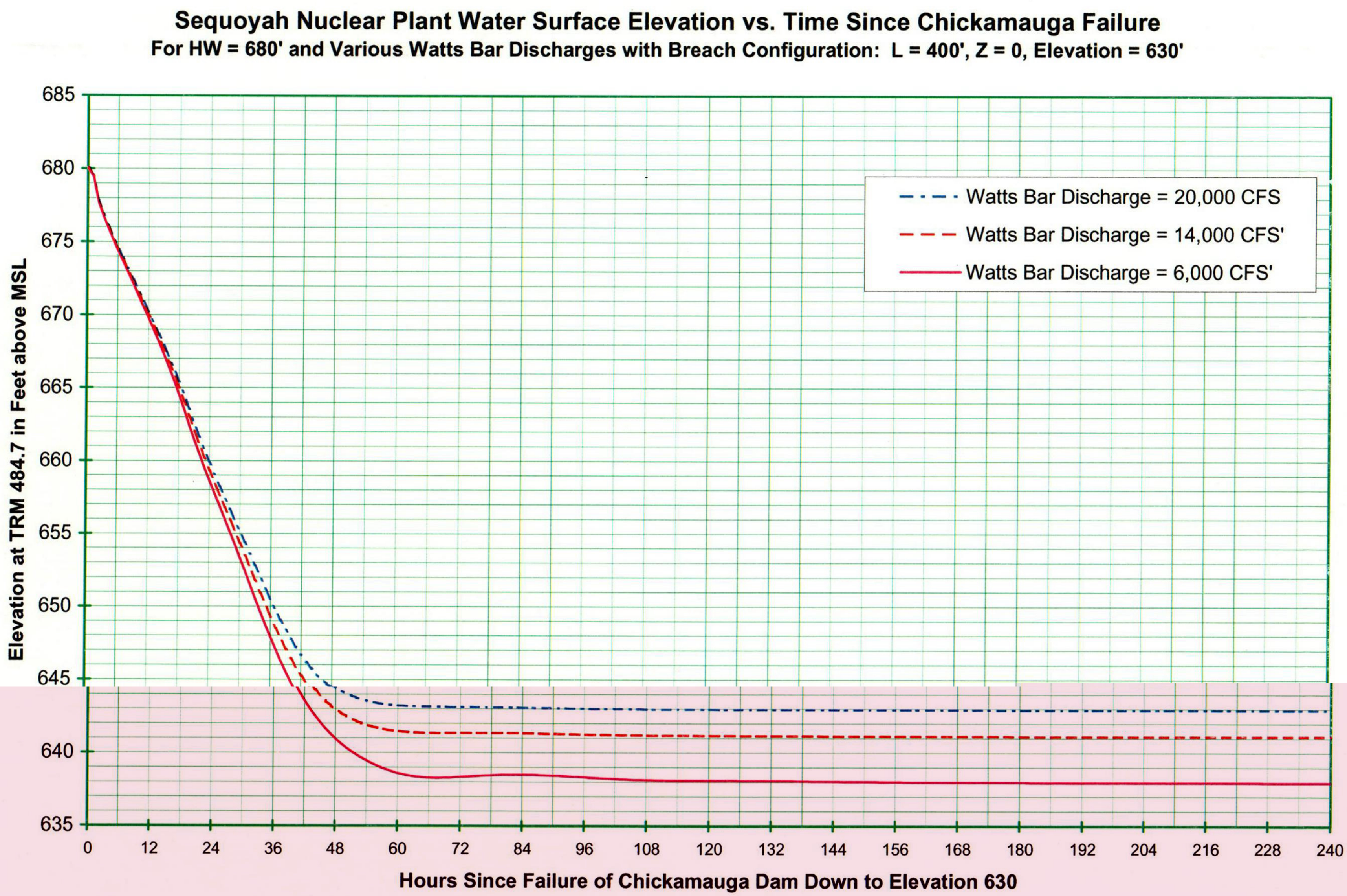
C06



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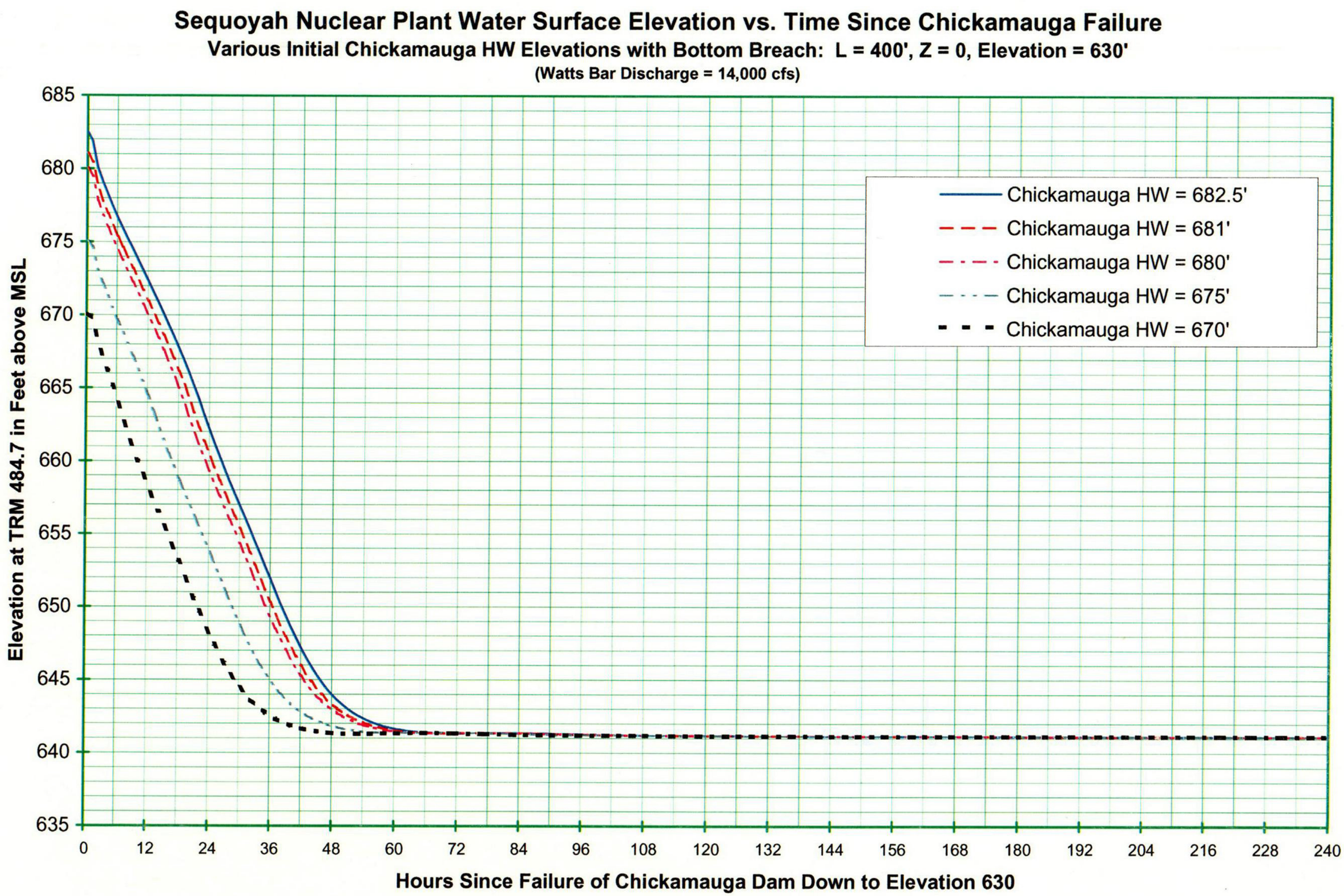

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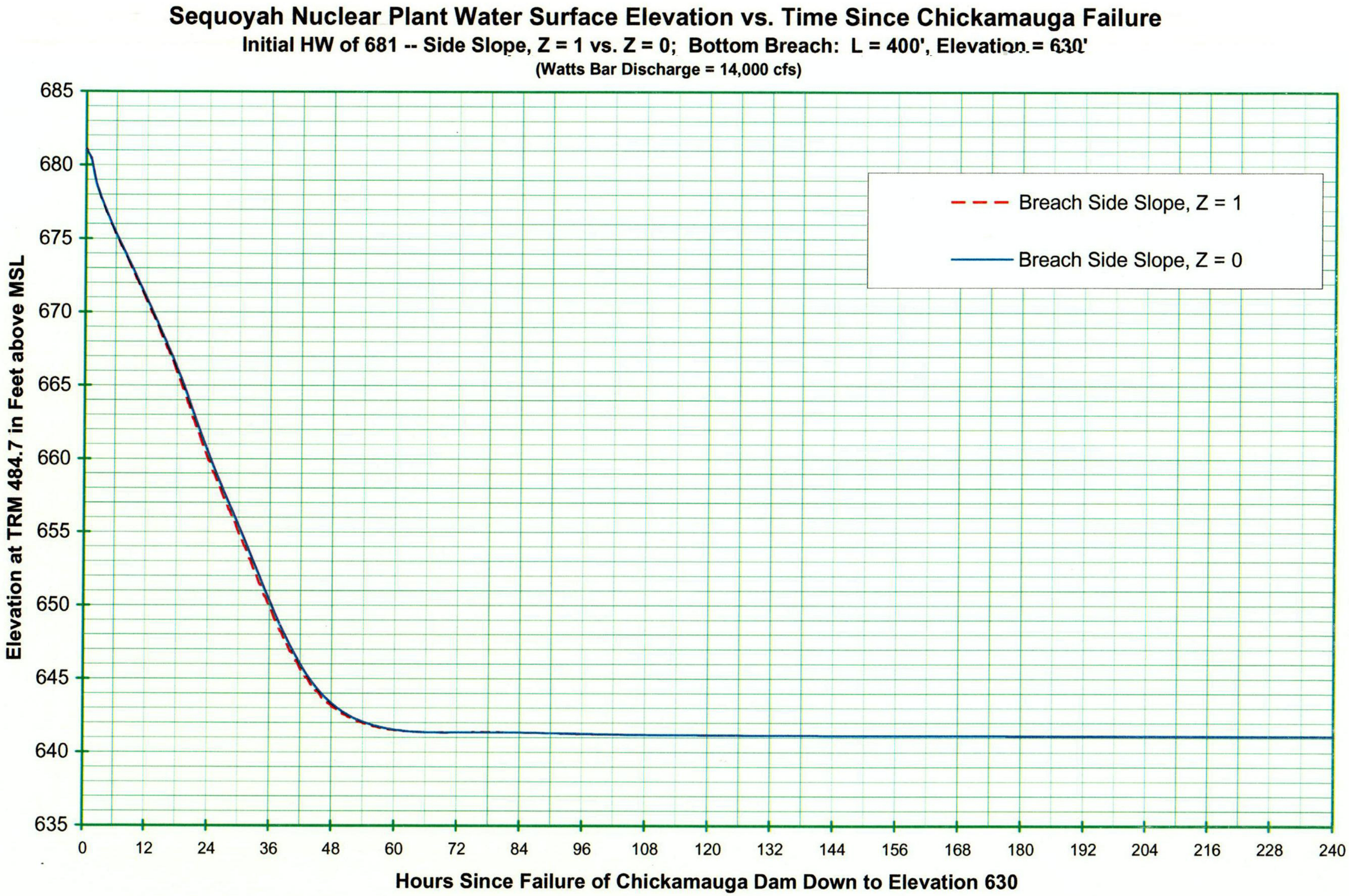
C08



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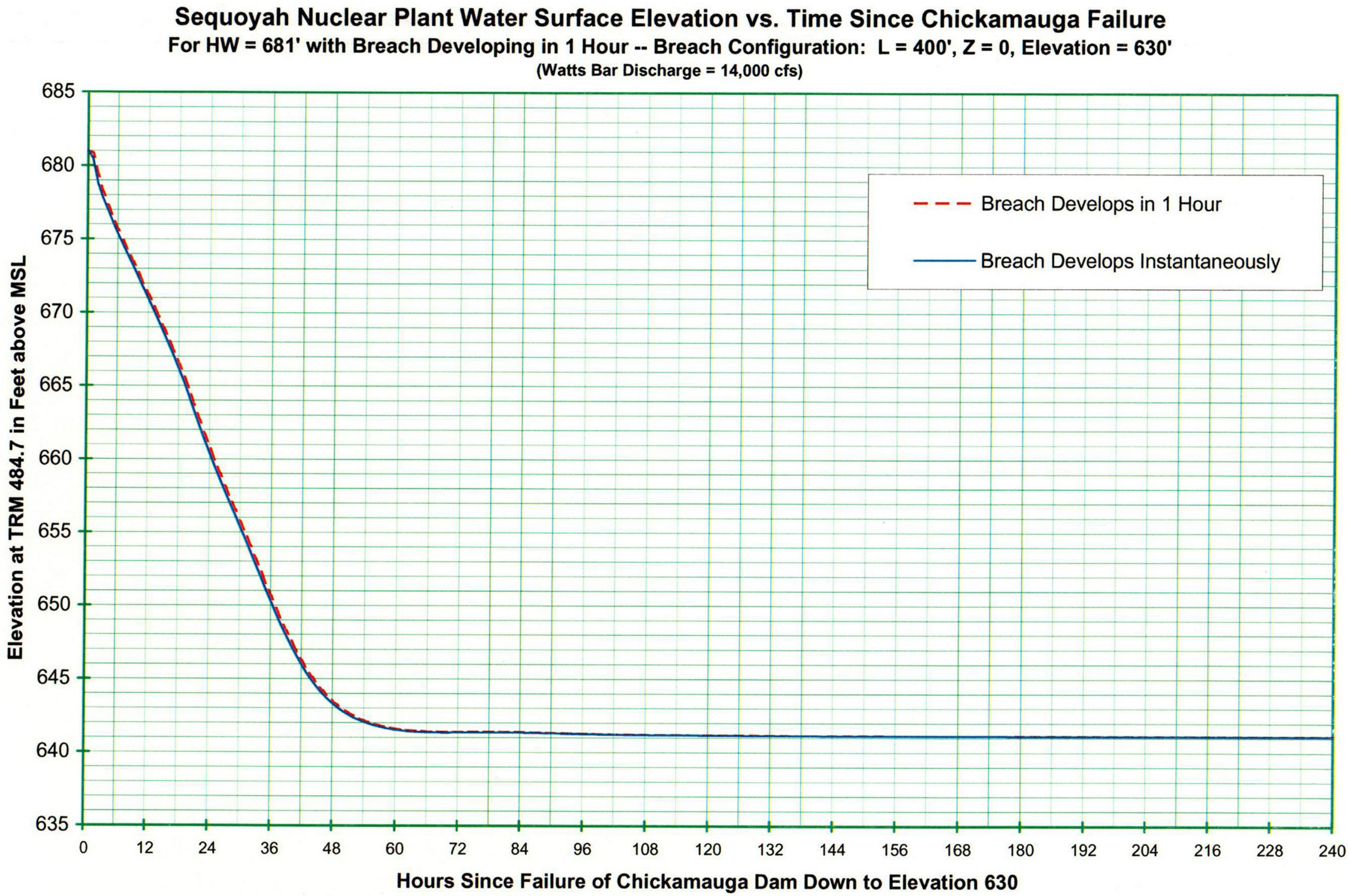
C09



SAL
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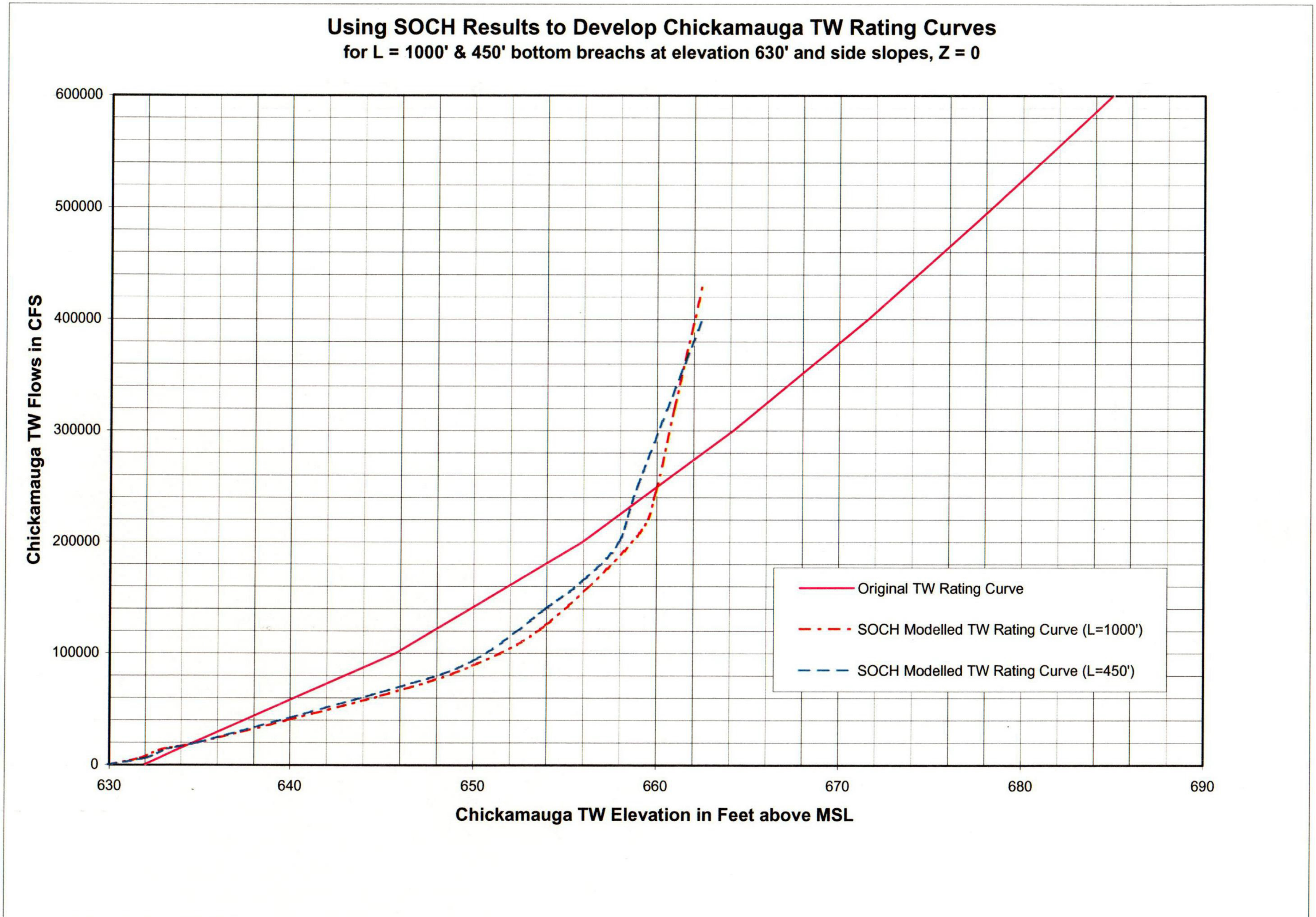
C10


Using SOCH Results to Develop Chickamauga TW Rating Curves
for L = 1000' & 450' bottom breachs at elevation 630' and side slopes, Z = 0
Chickamauga TW Flows in CFS
600000
500000
400000
300000
200000
100000
0
630
640
650
660
670
680
690
Chickamauga TW Elevation in Feet above MSL
Original TW Rating Curve
SOCH Modelled TW Rating Curve (L=1000')
SOCH Modelled TW Rating Curve (L=450')

C11

ENCLOSURE 4

TENNESSEE VALLEY AUTHORITY
SEQUOYAH NUCLEAR PLANT (SQN)
UNITS 1 AND 2

MONITORING AND MODERATING THE ULTIMATE HEAT SINK

MONITORING AND MODERATING SEQUOYAH ULTIMATE HEAT SINK

RIVER OPERATIONS

TVA manages the Tennessee River and power plants as an integrated and balanced system. The river system is operated to:

- Help protect people and property from floods;
- Maintain a navigable waterway;
- Supply reliable, flexible, and affordable hydropower;
- Enhance conditions for aquatic life; and
- Provide water for drinking, recreation and industry.

Providing water for industry includes providing adequate cooling water for TVA's thermal plants.

Special operations of the river system are used to mitigate intake temperature at Sequoyah Nuclear Plant (SQN). Special operations to control the intake temperature are planned, depending on the severity of the temperature problem. These special operation options to solve issues are listed below in order of increasing severity.

Unit Preference

When the temperature reaches the first threshold, unit preference is implemented. Watts Bar Hydro Plant, located upstream of Sequoyah Nuclear Plant, has five hydropower units. Under normal circumstances, the most efficient unit is operated first. If more hydropower or flow is needed, the next most efficient unit will be loaded, etc. Watts Bar Hydro Plant Unit 5 is located near the original river channel, and Unit 1 is closer to the bank. Water released from Unit 1 generally has higher dissolved oxygen than water from the other units. Usually in the summer, TVA runs Unit 1 preferentially to enhance conditions for aquatic life in the tailwater. Unit 5 is not the most efficient unit, and water released from Unit 5 commonly has lower dissolved oxygen than the other units. However water released from Unit 5 is generally cooler than that released from hydro units located closer to the river bank. When the ultimate heat sink water temperature limit is approached at Sequoyah, TVA runs Unit 5 preferentially to supply cooler water for the nuclear plant. This option does have the drawback of reducing dissolved oxygen in the Watts Bar tailwater, which can impact aquatic life.

Limiting Hours of No Flow

When unit preference is not sufficient to ensure temperature compliance at Sequoyah, TVA limits the number of hours of zero flow from Chickamauga. Because the hydropower plants are more flexible than the thermal plants, TVA typically runs the hydro plants during periods of peak power demand. Under normal circumstances at Watts Bar and Chickamauga Hydro Plants, upstream and downstream of Sequoyah, TVA does not generate during periods of low power demand. Hence, there may be many hours during the day with no water discharge from the dams. During these hours, reverse flows have been documented in Chickamauga Reservoir. Consequently, warmer water discharged from Sequoyah recirculates upstream toward the intake. Thus, TVA limiting the number of hours of zero flow from Chickamauga helps ensure temperature compliance at Sequoyah.

Minimum Flow

When limiting the hours of no flow is not sufficient to ensure water temperature compliance at Sequoyah, TVA releases at or above a guaranteed minimum flow from either Watts Bar or Chickamauga Hydro Plants, or from both plants. Upstream of Sequoyah, there are overbank areas, shallow pools of water near the banks of the river. Additionally, there are shallow embayments where small tributaries confluence with the reservoir. During days of low flow in the reservoir, these shallow areas stagnate and become heated. Providing a continuous flow above a certain level reduces stagnant heating of water in the overbank and embayment areas and provides a steady supply of cooler water to Sequoyah. These operations may involve either a one-unit or two-unit minimum flow, 24 hours a day. Dam releases are increased above this minimum during peak power demand hours.

Steady Flow

When minimum flow is not sufficient to ensure water temperature compliance at Sequoyah, TVA provides steady flows from Watts Bar and Chickamauga Hydro Plants. Varying the rate of hydropower generation during the day helps TVA supply reliable and affordable electricity. Varying the flow rates in the reservoir can cause mixing of warm surface water with cooler water at the bottom of the reservoir. This mixing can increase the intake temperature at Sequoyah. Thus, hydropower generation does not follow power demand, but is held constant 24 hours a day. Steady flow reduces mixing in Chickamauga Reservoir and helps protect the cold water, on the bottom of the reservoir, to supply to Sequoyah. However, this option can create problems with low dissolved oxygen in the reservoir, which can impact aquatic life.

Cold Water Releases Upstream

When steady flow is predicted to be insufficient to ensure water temperature compliance, TVA may provide special cold water releases from upstream locations, such as Norris and/or Tellico Dams. This operation was performed in 1988, and strongly considered again in 2000. This option is perhaps the most costly because it also requires special operations of Melton Hill, Fort Loudoun, Watts Bar, and Chickamauga Hydro Plants, as well as other upstream projects, to preserve the integrity of the cold water releases. These operations can also be damaging to other multipurpose objectives of the reservoir system. Additionally, these extreme operations must be conducted 10 to 12 days in advance of when temperature relief is needed, which requires meteorological forecasts more accurate than are frequently available.

Each of these options comes at a cost to TVA. Power prices are much higher during peak demand hours than at night. Therefore, reducing generation during peak power demand hours and increasing generation during off-peak can be costly. For this reason, these special operations are only conducted when necessary to ensure an ultimate heat sink for the nuclear plants.

PROCESS

The general process TVA uses to plan these operations is outlined below.

Provide Cost Forecast

TVA Customer Service and Marketing (CS&M) uses numerical models to predict power costs. CS&M sends the 6-month hourly price forecast to the TVA River Scheduling Forecast Team. TVA Transmission and Power Supply (TPS) sends the shorter term price forecasts to the Forecasting Team.

Develop River Schedule

The Forecasting Team develops a schedule that would optimize the hydro value, subject to non-power river constraints, using a numerical river scheduling model. The value of the current week's generation and of hydro energy in storage provides the standard of measure. Once the optimum water volume is determined, the block cost data is used to determine the daily and the 6-hour allocations.

Provide Plant Information

Sequoyah Nuclear Plant personnel provide information to the TVA River Operations Hydrothermal Team regarding:

- Plant capacity and intake temperature limit at full load.
- Unit availability and MW already derating.
- Amount of derate needed per degree of intake temperature rise.
- Cooling tower availability.
- Cooling tower and discharge diffuser performance data.

Many of these factors can impact the discharge temperature, which can impact the intake temperature during periods of recirculation in the reservoir.

Forecast Water Temperatures and Flows

The Hydrothermal Team uses current and forecasted weather and flow, as well as thermal plant performance and river characteristics, to model water temperatures at the thermal plant. Numerical hydrothermal models are used to predict water temperature and flow past the thermal plant. If no water temperature or flow violation is predicted, the process ends for the day, or until the next flow forecast is issued or other conditions change.

Evaluate Alternatives

If the ultimate heat sink water temperature limit is threatened at Sequoyah, the Hydrothermal Team uses the numerical models to test alternative hydro release schedules to determine their effect on compliance at the thermal plant. If a suitable solution is found, a recommendation will be sent to the Forecast Team.

The Forecast Team uses the river scheduling model to test the proposed change. If the alternative involves hydro unit preference, the TVA Reservoir Releases Improvement (RRI) Team offers information on how this change would affect achievement of dissolved oxygen targets. The

Forecast Team also discusses the proposal with TPS, and TPS provides additional updated information on power purchase availability and reliability issues.

Implement Change

If the alternative river schedule is needed to ensure ultimate heat sink for Sequoyah, TPS and River Scheduling Forecast and RRI Teams implement the change. The Hydrothermal Team contacts thermal plant personnel regarding the change. If a change in hydro operations is recommended, the Forecast Team contacts the River Scheduling Hydro Production Coordinator, who contacts hydro plant personnel.

MONITORING

TVA carefully monitors water temperature in the river system. Monitoring stations for Sequoyah are located at:

- The essential raw cooling water intake,
- Stations 8, 12, and 13 (see Figure 1), and
- Chickamauga and Watts Bar Dams.

Water temperature sensors at all stations consist of an epoxy-coated thermistor composite device, constructed for linear response. They have a range of 30°F to 120°F and are accurate to ±0.27°F. The sensors are laboratory-certified and checked for accuracy before installation.

A data logger collects, processes, transmits, and records the water data. The data logger system includes a minicomputer system, terminals, telemetry equipment, and communications equipment. The telemetry equipment interrogates the water stations periodically and the data values are scaled and stored in the computer. The data logger system outputs data to Sequoyah Nuclear Plant, and to the remote access computer in Chattanooga, every 15 minutes.

The remote access computer provides secure and high-speed data transfers. These data are available to authorized users throughout TVA through TVA's wide area network.

It should be noted that none of these data points are utilized for compliance with the surveillance requirements specified by the SQN Technical Specifications.

Water temperatures are also continuously (every 15 minutes) monitored at upstream reservoirs, including Norris tailwater, Bull Run Fossil Plant, and Melton Hill, Watts Bar, and Fort Loudon Hydro Plants.

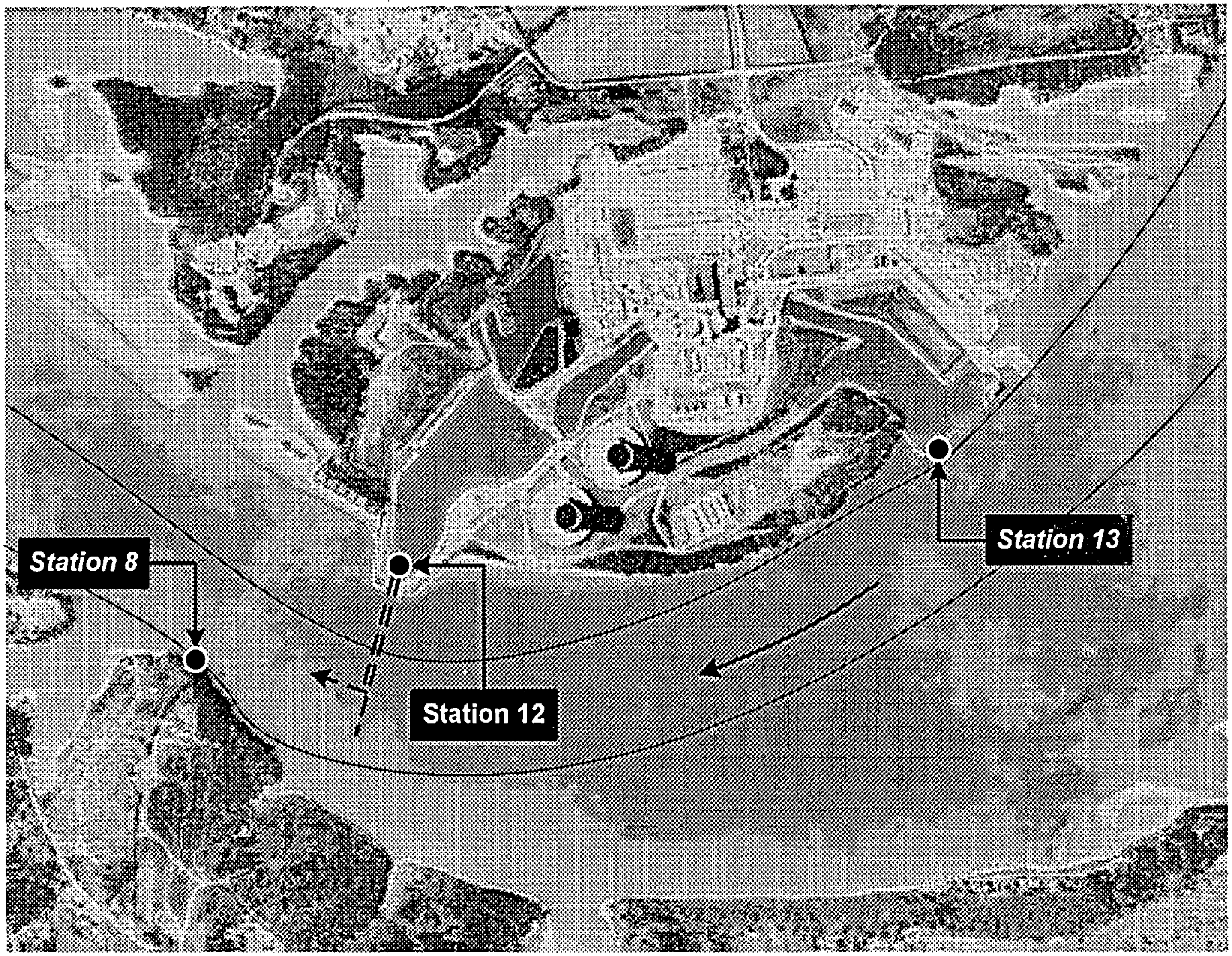


Figure 1. River Monitoring Stations Near Sequoyah

During critical periods, personnel are deployed to measure water temperatures at additional locations as needed. These data are used to assess the current water temperature situation and as input for the hydrothermal models to predict intake temperature at Sequoyah.

All the above-mentioned data are carefully monitored by both Sequoyah and River Operations personnel year-round for environmental compliance, and are monitored particularly close during the summer months for ultimate heat sink water temperature compliance.

SUMMARY

TVA manages the Tennessee River and power plants as an integrated and balanced system. The river system is operated to reduce flood damage, maintain a navigable waterway, supply power, enhance conditions for aquatic life, and supply water for drinking, recreation, and industry. Water temperature is controlled by many factors outside of TVA's control, such as air temperature, relative humidity, and cloud cover. However, by controlling the timing and quantity of releases from dams upstream and downstream of Sequoyah, TVA is able to reduce the water temperature at the Sequoyah Nuclear Plant intake.