September 21, 2001

TVA-SQN-TS-00-06 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 - REVISION OF INSTRUMENTATION MEASUREMENT RANGE, BORON CONCENTRATION LIMITS, REACTOR CORE LIMITATIONS, AND SPENT FUEL POOL STORAGE REQUIREMENTS FOR TRITIUM PRODUCTION CORES (TPCs) - TECHNICAL SPECIFICATION (TS) CHANGE NO. 00-06

In accordance with the provisions of 10 CFR 50.90, TVA is submitting a request for an amendment to SQN's Licenses DPR-77 and DPR-79 to change the TSs for Units 1 and 2 to allow SQN to provide irradiation services for the U.S. Department of Energy (DOE). This change would allow SQN to insert Tritium Producing Burnable Absorber Rods (TPBARs) into the reactor core to support DOE in maintaining the nation's tritium inventory (Tritium Program). The proposed license amendment involves revising the measurement range for the source range monitors in TS Table 3.3-9, increasing the required boron concentration for both the cold leg accumulators (TS 3/4.5.1) and the refueling water storage tank (TS 3/4.5.5), deleting the boron concentration and spent fuel storage requirements and associated Bases for the cask pit pool in TS Section 3/4.7.14 and Section 5.6, adding a limit on the number of TPBARs that can be irradiated in TS Section 5.3, providing storage requirements for spent fuel assemblies that contained TPBARs during irradiation in TS Section 5.6 and the Bases for TS Section 3/4.7.13, and the implementation of a TPBAR consolidation activity. This submittal also provides revisions to the TS Bases in Section 3/4.6.4 associated with combustible gas control.

This proposed change is justified based on extensive analysis, testing, and evaluation of the TPBARs as reported previously by the DOE. DOE has previously submitted a classified/proprietary version (NDP-98-153, Revision 1) and an unclassified/non-proprietary version (NDP-98-181, Revision 1) of the TPC Topical Report for NRC review. NRC reviewed these TPC Topical Reports and issued NUREG-1672, “Safety Evaluation Report (SER) Related to the Department of Energy’s Topical Report on the Tritium Production Core,” documenting its review. TVA used both versions of the TPC Topical Report and the NRC SER in the preparation of this license amendment request and has completed the appropriate plant-specific evaluations and analyses recommended by these documents, including the 17 interface items listed in NUREG-1672, Section 5.1. In order to maintain this license amendment request in an unclassified form, any classified text, tables, and figures that have been affected by the plant-specific application of TPBARs have been omitted from this submittal. Copies of the classified documents are available for NRC review at the Pacific Northwest National Laboratory (PNNL) offices.

TVA identified two issues that require further testing and analysis to confirm conservative assumptions. These issues involve lithium leaching and post loss-of-coolant accident (LOCA) material ejection from the TPBARs. Both issues incorporate current research and have been factored into the enclosed safety analyses. TVA has requested that DOE perform additional testing and analysis as described in Enclosure 4.

TVA has determined that there are no significant hazards considerations associated with the proposed change. The SQN Plant Operations Review Committee and the SQN Nuclear Safety Review Board have reviewed these proposed changes and have determined that operation of SQN Units 1 and 2, in accordance with the proposed changes will not endanger the health and safety of the public. Additionally, in accordance with 10 CFR 50.91(b)(1), TVA is sending a copy of this letter to the Tennessee State Department of Public Health.

Enclosure 1 to this letter provides the description and evaluation of the proposed TS changes (Part A) and a description of the TPBAR consolidation activity (Part B) required for the Tritium Program. TVA requests NRC review, under 10 CFR 50.90, to implement the changes necessary to irradiate TPBARs. This enclosure includes TVA's determination that the proposed changes do not involve a significant hazards consideration. In addition, an environmental impact consideration discussion is provided.

Enclosure 2 provides the appropriate TS pages marked to show the proposed changes. Enclosure 3 provides the revised TS pages.

Enclosure 4 provides Framatome-Advanced Nuclear Power (ANP) Report BAW-10237, Revision 1 which:

- contains information relative to items in the TPC Topical Report for which there is a SQN impact,
- contains confirmation of the plant-specific confirming checks recommended by the TPC Topical Report,
- addresses the 17 plant-specific interface issues listed in NUREG-1672, Section 5.1, and,
- addresses other items requested by NUREG-1672 such as the TPBAR surveillance program, lead test assembly (LTA) post irradiation results, and a discussion of proposed TS changes identified in NUREG-1672 that are not required at SQN.

Although the SQN thermal power uprate of 1.3 percent is not required for the implementation and utilization of TPBARs, TVA anticipates, subsequent to NRC approval, the implementation of a thermal power uprate prior to initial insertion of the TPBARS into SQN Unit 1 or 2. Accordingly, those evaluations and analyses contained in the Framatome-ANP Report have enveloped the uprated power level of 3455 megawatt thermal (MWt) versus the current rating of 3411 MWt.

Portions of Enclosures 1 (TPBAR consolidation activity) and Enclosure 4 were previously submitted on May 25, 2001. In that submittal, areas labeled as “Information to be provided later,” were identified. This submittal provides that information. The May 25th submittal also provided information regarding a new methodology for the spent fuel pool cooling analysis. TVA’s Watts Bar Nuclear Plant (WBN) has requested NRC review and approval for this methodology change, in accordance with 10 CFR 50.90 in a submittal to NRC dated April 20, 2001. NRC’s approval of this effort is expected to be completed before the date that the new methodology will be needed for SQN. Since both TVA sites will use the new methodology in the same manner, SQN will be able to implement this change in accordance with the 10 CFR 50.59 requirements after NRC’s approval of the WBN request.

Therefore, this submittal does not include a duplicate request for NRC review.

In order to meet DOE's Tritium Program requirements, TVA requests that this amendment be approved within one year of this submittal date and that the revised TSs be made effective during each unit's respective Cycle 12 refueling outage in order to properly implement the boron concentration changes.

There are no new regulatory commitments being made by this submittal. This letter is being sent in accordance with NRC RIS 2001-05. If you have any questions about this license amendment request, please contact Pedro Salas at (423) 843-7170.

Sincerely,

Original signed by

Dennis L. Koehl
Plant Manager

Enclosures

Subscribed and sworn to before me
on this 21th day of September

Peggy M. Billingsley
Notary Public

My Commission Expires October 9, 2002

ENCLOSURE 1

TENNESSEE VALLEY AUTHORITY
SEQUOYAH NUCLEAR PLANT (SQN)
UNITS 1 AND 2
DOCKET NO. 327, 328

PROPOSED TECHNICAL SPECIFICATION (TS) CHANGE TS 00-06
AND TPBAR CONSOLIDATION ACTIVITY
DESCRIPTION AND EVALUATION OF THE PROPOSED CHANGE

PART A - PROPOSED TECHNICAL SPECIFICATION (TS) CHANGE TS-00-06

I. DESCRIPTION OF THE PROPOSED CHANGE

In order to irradiate Tritium Producing Burnable Absorber Rods (TPBARs) at SQN, changes to six sections of the TSs, along with the appropriate Bases discussions and one TS Bases discussion, need to be made. The first change revises the measurement range for the backup source range monitor. The next two changes involve increasing the boron concentration in both Cold Leg Accumulators (CLAs) and Refueling Water Storage Tank (RWST) which stem from fuel core design. The fourth change deletes the provisions for storing spent fuel in the cask pit and the associated boron concentration requirements. The fifth change involves incorporating into the Design Features Section 5.0 the maximum number of TPBARs that can be inserted into the reactor core in an operating cycle. The sixth change adds discussions regarding fuel assemblies that contained TPBARs during a fuel cycle and the applicable storage requirements. A revision to the TS Bases discussion for combustible gas control has also been included to properly describe the possible sources of hydrogen gas. Each of these changes are described below and illustrated in Enclosures 2 and 3:

A. TS Table 3.3-9 - Remote Shutdown Monitoring Instrumentation - Revised Backup Source Range Monitor Measurement Range

This change will revise the measurement range of the backup source range monitor. The current range is from 1 to 10^6 counts per second (CPS) and the proposed range is from 0.1 to 10^5 CPS.

B. TS 3/4.5.1 - Cold Leg Injection Accumulators - Boron Concentration Increase

This change is requested to increase the CLA Boron Concentration from the present range of 2400 to 2700 parts per million (ppm) to a range of 3500 to 3800 ppm.

C. TS 3/4.5.5 - Refueling Water Storage Tank - Boron Concentration Increase

This change is requested to increase the RWST Boron Concentration from the present range of 2500 to 2700 ppm to a range of 3600 to 3800 ppm.

D. TS 3/4.7.14 and Bases - Cask Pit Pool Minimum Boron Concentration - Deletion of Requirements

This TS section and the associated Bases discussions are being deleted in their entirety.

E. TS 5.3.1 - Design Features/Reactor Core/Fuel Assemblies

A change is requested to Section 5.0, Design Features, to allow the insertion of a maximum of 2256 TPBARs into the SQN reactor core for irradiation purposes. The specific number of TPBARs to be irradiated during a given cycle would be identified in the Reload Safety Evaluation Report but will, in all cases, be less than or equal to 2256 TPBARs.

This request would insert a new sentence to Section 5.3.1 to read as follows:

> Sequoyah is authorized to place a maximum of 2256 Tritium Producing Burnable Absorber Rods into the reactor core in an operating cycle.

F. TS 5.6 and TS 3/4.7.13 Bases - Design Features/Fuel Storage and Spent Fuel Pool Minimum Boron Concentration - Revised Storage Requirements for Fuel Assemblies Containing TPBARs

Current Section 5.6.1.1 is being revised to accommodate new provisions that address the storage of spent fuel that contained TPBARs. Information has been included at the beginning of this section to define Type A fuel (spent fuel that has not contained TPBARs), Type T fuel (spent fuel that has contained TPBARs), fresh fuel, and cooling time. Spent fuel pool Region 1 is designated to contain fresh fuel and spent fuel Type A. Region 2 is designed to contain spent fuel Type A or Type T. Region 3 is designated to contain fresh fuel only. Region 4 is designated to contain fresh fuel and spent fuel Type T. As part of the revisions to Section 5.6.1.1, clarifying information regarding storage cells partially filled with non-fissile material has been included for all regions. This revision also deletes current Section

5.6.1.1.d that addresses spent fuel storage provisions for the cask pit pool.

Section 5.6.3 is also revised to delete the last sentence that reads:

> In addition, no more that 225 fuel assemblies will be stored in a rack module in the cask loading area of the cask pit.

The figures and tables associated with Section 5.6.1.1 have been revised accordingly to properly represent the acceptable spent fuel storage patterns for each fuel type with appropriate enrichment, burnup, and cooling time requirements for storage in respective regions of the spent fuel pit. This change has revised the labels for the existing figures and tables to clarify their use for Type A spent fuel and has included other changes to reflect the new Type T spent fuel. New figures and tables for Type T spent fuel have been added with appropriate labels and information for controlling storage requirements for this fuel.

Additionally, the Bases for spent fuel pool boron concentration for TS Section 3/4.7.13 has been revised to be consistent with the changes to TS Section 5.6.1.1. These changes reflect the use of TPBARs in fuel assemblies, the storage of Type A and Type T spent fuel, the designations for Regions 1 through 4 of the spent fuel pool, and the associated reference additions.

G. Bases 3/4.6.4 - Combustible Gas Control - Hydrogen Generation Sources

As a result of the Tritium Program, a change is being made to the TS Bases for combustible gas control to include the hydrogen and tritium inside the TPBARs as possible sources. This change would insert a fourth hydrogen generation item into the discussions as follows:

> , and 4) tritium and hydrogen that exist in the Tritium Producing Burnable Absorber Rods prior to the accident.

II. REASON FOR THE PROPOSED CHANGE

A. TS Table 3.3-9 - Remote Shutdown Monitoring Instrumentation - Revised Backup Source Range Monitor Measurement Range

The current measurement range for the backup source range monitor provides an acceptable range of values for the current fuel loading configurations and the typical boration levels of the reactor coolant system (RCS). With the higher levels of boron concentrations that will be utilized with the tritium production cores (TPCs), the availability of neutrons to be detected by the backup source range monitor will be reduced. Therefore, lowering the measurement range of the monitor by one decade will provide a more adequate range that will bound the amount of neutrons that will be available for detection. This will result in indications within a more accurate portion of the monitor's indication capabilities.

B. TS 3/4.5.1 - Cold Leg Injection Accumulators - Boron Concentration Increase

The post loss-of-coolant accident (LOCA) long-term core cooling analysis requires maintaining a subcritical boron concentration following a LOCA after all boration sources are injected and mixed in the containment sump and without taking credit for any rod cluster control assembly insertion. These boration sources include the CLAs, the RWST, and the melted ice from the ice condenser.

When large amounts of excess neutron poison are added to a core, such as with TPBARs, there is competition for neutrons from all the poisons and the negative worth of each poison (including the RCS boron) decreases. The positive reactivity insertion due to the negative moderator coefficient that occurs during the cooldown from hot full power to cold conditions following the LOCA must be entirely overcome by RCS boron. Because the RCS boron is now worth less, it takes a higher concentration to maintain subcriticality. The ice (at approximately 2000 ppm) is a dilution source which has to be overcome by the RWST concentration to reach a mixed sump concentration high enough to prevent criticality.

Therefore, the CLAs boron concentration will have to be increased to the values requested in Section I.B.

C. TS 3/4.5.5 - Refueling Water Storage Tank Boron Concentration Increase

Based on the discussion in Item B, the RWST boron concentration will also have to be increased to the values requested in Section I.C.

D. TS 3/4.7.14 and Bases - Cask Pit Pool Minimum Boron Concentration - Deletion of Requirements

TVA requested the inclusion of TS Section 3/4.7.14 and received approval in SQN Amendment Nos. 265 and 256 for Units 1 and 2, respectively. These amendments provided for the storage of spent fuel in the cask pit pool in the event that additional room might be needed. TVA now intends to utilize the dry cask storage provisions for additional storage space. This, combined with the need to use the cask pit pool for TPBAR consolidation and dry cask storage activities, has eliminated the need to use this area for spent fuel storage. Therefore, TVA no longer plans to use this area for spent fuel storage and the provisions that allowed this use, as well as the boron concentration requirements, are being deleted in the proposed request.

E. TS 5.3.1 - Design Features/Reactor Core/Fuel Assemblies

The purpose for this change is to place a limit on the number of TPBARs that can be inserted into the reactor core in an operating cycle based on plant safety analyses. The specific number of TPBARS to be irradiated during a given cycle would be identified in the Reload Safety Evaluation Report but never will be greater than 2256 TPBARs.

F. TS 5.6 and TS 3/4.7.13 Bases - Design Features/Fuel Storage and Spent Fuel Pool Minimum Boron Concentration - Revised Storage Requirements for Fuel Assemblies Containing TPBARs.

TVA will be producing tritium in TPBARs as part of an agreement with the Department of Energy (DOE). As a result, spent fuel assemblies associated with the tritium production will require storage in the spent fuel pool and will have different characteristics than other non-tritium producing spent fuel. The TPBAR related fuel will be more reactive than other fuel and therefore will require more restrictive storage limitations. The proposed changes for TS Section 5.6.1.1 and the Bases for TS Section 3/4.7.13 for Type A and Type T spent fuel will provide appropriate requirements to ensure acceptable storage arrangements that will maintain the necessary criticality limits.

The change to current TS Sections 5.6.1.1.d and 5.6.3 eliminates the provision to store spent fuel in the cask pit pool consistent with the proposed deletion of TS Section 3/4.7.14 described above in Section II.D.

G. Bases 3/4.6.4 - Combustible Gas Control - Hydrogen Generation Sources

The purpose for the addition of a fourth hydrogen source for the combustible gas control discussions is to include tritium and hydrogen inventories existing in the TPBARs that would be available for release during postulated accidents. This revision will properly describe the sources that have been considered in evaluating the adequacy of the combustible gas control functions.

III. SAFETY ANALYSIS

A. TS Table 3.3-9 - Remote Shutdown Monitoring Instrumentation - Revised Backup Source Range Monitor Measurement Range

The backup source range monitor provides an indication of core criticality conditions in the auxiliary control room. This monitor would be used in the event the main control room was required to be evacuated and shutdown conditions had to be monitored in a remote location. This monitor is used for indication of the core shutdown conditions and does not include the trip functions associated with the main control room monitors that support plant startup functions.

With the higher levels of boron concentrations that will be utilized with the TPCs, the availability of neutrons to be detected by the backup source range monitor will be reduced. Therefore, lowering the measurement range of the monitor by one decade will provide a more adequate range that will bound the amount of neutrons that will be available for detection during shutdown conditions. This change improves the ability to monitor neutron activity for verification of shutdown conditions which is the primary function of the monitor. This monitor has no startup or trip functions and therefore, there is no adverse impact for startup or operating conditions since these evolutions are handled by the main control room source range monitors.

While the bottom end of the monitor’s range is lower, likewise the top end is also lowered by one decade thereby preserving the existing overall loop accuracy. The range of neutron activity during shutdown conditions will not be of a magnitude that the reduction of the upper end of the range will affect the ability to verify shutdown conditions. The monitor will have equivalent or better capabilities to monitor changes in neutron activity with the revised measurement range to support the verification of unit shutdown. Since the backup source range monitors are used for indication of unit shutdown conditions and the lowering of the measurement range serves to improve this ability for lower leakage tritium cores, the proposed change is acceptable and no adverse impact to nuclear safety will result.

B. TS 3/4.5.1 - Cold Leg Injection Accumulators - Boron Concentration Increase

1. LOCA Related Analyses

a. Large Break LOCA (LBLOCA)

During an LBLOCA, the core becomes subcritical due to voids generated by the rapid system depressurization. Any additional boron injected due to the increase in the concentration levels would increase the margin by which the core is maintained in a subcritical condition. The LBLOCA analysis, however, does not explicitly model the boron concentration level of the accumulators or RWST; the calculated Peak Clad Temperature (PCT) and clad oxidation is not a function of the boron concentration. Thus, an increase in the accumulator and RWST boron concentrations would have no adverse effect on the LBLOCA analysis results.

b. Small Break LOCA (SBLOCA)

The SBLOCA analysis does not take credit for the boron present in the RWST and the accumulators. Though not modeled in the analysis, any additional boron injected due to the increase in the concentration levels would increase the margin by which the core is maintained in a subcritical condition. The calculated PCT and clad oxidation is not a function of the boron concentration level in the core. Thus, an increase in the accumulator and RWST boron concentrations would have no adverse effect on the SBLOCA analysis results.

c. Reactor Vessel Blowdown and Loop Forces

The LOCA blowdown hydraulic loads occur within the first few seconds of the LOCA transient and thus are not a function of the boron concentration level in the accumulators or RWST. Thus, an increase in the boron concentration levels in the accumulators and RWST would have no effect on the LOCA hydraulic forces calculation.

d. Post-LOCA Long-Term Core Cooling Requirements

The licensing basis commitment is that the reactor will remain shutdown by borated emergency core cooling system (ECCS) water residing in the sump following a LOCA. Since credit for the control rods is not taken for a LBLOCA, the borated ECCS water will result in the reactor core remaining subcritical assuming all control rods are out. Minimum boron concentrations are assumed in the calculation for each borated water source. For this calculation, the minimum RWST boron concentration is 3600 ppm and the minimum accumulator concentration is 3500 ppm.

Calculations have been performed to confirm that the sump solution will contain adequate boron to maintain the reactor in a shutdown condition following a LOCA. These calculations demonstrate that the required boron concentration to maintain subcriticality for the evaluated TPC is well below the mixed mean sump concentration. Reload TPCs will be evaluated to ensure continued compliance with this shutdown requirement.

Testing has indicated that TPBARs can experience cladding breach at LBLOCA conditions if the cladding temperature and internal pressure of the TPBARs reach limiting values. Consequently, the post-LOCA critical boron calculations accounted for the potential loss of a $LiAlO_2$ pencil, as well as partial leaching of lithium from the remaining pencils. Based on conservative assumptions, the calculations confirm that the tritium production core will remain subcritical following a LOCA.

e. Hot Leg Switchover Time to Prevent Boron Precipitation

The hot leg recirculation switchover time is determined for inclusion in emergency procedures to preclude long-term cooling problems associated with boron precipitation in the reactor vessel and core. The switchover time is dependent on power level and on the RCS, RWST, accumulator, and other (i.e., ice melt) water volumes and boron concentrations. In the event of a cold leg break during which the ECCS is aligned to the RCS cold legs, boron concentration in the core region increases due to boil-off of water. To reduce the plate out of boron, the ECCS is realigned to the RCS hot legs at the hot leg switchover time.

The increase in the maximum RWST and accumulator boron concentrations results in a reduction in the hot leg switchover time because sump boron concentration is higher, and the threshold for boron precipitation and possible core coolant blockage occurs sooner. In order to assure the same degree of long-term cooling with the higher boron concentration, the current hot leg switchover value of 12 hours will be reduced to 5.5 hours. TVA has determined that the shorter hot leg switchover time does not impose an adverse burden on plant operators.

2. Non-LOCA Transient Analysis

The following non-LOCA accidents model the RWST boron concentrations and the accumulators do not inject.

a. Steamline Break (SLB) at Hot Zero Power

Following a SLB, a safety injection (SI) signal occurs as a result of low steam generator pressure and the ECCS provides borated water from the RWST to the RCS. An increase in RWST boron concentration could be expected to reduce post-break core power. For the worst-case SLB, however, dry-out of the broken steam generator and a subsequent reduction in RCS cooling ends the core power excursion prior to the introduction of boron into the RCS. The core power excursion is, therefore, not sensitive to boron addition. Therefore, an increase in boron concentration in the RWST and accumulators has no effect on the SLB analyses.

b. Feedwater Line Break

Following a feedwater line break, a SI signal can occur as a result of low steam generator pressure and the ECCS provides borated water from the RWST to the RCS. A reactor trip occurs and an increase in RWST boron concentration could be considered as additional shutdown reactivity added to the core. However, no credit for boration is conservatively taken in the analysis. The increase in RWST and accumulator boron concentration required by the TPBAR core design, therefore, has no effect on the feedwater line break analyses.

c. Spurious Operation of the SI System at Power

This event is initiated by SI actuation. A spurious SI event is postulated to maximize the insertion of negative reactivity and assumes a maximum boron concentration. At the time the Sequoyah Final Safety Analysis Report (FSAR) analysis was performed, the boron injection tank (BIT) contained water borated to a concentration of 20,000 ppm. After the BIT concentration was reduced, the analysis was not revised as the high boron concentration was conservative. Because such a high boron concentration is considered in this event, an increase in the RWST boron concentration to as much as 3800 ppm is bounded by the current analysis. An increase in the RWST and accumulator boron concentration, therefore, does not affect the analysis of a spurious SI event.

3. SLB Mass and Energy (M&E) Releases

The SLB M&E analyses are performed for the containment integrity evaluation, compartment pressurization analysis and equipment qualification. These analyses assume the minimum allowable boron concentrations for the RWST and accumulators to minimize the amount of boron delivered to the core. The control rods provide the safety analysis value for the shutdown margin for this event. Therefore, the proposed boron concentration increase has no adverse impact.

4. Steam Generator Tube Rupture (SGTR)

During the SGTR event, a low pressurizer pressure signal actuates the SI system which delivers flow from the RWST to the RCS. The borated water from the RWST helps to maintain the reactor in a shutdown condition after the tube rupture has occurred. The increase in the RWST concentration will lead to a higher boration rate and ultimately increase the overall RCS boron concentration. The SGTR analysis does not model the boron in the accumulators or the RWST. Therefore, there is no impact on the analysis.

5. Containment M&E Releases

The LOCA temperature and pressure response analyses which are performed for containment integrity, compartment evaluation, and equipment qualification do not model the RWST and accumulator boron concentrations. Thus, the changes in concentration do not affect these analyses.

6. Nuclear Steam Supply System (NSSS) Systems and Components

a. Mechanical Components and Systems

The impact of an increase in the boron concentration range in the RWST and accumulators was assessed with respect to the mechanical and fluid system components. This increase in concentration will cause a decrease in the pH of the liquid and therefore required a review regarding the integrity of the RWST and accumulator materials, as well as other RCS component materials. This evaluation demonstrates that the integrity and operability of potentially affected equipment and systems will be maintained.

The RWST provides borated water to the refueling canal, charging pumps, SI pumps, containment spray pumps, and residual heat removal pumps. The accumulators supply water to the RCS during certain accident conditions. The immediate effect of raising the boric acid concentration in the RWST to 3800 ppm will be a decrease in the pH of the liquid. To assess the magnitude of this decrease, pH values of boric acid solutions containing 2700, 3250, and 3800 ppm at 40 degrees Fahrenheit (°F), 77°F, and 125°F were computed. These values are listed in the table below. The lowest and highest temperatures chosen, 40°F and 125°F, bound the range the RWST is expected to experience while 77°F is the temperature which the RWST liquid is expected to exhibit most of the time.

Table
pH of Boric Acid Solutions

Boron (ppm)	pH at 40 °F	pH at 77 °F	pH at 125 °F
2700	4.39	4.39	4.43
3250	4.27	4.28	4.32
3800	4.17	4.18	4.22

An inspection of the above table confirms that the pH of the RWST and accumulator liquids decreases very slightly when the boron concentration is increased from 2700 ppm to 3800 ppm. Specifically, the maximum reduction in pH in going from 2700 to 3800 ppm is only 0.22.

This minimal pH decrease is not expected to cause new concerns regarding the integrity of the RWST or accumulator material or any other stainless steel surfaces that may come in contact with the RWST and accumulator liquids in the above temperature range.

In addition, structural carbon steel surfaces in containment during either the injection or recirculation phase following a postulated LOCA are protected by approved coatings against corrosion. Wherever there are unprotected carbon steel surfaces, some corrosion is expected to take place in the moist air of the containment. The unprotected surfaces will receive a spray of RWST liquid containing 3800 ppm boron during the containment spray injection phase following a LOCA, but the slightly lower pH of the spray will not have a measurable effect on the corrosion rate of carbon steel. Based on engineering judgement, the slight pH decrease of the RWST and accumulator liquids resulting from the proposed increase in boron concentration to 3800 ppm will not cause any new corrosion concerns to unprotected (unpainted) carbon steel surfaces in the containment. During the recirculation phase following a LOCA, the expected pH of the containment sump is such that no significant corrosion of in-containment carbon steel surfaces is expected.

Finally, the solubility of boric acid at 40°F, 77°F, and 125°F is about 5402 ppm, 9493 ppm, and 18,758 ppm, respectively. Therefore, a boron concentration of 3800 ppm will remain in solution at the temperatures the liquids in the Sequoyah Units 1 and 2 RWSTs and accumulators may experience.

b. Instrumentation and Control Systems

An increase in boron concentration can impact accident/post-accident chemistry conditions in the containment building. With respect to the environmental qualification (EQ) of Class 1E equipment, such changes are only significant if the final pH of the containment sump solution differs greatly from that simulated during qualification testing. The intended objective is:

- to achieve and maintain pH above neutral (7.0) to preclude the possibility of chloride induced stress corrosion cracking, and

- to maintain a reasonable upper limit on pH (10.5 - 11.0) such that there is no significant degradation of polymer materials in the presence of strong alkali solutions.

Chloride induced stress corrosion cracking is a concern applicable to any stainless steel equipment located in the containment, but not unique to Class 1E equipment. Upper limits on pH range are established to provide adequate margin above the minimum pH (neutral 7.0) and with consideration of the likely non-metals used as vital sealing components of equipment. In practice, it is the non-metals that are selected for their endurance in the presence of the upper pH level selected by the equipment designer.

In the Westinghouse EQ program, documented as WCAP-8587, the purpose of chemistry conditions during EQ testing is to simulate a reasonable upper pH limit. The typical upper range limit value is 10.5 to 10.7 pH (varies among the specific tests performed). The intent is to affirm that chemistry, in conjunction with the extremes of pressure and temperature, does not result in a common mode failure of critical equipment/components. This is also the typical practice of other qualifiers of Class 1E equipment in that the choice of specific pH values simulated during testing will vary. TVA’s qualification program for 10 CFR 50.49 equipment addresses the chemistry in determination of the qualification for use inside containment.

A calculation of the post-LOCA sump pH with the higher boron concentrations indicates that the minimum long-term sump pH will be reduced, however, it will remain within the current SQN lower limit of 7.5 pH. The pH reduction will not result in an adverse impact to the qualification of Class 1E equipment or its components. There is no impact to the qualification of Class 1E equipment.

c. Emergency Operating Procedures (EOPs)

TVA will revise the EOPs to reflect the new hot leg switchover time defined previously in Section III.A.1.e of this submittal.

d. Radiological Dose and Hydrogen Production

The increase in RWST and accumulator boron concentrations and subsequent slight decrease in containment sump and spray pH does not impact the LOCA dose evaluation. While higher pH helps maintain volatile iodine in solution and lower pH drives the equilibrium to favor volatile iodine in a gaseous state, the change in sump pH is not sufficient to result in any measurable change in post-LOCA releases. Furthermore, current radiological analyses do not take credit for iodine removal efficiencies based on sump pH.

The analysis for iodine removal assumes that the ice condenser is the primary removal mechanism and no credit is taken for iodine removal by containment spray. Since there is no change in the concentration of the sodium tetraborate in the ice, the existing analysis for iodine removal is still valid. Iodine solubility has been correlated with alkaline aqueous solutions. The pH of the containment sump and spray remains basic and there is no impact on the solubility of iodine in the sump and core fluid. Therefore, the proposed change in RWST and accumulator boron concentration will not affect the LOCA radiological dose calculations and the present analysis remains bounding.

The slight decrease in sump, core and spray fluid pH has been evaluated to not significantly impact the corrosion rate (and subsequent generation of hydrogen) of aluminum and zinc inside containment so that the present analysis remains bounding. In addition, the decreased sump, core and spray fluid pH will not affect the amount of hydrogen generated from the radiolytic decomposition of the sump and core solution.

C. TS 3/4.5.5 - Refueling Water Storage Tank - Boron Concentration Increase

The evaluation for the previous section also applies for the RWST.

D. TS 3/4.7.14 and Bases - Cask Pit Pool Minimum Boron Concentration - Deletion of Requirements

TVA has not stored spent fuel in the cask pit and does not have plans to in the future. Since this TS requirement only addresses the potential for storage of spent fuel in the cask pit pool, the elimination will not have any adverse impact since the storage function was never utilized and a specific boron concentration is not required. If TVA chooses to utilize this area for spent fuel storage in the future, the appropriate analysis, along with a license amendment request to NRC, will have to be processed. Elimination of this requirement, along with the deletion of other provisions to allow storage in the cask pit pool, will not impact nuclear safety. Boron concentration will continue to be properly maintained for the storage of spent fuel in the spent fuel pool to control inadvertent criticality events.

E. TS 5.3.1 - Design Features/Reactor Core/Fuel Assemblies

The proposed change is justified based on extensive analysis, testing, and evaluation of the TPBARs as reported previously in the TPC Topical Report and on the evaluations performed for SQN described in Framatome-Advanced Nuclear Power (ANP) Topical Report BAW-10237. TVA has performed the confirming checks recommended by the DOE TPC Topical Report and plant specific evaluations requested by NRC’s NUREG-1672.

TVA has reviewed these changes and has identified two issues that required further testing and analysis. These issues are lithium leaching from the TPBAR failure during operation and post-LOCA material ejection from the TPBARs. See Sections 2 and 3 of Enclosure 4. Both issues incorporate current research and have been factored into the safety analyses enclosed. However, TVA has requested that DOE perform additional confirmatory testing as described in Enclosure 4. Details of these additional evaluations, confirming checks, and analyses to support the conclusion of safe operation can be found in Enclosure 4 of this submittal.

F. TS 5.6 and TS 3/4.7.13 Bases - Design Features/Fuel Storage and Spent Fuel Pool Minimum Boron Concentration - Revised Storage Requirements for Fuel Assemblies Containing TPBARs

For spent fuel pool storage, fuel is divided into three categories: spent fuel that has hosted TPBARs (designated Type T fuel), spent fuel that has not hosted TPBARs (designated Type A fuel), and fresh fuel. Fresh fuel can be stored in Regions 1, 3, or 4. Type A spent fuel can be stored in Regions 1 or 2 if the appropriate enrichment, burnup, and cooling time thresholds are met. Type T spent fuel can be stored in Regions 2 or 4 if the appropriate burnup and cooling time thresholds are met.

Design Feature 5.6.1.1 requirements pertaining to Type A spent fuel are unchanged from the current Design Feature 5.6.1.1 except for: (1) the clarification that storage of miscellaneous items or equipment displacing no more than 75% of cell volume applies to all regions and (2) the deletion of the 15 x 15 cask loading pit storage rack since this option will not be used. (The cask pit rack is also deleted from Design Feature 5.6.3). The previous criticality safety analysis (Holtec International Report HI-992349, Rev. 1) and boron dilution analysis (Holtec International Report HI-992302, Rev. 1) supporting TS Change 99-17 (Soluble Boron Credit) still apply to, and fully support, storage of Type A spent fuel.

Design Feature 5.6.1.1 requirements pertaining to Type T spent fuel are structured similar to the requirements for Type A spent fuel. A new storage region (Region 4) is defined for fresh fuel and Type T spent fuel in the same 1-of-4 pattern as Region 1 has for fresh fuel and Type A spent fuel but with different burnup and cooling time thresholds for the Type T spent fuel. Region 2 storage can intermingle Type A and Type T fuel but with separate enrichment, burnup and cooling time thresholds for each type fuel.

Region 3 is designed to store fresh fuel in a 2 of 4 array of fresh fuel assemblies and water filled cells. The presence or non-presence of TPBARs is immaterial for fresh fuel.

The criticality safety analysis for the spent fuel storage racks has been reanalyzed (Holtec International Report HI-2012629). This reanalysis was performed with fuel assemblies of nominal enrichments of 5.0 weight percent U235 containing TPBARs (Type T fuel) and also addressed other neutron poisons including Burnable Poison Rod Assemblies (BPRAs) and Gadolinia integral absorber rods (Type A fuel). The fuel was assumed to operate in-core with TPBARs, which were removed at the time the assemblies were placed in the spent fuel pool. As in the current analysis, credit was taken for soluble boron, fuel burnup, and cooling times, where appropriate.

The reanalysis adequately accounted for the effects of operating with TPBARs and determined burnup versus cooling time curves applicable to fuel burned with TPBARs for the various storage regions. The composition of the storage regions (i.e., 1 of 4 checkerboard, 2 of 4 checkerboard, or solid matrix) remains the same as in current TSs, but with different burnup and cooling time thresholds and with Regions 1 and 4 being limited to Types A and T spent fuel, respectively. The results of the reanalysis assure a safe storage configuration of fresh and spent fuel assemblies in the spent fuel pool.

G. Bases 3/4.6.4 - Combustible Gas Control - Hydrogen Generation Sources

The addition of a new source for hydrogen gas in the Bases only serves to completely describe considerations included in the evaluation for TPBAR irradiation. These changes do not alter the TS requirements or the functions for the combustible gas control features at SQN. This is an administrative addition for completeness and accuracy and will not impact nuclear safety. Details on the potential amount of hydrogen added by the TPBARs and the effect on the hydrogen recombiner functions can be found in Enclosure 4 of this submittal.

PART B - TRITIUM PRODUCING BURNABLE ABSORBER RODS (TPBARs) CONSOLIDATION ACTIVITY

I. DESCRIPTION OF THE PROPOSED CHANGE

TVA has designed a TPBAR Consolidation Fixture (TCF) to be installed in the cask loading pit for TPBAR consolidation activities. The TCF is quality related in accordance with TVA's NRC accepted Quality Assurance Program. It will normally be stored in the cask lay-down area when not in use. The TCF includes a video monitoring system, lighting, and tools designed to remove TPBARs from their baseplates. The TPBARs are deposited into a consolidation canister (up to 300 TPBARs per canister). The loaded canister is transferred back into the spent fuel pool for short-term storage until ultimately being placed into shipping casks for transport off site. The TPBAR consolidation canister loading concept has been successfully demonstrated at Department of Energy's Savannah River Site facility. The completed TCF and tools will be tested prior to delivery and also after installation to verify proper operation prior to actual use.

Consolidation Sequence:

Each tritium core is loaded with certain fuel assemblies containing up to 24 TPBARs attached to a baseplate (TPBAR assembly). The TPBARs then undergo an irradiation cycle. After the core is unloaded to the spent fuel pool during refueling, the irradiated TPBAR assemblies are removed from the fuel and transferred to available storage locations within the spent fuel pool using a burnable poison rod assembly (BPRA) handling tool. Material accountability for TPBAR assemblies is administratively controlled. TPBARs are normally shipped with the new fuel assemblies to the reactor site. TPBAR assemblies that are inserted into once burned fuel are transferred from their storage location into the required fuel assemblies using a BPRA handling tool.

Approximately 30 days after refueling is complete, TPBAR consolidation begins. The canisters (see Enclosure 4, Figure 1.5.1-3) to receive the irradiated TPBARs are transferred into the spent fuel pool, and placed into the consolidation fixture when required. A TPBAR assembly is then withdrawn from its storage location in the spent fuel pool and moved to the consolidation fixture using the TPBAR assembly handling tool suspended from the spent fuel pit (SFP) bridge crane. A TPBAR release tool is then utilized by personnel on the platform to detach individual TPBARs from the baseplate. The TPBAR slides along frame guides, through a funnel and into a roller brake, to limit its velocity, and then into the consolidation canister. The funnel, roller brake assembly, and canister are angled at approximately 15 degrees to enable the TPBARs to stack efficiently into the canister to maximize the loading. Activities take place underwater at a safe shielding water depth.

After TPBARs have been removed from a baseplate, the baseplate and any attached thimble plugs will be removed from the fixture (utilizing a hand held baseplate tool or a TPBAR assembly handling tool suspended from the SFP bridge crane), and placed in storage. The process is repeated until the canister is filled with up to 300 TPBARs. Disposal or storage of the baseplates and thimble plugs will be in accordance with accepted radwaste programs.

The loaded TPBAR consolidation canister is removed and transported to a designated storage position in the spent fuel pool storage rack using the canister handling tool suspended from the SFP bridge crane. The next empty consolidation canister is placed into the consolidation fixture and the process is repeated until all TPBARs irradiated during the fuel cycle have been consolidated. The consolidation fixture is then removed from the cask load pit and stored in the cask lay-down area. Subsequently, a shipping cask is placed into the cask loading pit. The cask is handled by the Auxiliary Building crane in accordance with NUREG-0612 program requirements. The canisters are transferred into the submerged cask. The cask is removed from the cask loading pit, drained of water and decontaminated, packaged and certified for shipment. This shipping process is repeated until all TPBARs irradiated during the past operating cycle have been shipped.

II. REASON FOR THE PROPOSED CHANGE

Equipment and methodologies do not currently exist for TPBAR consolidation and preparation for shipment. TVA requests NRC review under 10 CFR 50.90 to implement the changes necessary to irradiate TPBARs.

III. SAFETY ANALYSIS

Other than the removal of the TPBAR assembly from a spent fuel assembly, and transport of a loaded canister to and from the designated SFP storage cells, TPBAR consolidation is performed in the cask loading pit area of the SFP. The following topics are evaluated to provide assurance that consolidation activities do not pose a significant hazard to the plant or personnel:

1. Seismic Qualification of the SFP Racks With Loaded Consolidation Canisters

   The spent fuel pool racks have been seismically qualified containing consolidation canisters loaded with up to 300 TPBARs and have been found acceptable.

2. Heat Produced by the Irradiated TPBARs in a Consolidation Canister

   The additional heat produced by TPBARs (approximately 3 watts per rod at 30 days after shutdown) contained in a fully loaded consolidation canister is approximately 900 watts. Slots have been designed in the consolidation canister bottom and sides to provide flow paths for natural circulation cooling of the TPBARs, which will be adequate to help dissipate this small amount of heat.

3. Maintaining Criticality Limits for the Spent Fuel Racks Containing Loaded Canisters

   Analyses were performed to determine the limiting amount of water that can be displaced in order to checkerboard nonfissile bearing components with fresh fuel. These analyses conservatively determined that 75% of water can be safely displaced in empty cells by nonfissile bearing components. Because a fully loaded TPBAR storage canister containing 300 TPBARs displaces approximately 51% of the water in a storage cell, and the displacing material is a strong neutron poison, no additional restrictions are necessary on the location of the TPBAR canister in the spent fuel pool.

4. Fuel Handling and Storage for Assemblies Containing TPBARs

   The weight of a fuel assembly with 24 TPBARs and its hold-down assembly is less than an assembly with a rod control cluster, and therefore is bounded by the current assumed weight of assembly for purposes of analyzing fuel handling and storage facilities. The TPBAR equipped fuel assembly has the same external configuration to interface with the fuel handling and/or storage equipment. Additionally, this weight is conservative for purposes of defining NUREG-0612, "Heavy Load."

5. TPBAR Assembly Handling for Consolidation

   The weight of a TPBAR assembly is comparable to a burnable poison rod assembly (BPRA). The configuration of the baseplate and TPBAR attachment details are compatible with existing fuel assemblies and the BPRA handling tool. Therefore, the TPBAR assembly can be handled with the existing BPRA tool or any other tooling designed for the BPRA's. A postulated drop of the light weight, base plate with TPBARs, within the spent fuel pool/cask load pit area, is bounded by the analysis of a fuel handling accident damaging an irradiated fuel assembly and 24 included TPBARs.

6. TPBAR Consolidation Canister Handling

   Additional precautions are taken in addition to existing plant processes for handling heavy loads to ensure handling of the loaded canister will limit, to an acceptable level, the possibility of damage to no more than 24 TPBARs during handling.

   A. In accordance with NUREG-0612, -0554, and ANSI N14.6, the SFP bridge crane and canister lifting device will contain sufficient aspects of the single failure proof criteria to preclude a drop of the loaded canister as delineated below:

      1. The SFP bridge crane is considered equivalent single failure proof with respect to structural integrity in accordance with NUREG-0612 (NUREG-0554) due to the following:

         a. Since the SFP bridge crane has a capacity of 2000 pounds (lbs) and the weight of the submerged loaded canister is approximately 700 lbs, the crane has safety factors twice the normally required values.

         b. The crane is equipped with redundant high hook limit switches of different designs to preclude two blocking and subsequent structural failure.

      2. The lifting tool is provided with a safety lanyard attached to a hoist trolley to limit canister descent in the fuel pool to such an extent that spilling of the TPBARs out of the open topped canister is prevented. The lanyard is sized to stop the canister from a maximum hook speed of 40-feet per minute. Administrative requirements require that the safety lanyard be attached to the lifting tool during hoisting when the canister is not engaged in a SFP rack cell, the consolidation fixture holster, or cask by at least 12 inches.

         Additionally, analysis has been performed to demonstrate that damage to more than 24 TPBARs contained in a canister is precluded for all credible impact scenarios during canister handling. This analysis does not analyze a fuel assembly falling onto a loaded consolidation canister located in a spent fuel rack. Accordingly, administrative and/or design features will be in place to preclude the possibility of damage to TPBARs loaded into canisters resulting from a fuel handling accident.

3. In accordance with ANSI N14.6 sections for critical loads, the lifting tool is designed to twice the normal safety factors, tested to twice the normally required loads, and inspected utilizing required nondestructive testing methods, thereby rendering it equivalent single failure proof. It will also have a fail-closed safety latch to prevent the tool hook from disengaging from the canister lifting bail.

B. The loaded canister weight and its handling tool is less than that of a fuel assembly and its handling tool. Additionally, due to the design features listed above, the canister descent is limited to an uncontrolled lowering (e.g., a control failure) of a canister at a maximum hoist speed of 40 feet per minute, thereby limiting the kinetic energy to less than that of the fuel assembly during a postulated free-fall fuel handling accident. Therefore, fuel assembly drop accidents in the pool remain bounding with respect to damage to a stored fuel assembly.

7. Potential Damage to the Cask Loading Pit Liner and TPBARs from the Consolidation Fixture Installation and Handling

The consolidation fixture is designed to remain in place in both its use and storage positions during all credible postulated accidents and natural phenomena, precluding damage to other safety-related systems, structures, and components. This seismic category 1(L) design precludes damage to the spent fuel pool liner in the cask loading pit and consolidated TPBARs while in the fixture.

Due to close proximity to spent fuel in the pool, precautions are taken, in addition to existing plant processes for handling heavy loads, to ensure handling of the consolidation platform will limit, to an acceptable level, the possibility of a platform handling event. Accordingly, the handling of the consolidation platform is performed with the 125/10-ton Auxiliary Building crane and is considered equivalent single-failure-proof for this lift due to the following considerations:

A. The platform (or platform sections) weigh substantially less than ½ of the hook capacity of 125 or 10 tons (Note: The platform is handled as a single unit, and in two sections during assembly). Along with other design and administrative features, this crane is considered equivalent single-failure-proof consistent with the requirements of NUREG-0612 and NUREG-0554 for this lift.

B. The lifting devices are designed to the requirements of ANSI N14.6 for critical loads with increased safety factors and load test weights, in addition to the design, fabrication, inspection, and testing contained in Sections 1 through 7 of ANSI N14.6, therefore the lifting devices are considered equivalent single-failure-proof.

8. TPBAR Transport Cask Handling

The aspects of cask handling accidents associated with the production of tritium are the radiological effects of consolidated TPBARs in a legal weight truck (LWT) cask, and potential interactions between the cask and other safety-related systems, structures and components. No significant hazards to the plant or public are created due to the following considerations:

A. Due to close proximity to spent fuel in the pool, precautions are taken, in addition to existing plant processes for handling heavy loads, to ensure handling of the cask will limit, to an acceptable level, the possibility of a cask handling event. Accordingly, the handling of the LWT cask is performed with the 125-ton Auxiliary Building crane and is considered equivalent single-failure-proof for this lift due to the following considerations:

   1. The LWT cask weighs less than ½ of the crane capacity of 125 tons. Along with other design and administrative features, this crane is considered equivalent single-failure-proof consistent with the requirements of NUREG-0612 and NUREG-0554 for this lift.

   2. The lifting device is designed to the requirements of ANSI N14.6 for critical loads with increased safety factors and load test weights, in addition to the design, fabrication, inspection, and testing contained in Sections 1 through 7 of ANSI N14.6, therefore, the lifting device is considered equivalent single-failure-proof.

B. All other NUREG-0612 requirements as delineated in response to Generic Letter 81-07 for this crane, such as crane interlocks preventing crane hook travel over the new and spent fuel pools, safe load paths, crane inspection and operator training, etc., remain in force.

9. Worker Radiation Exposure During TPBAR Consolidation Activities

   The TPBAR handling and consolidation equipment is designed and configured such that minimum water shielding in the spent fuel pool and cask loading pit is maintained to keep dose rates ALARA (As Low as Reasonably Achievable). Tool design/features prevent inadvertently raising the TPBAR assemblies, loaded canisters or post consolidation baseplates above safe shielding depths.

   Personnel will work on a platform 24 inches above SFP normal water level over the deep end of the cask loading pit. The platform is designed to accommodate lead shielding, if required, for personnel protection.

IV. NO SIGNIFICANT HAZARDS CONSIDERATION DETERMINATION

TVA has concluded that operation of Sequoyah Nuclear Plant (SQN) Units 1 and 2 in accordance with the proposed changes to the technical specifications (TSs) does not involve a significant hazards consideration. TVA's conclusion is based on its evaluation, in accordance with 10 CFR 50.91(a)(1), of the three standards set forth in 10 CFR 50.92(c).

This determination evaluates the acceptability in the TS to lower the range of the source range monitors, increase the boron concentration requirements for the cold leg injection accumulators and the refueling water storage tanks (RWSTs), delete requirements for storage of spent fuel in the cask pit pool that is no longer to be utilized, and revise the storage requirements for spent fuel assemblies in the spent fuel pool that have been utilized to produce tritium. Additionally, the TS limit for the total number of tritium producing burnable absorber rods (TPBARs) that can be placed in the core is evaluated. The final change involves the addition of a TPBAR consolidation activity.

A. The proposed amendment does not involve a significant increase in the probability or consequences of an accident previously evaluated.

1. TS Table 3.3-9 - Remote Shutdown Monitoring Instrumentation - Revised Source Range Monitor Range

   The backup source range monitors are for indication of unit shutdown conditions only and do not perform any trip or mitigation functions. The monitors are not active components such that they could initiate a postulated accident and are not considered a contributor to accident generation. Therefore, the lowering of the indication range for this monitor will not increase the probability of an accident.

Since the monitor has only an indication function, it does not serve to mitigate postulated accidents. While the indications from this monitor can help to identify changing core conditions and promote actions to prevent undesired conditions, this is not a mitigation function credited in the accident analysis and is considered a diverse capability of the plant instrumentation system. Therefore, the proposed change will not impact any credited accident mitigation functions, and by improving shutdown monitoring capability, will not increase the consequences of an accident.

2. TS 3/4.5.1 - Cold Leg Injection Accumulators - Boron Concentration Increase

The accumulator boron concentration does not affect any initiating event for accidents currently evaluated in the Updated Final Safety Analysis Report (UFSAR). The increased concentrations will not adversely affect the performance of any system or component which is placed in contact with the accumulator water. The integrity and operability of the stainless steel surfaces in the accumulator and affected nuclear steam supply system (NSSS) components/systems will be maintained. The decrease in solution pH is small and will not degrade the stainless steel. Also, the integrity of the Class 1E instrumentation and control equipment will be maintained since the lower sump pH, resulting from the increased boron concentrations, is still within the applicable equipment qualification limits. These limits are set to preclude the possibility of chloride induced stress corrosion cracking and assure that there is no significant degradation of polymer materials. The design, material and construction standards of all components which are placed in contact with the accumulator water remain unaffected. Therefore, the possibility of an accident has not been increased.

The consequences of an accident previously evaluated in the UFSAR will not be increased. The change in the concentrations increase the amount of boron in the sump during a loss-of-coolant accident (LOCA). The increased boron in the sump is sufficient to maintain the core in a subcritical condition. Testing has indicated that TPBARs can experience cladding breach at Large Break LOCA (LBLOCA) conditions if the cladding temperature and internal pressure of the TPBARs reach limiting values. Consequently, the post-LOCA critical boron calculations accounted for the potential loss of a $LiAlO_2$ pencil, as well as partial leaching of lithium from the remaining pencils. Based on conservative assumptions, the calculations confirm that the tritium production core will remain subcritical following a LOCA. Also, a revised hot leg switchover time has been calculated and will be implemented in the plant emergency operating procedures (EOPs). Thus, there will be no added post-LOCA long-term cooling problems associated with boron precipitation in the core following a large break LOCA (LBLOCA).

An evaluation of the non-LOCA events shows that the accumulators do not actuate. An increase in accumulator boron concentration would have no effect on either the steam line break (SLB) at hot zero power event, the feedwater line break event, or the spurious operation of safety injection (SI) system event (events in which an SI signal does occur). Therefore, there is no increase in consequences of the non-LOCA events associated with the proposed increase in accumulator boron concentration.

The accumulators are not assumed to actuate in the steam generator tube rupture (SGTR) event analysis, and the SLB mass and energy (M&E) release evaluation relies on control rods for shutdown margin and assumes a minimum boron concentration. In addition, the increase in accumulator boron concentrations and subsequent slight decrease in containment sump and spray pH does not impact the LOCA dose evaluation since the analysis of record does not credit sump pH as an input or assumption regarding volatile iodine removal efficiencies. Therefore, the present analysis remains bounding. Also, the slight decrease in sump, core and spray fluid pH has been evaluated to not significantly impact the corrosion rate (and subsequent generation of hydrogen) of aluminum and zinc inside containment. Further, the decreased sump, core and spray fluid pH has been evaluated to not affect the amount of hydrogen generated from the post-LOCA radiolytic decomposition of the sump and core solution. The likelihood of containment failure due to hydrogen deflagration is therefore not impacted by pH changes.

In view of the preceding, it is concluded that the proposed change in accumulator boron concentration will not increase the radiological consequences of an accident previously evaluated in the UFSAR.

3. TS 3/4.5.5 - Refueling Water Storage Tank - Boron Concentration Increase

The RWST boron concentration does not affect any initiating event for accidents currently evaluated in the UFSAR. The increased concentration will not adversely affect the performance of any system or component which is placed in contact with the RWST water. The integrity and operability of the stainless steel surfaces in the RWST and affected NSSS components/systems will be maintained. The decrease in solution pH is small and will not degrade the stainless steel. Also, the integrity of the Class 1E instrumentation and control equipment will be maintained since the lower sump pH, resulting from the increased boron concentrations, is still within the applicable equipment qualification limits. These limits are set to preclude the possibility of chloride induced stress corrosion cracking and assure that there is no significant degradation of polymer materials. The design, material and construction standards of all components which are placed in contact with the RWST water remain unaffected. Therefore, the probability of an accident has not changed.

The consequences of an accident previously evaluated in the UFSAR will not be increased. The change in the RWST boron concentration increases the amount of boron in the sump following a LOCA. The increased boron in the sump is sufficient to maintain the core in a subcritical condition. Testing has indicated that TPBARs can experience cladding breach at Large Break LOCA (LBLOCA) conditions if the cladding temperature and internal pressure of the TPBARs reach limiting values. Consequently, the post-LOCA critical boron calculations accounted for the potential loss of a $LiAlO_2$ pencil, as well as partial leaching of lithium from the remaining pencils. Based on conservative assumptions, the calculations confirm that the tritium production core will remain subcritical following a LOCA. Also, a revised hot leg switchover time has been calculated and will be implemented in the plant EOPs. Thus, there will be no added post-LOCA long-term cooling problems associated with boron precipitation in the core following a LOCA.

An evaluation of the non-LOCA events indicates that an SI initiation occurs in the SLB at hot zero power event, the feedwater line break event, and the spurious operation of the SI system event. An increase in the RWST boron concentration would effectively reduce the return to power subsequent to a SLB. Boration is not credited in the feedwater line break analysis and the proposed boron increase is conservatively bounded by the boron inputs to the spurious SI system operation analysis. Therefore, there is no increase in consequences of the non-LOCA events associated with the proposed increase in RWST boron concentration.

The SLB M&E release evaluation relies on control rods for shutdown margin and assumes a minimum boron concentration. For the SGTR, the boron concentration in the accumulators and the RWST are not modeled. In addition, the increase in RWST boron concentrations and subsequent slight decrease in containment sump and spray pH does not impact the LOCA dose evaluation. While higher pH helps maintain volatile iodine in solution and lower pH drives the equilibrium to favor volatile iodine in a gaseous state, the change in sump pH is not sufficient to result in any measurable change in post-LOCA releases.

Furthermore, current radiological analyses do not take credit for volatile iodine removal efficiencies based on sump pH. Therefore, since the change in pH is minimal, and no credit is taken in release analysis, the present analysis remains bounding. Also, the slight decrease in sump, core and spray fluid pH has been evaluated to not significantly impact the corrosion rate (and subsequent generation of hydrogen) of aluminum and zinc inside containment and the present analysis remains bounding. Further, the decreased sump, core and spray fluid pH has been evaluated to not affect the amount of hydrogen generated from the radiolytic decomposition of the sump and core solution and therefore will not challenge containment integrity.

In view of the preceding, it is concluded that the proposed change in RWST boron concentration will not increase the radiological consequences of an accident previously evaluated in the UFSAR.

4. TS 3/4.7.14 and Bases - Cask Pit Pool Minimum Boron Concentration - Deletion of Requirements

This change removes the provisions that allow and support the storage of spent fuel in the cask pit pool. By eliminating this provision, the potential for criticality events associated with stored fuel in the cask pit pool is no longer credible. Not having boron concentration requirements for the cask pit for storage considerations is acceptable based on the removal of TS provisions that would allow such storage. The boron concentration requirement is not considered a contributor to accident generation and therefore, this deletion does not increase the potential for accident generation because spent fuel will not be stored in this location. Likewise, the consequences of an accident will not be increased because the dose generation source, in the form of spent fuel stored in the cask pit, will not be allowed.

5. TS 5.3.1 - Design Features/Reactor Core/Fuel Assemblies

The insertion of TPBARs into the SQN reactor core does not adversely affect reactor neutronic or thermal-hydraulic performance; therefore, they do not significantly increase the probability of accidents or equipment malfunctions while in the reactor. The neutronic behavior of the TPBARS mimics that of standard burnable absorbers with only slight differences which are accommodated in the core design. The reload safety analysis performed for SQN Units 1 and 2 prior to each refueling cycle will confirm that any minor effects of TPBARS on the reload core will be within fuel design limits.

As described in the tritium production core (TPC) topical, the TPBAR design is robust to all accident conditions except the large break LOCA (LBLOCA) where the rods are susceptible to failure. However, the failure of TPBARs has been determined to have an insignificant effect on the thermal hydraulic response of the core to this event, and analysis has shown that the core will remain subcritical following a LOCA.

The impacts of TPBARs on the radiological consequences for all evaluated events are very small, and they remain within 10 CFR 100 regulatory limits. The additional offsite doses due to tritium are small with respect to LOCA source terms and are well within regulatory limits.

The TPBAR could result in an increase in combustible gas released to the containment in a LBLOCA. This increase was found to be approximately 1495 scf which remains within the capability of the recombiners.

Analysis has shown that TPBARs are not expected to fail during Condition I through IV events with the exception of a LBLOCA and a fuel handling accident. The radiological consequences of these events are within 10 CFR 100 limits. Therefore, there is no significant increase in the consequences of these previously evaluated accidents.

6. TS 5.6 and TS 3/4.7.13 Bases - Design Features/Fuel Storage and Spent Fuel Pool Minimum Boron Concentration - Revised Storage Requirements for Fuel Assemblies Containing TPBARs

   A specified amount of soluble boron is needed in the spent fuel pool to provide margin to criticality sufficient to mitigate the effects of the most serious spent fuel pool accident condition. Previous spent fuel pool criticality safety analyses (for Type A fuel) determined the required amount of soluble boron to be 700 parts per million (ppm). The new spent fuel pool criticality safety analysis accounting for storage of Type T fuel confirmed that 700 ppm soluble boron still provides the required margin to criticality. Therefore, there is no significant increase in the consequences of previously evaluated accidents postulated for the spent fuel pool. Additionally, the administrative controls for loading the spent fuel pool are not changed and will continue to maintain acceptable storage configurations consistent with the analysis. Therefore, the proposed change will not increase the probability of an accident.

7. TPBAR Consolidation Activity

   TPBAR consolidation and associated handling activities are designed to be consistent with the existing fuel handling and heavy load handling processes and equipment currently utilized at the facility, and are designed to preclude increased probability of an accident previously evaluated.

   Consequences of a fuel handling accident for fuel containing TPBARs is evaluated and does not result in exceeding 10 CFR Part 100 limits for off-site dose. All consolidation and heavy load handling activities are designed such that the current fuel handling accident scenario remains bounding. Therefore the consequences of an accident previously evaluated remains within acceptable limits.

B. **<u>The proposed amendment does not create the possibility of a new or different kind of accident from any accident previously evaluated.</u>**

1. TS Table 3.3-9 - Remote Shutdown Monitoring Instrumentation - Revised Source Range Monitor Range

   The backup source range monitors are for indication of unit shutdown conditions only and do not perform any trip or mitigation functions. The monitors are not active components such that they could initiate a postulated accident and are not considered a contributor to accident generation. Therefore, the lowering of the indication range for this monitor will not create the possibility of a new or different kind of accident.

2. TS 3/4.5.1 - Cold Leg Injection Accumulators - Boron Concentration Increase

   The change to the accumulator concentration does not cause the initiation of any accident nor create any new credible limiting single failure. The change does not result in a condition where the design, material, and construction standards of the accumulators and other potentially affected NSSS components, that were applicable prior to the changes, are altered. The integrity and operability of the stainless steel surfaces in the accumulator and affected NSSS components/systems will be maintained. The decrease in solution pH is small and will not degrade the stainless steel. Also, the integrity of the Class 1E instrumentation and control equipment will be maintained during a LOCA since the lower sump pH, resulting from the increased boron concentrations, is still within the applicable equipment qualification limits. These limits are set to preclude the possibility of chloride induced stress corrosion cracking and assure that there is no significant degradation of polymer materials.

   The changes in the concentrations increase the amount of boron in the sump following a LOCA. The increased boron in the sump is sufficient to maintain the core in a subcritical condition. Also, a revised hot leg switchover time has been calculated and will be implemented in the plant EOPs. Thus, there will be no boron precipitation in the core following a LOCA.

   All systems, structures, and components previously required for the mitigation of an event remain capable of fulfilling their intended design function. The proposed change has no adverse affect on any safety-related system or component and does not challenge the performance or integrity of any safety related system. Therefore, the proposed increase in accumulator boron concentration does not create the possibility of a new or different kind of accident from any accident previously evaluated.

3. TS 3/4.5.5 - Refueling Water Storage Tank - Boron Concentration Increase

   The change to the RWST concentration does not cause the initiation of any accident nor create any new credible limiting single failure. The change does not result in a condition where the design, material, and construction standards of the RWST and other potentially affected NSSS components, that were applicable prior to the changes, are altered. The integrity and operability of the stainless steel surfaces in the RWST and affected NSSS components/systems will be maintained. The decrease in solution pH is small and will not degrade the stainless steel. Also, the integrity of the Class 1E instrumentation and control equipment will be maintained during a LOCA since the lower sump pH, resulting from the increased boron concentrations, is still within the applicable equipment qualification limits. These limits are set to preclude the possibility of chloride induced stress corrosion cracking and assure that there is no significant degradation of polymer materials.

   The changes in the concentrations increase the amount of boron in the sump following a LOCA. The increased boron in the sump is sufficient to maintain the core in a subcritical condition. Also, a revised hot leg switchover time has been calculated and will be implemented in the plant EOPs. Thus, there will be no boron precipitation in the core following a LOCA.

   All systems, structures, and components previously required for the mitigation of an event remain capable of fulfilling their intended design function. The proposed change has no adverse affect on any safety-related system or component and does not challenge the performance or integrity of any safety related system. Therefore, the proposed increase in RWST boron concentration does not create the possibility of a new or different kind of accident from any accident previously evaluated.

4. TS 3/4.7.14 and Bases - Cask Pit Pool Minimum Boron Concentration - Deletion of Requirements

   This change removes the provisions that allow and support the storage of spent fuel in the cask pit pool. By eliminating this provision, the potential for criticality events associated with stored fuel in the cask pit pool is no longer credible. The boron concentration requirement for the cask pit pool is not considered a contributor to accident generation and therefore, this deletion does not increase the potential for accident generation because spent fuel will not be stored in this location.

5. TS 5.3.1 - Design Features/Reactor Core/Fuel Assemblies

   TPBARS have been designed to be compatible with existing fuel assemblies supplied by Framatome-ANP and its predecessor Framatome Cogema Fuels and with conventional Burnable Poison Rod Assembly (BPRA) handling tools, equipment, and procedures. Therefore, no new accidents or equipment malfunctions are created by the handling of TPBARs. Consolidation activities are discussed separately in Enclosure 5.

   TPBARs use materials with known and predictable performance characteristics and are compatible with pressurized water reactor coolant. The TPBAR design has specifically included material similar to those used in standard burnable absorber rods with the exception of internal assemblies used in the production and retention of tritium. As described in the TPC Topical Report, these materials are compatible with the reactor coolant system (RCS) and core design. Therefore, no new accidents or equipment malfunctions are created by the presence of the TPBARs in the RCS.

   Mechanical design criteria have been established to ensure that TPBARs will not fail during Condition I or II events. Analysis has shown that TPBARs, appropriately positioned in the core, operate within the established thermal-hydraulic criteria. Due to the expected high reliability of TPBAR components, the frequency of TPBAR cladding failures is very small, such that multiple adjacent TPBAR failures in limiting locations is not considered credible. In addition, analysis has shown that if a single TPBAR fails catastrophically in a high power location during normal operation and the lithium is leached out, the global reactivity increase is negligible and the local power peaking is small enough that DNBR limits and fuel rod integrity are not challenged. Therefore, no new accidents or equipment malfunctions are created by the presence of the TPBARs in the reactor.

Analysis has shown that TPBARs will not fail during Condition III and IV events with the exception of a LBLOCA and a fuel handling accident. The radiological consequences of these events are within 10 CFR 100 limits. Therefore, there is no significant increase in consequences of these previously evaluated accidents.

TPBARs do not adversely affect reactor neutronic, thermal-hydraulic performance, therefore they do not create the possibility of accidents or equipment malfunctions of a different type than previously evaluated while in the reactor.

6. TS 5.6 and TS 3/4.7.13 Bases - Design Features/Fuel Storage and Spent Fuel Pool Minimum Boron Concentration - Revised Storage Requirements for Fuel Assemblies Containing TPBARs

   The storage in the spent fuel pool of spent fuel that has contained TPBARs is not a fundamental change in the use of the spent fuel pool. Specific provisions have been made for burnup and cooling time requirements in allowable configurations to ensure safe storage. The same administrative program to control storage requirements in the spent fuel pool will be utilized to handle Type A and Type T spent fuel. Therefore, the possibility of a new or different accident than previously evaluated has not been created.

7. TPBAR Consolidation Activity

   The consolidation and handling systems are designed to preclude the possibility of a consolidating and/or handling event which could damage more than 24 TPBARs. Therefore, this proposed amendment does not create the possibility of a new or different kind of accident from any previously evaluated.

C. <u>The proposed amendment does not involve a significant reduction in a margin of safety.</u>

1. TS Table 3.3-9 - Remote Shutdown Monitoring Instrumentation - Revised Source Range Monitor Range

   The backup source range monitors are for indication of unit shutdown conditions only and do not perform any trip or mitigation functions. The lowering of the monitor's range does allow improved indication of core conditions with the TPCs. While this monitor does not have any trip or accident mitigation functions, this change will improve the ability to assess the conditions of the unit such that necessary actions can be initiated to prevent undesired conditions. Therefore, the proposed change will not reduce a margin of safety.

2. TS 3/4.5.1 - Cold Leg Injection Accumulators - Boron Concentration Increase

   The change does not invalidate any of the non-LOCA safety analysis results or conclusions, and all of the non-LOCA safety analysis acceptance criteria continue to be met. The licensing basis small break LOCA (SBLOCA) analysis does not credit the accumulator boron and is not affected by the proposed change. Therefore, there is no reduction in the margin to the peak clad temperature (PCT) limit for the SBLOCA. There is no increase in the LBLOCA PCT; therefore, the ECCS acceptance criteria limit, dictated by 10 CFR 50.46, is not exceeded with regard to the LBLOCA analysis. The increased boron concentration is sufficient to maintain subcriticality during the LBLOCA, and a post-LOCA long-term core cooling analysis demonstrated that the post-LOCA sump boron concentration is sufficient to prevent recriticality. The revised hot leg switchover time, which will be implemented in the EOPs, will prevent long-term cooling problems associated with boron precipitation in the reactor vessel and core. The licensing analyses for containment, equipment qualification, and environmental consequences remain bounding and applicable and the acceptance criteria of the related events continue to be met. The proposed increase in accumulator boron concentration, therefore, does not involve a significant reduction in a margin of safety.

3. TS 3/4.5.5 - Refueling Water Storage Tank - Boron Concentration Increase

   The change does not invalidate any of the non-LOCA safety analysis results or conclusions, and all of the non-LOCA safety analysis acceptance criteria continue to be met. The licensing basis SBLOCA analysis does not credit the RWST boron and is not affected by the proposed change. Therefore, there is no reduction in the margin to the PCT limit for the SBLOCA. There is no increase in the LBLOCA PCT; therefore, the ECCS acceptance criteria limit, dictated by 10 CFR 50.46, is not exceeded with regard to the LBLOCA analysis. The increased boron concentration is sufficient to prevent recriticality. The revised hot leg switchover time, which will be implemented in the EOPs, will prevent boron precipitation. The licensing analyses for containment, equipment qualification, and environmental consequences remain bounding and applicable and the acceptance criteria of the related events continue to be met. The proposed increase in RWST boron concentration, therefore, does not involve a significant reduction in a margin of safety.

4. TS 3/4.7.14 and Bases - Cask Pit Pool Minimum Boron Concentration - Deletion of Requirements

   This change removes the provisions that allow and support the storage of spent fuel in the cask pit pool. This change will not alter plant systems, operating methods, or plant setpoints that maintain the margin of safety. Boron concentration will continue to be properly maintained for the storage of spent fuel in the spent fuel pool as required by the analysis to control inadvertent criticality events. Therefore, this change will not reduce the margin of safety.

5. TS 5.3.1 - Design Features/Reactor Core/Fuel Assemblies

   TPBARs have been designed to be compatible with existing fuel assemblies. TPBARs do not adversely affect reactor neutronic or thermal-hydraulic performance. Analysis indicates that reactor core behavior and offsite doses remain relatively unchanged. For these reasons, the proposed amendment does not involve a significant reduction in a margin of safety.

6. TS 5.6 and TS 3/4.7.13 Bases - Design Features/Fuel Storage and Spent Fuel Pool Minimum Boron Concentration - Revised Storage Requirements for Fuel Assemblies Containing TPBARs

   Addition of fuel assemblies containing TPBARs to the spent fuel pool is consistent with the pool design function. Specific provisions have been made as a result of reanalysis of spent fuel pool criticality safety analysis to limit storage configurations and burnup or cooling time requirements to those that will provide for safe storage of fresh and spent fuel. Therefore, the proposed amendment does not involve a significant reduction in a margin of safety.

7. TPBAR Consolidation Activity

The changes do not affect the safety-related performance of any plant operations, system, structures, or components. Therefore, there is no significant reduction in the margin of safety.

V. **ENVIRONMENTAL IMPACT CONSIDERATION**

The environmental impacts of producing tritium in TVA's Sequoyah Units 1 and 2 were assessed in a 1999, "Final Environmental Impact Statement (EIS) for the Production of Tritium in a Commercial Light Water Reactor," (DOE/EIS-0288) prepared by the Department of Energy. TVA was a cooperating agency in the preparation of this EIS. In accordance with 40 CFR 1506.3(c) of the Council on Environmental Quality regulations, TVA independently reviewed the EIS prepared by DOE, found it to be adequate, and adopted the EIS. TVA's, "Record of Decision and Adoption of the Final Environmental Impact Statement for the Production of Tritium in a Commercial Light Water Reactor," was published in the Federal Register at 65 Federal Register 26259 (May 5, 2000). As part of the process of developing this Tritium Program license amendment request, TVA conducted a contemporaneous review of the DOE EIS and TVA's Record of Decision, focusing on any changes in radiological impacts associated with the program. That review determined that there were no substantial changes in the Tritium Program since the publication of the 1999 EIS that were relevant to new circumstances or information relevant to environmental concerns which were bearing on the tritium program or its impacts.

ENCLOSURE 2

TENNESSEE VALLEY AUTHORITY
SEQUOYAH NUCLEAR PLANT (SQN)
UNITS 1 AND 2
DOCKET NO. 327, 328

PROPOSED TECHNICAL SPECIFICATION (TS) CHANGE
MARKED PAGES

I. AFFECTED PAGE LIST

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II. MARKED PAGES

See attached

LIMITING CONDITIONS FOR OPERATION AND SURVEILLANCE REQUIREMENTS

BASES

SECTION | PAGE

DESIGN FEATURES

TABLE 3.3-9

REMOTE SHUTDOWN MONITORING INSTRUMENTATION

	INSTRUMENT	READOUT LOCATION	MEASUREMENT RANGE	MINIMUM CHANNELS OPERABLE
1.	Source Range Nuclear Flux	NOTE 1	~~1 to 1 x 10^6~~ cps Ý ***0.1 to 1 x 10^5***	1
2.	Reactor Trip Breaker Indication	at trip switchgear	OPEN-CLOSE	1/trip breaker
3.	Reactor Coolant Temperature - Hot Leg	NOTE 1	0-650°F	1/loop
4.	Pressurizer Pressure	NOTE 1	0-3000 psig	1
5.	Pressurizer Leve1	NOTE 1	0-100%	1
6.	Steam Generator Pressure	NOTE 1	0-1200 psig	1/steam generator
7.	Steam Generator Leve1	NOTE 2 or near Auxilary F. W. Pump	0-100%	1/steam generator
8.	Deleted			
9.	RHR Flow Rate	NOTE 1	0-4500 gpm	1
10.	RHR Temperature	NOTE 1	50-400°F	1
11.	Auxiliary Feedwater Flow Rate	NOTE 1	0-440 gpm	1/steam generator

3/4.5 EMERGENCY CORE COOLING SYSTEMS (ECCS)

3/4.5.1 ACCUMULATORS

COLD LEG INJECTION ACCUMULATORS

LIMITING CONDITION FOR OPERATION

3.5.1.1 Each cold leg injection accumulator shall be OPERABLE with:

a. The isolation valve open,

b. A contained ~~borated~~ water volume of between 7615 and 7960 gallons of borated water,

c. Between ~~2400~~ **3500** and ~~2700~~ **3800** ppm of boron,

d. A nitrogen cover-pressure of between 624 and 668 psig, and

e. Power removed from isolation valve when RCS pressure is above 2000 psig.

APPLICABILITY: MODES 1, 2 and 3.*

ACTION:

a. With one cold leg injection accumulator inoperable, except as a result of boron concentration not within limits, restore the inoperable accumulator to OPERABLE status within one hour or be in at least HOT STANDBY within the next 6 hours and reduce pressurizer pressure to 1000 psig or less within the following 6 hours.

b. With one cold leg injection accumulator inoperable due to the boron concentration not within limits, restore boron concentration to within limits within 72 hours or be in at least HOT STANDBY within the next 6 hours and reduce pressurizer pressure to 1000 psig or less within the following 6 hours.

---

*Pressurizer pressure above 1000 psig.

3/4.5.5 REFUELING WATER STORAGE TANK

LIMITING CONDITION FOR OPERATION

3.5.5 The refueling water storage tank (RWST) shall be OPERABLE with:

a. A contained borated water volume of between 370,000 and 375,000 gallons,

b. A boron concentration of between ~~2500~~ **3600** and ~~2700~~ **3800** ppm of boron,

c. A minimum solution temperature of 60°F, and

d. A maximum solution temperature of 105°F.

APPLICABILITY: MODES 1, 2, 3 and 4.

ACTION:

With the RWST inoperable, restore the tank to OPERABLE status within 1 hour or be in at least HOT STANDBY within 6 hours and in COLD SHUTDOWN within the following 30 hours.

SURVEILLANCE REQUIREMENTS

4.5.5 The RWST shall be demonstrated OPERABLE:

a. At least once per 7 days by:

1. Verifying the contained borated water volume in the tank, and

2. Verifying the boron concentration of the water.

b. At least once per 24 hours by verifying the RWST temperature.

[This page deleted]

3/4.7.14 CASK PIT POOL MINIMUM BORON CONCENTRATION

LIMITING CONDITION FOR OPERATION

3.7.14 The cask pit pool boron concentration shall be ≥ 2000 ppm.

APPLICABILITY: Whenever fuel assemblies are stored in the cask pit rack.

ACTION:

a. With the requirements of the specification not satisfied, suspend all movement of fuel assemblies and initiate action to restore cask pit pool boron concentration to within limit. The provisions of Specification 3.0.3 are not applicable.

SURVEILLANCE REQUIREMENTS

4.7.14.1 Verify at least once per 7 days the cask pit pool boron concentration is within limit.

4.7.14.2 Verify at least once per 72 hours during fuel movement the cask pit pool boron concentration is within limit and until the configuration of the assemblies in the storage rack is verified to comply with the criticality loading criteria specified in Design Feature 5.6.1.1.d.

5.3 REACTOR CORE

FUEL ASSEMBLIES

5.3.1 The reactor shall contain 193 fuel assemblies. Each assembly shall consist of a matrix of zircaloy or M5 clad fuel rods with an initial composition of natural or slightly enriched uranium dioxide as fuel material. Limited substitutions of zirconium alloy or stainless steel filler rods for fuel rods, in accordance with NRC-approved applications of fuel rod configurations, may be used. Fuel assemblies shall be limited to those fuel designs that have been analyzed with applicable NRC staff-approved codes and methods, and shown by tests or analyses to comply with all fuel safety design bases. A limited number of lead test assemblies that have not completed representative testing may be placed in nonlimiting core regions. Sequoyah is authorized to place a limited number of lead test assemblies into the reactor as described in the Framatome-Cogema Fuels report BAW-2328, beginning with the Unit 1 Operating Cycle 12.

Insert

CONTROL ROD ASSEMBLIES

5.3.2 The reactor core shall contain 53 full length and no part length control rod assemblies. The full length control rod assemblies shall contain a nominal 142 inches of absorber material. The nominal values of absorber material shall be 80 percent silver, 15 percent indium and 5 percent cadmium. All control rods shall be clad with stainless steel tubing.

5.4 REACTOR COOLANT SYSTEM

DESIGN PRESSURE AND TEMPERATURE

5.4.1 The reactor coolant system is designed and shall be maintained:

a. In accordance with the code requirements specified in Section 5.2 of the FSAR, with allowance for normal degradation pursuant to the applicable Surveillance Requirements,

b. For a pressure of 2485 psig, and

c. For a temperature of 650°F, except for the pressurizer which is 680°F.

VOLUME

5.4.2 The total water and steam volume of the reactor coolant system is 12,612 $\pm$ 100 cubic feet at a nominal T_{avg} of 525°F.

5.5 METEOROLOGICAL TOWER LOCATION

5.5.1 The meteorological tower shall be located as shown on Figure 5.1-1.

Sequoyah is authorized to place a maximum of 2256 Tritium Producing Burnable Absorber Rods into the reactor in an operating cycle.

5.6 FUEL STORAGE

CRITICALITY - SPENT FUEL

[Insert 1]

5.6.1.1 The spent fuel storage racks are designed for fuel enriched to 5 weight percent U-235 and shall be maintained with:

a. A k_{eff} less than critical when flooded with unborated water and a k_{eff} less than or equal to 0.95 when flooded with water containing 300 ppm soluble boron.*

b. A nominal 8.972 inch center-to-center distance between fuel assemblies placed in the storage racks.

c. Arrangements of one or more of three different arrays (Regions) or sub-arrays as illustrated in Figures 5.6-1 and 5.6-1a. These arrangements in the spent fuel storage pool have the following definitions:

Type A

1. Region 1 is designed to accommodate new fuel with a maximum enrichment of 4.95 ± 0.05 wt% U-235, (or spent fuel regardless of the fuel burnup), in a 1-in-4 checkerboard arrangement of ~~1 fresh assembly~~ with 3 spent fuel assemblies with enrichment-burnup and cooling times illustrated in Figure 5.6-2 and defined by the equations ~~in Table 5.6-1. Cooling time is defined as the period since reactor shutdown at the end of the last operating cycle for the discharged spent fuel assembly.~~ The presence of a removable, non-fissile insert such as a burnable poison rod assembly (BPRA) or either gadolinia or integral fuel burnable absorber (IFBA) in a fresh fuel assembly does not affect the applicability of Figure 5.6-2 or Table 5.6-1.

   Two alternative storage arrays (or sub-arrays) are acceptable in Region 1 if the fresh fuel assemblies contain rods with either gadolinia or integral fuel burnable absorber (IFBA). For these types of assemblies, the minimum burnup of the spent fuel in the 1-of-4 sub-array are defined by the equations in Table 5.6-2.

Restrictions in Region 1

Any of the three sub-arrays illustrated in Figure 5.6-1a may be used in any combination provided that:

~~1~~ ***A***) Each sub-array of 4 fuel assemblies includes, in addition to the fresh fuel assembly, 3 assemblies with enrichment and minimum burnup requirements defined by the equations in Tables 5.6-1 and 5.6-2, as appropriate.

~~2~~ ***B***) The arrangement of Region 1 sub-arrays must not allow a configuration with fresh assemblies adjacent to each other.

~~3~~ ***C***) If Region 1 arrays are used in conjunction with ~~Region 2~~ ⇑ ***3*** or Region ~~3~~ ⇑ ***4*** arrangements (see below), the arrangements shall not allow fresh fuel assemblies to be adjacent to each other (see also Figure 5.6-1).

*For some accident conditions, the presence of dissolved boron in the pool water may be taken into account by applying the double contingency principle which requires two unlikely, independent, concurrent events to produce a criticality accident.

Insert 1

For convenience of reference, the following definitions apply:

Type A fuel refers to spent fuel assemblies which have not contained tritium producing burnable absorber rods (TPBAR's) during in-core operations.

Type T fuel refers to spent fuel assemblies which have contained tritium producing burnable absorber rods (TPBAR's) during in-core operations.

Fresh fuel refers to unirradiated Type A or Type T fuel or irradiated Type A or Type T fuel that has not attained sufficient burnup to meet spent fuel requirements.

Cooling time is defined as the period since reactor shutdown at the end of the last operating cycle for the discharged spent fuel assembly.

5.6 FUEL STORAGE

[Insert 2]

2. Region 2 is designed to accommodate ***[Insert 3]*** fuel of 4.95±0.05 wt% U-235 initial enrichment burned to at least 30.27 ***[Insert 4]*** MWD/KgU (assembly average), or fuel of other enrichments with a burnup yielding an equivalent reactivity in the fuel racks. The minimum required assembly average burnup in MWD/KgU and cooling time is given by the equations in Table 5.6-3 ***[Insert 5]*** ~~in terms of E, where E is the initial enrichment in the axial zone of highest enrichment (wt% U-235)~~. The minimum required burnups are illustrated in Figure 5.6-3 ***[Insert 5]*** in terms of the initial enrichment and cooling time.

Restrictions in Region 2

The following restrictions apply to the storage of spent fuel in the Region 2 cells:

~~1~~ ***A***) The spent fuel shall conform to the minimum burnup requirements defined by the equations in Table 5.6-3 ***[Insert 6]***. Linear interpolation between cooling times may be made if desired.

~~2~~ ***B***) For the interface with Region 1 ***[Insert 7]***storage cells, fresh fuel in Region 1 ***[Insert 7]***shall not be stored adjacent to spent fuel assemblies in the Region 2 storage cells.

[Insert 8]

3. Region 3 is designed to accommodate fuel of 4.95±0.05 wt% U-235 initial enrichment (or fuel assemblies of any lower reactivity) in a 2-out-of-4 checkerboard arrangement with water-filled cells. The water-filled cells shall not contain any components bearing any fissile material, but may accommodate miscellaneous items or equipment.

Restrictions in Region 3

[Insert 9] ***3*** ***1 or 4***

~~1~~ ***A***) For the interface between Region ~~1~~ ⇑ and Region ~~3~~ ⇑ storage regions, fresh fuel assemblies shall not be stored adjacent to each other.

non-fissile bearing

~~2~~ ***B***) If miscellaneous ⇑ items or equipment are stored in the water cells of Region 3, the total volume of the miscellaneous items shall be no more than 75% of the storage cell volume.

loose

~~3~~ ***C***) No ⇑ fuel rods~~, assemblies,~~ or items containing fissile material shall be stored in the water cells of Region 3.

[Insert 10]

~~An empty cell is less reactive than any cell containing fuel and therefore may be used as a Region 1, Region 2, or Region 3 cell in any arrangement.~~

~~d. Region 2 array described above may be used in the 15 x 15 storage rack module in the cask loading area of the cask pit.~~

~~[Insert 11]~~

e. A nominal concentration of 2000 ppm boron ***is*** ~~in~~ the pool water. This concentration of soluble boron provides a margin sufficient to allow timely detection of a boron dilution accident and corrective action before the minimum concentration (700 ppm) required to protect against the most severe postulated fuel handling accident or before the minimum concentration (300 ppm) required to maintain the storage configuration design basis (k_{eff} less than 0.95) is reached.

Insert 2

D) If miscellaneous non-fissile bearing items or equipment are stored in cells of Region 1, the total volume of the miscellaneous items shall be no more than 75% of the total storage cell volume.

Insert 3

Type A or Type T

Insert 4

(Type A) or 33.1095 (Type T)

Insert 5

(Type A) or 5.6-4 (Type T)

Insert 6

or 5.6-4, as appropriate

Insert 7

or 4

Insert 8

C) If miscellaneous non-fissile bearing items or equipment are stored in cells of Region 2, the total volume of the miscellaneous items shall be no more than 75% of the total storage cell volume.

Insert 9

The following restrictions apply to the storage of fuel in the Region 3 cells:

Insert 10

4. Region 4 is designed to accommodate fresh fuel with a maximum enrichment of 4.95 ± 0.05 wt% U-235 (or spent fuel regardless of the fuel burnup), in a 1-in-4 checkerboard arrangement of 1 fresh assembly with three Type T spent fuel assemblies having burnup and cooling times illustrated in Figure 5.6-5 and defined by the equations in Table 5.6-5. The presence of either gadolinia or integral fuel burnable absorber (IFBA) in a fresh fuel assembly does not affect the applicability of Figure 5.6-5 or Table 5.6-5.

Insert 10 continued

One alternative storage array (or sub-array) is acceptable in Region 4 if the fresh fuel contains rods with gadolinia fuel burnable absorber. For these types of assemblies, the minimum burnup of the spent fuel in the 1-of-4 sub-array is defined by the equations in Table 5.6-6 and illustrated in Figure 5.6-6. For fresh assemblies containing more than eight (8) gadolinia bearing fuel rods, the limiting burnup for eight (8) gadolinia rods shall apply.

Restrictions in Region 4

Any of the two sub-arrays illustrated in Figure 5.6-1a applying to Region 4 storage may be used in any combination provided that:

A) Each sub-array of 4 fuel assemblies includes, in addition to the fresh fuel assembly, 3 assemblies with enrichment and minimum burnup requirements defined by the equations in Tables 5.6-5 and 5.6-6, as appropriate.

B) The arrangement of Region 4 sub-arrays must not allow a configuration with fresh assemblies adjacent to each other.

C) If Region 4 arrays are used in conjunction with Region 1 or 3 arrangements, the arrangements shall not allow fresh fuel assemblies to be adjacent to each other (see Figure 5.6-1)

D) If miscellaneous non-fissile bearing items or equipment are stored in cells of Region 4, the total volume of the miscellaneous items shall be no more than 75% of the total storage cell volume.

Insert 11

d. An empty cell (or a cell containing non-fissile bearing miscellaneous items displacing no more than 75% of the storage cell volume) is less reactive than any cell containing fuel and therefore may be used as a Region 1, 2, 3, or 4 cell in any arrangement.

5.6 FUEL STORAGE

CRITICALITY - NEW FUEL

5.6-7

5.6.1.2 The new fuel pit storage racks are designed for fuel enriched to 5.0 weight percent U-235 and shall be maintained with the arrangement of 146 storage locations shown in Figure ~~5.6-4~~. The cells shown as empty cells in Figure ~~5.6-4~~ shall have physical barriers installed to ensure that inadvertant loading of fuel assemblies into these locations does not occur. This configuration ensures k_{eff} will remain less than or equal to 0.95 when flooded with unborated water and less than or equal to 0.98 under optimum moderation conditions.

DRAINAGE

5.6.2 The spent fuel pit is designed and shall be maintained to prevent inadvertent draining of the pool below elevation 722 ft.

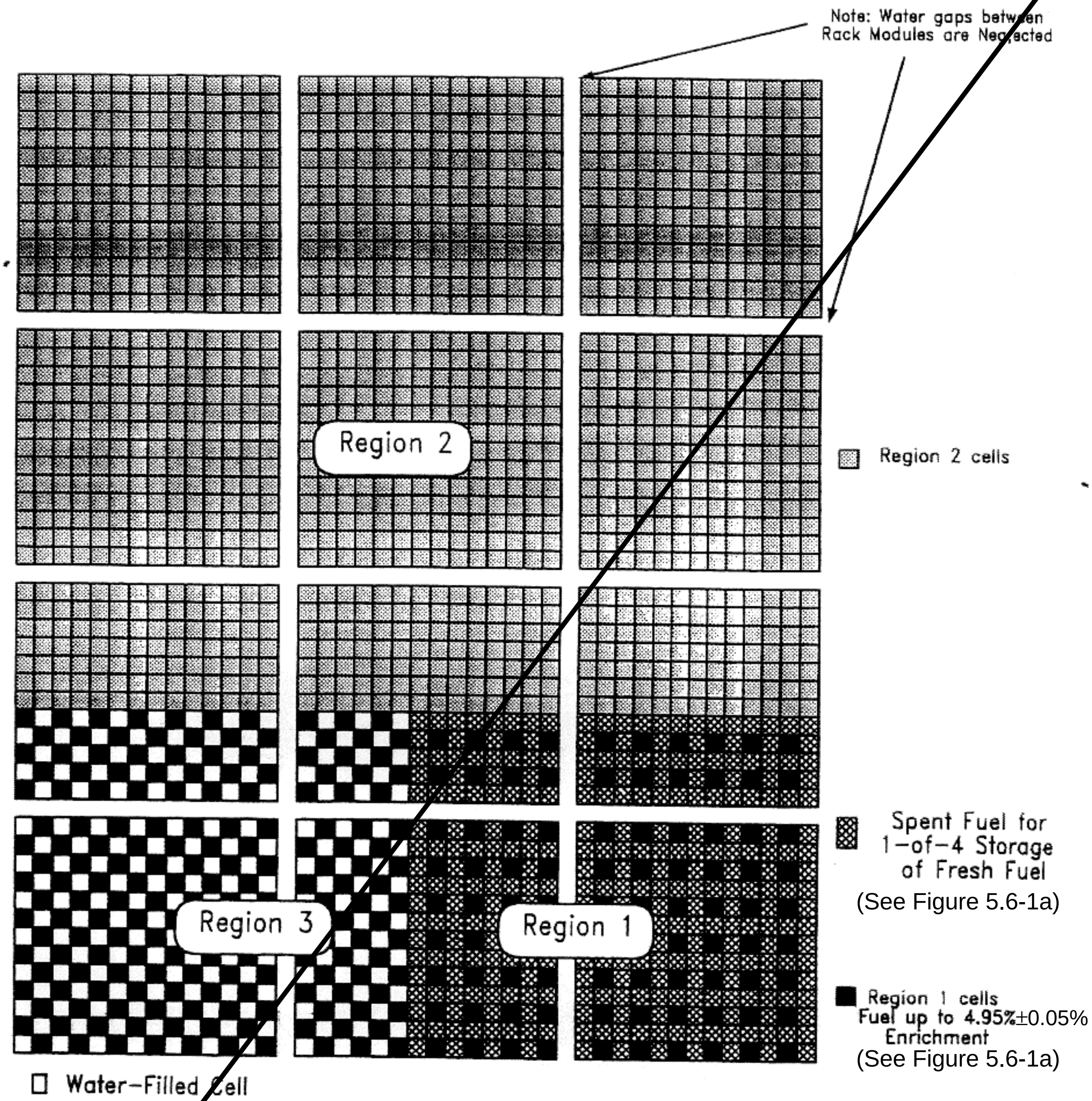
CAPACITY

5.6.3 The spent fuel storage pool is designed and shall be maintained with a storage capacity limited to no more than 2091 fuel assemblies. ~~In addition, no more than 225 fuel assemblies will be stored in a rack module in the cask loading area of the cask pit.~~

5.7 COMPONENT CYCLIC OR TRANSIENT LIMIT

5.7.1 The components identified in Table 5.7-1 are designed and shall be maintained within the cyclic or transient limits of Table 5.7-1.

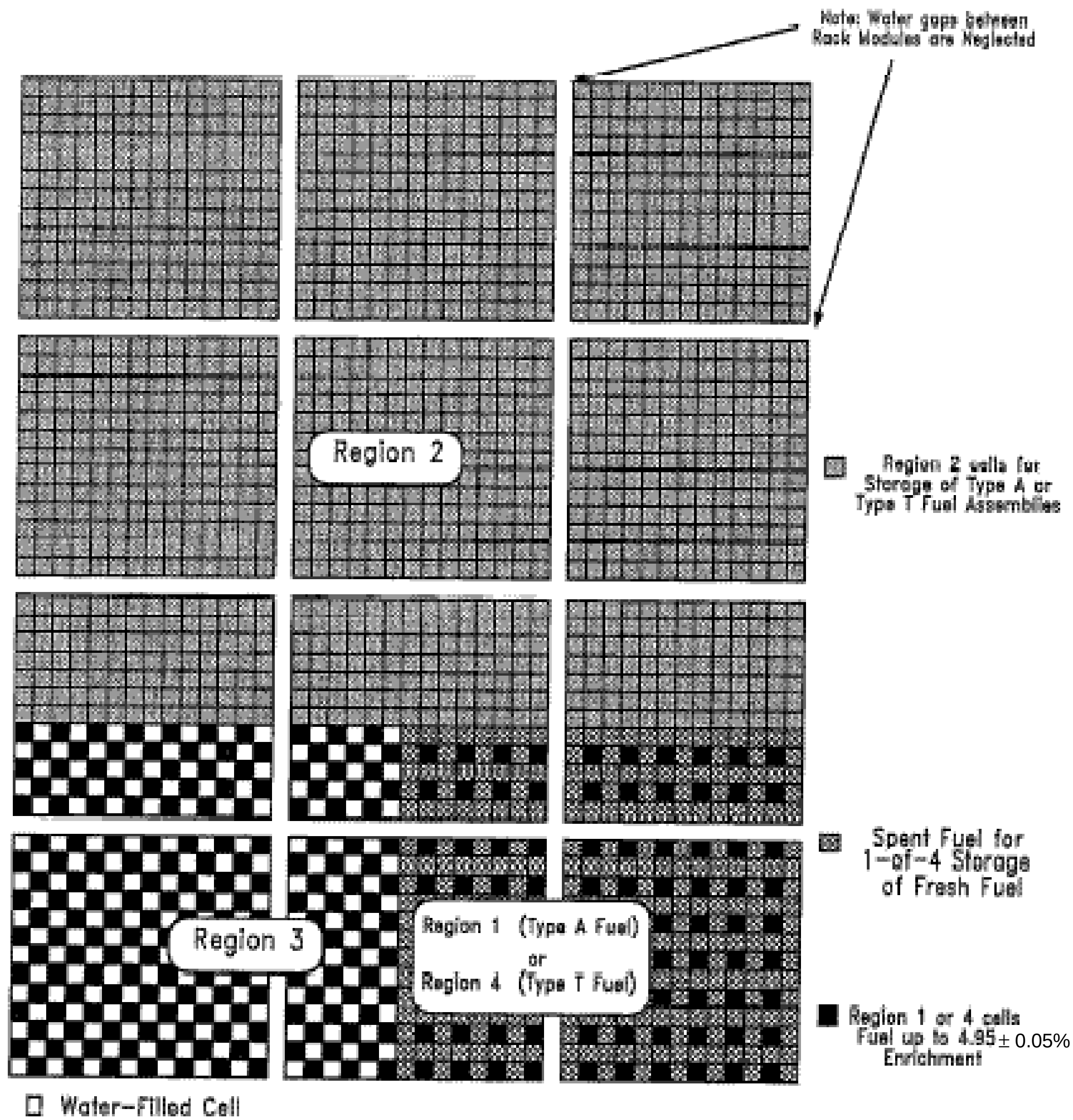
[Replace with Insert 12]



Note: The edges of the sketch above are not necessarily the edges of the pool. The Regions may appear anywhere in the pool and in any orientation, subject to the restriction in Design Feature 5.6.1.1.c.

Figure 5.6-1
Arrangements of Fuel Storage Regions in the Sequoyah Spent Fuel Storage Pool

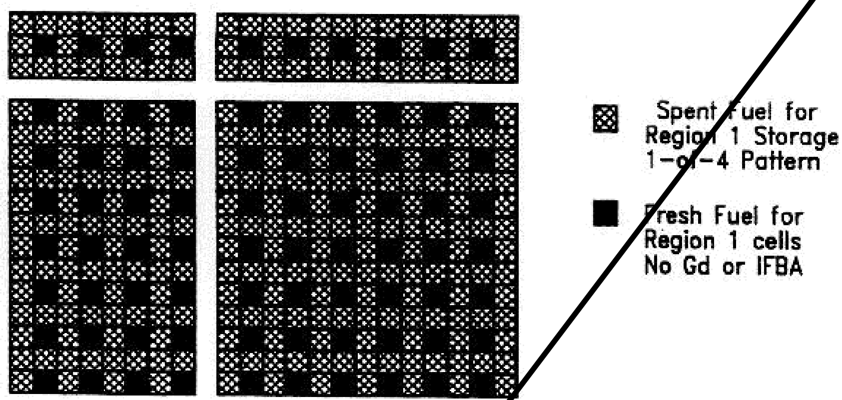
Insert 12



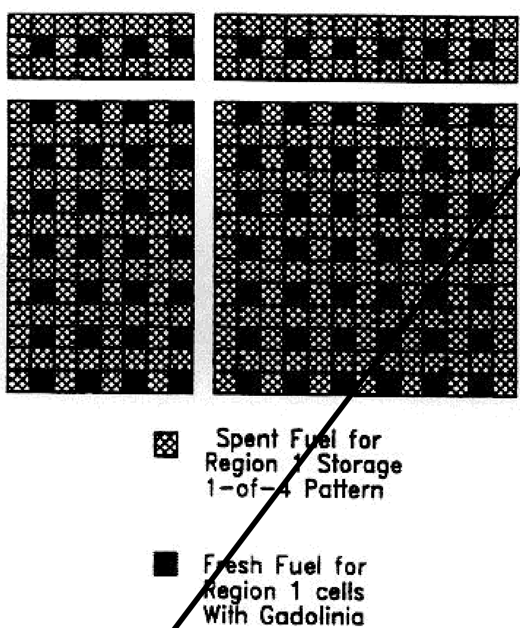
Note: The edges of the sketch above are not necessarily the edges of the pool. The Regions may appear anywhere in the pool and in any orientation, subject to the restrictions in Design Features 5.6.1.1.c.

FIG 5.6-1 Arrangements of Fuel Storage Regions in the Sequoyah Spent Fuel Storage Pool

[Replace with Insert 13]



NOTE: WHEN CREDIT IS TAKEN FOR GADOLINIA OR IFBA RODS IN FRESH ASSEMBLIES THE SPENT FUEL ASSEMBLIES NEED NOT HAVE CONTAINED GADOLINIA OR IFBA RODS..



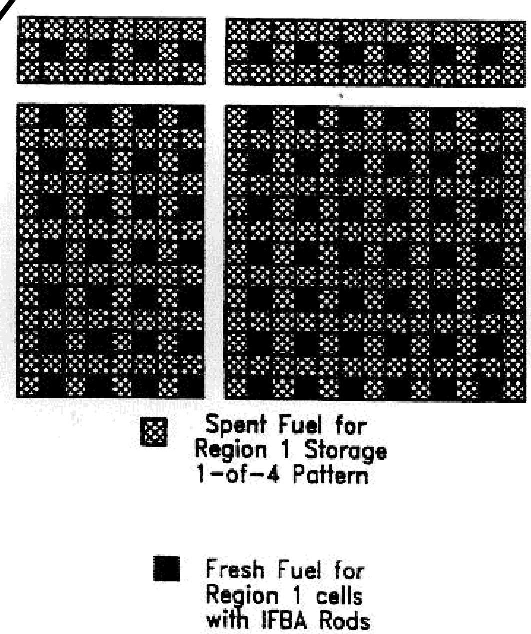
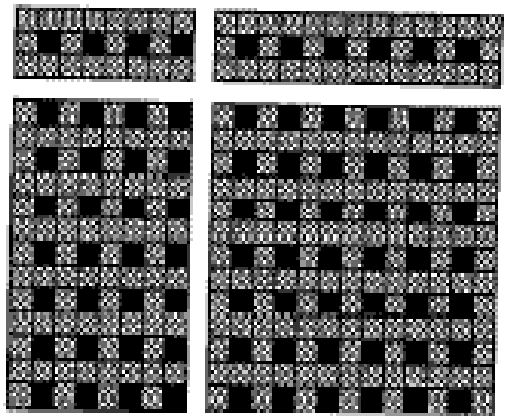
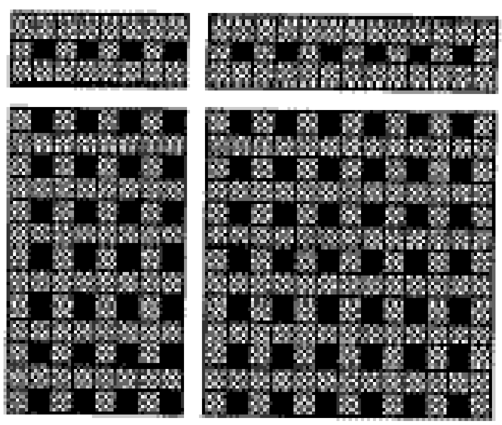


Figure 5.6-1a
Acceptable Spent Fuel Pool Loading Patterns for Checkerboard Storage of Fresh and Spent Fuel Assemblies - Example

Insert 13



NOTE: WHEN CREDIT IS TAKEN FOR GADOLINIA RODS IN FRESH ASSEMBLIES THE SPENT FUEL ASSEMBLIES NEED NOT HAVE CONTAINED GADOLINIA RODS..



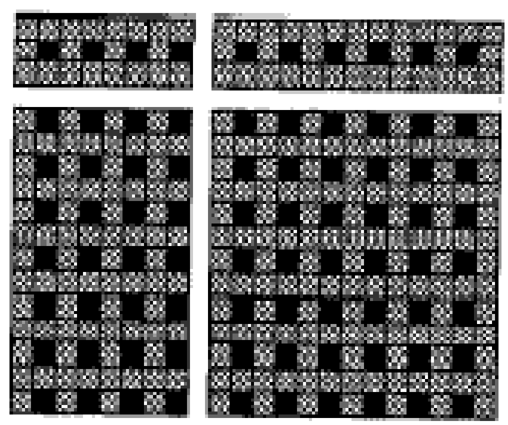


Fig. 5.6-1a Acceptable Storage Patterns for Checkerboard Storage of Fresh and Spent Fuel Assemblies in Region 1 or Region 4 – Example

for Type A Fuel

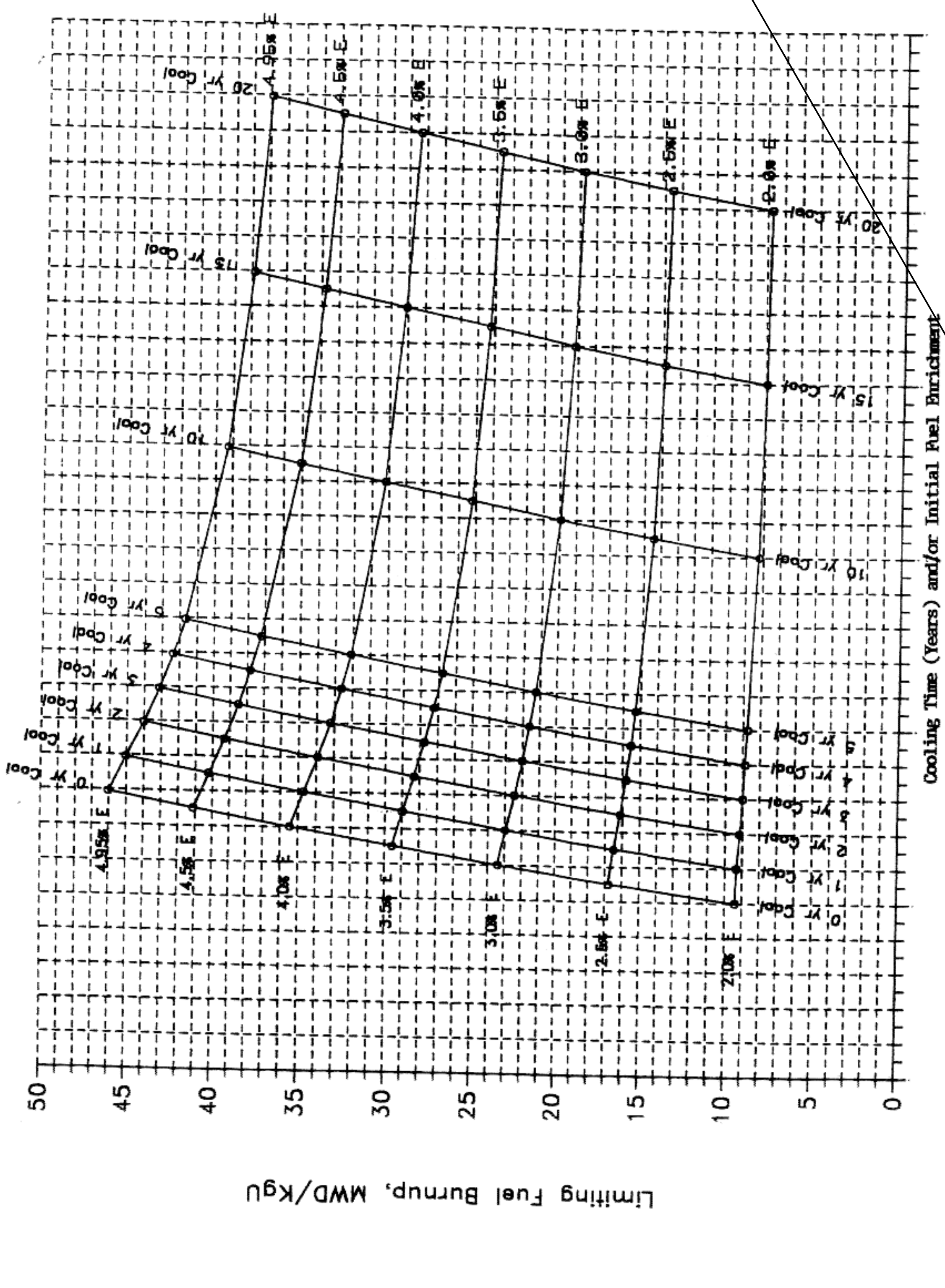


Fig. 5.6-2 3-Dimensional Plot of Minimum Fuel Burnups in Region 1 for Enrichments and/or Cooling Times

For Type A Fuel

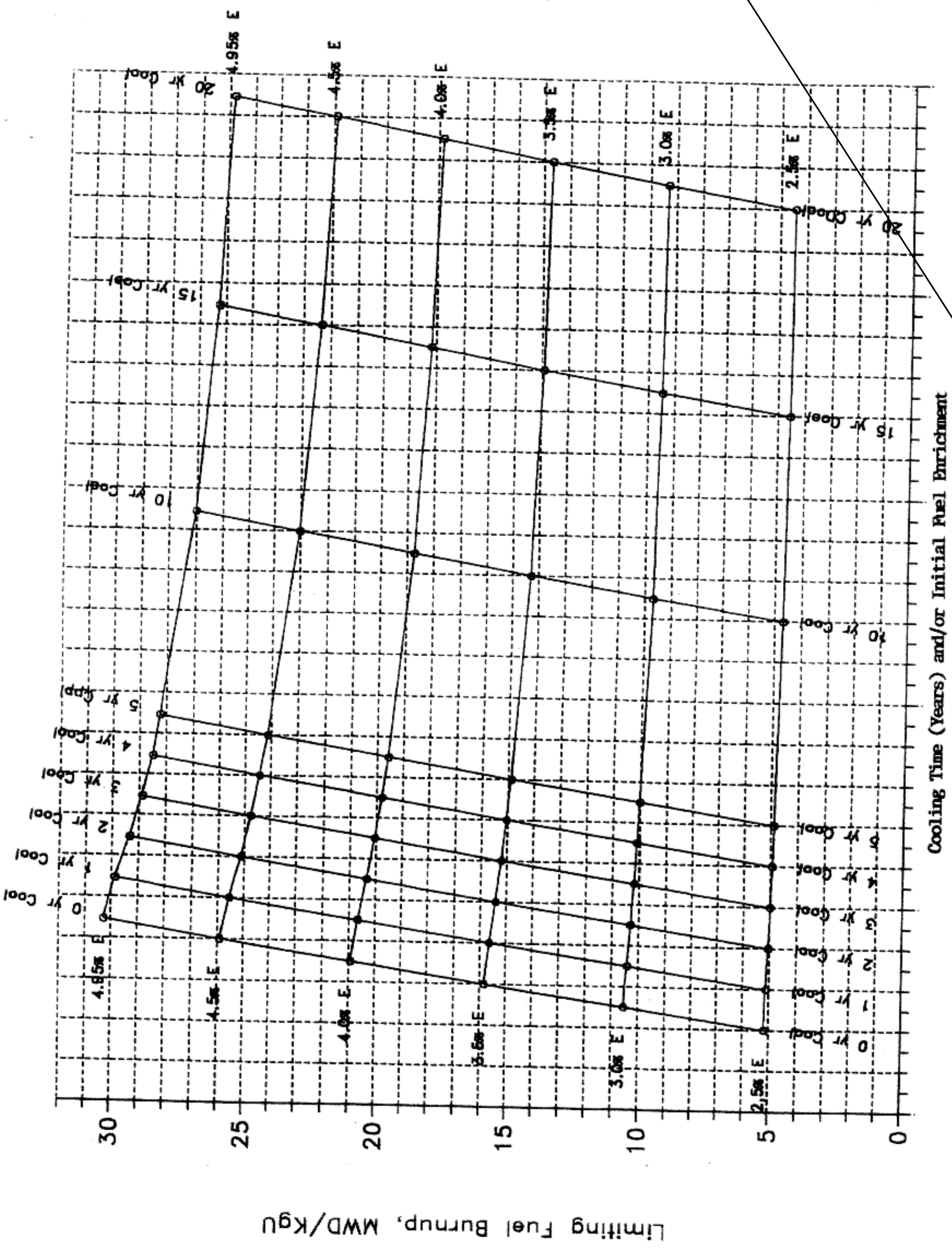


Fig. 5.6-3 3- Dimensional Plot of Minimum Fuel Burnups in Region 2 for Enrichments and Cooling Times

[Add Inserts 14, 15, and 16]

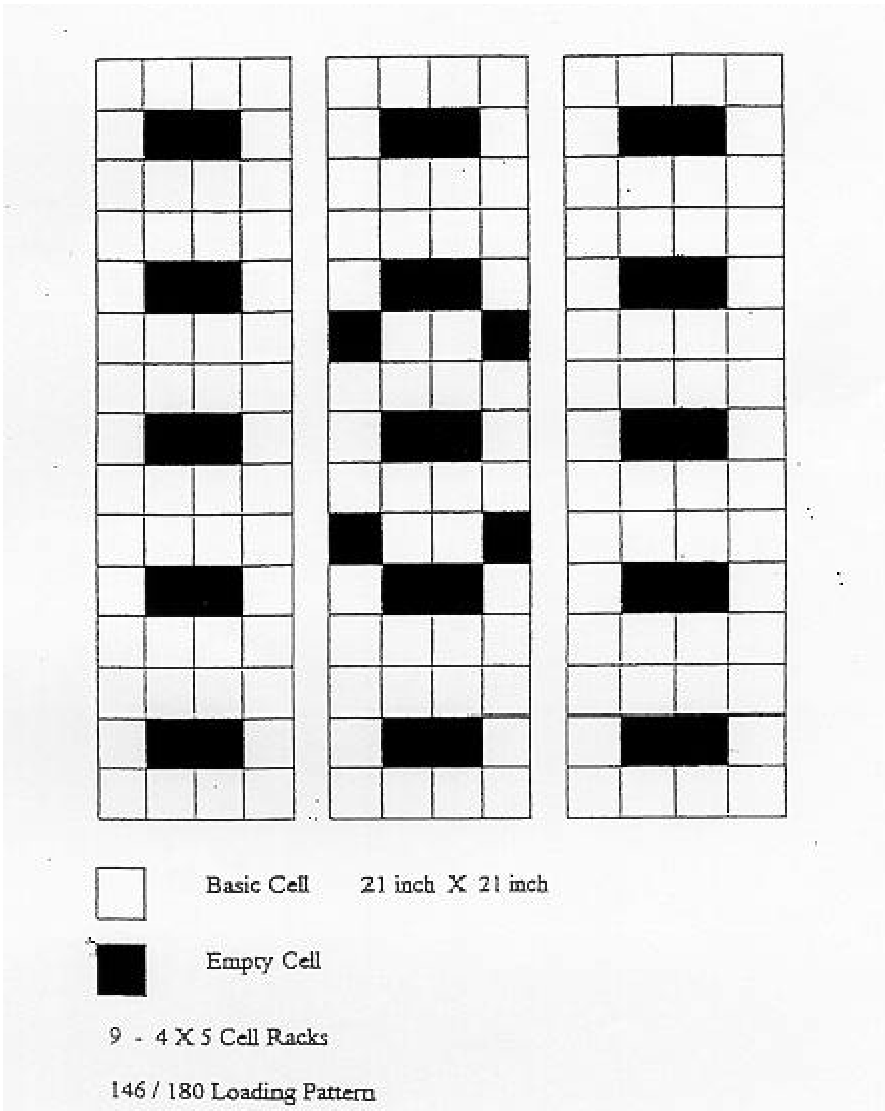


Figure ~~5.6-4~~ ***5.6-7***
New Fuel Pit Storage Rack Loading Pattern

Insert 14

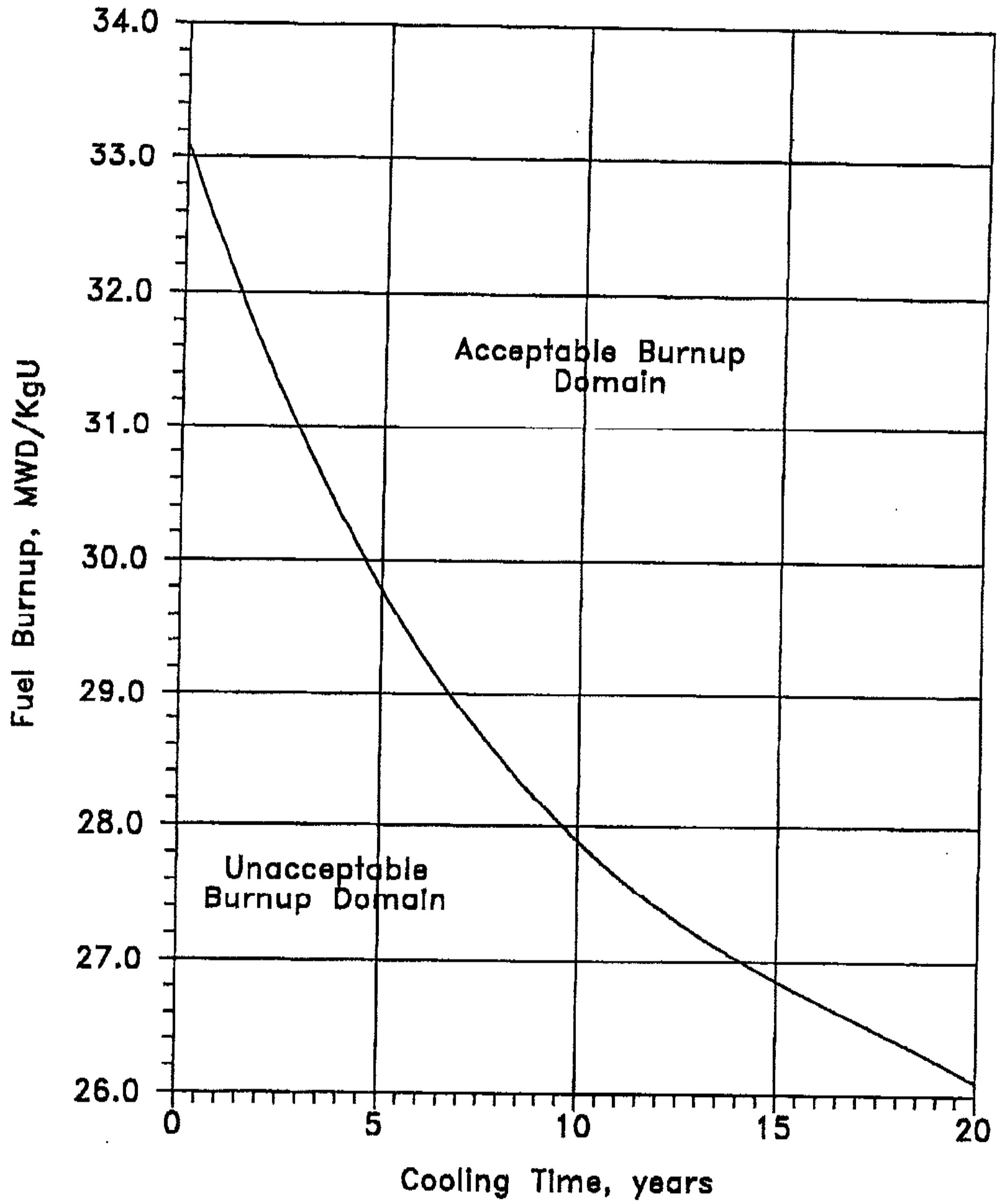


Fig. 5.6-4 Limiting Burnup Requirements in Region 2 for Face Adjacent Storage of Type T Spent Fuel Assemblies

Insert 15

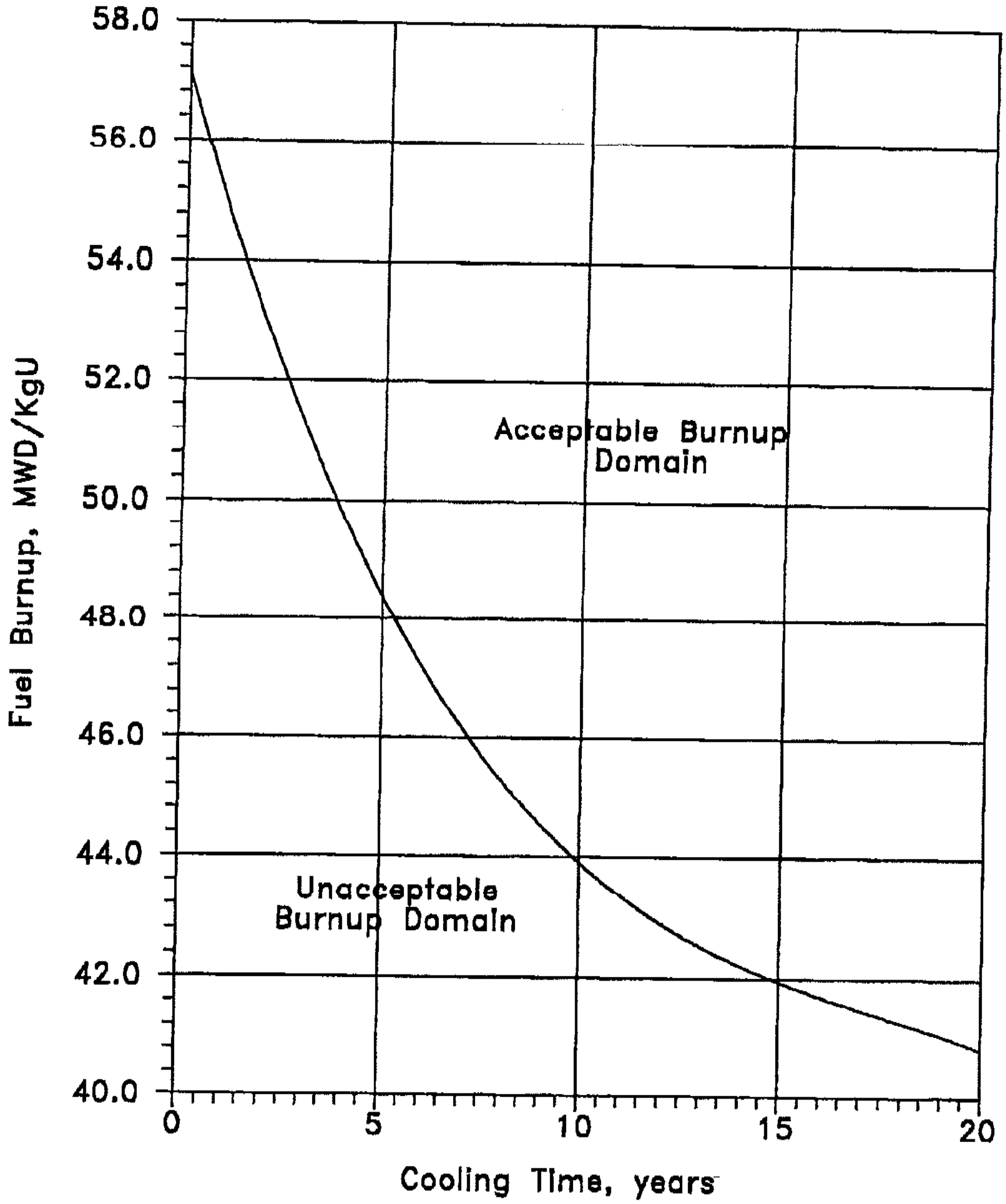


Fig. 5.6–5 Limiting Burnup Requirements in Region 4, Checkerboard Array of 1 Fresh and 3 Type T Spent Fuel Assemblies

Insert 16

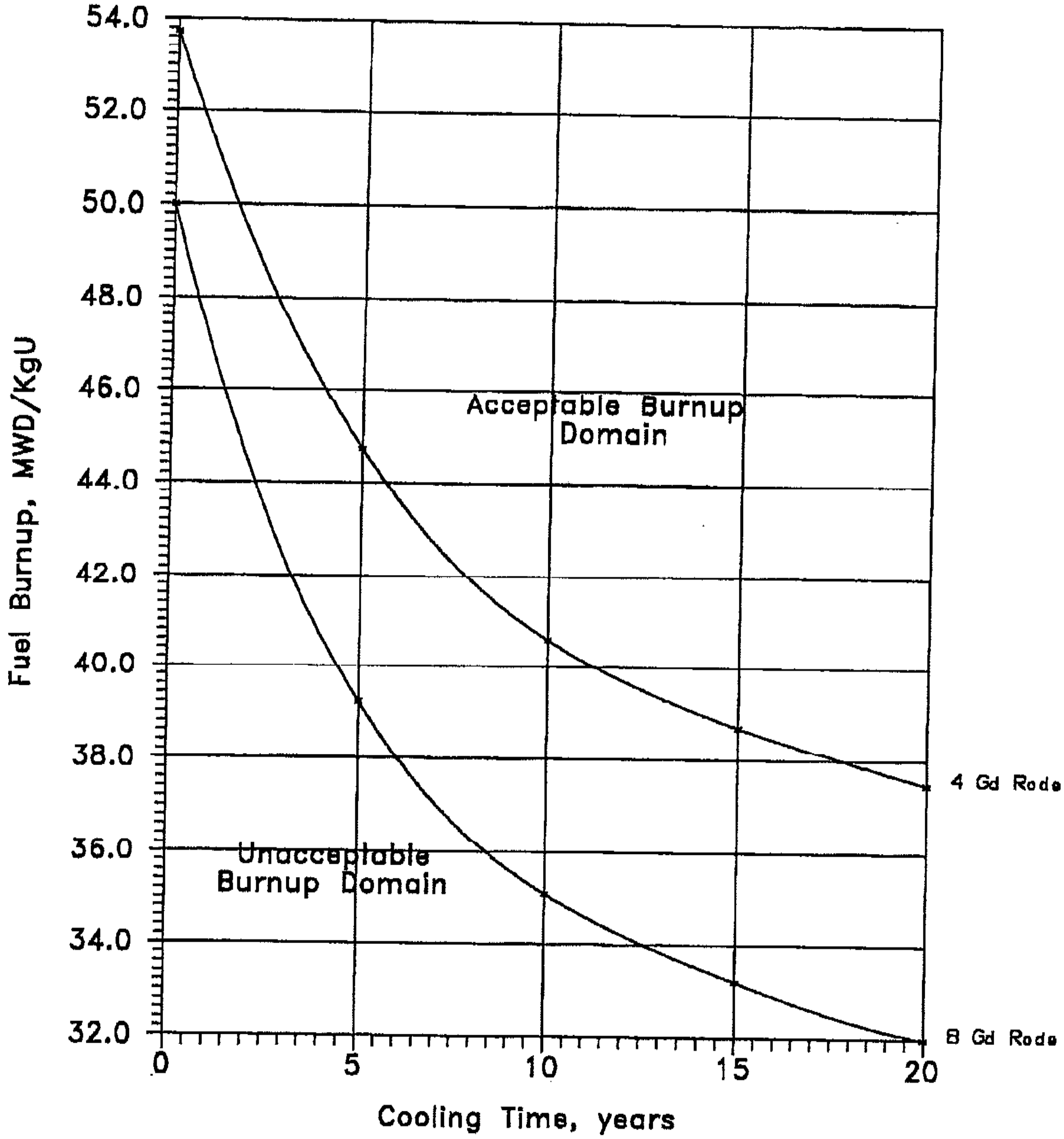


Fig. 5.6-6 Limiting Burnup Requirements in Region 4, Checkerboard Array of 1 Fresh (with Gadolinia) and 3 Type T Spent Fuel Assemblies

Table 5.6-1
Region 1 Storage Burnup Restrictions: Checkerboard of 1 Fresh Fuel Assembly ⇓ and 3 ***Type A*** Spent Fuel Assemblies ~~(Without Gadolinium or IFBA Rods)~~
(Without Gadolinium or IFBA Rods)

For Zero Year Cooling Time
Bu (limit) = $- 28.1868 + 23.0765 \times E - 2.46264 \times E^2 + 0.167868 \times E^3$
For One Year Cooling Time
Bu (limit) = $- 27.3317 + 22.5087 \times E - 2.40586 \times E^2 + 0.164207 \times E^3$
For Two Years Cooling Time
Bu (limit) = $-26.4693 + 21.8404 \times E - 2.31873 \times E^2 + 0.158218 \times E^3$
For Three Years Cooling Time
Bu (limit) = $-25.7404 + 21.2659 \times E - 2.24287 \times E^2 + 0.153018 \times E^3$
For Four Years Cooling Time
Bu (limit) = $- 25.1367 + 20.7910 \times E - 2.18484 \times E^2 + 0.1499363 \times E^3$
For Five Years Cooling Time
Bu (limit) = $- 24.5981 + 20.3568 \times E - 2.12719 \times E^2 + 0.145431 \times E^3$
For Ten Years Cooling Time
Bu (limit) = $- 23.2050 + 19.2969 \times E - 2.06993 \times E^2 + 0.145875 \times E^3$
For Fifteen Years Cooling Time
Bu (limit) = $-22.6098 + 18.8544 \times E - 2.08617 \times E^2 + 0.150473 \times E^3$
For Twenty Years Cooling Time
Bu (limit) = $- 22.3017 + 18.622 \times E - 2.11206 \times E^2 + 0.15467 \times E^3$

Note: E = initial enrichment in the axial zone of highest enrichment (wt% U-235)

Table 5.6-2
Region 1 Storage Burnup Restrictions with Gadolinium or IFBA ***in Fresh Fuel***

Type A

With Gadolinium Credit: Checkerboard of 1 Fresh Fuel Assembly with 3 ⇑ Spent Fuel Assemblies

Zero Year Cooling Time, 0 Gadolinia Rods
Bu (limit) = $- 28.1868 + 23.0765 \times E - 2.46264 \times E^2 + 0.167868 \times E^3$
Zero Year Cooling Time, 4 Gadolinia Rods
Bu (limit) = $- 28.4012 + 22.0062 \times E - 2.19268 \times E^2 + 0.143601 \times E^3$
Zero Year Cooling Time, 8 Gadolinia Rods
Bu (limit) = $- 31.4262 + 22.0768 \times E - 2.38845 \times E^2 + 0.164888 \times E^3$

Note: If more that 8 Gadolinium rods per assembly, use the 8 rod correlation

Type A

With IFBA Credit: Checkerboard of 1 Fresh Fuel Assembly with 3 ⇑ Spent Fuel Assemblies

Zero Year Cooling Time, 0 IFBA Rods
Bu (limit) = $- 28.1868 + 23.0765 \times E - 2.46264 \times E^2 + 0.167868 \times E^3$
Zero Year Cooling Time, 16 IFBA Rods
Bu (limit) = $- 28.5048 + 21.6411 \times E - 2.15262 \times E^2 + 0.140904 \times E^3$
Zero Year Cooling Time, 32 IFBA Rods
Bu (limit) = $- 31.0949 + 22.0435 \times E - 2.36088 \times E^2 + 0.162229 \times E^3$
Zero Year Cooling Time, 48 IFBA Rods
Bu (limit) = $- 33.1342 + 22.3999 \times E - 2.55367 \times E^2 + 0.18082 \times E^3$
Zero Year Cooling Time, 64 IFBA Rods
Bu (limit) = $- 36.0468 + 24.1492 \times E - 3.11807 \times E^2 + 0.233987 \times E^3$

Note: If more that 64 IFBA rods per assembly, use the correlation for 64 IFBA rods

Note: E = initial enrichment in the axial zone of highest enrichment (wt% U-235)

Table 5.6-3
Region 2 Storage Burnup Restrictions
For Type A Fuel

Zero Cooling Time $\text{Bu (limit)} = -23.8702 + 12.3026 \times E - 0.275672 \times E^2$
1 Year Cooling Time $\text{Bu (limit)} = -23.6854 + 12.2384 \times E - 0.287498 \times E^2$
2 Years Cooling Time $\text{Bu (limit)} = -23.499 + 12.1873 \times E - 0.305988 \times E^2$
3 Years Cooling Time $\text{Bu (limit)} = -23.3124 + 12.1249 \times E - 0.319566 \times E^2$
4 Years Cooling Time $\text{Bu (limit)} = -23.1589 + 12.0748 \times E - 0.332212 \times E^2$
5 Years Cooling Time $\text{Bu (limit)} = -22.6375 + 11.7906 \times E - 0.307623 \times E^2$
10 Years Cooling Time $\text{Bu (limit)} = -21.7256 + 11.3660 \times E - 0.31029 \times E^2$
15 Years Cooling Time $\text{Bu (limit)} = -21.1160 + 11.0663 \times E - 0.306231 \times E^2$
20 Years Cooling Time $\text{Bu (limit)} = -20.6055 + 10.7906 \times E - 0.29291 \times E^2$

Note: E = initial enrichment in the axial zone of highest enrichment (wt% U-235)

Table 5.6-4

Face Adjacent Storage of Type T Spent Fuel (Region 2)

$$Bu\ (limit) = 33.1095 - 0.845146 \times CT + 0.0399888 \times CT^2 - 0.000762846 \times CT^3$$

Table 5.6-5

Limiting Burnup For Checkerboard Storage of Fresh and Type T Spent Fuel
(Region 4: 1 Fresh Assembly and 3 Spent Fuel Assemblies in a 2X2 Arrangement)

$$Bu\ (limit) = 57.118 - 2.13277 \times CT + 0.0772537 \times CT^2 + 0.00127446 \times CT^3 - 9.15855\ E\text{-}5 \times CT^4$$

Table 5.6-6

Gadolinia Credit: Limiting Burnup For Checkerboard Storage of Fresh and Type T Spent Fuel
(Region 4: 1 Fresh Assembly with Gadolinia and 3 Spent Fuel Assemblies in a 2X2 Arrangement)

4 Gadolinia Rods

$$Bu\ (limit) = 53.73 - 2.5265 \times CT + 0.172283 \times CT^2 - 0.00585995 \times CT^3 + 0.0000766655 \times CT^4$$

8 Gadolinia Rods

$$Bu\ (limit) = 50.00 - 3.26817 \times CT + 0.276117 \times CT^2 - 0.0117934 \times CT^3 + 0.000195334 \times CT^4$$

Note: 1. If more than 8 gadolinia rods per assembly, use the 8 rod correlation
2. BU = Fuel Burnup, MWD/Kg-U; CT = Cooling Time of Spent Fuel Assemblies, Years

, and 4) tritium and hydrogen that exist in the Tritium Producing Burnable Absorber Rods prior to the accident

3/4.6.4 COMBUSTIBLE GAS CONTROL

The OPERABILITY of the equipment and systems required for the detection and control of hydrogen gas ensures that this equipment will be available to maintain the hydrogen concentration within containment below its flammable limit during post-LOCA conditions. Either recombiner unit or the hydrogen mitigation system, consisting of 68 hydrogen ignitions per unit, is capable of controlling the expected hydrogen generation associated with 1) zirconium-water reactions, 2) radiolytic decomposition of water, ~~and~~ 3) corrosion of metals within containment. These hydrogen control systems are designed to mitigate the effects of an accident as described in Regulatory Guide 1.7, "Control of Combustible Gas Concentrations in Containment Following a LOCA", Revision 2 dated November 1978. The hydrogen monitors of Specification 3.6.4.1 are part of the accident monitoring instrumentation in Specification 3.3.3.7 and are designated as Type A, Category 1 in accordance with Regulatory Guide 1.97, Revision 2, "Instrumentation for Light-Water-Cooled Nuclear Power Plants to Assess Plant Conditions During and Following an Accident," December 1980.

The hydrogen mixing systems are provided to ensure adequate mixing of the containment atmosphere following a LOCA. This mixing action will prevent localized accumulations of hydrogen from exceeding the flammable limit.

The operability of at least 66 of 68 ignitors in the hydrogen mitigation system will maintain an effective coverage throughout the containment. This system of ignitors will initiate combustion of any significant amount of hydrogen released after a degraded core accident. This system is to ensure burning in a controlled manner as the hydrogen is released instead of allowing it to be ignited at high concentrations by a random ignition source.

3/4.6.5 ICE CONDENSER

The requirements associated with each of the components of the ice condenser ensure that the overall system will be available to provide sufficient pressure suppression capability to limit the containment peak pressure transient to less than 12 psig during LOCA conditions.

3/4.6.5.1 ICE BED

The OPERABILITY of the ice bed ensures that the required ice inventory will 1) be distributed evenly through the containment bays, 2) contain sufficient boron to preclude dilution of the containment sump following the LOCA and 3) contain sufficient heat removal capability to condense the reactor system volume released during a LOCA. These conditions are consistent with the assumptions used in the accident analyses.

The minimum weight figure of 1071 pounds of ice per basket contains a 15% conservative allowance for ice loss through sublimation which is a factor of 15 higher than assumed for the ice condenser design. The minimum weight figure of 2,082,024 pounds of ice also contains an additional 1% conservative allowance to account for systematic error in weighing instruments. In the

Reports HI-992349 (Ref 1) and HI-2012629 (Ref 9)

3/4.7.13 SPENT FUEL POOL MINIMUM BORON CONCENTRATION

BACKGROUND

The spent fuel racks have been analyzed in accordance with the Holtec International methodology contained in Holtec ~~Report HI - 992349 (Ref. 1)~~. This methodology ensures that the spent fuel rack multiplication factor, k_{eff} is less than or equal to 0.95, as recommended by the NRC guidance contained in NRC Letter to All Power Reactor Licensees from B.K. Grimes, "OT Position for Review and Acceptance of Spent Fuel Storage and Handling Applications", April 14, 1978 and USNRC Internal Memorandum from L. Kopp, "Guidance On The Regulatory Requirements For Criticality Analysis Of Fuel Storage At Light-Water Reactor Power Plants", August 19, 1998 (Refs. 2 & 3). The codes, methods, and techniques contained in the methodology are used to satisfy the k_{eff} criterion. The spent fuel storage racks were analyzed using Westinghouse 17x17 V5H fuel assemblies, with enrichments up to 4.95 ±0.05 w/o U-235 and configurations which take credit for checkerboarding, burnup, soluble boron, integral fuel burnable absorbers (such as IFBA or gadolinia), and cooling time to ensure that k_{eff} is maintained ≤ 0.95, including uncertainties, tolerances, and accident conditions. ***[Insert 17]*** In addition, the SFP k_{eff} is maintained < 1.0, including uncertainties, tolerances on a 95/95 basis without any soluble boron. Calculations were performed to evaluate the reactivity of fuel types used at SQN. The results show that the Westinghouse 17x17 V5H fuel assembly exhibits the highest reactivity, thereby bounding all fuel types utilized and stored at SQN.

Replace with Insert 18

~~In the high density Spent Fuel Storage Rack design (Refs. 1 and 4), the spent fuel storage pool is divided into three separate and distinct regions which, for the purpose of criticality considerations, are considered as separate pools. Region 1 is designed to accommodate new fuel with a maximum enrichment of 4.95 ± 0.05 wt% U-235, or spent fuel regardless of the discharge fuel burnup in a 1-in-4 checkerboard arrangement of 1 fresh assembly with 3 spent fuel assemblies with enrichment, burnup and cooling times in accordance with Design Features 5.6.1.1.c.1. Region 2 is designed to accommodate fuel which have 4.95 ± 0.05 wt% U-235 initial enrichment burned to at least 30.27 MWD/KgU (assembly average), or fuel of other enrichment with a burnup yielding an equivalent reactivity in the fuel racks in accordance with Design Features 5.6.1.1.c.2. Region 3 is designed to accommodate fuel of 4.95 ± 0.05 wt% U-235 initial enrichment or fuel assemblies of any lower reactivity in a 2-out-of-4 checkerboard arrangement with water-filled cells and in accordance with Design Features 5.6.1.1.c.3.~~

The water in the spent fuel storage pool normally contains soluble boron, which results in large subcriticality margins under actual operating conditions. However, the NRC guidelines, based upon the accident condition in which all soluble poison is assumed to have been lost, specify that the limiting k_{eff} of < 1.0 be evaluated in the absence of soluble boron. Hence, the design of all regions is based on the use of unborated water, which maintains each region in a subcritical condition during normal operation with the regions fully loaded. The double contingency principle discussed in ANSI N-16.1-1975 and the April 1978 NRC letter (Ref. 5) allows credit for soluble boron under other abnormal or accident conditions, since only a single accident need be considered at one time. For example, the most

(continued)

Insert 17

The analysis also accounts for the reactivity effects of operating the fuel with discrete burnable poisons (such as burnable poison rod absorbers or tritium producing burnable absorber rods).

Insert 18

In the high density Spent Fuel Rack design (Ref. 9), the spent fuel storage pool is divided into four separate and distinct regions which, for the purpose of criticality considerations, are considered as separate pools. For convenience of reference, the following definitions apply:

Type A fuel refers to spent fuel assemblies which have not contained tritium producing burnable absorber rods (TPBAR’s) during in-core operation.

Type T fuel refers to spent fuel assemblies which have contained tritium producing burnable absorber rods (TPBAR’s) during in-core operation.

Fresh fuel refers to unirradiated Type A or Type T fuel or irradiated Type A or Type T fuel which has not attained sufficient burnup to meet spent fuel requirements.

Cooling time is defined as the period since reactor shutdown at the end of the last operating cycle for the discharged spent fuel assembly.

Region 1 is designed to accommodate fresh fuel with a maximum enrichment of 4.95 +/- 0.05 wt% U-235, or spent fuel regardless of the discharge burnup in a 1-of-4 checkerboard arrangement of 1 fresh assembly with 3 spent Type A fuel assemblies with enrichment, burnup, and cooling times in accordance with Design Feature 5.6.1.1.c.1. Region 2 is designed to accommodate Type A or Type T fuel of up to 4.95 +/- 0.05 wt% U-235 initial enrichment burned to an assembly average burnup of at least 30.27 MWD/kgU for Type A fuel or 33.1095 MWD/kgU for Type T fuel, or other enrichment with a burnup yielding an equivalent reactivity in the fuel racks in accordance with Design Feature 5.6.1.1.c.2. Region 3 is designed to accommodate fresh fuel of up to 4.95 +/- 0.05 wt% U-235 initial enrichment, or fuel assemblies of any lower reactivity in a 2-of-4 checkerboard arrangement with water-filled cells in accordance with Design Feature 5.6.1.1.c.3. Region 4 is designed to accommodate fresh fuel up to 4.95 +/- 0.05 wt% U-235 initial enrichment, or spent fuel regardless of the discharge burnup in a 1-of-4 checkerboard arrangement of 1 fresh assembly with 3 spent Type T fuel assemblies with burnup and cooling times in accordance with Design Feature 5.6.1.1.c.4.

BACKGROUND (continued)

severe accident scenario is associated with the accidental mishandling of a fresh fuel assembly face adjacent to a fresh fuel assembly of Region 3. This could potentially increase the criticality of Region 3. To mitigate these postulated criticality related accidents, boron is dissolved in the pool water. The soluble boron concentration required to maintain $k_{eff} \leq 0.95$ under normal conditions is 300 ppm and 700 ppm under the most severe postulated fuel mis-location accident. Safe operation of the spent fuel storage racks may therefore be achieved by controlling the location of each assembly in accordance with Design Features 5.6 FUEL STORAGE. During fuel movement, it is necessary to perform Surveillance Requirement 4.7.13.2.

APPLICABLE SAFETY ANALYSES

Most accident conditions do not result in an increase in the reactivity of any one of the three regions. Examples of these accident conditions are the loss of cooling and the dropping of a fuel assembly on the top of the rack. However, accidents can be postulated that could increase the reactivity. This increase in reactivity is unacceptable with unborated water in the storage pool. Thus, for these accident occurrences, the presence of soluble boron in the storage pool prevents criticality in all regions. The most limiting postulated accident with respect to the storage configurations assumed in the spent fuel rack criticality analysis is the misplacement of a nominal 4.95 ± 0.05 w/o U-235 ***fresh*** fuel assembly into an empty storage cell location in the Region 3 checkerboard storage arrangement. The amount of soluble boron required to maintain k_{eff} less than or equal to 0.95 due to this fuel misload accident is 700 ppm (Ref. 1 ***and Ref. 9).***

A spent fuel boron dilution analysis was performed to ensure that sufficient time is available to detect and mitigate dilution of the spent fuel pool prior to exceeding the k_{eff} design basis limit of 0.95 (Ref. 6). The spent fuel pool boron dilution analysis concluded that an inadvertent or unplanned event that would result in a dilution of the spent fuel pool boron concentration from 2000 ppm to 700 ppm is not a credible event.

The concentration of dissolved boron in the spent fuel storage pool satisfies Criterion 2 of the NRC Policy Statement.

LCO

The spent fuel storage pool boron concentration is required to be ≥ 2000 ppm. The specified concentration of dissolved boron in the spent fuel storage pool preserves the assumptions used in the analyses of the potential critical accident scenarios as described in Reference 7. This concentration of dissolved boron is the minimum required concentration for fuel assembly storage and movement within the spent fuel storage pool.

(continued)

PLANT SYSTEMS

BASES (continued)

APPLICABILITY

This LCO applies whenever fuel assemblies are stored in the spent fuel storage pool.

ACTIONS

Action a:

When the concentration of boron in the spent fuel storage pool is less than required, immediate action must be taken to preclude the occurrence of an accident or to mitigate the consequences of an accident in progress. This is most efficiently achieved by immediately suspending the movement of fuel assemblies. The concentration of boron is restored along with suspending movement of fuel assemblies.

Action a is modified by a provision indicating that LCO 3.0.3 does not apply. If the LCO is not met while moving irradiated fuel assemblies in MODE 5 or 6, LCO 3.0.3 would not be applicable. Moving irradiated fuel assemblies while in MODE 1, 2, 3, or 4 is independent of reactor operation. Therefore, inability to suspend movement of fuel assemblies is not sufficient reason to require a reactor shutdown.

SURVEILLANCE REQUIREMENTS

Surveillance 4.7.13.1

This Surveillance Requirement verifies that the concentration of boron in the spent fuel storage pool is within the required limit. As long as this Surveillance Requirement is met, the analyzed accidents are fully addressed. The 7 day Frequency is appropriate because no significant replenishment of pool water is expected to take place over such a short period of time. (Ref. 6)

Surveillance 4.7.13.2

This Surveillance Requirement verifies that the concentration of boron in the spent fuel storage pool is within the required limit during fuel movement until the final configuration of the assemblies in the storage racks is verified to be correct. As long as this Surveillance Requirement is met, the analyzed accidents are fully addressed. The 72 hour Frequency provides additional assurance that the maximum k_{eff} remains below the 0.95 limit under the postulated accident condition. (Ref. ~~8~~ ***1, 8 and 9*****)**

(continued)

REFERENCES

1. Stanley E. Turner (Holtec International), “Criticality Safety Analyses of Sequoyah Spent Fuel Racks with Alternative Arrangements,” HI-992349

2. B.K. Grimes (NRC GL78011), “OT Position for Review and Acceptance of Spent Fuel Storage and Handling Applications”, April 14, 1978

3. L. Kopp, “Guidance On The Regulatory Requirements For Criticality Analysis Of Fuel Storage At Light-Water Reactor Power Plants”, August 19, 1998

4. UFSAR, Section 4.3.2.7, "Critically of Fuel Assemblies"

5. Double contingency principle of ANSI N16.1-1975, as specified in the April 14, 1978 NRC letter (Section 1.2) and implied in the proposed revision to Regulatory Guide 1.13 (Section 1.4, Appendix A).

6. K K Niyogi (Holtec International), “Boron Dilution Analysis,” HI-992302

7. FSAR, Section 15.4.5

8. NRC letter to TVA dated August 1, 1990, “ Increase Fuel Enrichment to 5.0 Weight Percent (TAC Nos. 76074, 76075, 76774, 76775) (TS 90-12) - Sequoyah Nuclear Plant, Units 1 and 2”

9. ***Stanley E. Turner (Holtec International), “Evaluation of the Effect of the Use of Tritium Producing Burnable Absorber Rods (TPBARs) on Fuel Storage Requirements”, HI-2012629***

PLANT SYSTEMS **_[This page deleted]_**

BASES

3/4.7.14 CASK PIT POOL MINIMUM BORON CONCENTRATION

BACKGROUND

The Sequoyah cask pit pool consists of a deep pool with adjacent shelf area. The cask pit pool is connected to the spent fuel pool through a weir gate. The cask pit is intended to be used for spent fuel shipment activities.

High density spent fuel storage racks have been approved for addition and use in the cask loading area of the cask pit (Ref. 1) but presently are not installed. The 15 x 15 module could store 225 fuel assemblies and is designed to maintain stored fuel having an initial enrichment of up to 5 wt % U-235, in a safe, coolable, and sub-critical configuration during normal discharge, full core offload storages and postulated accident conditions. Fuel assemblies shall be stored in accordance with paragraph 5.6.1.1.d in Design Features 5.6, Fuel Storage.

APPLICABLE SAFETY ANALYSES

Most accident conditions do not result in an increase in the reactivity of the cask pit. Examples of accident conditions are the loss of cooling and the dropping of a fuel assembly on the top of the rack. However, accidents can be postulated that could increase the reactivity. This increase in reactivity is unacceptable with unborated water in the storage pool. Thus, for these accident occurrences, the presence of soluble boron in the cask pit pool prevents criticality. The most limiting postulated accident bounding the cask pit pool has been determined to occur in the spent fuel pool. The postulated accident with respect to the storage configurations assumed in the spent fuel rack criticality analysis is the misplacement of a nominal 4.95 ± 0.05 w/o U-235 fuel assembly into an storage cell location in the Region 2 checkerboard storage arrangement for an irradiated fuel assembly. The amount of soluble boron required to maintain k_{eff} less than or equal to 0.95 due to this fuel misload accident is 700 ppm (Ref. 2).

The concentration of dissolved boron in the fuel storage pool satisfies Criterion 2 of the NRC Policy Statement.

LCO

The cask pit pool boron concentration is required to be ≥ 2000 ppm. The specified concentration of dissolved boron in the cask pit pool preserves the assumptions used in the analyses of the potential critical accident scenarios as described in Reference 3. This concentration of dissolved boron is the minimum required concentration for fuel assembly storage and movement within the cask pit pool.

(continued)

PLANT SYSTEMS

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BASES (continued)

APPLICABILITY

This LCO applies whenever fuel assemblies are stored in the cask pit pool.

ACTIONS

Action a:

When the concentration of boron in the cask pit pool is less than required, immediate action must be taken to preclude the occurrence of an accident or to mitigate the consequences of an accident in progress. This is most efficiently achieved by immediately suspending the movement of fuel assemblies. The concentration of boron is restored along with suspending movement of fuel assemblies.

Action a is modified by a provision indicating that LCO 3.0.3 does not apply. If the LCO is not met while moving irradiated fuel assemblies in MODE 5 or 6, LCO 3.0.3 would not be applicable. Moving irradiated fuel assemblies while in MODE 1, 2, 3, or 4 is independent of reactor operation. Therefore, inability to suspend movement of fuel assemblies is not sufficient reason to require a reactor shutdown.

SURVEILLANCE REQUIREMENTS

Surveillance 4.7.14.1

This Surveillance Requirement verifies that the concentration of boron in the cask pit pool is within the required limit. As long as this Surveillance Requirement is met, the analyzed accidents are fully addressed. The 7 day Frequency is appropriate because no significant replenishment of pool water is expected to take place over such a short period of time. (Ref. 4)

Surveillance 4.7.14.2

This Surveillance Requirement verifies that the concentration of boron in the cask pit pool is within the required limit during fuel movement until the final configuration of the assemblies in the storage racks is verified to be correct. As long as this Surveillance Requirement is met, the analyzed accidents are fully addressed. The 72 hour Frequency provides additional assurance that the maximum k_{eff} remains below the 0.95 limit under the postulated accident condition. (Ref. 1)

(continued)

PLANT SYSTEMS **_[This page deleted]_**

BASES (continued)

REFERENCES

1. NRC letter to TVA dated April 28, 1993, "Issuance of Amendments (TAC Nos. M83068 and M83069)"

2. Stanley E. Turner (Holtec International), "Criticality Safety Analyses of Sequoyah Spent Fuel Racks with Alternative Arrangements," HI-992349

3. FSAR, Section 15.4.5

4. K. K. Niyogi (Holtec International), "Boron Dilution Analysis," HI-992302

LIMITING CONDITIONS FOR OPERATION AND SURVEILLANCE REQUIREMENTS

BASES

SECTION PAGE

INDEX

DESIGN FEATURES

TABLE 3.3-9

REMOTE SHUTDOWN MONITORING INSTRUMENTATION

INSTRUMENT	READOUT LOCATION	MEASUREMENT RANGE	MINIMUM CHANNELS OPERABLE
1. Source Range Nuclear Flux	NOTE 1	~~1 to 1 x 10^{6}~~ cps Ý ***0.1 to 1 x 10^{5}***	1
2. Reactor Trip Breaker Indication	at trip switchgear	OPEN-CLOSE	1/trip breaker
3. Reactor Coolant Temperature - Hot Leg	NOTE 1	0-650^{o}F	1/loop
4. Pressurizer Pressure	NOTE 1	0-3000 psig	1
5. Pressurizer Level	NOTE 1	0-100%	1
6. Steam Generator Pressure	NOTE 1	0-1200 psig	1/steam generator
7. Steam Generator Level	NOTE 2 or near Auxilary F. W. Pump	0-100%	1/steam generator
8. Deleted			
9. RHR Flow Rate	NOTE 1	0-4500 gpm	1
10. RHR Temperature	NOTE 1	50-400^{o}F	1
11. Auxiliary Feedwater Flow Rate	NOTE 1	0-440 gpm	1/steam generator

3/4.5 EMERGENCY CORE COOLING SYSTEMS

3/4.5.1 ACCUMULATORS

COLD LEG INJECTION ACCUMULATORS

LIMITING CONDITION FOR OPERATION

3.5.1.1 Each cold leg injection accumulator shall be OPERABLE with:

a. The isolation valve open,

b. A contained borated water volume of between 7615 and 7960 gallons of borated water,

c. Between ~~2400~~ 3500 and ~~2700~~ 3800 ppm of boron,

d. A nitrogen cover-pressure of between 624 and 668 psig, and

e. Power removed from isolation valve when RCS pressure is above 2000 psig.

APPLICABILITY: MODES 1, 2 and 3.*

ACTION:

a. With one cold leg injection accumulator inoperable, except as a result of boron concentration not within limits, restore the inoperable accumulator to OPERABLE status within one hour or be in at least HOT STANDBY within the next 6 hours and reduce pressurizer pressure to 1000 psig or less within the following 6 hours.

b. With one cold leg injection accumulator inoperable due to the boron concentration not within limits, restore boron concentration to within limits within 72 hours or be in at least HOT STANDBY within the next 6 hours and reduce pressurizer pressure to 1000 psig or less within the following 6 hours.

* Pressurizer pressure above 1000 psig.

3/4.5.5 REFUELING WATER STORAGE TANK

LIMITING CONDITION FOR OPERATION

3.5.5 The refueling water storage tank (RWST) shall be OPERABLE with:

a. A contained borated water volume of between 370,000 and 375,000 gallons,

b. A boron concentration of between ~~2500~~ ***3600*** ⇑ and ~~2700~~ ***3800*** ⇑ ppm of boron,

c. A minimum solution temperature of 60°F, and

d. A maximum solution temperature of 105°F.

APPLICABILITY: MODES 1, 2, 3 and 4.

ACTION:

With the RWST inoperable, restore the tank to OPERABLE status within 1 hour or be in at least HOT STANDBY within 6 hours and in COLD SHUTDOWN within the following 30 hours.

SURVEILLANCE REQUIREMENTS

4.5.5 The RWST shall be demonstrated OPERABLE:

a. At least once per 7 days by:

   1. Verifying the contained borated water volume in the tank, and

   2. Verifying the boron concentration of the water.

b. At least once per 24 hours by verifying the RWST temperature.

[This page deleted]

3/4.7.14 CASK PIT POOL MINIMUM BORON CONCENTRATION

LIMITING CONDITION FOR OPERATION

3.7.14 The cask pit pool boron concentration shall be ≥ 2000 ppm.

APPLICABILITY: Whenever fuel assemblies are stored in the cask pit rack.

ACTION:

a. With the requirements of the specification not satisfied, suspend all movement of fuel assemblies and initiate action to restore cask pit pool boron concentration to within limit. The provisions of Specification 3.0.3 are not applicable.

SURVEILLANCE REQUIREMENTS

4.7.14.1 Verify at least once per 7 days the cask pit pool boron concentration is within limit.

4.7.14.2 Verify at least once per 72 hours during fuel movement the cask pit pool boron concentration is within limit and until the configuration of the assemblies in the storage rack is verified to comply with the criticality loading criteria specified in Design Feature 5.6.1.1.d.

5.3 REACTOR CORE

FUEL ASSEMBLIES

5.3.1 The reactor shall contain 193 fuel assemblies. Each assembly shall consist of a matrix of zircaloy or M5 clad fuel rods with an initial composition of natural or slightly enriched uranium dioxide as fuel material. Limited substitutions of zirconium alloy or stainless steel filler rods for fuel rods, in accordance with NRC-approved applications of fuel rod configurations, may be used. Fuel assemblies shall be limited to those fuel designs that have been analyzed with applicable NRC staff-approved codes and methods, and shown by tests or analyses to comply with all fuel safety design bases. A limited number of lead test assemblies that have not completed representative testing may be placed in nonlimiting core regions. Sequoyah is authorized to place a limited number of lead test assemblies into the reactor, as described in the Framatome Cogema Fuels Report BAW-2328, beginning with the Unit 2 Operating Cycle 10 core.

INSERT

CONTROL ROD ASSEMBLIES

5.3.2 The reactor core shall contain 53 full length and no part length control rod assemblies. The full length control rod assemblies shall contain a nominal 142 inches of absorber material. The nominal values of absorber material shall be 80 percent silver, 15 percent indium and 5 percent cadmium. All control rods shall be clad with stainless steel tubing.

5.4 REACTOR COOLANT SYSTEM

DESIGN PRESSURE AND TEMPERATURE

5.4.1 The reactor coolant system is designed and shall be maintained:

a. In accordance with the code requirements specified in Section 5.2 of the FSAR, with allowance for normal degradation pursuant to the applicable Surveillance Requirements,

b. For a pressure of 2485 psig, and

c. For a temperature of 650°F, except for the pressurizer which is 680°F.

VOLUME

5.4.2 The total water and steam volume of the reactor coolant system is 12,612 ± 100 cubic feet at a nominal T_{avg} of 525°F.

5.5 METEOROLOGICAL TOWER LOCATION

5.5.1 The meteorological tower shall be located as shown on Figure 5.1-1.

Sequoyah is authorized to place a maximum of 2256 Tritium Producing Burnable Absorber Rods into the reactor in an operating cycle.

5.6 FUEL STORAGE

~~5.6.1~~ CRITICALITY - SPENT FUEL
[Insert 1]

5.6.1.1 The spent fuel storage racks are designed for fuel enriched to 5 weight percent U-235 and shall be maintained with:

a. A k_{eff} less than critical when flooded with unborated water and a k_{eff} less than or equal to 0.95 when flooded with water containing 300 ppm soluble boron.*

b. A nominal 8.972 inch center-to-center distance between fuel assemblies placed in the storage racks.

c. Arrangements of one or more of three different arrays (Regions) or sub-arrays as illustrated in Figures 5.6-1 and 5.6-1a. These arrangements in the spent fuel storage pool have the following definitions:

Type A

1. Region 1 is designed to accommodate new fuel with a maximum enrichment of 4.95 ± 0.05 wt% U-235, (or spent fuel regardless of the fuel burnup), in a 1-in-4 checkerboard arrangement of 1 fresh ~~assembly~~ with 3 spent fuel assemblies with enrichment-burnup and cooling times illustrated in Figure 5.6-2 and defined by the ~~equations in Table 5.6-1. Cooling time is defined as the period since reactor shutdown at the end of the last operating cycle for the discharged spent fuel assembly.~~ The presence of a removable, non-fissile insert such as a burnable poison rod assembly (BPRA) or either gadolinia or integral fuel burnable absorber (IFBA) in a fresh fuel assembly does not affect the applicability of Figure 5.6-2 or Table 5.6-1.

   Two alternative storage arrays (or sub-arrays) are acceptable in Region 1 if the fresh fuel assemblies contain rods with either gadolinia or integral fuel burnable absorber (IFBA). For these types of assemblies, the minimum burnup of the spent fuel in the 1-of-4 sub-array are defined by the equations in Table 5.6-2.

Restrictions in Region 1

Any of the three sub-arrays illustrated in Figure 5.6-1a may be used in any combination provided that:

~~1~~ ***A***) Each sub-array of 4 fuel assemblies includes, in addition to the fresh fuel assembly, 3 assemblies with enrichment and minimum burnup requirements defined by the equations in Tables 5.6-1 and 5.6-2, as appropriate.

~~2~~ ***B***) The arrangement of Region 1 sub-arrays must not allow a configuration with fresh assemblies adjacent to each other.

~~3~~ ***C***) If Region 1 arrays are used in conjunction with Region ~~2~~ ***3*** ⇑ or Region ~~3~~ ***4*** ⇑ arrangements (see below), the arrangements shall not allow fresh fuel assemblies to be adjacent to each other (see also Figure 5.6-1).

---

*For some accident conditions, the presence of dissolved boron in the pool water may be taken into account by applying the double contingency principle which requires two unlikely, independent, concurrent events to produce a criticality accident.

Insert 1

For convenience of reference, the following definitions apply:

Type A fuel refers to spent fuel assemblies which have not contained tritium producing burnable absorber rods (TPBAR's) during in-core operations.

Type T fuel refers to spent fuel assemblies which have contained tritium producing burnable absorber rods (TPBAR's) during in-core operations.

Fresh fuel refers to unirradiated Type A or Type T fuel or irradiated Type A or Type T fuel that has not attained sufficient burnup to meet spent fuel requirements.

Cooling time is defined as the period since reactor shutdown at the end of the last operating cycle for the discharged spent fuel assembly.

5.6 FUEL STORAGE

[Insert 2]

2. Region 2 is designed to accommodate ***[Insert 3]*** fuel of 4.95±0.05 wt% U-235 initial enrichment burned to at least 30.27 ***[Insert 4]*** MWD/KgU (assembly average), or fuel of other enrichments with a burnup yielding an equivalent reactivity in the fuel racks. The minimum required assembly average burnup in MWD/KgU and cooling time is given by the equations in Table 5.6-3 ***[Insert 5]*** ~~in terms of E, where E is the initial enrichment in the axial zone of highest enrichment (wt% U-235)~~. The minimum required burnups are illustrated in Figure 5.6-3 ***[Insert 5]*** in terms of the initial enrichment and cooling time.

Restrictions in Region 2

The following restrictions apply to the storage of spent fuel in the Region 2 cells:

~~1~~ ***A***) The spent fuel shall conform to the minimum burnup requirements defined by the equations in Table 5.6-3 ***[Insert 6]***. Linear interpolation between cooling times may be made if desired.

~~2~~ ***B***) For the interface with Region 1 ***[Insert 7]***storage cells, fresh fuel in Region 1 ***[Insert 7]***shall not be stored adjacent to spent fuel assemblies in the Region 2 storage cells.

[Insert 8]

3. Region 3 is designed to accommodate fuel of 4.95±0.05 wt% U-235 initial enrichment (or fuel assemblies of any lower reactivity) in a 2-out-of-4 checkerboard arrangement with water-filled cells. The water-filled cells shall not contain any components bearing any fissile material, but may accommodate miscellaneous items or equipment.

Restrictions in Region 3

[Insert 9]

~~1~~ ***A***) For the interface between Region ~~1~~ ⇑ ***3*** and Region ~~3~~ ⇑ ***1 or 4*** storage regions, fresh fuel assemblies shall not be stored adjacent to each other.

~~2~~ ***B***) If miscellaneous ⇑ ***non-fissile bearing*** items or equipment are stored in the water cells of Region 3, the total volume of the miscellaneous items shall be no more than 75% of the storage cell volume.

~~3~~ ***C***) No ⇑ ***loose*** fuel rods~~, assemblies,~~ or items containing fissile material shall be stored in the water cells of Region 3.

[Insert 10]

~~An empty cell is less reactive than any cell containing fuel and therefore may be used as a Region 1, Region 2, or Region 3 cell in any arrangement.~~

~~d. Region 2 array described above may be used in the 15 x 15 storage rack module in the cask loading area of the cask pit.~~

[Insert 11]

e. A nominal concentration of 2000 ppm boron ***is*** ~~is~~ in the pool water. This concentration of soluble boron provides a margin sufficient to allow timely detection of a boron dilution accident and corrective action before the minimum concentration (700 ppm) required to protect against the most severe postulated fuel handling accident or before the minimum concentration (300 ppm) required to maintain the storage configuration design basis (k_{eff} less than 0.95) is reached.

Insert 2

D) If miscellaneous non-fissile bearing items or equipment are stored in cells of Region 1, the total volume of the miscellaneous items shall be no more than 75% of the total storage cell volume.

Insert 3

Type A or Type T

Insert 4

(Type A) or 33.1095 (Type T)

Insert 5

(Type A) or 5.6-4 (Type T)

Insert 6

or 5.6-4, as appropriate

Insert 7

or 4

Insert 8

C) If miscellaneous non-fissile bearing items or equipment are stored in cells of Region 2, the total volume of the miscellaneous items shall be no more than 75% of the total storage cell volume.

Insert 9

The following restrictions apply to the storage of fuel in the Region 3 cells:

Insert 10

4. Region 4 is designed to accommodate fresh fuel with a maximum enrichment of 4.95 ± 0.05 wt% U-235 (or spent fuel regardless of the fuel burnup), in a 1-in-4 checkerboard arrangement of 1 fresh assembly with three Type T spent fuel assemblies having burnup and cooling times illustrated in Figure 5.6-5 and defined by the equations in Table 5.6-5. The presence of either gadolinia or integral fuel burnable absorber (IFBA) in a fresh fuel assembly does not affect the applicability of Figure 5.6-5 or Table 5.6-5.

Insert 10 continued

One alternative storage array (or sub-array) is acceptable in Region 4 if the fresh fuel contains rods with gadolinia fuel burnable absorber. For these types of assemblies, the minimum burnup of the spent fuel in the 1-of-4 sub-array is defined by the equations in Table 5.6-6 and illustrated in Figure 5.6-6. For fresh assemblies containing more than eight (8) gadolinia bearing fuel rods, the limiting burnup for eight (8) gadolinia rods shall apply.

Restrictions in Region 4

Any of the two sub-arrays illustrated in Figure 5.6-1a applying to Region 4 storage may be used in any combination provided that:

A) Each sub-array of 4 fuel assemblies includes, in addition to the fresh fuel assembly, 3 assemblies with enrichment and minimum burnup requirements defined by the equations in Tables 5.6-5 and 5.6-6, as appropriate.

B) The arrangement of Region 4 sub-arrays must not allow a configuration with fresh assemblies adjacent to each other.

C) If Region 4 arrays are used in conjunction with Region 1 or 3 arrangements, the arrangements shall not allow fresh fuel assemblies to be adjacent to each other (see Figure 5.6-1)

D) If miscellaneous non-fissile bearing items or equipment are stored in cells of Region 4, the total volume of the miscellaneous items shall be no more than 75% of the total storage cell volume.

Insert 11

d. An empty cell (or a cell containing non-fissile bearing miscellaneous items displacing no more than 75% of the storage cell volume) is less reactive than any cell containing fuel and therefore may be used as a Region 1, 2, 3, or 4 cell in any arrangement.

5.6 FUEL STORAGE

CRITICALITY - NEW FUEL

5.6.1.2 The new fuel pit storage racks are designed for fuel enriched to 5.0 weight percent U-235 and shall be maintained with the arrangement of 146 storage locations shown in Figure 5.6-4 5.6-7. The cells shown as empty cells in Figure 5.6-4 5.6-7 shall have physical barriers installed to ensure that inadvertant loading of fuel assemblies into these locations does not occur. This configuration ensures k_{eff} will remain less than or equal to 0.95 when flooded with unborated water and less than or equal to 0.98 under optimum moderation conditions.

DRAINAGE

5.6.2 The spent fuel storage pool is designed and shall be maintained to prevent inadvertent draining of the pool below elevation 722 ft.

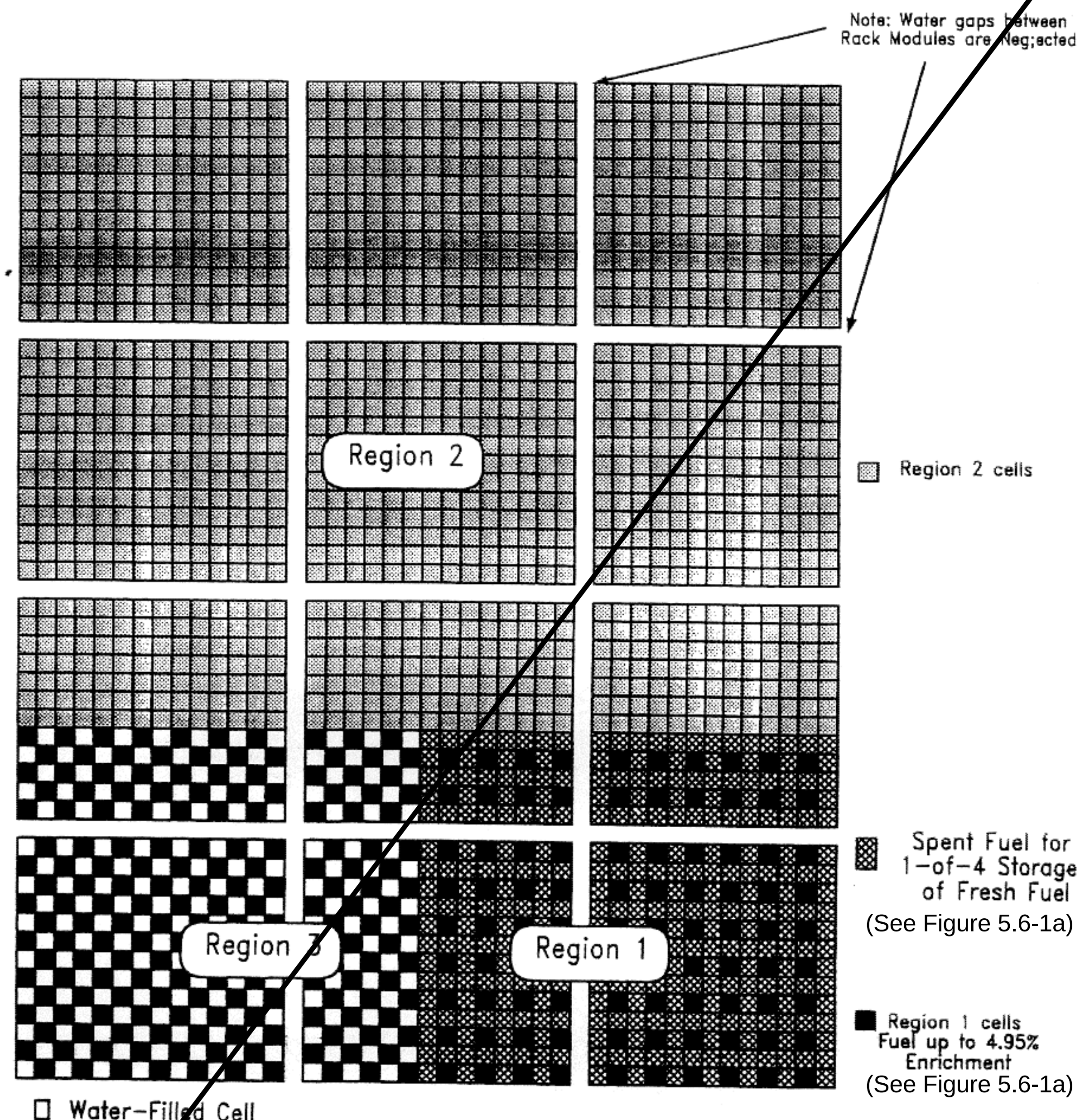
CAPACITY

5.6.3 The spent fuel storage pool is designed and shall be maintained with a storage capacity limited to no more than 2091 fuel assemblies. ~~In addition, no more than 225 fuel assemblies will be stored in a rack module in the cask loading area of the cask pit.~~

5.7 COMPONENT CYCLIC OR TRANSIENT LIMIT

5.7.1 The components identified in Table 5.7-1 are designed and shall be maintained within the cyclic or transient limits of Table 5.7-1.

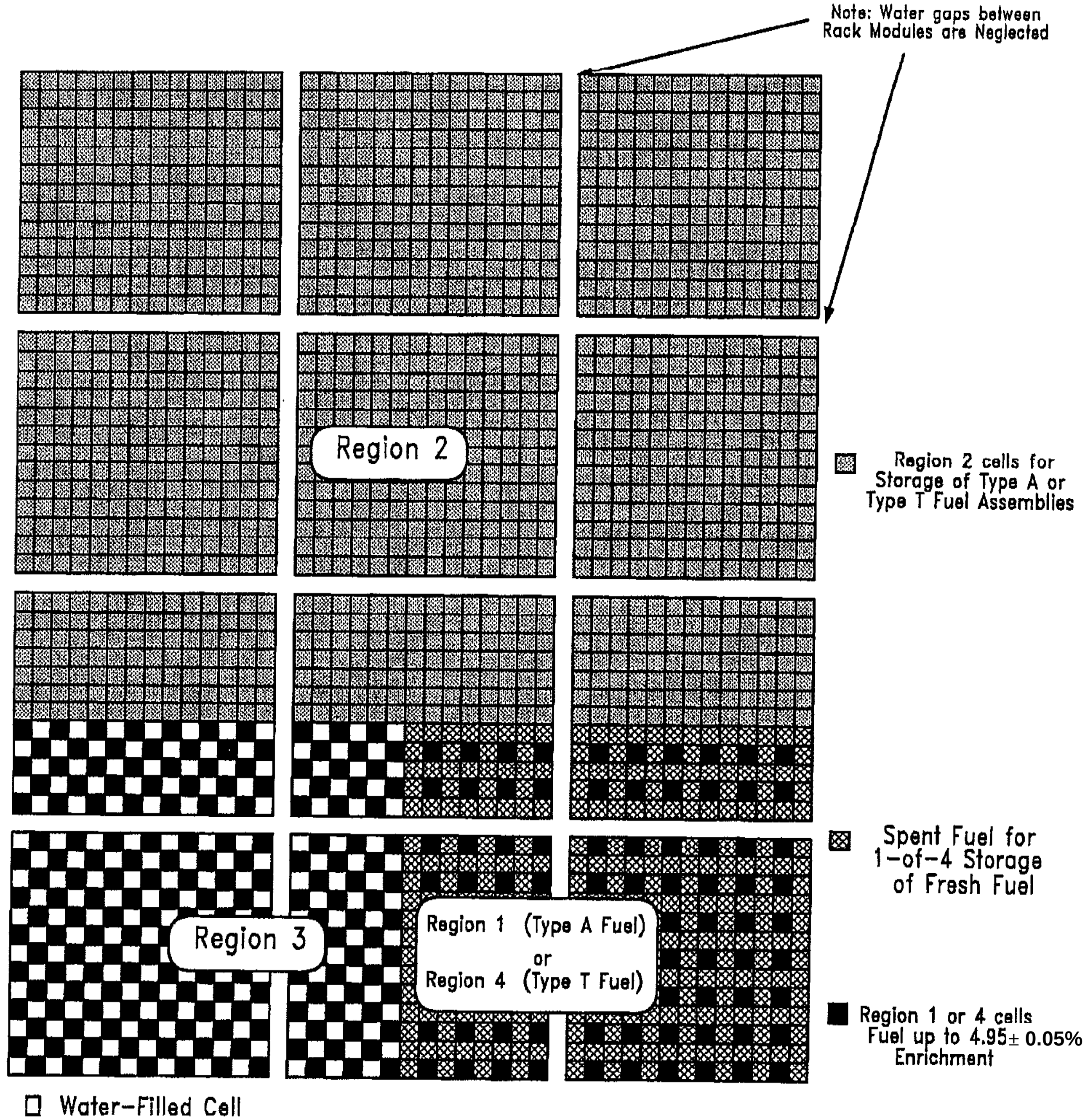
[Replace with Insert 12]



Note: The edges of the sketch above are not necessarily the edges of the pool. The Regions may appear anywhere in the pool and in any orientation, subject to the restriction in Design Feature 5.6.1.1.c.

Figure 5.6-1
Arrangements of Fuel Storage Regions in the Sequoyah Spent Fuel Storage Pool

Insert 12



Note: The edges of the sketch above are not necessarily the edges of the pool. The Regions may appear anywhere in the pool and in any orientation, subject to the restrictions in Design Features 5.6.1.1.c.

FIG 5.6-1 Arrangements of Fuel Storage Regions in the Sequoyah Spent Fuel Storage Pool

[Replace with Insert 13]

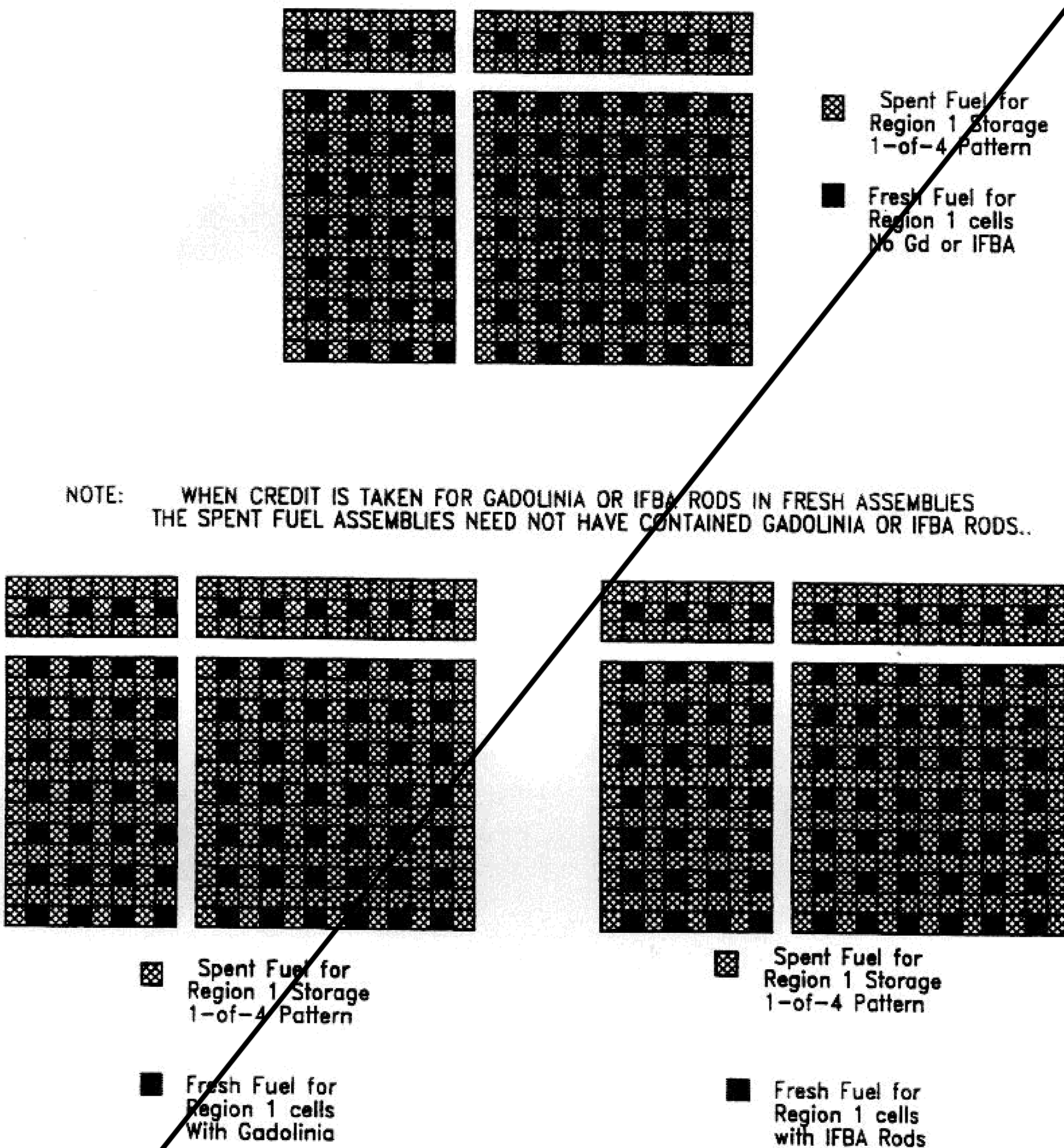
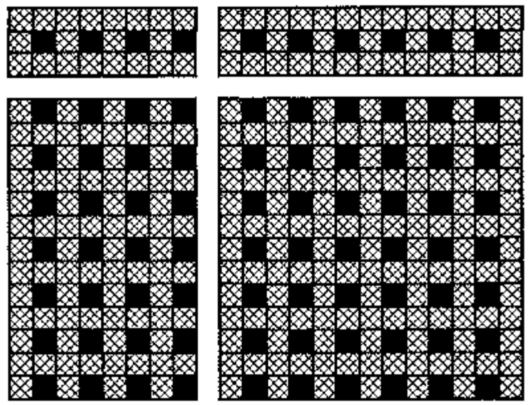


Figure 5.6-1a
Acceptable Spent Fuel Pool Loading Patterns for Checkerboard Storage
of Fresh and Spent Fuel Assemblies - Example

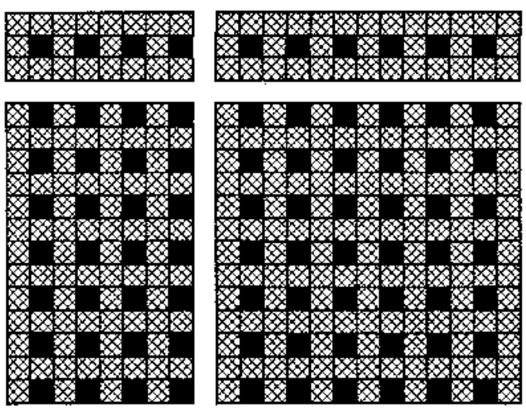
Insert 13



Spent Fuel for Storage in Region 1 (Type A Fuel) or Region 4 (Type T Fuel) in 1-of-4 Pattern

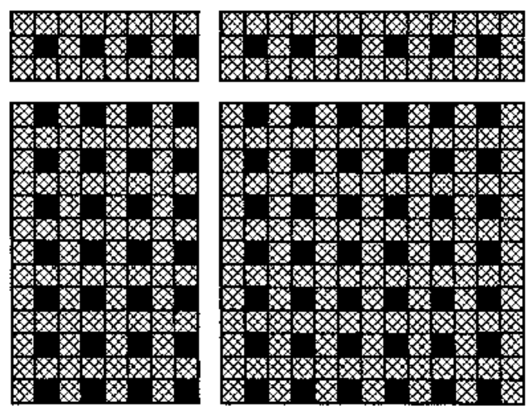
Fresh Fuel for Region 1 or Region 4 cells (No Gd or IFBA)

NOTE: WHEN CREDIT IS TAKEN FOR GADOLINIA RODS IN FRESH ASSEMBLIES THE SPENT FUEL ASSEMBLIES NEED NOT HAVE CONTAINED GADOLINIA RODS..



Spent Fuel for Storage of Region 1 (Type A Fuel) or Region 4 (Type T Fuel) in 1-of-4 Pattern

Fresh Fuel with Gadolinia for Region 1 or Region 4 cells



Spent Fuel for Storage in Region 1 in 1-of-4 Pattern

Fresh Fuel with IFBA Rods for Storage in Region 1 only (1-of-4 Pattern)

Fig. 5.6-1a Acceptable Storage Patterns for Checkerboard Storage of Fresh and Spent Fuel Assemblies in Region 1 or Region 4 – Example

for Type A Fuel

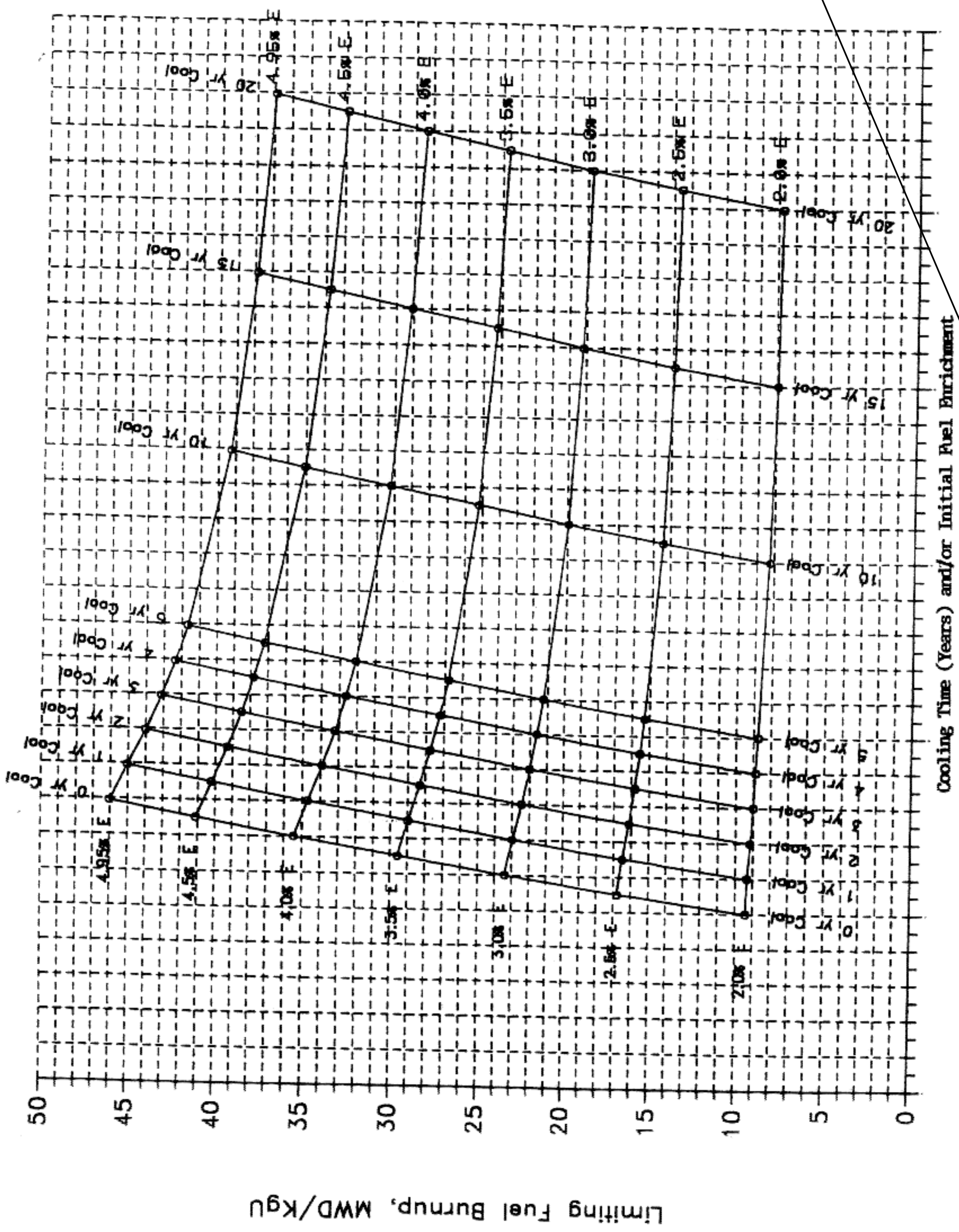


Fig. 5.6-2 3-Dimensional Plot of Minimum Fuel Burnups in Region 1 for Enrichments and/or Cooling Times

For Type A Fuel

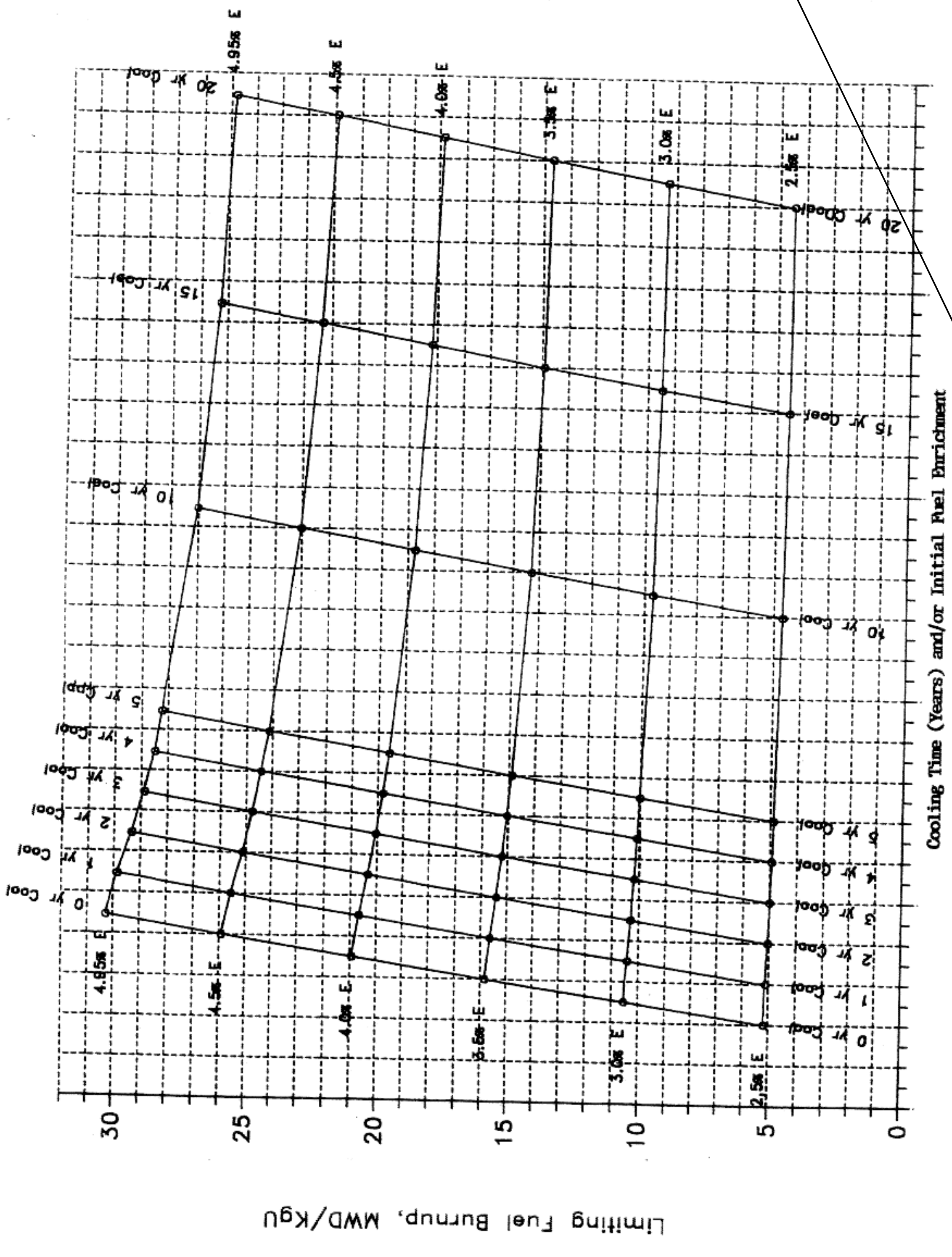


Fig. 5.6-3 3- Dimensional Plot of Minimum Fuel Burnups in Region 2 for Enrichments and Cooling Times

[Add Inserts 14, 15, and 16]

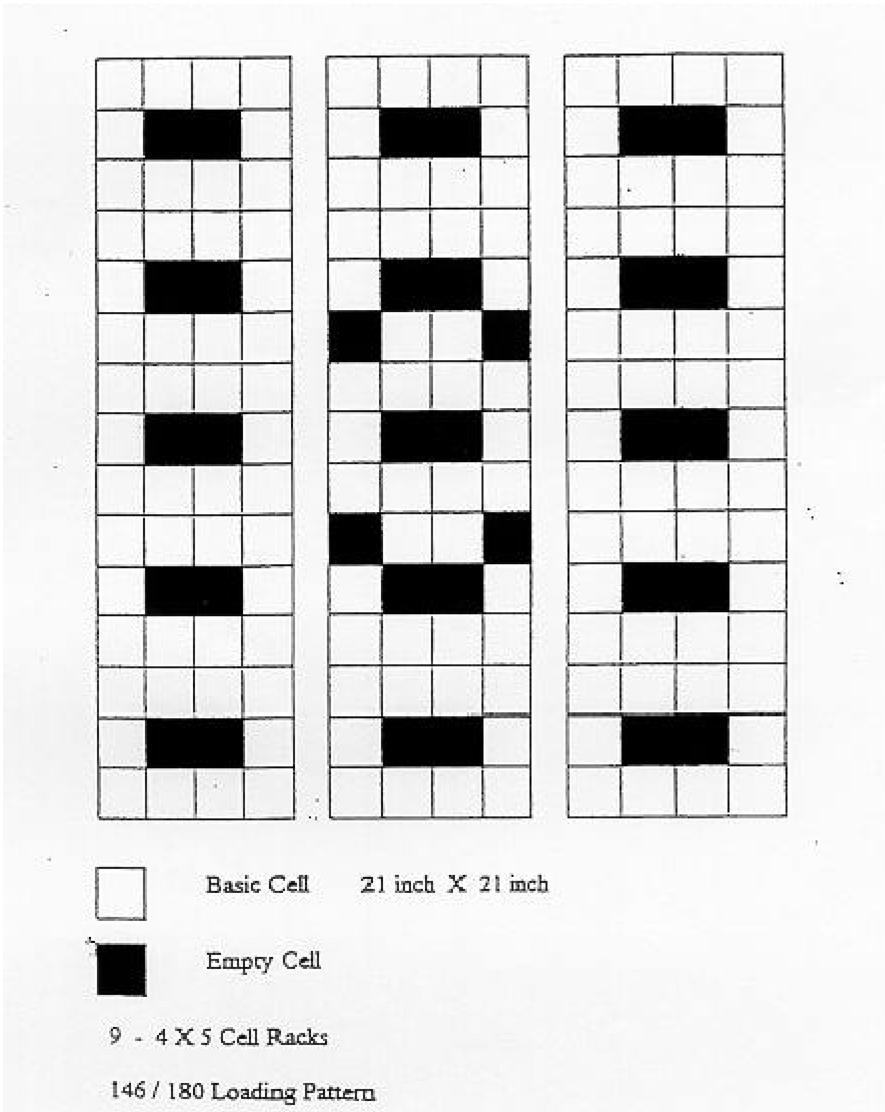


Figure ~~5.6-4~~ ***5.6-7***
New Fuel Pit Storage Rack Loading Pattern

Insert 14

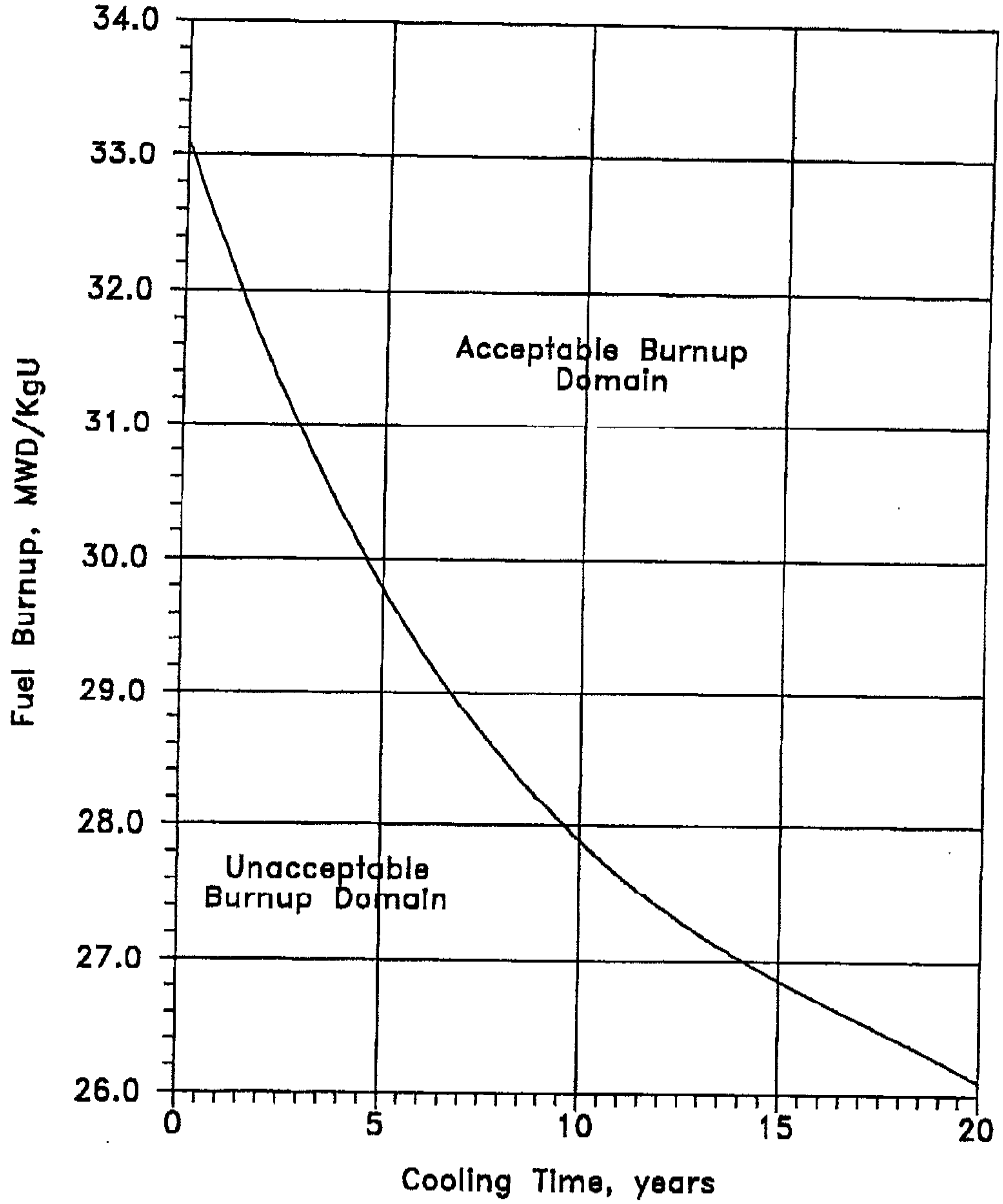


Fig. 5.6-4 Limiting Burnup Requirements in Region 2 for Face Adjacent Storage of Type T Spent Fuel Assemblies

Insert 15

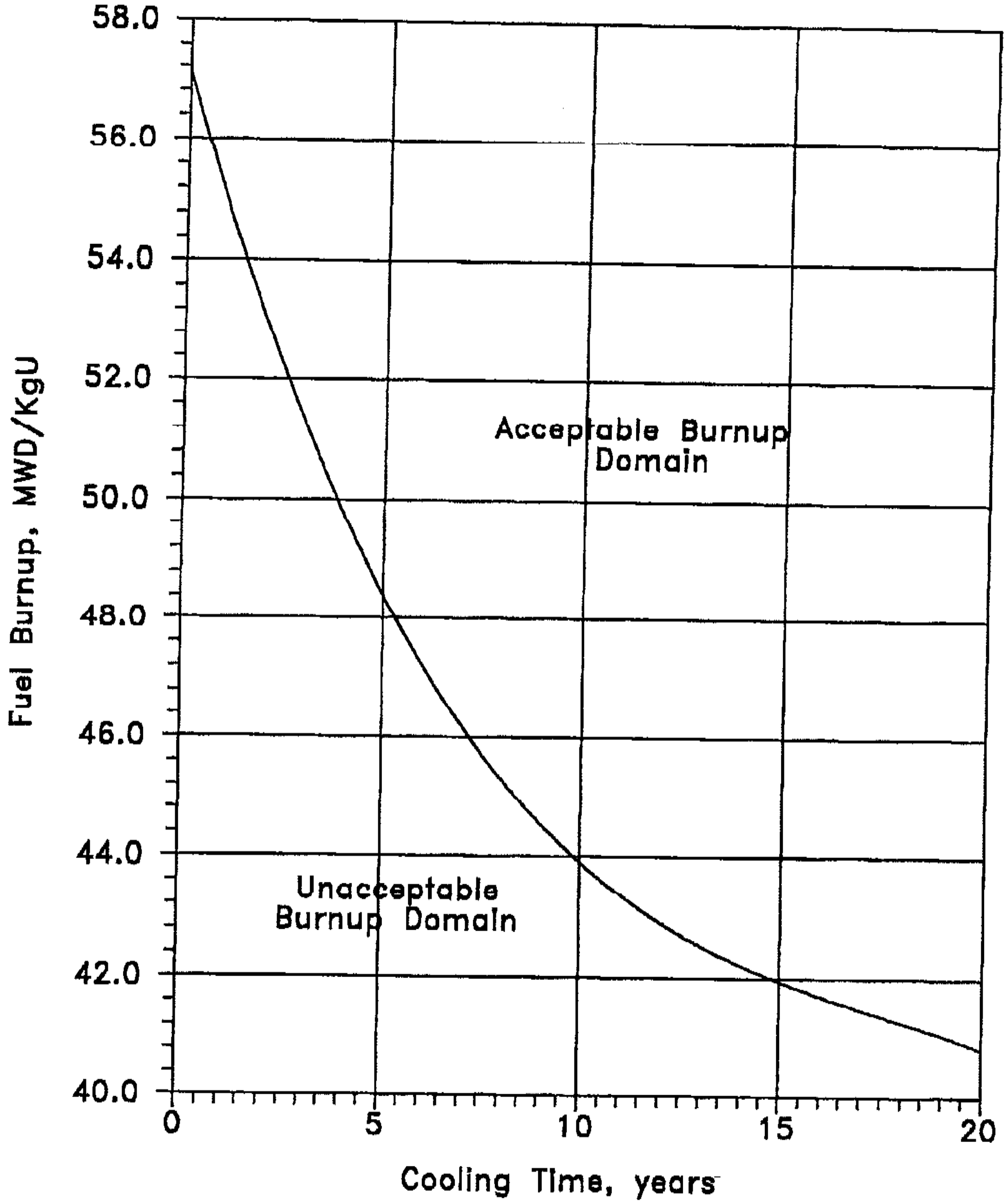


Fig. 5.6–5 Limiting Burnup Requirements in Region 4, Checkerboard Array of 1 Fresh and 3 Type T Spent Fuel Assemblies

Insert 16

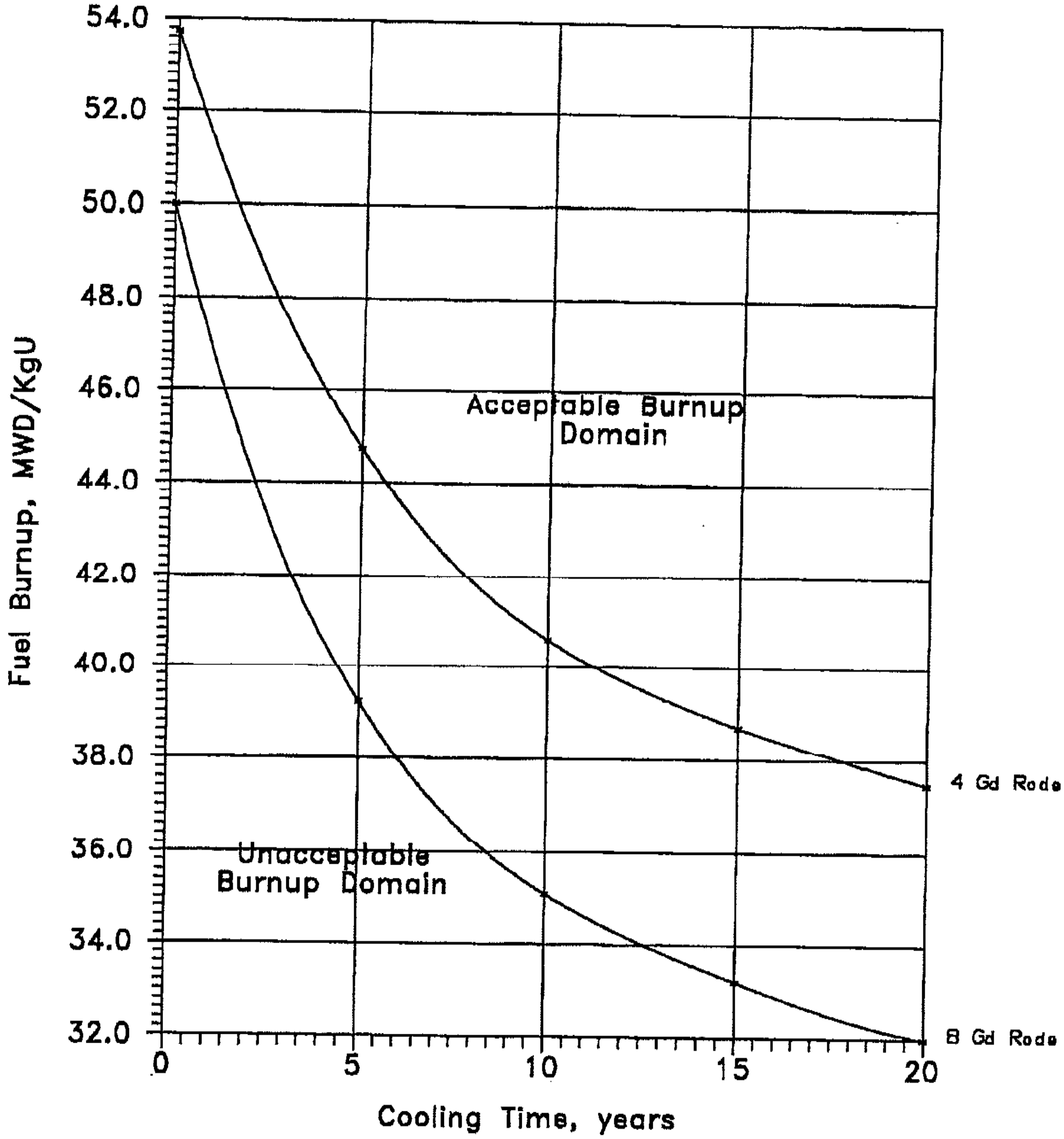


Fig. 5.6-6 Limiting Burnup Requirements in Region 4, Checkerboard Array of 1 Fresh (with Gadolinia) and 3 Type T Spent Fuel Assemblies

Table 5.6-1

Region 1 Storage Burnup Restrictions: Checkerboard of 1 Fresh Fuel Assembly ⇓ and 3 ***Type A*** Spent Fuel Assemblies ~~(Without Gadolinium or IFBA Rods)~~

(Without Gadolinium or IFBA Rods)

For Zero Year Cooling Time $\text{Bu (limit)} = -\ 28.1868 + 23.0765 \times E - 2.46264 \times E^2 + 0.167868 \times E^3$
For One Year Cooling Time $\text{Bu (limit)} = -\ 27.3317 + 22.5087 \times E - 2.40586 \times E^2 + 0.164207 \times E^3$
For Two Years Cooling Time $\text{Bu (limit)} = -26.4693 + 21.8404 \times E - 2.31873 \times E^2 + 0.158218 \times E^3$
For Three Years Cooling Time $\text{Bu (limit)} = -25.7404 + 21.2659 \times E - 2.24287 \times E^2 + 0.153018 \times E^3$
For Four Years Cooling Time $\text{Bu (limit)} = -\ 25.1367 + 20.7910 \times E - 2.18484 \times E^2 + 0.1499363 \times E^3$
For Five Years Cooling Time $\text{Bu (limit)} = -\ 24.5981 + 20.3568 \times E - 2.12719 \times E^2 + 0.145431 \times E^3$
For Ten Years Cooling Time $\text{Bu (limit)} = -\ 23.2050 + 19.2969 \times E - 2.06993 \times E^2 + 0.145875 \times E^3$
For Fifteen Years Cooling Time $\text{Bu (limit)} = -22.6098 + 18.8544 \times E - 2.08617 \times E^2 + 0.150473 \times E^3$
For Twenty Years Cooling Time $\text{Bu (limit)} = -\ 22.3017 + 18.622 \times E - 2.11206 \times E^2 + 0.15467 \times E^3$

Note: E = initial enrichment in the axial zone of highest enrichment (wt% U-235)

Table 5.6-2
Region 1 Storage Burnup Restrictions with Gadolinium or IFBA ***in Fresh Fuel***

With Gadolinium Credit: Checkerboard of 1 Fresh Fuel Assembly with 3 ***Type A*** Spent Fuel Assemblies

Zero Year Cooling Time, 0 Gadolinia Rods Bu (limit) = $- 28.1868 + 23.0765 \times E - 2.46264 \times E^2 + 0.167868 \times E^3$
Zero Year Cooling Time, 4 Gadolinia Rods Bu (limit) = $- 28.4012 + 22.0062 \times E - 2.19268 \times E^2 + 0.143601 \times E^3$
Zero Year Cooling Time, 8 Gadolinia Rods Bu (limit) = $- 31.4262 + 22.0768 \times E - 2.38845 \times E^2 + 0.164888 \times E^3$

Note: If more that 8 Gadolinium rods per assembly, use the 8 rod correlation

With IFBA Credit: Checkerboard of 1 Fresh Fuel Assembly with 3 ***Type A*** Spent Fuel Assemblies

Zero Year Cooling Time, 0 IFBA Rods Bu (limit) = $- 28.1868 + 23.0765 \times E - 2.46264 \times E^2 + 0.167868 \times E^3$
Zero Year Cooling Time, 16 IFBA Rods Bu (limit) = $- 28.5048 + 21.6411 \times E - 2.15262 \times E^2 + 0.140904 \times E^3$
Zero Year Cooling Time, 32 IFBA Rods Bu (limit) = $- 31.0949 + 22.0435 \times E - 2.36088 \times E^2 + 0.162229 \times E^3$
Zero Year Cooling Time, 48 IFBA Rods Bu (limit) = $- 33.1342 + 22.3999 \times E - 2.55367 \times E^2 + 0.18082 \times E^3$
Zero Year Cooling Time, 64 IFBA Rods Bu (limit) = $- 36.0468 + 24.1492 \times E - 3.11807 \times E^2 + 0.233987 \times E^3$

Note: If more that 64 IFBA rods per assembly, use the correlation for 64 IFBA rods
Note: E = initial enrichment in the axial zone of highest enrichment (wt% U-235)

Table 5.6-3
Region 2 Storage Burnup Restrictions
For Type A Fuel

Zero Cooling Time Bu (limit) = - 23.8702 + 12.3026 x E - 0.275672 x E^2
1 Year Cooling Time Bu (limit) = - 23.6854 + 12.2384 x E - 0.287498 x E^2
2 Years Cooling Time Bu (limit) = - 23.499 + 12.1873 x E - 0.305988 x E^2
3 Years Cooling Time Bu (limit) = - 23.3124 + 12.1249 x E - 0.319566 x E^2
4 Years Cooling Time Bu (limit) = - 23.1589 + 12.0748 x E - 0.332212 x E^2
5 Years Cooling Time Bu (limit) = - 22.6375 + 11.7906 x E - 0.307623 x E^2
10 Years Cooling Time Bu (limit) = - 21.7256 + 11.3660 x E – 0.31029 x E^2
15 Years Cooling Time Bu (limit) = - 21.1160 + 11.0663 x E - 0.306231 x E^2
20 Years Cooling Time Bu (limit) = - 20.6055 + 10.7906 x E - 0.29291 x E^2

Note: E = initial enrichment in the axial zone of highest enrichment (wt% U-235)

Table 5.6-4

Face Adjacent Storage of Type T Spent Fuel (Region 2)

$$Bu\ (limit) = 33.1095 - 0.845146 \times CT + 0.0399888 \times CT^2 - 0.000762846 \times CT^3$$

Table 5.6-5

Limiting Burnup For Checkerboard Storage of Fresh and Type T Spent Fuel
(Region 4: 1 Fresh Assembly and 3 Spent Fuel Assemblies in a 2X2 Arrangement)

$$Bu\ (limit) = 57.118 - 2.13277 \times CT + 0.0772537 \times CT^2 + 0.00127446 \times CT^3 - 9.15855\ E\text{-}5 \times CT^4$$

Table 5.6-6

Gadolinia Credit: Limiting Burnup For Checkerboard Storage of Fresh and Type T Spent Fuel
(Region 4: 1 Fresh Assembly with Gadolinia and 3 Spent Fuel Assemblies in a 2X2 Arrangement)

4 Gadolinia Rods

$$Bu\ (limit) = 53.73 - 2.5265 \times CT + 0.172283 \times CT^2 - 0.00585995 \times CT^3 + 0.0000766655 \times CT^4$$

8 Gadolinia Rods

$$Bu\ (limit) = 50.00 - 3.26817 \times CT + 0.276117 \times CT^2 - 0.0117934 \times CT^3 + 0.000195334 \times CT^4$$

Note: 1. If more than 8 gadolinia rods per assembly, use the 8 rod correlation
2. BU = Fuel Burnup, MWD/Kg-U; CT = Cooling Time of Spent Fuel Assemblies, Years

, and 4) tritium and hydrogen that exist in the Tritium Producing Burnable Absorber Rods prior to the accident

3/4.6.4 COMBUSTIBLE GAS CONTROL

The OPERABILITY of the equipment and systems required for the detection and control of hydrogen gas ensures that this equipment will be available to maintain the hydrogen concentration within containment below its flammable limit during post-LOCA conditions. Either recombiner unit or the hydrogen mitigation system, consisting of 68 hydrogen igniters per unit, is capable of controlling the expected hydrogen generation associated with 1) zirconium-water reactions, 2) radiolytic decomposition of water, ~~and~~ 3) corrosion of metals within containment. These hydrogen control systems are designed to mitigate the effects of an accident as described in Regulatory Guide 1.7, "Control of Combustible Gas Concentrations in Containment Following a LOCA," Revision 2, dated November 1978. The hydrogen monitors of Specification 3.6.4.1 are part of the accident monitoring instrumentation in Specification 3.3.3.7 and are designated as Type A, Category 1 in accordance with Regulatory Guide 1.97, Revision 2, "Instrumentation for Light-Water-Cooled Nuclear Power Plants to Assess Plant Conditions During and Following an Accident," December 1980.

The hydrogen mixing systems are provided to ensure adequate mixing of the containment atmosphere following a LOCA. This mixing action will prevent localized accumulations of hydrogen from exceeding the flammable limit.

The operability of at least 66 of 68 igniters in the hydrogen control distributed ignition system will maintain an effective coverage throughout the containment. This system of ignitors will initiate combustion of any significant amount of hydrogen released after a degraded core accident. This system is to ensure burning in a controlled manner as the hydrogen is released instead of allowing it to be ignited at high concentrations by a random ignition source.

3/4.6.5 ICE CONDENSER

The requirements associated with each of the components of the ice condenser ensure that the overall system will be available to provide sufficient pressure suppression capability to limit the containment peak pressure transient to less than 12 psig during LOCA conditions.

3/4.6.5.1 ICE BED

The OPERABILITY of the ice bed ensures that the required ice inventory will 1) be distributed evenly through the containment bays, 2) contain sufficient boron to preclude dilution of the containment sump following the LOCA and 3) contain sufficient heat removal capability to condense the reactor system volume released during a LOCA. These conditions are consistent with the assumptions used in the accident analyses.

The minimum weight figure of 1071 pounds of ice per basket contains a 15% conservative allowance for ice loss through sublimation which is a factor of 15 higher than assumed for the ice condenser design. The minimum weight figure of 2,082,024 pounds of ice also contains an additional 1% conservative allowance to account for systematic error in weighing instruments. In the

PLANT SYSTEMS

BASES

3/4.7.13 SPENT FUEL POOL MINIMUM BORON CONCENTRATION

Reports HI-992349 (Ref 1) and HI-2012629 (Ref 9)

BACKGROUND The spent fuel racks have been analyzed in accordance with the Holtec International methodology contained in Holtec ~~Report HI - 992349 (Ref. 1)~~. This methodology ensures that the spent fuel rack multiplication factor, k_{eff} is less than or equal to 0.95, as recommended by the NRC guidance contained in NRC Letter to All Power Reactor Licensees from B.K. Grimes, "OT Position for Review and Acceptance of Spent Fuel Storage and Handling Applications", April 14, 1978 and USNRC Internal Memorandum from L. Kopp, "Guidance On The Regulatory Requirements For Criticality Analysis Of Fuel Storage At Light-Water Reactor Power Plants", August 19, 1998 (Refs. 2 & 3). The codes, methods, and techniques contained in the methodology are used to satisfy the k_{eff} criterion. The spent fuel storage racks were analyzed using Westinghouse 17x17 V5H fuel assemblies, with enrichments up to 4.95 ±0.05 w/o U-235 and configurations which take credit for checkerboarding, burnup, soluble boron, integral fuel burnable absorbers (such as IFBA or gadolinia), and cooling time to ensure that k_{eff} is maintained ≤ 0.95, including uncertainties, tolerances, and accident conditions. ***[Insert 17]*** In addition, the SFP k_{eff} is maintained < 1.0, including uncertainties, tolerances on a 95/95 basis without any soluble boron. Calculations were performed to evaluate the reactivity of fuel types used at SQN. The results show that the Westinghouse 17x17 V5H fuel assembly exhibits the highest reactivity, thereby bounding all fuel types utilized and stored at SQN.

Replace with Insert 18

In the high density Spent Fuel Storage Rack design (Refs. 1 and 4), the spent fuel storage pool is divided into three separate and distinct regions which, for the purpose of criticality considerations, are considered as separate pools. Region 1 is designed to accommodate new fuel with a maximum enrichment of 4.95 ± 0.05 wt% U-235, or spent fuel regardless of the discharge fuel burnup in a 1-in-4 checkerboard arrangement of 1 fresh assembly with 3 spent fuel assemblies with enrichment, burnup and cooling times in accordance with Design Features 5.6.1.1.c.1. Region 2 is designed to accommodate fuel which have 4.95 ± 0.05 wt% U-235 initial enrichment burned to at least 30.27 MWD/KgU (assembly average), or fuel of other enrichment with a burnup yielding an equivalent reactivity in the fuel racks in accordance with Design Features 5.6.1.1.c.2. Region 3 is designed to accommodate fuel of 4.95 ± 0.05 wt% U-235 initial enrichment or fuel assemblies of any lower reactivity in a 2-out-of-4 checkerboard arrangement with water-filled cells and in accordance with Design Features 5.6.1.1.c.3.

The water in the spent fuel storage pool normally contains soluble boron, which results in large subcriticality margins under actual operating conditions. However, the NRC guidelines, based upon the accident condition in which all soluble poison is assumed to have been lost, specify that the limiting k_{eff} of < 1.0 be evaluated in the absence of soluble boron. Hence, the design of all regions is based on the use of unborated water, which maintains each region in a subcritical condition during normal operation with the regions fully loaded. The double contingency principle discussed in ANSI N-16.1-1975 and the April 1978 NRC letter (Ref. 5) allows credit for soluble boron under other abnormal or accident conditions, since only a single accident need be considered at one time. For example, the most

(continued)

Insert 17

The analysis also accounts for the reactivity effects of operating the fuel with discrete burnable poisons (such as burnable poison rod absorbers or tritium producing burnable absorber rods).

Insert 18

In the high density Spent Fuel Rack design (Ref. 9), the spent fuel storage pool is divided into four separate and distinct regions which, for the purpose of criticality considerations, are considered as separate pools. For convenience of reference, the following definitions apply:

Type A fuel refers to spent fuel assemblies which have not contained tritium producing burnable absorber rods (TPBAR's) during in-core operation.

Type T fuel refers to spent fuel assemblies which have contained tritium producing burnable absorber rods (TPBAR's) during in-core operation.

Fresh fuel refers to unirradiated Type A or Type T fuel or irradiated Type A or Type T fuel which has not attained sufficient burnup to meet spent fuel requirements.

Cooling time is defined as the period since reactor shutdown at the end of the last operating cycle for the discharged spent fuel assembly.

Region 1 is designed to accommodate fresh fuel with a maximum enrichment of 4.95 +/- 0.05 wt% U-235, or spent fuel regardless of the discharge burnup in a 1-of-4 checkerboard arrangement of 1 fresh assembly with 3 spent Type A fuel assemblies with enrichment, burnup, and cooling times in accordance with Design Feature 5.6.1.1.c.1. Region 2 is designed to accommodate Type A or Type T fuel of up to 4.95 +/- 0.05 wt% U-235 initial enrichment burned to an assembly average burnup of at least 30.27 MWD/kgU for Type A fuel or 33.1095 MWD/kgU for Type T fuel, or other enrichment with a burnup yielding an equivalent reactivity in the fuel racks in accordance with Design Feature 5.6.1.1.c.2. Region 3 is designed to accommodate fresh fuel of up to 4.95 +/- 0.05 wt% U-235 initial enrichment, or fuel assemblies of any lower reactivity in a 2-of-4 checkerboard arrangement with water-filled cells in accordance with Design Feature 5.6.1.1.c.3. Region 4 is designed to accommodate fresh fuel up to 4.95 +/- 0.05 wt% U-235 initial enrichment, or spent fuel regardless of the discharge burnup in a 1-of-4 checkerboard arrangement of 1 fresh assembly with 3 spent Type T fuel assemblies with burnup and cooling times in accordance with Design Feature 5.6.1.1.c.4.

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BACKGROUND (continued)

severe accident scenario is associated with the accidental mishandling of a fresh fuel assembly face adjacent to a fresh fuel assembly of Region 3. This could potentially increase the criticality of Region 3. To mitigate these postulated criticality related accidents, boron is dissolved in the pool water. The soluble boron concentration required to maintain $k_{eff} \leq 0.95$ under normal conditions is 300 ppm and 700 ppm under the most severe postulated fuel mis-location accident. Safe operation of the spent fuel storage racks may therefore be achieved by controlling the location of each assembly in accordance with Design Features 5.6 FUEL STORAGE. During fuel movement, it is necessary to perform Surveillance Requirement 4.7.13.2.

APPLICABLE SAFETY ANALYSES

Most accident conditions do not result in an increase in the reactivity of any one of the three regions. Examples of these accident conditions are the loss of cooling and the dropping of a fuel assembly on the top of the rack. However, accidents can be postulated that could increase the reactivity. This increase in reactivity is unacceptable with unborated water in the storage pool. Thus, for these accident occurrences, the presence of soluble boron in the storage pool prevents criticality in all regions. The most limiting postulated accident with respect to the storage configurations assumed in the spent fuel rack criticality analysis is the misplacement of a nominal 4.95 ± 0.05 w/o U-235 ***fresh*** fuel assembly into an empty storage cell location in the Region 3 checkerboard storage arrangement. The amount of soluble boron required to maintain k_{eff} less than or equal to 0.95 due to this fuel misload accident is 700 ppm (Ref. 1 ***and Ref. 9***).

A spent fuel boron dilution analysis was performed to ensure that sufficient time is available to detect and mitigate dilution of the spent fuel pool prior to exceeding the k_{eff} design basis limit of 0.95 (Ref. 6). The spent fuel pool boron dilution analysis concluded that an inadvertent or unplanned event that would result in a dilution of the spent fuel pool boron concentration from 2000 ppm to 700 ppm is not a credible event.

The concentration of dissolved boron in the spent fuel storage pool satisfies Criterion 2 of the NRC Policy Statement.

LCO

The spent fuel storage pool boron concentration is required to be ≥ 2000 ppm. The specified concentration of dissolved boron in the spent fuel storage pool preserves the assumptions used in the analyses of the potential critical accident scenarios as described in Reference 7. This concentration of dissolved boron is the minimum required concentration for fuel assembly storage and movement within the spent fuel storage pool.

(continued)

PLANT SYSTEMS

BASES (continued)

APPLICABILITY

This LCO applies whenever fuel assemblies are stored in the spent fuel storage pool.

ACTIONS

Action a:

When the concentration of boron in the spent fuel storage pool is less than required, immediate action must be taken to preclude the occurrence of an accident or to mitigate the consequences of an accident in progress. This is most efficiently achieved by immediately suspending the movement of fuel assemblies. The concentration of boron is restored along with suspending movement of fuel assemblies.

Action a is modified by a provision indicating that LCO 3.0.3 does not apply. If the LCO is not met while moving irradiated fuel assemblies in MODE 5 or 6, LCO 3.0.3 would not be applicable. Moving irradiated fuel assemblies while in MODE 1, 2, 3, or 4 is independent of reactor operation. Therefore, inability to suspend movement of fuel assemblies is not sufficient reason to require a reactor shutdown.

SURVEILLANCE REQUIREMENTS

Surveillance 4.7.13.1

This Surveillance Requirement verifies that the concentration of boron in the spent fuel storage pool is within the required limit. As long as this Surveillance Requirement is met, the analyzed accidents are fully addressed. The 7 day Frequency is appropriate because no significant replenishment of pool water is expected to take place over such a short period of time. (Ref. 6)

Surveillance 4.7.13.2

This Surveillance Requirement verifies that the concentration of boron in the spent fuel storage pool is within the required limit during fuel movement until the final configuration of the assemblies in the storage racks is verified to be correct. As long as this Surveillance Requirement is met, the analyzed accidents are fully addressed. The 72 hour Frequency provides additional assurance that the maximum k_{eff} remains below the 0.95 limit under the postulated accident condition. (Ref. ~~8~~ ***1, 8, and 9***)

(continued)

PLANT SYSTEMS

BASES (continued)

REFERENCES

1. Stanley E. Turner (Holtec International), “Criticality Safety Analyses of Sequoyah Spent Fuel Racks with Alternative Arrangements,” HI-992349

2. B.K. Grimes (NRC GL78011), “OT Position for Review and Acceptance of Spent Fuel Storage and Handling Applications”, April 14, 1978

3. L. Kopp, “Guidance On The Regulatory Requirements For Criticality Analysis Of Fuel Storage At Light-Water Reactor Power Plants”, August 19, 1998

4. UFSAR, Section 4.3.2.7, "Critically of Fuel Assemblies"

5. Double contingency principle of ANSI N16.1-1975, as specified in the April 14, 1978 NRC letter (Section 1.2) and implied in the proposed revision to Regulatory Guide 1.13 (Section 1.4, Appendix A).

6. K K Niyogi (Holtec International), “Boron Dilution Analysis,” HI-992302

7. FSAR, Section 15.4.5

8. NRC letter to TVA dated August 1, 1990, “ Increase Fuel Enrichment to 5.0 Weight Percent (TAC Nos. 76074, 76075, 76774, 76775) (TS 90-12) - Sequoyah Nuclear Plant, Units 1 and 2”

9. ***Stanley E. Turner (Holtec International), “Evaluation of the Effect of the Use of Tritium Producing Burnable Absorber Rods (TPBARs) on Fuel Storage Requirements”, HI-2012629***

PLANT SYSTEMS **_[This page deleted]_**

BASES

3/4.7.14 CASK PIT POOL MINIMUM BORON CONCENTRATION

BACKGROUND

The Sequoyah cask pit pool consists of a deep pool with adjacent shelf area. The cask pit pool is connected to the spent fuel pool through a weir gate. The cask pit is intended to be used for spent fuel shipment activities.

High density spent fuel storage racks have been approved for addition and use in the cask loading area of the cask pit (Ref. 1) but presently are not installed. The 15 x 15 module could store 225 fuel assemblies and is designed to maintain stored fuel having an initial enrichment of up to 5 wt % U-235, in a safe, coolable, and sub-critical configuration during normal discharge, full core offload storages and postulated accident conditions. Fuel assemblies shall be stored in accordance with paragraph 5.6.1.1.d in Design Features 5.6, Fuel Storage.

APPLICABLE SAFETY ANALYSES

Most accident conditions do not result in an increase in the reactivity of the cask pit. Examples of accident conditions are the loss of cooling and the dropping of a fuel assembly on the top of the rack. However, accidents can be postulated that could increase the reactivity. This increase in reactivity is unacceptable with unborated water in the storage pool. Thus, for these accident occurrences, the presence of soluble boron in the cask pit pool prevents criticality. The most limiting postulated accident bounding the cask pit pool has been determined to occur in the spent fuel pool. The postulated accident with respect to the storage configurations assumed in the spent fuel rack criticality analysis is the misplacement of a nominal 4.95 ± 0.05 w/o U-235 fuel assembly into an storage cell location in the Region 2 checkerboard storage arrangement for an irradiated fuel assembly. The amount of soluble boron required to maintain k_{eff} less than or equal to 0.95 due to this fuel misload accident is 700 ppm (Ref. 2).

The concentration of dissolved boron in the fuel storage pool satisfies Criterion 2 of the NRC Policy Statement.

LCO

The cask pit pool boron concentration is required to be ≥ 2000 ppm. The specified concentration of dissolved boron in the cask pit pool preserves the assumptions used in the analyses of the potential critical accident scenarios as described in Reference 3. This concentration of dissolved boron is the minimum required concentration for fuel assembly storage and movement within the cask pit pool.

(continued)

PLANT SYSTEMS

[This page deleted]

BASES (continued)

APPLICABILITY

This LCO applies whenever fuel assemblies are stored in the cask pit pool.

ACTIONS

Action a:

When the concentration of boron in the cask pit pool is less than required, immediate action must be taken to preclude the occurrence of an accident or to mitigate the consequences of an accident in progress. This is most efficiently achieved by immediately suspending the movement of fuel assemblies. The concentration of boron is restored along with suspending movement of fuel assemblies.

Action a is modified by a provision indicating that LCO 3.0.3 does not apply. If the LCO is not met while moving irradiated fuel assemblies in MODE 5 or 6, LCO 3.0.3 would not be applicable. Moving irradiated fuel assemblies while in MODE 1, 2, 3, or 4 is independent of reactor operation. Therefore, inability to suspend movement of fuel assemblies is not sufficient reason to require a reactor shutdown.

SURVEILLANCE REQUIREMENTS

Surveillance 4.7.14.1

This Surveillance Requirement verifies that the concentration of boron in the cask pit pool is within the required limit. As long as this Surveillance Requirement is met, the analyzed accidents are fully addressed. The 7 day Frequency is appropriate because no significant replenishment of pool water is expected to take place over such a short period of time. (Ref. 4)

Surveillance 4.7.14.2

This Surveillance Requirement verifies that the concentration of boron in the cask pit pool is within the required limit during fuel movement until the final configuration of the assemblies in the storage racks is verified to be correct. As long as this Surveillance Requirement is met, the analyzed accidents are fully addressed. The 72 hour Frequency provides additional assurance that the maximum k_{eff} remains below the 0.95 limit under the postulated accident condition. (Ref. 1)

(continued)

PLANT SYSTEMS **_[This page deleted]_**

BASES (continued)

REFERENCES

1. NRC letter to TVA dated April 28, 1993, “Issuance of Amendments (TAC Nos. M83068 and M83069)”

2. Stanley E. Turner (Holtec International), “Criticality Safety Analyses of Sequoyah Spent Fuel Racks with Alternative Arrangements,” HI-992349

3. FSAR, Section 15.4.5

4. K. K. Niyogi (Holtec International), “Boron Dilution Analysis,” HI-992302

ENCLOSURE 3

TENNESSEE VALLEY AUTHORITY
SEQUOYAH NUCLEAR PLANT (SQN)
UNITS 1 AND 2
DOCKET NO. 327, 328

PROPOSED TECHNICAL SPECIFICATION (TS) CHANGE
REVISED PAGES

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5-5d	5-5d
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5-5f	5-5f
5-5g	5-5g
5-5h	5-5h
5-5i	5-5i
5-5j	5-5j
5-5k	5-5k
5-5l	5-5l
5-5m	5-5m
5-5n	5-5n
5-5o	5-5o
B 3/4 6-4	B 3/4 6-4
B 3/4 7-9	B 3/4 7-9
B 3/4 7-10	B 3/4 7-10
B 3/4 7-11	B 3/4 7-11
B 3/4 7-12	B 3/4 7-12
B 3/4 7-13	B 3/4 7-13

II. REVISED PAGES

See attached

LIMITING CONDITIONS FOR OPERATION AND SURVEILLANCE REQUIREMENTS

This portion affected by TS Change Request 99-18

This portion affected by TS Change Request 99-18

TABLE 3.3-9

REMOTE SHUTDOWN MONITORING INSTRUMENTATION

	INSTRUMENT	READOUT LOCATION	MEASUREMENT RANGE	MINIMUM CHANNELS OPERABLE
1.	Source Range Nuclear Flux	NOTE 1	0.1 to 1 x 10^5 cps	1
2.	Reactor Trip Breaker Indication	at trip switchgear	OPEN-CLOSE	1/trip breaker
3.	Reactor Coolant Temperature - Hot Leg	NOTE 1	0-650°F	1/loop
4.	Pressurizer Pressure	NOTE 1	0-3000 psig	1
5.	Pressurizer Leve1	NOTE 1	0-100%	1
6.	Steam Generator Pressure	NOTE 1	0-1200 psig	1/steam generator
7.	Steam Generator Leve1	NOTE 2 or near Auxilary F. W. Pump	0-100%	1/steam generator
8.	Deleted			
9.	RHR Flow Rate	NOTE 1	0-4500 gpm	1
10.	RHR Temperature	NOTE 1	50-400°F	1
11.	Auxiliary Feedwater Flow Rate	NOTE 1	0-440 gpm	1/steam generator

3/4.5 EMERGENCY CORE COOLING SYSTEMS (ECCS)

3/4.5.1 ACCUMULATORS

COLD LEG INJECTION ACCUMULATORS

LIMITING CONDITION FOR OPERATION

3.5.1.1 Each cold leg injection accumulator shall be OPERABLE with:

a. The isolation valve open,

b. A contained borated water volume of between 7615 and 7960 gallons of borated water,

c. Between 3500 and 3800 ppm of boron,

d. A nitrogen cover-pressure of between 624 and 668 psig, and

e. Power removed from isolation valve when RCS pressure is above 2000 psig.

APPLICABILITY: MODES 1, 2 and 3.*

ACTION:

a. With one cold leg injection accumulator inoperable, except as a result of boron concentration not within limits, restore the inoperable accumulator to OPERABLE status within one hour or be in at least HOT STANDBY within the next 6 hours and reduce pressurizer pressure to 1000 psig or less within the following 6 hours.

b. With one cold leg injection accumulator inoperable due to the boron concentration not within limits, restore boron concentration to within limits within 72 hours or be in at least HOT STANDBY within the next 6 hours and reduce pressurizer pressure to 1000 psig or less within the following 6 hours.

*Pressurizer pressure above 1000 psig.

3/4.5.5 REFUELING WATER STORAGE TANK

LIMITING CONDITION FOR OPERATION

3.5.5 The refueling water storage tank (RWST) shall be OPERABLE with:

a. A contained borated water volume of between 370,000 and 375,000 gallons,

b. A boron concentration of between 3600 and 3800 ppm of boron,

c. A minimum solution temperature of 60°F, and

d. A maximum solution temperature of 105°F.

APPLICABILITY: MODES 1, 2, 3 and 4.

ACTION:

With the RWST inoperable, restore the tank to OPERABLE status within 1 hour or be in at least HOT STANDBY within 6 hours and in COLD SHUTDOWN within the following 30 hours.

SURVEILLANCE REQUIREMENTS

4.5.5 The RWST shall be demonstrated OPERABLE:

a. At least once per 7 days by:

   1. Verifying the contained borated water volume in the tank, and

   2. Verifying the boron concentration of the water.

b. At least once per 24 hours by verifying the RWST temperature.

3/4.7.14 CASK PIT POOL MINIMUM BORON CONCENTRATION

LIMITING CONDITION FOR OPERATION

3.7.14 This specification has been deleted.

5.3 REACTOR CORE

FUEL ASSEMBLIES

5.3.1 The reactor shall contain 193 fuel assemblies. Each assembly shall consist of a matrix of zircaloy or M5 clad fuel rods with an initial composition of natural or slightly enriched uranium dioxide as fuel material. Limited substitutions of zirconium alloy or stainless steel filler rods for fuel rods, in accordance with NRC-approved applications of fuel rod configurations, may be used. Fuel assemblies shall be limited to those fuel designs that have been analyzed with applicable NRC staff-approved codes and methods, and shown by tests or analyses to comply with all fuel safety design bases. A limited number of lead test assemblies that have not completed representative testing may be placed in nonlimiting core regions. Sequoyah is authorized to place a limited number of lead test assemblies into the reactor as described in the Framatome-Cogema Fuels report BAW-2328, beginning with the Unit 1 Operating Cycle 12.

Sequoyah is authorized to place a maximum of 2256 Tritium Producing Burnable Absorber Rods into the reactor in an operating cycle.

CONTROL ROD ASSEMBLIES

5.3.2 The reactor core shall contain 53 full length and no part length control rod assemblies. The full length control rod assemblies shall contain a nominal 142 inches of absorber material. The nominal values of absorber material shall be 80 percent silver, 15 percent indium and 5 percent cadmium. All control rods shall be clad with stainless steel tubing.

5.4 REACTOR COOLANT SYSTEM

DESIGN PRESSURE AND TEMPERATURE

5.4.1 The reactor coolant system is designed and shall be maintained:

a. In accordance with the code requirements specified in Section 5.2 of the FSAR, with allowance for normal degradation pursuant to the applicable Surveillance Requirements,

b. For a pressure of 2485 psig, and

c. For a temperature of 650°F, except for the pressurizer which is 680°F.

VOLUME

5.4.2 The total water and steam volume of the reactor coolant system is 12,612 ± 100 cubic feet at a nominal T_{avg} of 525°F.

5.5 METEOROLOGICAL TOWER LOCATION

5.5.1 The meteorological tower shall be located as shown on Figure 5.1-1.

5.6 FUEL STORAGE

CRITICALITY - SPENT FUEL

For convenience of reference, the following definitions apply:

Type A fuel refers to spent fuel assemblies which have not contained tritium producing burnable absorber rods (TPBAR's) during in-core operations.

Type T fuel refers to spent fuel assemblies which have contained tritium producing burnable absorber rods (TPBAR's) during in-core operations.

Fresh fuel refers to unirradiated Type A or Type T fuel or irradiated Type A or Type T fuel that has not attained sufficient burnup to meet spent fuel requirements.

Cooling time is defined as the period since reactor shutdown at the end of the last operating cycle for the discharged spent fuel assembly.

5.6.1.1 The spent fuel storage racks are designed for fuel enriched to 5 weight percent U-235 and shall be maintained with:

a. A k_{eff} less than critical when flooded with unborated water and a k_{eff} less than or equal to 0.95 when flooded with water containing 300 ppm soluble boron.*

b. A nominal 8.972 inch center-to-center distance between fuel assemblies placed in the storage racks.

c. Arrangements of one or more of three different arrays (Regions) or sub-arrays as illustrated in Figures 5.6-1 and 5.6-1a. These arrangements in the spent fuel storage pool have the following definitions:

   1. Region 1 is designed to accommodate new fuel with a maximum enrichment of 4.95 ± 0.05 wt% U-235, (or spent fuel regardless of the fuel burnup), in a 1-in-4 checkerboard arrangement of 1 fresh assembly with 3 Type A spent fuel assemblies with enrichment-burnup and cooling times illustrated in Figure 5.6-2 and defined by the equations in Table 5.6-1. The presence of a removable, non-fissile insert such as a burnable poison rod assembly (BPRA) or either gadolinia or integral fuel burnable absorber (IFBA) in a fresh fuel assembly does not affect the applicability of Figure 5.6-2 or Table 5.6-1.

      Two alternative storage arrays (or sub-arrays) are acceptable in Region 1 if the fresh fuel assemblies contain rods with either gadolinia or integral fuel burnable absorber (IFBA). For these types of assemblies, the minimum burnup of the spent fuel in the 1-of-4 sub-array are defined by the equations in Table 5.6-2.

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*For some accident conditions, the presence of dissolved boron in the pool water may be taken into account by applying the double contingency principle which requires two unlikely, independent, concurrent events to produce a criticality accident.

5.6 FUEL STORAGE

Restrictions in Region 1

Any of the three sub-arrays illustrated in Figure 5.6-1a may be used in any combination provided that:

A) Each sub-array of 4 fuel assemblies includes, in addition to the fresh fuel assembly, 3 assemblies with enrichment and minimum burnup requirements defined by the equations in Tables 5.6-1 and 5.6-2, as appropriate.

B) The arrangement of Region 1 sub-arrays must not allow a configuration with fresh assemblies adjacent to each other.

C) If Region 1 arrays are used in conjunction with Region 3 or Region 4 arrangements (see below), the arrangements shall not allow fresh fuel assemblies to be adjacent to each other (see also Figure 5.6-1).

D) If miscellaneous non-fissile bearing items or equipment are stored in cells of Region 1, the total volume of the miscellaneous items shall be no more than 75% of the total storage cell volume.

2. Region 2 is designed to accommodate Type A or Type T fuel of 4.95±0.05 wt% U-235 initial enrichment burned to at least 30.27 (Type A) or 33.1095 (Type T) MWD/KgU (assembly average), or fuel of other enrichments with a burnup yielding an equivalent reactivity in the fuel racks. The minimum required assembly average burnup in MWD/KgU and cooling time is given by the equations in Table 5.6-3 (Type A) or 5.6-4 (Type T). The minimum required burnups are illustrated in Figure 5.6-3 (Type A) or 5.6-4 (Type T) in terms of the initial enrichment and cooling time.

Restrictions in Region 2

The following restrictions apply to the storage of spent fuel in the Region 2 cells:

A) The spent fuel shall conform to the minimum burnup requirements defined by the equations in Table 5.6-3 or 5.6-4, as appropriate. Linear interpolation between cooling times may be made if desired.

B) For the interface with Region 1 or 4 storage cells, fresh fuel in Region 1 or 4 shall not be stored adjacent to spent fuel assemblies in the Region 2 storage cells.

C) If miscellaneous non-fissile bearing items or equipment are stored in cells of Region 2, the total volume of the miscellaneous items shall be no more than 75% of the total storage cell volume.

3. Region 3 is designed to accommodate fuel of 4.95±0.05 wt% U-235 initial enrichment (or fuel assemblies of any lower reactivity) in a 2-out-of-4 checkerboard arrangement with water-filled cells. The water-filled cells shall not contain any components bearing any fissile material, but may accommodate miscellaneous items or equipment.

5.6 FUEL STORAGE

Restrictions in Region 3

The following restrictions apply to the storage of fuel in the Region 3 cells:

A) For the interface between Region 3 and Region 1 or 4 storage regions, fresh fuel assemblies shall not be stored adjacent to each other.

B) If miscellaneous non-fissile bearing items or equipment are stored in the water cells of Region 3, the total volume of the miscellaneous items shall be no more than 75% of the storage cell volume.

C) No loose fuel rods or items containing fissile material shall be stored in the water cells of Region 3.

4. Region 4 is designed to accommodate fresh fuel with a maximum enrichment of 4.95 ± 0.05 wt% U-235 (or spent fuel regardless of the fuel burnup), in a 1-in-4 checkerboard arrangement of 1 fresh assembly with three Type T spent fuel assemblies having burnup and cooling times illustrated in Figure 5.6-5 and defined by the equations in Table 5.6-5. The presence of either gadolinia or integral fuel burnable absorber (IFBA) in a fresh fuel assembly does not affect the applicability of Figure 5.6-5 or Table 5.6-5.

One alternative storage array (or sub-array) is acceptable in Region 4 if the fresh fuel contains rods with gadolinia fuel burnable absorber. For these types of assemblies, the minimum burnup of the spent fuel in the 1-of-4 sub-array is defined by the equations in Table 5.6-6 and illustrated in Figure 5.6-6. For fresh assemblies containing more than eight (8) gadolinia bearing fuel rods, the limiting burnup for eight (8) gadolinia rods shall apply.

Restrictions in Region 4

Any of the two sub-arrays illustrated in Figure 5.6-1a applying to Region 4 storage may be used in any combination provided that:

A) Each sub-array of 4 fuel assemblies includes, in addition to the fresh fuel assembly, 3 assemblies with enrichment and minimum burnup requirements defined by the equations in Tables 5.6-5 and 5.6-6, as appropriate.

B) The arrangement of Region 4 sub-arrays must not allow a configuration with fresh assemblies adjacent to each other.

C) If Region 4 arrays are used in conjunction with Region 1 or 3 arrangements, the arrangements shall not allow fresh fuel assemblies to be adjacent to each other (see Figure 5.6-1)

D) If miscellaneous non-fissile bearing items or equipment are stored in cells of Region 4, the total volume of the miscellaneous items shall be no more than 75% of the total storage cell volume.

d. An empty cell (or a cell containing non-fissile bearing miscellaneous items displacing no more than 75% of the storage cell volume) is less reactive than any cell containing fuel and therefore may be used as a Region 1, 2, 3, or 4 cell in any arrangement.

e. A nominal concentration of 2000 ppm boron is in the pool water. This concentration of soluble boron provides a margin sufficient to allow timely detection of a boron dilution accident and corrective action before the minimum concentration (700 ppm) required to protect against the most severe postulated fuel handling accident or before the minimum concentration (300 ppm) required to maintain the storage configuration design basis (keff less than 0.95) is reached.

5.6 FUEL STORAGE

CRITICALITY - NEW FUEL

5.6.1.2 The new fuel pit storage racks are designed for fuel enriched to 5.0 weight percent U-235 and shall be maintained with the arrangement of 146 storage locations shown in Figure 5.6-7. The cells shown as empty cells in Figure 5.6-7 shall have physical barriers installed to ensure that inadvertant loading of fuel assemblies into these locations does not occur. This configuration ensures k_{eff} will remain less than or equal to 0.95 when flooded with unborated water and less than or equal to 0.98 under optimum moderation conditions.

DRAINAGE

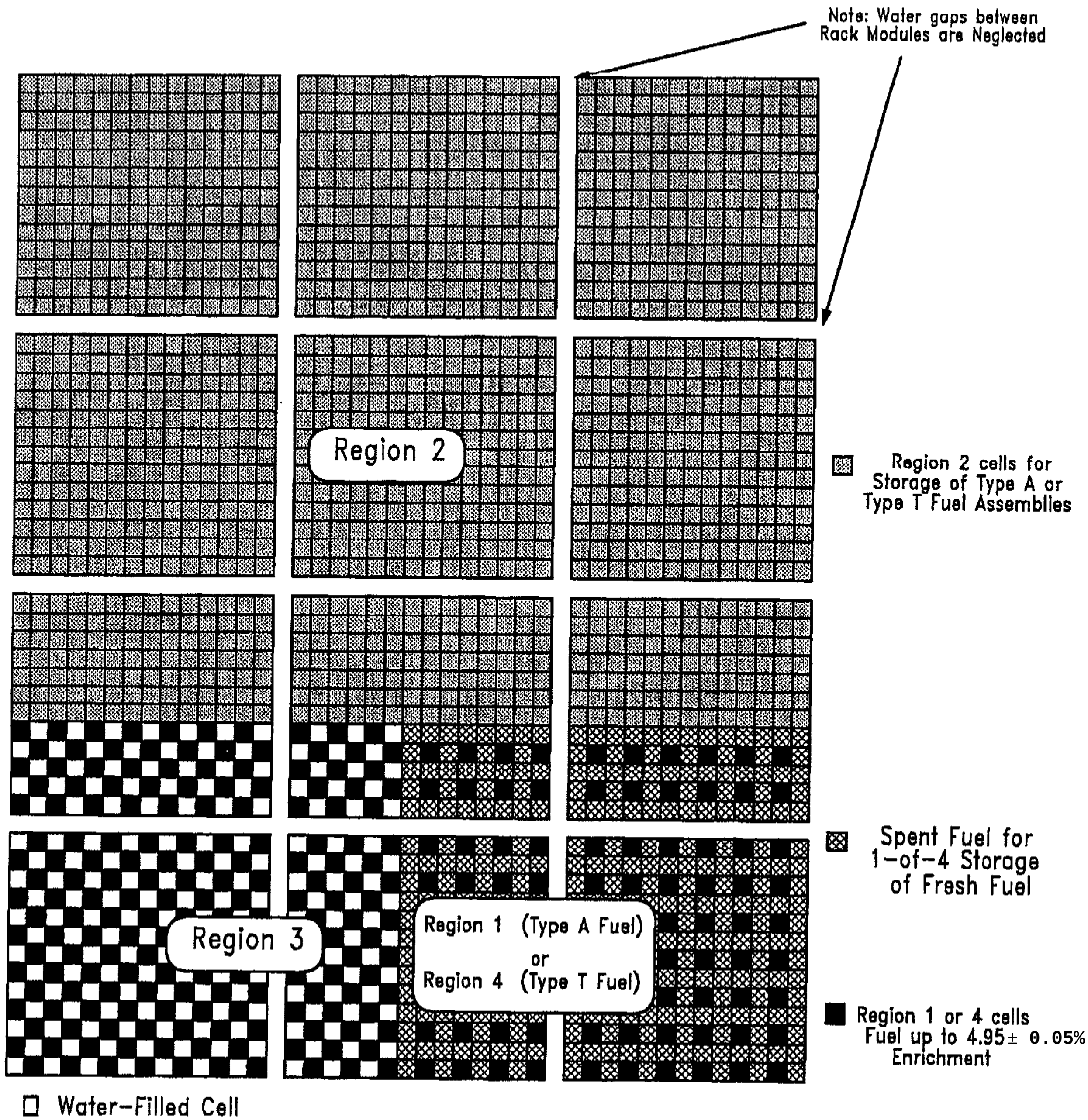
5.6.2 The spent fuel pit is designed and shall be maintained to prevent inadvertent draining of the pool below elevation 722 ft.

CAPACITY

5.6.3 The spent fuel storage pool is designed and shall be maintained with a storage capacity limited to no more than 2091 fuel assemblies.

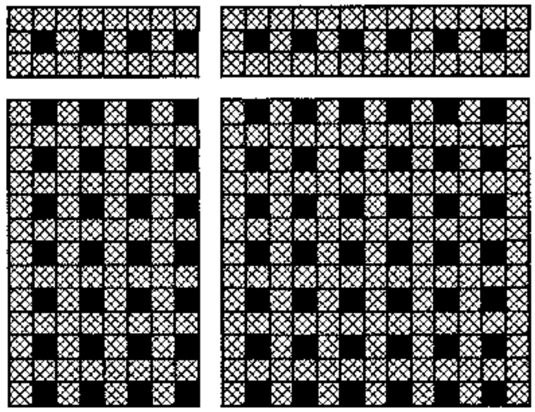
5.7 COMPONENT CYCLIC OR TRANSIENT LIMIT

5.7.1 The components identified in Table 5.7-1 are designed and shall be maintained within the cyclic or transient limits of Table 5.7-1.



Note: The edges of the sketch above are not necessarily the edges of the pool. The Regions may appear anywhere in the pool and in any orientation, subject to the restrictions in Design Features 5.6.1.1.c.

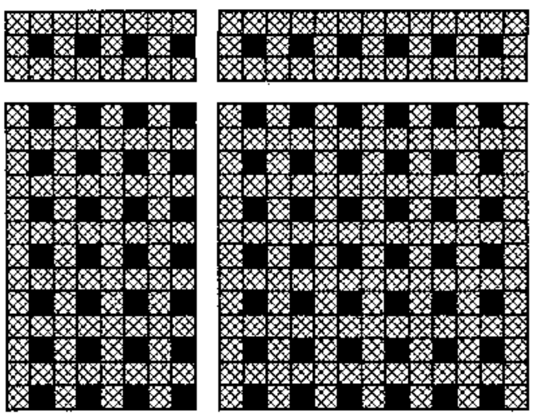
FIG 5.6-1 Arrangements of Fuel Storage Regions in the Sequoyah Spent Fuel Storage Pool



☒ Spent Fuel for Storage in Region 1 (Type A Fuel) or Region 4 (Type T Fuel) in 1-of-4 Pattern

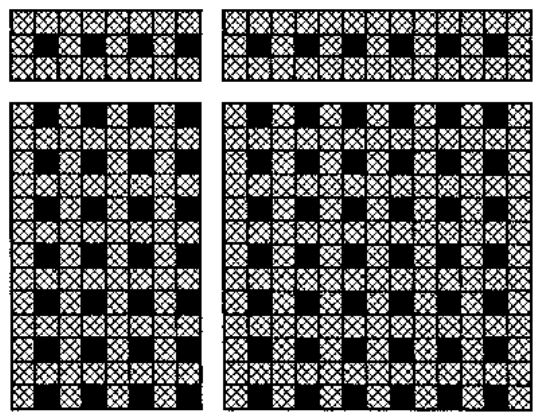
■ Fresh Fuel for Region 1 or Region 4 cells (No Gd or IFBA)

NOTE: WHEN CREDIT IS TAKEN FOR GADOLINIA RODS IN FRESH ASSEMBLIES THE SPENT FUEL ASSEMBLIES NEED NOT HAVE CONTAINED GADOLINIA RODS..



☒ Spent Fuel for Storage of Region 1 (Type A Fuel) or Region 4 (Type T Fuel) in 1-of-4 Pattern

■ Fresh Fuel with Gadolinia for Region 1 or Region 4 cells



☒ Spent Fuel for Storage in Region 1 in 1-of-4 Pattern

■ Fresh Fuel with IFBA Rods for Storage in Region 1 only (1-of-4 Pattern)

Fig. 5.6-1a Acceptable Storage Patterns for Checkerboard Storage of Fresh and Spent Fuel Assemblies in Region 1 or Region 4 - Example

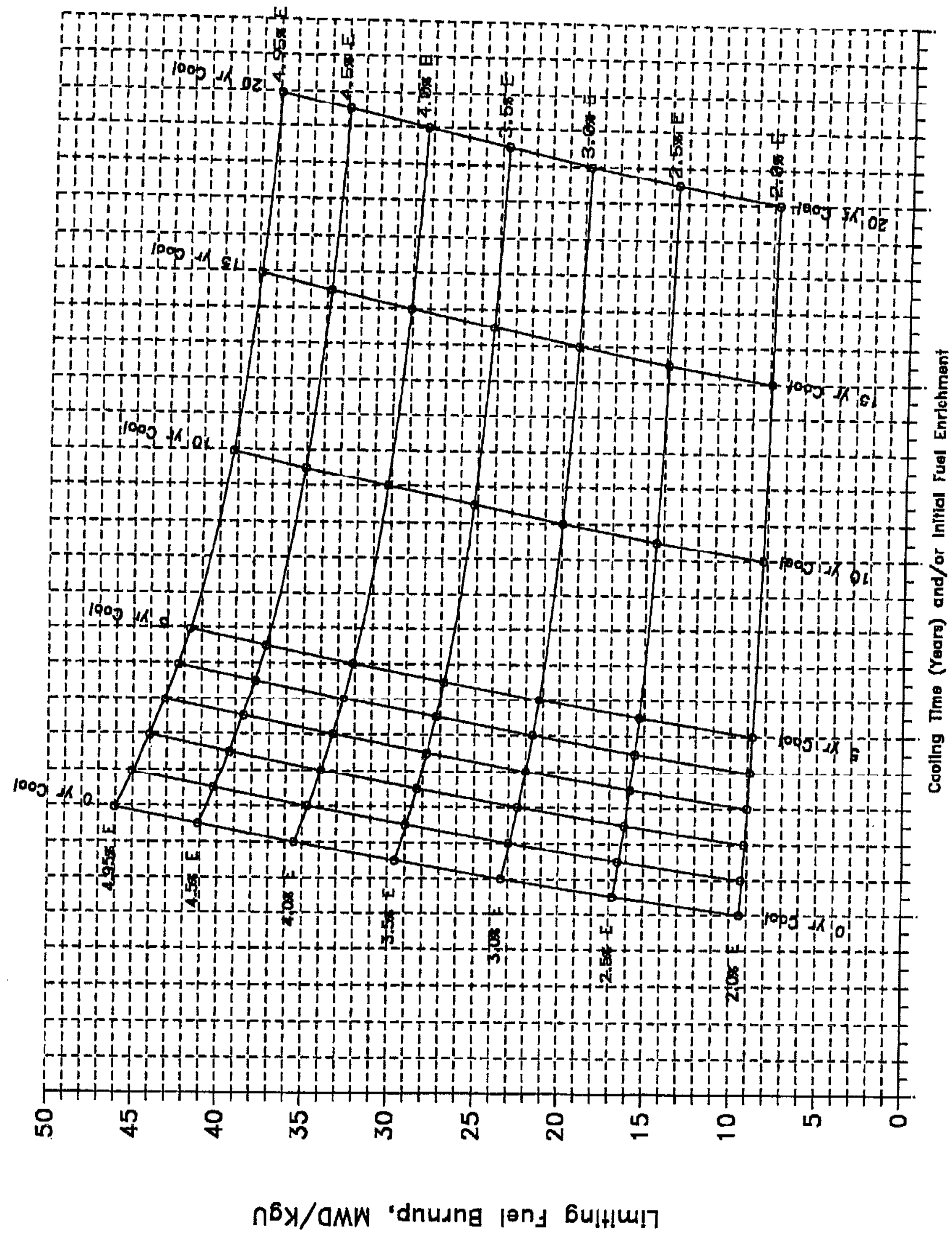


Fig. 5.6−2 3−Dimensional Plot of Minimum Fuel Burnups for Type A Fuel in Region 1 for Enrichments and/or Cooling Times

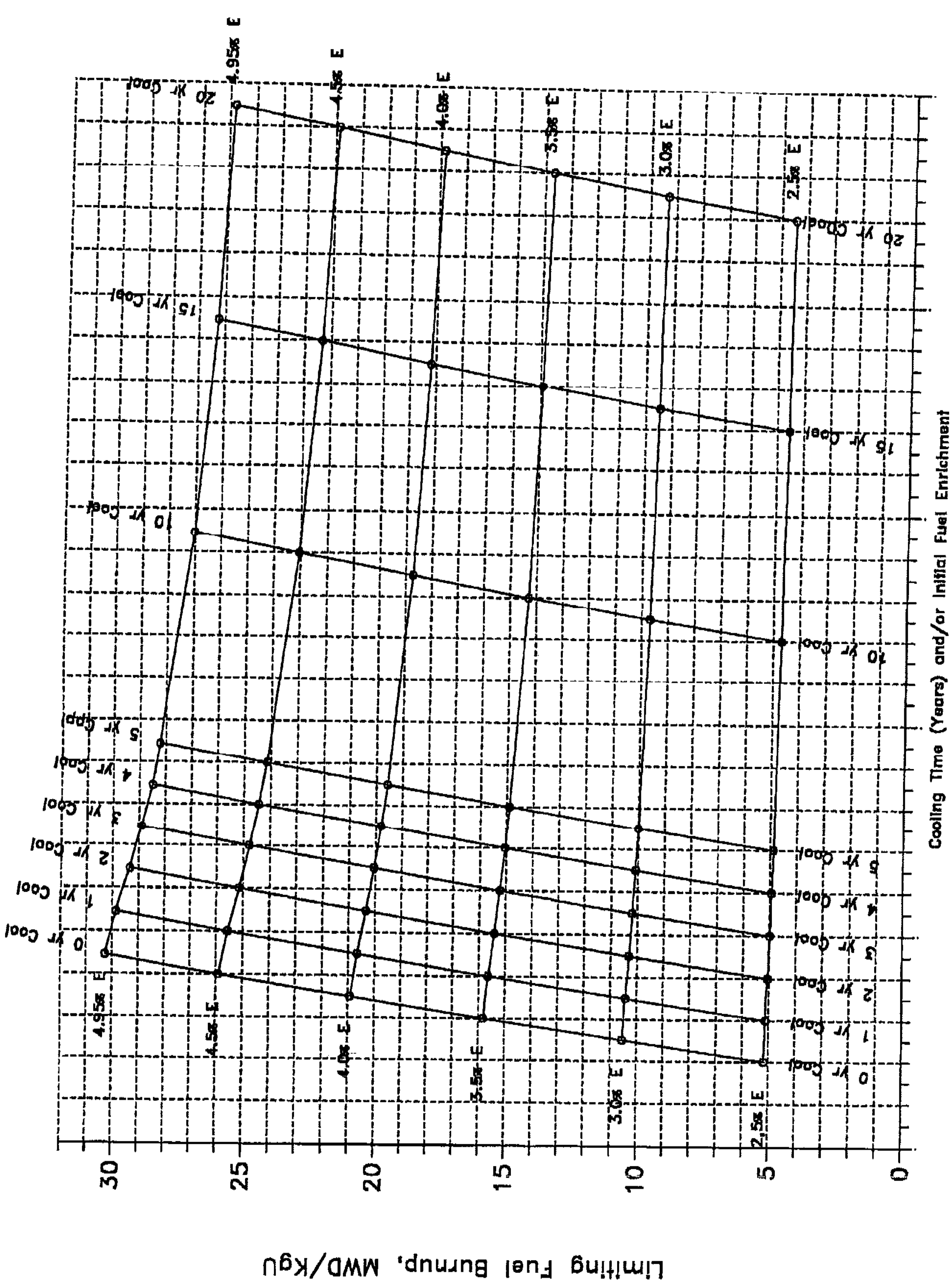


Fig. 5.6-3 3-dimensional Plot of Minimum Fuel Burnups For Type A Fuel in Region 2 for Enrichments and Cooling Times

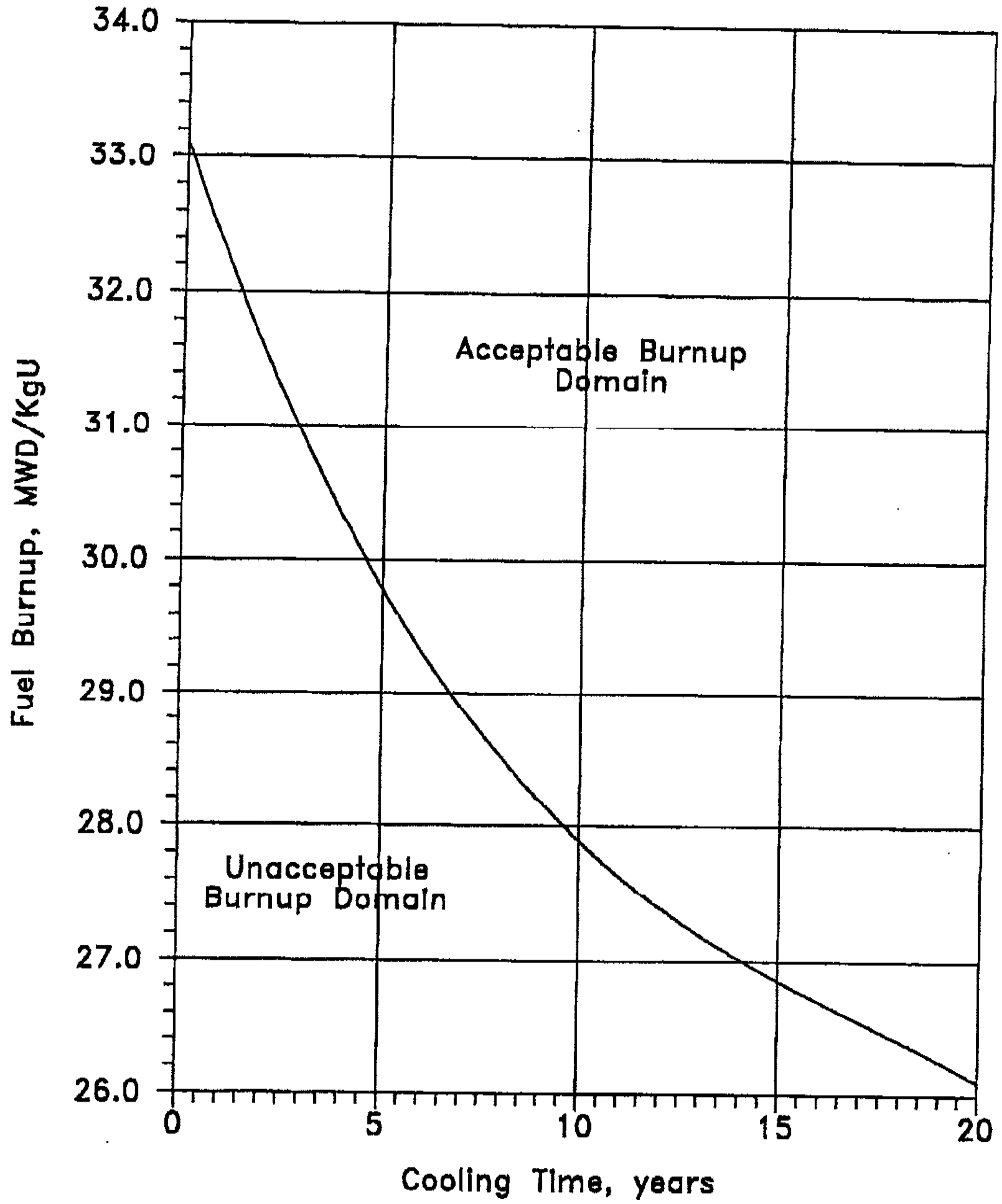


Fig. 5.6-4 Limiting Burnup Requirements in Region 2 for Face Adjacent Storage of Type T Spent Fuel Assemblies

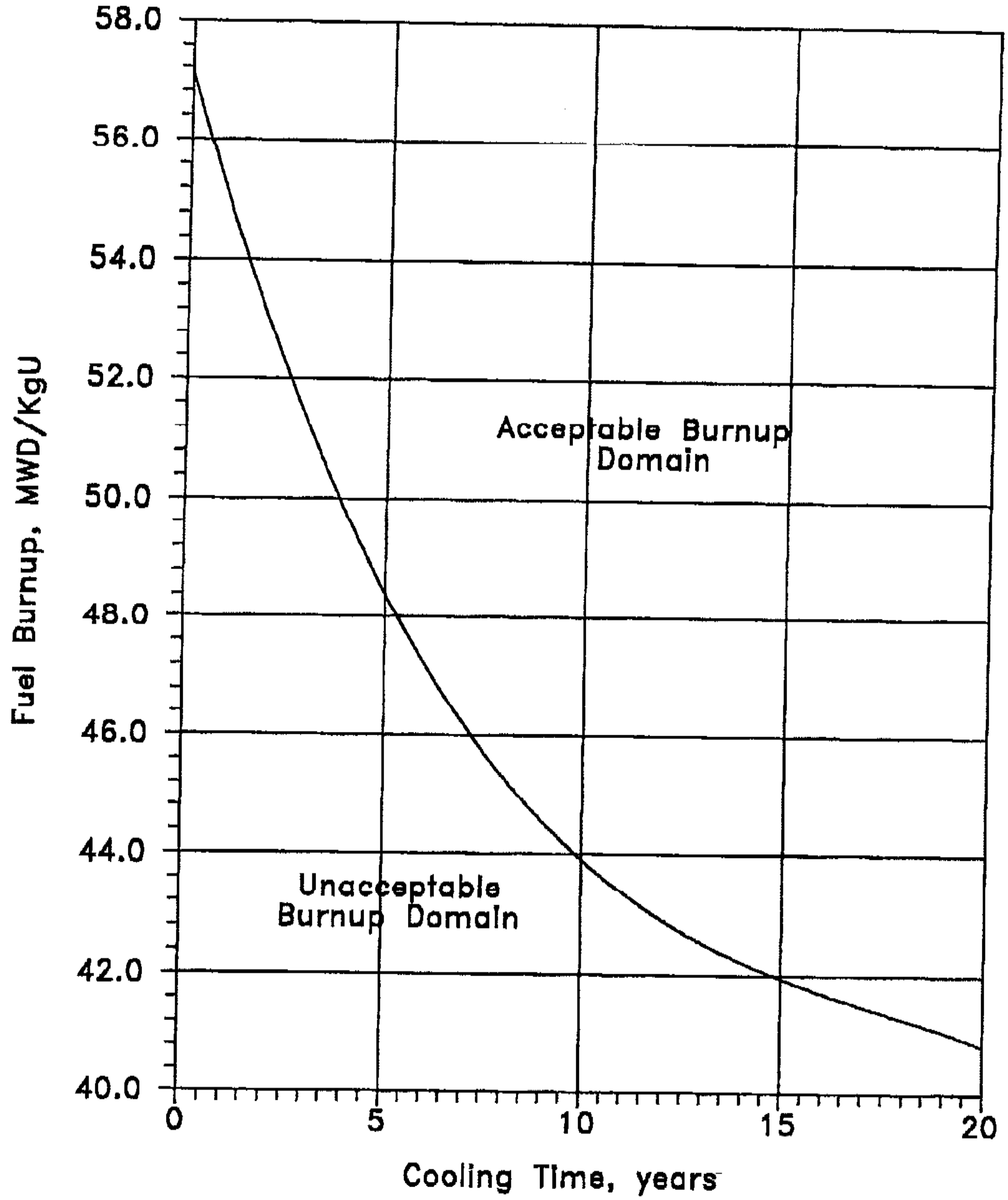


Fig. 5.6–5 Limiting Burnup Requirements in Region 4, Checkerboard Array of 1 Fresh and 3 Type T Spent Fuel Assemblies

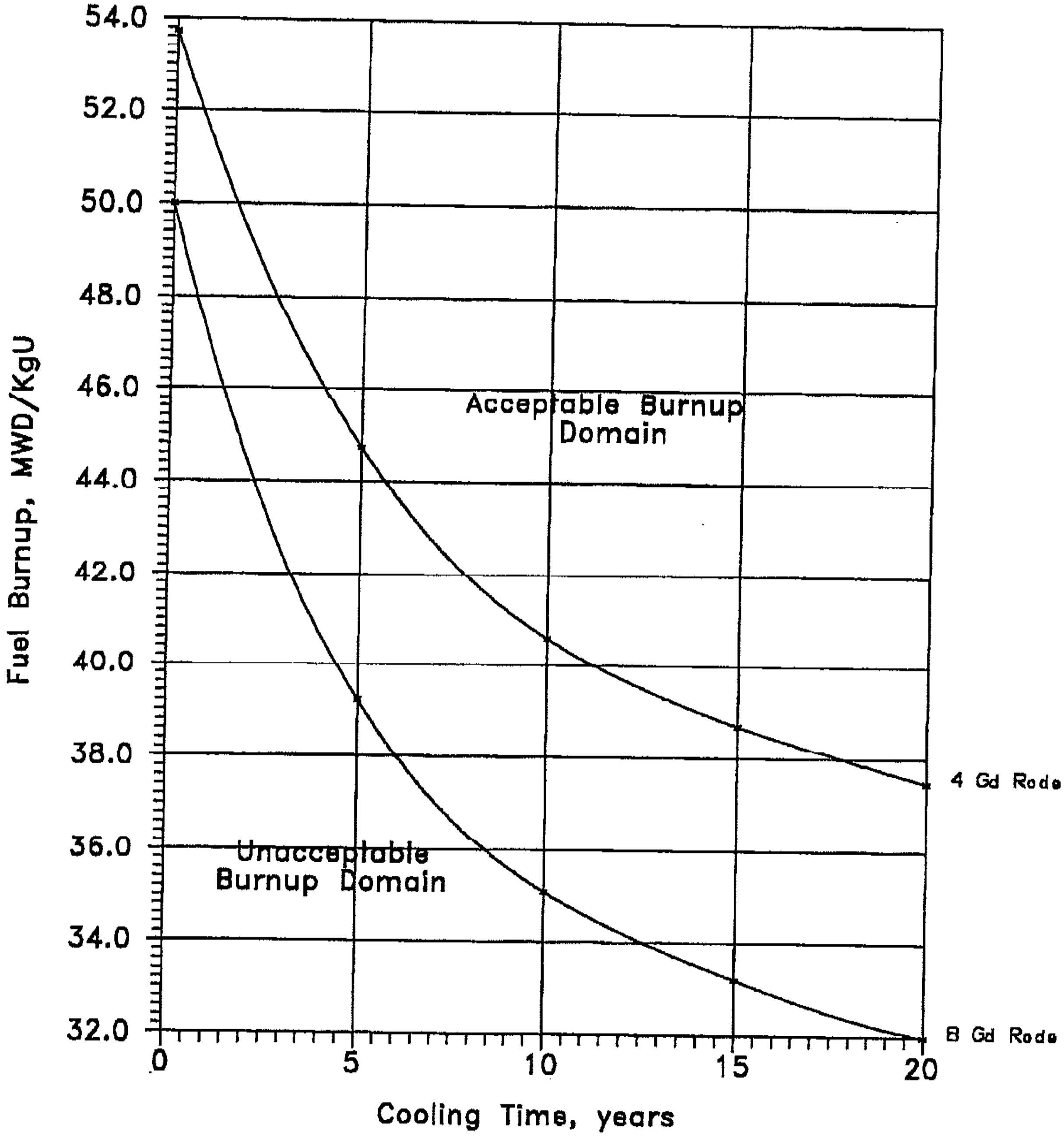


Fig. 5.6-6 Limiting Burnup Requirements in Region 4, Checkerboard Array of 1 Fresh (with Gadolinia) and 3 Type T Spent Fuel Assemblies

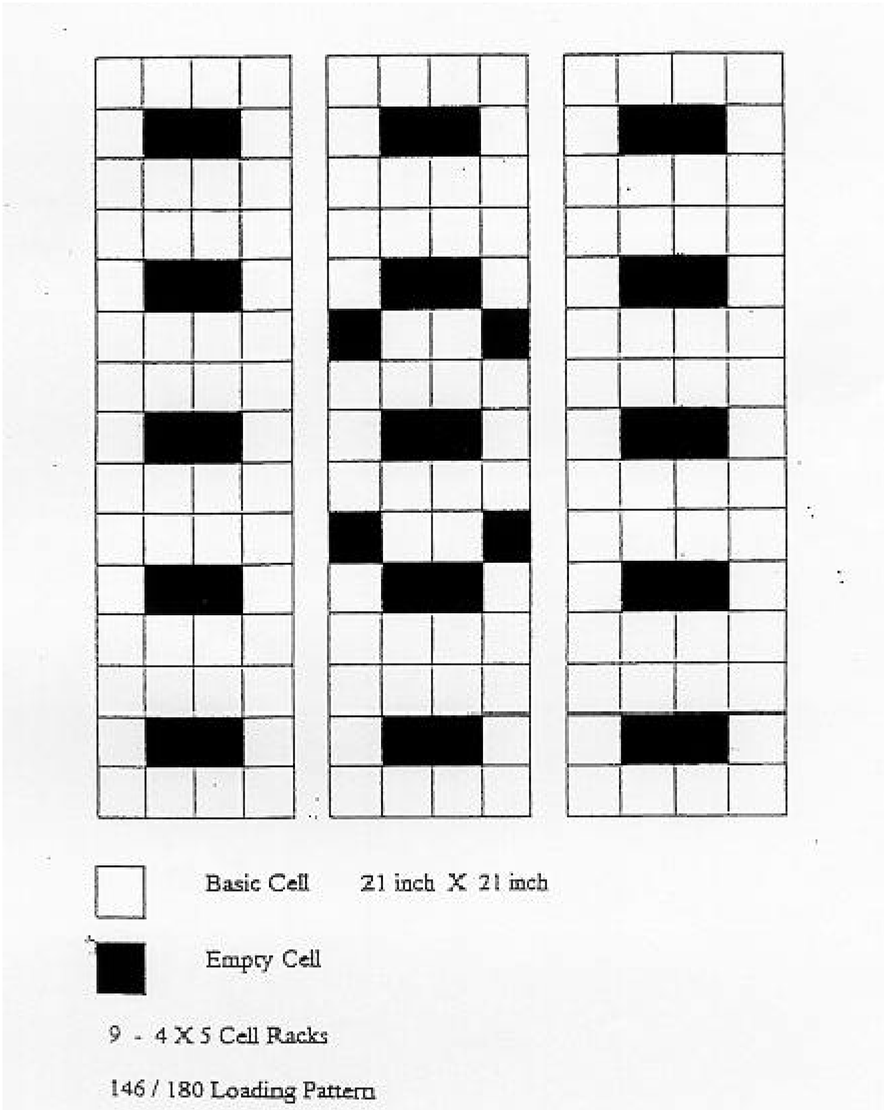


Figure 5.6-7
New Fuel Pit Storage Rack Loading Pattern

Table 5.6-1
Region 1 Storage Burnup Restrictions: Checkerboard of 1
Fresh Fuel Assembly (Without Gadolinium or IFBA Rods) and 3 Type A Spent Fuel Assemblies

For Zero Year Cooling Time
Bu (limit) = - 28.1868 + 23.0765 x E – 2.46264 x E^2 + 0.167868 x E^3
For One Year Cooling Time
Bu (limit) = - 27.3317 + 22.5087 x E – 2.40586 x E^2 + 0.164207 x E^3
For Two Years Cooling Time
Bu (limit) = -26.4693 + 21.8404 x E – 2.31873 x E^2 + 0.158218 x E^3
For Three Years Cooling Time
Bu (limit) = -25.7404 + 21.2659 x E – 2.24287 x E^2 + 0.153018 x E^3
For Four Years Cooling Time
Bu (limit) = - 25.1367 + 20.7910 x E –2.18484 x E^2 + 0.1499363 x E^3
For Five Years Cooling Time
Bu (limit) = - 24.5981 + 20.3568 x E – 2.12719 x E^2 + 0.145431 x E^3
For Ten Years Cooling Time
Bu (limit) = - 23.2050 + 19.2969 x E – 2.06993 x E^2 + 0.145875 x E^3
For Fifteen Years Cooling Time
Bu (limit) = -22.6098 + 18.8544 x E – 2.08617 x E^2 + 0.150473 x E^3
For Twenty Years Cooling Time
Bu (limit) = - 22.3017 + 18.622 x E – 2.11206 x E^2 + 0.15467 x E^3

Note: E = initial enrichment in the axial zone of highest enrichment (wt% U-235)

Table 5.6-2
Region 1 Storage Burnup Restrictions with Gadolinium or IFBA in Fresh Fuel

With Gadolinium Credit: Checkerboard of 1 Fresh Fuel Assembly with 3 Type A Spent Fuel Assemblies

Zero Year Cooling Time, 0 Gadolinia Rods
Bu (limit) = - 28.1868 + 23.0765 x E – 2.46264 x E^2 + 0.167868 x E^3
Zero Year Cooling Time, 4 Gadolinia Rods
Bu (limit) = - 28.4012 + 22.0062 x E – 2.19268 x E^2 + 0.143601 x E^3
Zero Year Cooling Time, 8 Gadolinia Rods
Bu (limit) = - 31.4262 + 22.0768 x E – 2.38845 x E^2 + 0.164888 x E^3

Note: If more that 8 Gadolinium rods per assembly, use the 8 rod correlation

With IFBA Credit: Checkerboard of 1 Fresh Fuel Assembly with 3 Type A Spent Fuel Assemblies

Zero Year Cooling Time, 0 IFBA Rods
Bu (limit) = - 28.1868 + 23.0765 x E – 2.46264 x E^2 + 0.167868 x E^3
Zero Year Cooling Time, 16 IFBA Rods
Bu (limit) = - 28.5048 + 21.6411 x E – 2.15262 x E^2 + 0.140904 x E^3
Zero Year Cooling Time, 32 IFBA Rods
Bu (limit) = - 31.0949 + 22.0435 x E – 2.36088 x E^2 + 0.162229 x E^3
Zero Year Cooling Time, 48 IFBA Rods
Bu (limit) = - 33.1342 + 22.3999 x E – 2.55367 x E^2 + 0.18082 x E^3
Zero Year Cooling Time, 64 IFBA Rods
Bu (limit) = - 36.0468 + 24.1492 x E – 3.11807 x E^2 + 0.233987 x E^3

Note: If more that 64 IFBA rods per assembly, use the correlation for 64 IFBA rods

Note: E = initial enrichment in the axial zone of highest enrichment (wt% U-235)

Table 5.6-3
Region 2 Storage Burnup Restrictions
For Type A Fuel

Zero Cooling Time
$Bu\ (limit) = -23.8702 + 12.3026 \times E - 0.275672 \times E^2$
1 Year Cooling Time
$Bu\ (limit) = -23.6854 + 12.2384 \times E - 0.287498 \times E^2$
2 Years Cooling Time
$Bu\ (limit) = -23.499 + 12.1873 \times E - 0.305988 \times E^2$
3 Years Cooling Time
$Bu\ (limit) = -23.3124 + 12.1249 \times E - 0.319566 \times E^2$
4 Years Cooling Time
$Bu\ (limit) = -23.1589 + 12.0748 \times E - 0.332212 \times E^2$
5 Years Cooling Time
$Bu\ (limit) = -22.6375 + 11.7906 \times E - 0.307623 \times E^2$
10 Years Cooling Time
$Bu\ (limit) = -21.7256 + 11.3660 \times E - 0.31029 \times E^2$
15 Years Cooling Time
$Bu\ (limit) = -21.1160 + 11.0663 \times E - 0.306231 \times E^2$
20 Years Cooling Time
$Bu\ (limit) = -20.6055 + 10.7906 \times E - 0.29291 \times E^2$

Note: E = initial enrichment in the axial zone of highest enrichment (wt% U-235)

Table 5.6-4

Face Adjacent Storage of Type T Spent Fuel (Region 2)

$$Bu\ (limit) = 33.1095 - 0.845146 \times CT + 0.0399888 \times CT^2 - 0.000762846 \times CT^3$$

Table 5.6-5

Limiting Burnup For Checkerboard Storage of Fresh and Type T Spent Fuel
(Region 4: 1 Fresh Assembly and 3 Spent Fuel Assemblies in a 2X2 Arrangement)

$$Bu\ (limit) = 57.118 - 2.13277 \times CT + 0.0772537 \times CT^2 + 0.00127446 \times CT^3 - 9.15855\ E\text{-}5 \times CT^4$$

Table 5.6-6

Gadolinia Credit: Limiting Burnup For Checkerboard Storage of Fresh and Type T Spent Fuel
(Region 4: 1 Fresh Assembly With Gadolinia and 3 Spent Fuel Assemblies in a 2X2 Arrangement)

4 Gadolinia Rods

$$Bu\ (limit) = 53.73 - 2.5265 \times CT + 0.172283 \times CT^2 - 0.00585995 \times CT^3 + 0.0000766655 \times CT^4$$

8 Gadolinia Rods

$$Bu\ (limit) = 50.00 - 3.26817 \times CT + 0.276117 \times CT^2 - 0.0117934 \times CT^3 + 0.000195334 \times CT^4$$

Note: 1. If more than 8 gadolinia rods per assembly, use the 8 rod correlation
2. BU = Fuel Burnup, MWD/Kg-U; CT = Cooling Time of Spent Fuel Assemblies, Years

3/4.6.4 COMBUSTIBLE GAS CONTROL

The OPERABILITY of the equipment and systems required for the detection and control of hydrogen gas ensures that this equipment will be available to maintain the hydrogen concentration within containment below its flammable limit during post-LOCA conditions. Either recombiner unit or the hydrogen mitigation system, consisting of 68 hydrogen ignitions per unit, is capable of controlling the expected hydrogen generation associated with 1) zirconium-water reactions, 2) radiolytic decomposition of water, 3) corrosion of metals within containment, and 4) tritium and hydrogen that exist in the Tritium Producing Burnable Absorber Rods prior to the accident. These hydrogen control systems are designed to mitigate the effects of an accident as described in Regulatory Guide 1.7, "Control of Combustible Gas Concentrations in Containment Following a LOCA", Revision 2 dated November 1978. The hydrogen monitors of Specification 3.6.4.1 are part of the accident monitoring instrumentation in Specification 3.3.3.7 and are designated as Type A, Category 1 in accordance with Regulatory Guide 1.97, Revision 2, "Instrumentation for Light-Water-Cooled Nuclear Power Plants to Assess Plant Conditions During and Following an Accident," December 1980.

The hydrogen mixing systems are provided to ensure adequate mixing of the containment atmosphere following a LOCA. This mixing action will prevent localized accumulations of hydrogen from exceeding the flammable limit.

The operability of at least 66 of 68 ignitors in the hydrogen mitigation system will maintain an effective coverage throughout the containment. This system of ignitors will initiate combustion of any significant amount of hydrogen released after a degraded core accident. This system is to ensure burning in a controlled manner as the hydrogen is released instead of allowing it to be ignited at high concentrations by a random ignition source.

3/4.6.5 ICE CONDENSER

The requirements associated with each of the components of the ice condenser ensure that the overall system will be available to provide sufficient pressure suppression capability to limit the containment peak pressure transient to less than 12 psig during LOCA conditions.

3/4.6.5.1 ICE BED

The OPERABILITY of the ice bed ensures that the required ice inventory will 1) be distributed evenly through the containment bays, 2) contain sufficient boron to preclude dilution of the containment sump following the LOCA and 3) contain sufficient heat removal capability to condense the reactor system volume released during a LOCA. These conditions are consistent with the assumptions used in the accident analyses.

The minimum weight figure of 1071 pounds of ice per basket contains a 15% conservative allowance for ice loss through sublimation which is a factor of 15 higher than assumed for the ice condenser design. The minimum weight figure of 2,082,024 pounds of ice also contains an additional 1% conservative allowance to account for systematic error in weighing instruments. In the

B 3.7 PLANT SYSTEMS

B 3/4.7.13 SPENT FUEL POOL MINIMUM BORON CONCENTRATION

BASES

BACKGROUND

The spent fuel racks have been analyzed in accordance with the Holtec International methodology contained in Holtec Reports HI - 992349 (Ref. 1) and HI-2012629 (Ref 9). This methodology ensures that the spent fuel rack multiplication factor, k_{eff} is less than or equal to 0.95, as recommended by the NRC guidance contained in NRC Letter to All Power Reactor Licensees from B.K. Grimes, “OT Position for Review and Acceptance of Spent Fuel Storage and Handling Applications”, April 14, 1978 and USNRC Internal Memorandum from L. Kopp, “Guidance On The Regulatory Requirements For Criticality Analysis Of Fuel Storage At Light-Water Reactor Power Plants”, August 19, 1998 (Refs. 2 & 3). The codes, methods, and techniques contained in the methodology are used to satisfy the k_{eff} criterion. The spent fuel storage racks were analyzed using Westinghouse 17x17 V5H fuel assemblies, with enrichments up to 4.95 $\pm$0.05 w/o U-235 and configurations which take credit for checkerboarding, burnup, soluble boron, integral fuel burnable absorbers (such as IFBA or gadolinia), and cooling time to ensure that k_{eff} is maintained $\leq$ 0.95, including uncertainties, tolerances, and accident conditions. The analysis also accounts for the reactivity effects of operating the fuel with discrete burnable poisons (such as burnable poison rod absorbers or tritium producing burnable absorber rods). In addition, the SFP k_{eff} is maintained $<$ 1.0, including uncertainties, tolerances on a 95/95 basis without any soluble boron. Calculations were performed to evaluate the reactivity of fuel types used at SQN. The results show that the Westinghouse 17x17 V5H fuel assembly exhibits the highest reactivity, thereby bounding all fuel types utilized and stored at SQN.

In the high density Spent Fuel Rack design (Ref. 9), the spent fuel storage pool is divided into four separate and distinct regions which, for the purpose of criticality considerations, are considered as separate pools. For convenience of reference, the following definitions apply:

Type A fuel refers to spent fuel assemblies which have not contained tritium producing burnable absorber rods (TPBAR’s) during in-core operation.

Type T fuel refers to spent fuel assemblies which have contained tritium producing burnable absorber rods (TPBAR’s) during in-core operation.

Fresh fuel refers to unirradiated Type A or Type T fuel or irradiated Type A or Type T fuel which has not attained sufficient burnup to meet spent fuel requirements.

Cooling time is defined as the period since reactor shutdown at the end of the last operating cycle for the discharged spent fuel assembly.

Region 1 is designed to accommodate fresh fuel with a maximum enrichment of 4.95 +/- 0.05 wt% U-235, or spent fuel regardless of the discharge burnup in a 1-of-4 checkerboard arrangement of 1 fresh assembly with 3 spent Type A fuel

BASES

BACKGROUND (continued)

assemblies with enrichment, burnup, and cooling times in accordance with Design Feature 5.6.1.1.c.1. Region 2 is designed to accommodate Type A or Type T fuel of up to 4.95 +/- 0.05 wt% U-235 initial enrichment burned to an assembly average burnup of at least 30.27 MWD/kgU for Type A fuel or 33.1095 MWD/kgU for Type T fuel, or other enrichment with a burnup yielding an equivalent reactivity in the fuel racks in accordance with Design Feature 5.6.1.1.c.2. Region 3 is designed to accommodate fresh fuel of up to 4.95 +/- 0.05 wt% U-235 initial enrichment, or fuel assemblies of any lower reactivity in a 2-of-4 checkerboard arrangement with water-filled cells in accordance with Design Feature 5.6.1.1.c.3. Region 4 is designed to accommodate fresh fuel up to 4.95 +/- 0.05 wt% U-235 initial enrichment, or spent fuel regardless of the discharge burnup in a 1-of-4 checkerboard arrangement of 1 fresh assembly with 3 spent Type T fuel assemblies with burnup and cooling times in accordance with Design Feature 5.6.1.1.c.4.

The water in the spent fuel storage pool normally contains soluble boron, which results in large subcriticality margins under actual operating conditions. However, the NRC guidelines, based upon the accident condition in which all soluble poison is assumed to have been lost, specify that the limiting k_{eff} of < 1.0 be evaluated in the absence of soluble boron. Hence, the design of all regions is based on the use of unborated water, which maintains each region in a subcritical condition during normal operation with the regions fully loaded. The double contingency principle discussed in ANSI N-16.1-1975 and the April 1978 NRC letter (Ref. 5) allows credit for soluble boron under other abnormal or accident conditions, since only a single accident need be considered at one time. For example, the most severe accident scenario is associated with the accidental mishandling of a fresh fuel assembly face adjacent to a fresh fuel assembly of Region 3. This could potentially increase the criticality of Region 3. To mitigate these postulated criticality related accidents, boron is dissolved in the pool water. The soluble boron concentration required to maintain $k_{eff} \leq 0.95$ under normal conditions is 300 ppm and 700 ppm under the most severe postulated fuel mis-location accident. Safe operation of the spent fuel storage racks may therefore be achieved by controlling the location of each assembly in accordance with Design Features 5.6 FUEL STORAGE. During fuel movement, it is necessary to perform Surveillance Requirement 4.7.13.2.

APPLICABLE SAFETY ANALYSES

Most accident conditions do not result in an increase in the reactivity of any one of the three regions. Examples of these accident conditions are the loss of cooling and the dropping of a fuel assembly on the top of the rack. However, accidents can be postulated that could increase the reactivity. This increase in reactivity is unacceptable with unborated water in the storage pool. Thus, for these accident occurrences, the presence of soluble boron in the storage pool prevents criticality in all regions. The most limiting postulated accident with respect to the storage configurations assumed in the spent fuel rack

BASES

APPLICABLE SAFETY ANALYSES (continued)

criticality analysis is the misplacement of a nominal 4.95 ± 0.05 w/o U-235 fresh fuel assembly into an empty storage cell location in the Region 3 checkerboard storage arrangement. The amount of soluble boron required to maintain k_{eff} less than or equal to 0.95 due to this fuel misload accident is 700 ppm (Ref. 1 and Ref. 9).

A spent fuel boron dilution analysis was performed to ensure that sufficient time is available to detect and mitigate dilution of the spent fuel pool prior to exceeding the k_{eff} design basis limit of 0.95 (Ref. 6). The spent fuel pool boron dilution analysis concluded that an inadvertent or unplanned event that would result in a dilution of the spent fuel pool boron concentration from 2000 ppm to 700 ppm is not a credible event.

The concentration of dissolved boron in the spent fuel storage pool satisfies Criterion 2 of the NRC Policy Statement.

LCO

The spent fuel storage pool boron concentration is required to be ≥ 2000 ppm. The specified concentration of dissolved boron in the spent fuel storage pool preserves the assumptions used in the analyses of the potential critical accident scenarios as described in Reference 7. This concentration of dissolved boron is the minimum required concentration for fuel assembly storage and movement within the spent fuel storage pool.

APPLICABILITY

This LCO applies whenever fuel assemblies are stored in the spent fuel storage pool.

ACTIONS

Action a:

When the concentration of boron in the spent fuel storage pool is less than required, immediate action must be taken to preclude the occurrence of an accident or to mitigate the consequences of an accident in progress. This is most efficiently achieved by immediately suspending the movement of fuel assemblies. The concentration of boron is restored along with suspending movement of fuel assemblies.

Action a is modified by a provision indicating that LCO 3.0.3 does not apply. If the LCO is not met while moving irradiated fuel assemblies in MODE 5 or 6, LCO 3.0.3 would not be applicable. Moving irradiated fuel assemblies while in MODE 1, 2, 3, or 4 is independent of reactor operation. Therefore, inability to suspend movement of fuel assemblies is not sufficient reason to require a reactor shutdown.

BASES

SURVEILLANCE REQUIREMENTS

4.7.13.1

This Surveillance Requirement verifies that the concentration of boron in the spent fuel storage pool is within the required limit. As long as this Surveillance Requirement is met, the analyzed accidents are fully addressed. The 7 day Frequency is appropriate because no significant replenishment of pool water is expected to take place over such a short period of time. (Ref. 6)

4.7.13.2

This Surveillance Requirement verifies that the concentration of boron in the spent fuel storage pool is within the required limit during fuel movement until the final configuration of the assemblies in the storage racks is verified to be correct. As long as this Surveillance Requirement is met, the analyzed accidents are fully addressed. The 72 hour Frequency provides additional assurance that the maximum k_{eff} remains below the 0.95 limit under the postulated accident condition. (Ref. 1, 8, and 9)

REFERENCES

1. Stanley E. Turner (Holtec International), “Criticality Safety Analyses of Sequoyah Spent Fuel Racks with Alternative Arrangements,” HI-992349

2. B.K. Grimes (NRC GL78011), “OT Position for Review and Acceptance of Spent Fuel Storage and Handling Applications”, April 14, 1978

3. L. Kopp, “Guidance On The Regulatory Requirements For Criticality Analysis Of Fuel Storage At Light-Water Reactor Power Plants”, August 19, 1998

4. UFSAR, Section 4.3.2.7, "Critically of Fuel Assemblies"

5. Double contingency principle of ANSI N16.1-1975, as specified in the April 14, 1978 NRC letter (Section 1.2) and implied in the proposed revision to Regulatory Guide 1.13 (Section 1.4, Appendix A).

6. K K Niyogi (Holtec International), “Boron Dilution Analysis,” HI-992302

7. FSAR, Section 15.4.5

8. NRC letter to TVA dated August 1, 1990, “ Increase Fuel Enrichment to 5.0 Weight Percent (TAC Nos. 76074, 76075, 76774, 76775) (TS 90-12) - Sequoyah Nuclear Plant, Units 1 and 2”

9. Stanley E. Turner (Holtec International, “Evaluation of the Effect of the Use of Tritium Producing Burnable Absorber Rods (TPBARS) on Fuel Storage Requirements,” HI-2012629

PLANT SYSTEMS

BASES

3/4.7.14 CASK PIT POOL MINIMUM BORON CONCENTRATION

This specification is deleted.

Pages B3/4 7-13 through B3/4 7-15 are deleted.

(continued)

LIMITING CONDITIONS FOR OPERATION AND SURVEILLANCE REQUIREMENTS

This portion affected by TS Change Request 99-18

BASES

INDEX

DESIGN FEATURES

TABLE 3.3-9

REMOTE SHUTDOWN MONITORING INSTRUMENTATION

INSTRUMENT	READOUT LOCATION	MEASUREMENT RANGE	MINIMUM CHANNELS OPERABLE
1. Source Range Nuclear Flux	NOTE 1	0.1 to 1 x 10^5 cps	1
2. Reactor Trip Breaker Indication	at trip switchgear	OPEN-CLOSE	1/trip breaker
3. Reactor Coolant Temperature - Hot Leg	NOTE 1	0-650^{o}F	1/loop
4. Pressurizer Pressure	NOTE 1	0-3000 psig	1
5. Pressurizer Level	NOTE 1	0-100%	1
6. Steam Generator Pressure	NOTE 1	0-1200 psig	1/steam generator
7. Steam Generator Level	NOTE 2 or near Auxilary F. W. Pump	0-100%	1/steam generator
8. Deleted			
9. RHR Flow Rate	NOTE 1	0-4500 gpm	1
10. RHR Temperature	NOTE 1	50-400^{o}F	1
11. Auxiliary Feedwater Flow Rate	NOTE 1	0-440 gpm	1/steam generator

3/4.5 EMERGENCY CORE COOLING SYSTEMS

3/4.5.1 ACCUMULATORS

COLD LEG INJECTION ACCUMULATORS

LIMITING CONDITION FOR OPERATION

3.5.1.1 Each cold leg injection accumulator shall be OPERABLE with:

a. The isolation valve open,

b. A contained borated water volume of between 7615 and 7960 gallons of borated water,

c. Between 3500 and 3800 ppm of boron,

d. A nitrogen cover-pressure of between 624 and 668 psig, and

e. Power removed from isolation valve when RCS pressure is above 2000 psig.

APPLICABILITY: MODES 1, 2 and 3.*

ACTION:

a. With one cold leg injection accumulator inoperable, except as a result of boron concentration not within limits, restore the inoperable accumulator to OPERABLE status within one hour or be in at least HOT STANDBY within the next 6 hours and reduce pressurizer pressure to 1000 psig or less within the following 6 hours.

b. With one cold leg injection accumulator inoperable due to the boron concentration not within limits, restore boron concentration to within limits within 72 hours or be in at least HOT STANDBY within the next 6 hours and reduce pressurizer pressure to 1000 psig or less within the following 6 hours.

* Pressurizer pressure above 1000 psig.

3/4.5.5 REFUELING WATER STORAGE TANK

LIMITING CONDITION FOR OPERATION

3.5.5 The refueling water storage tank (RWST) shall be OPERABLE with:

a. A contained borated water volume of between 370,000 and 375,000 gallons,

b. A boron concentration of between 3600 and 3800 ppm of boron,

c. A minimum solution temperature of 60°F, and

d. A maximum solution temperature of 105°F.

APPLICABILITY: MODES 1, 2, 3 and 4.

ACTION:

With the RWST inoperable, restore the tank to OPERABLE status within 1 hour or be in at least HOT STANDBY within 6 hours and in COLD SHUTDOWN within the following 30 hours.

SURVEILLANCE REQUIREMENTS

4.5.5 The RWST shall be demonstrated OPERABLE:

a. At least once per 7 days by:

1. Verifying the contained borated water volume in the tank, and

2. Verifying the boron concentration of the water.

b. At least once per 24 hours by verifying the RWST temperature.

3/4.7.14 CASK PIT POOL MINIMUM BORON CONCENTRATION

LIMITING CONDITION FOR OPERATION

3.7.14 This specification has been deleted.

5.3 REACTOR CORE

FUEL ASSEMBLIES

5.3.1 The reactor shall contain 193 fuel assemblies. Each assembly shall consist of a matrix of zircaloy or M5 clad fuel rods with an initial composition of natural or slightly enriched uranium dioxide as fuel material. Limited substitutions of zirconium alloy or stainless steel filler rods for fuel rods, in accordance with NRC-approved applications of fuel rod configurations, may be used. Fuel assemblies shall be limited to those fuel designs that have been analyzed with applicable NRC staff-approved codes and methods, and shown by tests or analyses to comply with all fuel safety design bases. A limited number of lead test assemblies that have not completed representative testing may be placed in nonlimiting core regions. Sequoyah is authorized to place a limited number of lead test assemblies into the reactor, as described in the Framatome Cogema Fuels Report BAW-2328, beginning with the Unit 2 Operating Cycle 10 core.

Sequoyah is authorized to place a maximum of 2256 Tritium Producing Burnable Absorber Rods into the reactor in an operating cycle.

CONTROL ROD ASSEMBLIES

5.3.2 The reactor core shall contain 53 full length and no part length control rod assemblies. The full length control rod assemblies shall contain a nominal 142 inches of absorber material. The nominal values of absorber material shall be 80 percent silver, 15 percent indium and 5 percent cadmium. All control rods shall be clad with stainless steel tubing.

5.4 REACTOR COOLANT SYSTEM

DESIGN PRESSURE AND TEMPERATURE

5.4.1 The reactor coolant system is designed and shall be maintained:

a. In accordance with the code requirements specified in Section 5.2 of the FSAR, with allowance for normal degradation pursuant to the applicable Surveillance Requirements,

b. For a pressure of 2485 psig, and

c. For a temperature of 650°F, except for the pressurizer which is 680°F.

VOLUME

5.4.2 The total water and steam volume of the reactor coolant system is 12,612 ± 100 cubic feet at a nominal T_{avg} of 525°F.

5.5 METEOROLOGICAL TOWER LOCATION

5.5.1 The meteorological tower shall be located as shown on Figure 5.1-1.

5.6 FUEL STORAGE

CRITICALITY - SPENT FUEL

For convenience of reference, the following definitions apply:

Type A fuel refers to spent fuel assemblies which have not contained tritium producing burnable absorber rods (TPBAR's) during in-core operations.

Type T fuel refers to spent fuel assemblies which have contained tritium producing burnable absorber rods (TPBAR's) during in-core operations.

Fresh fuel refers to unirradiated Type A or Type T fuel or irradiated Type A or Type T fuel that has not attained sufficient burnup to meet spent fuel requirements.

Cooling time is defined as the period since reactor shutdown at the end of the last operating cycle for the discharged spent fuel assembly.

5.6.1.1 The spent fuel storage racks are designed for fuel enriched to 5 weight percent U-235 and shall be maintained with:

a. A k_{eff} less than critical when flooded with unborated water and a k_{eff} less than or equal to 0.95 when flooded with water containing 300 ppm soluble boron.*

b. A nominal 8.972 inch center-to-center distance between fuel assemblies placed in the storage racks.

c. Arrangements of one or more of three different arrays (Regions) or sub-arrays as illustrated in Figures 5.6-1 and 5.6-1a. These arrangements in the spent fuel storage pool have the following definitions:

   1. Region 1 is designed to accommodate new fuel with a maximum enrichment of 4.95 ± 0.05 wt% U-235, (or spent fuel regardless of the fuel burnup), in a 1-in-4 checkerboard arrangement of 1 fresh assembly with 3 Type A spent fuel assemblies with enrichment-burnup and cooling times illustrated in Figure 5.6-2 and defined by the equations in Table 5.6-1. The presence of a removable, non-fissile insert such as a burnable poison rod assembly (BPRA) or either gadolinia or integral fuel burnable absorber (IFBA) in a fresh fuel assembly does not affect the applicability of Figure 5.6-2 or Table 5.6-1.

      Two alternative storage arrays (or sub-arrays) are acceptable in Region 1 if the fresh fuel assemblies contain rods with either gadolinia or integral fuel burnable absorber (IFBA). For these types of assemblies, the minimum burnup of the spent fuel in the 1-of-4 sub-array are defined by the equations in Table 5.6-2.

*For some accident conditions, the presence of dissolved boron in the pool water may be taken into account by applying the double contingency principle which requires two unlikely, independent, concurrent events to produce a criticality accident.

5.6 FUEL STORAGE

Restrictions in Region 1

Any of the three sub-arrays illustrated in Figure 5.6-1a may be used in any combination provided that:

A) Each sub-array of 4 fuel assemblies includes, in addition to the fresh fuel assembly, 3 assemblies with enrichment and minimum burnup requirements defined by the equations in Tables 5.6-1 and 5.6-2, as appropriate.

B) The arrangement of Region 1 sub-arrays must not allow a configuration with fresh assemblies adjacent to each other.

C) If Region 1 arrays are used in conjunction with Region 3 or Region 4 arrangements (see below), the arrangements shall not allow fresh fuel assemblies to be adjacent to each other (see also Figure 5.6-1).

D) If miscellaneous non-fissile bearing items or equipment are stored in cells of Region 1, the total volume of the miscellaneous items shall be no more than 75% of the total storage cell volume.

2. Region 2 is designed to accommodate Type A or Type T fuel of 4.95±0.05 wt% U-235 initial enrichment burned to at least 30.27 (Type A) or 33.1095 (Type T) MWD/KgU (assembly average), or fuel of other enrichments with a burnup yielding an equivalent reactivity in the fuel racks. The minimum required assembly average burnup in MWD/KgU and cooling time is given by the equations in Table 5.6-3 (Type A) or 5.6-4 (Type T). The minimum required burnups are illustrated in Figure 5.6-3 (Type A) or 5.6-4 (Type T) in terms of the initial enrichment and cooling time.

Restrictions in Region 2

The following restrictions apply to the storage of spent fuel in the Region 2 cells:

A) The spent fuel shall conform to the minimum burnup requirements defined by the equations in Table 5.6-3 or 5.6-4, as appropriate. Linear interpolation between cooling times may be made if desired.

B) For the interface with Region 1 or 4 storage cells, fresh fuel in Region 1 or 4 shall not be stored adjacent to spent fuel assemblies in the Region 2 storage cells.

C) If miscellaneous non-fissile bearing items or equipment are stored in cells of Region 2, the total volume of the miscellaneous items shall be no more than 75% of the total storage cell volume.

3. Region 3 is designed to accommodate fuel of 4.95±0.05 wt% U-235 initial enrichment (or fuel assemblies of any lower reactivity) in a 2-out-of-4 checkerboard arrangement with water-filled cells. The water-filled cells shall not contain any components bearing any fissile material, but may accommodate miscellaneous items or equipment.

5.6 FUEL STORAGE

Restrictions in Region 3

The following restrictions apply to the storage of fuel in the Region 3 cells:

A) For the interface between Region 3 and Region 1 or 4 storage regions, fresh fuel assemblies shall not be stored adjacent to each other.

B) If miscellaneous non-fissile bearing items or equipment are stored in the water cells of Region 3, the total volume of the miscellaneous items shall be no more than 75% of the storage cell volume.

C) No loose fuel rods or items containing fissile material shall be stored in the water cells of Region 3.

4. Region 4 is designed to accommodate fresh fuel with a maximum enrichment of 4.95 ± 0.05 wt% U-235 (or spent fuel regardless of the fuel burnup), in a 1-in-4 checkerboard arrangement of 1 fresh assembly with three Type T spent fuel assemblies having burnup and cooling times illustrated in Figure 5.6-5 and defined by the equations in Table 5.6-5. The presence of either gadolinia or integral fuel burnable absorber (IFBA) in a fresh fuel assembly does not affect the applicability of Figure 5.6-5 or Table 5.6-5.

One alternative storage array (or sub-array) is acceptable in Region 4 if the fresh fuel contains rods with gadolinia fuel burnable absorber. For these types of assemblies, the minimum burnup of the spent fuel in the 1-of-4 sub-array is defined by the equations in Table 5.6-6 and illustrated in Figure 5.6-6. For fresh assemblies containing more than eight (8) gadolinia bearing fuel rods, the limiting burnup for eight (8) gadolinia rods shall apply.

Restrictions in Region 4

Any of the two sub-arrays illustrated in Figure 5.6-1a applying to Region 4 storage may be used in any combination provided that:

A) Each sub-array of 4 fuel assemblies includes, in addition to the fresh fuel assembly, 3 assemblies with enrichment and minimum burnup requirements defined by the equations in Tables 5.6-5 and 5.6-6, as appropriate.

B) The arrangement of Region 4 sub-arrays must not allow a configuration with fresh assemblies adjacent to each other.

C) If Region 4 arrays are used in conjunction with Region 1 or 3 arrangements, the arrangements shall not allow fresh fuel assemblies to be adjacent to each other (see Figure 5.6-1)

D) If miscellaneous non-fissile bearing items or equipment are stored in cells of Region 4, the total volume of the miscellaneous items shall be no more than 75% of the total storage cell volume.

d. An empty cell (or a cell containing non-fissile bearing miscellaneous items displacing no more than 75% of the storage cell volume) is less reactive than any cell containing fuel and therefore may be used as a Region 1, 2, 3, or 4 cell in any arrangement.

e. A nominal concentration of 2000 ppm boron is in the pool water. This concentration of soluble boron provides a margin sufficient to allow timely detection of a boron dilution accident and corrective action before the minimum concentration (700 ppm) required to protect against the most severe postulated fuel handling accident or before the minimum concentration (300 ppm) required to maintain the storage configuration design basis (keff less than 0.95) is reached.

5.6 FUEL STORAGE

CRITICALITY - NEW FUEL

5.6.1.2 The new fuel pit storage racks are designed for fuel enriched to 5.0 weight percent U-235 and shall be maintained with the arrangement of 146 storage locations shown in Figure 5.6-7. The cells shown as empty cells in Figure 5.6-7 shall have physical barriers installed to ensure that inadvertant loading of fuel assemblies into these locations does not occur. This configuration ensures k_{eff} will remain less than or equal to 0.95 when flooded with unborated water and less than or equal to 0.98 under optimum moderation conditions.

DRAINAGE

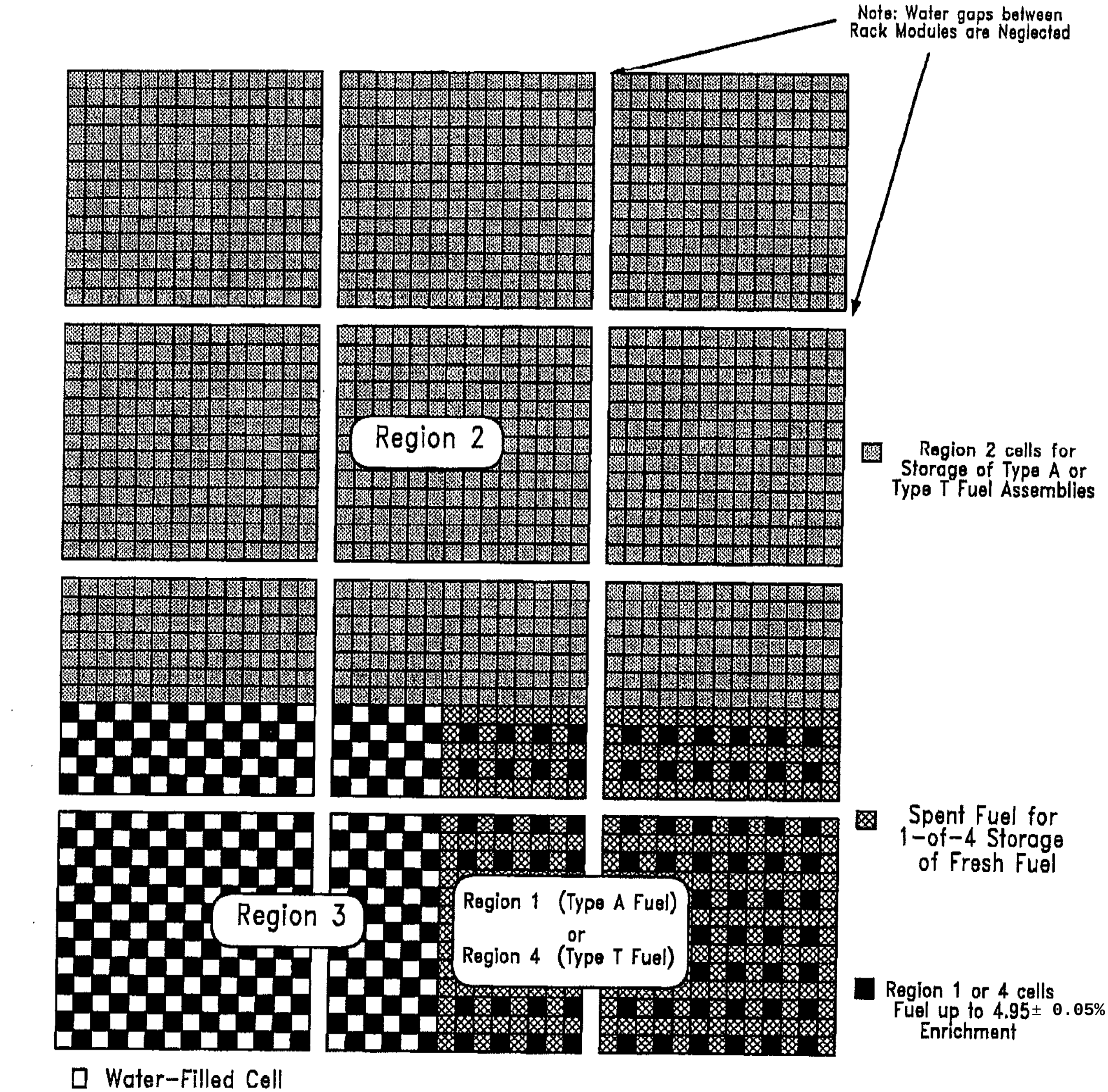
5.6.2 The spent fuel pit is designed and shall be maintained to prevent inadvertent draining of the pool below elevation 722 ft.

CAPACITY

5.6.3 The spent fuel storage pool is designed and shall be maintained with a storage capacity limited to no more than 2091 fuel assemblies.

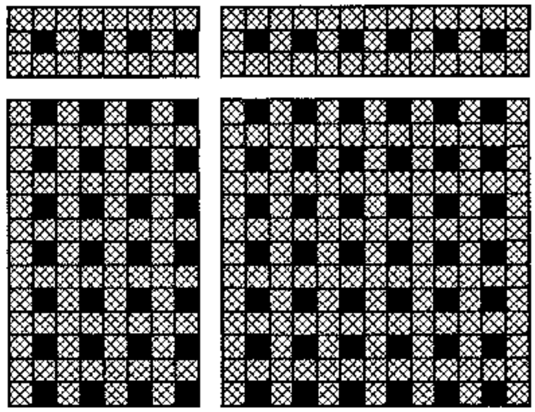
5.7 COMPONENT CYCLIC OR TRANSIENT LIMIT

5.7.1 The components identified in Table 5.7-1 are designed and shall be maintained within the cyclic or transient limits of Table 5.7-1.



Note: The edges of the sketch above are not necessarily the edges of the pool. The Regions may appear anywhere in the pool and in any orientation, subject to the restrictions in Design Features 5.6.1.1.c.

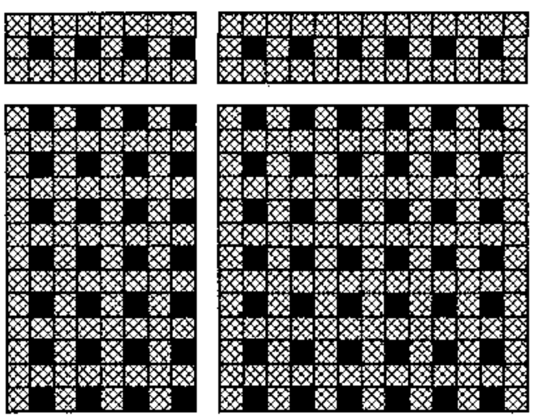
FIG 5.6-1 Arrangements of Fuel Storage Regions in the Sequoyah Spent Fuel Storage Pool



Spent Fuel for Storage in Region 1 (Type A Fuel) or Region 4 (Type T Fuel) in 1-of-4 Pattern

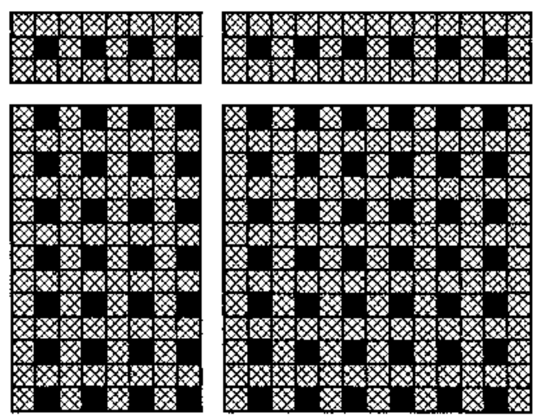
Fresh Fuel for Region 1 or Region 4 cells (No Gd or IFBA)

NOTE: WHEN CREDIT IS TAKEN FOR GADOLINIA RODS IN FRESH ASSEMBLIES THE SPENT FUEL ASSEMBLIES NEED NOT HAVE CONTAINED GADOLINIA RODS..



Spent Fuel for Storage of Region 1 (Type A Fuel) or Region 4 (Type T Fuel) in 1-of-4 Pattern

Fresh Fuel with Gadolinia for Region 1 or Region 4 cells



Spent Fuel for Storage in Region 1 in 1-of-4 Pattern

Fresh Fuel with IFBA Rods for Storage in Region 1 only (1-of-4 Pattern)

Fig. 5.6-1a Acceptable Storage Patterns for Checkerboard Storage of Fresh and Spent Fuel Assemblies in Region 1 or Region 4 – Example

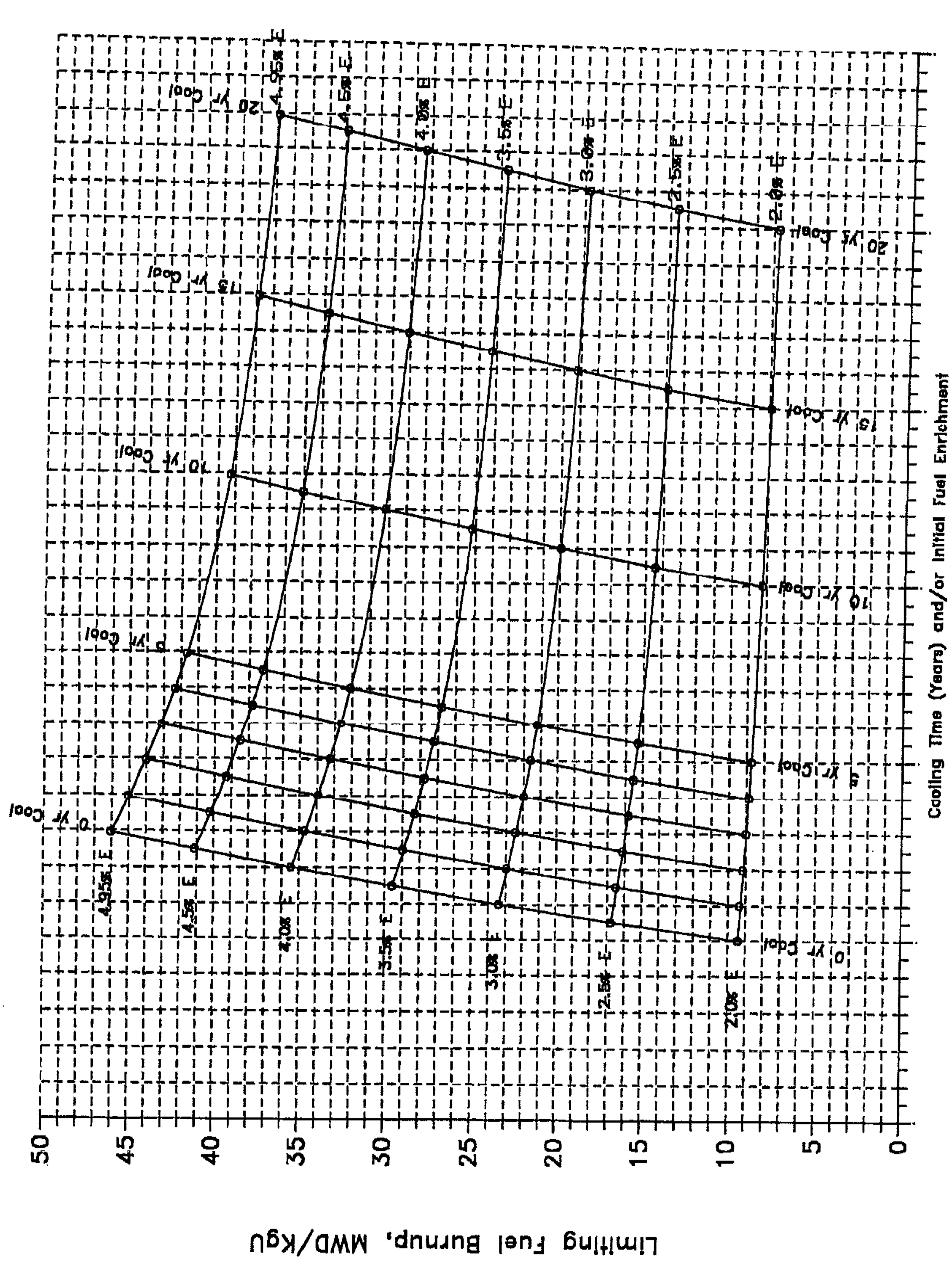


Fig. 5.6-2 3-Dimensional Plot of Minimum Fuel Burnups for Type A Fuel in Region 1 for Enrichments and/or Cooling Times

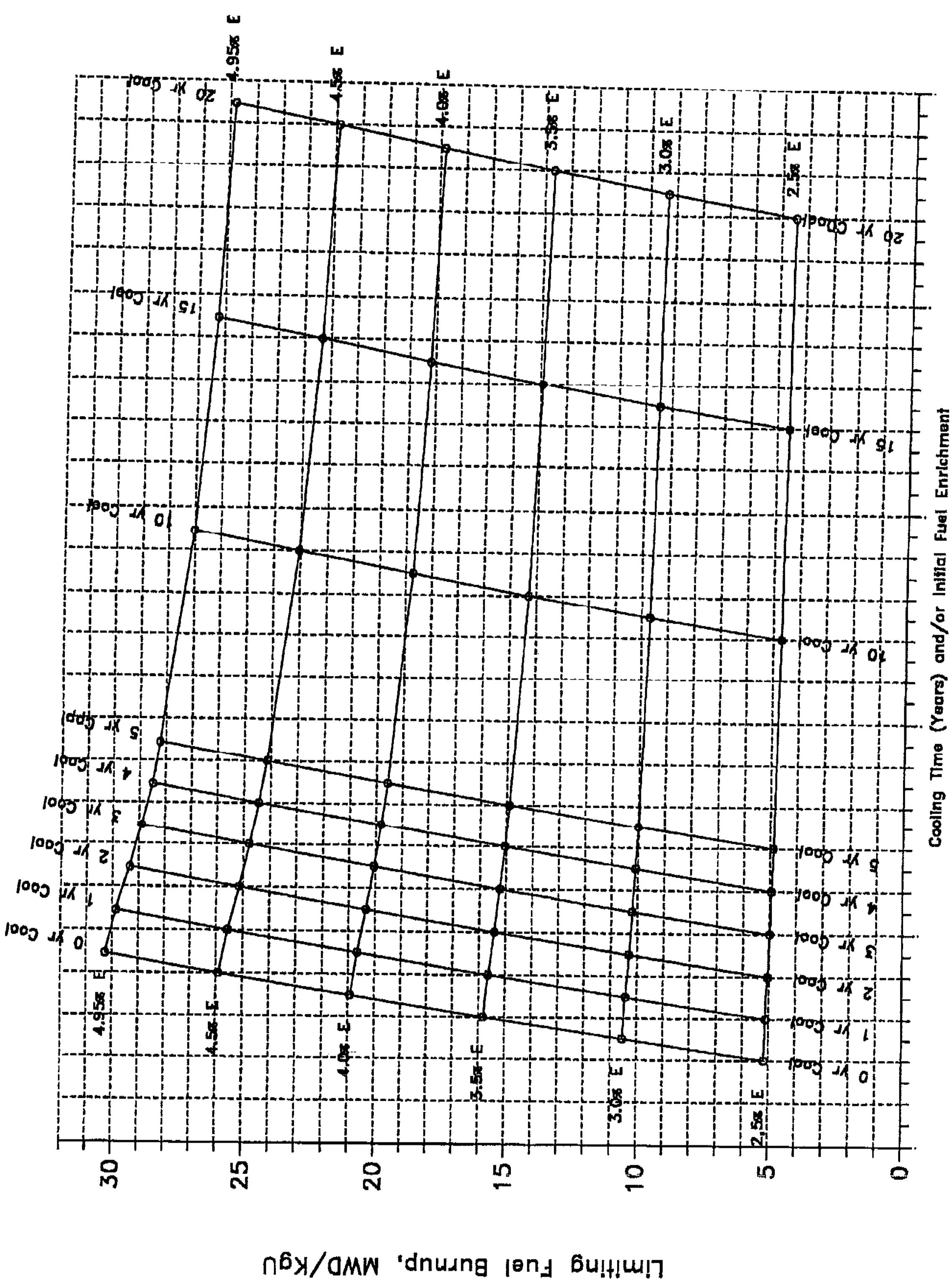


Fig. 5.6–3 3–dimensional Plot of Minimum Fuel Burnups For Type A Fuel in Region 2 for Enrichments and Cooling Times

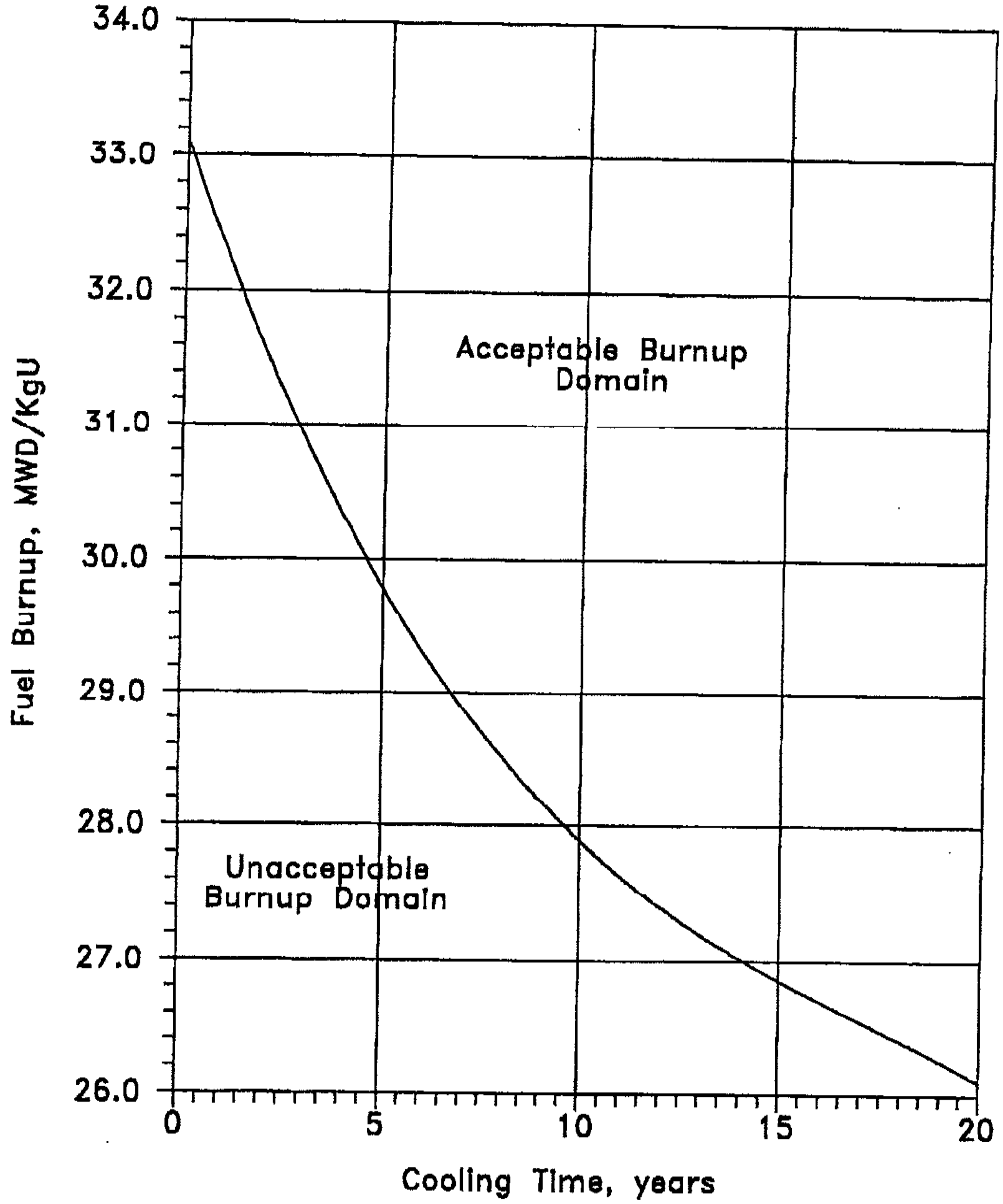


Fig. 5.6-4 Limiting Burnup Requirements in Region 2 for Face Adjacent Storage of Type T Spent Fuel Assemblies

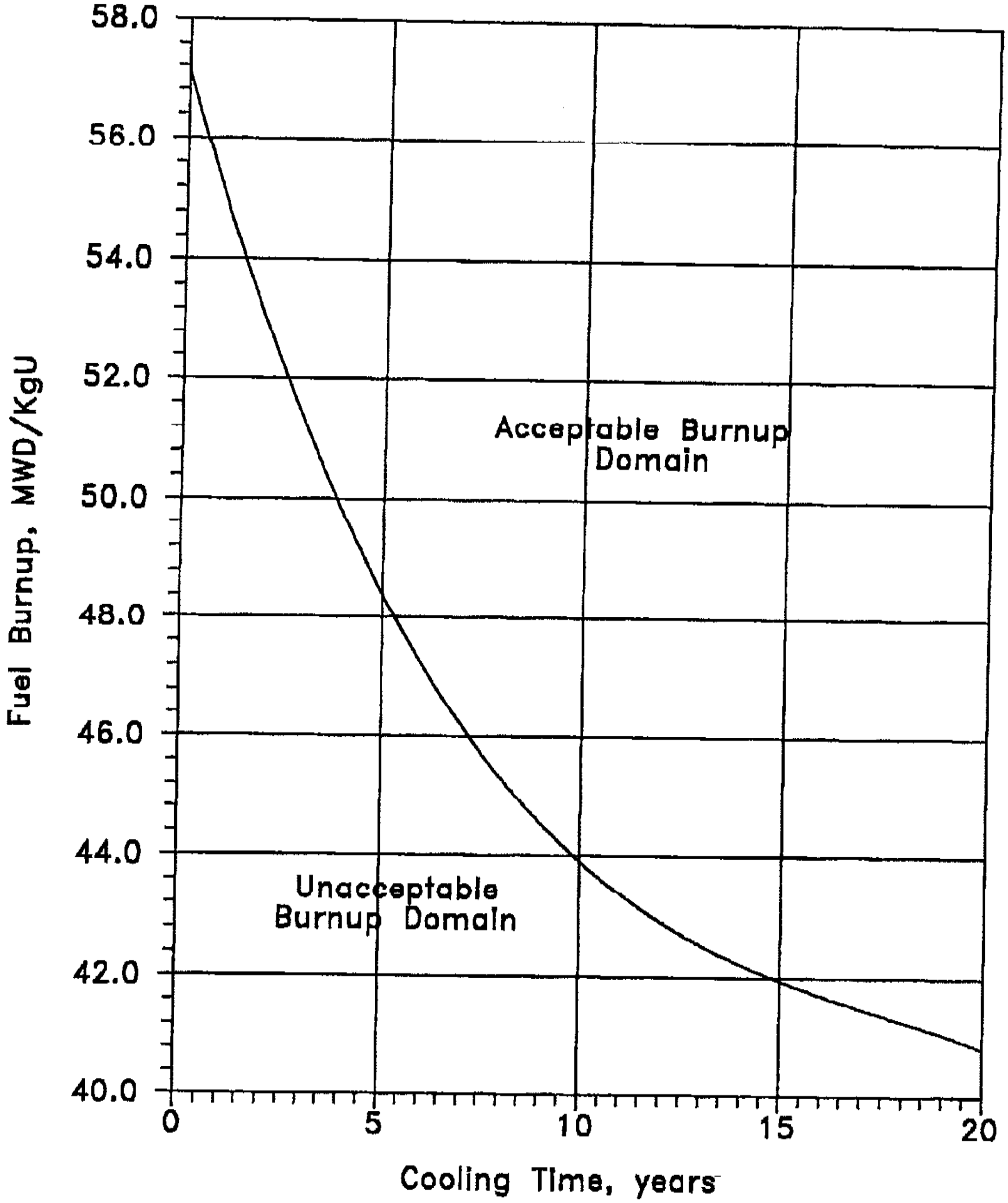


Fig. 5.6–5 Limiting Burnup Requirements in Region 4, Checkerboard Array of 1 Fresh and 3 Type T Spent Fuel Assemblies

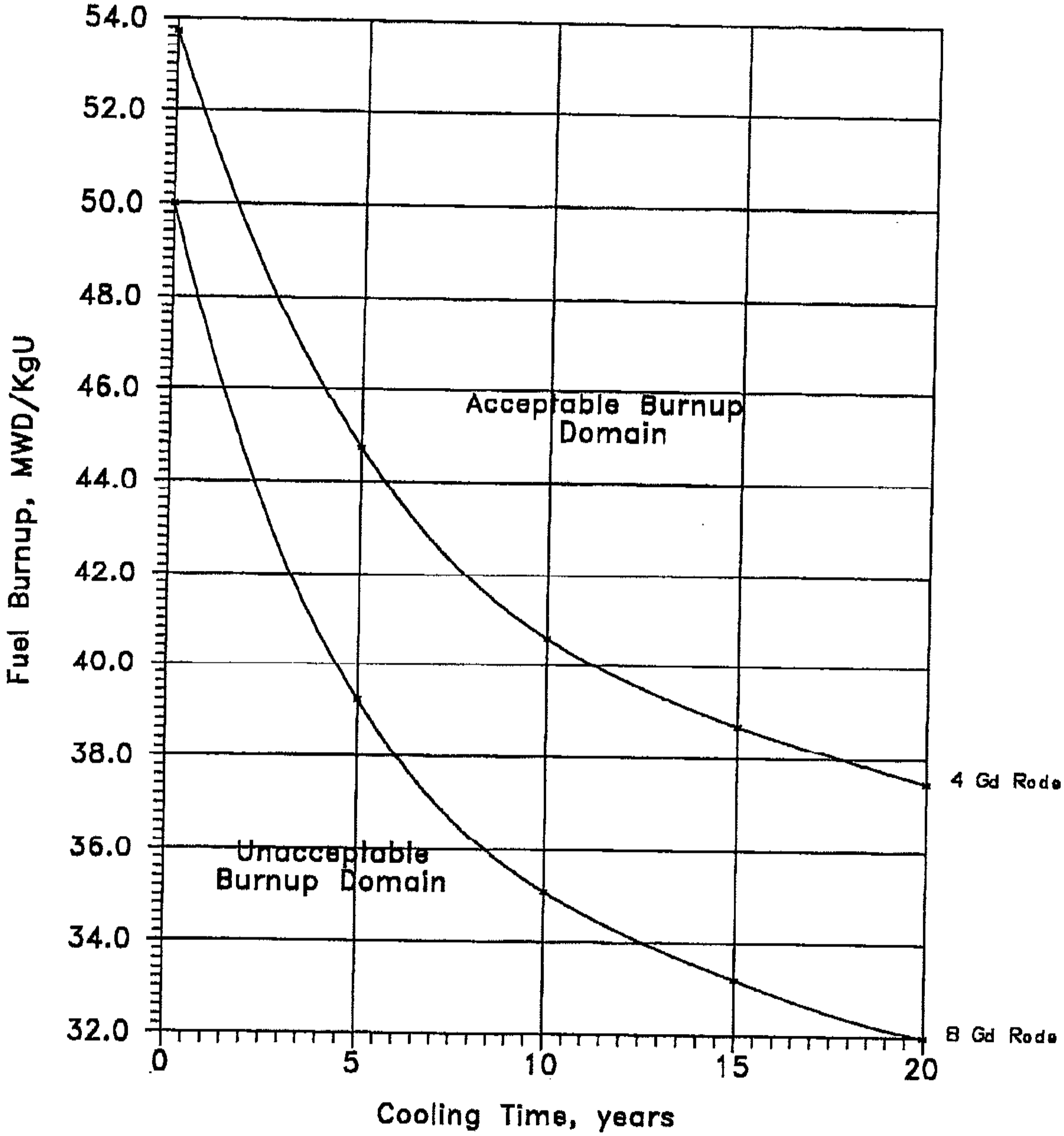


Fig. 5.6-6 Limiting Burnup Requirements in Region 4, Checkerboard Array of 1 Fresh (with Gadolinia) and 3 Type T Spent Fuel Assemblies

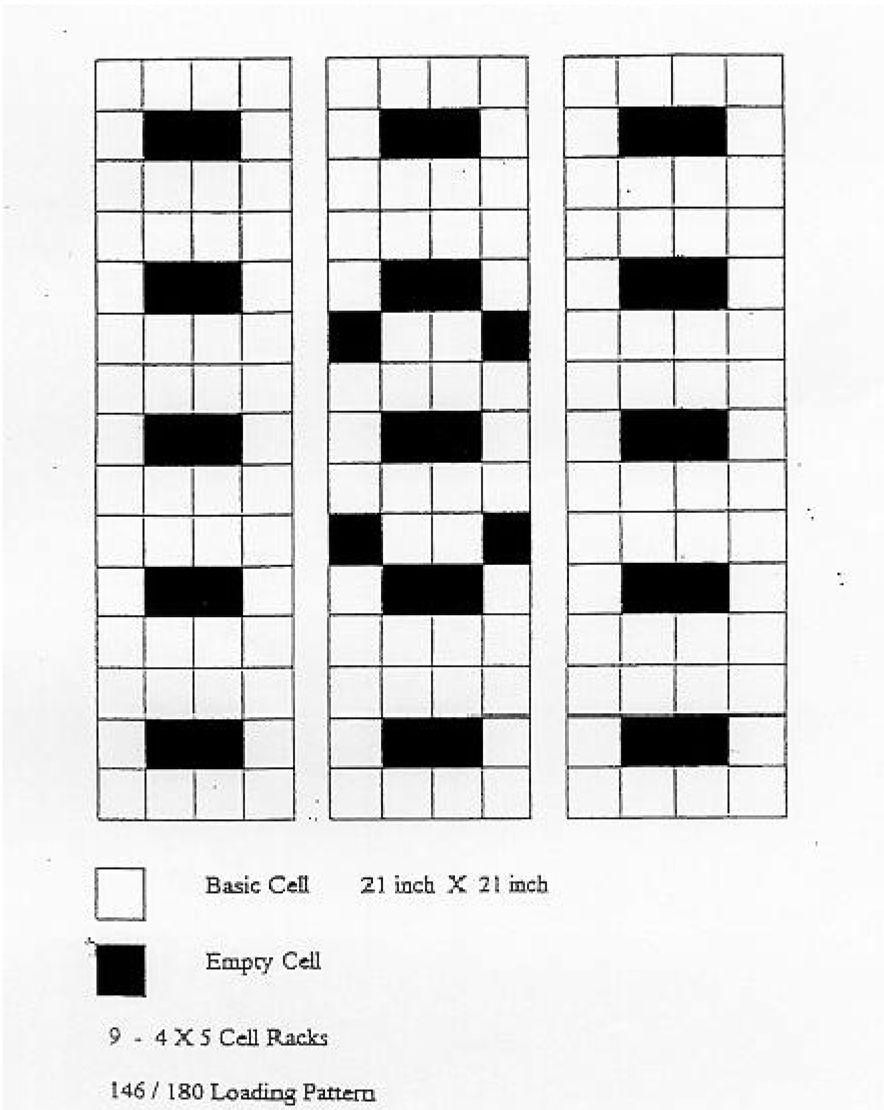


Figure 5.6-7
New Fuel Pit Storage Rack Loading Pattern

Table 5.6-1
Region 1 Storage Burnup Restrictions: Checkerboard of 1
Fresh Fuel Assembly (Without Gadolinium or IFBA Rods) and 3 Type A Spent Fuel Assemblies

For Zero Year Cooling Time Bu (limit) = $- 28.1868 + 23.0765 \times E - 2.46264 \times E^2 + 0.167868 \times E^3$
For One Year Cooling Time Bu (limit) = $- 27.3317 + 22.5087 \times E - 2.40586 \times E^2 + 0.164207 \times E^3$
For Two Years Cooling Time Bu (limit) = $-26.4693 + 21.8404 \times E - 2.31873 \times E^2 + 0.158218 \times E^3$
For Three Years Cooling Time Bu (limit) = $-25.7404 + 21.2659 \times E - 2.24287 \times E^2 + 0.153018 \times E^3$
For Four Years Cooling Time Bu (limit) = $- 25.1367 + 20.7910 \times E - 2.18484 \times E^2 + 0.1499363 \times E^3$
For Five Years Cooling Time Bu (limit) = $- 24.5981 + 20.3568 \times E - 2.12719 \times E^2 + 0.145431 \times E^3$
For Ten Years Cooling Time Bu (limit) = $- 23.2050 + 19.2969 \times E - 2.06993 \times E^2 + 0.145875 \times E^3$
For Fifteen Years Cooling Time Bu (limit) = $-22.6098 + 18.8544 \times E - 2.08617 \times E^2 + 0.150473 \times E^3$
For Twenty Years Cooling Time Bu (limit) = $- 22.3017 + 18.622 \times E - 2.11206 \times E^2 + 0.15467 \times E^3$

Note: E = initial enrichment in the axial zone of highest enrichment (wt% U-235)

Table 5.6-2
Region 1 Storage Burnup Restrictions with Gadolinium or IFBA in Fresh Fuel

With Gadolinium Credit: Checkerboard of 1 Fresh Fuel Assembly with 3 Type A Spent Fuel Assemblies

Zero Year Cooling Time, 0 Gadolinia Rods
Bu (limit) = - 28.1868 + 23.0765 x E – 2.46264 x E^2 + 0.167868 x E^3
Zero Year Cooling Time, 4 Gadolinia Rods
Bu (limit) = - 28.4012 + 22.0062 x E – 2.19268 x E^2 + 0.143601 x E^3
Zero Year Cooling Time, 8 Gadolinia Rods
Bu (limit) = - 31.4262 + 22.0768 x E – 2.38845 x E^2 + 0.164888 x E^3

Note: If more that 8 Gadolinium rods per assembly, use the 8 rod correlation

With IFBA Credit: Checkerboard of 1 Fresh Fuel Assembly with 3 Type A Spent Fuel Assemblies

Zero Year Cooling Time, 0 IFBA Rods
Bu (limit) = - 28.1868 + 23.0765 x E – 2.46264 x E^2 + 0.167868 x E^3
Zero Year Cooling Time, 16 IFBA Rods
Bu (limit) = - 28.5048 + 21.6411 x E – 2.15262 x E^2 + 0.140904 x E^3
Zero Year Cooling Time, 32 IFBA Rods
Bu (limit) = - 31.0949 + 22.0435 x E – 2.36088 x E^2 + 0.162229 x E^3
Zero Year Cooling Time, 48 IFBA Rods
Bu (limit) = - 33.1342 + 22.3999 x E – 2.55367 x E^2 + 0.18082 x E^3
Zero Year Cooling Time, 64 IFBA Rods
Bu (limit) = - 36.0468 + 24.1492 x E – 3.11807 x E^2 + 0.233987 x E^3

Note: If more that 64 IFBA rods per assembly, use the correlation for 64 IFBA rods

Note: E = initial enrichment in the axial zone of highest enrichment (wt% U-235)

Table 5.6-3
Region 2 Storage Burnup Restrictions
For Type A Fuel

Zero Cooling Time $Bu\ (limit) = -23.8702 + 12.3026 \times E - 0.275672 \times E^2$
1 Year Cooling Time $Bu\ (limit) = -23.6854 + 12.2384 \times E - 0.287498 \times E^2$
2 Years Cooling Time $Bu\ (limit) = -23.499 + 12.1873 \times E - 0.305988 \times E^2$
3 Years Cooling Time $Bu\ (limit) = -23.3124 + 12.1249 \times E - 0.319566 \times E^2$
4 Years Cooling Time $Bu\ (limit) = -23.1589 + 12.0748 \times E - 0.332212 \times E^2$
5 Years Cooling Time $Bu\ (limit) = -22.6375 + 11.7906 \times E - 0.307623 \times E^2$
10 Years Cooling Time $Bu\ (limit) = -21.7256 + 11.3660 \times E - 0.31029 \times E^2$
15 Years Cooling Time $Bu\ (limit) = -21.1160 + 11.0663 \times E - 0.306231 \times E^2$
20 Years Cooling Time $Bu\ (limit) = -20.6055 + 10.7906 \times E - 0.29291 \times E^2$

Note: E = initial enrichment in the axial zone of highest enrichment (wt% U-235)

Table 5.6-4
Face Adjacent Storage of Type T Spent Fuel (Region 2)

$$Bu\ (limit) = 33.1095 - 0.845146 \times CT + 0.0399888 \times CT^2 - 0.000762846 \times CT^3$$

Table 5.6-5
Limiting Burnup For Checkerboard Storage of Fresh and Type T Spent Fuel
(Region 4: 1 Fresh Assembly and 3 Spent Fuel Assemblies in a 2X2 Arrangement)

$$Bu\ (limit) = 57.118 - 2.13277 \times CT + 0.0772537 \times CT^2 + 0.00127446 \times CT^3 - 9.15855\ E\text{-}5 \times CT^4$$

Table 5.6-6
Gadolinia Credit: Limiting Burnup For Checkerboard Storage of Fresh and Type T Spent Fuel
(Region 4: 1 Fresh Assembly With Gadolinia and 3 Spent Fuel Assemblies in a 2X2 Arrangement)

4 Gadolinia Rods

$$Bu\ (limit) = 53.73 - 2.5265 \times CT + 0.172283 \times CT^2 - 0.00585995 \times CT^3 + 0.0000766655 \times CT^4$$

8 Gadolinia Rods

$$Bu\ (limit) = 50.00 - 3.26817 \times CT + 0.276117 \times CT^2 - 0.0117934 \times CT^3 + 0.000195334 \times CT^4$$

Note: 1. If more than 8 gadolinia rods per assembly, use the 8 rod correlation
2. BU = Fuel Burnup, MWD/Kg-U; CT = Cooling Time of Spent Fuel Assemblies, Years

3/4.6.4 COMBUSTIBLE GAS CONTROL

The OPERABILITY of the equipment and systems required for the detection and control of hydrogen gas ensures that this equipment will be available to maintain the hydrogen concentration within containment below its flammable limit during post-LOCA conditions. Either recombiner unit or the hydrogen mitigation system, consisting of 68 hydrogen ignitions per unit, is capable of controlling the expected hydrogen generation associated with 1) zirconium-water reactions, 2) radiolytic decomposition of water, 3) corrosion of metals within containment, and 4) tritium and hydrogen that exist in the Tritium Producing Burnable Absorber Rods prior to the accident. These hydrogen control systems are designed to mitigate the effects of an accident as described in Regulatory Guide 1.7, "Control of Combustible Gas Concentrations in Containment Following a LOCA", Revision 2 dated November 1978. The hydrogen monitors of Specification 3.6.4.1 are part of the accident monitoring instrumentation in Specification 3.3.3.7 and are designated as Type A, Category 1 in accordance with Regulatory Guide 1.97, Revision 2, "Instrumentation for Light-Water-Cooled Nuclear Power Plants to Assess Plant Conditions During and Following an Accident," December 1980.

The hydrogen mixing systems are provided to ensure adequate mixing of the containment atmosphere following a LOCA. This mixing action will prevent localized accumulations of hydrogen from exceeding the flammable limit.

The operability of at least 66 of 68 igniters in the hydrogen control distributed ignition system will maintain an effective coverage throughout the containment. This system of ignitors will initiate combustion of any significant amount of hydrogen released after a degraded core accident. This system is to ensure burning in a controlled manner as the hydrogen is released instead of allowing it to be ignited at high concentrations by a random ignition source.

3/4.6.5 ICE CONDENSER

The requirements associated with each of the components of the ice condenser ensure that the overall system will be available to provide sufficient pressure suppression capability to limit the containment peak pressure transient to less than 12 psig during LOCA conditions.

3/4.6.5.1 ICE BED

The OPERABILITY of the ice bed ensures that the required ice inventory will 1) be distributed evenly through the containment bays, 2) contain sufficient boron to preclude dilution of the containment sump following the LOCA and 3) contain sufficient heat removal capability to condense the reactor system volume released during a LOCA. These conditions are consistent with the assumptions used in the accident analyses.

The minimum weight figure of 1071 pounds of ice per basket contains a 15% conservative allowance for ice loss through sublimation which is a factor of 15 higher than assumed for the ice condenser design. The minimum weight figure of 2,082,024 pounds of ice also contains an additional 1% conservative allowance to account for systematic error in weighing instruments. In the

B 3.7 PLANT SYSTEMS

B 3/4.7.13 SPENT FUEL POOL MINIMUM BORON CONCENTRATION

BASES

BACKGROUND

The spent fuel racks have been analyzed in accordance with the Holtec International methodology contained in Holtec Reports HI - 992349 (Ref. 1) and HI-2012629 (Ref 9). This methodology ensures that the spent fuel rack multiplication factor, k_{eff} is less than or equal to 0.95, as recommended by the NRC guidance contained in NRC Letter to All Power Reactor Licensees from B.K. Grimes, "OT Position for Review and Acceptance of Spent Fuel Storage and Handling Applications", April 14, 1978 and USNRC Internal Memorandum from L. Kopp, "Guidance On The Regulatory Requirements For Criticality Analysis Of Fuel Storage At Light-Water Reactor Power Plants", August 19, 1998 (Refs. 2 & 3). The codes, methods, and techniques contained in the methodology are used to satisfy the k_{eff} criterion. The spent fuel storage racks were analyzed using Westinghouse 17x17 V5H fuel assemblies, with enrichments up to 4.95 $\pm$0.05 w/o U-235 and configurations which take credit for checkerboarding, burnup, soluble boron, integral fuel burnable absorbers (such as IFBA or gadolinia), and cooling time to ensure that k_{eff} is maintained $\leq$ 0.95, including uncertainties, tolerances, and accident conditions. The analysis also accounts for the reactivity effects of operating the fuel with discrete burnable poisons (such as burnable poison rod absorbers or tritium producing burnable absorber rods). In addition, the SFP k_{eff} is maintained < 1.0, including uncertainties, tolerances on a 95/95 basis without any soluble boron. Calculations were performed to evaluate the reactivity of fuel types used at SQN. The results show that the Westinghouse 17x17 V5H fuel assembly exhibits the highest reactivity, thereby bounding all fuel types utilized and stored at SQN.

In the high density Spent Fuel Rack design (Ref. 9), the spent fuel storage pool is divided into four separate and distinct regions which, for the purpose of criticality considerations, are considered as separate pools. For convenience of reference, the following definitions apply:

Type A fuel refers to spent fuel assemblies which have not contained tritium producing burnable absorber rods (TPBAR's) during in-core operation.

Type T fuel refers to spent fuel assemblies which have contained tritium producing burnable absorber rods (TPBAR's) during in-core operation.

Fresh fuel refers to unirradiated Type A or Type T fuel or irradiated Type A or Type T fuel which has not attained sufficient burnup to meet spent fuel requirements.

Cooling time is defined as the period since reactor shutdown at the end of the last operating cycle for the discharged spent fuel assembly.

Region 1 is designed to accommodate fresh fuel with a maximum enrichment of 4.95 +/- 0.05 wt% U-235, or spent fuel regardless of the discharge burnup in a 1-of-4 checkerboard arrangement of 1 fresh assembly with 3 spent Type A fuel

BASES

BACKGROUND (continued)

assemblies with enrichment, burnup, and cooling times in accordance with Design Feature 5.6.1.1.c.1. Region 2 is designed to accommodate Type A or Type T fuel of up to 4.95 +/- 0.05 wt% U-235 initial enrichment burned to an assembly average burnup of at least 30.27 MWD/kgU for Type A fuel or 33.1095 MWD/kgU for Type T fuel, or other enrichment with a burnup yielding an equivalent reactivity in the fuel racks in accordance with Design Feature 5.6.1.1.c.2. Region 3 is designed to accommodate fresh fuel of up to 4.95 +/- 0.05 wt% U-235 initial enrichment, or fuel assemblies of any lower reactivity in a 2-of-4 checkerboard arrangement with water-filled cells in accordance with Design Feature 5.6.1.1.c.3. Region 4 is designed to accommodate fresh fuel up to 4.95 +/- 0.05 wt% U-235 initial enrichment, or spent fuel regardless of the discharge burnup in a 1-of-4 checkerboard arrangement of 1 fresh assembly with 3 spent Type T fuel assemblies with burnup and cooling times in accordance with Design Feature 5.6.1.1.c.4.

The water in the spent fuel storage pool normally contains soluble boron, which results in large subcriticality margins under actual operating conditions. However, the NRC guidelines, based upon the accident condition in which all soluble poison is assumed to have been lost, specify that the limiting k_{eff} of < 1.0 be evaluated in the absence of soluble boron. Hence, the design of all regions is based on the use of unborated water, which maintains each region in a subcritical condition during normal operation with the regions fully loaded. The double contingency principle discussed in ANSI N-16.1-1975 and the April 1978 NRC letter (Ref. 5) allows credit for soluble boron under other abnormal or accident conditions, since only a single accident need be considered at one time. For example, the most severe accident scenario is associated with the accidental mishandling of a fresh fuel assembly face adjacent to a fresh fuel assembly of Region 3. This could potentially increase the criticality of Region 3. To mitigate these postulated criticality related accidents, boron is dissolved in the pool water. The soluble boron concentration required to maintain $k_{eff} \leq 0.95$ under normal conditions is 300 ppm and 700 ppm under the most severe postulated fuel mis-location accident. Safe operation of the spent fuel storage racks may therefore be achieved by controlling the location of each assembly in accordance with Design Features 5.6 FUEL STORAGE. During fuel movement, it is necessary to perform Surveillance Requirement 4.7.13.2.

APPLICABLE SAFETY ANALYSES

Most accident conditions do not result in an increase in the reactivity of any one of the three regions. Examples of these accident conditions are the loss of cooling and the dropping of a fuel assembly on the top of the rack. However, accidents can be postulated that could increase the reactivity. This increase in reactivity is unacceptable with unborated water in the storage pool. Thus, for these accident occurrences, the presence of soluble boron in the storage pool prevents criticality in all regions. The most limiting postulated accident with respect to the storage configurations assumed in the spent fuel rack

BASES

APPLICABLE SAFETY ANALYSES (continued)

criticality analysis is the misplacement of a nominal 4.95 ± 0.05 w/o U-235 fresh fuel assembly into an empty storage cell location in the Region 3 checkerboard storage arrangement. The amount of soluble boron required to maintain k_{eff} less than or equal to 0.95 due to this fuel misload accident is 700 ppm (Ref. 1 and Ref. 9).

A spent fuel boron dilution analysis was performed to ensure that sufficient time is available to detect and mitigate dilution of the spent fuel pool prior to exceeding the k_{eff} design basis limit of 0.95 (Ref. 6). The spent fuel pool boron dilution analysis concluded that an inadvertent or unplanned event that would result in a dilution of the spent fuel pool boron concentration from 2000 ppm to 700 ppm is not a credible event.

The concentration of dissolved boron in the spent fuel storage pool satisfies Criterion 2 of the NRC Policy Statement.

LCO

The spent fuel storage pool boron concentration is required to be ≥ 2000 ppm. The specified concentration of dissolved boron in the spent fuel storage pool preserves the assumptions used in the analyses of the potential critical accident scenarios as described in Reference 7. This concentration of dissolved boron is the minimum required concentration for fuel assembly storage and movement within the spent fuel storage pool.

APPLICABILITY

This LCO applies whenever fuel assemblies are stored in the spent fuel storage pool.

ACTIONS

Action a:

When the concentration of boron in the spent fuel storage pool is less than required, immediate action must be taken to preclude the occurrence of an accident or to mitigate the consequences of an accident in progress. This is most efficiently achieved by immediately suspending the movement of fuel assemblies. The concentration of boron is restored along with suspending movement of fuel assemblies.

Action a is modified by a provision indicating that LCO 3.0.3 does not apply. If the LCO is not met while moving irradiated fuel assemblies in MODE 5 or 6, LCO 3.0.3 would not be applicable. Moving irradiated fuel assemblies while in MODE 1, 2, 3, or 4 is independent of reactor operation. Therefore, inability to suspend movement of fuel assemblies is not sufficient reason to require a reactor shutdown.

BASES

SURVEILLANCE REQUIREMENTS

4.7.13.1

This Surveillance Requirement verifies that the concentration of boron in the spent fuel storage pool is within the required limit. As long as this Surveillance Requirement is met, the analyzed accidents are fully addressed. The 7 day Frequency is appropriate because no significant replenishment of pool water is expected to take place over such a short period of time. (Ref. 6)

4.7.13.2

This Surveillance Requirement verifies that the concentration of boron in the spent fuel storage pool is within the required limit during fuel movement until the final configuration of the assemblies in the storage racks is verified to be correct. As long as this Surveillance Requirement is met, the analyzed accidents are fully addressed. The 72 hour Frequency provides additional assurance that the maximum k_{eff} remains below the 0.95 limit under the postulated accident condition. (Ref. 1, 8, and 9)

REFERENCES

1. Stanley E. Turner (Holtec International), “Criticality Safety Analyses of Sequoyah Spent Fuel Racks with Alternative Arrangements,” HI-992349

2. B.K. Grimes (NRC GL78011), “OT Position for Review and Acceptance of Spent Fuel Storage and Handling Applications”, April 14, 1978

3. L. Kopp, “Guidance On The Regulatory Requirements For Criticality Analysis Of Fuel Storage At Light-Water Reactor Power Plants”, August 19, 1998

4. UFSAR, Section 4.3.2.7, "Critically of Fuel Assemblies"

5. Double contingency principle of ANSI N16.1-1975, as specified in the April 14, 1978 NRC letter (Section 1.2) and implied in the proposed revision to Regulatory Guide 1.13 (Section 1.4, Appendix A).

6. K K Niyogi (Holtec International), “Boron Dilution Analysis,” HI-992302

7. FSAR, Section 15.4.5

8. NRC letter to TVA dated August 1, 1990, “ Increase Fuel Enrichment to 5.0 Weight Percent (TAC Nos. 76074, 76075, 76774, 76775) (TS 90-12) - Sequoyah Nuclear Plant, Units 1 and 2”

9. Stanley E. Turner (Holtec International, “Evaluation of the Effect of the Use of Tritium Producing Burnable Absorber Rods (TPBARS) on Fuel Storage Requirements,” HI-2012629

B 3.7 PLANT SYSTEMS

3/4.7.14 CASK PIT POOL MINIMUM BORON CONCENTRATION

BASES

This specification is deleted.

Pages B3/4 7-13 through B3/4 7-15 are deleted.

ENCLOSURE 4

TENNESSEE VALLEY AUTHORITY
SEQUOYAH NUCLEAR PLANT (SQN)
UNITS 1 AND 2
DOCKET NO. 327, 328

FRAMATOME-ADVANCED NECLEAR POWER (ANP)
REPORT NO. BAW 10237, Revision 1