BEFORE THE
UNITED STATES NUCLEAR REGULATORY COMMISSION

In the Matter of :

Docket No. 50-387

PENNSYLVANIA POWER & :
LIGHT COMPANY

PROPOSED AMENDMENT No. 166
FACILITY OPERATING LICENSE NO. NPF-14
SUSQUEHANNA STEAM ELECTRIC STATION
UNIT NO. 1

Licensee, Pennsylvania Power & Light Company, hereby files proposed Amendment No. 166 to its Facility Operating License No. NPF-14 dated July 17, 1982.

This amendment contains a revision to the Susquehanna SES Unit 1 Technical Specifications.

PENNSYLVANIA POWER & LIGHT COMPANY
BY:

R. G. Byram
Sr. Vice President - Nuclear

Sworn to and subscribed before me
this 19 of July, 1994.

Notary Public

Notarial Seal
Martha C. Sedora, Notary Public
Allentown, Lehigh County
My Commission Expires Jan. 15, 1998
Member, Pennsylvania Association of Notaries

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BEFORE THE
UNITED STATES NUCLEAR REGULATORY COMMISSION

In the Matter of	:	Docket No. 50-388
PENNSYLVANIA POWER & LIGHT COMPANY	:	

PROPOSED AMENDMENT No. 121
FACILITY OPERATING LICENSE NO. NPF-22
SUSQUEHANNA STEAM ELECTRIC STATION
UNIT NO. 2

Licensee, Pennsylvania Power & Light Company, hereby files proposed Amendment No. 121 to its Facility Operating License No. NPF-22 dated March 23, 1984.

This amendment contains a revision to the Susquehanna SES Unit 2 Technical Specifications.

PENNSYLVANIA POWER & LIGHT COMPANY
BY:

R. G. Byram
Sr. Vice President - Nuclear

Sworn to and subscribed before me
this 19th of July, 1994.

Notary Public

Notarial Seal
Martha C. Sedora, Notary Public
Allentown, Lehigh County
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SAFETY ASSESSMENT
STANDBY LIQUID CONTROL SYSTEM
TECHNICAL SPECIFICATION 3.1.5

BACKGROUND

Susquehanna Technical Specification 3.1.5 requires having the Standby Liquid Control (SLC) System operable during OPERATIONAL CONDITION 5 (OPCON 5 - Refueling) with any control rod withdrawn. The SLC System is required to be operable in order to terminate an inadvertent criticality event during core alterations. The safety analysis provided here will show that the SLC System was not designed or intended to terminate an inadvertent criticality event during core alterations.

The purpose of the Standby Liquid Control System is to provide backup capability for bringing the reactor from full power to a cold, Xenon-free shutdown, assuming that none of the withdrawn control rods can be inserted. Guidance pertaining to the SLC System purpose and required capability is included in General Design Criteria (GDC) 27 and 26.

Design conformance to GDC 27, Combined Reactivity Control Systems Capability, states that there is no credible event applicable to the BWR which requires combined capability of the control rod system and poison additions. The primary reactivity control system for the BWR during postulated accident conditions is the control rod system. However, in the very unlikely event that more than one control rod fails to insert, and the core cannot be maintained in a subcritical condition by control rods alone as the reactor is cooled down subsequent to initial shutdown, the Standby Liquid Control System will be actuated to insert soluble boron into the reactor core and achieve and maintain a subcritical condition. This is the Anticipated Transient Without Scram (ATWS) scenario, and is the design purpose for SLC in OPCONs 1&2. 10CFR50.62(c)(4) requires that each boiling water reactor have a SLC System to reduce the risk associated with ATWS events. The SLC System at Susquehanna SES satisfies the regulatory requirement.

According to GDC 26, two independent reactivity control systems of different design principles shall be provided. However, according to the GDC, only one of the two reactivity control systems must be capable of holding the reactor subcritical under cold conditions. Cold conditions are OPCONs 4, (Cold Shutdown) or 5 (Refueling). As stated in Final Safety Analysis Report (FSAR) Section 3.1.2.3.7, "Reactivity Control System Redundancy and Capability," Susquehanna SES compliance with GDC 26 is accomplished with the Control Rod System and the Reactor Recirculation System. The Control Rod System is capable of holding the reactor core subcritical under cold conditions regardless of the water level in the reactor, and even with the highest worth rod withdrawn from the core. In the unlikely event that the control rod system were to allow additional rod withdrawals, the Reactor Protection System (RPS) would respond by inserting all control rods via the Scram function. The RPS monitors for recriticality during OPCON 5 with SRMs (except during specific controlled evolution's), IRMs, and APRMs. The Scram circuitry is completely redundant from the insert and withdrawal circuitry for the control rods.

Susquehanna Technical Specification Surveillance Requirement 4.1.5.d.3 requires an operability check be performed on the SLC System tank heaters every 18 months. The purpose of the SLC tank heaters is; (1) to maintain the temperature of the SLC tank high enough to prevent the boric acid from precipitating out of solution, and (2) to maintain the tank temperature while chemicals are being mixed. The second function is necessary because the mixing of sodium pentaborate and water is an endothermic (heat consuming) reaction. Typically, both heaters are used when adding chemicals. During steady state system operation, heater 'A' is used to maintain tank temperature. The heaters have local indicating lights which show the status of the heaters. In addition, there is an alarm in the control room on tank temperature with a low and high setpoint.

The safety analysis provided here will show that heater 'A' operability is confirmed through Surveillance Requirement 4.1.5.a.1 on a daily basis; thus the 18 month operability check is redundant to an existing surveillance requirement. Further, the safety analysis will show that the ambient temperature in the SLC System area precludes the sodium pentaborate solution from rapidly decreasing in temperature. Heater 'B' operability is confirmed through the procedure used to add chemicals to the SLC Tank. The function of heater 'B' is to maintain tank temperature during chemical addition, so verification through the procedure ensures that heater 'B' is operable at the point in time when it is needed.

DESCRIPTION OF CHANGES

Pennsylvania Power & Light proposes modifying Technical Specification 3.1.5 to:

1. remove the requirement for the Standby Liquid Control System to be operable in OPCON 5 with any control rod withdrawn.

2. delete Surveillance Requirement 4.1.5.d.3.

A mark-up of Technical Specification 3.1.5, showing the proposed changes, is attached to this analysis.

SAFETY ANALYSIS

Safety Analysis for Deleting OPCON 5* Operability Requirement

The purpose of the SLC System is to provide backup capability for bringing the reactor from full power to a cold, Xenon-free shutdown, assuming that none of the withdrawn control rods can be inserted. This bases is consistent with the required operability of the SLC System in OPCONs 1 & 2. The current Technical Specification requirement for SLC operability in OPCON 5 with any control rod withdrawn is unnecessary / inappropriate because:

- compliance with the licensing basis for Susquehanna SES does not depend on the operability of SLC in OPCON 5.

- adequate shutdown margin and redundancy is maintained by systems and controls independent of SLC in OPCON 5.

- the SLC System is not designed to terminate an inadvertent criticality event during core alterations (OPCON 5) with vessel water level at least 22 feet above top of vessel flange.

Compliance with the licensing basis for Susquehanna SES does not depend on the operability of SLC in OPCON 5.

General Design Criteria (GDC) 29, 28, 27, and 26 establish the licensing basis for Reactivity Control Systems. These criteria are attached.

GDC 29 requires that the Reactivity Control System be designed to ensure an extremely high probability of meeting its design function. This requirement is not affected by modifying the operability requirement of SLC in OPCON 5*.

GDC 28 requires that the Reactivity Control System be designed with appropriate limits on the potential amount and rate of reactivity increase to assure that the effects of postulated reactivity accidents do not compromise the integrity of the reactor pressure vessel or the ability to cool the core. Design conformance to GDC 28 references accident analysis performed under FSAR Chapter 15; specifically section 15.4 discusses accident analysis considerations for Reactivity Control. Section 15.4.1 discusses postulated accidents at low power and/or refueling. The analysis does not rely on or mention the use of SLC as a mitigator to postulated accidents during refueling.

Design conformance to GDC 27, Combined Reactivity Control Systems Capability, states that there is no credible event applicable to the BWR which requires combined capability of the control rod system and poison additions. The primary reactivity control system for the BWR during postulated accident conditions is the control rod system. However, in the very unlikely event that more than one control rod fails to insert, and the core cannot be maintained in a subcritical condition by control rods alone as the reactor is cooled down subsequent to initial shutdown, the Standby Liquid Control System will be actuated to insert soluble boron into the reactor core and achieve and maintain a subcritical condition. This is the Anticipated Transient Without Scram (ATWS) scenario, and is the design purpose for SLC in OPCONs 1&2. 10CFR50.62(c)(4) requires that each boiling water reactor have a SLC System to reduce the risk associated with ATWS events. The SLC System at Susquehanna SES satisfies the regulatory requirement.

According to GDC 26, two independent reactivity control systems of different design principles shall be provided. However, according to the GDC, only one of the two reactivity control systems must be capable of holding the reactor subcritical under cold conditions. Cold conditions are OPCONs 4, (Cold Shutdown) or 5 (Refueling). As stated in Final Safety Analysis Report (FSAR) Section 3.1.2.3.7, "Reactivity Control System Redundancy and Capability," Susquehanna SES compliance with GDC 26 is accomplished with the Control Rod System and the Reactor Recirculation System. The Control Rod System is capable of holding the reactor core subcritical under cold conditions regardless of the water level in the reactor, and even with the highest worth rod withdrawn from the core. In the unlikely event that the control rod system were to allow additional rod withdrawals, the Reactor Protection System (RPS) would respond by inserting all control rods via the Scram function. The RPS monitors for recriticality during OPCON 5 with SRMs (except during specific controlled evolutions), IRMs, and APRMs. The Scram circuitry is completely redundant from the insert and withdrawal circuitry for the control rods.

Thus the Susquehanna SES licensing basis for reactivity control in OPCON 5 depends on the Control Rod System. The provisions of GDC 29, 28, 27, and 26 show that the proposed Technical Specification is consistent with the licensing basis of Susquehanna SES.

Adequate shutdown margin and redundancy is maintained by systems and controls independent of SLC in OPCON 5.

There are four conditions applicable to OPCON 5 which involve shutdown margin:

- Full core loaded (shutdown)
- Core off-loading
- Core reloading
- Full core loaded (refueled)

In each case, adequate shutdown margin is maintained through design and administrative control. In addition, RPS monitors for recriticality and actuates the Control Rod Scram function if a significant reactivity addition is sensed.

During the post shutdown phase, with the core fully loaded, adequate shutdown margin is assured via the Shutdown Margin Demonstration which was performed when the core was loaded.

During core off-loading, adequate shutdown margin is maintained or increased. This condition is required by Technical Specification 3.1.1 and implemented via procedural controls which govern the off-loading process. Fuel movement and other core alterations with control rods removed from the core are controlled by section 3/4.9 (Refueling Operations) of the Technical Specifications. These requirements along with the associated refueling interlocks sufficiently minimize the possibility of inadvertently moving fuel into a cell containing no control rod, or

moving the refueling platform over the core and withdrawing additional control rods when there is uncontrolled fuel in the core.

SDM is analytically determined prior to the reactor core being reloaded into the vessel. The calculated SDM is the acceptance criteria used in Technical Specification Surveillance 4.1.1. This analytical SDM, in conjunction with Technical Specification requirements, refueling interlocks, and procedural controls, assures that an inadvertent criticality will not occur during core reloading activities.

Lastly, after the core has been reloaded, Technical Specification 3.10.3, Shutdown Margin Demonstration, establishes additional controls so that more than one rod can be withdrawn. In the extremely unlikely event that an inadvertent criticality occurs during this time, these additional restrictions assure the Control Rod System will be automatically actuated by the Reactor Protection System. Both the Control Rod System and the RPS are highly reliable systems. This conclusion is based upon the following:

1. Both the Control Rod System and RPS are designed such that no single active failure will prevent them from performing their protective functions.

2. The RPS is a fail safe system such that upon a loss of power it will perform its safety function.

3. The RPS, control rods and control rod drive mechanisms are standard designs with many years of operation which have demonstrated the soundness of their design and reliability.

4. The preventative maintenance program for these systems maintains them in a highly reliable state.

5. Numerous Technical Specification Surveillances demonstrate the operational readiness of the Control Rod System and the RPS.

Therefore, maintaining shutdown margin in OPCON 5* is not dependent on SLC operability.

The SLC System is not designed to terminate an inadvertent criticality event during core alterations (OPCON 5) with vessel water level at least 22 feet above top of vessel flange.

The amount of sodium pentaborate solution contained in the SLC System is designed to achieve and maintain shutdown assuming the water inventory in the reactor vessel is at normal power operating levels. During refueling operations, the reactor vessel head is removed and the refueling cavity is flooded to a level at least 22 feet above the top of the vessel flange per Technical Specification 3.9.8. With the refueling cavity flooded, the amount of sodium pentaborate solution in the SLC System may not be sufficient to obtain a poison concentration in the reactor which would halt an inadvertent criticality event or maintain the reactor subcritical.

Based on the above analysis it is concluded that operability of the Standby Liquid Control System is not required, necessary, or intended in OPCON 5*.

Safety Analysis for Deleting Heater Operability Surveillance

The purpose of the SLC tank heaters is; (1) to maintain the temperature of the SLC tank high enough to prevent the boric acid from precipitating out of solution, and (2) to maintain the tank temperature while chemicals are being mixed. The second function is necessary because the mixing of sodium pentaborate and water is an endothermic (heat consuming) reaction. Typically, both heaters are used when adding chemicals. During steady state system operation, heater 'A' is used to maintain tank temperature between 85°F and 95°F. The heaters have local indicating lights which show the status of the heaters. In addition, there is an alarm in the control room on tank temperature with a low setpoint of 80°F and a high setpoint of 110°F. The alarm function is maintained under Susquehanna preventive maintenance activities.

Technical Specification Surveillance Requirement 4.1.5.d.3 requires an 18 month operability test be performed on the SLC tank heaters. The test is performed under Susquehanna surveillance procedures. The test is performed by recording the present tank temperature at the start of the test (after a 1 hour agitation period), energizing both heaters for 2 hours, and then recording the temperature rise during the heating period. Operability of the heaters is determined by showing a greater than 2°F temperature rise during the test.

The operability of both SLC tank heaters is ensured through procedures and controls independent from surveillance requirement 4.1.5.d.3.

The operability of heater 'A', which maintains solution temperature in the acceptance range, is verified through the daily performance of Technical Specification Surveillance Requirement 4.1.5.a.1 and a control room alarm. Surveillance 4.1.5.a.1 requires that the temperature of the sodium pentaborate solution be within the acceptance range for the solution concentration. Heater 'A' failure would be indicated by gradually decreasing temperatures as recorded during this surveillance. In addition, tank temperature is also monitored by an alarm in the control room. As a result, two independent means of verifying heater operability exist without requiring an 18 month heater operability test (Surveillance Requirement 4.1.5.d.3). Moreover, failure of heater 'A' is unlikely to result in a drastic change in solution temperature, or temperature reduction below the acceptance value of 70°F. Long term trending of temperature data in the Unit 1 & 2 SLC areas shows that the average ambient temperature is approximately 80°F. In addition, this trending shows that ambient temperatures below 70°F occur only approximately 4% of the time, and that the low ambient is approximately 65°F.

The operability of heater 'B', which maintains the tank temperature while chemicals are being added and mixed, is verified through the performance of the procedure used to add the chemicals. These procedures contain steps which instruct the operator to turn on the 'B' heater and verify an increase in the tank temperature above 100°F, prior to adding chemicals to the tank. Since the tank temperature is maintained between 85°F and 95°F during normal periods, the requirement to raise tank temperature above 100°F verifies the operability of the 'B' heater. The procedure also instructs the operator to ensure that the solution temperature does not decrease below 100°F during chemical addition. The control room alarm on low tank temperature provides a second independent check of heater operability, since heat input is required to offset the endothermic reaction associated with chemical addition.

Conclusions

Deleting the Technical Specification requirement to have SLC operable in OPCON 5* does not impact the safe operation of the Susquehanna SES. The basis for this change is that the SLC System was not intended or designed to terminate an inadvertent criticality event during OPCON 5*. Shutdown margin, either demonstrated or analytically determined, in conjunction with Technical Specification requirements and procedural controls, will assure that an inadvertent criticality event will not occur during refuel operations. In addition, the RPS and Control Rod Systems provide protection in the unlikely event that an inadvertent criticality should occur during OPCON 5.

Deleting Technical Specification Surveillance Requirement 4.1.5.d.3, SLC Heater Operability Test, does not impact the safe operation of the Susquehanna SES. The 18 month operability test is redundant to other surveillance requirements, procedures, and controls which verify the operability of both the 'A' and 'B' heaters. Moreover, the 18 month heater operability test does not directly ensure that the temperature of the SLC tank solution is maintained in the Technical Specification acceptance range. Independent measures of SLC solution temperature are currently employed which ensure solution temperature remains in the acceptance range. In addition, long term data trending has shown that ambient temperatures in the SLC area act to maintain SLC solution temperature in the acceptance range or prevent solution temperature from rapidly decreasing.

NO SIGNIFICANT HAZARDS CONSIDERATIONS

I. This proposal does not involve a significant increase in the probability or consequences of an accident previously evaluated.

The proposed Technical Specification change to delete the operability requirement for the SLC System in OPCON 5* (OPERATIONAL CONDITION 5 with any control rod withdrawn) does not affect the probability or consequences of an accident previously evaluated. Design basis accident mitigation scenarios for SSES in OPCON 5 do not depend on, or require, SLC operability; therefore, the proposed change to delete SLC operability in OPCON 5* does not affect the probability or consequences of an accident previously evaluated.

The proposed Technical Specification change to delete Surveillance Requirement 4.1.5.d.3, 18 month SLC heater operability check, does not affect the probability or consequences of an accident previously evaluated. Regarding the SLC heater function, the operability of the SLC systems depends on maintaining the temperature of the sodium pentaborate solution above 70°F to prevent the boric acid from precipitating out of solution. SLC heater 'A' is used to maintain tank temperature between 85°F and 95°F, thus ensuring that the boric acid remains in solution. The operability of heater 'A' is verified through the daily performance of Technical Specification Surveillance Requirement 4.1.5.a.1, which checks SLC solution temperature, and a control room alarm. Heater 'B' functions to raise SLC solution temperature prior to the mixing of SLC chemicals - the mixing of sodium pentaborate and water is an endothermic (heat consuming) reaction. The operability of heater 'B' is verified at the time when chemicals are added to the SLC tank, since a precondition for adding the chemicals is using heater 'B' to increase tank temperature to 100°F. Heater 'B' does not function to maintain tank temperature during normal operation. Therefore, the proposed change does not impact Susquehanna's ability to maintain SLC solution temperature and thus does not increase the probability or consequences of an accident previously evaluated.

II. This proposal does not create the possibility of a new or different kind of accident or from any accident previously evaluated.

The proposed Technical Specification change to delete the operability requirement for the SLC System in OPCON 5* does not create the possibility of a new or different kind of accident or from any accident previously evaluated. The purpose of the SLC System is to provide backup capability for bringing the reactor from full power to a cold, Xenon-free shutdown, assuming that none of the withdrawn control rods can be inserted. This bases is consistent with the required operability of the SLC System in OPCONs 1 & 2. The proposed change does not affect the ability of SLC to meet its design basis. No credit is taken for SLC in OPCON 5 to mitigate the effects of reactivity transients, and the SLC system is not designed to terminate an inadvertent criticality event during core alterations (OPCON 5) with vessel water level at least 22 feet above top of vessel flange. Therefore, no new or different accident scenarios are created by the proposed change.

The proposed Technical Specification change to delete Surveillance Requirement 4.1.5.d.3, 18 month SLC heater operability check, does not create the possibility of a new or different kind of accident or from any accident previously evaluated. The proposed change does not affect systems, structures, or components (SSCs) or the operation of these SCCs. The heating and heater control subsystems of the SLC system will continue to function as they were designed. The proposed change does not alter the heating limits or the method for maintaining SLC solution temperature. Therefore, the proposed change does not create the possibility of a new or different kind of accident or from any accident previously evaluated.

III. This change does not involve a significant reduction in a margin of safety.

The proposed Technical Specification change to delete the operability requirement for the SLC System in OPCON 5* does not involve a significant reduction in a margin of safety. The potential for a decrease in the margin of safety, under this proposed change, would be associated with periods during OPCON 5* when the SLC system was not operable. Allowing the SLC system to be inoperable during OPCON 5* with the vessel level at least 22 feet above top of vessel flange, represents no reduction in the margin of safety since the SLC system is not designed to terminate an inadvertent criticality event with a greater volume of water in the reactor. Having the SLC system inoperable in OPCON 5* with reactor water levels at normal operating volumes, does not significantly reduce the margin of safety because of the number of other design and operating features which act to prevent inadvertent criticality events. Adequate shutdown margin is maintained through design and administrative controls; including, Shutdown Margin Demonstration, Technical Specification 3.1.1, defueling and refueling procedures, and refueling interlocks. In addition, the Reactor Protection System monitors for recriticality and actuates the Control Rod Scram function if a significant reactivity addition is sensed.

The proposed Technical Specification change to delete Surveillance Requirement 4.1.5.d.3, 18 month SLC heater operability check, does not involve a significant reduction in a margin of safety. Adequate controls are in place, independent of the 18 month heater operability check, to ensure that the temperature of the sodium pentaborate solution is maintained above 70°F. These controls include Surveillance Requirement 4.1.5.a.1, which checks SLC solution temperature daily, a control room alarm on low and high temperature, and the ambient temperature conditions in the SLC area which prevent rapid changes in SLC solution temperature. Operability of the 'B' heater is not needed to maintain SLC solution temperature, and the operability of this heater is verified at the time when chemicals are added to the SLC tank.

IMPLEMENTATION

It is requested that this change be approved as soon as possible but no later than February 10, 1995 with implementation within 30 days of the date of issuance.

GENERAL DESIGN CRITERIA

Reactivity Control System Redundancy and Capability (Criterion 26)

Criterion

Two independent reactivity control systems of different design principles shall be provided. One of the systems shall use control rods, preferably including a positive means for inserting the rods, and shall be capable of reliably controlling reactivity changes to assure that under conditions of normal operation, including anticipated operational occurrences, and with appropriate margin for malfunctions such as stuck rods, specified acceptable fuel design limits are not exceeded. The second reactivity control system shall be capable of reliably controlling the rate of reactivity changes resulting from planned, normal power changes (including xenon burnout) to assure acceptable fuel design limits are not exceeded. One of the systems shall be capable of holding the reactor core subcritical under cold conditions.

Design Conformance

Two independent reactivity control systems utilizing different design principles are provided. The normal method of reactivity control employs control rod assemblies which contain boron carbide (B C) powder. Positive insertion of these control rods is provided by means of the control rod drive hydraulic system. The control rods are capable of reliably controlling reactivity changes during normal operation (e.g., power changes, power shaping, xenon burnout, normal startup and shutdown) via operator-controlled insertions and withdrawals. The control rods are also capable of maintaining the core within acceptable fuel design limits during anticipated operational occurrences via the automatic scram function. The unlikely occurrence of a limited number stuck rods during a scram will not adversely affect the capability to maintain the core within fuel design limits.

The circuitry for manual insertion or withdrawal of control rods is completely independent of the circuitry for reactor scram. This separation of the scram and normal rod control functions prevents failures in the reactor manual control circuitry from affecting the scram circuitry. Two sources of scram energy (accumulator pressure and reactor vessel pressure) provide needed scram performance over the entire range of reactor pressure, i.e., from operating conditions to cold shutdown. The design of the control rod system includes appropriate margin for malfunctions such as stuck rods in the highly unlikely event that they do occur. Control rod withdrawal sequences and patterns are selected prior to operation to achieve optimum core performance, and simultaneously, low individual rod worths. The operating procedures to accomplish such patterns are supplemented by the rod sequence control system, which prevents rod withdrawals yielding a rod worth greater than permitted by the preselected rod withdrawal pattern. Because of the carefully planned and regulated rod withdrawal sequence, prompt shutdown of the reactor can be achieved with the insertion of a small number of the many independent control rods. In the event that a reactor scram is necessary, the unlikely occurrence of a limited number of stuck rods will not hinder the capability of the control rod system to render the core subcritical.

The second independent reactivity control system is provided by the reactor coolant recirculation system. By varying reactor flow, it is possible to affect the type of reactivity changes necessary for planned, normal power changes (including xenon burnout). In the unlikely event that reactor flow is suddenly increased to its maximum value (pump runout), the core will not exceed fuel design limits because the power flow map defines the allowable initial operating states such that the pump runout will not violate these limits.

The control rod system is capable of holding the reactor core subcritical under cold conditions, even when the control rod of highest worth is assumed to be stuck in the fully withdrawn position. This shutdown capability of the control rod system Gd_2O_3) to control the high reactivity of fresh fuel. In addition, the Standby Liquid Control System is available to add soluble boron to the core and render it subcritical, as discussed in Subsection 3.1.2.3.8.

The redundancy and capabilities of the reactivity control systems for the BWR satisfy the requirements of Criterion 26.

Combined Reactivity Control Systems Capability (Criterion 27)

Criterion

The reactivity control systems shall be designed to have a combined capability, in conjunction with poison addition by the emergency core cooling system, of reliably controlling reactivity changes to assure that under postulated accident conditions and with appropriate margin for stuck rods the capability to cool the core is maintained.

Design Conformance

There is no credible event applicable to the BWR which requires combined capability of the control rod system and poison additions by the emergency core cooling network. The BWR design is capable of maintaining the reactor core subcritical, including allowance for a stuck rod, without addition of any poison to the reactor coolant. The primary reactivity control system for the BWR during postulated accident conditions is the control rod system. Abnormalities are sensed, and, if protection system limits are reached, corrective action is initiated through automatic insertion of control rods. High integrity of the protection system is achieved through the combination of logic arrangement, actuator redundancy, power supply redundancy, and physical separation. High reliability of reactor scram is further achieved by separation of scram and manual control circuitry, individual control units for each control rod, and fail-safe design features built into the rod drive system. Response by the reactor protection system is prompt and the total scram time is short.

In the very unlikely event that more than one control rod fails to insert, and the core cannot be maintained in a subcritical condition by control rods alone as the reactor is cooled down subsequent to initial shutdown, the Standby Liquid Control System (SLCS) will be actuated to insert soluble boron into the reactor core. The SLCS has sufficient capacity to ensure that the reactor can always be maintained subcritical; and hence, only decay heat will be generated by the core which can be removed by the Residual Heat Removal System, thereby ensuring that the core will always be coolable.

The design of the reactivity control systems assures reliable control of reactivity under postulated accident conditions with appropriate margin for stuck rods. Anticipated Transients without scram are discussed in Section 15.8. The capability to cool the core is maintained under all postulated accident conditions; thus, Criterion 27 is satisfied.

Reactivity Limits (Criterion 28)

Criterion

The reactivity control systems shall be designed with appropriate limits on the potential amount and rate of reactivity increase to assure that the effects of postulated reactivity accidents can neither (1) result in damage to the reactor coolant pressure boundary greater than limited local yielding nor (2) sufficiently disturb the core, its support structures or other reactor pressure vessel internals to impair significantly the capability to cool the core. These postulated reactivity accidents shall include consideration of rod ejection (unless prevented by positive means), rod dropout, steamline rupture, changes in reactor coolant temperature and pressure, and cold water addition.

Design Conformance

The control rod system design incorporates appropriate limits on the potential amount and rate of reactivity increase. Control rod withdrawal sequences and patterns are selected to achieve optimum core performance and low individual rod worths. The rod sequence control system prevents withdrawal other than by the preselected rod withdrawal pattern. The rod sequence control system function assists the operator with an effective backup control rod monitoring routine that enforces adherence to established startup, shutdown, and low power level operations control rod procedures.

The control rod mechanical design incorporates a hydraulic velocity limiter in the control rod which prevents rapid rod ejection.

This engineered safety feature protects against a high reactivity insertion rate by limiting the control rod velocity to less than 5 fps. Normal rod movement is limited to 6 in. increments and the rod withdrawal rate is limited through the hydraulic valve to 3 in./sec.

The accident analysis (Chapter 15) evaluates the postulated reactivity accidents as well as abnormal operational transients. Analyses are included for rod dropout, steamline rupture, changes in reactor coolant temperature and pressure, and cold water addition. The initial conditions, assumptions, calculational models, sequences of events, and anticipated results of each postulated occurrence are covered in detail. The results of these analyses indicate that none of the postulated reactivity transients or accidents results in damage to the RCPB. In addition, the integrity of the core, its support structures, or other reactor pressure vessel internals are maintained so that the capability to cool the core is not impaired for any of the postulated reactivity accidents described in the accident analysis.

The design features of the reactivity control system, which limit the potential amount and rate of reactivity increase, ensure that Criterion 28 is satisfied for all postulated reactivity accidents.

Protection Against Anticipated Operational Occurrences (Criterion 29)

Criterion

The protection and reactivity control systems shall be designed to assure an extremely high probability of accomplishing their safety functions in the event of anticipated operational occurrences.

Design Conformance

The high functional reliability of the protection and reactivity control systems is achieved through the combination of logic arrangement, redundancy, physical and electrical independence, functional separation, fail-safe design, and inservice testability. These design features are discussed in detail in Subsections 3.1.2.3.2, 3.1.2.3.3, 3.1.2.3.4, 3.1.2.3.5 and 3.1.2.3.7.

An extremely high reliability of timely response to anticipated operational occurrences is maintained by a thorough program of inservice testing and surveillance. Active components can be tested or removed from service for maintenance during reactor operation without compromising the protection or reactivity control functions even in the event of a subsequent single failure. Components important to safety, such as control rod drives, main steamline isolation valves, RHR pumps, are tested during normal reactor operation. Functional testing and calibration schedules are developed using available failure rate data, reliability analyses, and operating experience. These schedules represent an optimization of protection and reactivity control system reliability by considering, on one hand, the failure probabilities of individual components and, on the other hand, the reliability effects during individual component testing on the portion of the system not undergoing test. The capability for inservice testing ensures the high functional reliability of protection and reactivity control systems should a reactor variable exceed the corrective action set point.

The capabilities of the protection and reactivity control systems to perform their safety functions in the event of anticipated operational occurrences are satisfied in agreement with the requirements of Criterion 29.

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