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June 21, 1984

Mr. Harold R. Denton, Director
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Attention: Ms. E. G. Adensam, Chief
Licensing Branch No. 4

Re: Catawba Nuclear Station
Docket Nos. 50-413 and 50-414

Dear Mr. Denton:

Section 15.2.4.2 of the Catawba Safety Evaluation Report discusses Open Item 17, Alarm in the Control Room for Boron Dilution Modes in All Modes of Operation. My letters of May 10 and June 7, 1984 provided a revised FSAR Section 15.4.6 and proposed Technical Specifications in response to this item.

The revised boron dilution analysis was not done for hot shutdown (Mode 4) since this condition was considered bounded by other modes. The attached revised FSAR pages provide a specific analysis for hot shutdown. The attached change to the Catawba Technical Specifications is requested as a result of the revised analysis.

SER Section 15.2.4.2 requires that the equipment used to mitigate a boron dilution event meet the single-failure criteria. The operator would be alerted to a boron dilution event by the "High Flux at Shutdown" alarm which receives a signal from each of the two source range neutron detectors which are described in FSAR Section 7.2.1.1. This alarm is currently a single annunciator actuated by either source range channel. In order to provide two separate alarms, Duke Power would propose to provide separate annunciators for the two source range channels. This modification would be implemented prior to initial criticality. This schedule is justified since, through the fuel loading and pre-critical testing phases, the boron concentration in the Reactor Coolant System will be maintained at or above 2000 ppm and there are numerous control room indications of boron concentration and neutron flux. These include the operator aid computer which provides an independent, audible alarm at a pre-set neutron count rate.

Very truly yours,

Hal B. Tucker

Hal B. Tucker

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Attachment

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cc: Mr. James P. O'Reilly, Regional Administrator
U. S. Nuclear Regulatory Commission
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101 Marietta Street, NW, Suite 2900
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Dilution During Cold Shutdown

Conditions at cold shutdown require the reactor to be shut down by at least 1.0% Δk. The critical boron concentration is conservatively estimated to be 731 ppm for Cycle 1. The following conditions are assumed for an uncontrolled boron dilution during cold shutdown:

Dilution flow is assumed to be 120 gpm.

Mixing of the reactor coolant is accomplished by the operation of one residual heat removal pump.

A minimum water volume (3588 ft^3) in the RCS is used. This is the minimum volume of the RCS for residual heat removal system operation.

Dilution During Hot Shutdown

Conditions at hot shutdown require the reactor to be shut down by at least 1.3% Δk. The critical boron concentration is conservatively estimated to be 722 ppm for Cycle 1. The following conditions are assumed for an uncontrolled boron dilution during hot shutdown:

Dilution flow is assumed to be 120 gpm.

Mixing of the reactor coolant is accomplished by the operation of one residual heat removal pump.

A minimum water volume (3588 ft^3) in the RCS is used. This is the minimum volume of the RCS for residual heat removal system operation.

Dilution During Hot Standby

Conditions at hot standby require the reactor to have available at least 1.30% Δk shutdown margin. This mode of operation is analyzed both with and without the most reactive rod cluster control assembly (RCCA) stuck out of the core. The stuck rod case is assumed to occur immediately after a reactor trip and is therefore analyzed at no-load conditions. The case with no stuck rod is analyzed at 350°F which is conservative since this is the lowest permissible temperature in this mode. The critical boron concentrations are conservatively estimated to be 630 ppm (without stuck RCCA) and 448 ppm (with stuck RCCA) for Cycle 1. The following conditions are assumed in each case for a continuous boron dilution during hot standby:

1. Dilution flow is assumed to be output of two reactor makeup water pumps (240 gpm).

2. A minimum water volume (9029 ft^3) in the Reactor Coolant System is used. This corresponds to the active volume of the Reactor Coolant System while on natural circulation, i.e., the reactor vessel upper head and the pressurizer are not included.

centration in the reactor coolant event. The reactor trip causes a turbine-trip, and heat is removed from the secondary system through the steam generator power relief valves or safety valves. Since no fuel damage occurs from this transient, the radiological consequences associated with this event are less severe than the steamline break event analyzed in Section 15.1.5.

15.4.6.4 Results

Dilution During Refueling

During refueling, an inadvertent dilution from the reactor makeup water system is prevented by administrative controls which isolate the RCS from the potential source of unborated makeup water.

The most limiting conditions for an inadvertent dilution from either the BTRS or the reactor makeup water system occurs with the RCS drained to 26" above the borrom ID of the reactor vessel inlet nozzles. The high flux at shutdown alarm, set at $\sqrt{10}$ times the background flux level measured by the source range nuclear instrumentation, is available at these conditions to alert the operator that a dilution event is in progress.

For this case, the operator has 96.3 minutes from the high flux at shutdown alarm to recognize and terminate the dilution before shutdown margin is lost and the reactor becomes critical.

Dilution During Cold Shutdown

While in cold shutdown, the high flux at shutdown alarm, set at $\sqrt{10}$ times the background flux level measured by the source range nuclear instrumentation, is available to alert the operator that a dilution event is in progress.

During the cold shutdown mode while operating on the residual heat removal system (RHRS) with the RCS drained to 26" above the bottom ID of the reactor vessel inlet nozzles, the operator has 17.9 minutes from the high flux at shutdown alarm to recognize and terminate the uncontrolled reactivity insertion before shutdown margin is lost and the reactor becomes critical.

Dilution During Hot Shutdown

While in hot shutdown, the high flux at shutdown alarm, set at $\sqrt{10}$ times the background flux level measured by the source range nuclear instrumentation, is available to alert the operator that a dilution event is in progress.

During the hot shutdown mode, the operator has 17.7 minutes from the high flux at shutdown alarm to recognize and terminate the uncontrolled recativity insertion before shutdown margin is lost and the reactor becomes critical.

TABLE 15.4.1-1 (Page 2)

Time Sequence of Events for Incidents which Cause Reactivity and Power Distribution Anomalies

Accident	Event	Time (sec.)
	Rods begin to fall into core	66.2
	Minimum DNBR occurs	67.1
Startup of an inactive reactor coolant loop at an incorrect temperature	Initiation of pump startup	1.0
	Power reaches P-8 trip setpoint	13.4
	Rods begin to drop	13.9
	Minimum DNBR occurs	15.0
CVCS Malfunction that results in a decrease in the boron concentration in the reactor coolant		
1. Dilution during refueling	Dilution begins	0
	High flux at shutdown alarm occurs	7634
	Criticality occurs	13506
2. Dilution during cold shutdown	Dilution begins	0
	High flux at shutdown alarm occurs	2064
	Criticality occurs	3137
3. Dilution during hot shutdown	Dilution begins	0
	High flux at shutdown alarm occurs	2048
	Criticality occurs	3112
4a. Dilution during hot standby (w/o stuck rod)	Dilution begins	0
	High flux at shutdown alarm occurs	2977
	Criticality occurs	4553
4b. Dilution during hot standby (w/stuck rod)	Dilution begins	0
	High flux at shutdown alarm occurs	4002
	Criticality occurs	6233

TABLE 15.4.1-1 (Page 3)

Time Sequence of Events for Incidents which Cause Reactivity and Power Distribution Anomalies

Accident		Event	Time (sec.)
5. Dilution during startup		Power range low setpoint reactor trip due to dilution	0
		Criticality occurs (if dilution continues after trip)	1620
6. Dilution during full power operation			
	a. Automatic reactor control	Operator receives low-low rod insertion limit alarm due to dilution	0
		Shutdown margin lost (if dilution continues after trip)	3900
	b. Manual reactor control	Reactor trip setpoint reached for overtemperature ΔT	0
		Shutdown margin is lost (if dilution continues after trip)	1620
Rod Cluster Control Assembly Ejection			
1. Beginning-of-Life, Full Power		Initiation of rod ejection	0.0
		Power range high neutron flux setpoint reached	0.05
		Peak nuclear power occurs	0.14
		Rods begin to fall into core	0.55
		Peak fuel average temperature occurs	2.3
		Peak heat flux occurs	2.36
		Peak clad temperature occurs	2.37

e. When in MODE 3 or 4, at least once per 24 hours by consideration of the following factors:

1) Reactor Coolant System boron concentration,

2) Control rod position,

3) Reactor Coolant System average temperature,

4) Fuel burnup based on gross thermal energy generation,

5) Xenon concentration, and

6) Samarium concentration.

4.1.1.1.2 The overall core reactivity balance shall be compared to predicted values to demonstrate agreement within ± 1% Δk/k at least once per 31 Effective Full Power Days (EFPD). This comparison shall consider at least those factors stated in Specification 4.1.1.1.1e., above. The predicted reactivity values shall be adjusted (normalized) to correspond to the actual core conditions prior to exceeding a fuel burnup of 60 EFPD after each fuel loading.

4.1.1.1.3 When in MODE 3 ~~or 4~~, the Reactor Makeup Water pumps shall be demonstrated to have a total combined flow rate of less than or equal to 240 gpm at least once per 18 months.

4.1.1.1.4 When in Mode 4, the OPERABLE Reactor Makeup Water pump shall be demonstrated to have a flow rate of less than or equal to 120 gpm at least once per 18 months. One Reactor Makeup Water pump shall be demonstrated inoperable at least once per 31 days by verifying ~~that~~ the motor circuit breaker is secured in the open position