WESTINGHOUSE CLASS III

WCAP-11902

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REDUCED TEMPERATURE AND PRESSURE OPERATION FOR DONALD C. COOK NUCLEAR PLANT UNIT 1 LICENSING REPORT

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cumulative fatigue usage factor was calculated to be 0.69 which is less than the 1.0 Code limit.

This value includes the thermal stress due to the non-linear portion of the thermal gradient for conservatism. A substantial reduction in the maximum range of stress intensity could be achieved if the non-linear thermal gradient contribution were neglected as permitted by the ASME Code.

3.10.1.2 Reactor Vessel Integrity

An evaluation of the impact of rerating on reactor vessel integrity for neutron embrittlement was performed. Neutron fluence changes for the rerating were calculated. Using these revised fluences and those from other relevant systems parameters associated with the rerating, the assessment included review of surveillance capsule withdrawal schedules, the schedule of applicability of the plant heatup and cooldown limits, and 10 CFR 50 - Appendix G analyses, including a verification of plant specific material properties. A revision to the calculations used in the submittal to the NRC for meeting the requirements of the pressurized thermal shock (PTS) rule were performed. Finally, an initial evaluation of the impact of rerating on the PTS risk of vessel failure was carried out to confirm the applicability of the screening criteria in the PTS rule for the Cook Nuclear Plant reactor vessels. The rerating affects the PTS transient initiating temperature which is lower than that used in the generic PTS risk analyses which support the screening criteria.

Neutron transport calculations have been completed at a conservatively high power level of 3600 MWt, and reduced temperature/pressure conditions for Cook Nuclear Plant Unit 1. Results of these analyses have indicated that in addition to the increased reactor power, operation of the units with reduced coolant temperatures, particularly in the downcomer regions, also has a significant impact on the fast neutron exposure rates incident on the pressure vessel. Also impacted are the relationships among the neutron exposure rates at surveillance capsule locations and those at positions within the pressure vessel wall; i.e., capsule lead factors.

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To provide a bounding evaluation of these various effects, calculations were performed for the current licensed conditions as well as for uprated power with both maximum and minimum downcomer temperatures. The results of these studies are summarized in Tables 3.10.1-1 and 3.10.1-2.

An examination of Tables 3.10.1-1 and 3.10.1-2 shows that the impact of higher power operation and changed coolant temperatures is greater on the absolute magnitude of the neutron exposure rate than on the relative behavior of neutron flux distributions as reflected in capsule lead factors.

Two sets of data have been provided to establish upper and lower bound exposures for Cook Nuclear Plant Unit 1. The upper limit conditions are consistent with assuming an uprating at the onset of the next fuel cycle with continued operation at an inlet temperature of 547°F for unit 1. Lower bound fluence estimates were based on no uprating in power level, but with future operation occurring at reduced T_{avg}; i.e., the inlet temperature was assumed to be 512°F. These lower bound fluence estimates are lower than those at current operating conditions.

Review of the heatup and cooldown curves that were previously generated by Southwest Research Institute indicate that these curves were generated in accordance with Regulatory Guide 1.99-Revision 1. Per NRC Generic Letter 88-11, dated July 12, 1988, all utilities must submit to the NRC by November 1988 the results of their technical analysis relative to the implementation of Regulatory Guide 1.99-Revision 2, which was officially issued in May 1988. Given this regulatory change, the effect of rerating should be incorporated into future calculations that will be performed for revising heatup and cooldown curves in accordance with this latest revision of Regulatory Guide 1.99. The effect of the rerating is deemed to not be significant.

The changes in the systems parameters associated with the rerating have been judged to not have any significant impact on 10 CFR Part 50 - Appendix G analysis.

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The Cook Nuclear Plant Unit 1 reactor vessel beltline region material properties were verified against the latest available information in various industry data bases and surveillance capsule reports. The properties defined from the latest information are consistent with those used in prior utility submittals to the NRC relative to meeting the requirements of the PTS rule.

Since the core loading pattern will be changing as a result of the rerating, an update to the PTS submittal will be required as stated in the PTS Rule.

Revised calculations were performed for the rerating using the current PTS Rule methodology and the latest procedure specified by Regulatory Guide 1.99 - Revision 2. As stated in NRC Generic Letter 88-11, the staff is presently considering an amendment to the PTS Rule, 10 CFR 50.61, that will replace the equations for RTpts given in paragraph (b) (2) with the calculation procedure in Section C.1 of Revision 2 to Regulatory Guide 1.99, but they will not change the screening criteria.

All the RTpts values remain below the NRC screening values for PTS using the projected fluence values that are based upon rerated conditions through the license expiration. The highest RTpts value (265°F) was calculated at the circumferential weld of the Cook Nuclear Plant Unit 1 reactor vessel, using the methodology of Regulatory Guide 1.99 Revision 2.

On the basis of probabilistic work described in the PTS Rule, the NRC staff concluded that PWR vessels with conservatively calculated values of RTndt (i.e., RTpts) less than 270°F for plate material and axial welds, and less than 300°F for circumferential welds present an acceptably low risk of vessel failure from PTS events. This evaluation, however, did not take into account the impact of rerating, which causes potential PTS transient scenarios to begin from a lower system temperature.

An initial evaluation was performed to determine the impact of rerating on the applicability of the PTS screening criteria in terms of risk of vessel failure. A probabilistic fracture mechanics sensitivity study of limiting PTS transient characteristics, starting from a lower operating temperature, showed that the conditional probability of reactor vessel failure will not be adversely affected. Therefore, the overall risk of vessel failure will not be adversely impacted meaning that that the screening criteria in the PTS Rule are still applicable for the Cook Nuclear Plant Unit 1 reactor vessel relative to rerated conditions.

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TABLE 3.10.1-1

FAST NEUTRON (E > 1.0 MeV) FLUENCE
PROJECTIONS FOR COOK NUCLEAR PLANT UNIT 1

Unit 1 (22.89 EFPY)	Upper Bound	Lower Bound
All plates; Weld 9-442	1.84×10^{19}	1.55×10^{19}
Welds 2-442B, 2-442C, 3-442A, 3-442C	1.19×10^{19}	1.01×10^{19}
Welds 2-442A, 3-442B	5.92×10^{18}	5.01×10^{18}

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TABLE 3.10.1-2

SURVEILLANCE CAPSULE LEAD FACTORS FOR
COOK NUCLEAR PLANT UNIT 1

	4° Capsules	40° Capsules
Unit 1 Base Case (3250 MWt, 536°F Downcomer)	1.3	4.2
Unit 1 At Uprated Power (3588 MWt, 547°F Downcomer)	1.3	4.2
Unit 1 At Uprated Power (3588 MWt, 512°F Downcomer)	1.3	4.4

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TABLE 4.1-1

SYSTEM DESIGN AND OPERATING PARAMETERS

Plant design life, years	40
Number of heat transfer loops	4
Design pressure, psig	2485
Nominal operating pressure, psig	2235
Total system volume including pressurizer and surge line (ambient conditions), ft^3 (estimated)	12,500
System liquid volume, including pressurizer and surge line (ambient conditions), ft^3	11,892
System liquid volume, including pressurizer max. guaranteed power, ft^3 (estimated)	11,780
Total Reactor heat output (100% power) Btu/hr	$11,089 \times 10^6$ (Unit 1) (3250 MWt) $11,641 \times 10^6$ (Unit 2) (3411 MWt)

	Unit 1 Bounding Conditions for Rerating Lower/Upper	Unit 2
Reactor vessel coolant temperature at full power:		
Inlet, nominal, °F	514.9/545.2	541.3
Outlet, nominal, °F	579.1/607.5	606.4
Coolant temperature rise in vessel at full power, avg., °F	64.2/62.3	64.8
Total coolant flow rate, lb/hr x 10^6	139.0/133.9	134.6
Steam pressure at full power, psia	618/820	820
Steam Temp. @ full power, °F	489.4/521.1	521.1
Total Reactor Coolant Volume at ambient conditions, ft^3	12,438	12,470