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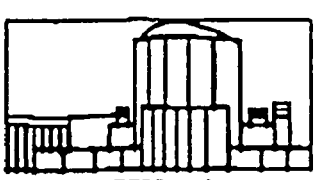

WATERFORD 3

CR-WF3-2004-1011

INITIAL ENGINEERING EVALUATION FOR SBLOCA WITH DC BUS SINGLE FAILURE

1. SUMMARY

The current licensing basis small break LOCA (SBLOCA) analysis using the S2M version of Westinghouse Evaluation Model for CE PWR model assumes a single failure of one Emergency Diesel Generator (EDG). However, a single failure of a DC power bus would have a more severe impact in that it would also result in a loss of charging flow to the RCS during the SBLOCA. This is an unanalyzed condition that may result in unacceptable consequences (peak cladding temperature exceeding 2200°F) with no charging flow.

Alternate SBLOCA analyses and conservatisms in the existing analysis provide reasonable assurance that the 10CFR50.46 acceptance criteria can be met. Scoping studies using the NRC approved Westinghouse NOTRUMP model show significantly lower peak cladding temperatures without charging flow relative to the current analysis S2M model. Furthermore, credit for the Atmospheric Dump Valves (ADV) in the current S2M model would also decrease the peak cladding temperature to offset the impact of the loss of charging flow. Current analyses do not take credit for ADVs.

Therefore, there is reasonable assurance that acceptable results can be obtained with a re-analysis of the SBLOCA and that continued compliance with 10CFR50.46 exists.

2. REFERENCES

1. CENPD-137, Supplement 2, "Calculative Methods for the ABB CE Small Break LOCA Evaluation Model", dated May, 1996.

2. EC-S00-003, "WSES 3 S2M SBLOCA ECCS Performance Analysis", dated 3/13/00.

3. DAR-OA-01-1, "Scoping Study and Budgetary Estimate for Extended Power Uprate at W3", dated November 2001.

4. CR-WF3-2004-1011

5. CENPD-279, Supplement 15, "Annual Report on Combustion Engineering ECCS Performance Evaluation Models on PWRs", dated March, 2004.

6. Waterford 3 FSAR, Chapter 15.

7. Westinghouse calculation CN-LIS-01-165, SBLOCA Scoping Study for the Waterford-3 Station using the NOTRUMP Evaluation Model.

8. Westinghouse letter LTR-OA-04-043 dated 1 April 2004.

9. Westinghouse calculation CN-OA-02-4, Waterford 3 ECCS Performance Analysis Evaluation for Increasing SG Plugged Tubes from 500 to 700 per SG.

10. TAC No. M95687

11. Waterford 3 Drawings B424, Sheets 381 and 382

12. Waterford 3 Drawings B429, Sheets 147 and 148

13. CE NPSD-1072-P, "CEOG PSA Standards, Vol. II, Technical Position Papers, No. 5: Success Criteria for the Minimum Number of Safety Injection Pathways Following Large and Small Break LOCAs for CE PWRs," CEOG Task 941, Combustion Engineering Owner's Group, Probabilistic Safety Analysis Working Group, January 1997.

14. CEN-420-P, "Small Break LOCA Realistic Evaluation Model," Combustion Engineering, Inc., October 1993.

15. WCAP-15701, Rev. 0, "Determination of LOCA Realistic Success Criteria and Selected LOCA based Human Actions for PSA Applications," CEOG Task 2013, Westinghouse Electric Co. LLC, June 2002.

16. FSAR Section 6.3.

3. DETAILED PROBLEM STATEMENTS

A newly postulated worst case single failure of a DC power bus may result in unacceptable analysis results for a small break LOCA (SBLOCA).

The current FSAR SBLOCA analysis using the S2M version of Westinghouse Evaluation Model for CE PWR assumes a single failure of one EDG and credits additional safety injection flow from one charging pump to get acceptable results. The peak cladding temperature (PCT) for this analysis is 1982 °F compared to the acceptance criteria of 2200 °F. Half of the flow from a charging pump is assumed to go to the RCS (18 gpm) and half is assumed to flow out the postulated break, as discussed in FSAR Section 6.3.3.3.1. During discussions on power uprate analyses, it was identified that a single failure of a DC power bus would be more limiting than the currently assumed single failure of an EDG. This is because the DC bus failure will result in the EDG failure to start and also cause one charging loop isolation valve to the RCS to fail closed on loss of DC power. The other charging flow path to the RCS is on the assumed broken RCS leg so it is assumed to be spilled to the containment (no flow to the RCS). Therefore, no charging flow will be delivered to the RCS as assumed in the current licensing basis SBLOCA analysis. Note that the concerns for potentially unacceptable results apply to a small range of break sizes around the limiting 0.05 ft^2 SBLOCA and does not affect other size LOCAs analyzed. This condition has not been analyzed.

Based on prior sensitivity studies the10CFR50.46 acceptance criteria of 2200 °F may be exceeded if the charging flow is not credited in the design basis S2M analysis of record.

4. ASSUMPTIONS

None

5. DESIGN EVALUATION

Condition report WF3-2004-1011 identified that a new single failure for the Small Break Loss of Coolant Accident (SBLOCA) will produce more severe consequences than currently evaluated. The new single failure is the failure of the DC bus which will fail the Emergency Diesel Generator (EDG) and the associated CVCMVAAA218 (CHARGING LINE TO RCS LOOP ISOLATION valve). This condition would prevent charging flow from entering the Reactor Coolant System (RCS) during a SBLOCA. FSAR Table 15.6-13a lists that charging flow of 18 gpm is credited in the SBLOCA analysis.

FSAR Section 15.6.3.3.3.2 describes the SBLOCA analysis. The SBLOCA Emergency Core Cooling System (ECCS) performance analysis is performed using the S2M evaluation model [CENPD-137]. The S2M evaluation model has NRC approval for use in licensing application of Combustion Engineering (CE) pressurized water reactors (PWR), including reference in the Technical Specifications (TS) and Core Operating Limits Report (COLR) [TAC No. M95687]. The limiting SBLOCA results are a peak cladding temperature of 1929 °F, maximum cladding oxidation of 8.09%, and maximum core wide cladding oxidation of <0.58% which assumes 500 SG plugged tubes [FSAR Table 15.6-14a]. Conservative sensitivity studies based on other CE plants were used to determine a 1982°F PCT with 700 plugged steam generator tubes.

This design evaluation will discuss other analyses and several conservatisms that are included in the SBLOCA analysis that offset the loss of 18 gpm currently credited to charging flow. Note that the concerns for potentially unacceptable results apply to a small range of break sizes around the limiting 0.05 ft^2 SBLOCA and does not affect other size LOCAs analyzed. The alternate analyses are several NOTRUMP SBLOCA results obtained during the extended power uprate scoping study. Conservatisms include crediting steam flow from an Atmospheric Dump Valve and the 1.2 decay heat multiplier.

ADV Credit

In the analysis of SBLOCA, main steam safety valves are credited to provide secondary pressure control during the event. Main Steam Safety Valve nominal setpoints, per Waterford-3 Technical Specifications, range from 1070 psig to 1135 psig. A tolerance of +3% is assumed in the analysis. These values are specified in the Westinghouse ECCS Performance Analysis Comprehensive Checklist (CCL) for Waterford-3. Primary pressure and temperature are controlled by secondary pressure, dependent on steam generator heat transfer. A safety-related Atmospheric Dump Valves (ADV's) and ADV controller is provided for each Steam Generator, with a nominal setpoint of 1050 psig. While not credited in the current license basis SBLOCA analysis, these ADV's would function to provide additional relief for the secondary side, resulting in lower secondary pressure and hence more heat removal than in the current analysis of record crediting the MSSV's only.

By lowering secondary pressure, primary pressure is similarly decreased which means that HPSI flow injected into the reactor vessel would increase, resulting in improved PCT performance. Safety Analyses assume a HPSI pump shutoff head of 1344 psia. The minimum HPSI flow assumed in analyses increases to 148 gpm at 1203 psia and to 217 gpm at 1075 psia. These values are based on the minimum delivered flow to 3 of the 4 cold legs, with the assumption that the break is occurring in the 4th cold leg and all the flow to that loop is spilled to containment.

Scoping studies performed by Westinghouse in 2001 for Extended Power Uprate, using S2M, indicated that crediting ADV's would result in a substantial improvement in PCT margin. Crediting both ADV's in automatic with a proposed 1000 psia setpoint and without charging flow resulted in a PCT decrease of 160°F compared to the SBLOCA Analysis of Record. The postulated failure of a DC train would result in one ADV being out of service due to loss of its controls. Since the current ADV setpoint is 1050 psig, some but not all of this decrease will be realized for the current analysis.

NOTRUMP Model

Additional assurance of operability is provided through consideration of NOTRUMP code results. NOTRUMP is the Westinghouse SBLOCA evaluation model. Sensitivity studies for Waterford-3 were performed in support of Waterford-3 Extended Power Uprate scoping studies (Scoping Study and Budgetary Estimate for Extended Power Uprate at W3, DAR-OA-01-1, November, 2001). These were for the purpose of scoping the analysis results and have not undergone formal design verification by Westinghouse. These studies demonstrate there is over 200°F of margin to the PCT limit of 2200°F for a SBLOCA without charging flow. Westinghouse engineers who performed the NOTRUMP studies as well as the Westinghouse engineers cognizant for CE plant LOCA analyses have re-reviewed the NOTRUMP analyses to confirm the continued applicability of those analyses to support the engineering judgment that a detailed and quality verified NOTRUMP analyses would demonstrate compliance with 50.46 acceptance criteria without the need to credit charging flow. This review is documented in the attached letter from Westinghouse, CWTR3-04-43, dated 4/1/04.

Use of NOTRUMP has been approved by the NRC for use on PWR plants. It has been used for Westinghouse plants and two CE designed plants, Fort Calhoun and Millstone. The NOTRUMP evaluation model is divided into two parts, a model which determines the thermal-hydraulic response of the RCS under SBLOCA conditions, NOTRUMP, and a model which uses boundary conditions from the thermal-hydraulic calculations to calculate fuel rod cladding heat-up, SBLOCTA. NOTRUMP Small Break Loss-of-Coolant Accident Emergency Core Cooling System Evaluation Model (NOTRUMP SBLOCA ECCS EM) was developed to determine the RCS response to design basis small break LOCAs.

Analysis of Record (AOR) conditions were executed to establish a baseline for comparison for both the uprate cases and the S2M model results. The NOTRUMP Analysis of Record (AOR) case (no charging flow and EFW starting at 400s) was performed and the peak cladding temperature calculated was approximately 300 °F below the S2M results. This

demonstrates conservatism in the S2M model. The NOTRUMP case with no charging flow demonstrated that the peak cladding temperature, maximum cladding oxidation, and maximum core wide cladding oxidation less than the 10CFR50.46 acceptance criteria [DAR-OA-01-1 Table 5.1-1]. The NOTRUMP sensitivity studies demonstrate there is over 200°F of margin to the PCT limit of 2200°F for a SBLOCA without charging flow.

Thus, if a detailed analysis were performed for W3 with the NOTRUMP code there is reasonable assurance due to the large margins that acceptable results would be achieved without any charging flow.

Decay Heat Multiplier

The overall conservatism in the S2M model is the difference between the peak cladding temperature calculated by the Appendix K model and that calculated by a realistic evaluation model. It is generally recognized that the 10CFR50 Appendix K requirement to use a multiplier of 1.2 times the 1971 ANS standard for decay heat is the single largest conservatism in the SBLOCA evaluation model. With the decay heat multiplier not included in the S2M SBLOCA analysis (i.e. a decay heat multiplier of 1.0) a decrease of approximately 663 °F in peak cladding temperature is obtained. It should be noted that the 1.0 1971 ANS standard decay heat curve is approximately equal to the 1979 ANS standard decay heat curve at the +2σ uncertainty level. The 1979 ANS standard decay heat curve has been approved for use by the NRC. Although the 1.2 decay heat multiplier is required for compliance to Appendix K, this illustrates the additional margin prior to core damage and conservatism that actually exists in the analysis.

Realistic (Non-Appendix K) SBLOCA Analysis

The Waterford 3 Probabilistic Safety Assessment (PSA) model uses a HPSI success criterion of 1 HPSI pump providing flow through 2 intact (not connected to the broken leg) injection paths. This is based on Reference 13, the CE Owners Group standard for safety injection PSA success criteria. Charging is not included in the analysis; in other words, charging is not needed for success. The Reference 13 standard is based on Reference 14, which describes best-estimate small LOCA analyses, performed using the Small Break LOCA Realistic Evaluation Model (REM). In the REM analyses in Reference 14, the peak cladding temperature (PCT) was predicted to remain below 1600 °F for a range of break sizes, *with no charging*. This means there is significant margin to the PCT limit of 2200 °F.

Another PSA success criteria analysis is described in Reference 15, which used the REM for a set of small LOCA cases specific to PSA issues. These analyses also showed success with 1 HPSI pump and no charging, providing confirmation that charging is realistically not needed for small LOCA. In addition, for the best-estimate cases, these analyses were consistent with the Reference 14 analyses in terms of margin to the PCT limit.

In conclusion, analyses supporting for the Waterford 3 PSA using the Small Break LOCA REM demonstrate that charging is realistically not necessary for small break LOCA.

Conclusion

Scoping studies using the NRC approved Westinghouse NOTRUMP model show significantly lower peak cladding temperatures relative to the current analysis S2M model. Furthermore, credit for the Atmospheric Dump Valves (ADV) in the current S2M model would also decrease the peak cladding temperature to offset the impact of the loss of charging flow. Therefore, there is reasonable assurance that 10CFR50.46 acceptance criteria can be met with the current plant design.

In addition, the multiplier of 1.2 times decay heat, although required for compliance to 10CFR50.46 Appendix K, also adds significant conservatism relative to actual SBLOCA response.

6. IMPACT ON NUCLEAR SAFETY

Consideration of the conservatisms present in the analysis input parameters and consideration of the results from the NOTRUMP analyses lead to the engineering judgment that 50.46 acceptance criteria will continue to be met. Thus, Waterford-3 will continue to operate within the acceptance criteria for its licensing basis.

7. IMMEDIATE ACTIONS

Westinghouse performed an analysis of Waterford-3 at the Extended Power Uprate (EPU) conditions as part of the feasibility study conducted prior to the start of the EPU licensing analysis effort. Cognizant technical personnel from Westinghouse Windsor and Pittsburgh locations, conducted a "reasonableness" review of this analysis. The purpose of this review was to verify the applicability of the NOTRUMP model to Waterford-3 and the acceptability of the analysis results to provide input to support this initial engineering evaluation regarding a new worst case single failure scenario in the SBLOCA analysis.

8. LONG TERM ACTIONS

The licensing basis SBLOCA analysis will be updated to remove credit for charging flow.

This issue is designated as a NRC Generic Letter 91-18, Revision 1, Nonconformance, and the resolution of this issue will be resolved pursuant to this regulatory process.