UNITED STATES
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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

MAIN STEAM LINE BREAK (MSLB) OUTSIDE CONTAINMENT WITH SUPERHEATED STEAM RELEASES

UNION ELECTRIC COMPANY
CALLAWAY PLANT, UNIT 1
DOCKET NO. 50-483

## 1.0 INTRODUCTION

By letter dated April 4, 1986, the licensee submitted a report entitled "Evaluation of Environmental Qualification of Equipment Considering Superheat Effects of High Energy Line Breaks for Callaway Plant and Wolf Creek Generating Station." This report responded to the staff concerns described in IE Information Notice 84-90. For certain MSLB accidents, steam generator tube bundle uncovery occurs and may result in the release of superheated steam. This will raise the temperature in the break compartment and adjoining compartments to levels above that previously calculated. The above report and a subsequent letter dated March 24, 1987 described an analysis of this condition which is applicable for both the Callaway Plant and Wolf Creek Generating Station.

## 2.0 EVALUATION

In the analysis of main steam line breaks (MSLB) with superheated steam, the mass and energy releases following a MSLB with superheated steam blowdown were obtained from Westinghouse report WCAP-10961 and were calculated using the Westinghouse computer code LOFTRAN. The version of LOFTRAN used includes the modification to account for heat transfer to the steam during steam generator tube bundle uncovery. This modification is described in Westinghouse Topical Report WCAP-8860, Supplement 1, which the staff found acceptable in its safety evaluation transmitted to Westinghouse by letter dated May 27, 1986.

The licensee postulated a spectrum of steam line break sizes (4.6 $ft^2$, 1.0 $ft^2$, 0.7 $ft^2$ and 0.5 $ft^2$) at different power levels (102% and 70%) in the mainsteam tunnel. The licensee found that a break size of less than 0.5 $ft^2$ was less limiting than the larger breaks because it does not result in steam generator tube uncovery until after the operator response time for terminating auxiliary feedwater. The staff finds the postulated spectrum of breaks acceptable.

The licensee used the Bechtel computer code FLUD to calculate the compartment environmental temperature profiles. Credit was taken for heat transfer to the concrete structures and structural steel. When the atmosphere was superheated, a maximum of 8 percent of re-evaporization ratio was assumed. The peak calculated pressure values in the break compartment were below the qualification requirements used for safety-related equipment in the steam tunnel. However, the calculated peak environmental temperature values exceeded the qualification limit of some affected safety-related components.

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Since the component temperatures generally lag the changes in the environmental temperature, the licensee performed a component thermal lag analysis on certain components including main steam pressure transmitters, transmitter instrument cable, MSIV/MFIV solenoid valves, MSIV/MFIV wiring and lugs, MSIV/MFIV terminal blocks, MSIV/MFIV control cable, MSIV/MFIV limit switch, MSIV/MFIV conax connector, MSIV/MFIV limit switch instrument cable, J-601A solenoid valve, and J-601A control cable. Four times the maximum Uchida correlation and forced convection heat transfer coefficients (Hilpert correlation) were assumed in modeling the condensing mode and saturation mode respectively. The results of the licensee's calculation were presented in Table 3.4 (Rev. 1) of the March 24, 1987 letter.

The results showed that with a few exceptions, the equipment surface temperatures did not exceed the qualification temperature limits until the time when a Steam Line Isolation Signal (SLIS) or Feedwater Isolation Signal (FWIS) was initiated (from the begining of the accident to the time of the FWIS and/or SLIS is defined as the calculation time). The exceptions are main steam pressure transmitter instrument cable, MSIV/MFIV limit switch instrument cable, and J-601A Control Cable which exceeded their corresponding qualification temperature limits. The licensee provided a failure mode and effects analysis (FMEA) to justify the above exceptions. The FMEA confirmed that failure of these components will not affect the ability to safely shutdown following the postulated steam line breaks as the equipment will either fail safe, or alternative capability is provided.

The staff has reviewed the licensee's analysis and finds that, with one exception, the assumptions and methodologies are consistent with the staff guidance in NUREG-0588, "Interim Staff Position on Environmental Qualification of Safety-Related Electrical Equipment." The exception is the method of calculating flow velocity for determining the forced convection heat transfer coefficient. The licensee's velocity was obtained from dividing the volumetric break flow by the flow area, while in NUREG-0588 the velocity is a function of blowdown rate divided by the containment volume. The staff finds the licensee's velocity calculation for determining the forced convection heat transfer coefficient to be appropriate, and therefore, acceptable for determining inter-compartmental flow.

In order to assess the licensee's results, Battelle Pacific Northwest Laboratory (PNL) performed an independent confirmatory analysis for the staff using the modified COBRA-NC computer code. This code has previously been used by the staff for compartmental pressure/temperature response analysis. The modified code incorporates a heat transfer model and re-evaporization model (8% re-evaporization rate) in accordance with Appendix B of NUREG-0588, and provides both the compartment environmental temperature and component thermal lag analyses simultaneously. The resulting peak component temperatures from the confirmatory analysis are consistently bounded by the licensee's results.

In summary, based on review of the assumptions and methodology of the licensee's analyses for determining steam line break environments including superheated steam blowdown, and the results of the independent analyses, the staff concludes that the component temperatures calculated by the licensee are acceptable. In addition, by letters dated October 5, 1987 and February 10, 1988, the licensee responded to staff requests for additional information. These responses provided discussions and explanations which clarified concerns involving the failure modes and effects analysis. As a result, based on the information provided the staff finds the failure modes and effects analysis and calculation times acceptable.

## 3.0 CONCLUSION

Based on the staff review of the mass and energy release data, compartment temperature response analysis, component surface temperature analysis, failure modes and effects analysis, and the staff's independent analyses, the staff finds the licensee's evaluation of environmental qualification of safety-related equipment in the steam tunnel following a MSLB with superheated steam releases to be acceptable. Therefore, the staff concludes that proper environmental qualification of safety-related equipment outside containment has been demonstrated.

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