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SUBJECT: Forwards responses to NRC 831215 questions re XN-NF-82-18(P),Suppl 2, "ECCS & Plant Transient Analyses for HB Robinson Unit 2 Operating at Redced Primary Temp Suppl 2 Analyses for 30% Steam Generator Tube Plugging."

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Director of Nuclear Reactor Regulation
Attention: Mr. Steven A. Varga, Chief
Operating Reactors Branch No. 1
Division of Licensing
United States Nuclear Regulatory Commission
Washington, DC 20555

H. B. ROBINSON STEAM ELECTRIC PLANT, UNIT NO. 2
DOCKET NO. 50-261
LICENSE NO. DPR-23
RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION
30% STEAM GENERATOR TUBE PLUGGING ANALYSIS

Dear Mr. Varga:

Please find attached Carolina Power & Light Company's (CP&L) response to NRC Staff questions regarding the following document submittal to you on October 5, 1983.

Reference: XN-NF-82-18(P) Supplement 2, "ECCS and Plant Transient Analyses for H. B. Robinson Unit 2 Reactor Operating at Reduced Primary Temperature Supplement 2 Analyses for 30 Percent Steam Generator Tube Plugging," September 1, 1983.

These questions were provided by your staff in a telephone conference call on December 15, 1983 and subsequent conversations.

Should you have any further questions regarding this information, please contact a member of our Nuclear Licensing Staff.

Yours very truly,

A. B. Cutter
Vice President
Nuclear Engineering & Licensing

DCS/ccc (9274DCS)
Attachment

cc: Mr. J. P. O'Reilly (NRC-RII)
Mr. G. Requa (NRC)
Mr. Steve Weise (NRC-HBR)

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411 Fayetteville Street • P. O. Box 1551 • Raleigh, N. C. 27602

ANSWERS TO NRC QUESTIONS RELATING TO
H. B. ROBINSON UNIT 2 ANALYSIS FOR 30 PERCENT
STEAM GENERATOR TUBE PLUGGING
XN-NF-82-18, SUPPLEMENT 2

QUESTION

The SLOTRAX code was used to evaluate the consequences of the Loss of Normal Feedwater event in XN-NF-82-18(P), Supplement 2. The SLOTRAX code is described in XN-NF-82-91(P) and includes an "equilibrium" pressurizer model. Please justify its use for this application relative to a "non-equilibrium" model.

RESPONSE

The criteria employed by ENC for evaluating the loss of normal feedwater event are:

1) No liquid is expelled from the pressurizer

2) The steam generators receiving auxiliary feedwater do not dry out.

These criteria are intended to protect the specified acceptable fuel design limits (SAFDLs) during the decay heat removal phase of the event. Criterion 1 provides that a sufficient primary coolant mass inventory is retained to cover the core, should the event terminate in an uncontrolled cooldown, thus assuring adequate fuel cooling. Criterion 2 assures that the long term decay heat removal capability provided by the auxiliary feedwater system will remain indefinitely available and effective to prevent excessive primary coolant volumetric expansion. The FSAR reports that the loss of normal feedwater event is the most limiting with respect to decay heat removal. Thus, the above two criteria establish the adequacy of plant and auxiliary system design for decay heat removal. It is noted that the short term consequences of the loss of normal feedwater event with respect to the system pressurization criterion and the fuel-cladding integrity criterion (Standard Review Plan section 15.2.7-11) are bounded by the loss of load event reported in XN-NF-82-18(P), Supplement 2. The pressurizer safties (3) have a total relief capacity of 240 lbs/sec at 2500 psig + 3% accumulation. The

maximum relief rate caused by the Loss of Load Event is 171 lbs/sec and the maximum relief rate caused by the Loss of Feedwater Event with a non-equilibrium pressurizer is 14 lbs/sec. This clearly demonstrates sufficient pressurizer safety relief capacity.

ENC analysis indicates that the equilibrium pressurizer model employed in the Loss of Normal Feedwater analysis provides a conservative estimation of the event results relative to these criteria.

Discussion Concerning Criterion 1

The conservative approach in analyzing the loss of normal feedwater event with respect to Criterion 1 is to maximize pressurizer liquid and primary coolant volumetric expansion. The following discussion compares results as may be obtained by the two models.

The equilibrium pressurizer model results in an initial, rapid pressure decrease of about 100 psi because of insurge of cooler primary liquid. A relatively slow return to the initial pressure then occurs, with pressure remaining constant at the initial value for the remainder of the event because of action of the pressurizer heaters and heater controllers.

An adiabatic pressurizer model represents the extreme case of non-equilibrium behavior. The pressure history for the loss of normal feedwater event with adiabatic compression will increase due to insurge flow resulting from primary coolant heatup. The pressure increase would halt at the safety valve setpoint of 2500 psia and would remain at approximately 2500 psia. Pressure calculated assuming the adiabatic model will remain higher throughout the event than that calculated using the equilibrium model.

Primary to secondary heat transfer during the event is independent of primary system pressure. Thus, the primary system temperature transient is not dependent on the pressurizer model employed.

Primary coolant volumetric expansion as predicted with the equilibrium model will therefore differ from that predicted by an adiabatic compression model only because of the pressure dependence of the subcooled primary liquid specific volume. Taking primary coolant average temperature

and pressurizer liquid temperature from the equilibrium model predictions at the time of peak pressurizer level, ENC has calculated primary liquid volume based on the safety valve setpoint pressure of 2500 psia. This represents an upper bounding value of pressure for the system. This high pressure condition would result in approximately 25 cu.ft. less water in the pressurizer than predicted by the equilibrium pressurizer model. This result is due to the slight decrease in specific volume of liquid water (at constant temperature) associated with a pressure increase from 2250 psia (equilibrium) to 2500 psia (non-equilibrium).

The equilibrium model predicts pressurizer heater operation over the initial part of the simulation because of the initial depressurization. Energy is added to the pressurizer liquid by the heaters. This increases the pressurizer liquid temperature, resulting in additional swell which would not be predicted by a non-equilibrium model. The equilibrium model is estimated to predict an additional 13 cu.ft. of pressurizer liquid volume due to this effect. This conclusion has also been arrived at by other vendors.

It is thus seen that primary liquid swell is conservatively maximized by underprediction of system pressure by an equilibrium pressurizer versus non-equilibrium pressurizer model. This has the effect of conservatively evaluating acceptance criterion one.

Discussion Concerning Steam Generator Drying

Since primary to secondary heat transfer is essentially independent of primary system pressure, the equilibrium and non-equilibrium pressurizer models will provide the same evaluation of secondary system state. Thus, the equilibrium pressurizer model is judged to be appropriate for evaluating loss of normal feedwater results relative to the drying of the steam generator receiving the auxiliary feedwater.

QUESTION

The SLOTRAX code used to analyze the loss of feedwater event in Supplement 2 of XN-NF-82-18 does not predict pressure rise above the set point of 2250 psia. A non-equilibrium pressurizer model would be expected to predict steam relief through the relief valves because of predicted pressure rise in the pressurizer, but the equilibrium model does not predict pressure which would vent steam from the pressurizer. Please discuss the relative affects on pressurizer level and primary inventory of coolant.

RESPONSE

Two observations are relevant to the discussion.

1) Pressurizer level surge is driven by the increase in primary average temperature and liquid volumetric expansion in the primary.

2) Venting of the steam relieves mass from the primary while lack of venting conserves mass.

The pressurizer level surge is driven by the increase in average coolant temperature. The temperature increase is not significantly affected by the pressure at which energy is added. Therefore, the temperature rise and volumetric swell would be independent of pressure except as related to compressibility. Due to compressibility effects, the higher pressure non-equilibrium process will predict less swell. (See previous question.)

Venting of steam from the pressurizer relieves mass from the primary system. Lack of venting conserves the contained mass. The non-equilibrium model could be expected to vent three to five hundred cubic feet of steam. The equilibrium model forces the volume of steam displaced by swell (approximately 500 cubic feet) to condense rather than vent. This has been calculated to add approximately 90 cubic feet of liquid swell.

The equilibrium model will underpredict primary system steam loss. The extreme mass loss being the volume of steam displaced by level swell, approximately 500 cubic feet. This corresponds to nearly 3400 lb of coolant which may be predicted to be vented with a non-equilibrium model. The initial primary inventory is calculated to be 387000 lb. The loss of 3400 lb from the initial inventory is insignificant to any considerations relating to core recovery.

Thus, the equilibrium model will provide results conservative to evaluation of pressurizer level swell, but slightly underestimates system mass loss.

QUESTION

The NRC Staff included in the H. B. Robinson Cycle 9 Safety Evaluation Report that the ENC model for main steam line break (MSLB) simulation is excessively conservative to the extent that the analysis may mask important system effects. The MSLB simulation reported in XN-NF-82-18(P), Supplement 2 for Cycle 10 predicts 2% of the fuel could experience DNB. This has not heretofore been predicted. Please quantitatively assess the margin of conservatism in that simulation.

RESPONSE

The Cycle 10 MSLB simulation employed a bounding EOC shutdown margin of $-1.77\%\Delta\rho$. The best estimate of EOC 10 shutdown margin is $-3.9\%\Delta\rho$. The Cycle 10 MSLB simulation has been repeated using a still conservative $-3.4\%\Delta\rho$ shutdown margin. The resulting peak power is 103 MWt, less than 1/10 of the peak power reported in XN-NF-82-18(P), Supplement 2. The calculated MCHFR for the case using best estimate shutdown margin is 9.9. Thus, with all conservatisms inherent in the model left intact except for the shutdown margin, no fuel is calculated to experience boiling transition as a result of the MSLB.

A radiological dose assessment was performed based on 2% fuel failure per SRP 15.1.5. The following assumptions were made:

1. No credit for containment (limiting break is inside containment between SG and flow restrictor with offsite power available). This is conservative in that no credit is taken for holdup time or containment spray removal of iodine.

2. At time of fuel failure the entire gap activity of the failed fuel is released to the primary fluid.

3. The Technical Specifications maximum leakage rate of 0.35 gpm per SG was assumed at the start of the transient. This leakage rate was assumed to vary in proportion to the differential pressure between the primary and secondary throughout the release period for the SG with the broken loop.

4. As an additional source of radioactivity, the maximum equilibrium activity levels in the primary and secondary allowed by the technical specifications were assumed to be present.

5. The fluid release included all secondary fluid of the failed SG, the primary leakage into that SG, and the secondary fluid from the non-failed SG until the MSIV's closed.

The resulting thyroid dose from iodine was 27 rem which is below SRP 15.1.5 Appendix A, Section II guideline value of 30 rem and the whole body dose of 0.29 rem is below SRP 15.1.5 Appendix A guideline of 2.5 rem.

QUESTION

The maximum pressurizer safety valve set point for H. B. Robinson is given in the Technical Specification as 2575 psia. The analysis of the loss of load event reported in XN-NF-82-18(P), Supplement 2, employed a mid-range value of 2500 psia. Provide assurance that the reactor vessel peak pressurizer limit of 2750 psia is not violated in this event.

RESPONSE

Protection of the vessel peak pressure limit is afforded by the designed steam flow capacity of the pressurizer safety valves. The loss of load analysis reported in XN-NF-82-18(P), Supplement 2, demonstrates that the pressurizer pressure increase for this event is effectively terminated by the opening of the safety valves, thus assuring that the capacity of the valves is adequate to perform the design function. Had the more conservative Technical Specification safety valve pressure set point been employed in the reported analysis, the pressure increase would similarly terminate at the higher set point pressure. Thus, peak system pressure would be less than 5 psi above the maximum safety valve set point, well below the peak vessel pressurization limit of 2750 psia.