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December 6, 2001

2CAN120105

U. S. Nuclear Regulatory Commission
Document Control Desk
Mail Station OP1-17
Washington, DC 20555

Subject: Arkansas Nuclear One - Unit 2
Docket No. 50-368
License No. NPF-6
Response to Fourth Request for Additional Information from the Reactor Systems Branch Regarding the ANO-2 Power Uprate License Application

Gentlemen:

Entergy Operations, Inc. submitted an "Application for License Amendment to Increase Authorized Power Level," on December 19, 2001 (2CAN120001). Entergy responded to requests for additional information from the NRC staff regarding the application in letters dated October 17, 2001 (2CAN100110), and October 31, 2001 (2CAN100102).

During a teleconference on November 15, 2001, the NRC asked for clarifying information regarding the response to NRC Question 15 from the October 17, 2001, letter and Question 10d from the October 31, 2001, letter. In particular, the staff asked for additional information in regard to the use of the NOTRUMP computer code for modeling the low steam generator level trip setpoint in the affected steam generator for a feedwater line break considering instrument uncertainty and thermal-hydraulic issues. The staff also requested additional information regarding the limiting factors of a small feedwater line break versus a large feedwater line break.

The staff requested the information via telex. In response, additional information was telexed on November 19, 2001. During a subsequent telephone conversation on November 26, 2001, the NRC Project Manager requested that the telexed information be submitted officially on the docket. The attachment to this letter contains a duplication of the information telexed to the NRC on November 19, 2001.

This submittal contains no regulatory commitments.

I declare under penalty of perjury that the foregoing is true and correct. Executed on December 6, 2001.

Very truly yours,

Glenn R. Ashley

Glenn R. Ashley
Manager, Licensing

GRA/dwb
Attachment

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**Response to November 15, 2001, Verbal Question From the NRC
Regarding the Feedwater Line Break Analysis for ANO-2 Power Uprate**

The ANO-2 replacement steam generators (Westinghouse Delta-109 steam generators) are similar in design to steam generators installed on Westinghouse-designed plants, such as the Delta-94 steam generators. Based on the similarity in steam generator design and the flexibility of the NOTRUMP code, NOTRUMP was used to assess the inventory in the steam generator following a feedwater line break (FWLB) as is done for other Westinghouse plants. The NOTRUMP method is applicable to the ANO-2 steam generators. The method was used only to model the steam generator secondary side inventory response following a FWLB. CENTS was utilized to model the integrated primary and secondary response to a FWLB. NOTRUMP was used only to determine the inventory in the ruptured steam generator at the low-level trip setpoint. This inventory was then used by CENTS to determine the time of trip. When the steam generator inventory in CENTS reached the 40,000 lbm defined by NOTRUMP, a reactor trip signal was assumed to be generated at that time. The use of NOTRUMP has been applied consistently and conservatively with respect to the methods documented in WCAP 9230, "Report on the Consequences of a Postulated Main Feedline Rupture" (January 1978) and WCAP 9236, "NOTRUMP: A Nodal Transient Steam Generator and General Network Code" (September 1977).

NOTRUMP is a general, one-dimensional network code that is used for the analysis of thermal-hydraulic transients. The NOTRUMP code was developed to address the following important phenomena:

(1) a momentum balance suitable for calculating time dependent flows,
(2) two-phase flow capabilities including natural and mechanical phase separation models, and counter-current flow modeling capabilities,
(3) thermal non-equilibrium models that can account for significant non-equilibrium effects such as bubble rise, droplet fall, interfacial heat and mass transfer, condensation, and evaporation,
(4) the capability of incorporating time and spatial changes in a system due to changes in boundary conditions or control systems, and
(5) representation of different physical regions or components of a system as well as significant physical processes.

The spatial detail of a problem is modeled by element control volumes (nodes) appropriately interconnected by paths (links). The spatial-temporal solution is then governed by the integral forms of the conservation equations in the nodes and links.

The numerical integration procedure for the network conservation equations is a generalization of the implicit method. NOTRUMP permits a full nodal treatment of both the primary and secondary sides of the nuclear power plant, including metal nodes for modeling steam generator tubes. The NOTRUMP analysis is typically performed iteratively with the LOFTRAN code to define the boundary conditions for the NOTRUMP model. For ANO-2, the CENTS primary conditions were used as input into the NOTRUMP model.

Westinghouse's methodology involves using the NOTRUMP code to perform a detailed nodalization analysis of the faulted steam generator during a FWLB and determine a SG total mass in relationship to the indicated level for the narrow range level measurement system. The NOTRUMP SG total mass relationship (40,000 lbm) used in the FWLB analysis was based on a narrow range level of 0 %. This narrow range level of 0% is based on the actual physical dimensions at which a narrow range level of 0% would occur. This narrow range level from NOTRUMP is converted to a SG low-level narrow range setpoint based on the calibration of the instrumentation as indicated below.

The current SG low level trip setpoint of 22.2 % narrow range level established for Cycle 15 is based upon appropriate consideration of applicable process, environmental, and hardware uncertainties in the intact SG. These uncertainties are added to the appropriate analytical limit for the various accidents and transients for which protective action is credited in deriving the setpoint mentioned above. Where different analytical limits and uncertainties apply to the event of concern, each case is separately evaluated and the highest (most conservative) setpoint is selected. The following summarizes major aspects of the analysis:

(1) Level transmitters are calibrated for normal, full power SG water and steam densities. Consideration is given to the decalibration effects that can occur as density deviates from the calibration reference conditions due to transients and accidents (including the FWLB). The effects of decalibration are evaluated over a wide range of pressures and temperatures. The water and steam densities are evaluated from atmospheric conditions up to pressures well in excess of normal operating pressure. Reference leg temperatures are evaluated from normal expected conditions up to the expected accident conditions for the event of concern.

(2) Feedwater and steam flow within the SG gives rise to dynamic pressure drops associated with fluid motion. Adjustments are made to the level transmitter calibration such that the dynamic factors (pressure drop across the mid deck plate, etc.) at full power are essentially nulled out at full power flowing conditions. Consideration is given to extreme flow conditions that may occur during transients or accidents. Any dynamic effects that would cause non-conservative actuation with respect to the low level trip setpoint are included within the total channel uncertainty.

(3) Equipment errors such as drift, reference accuracy, M&TE, temperature effects, etc. from the transmitters through the channel trip bistables are evaluated for the appropriate conditions considered to be applicable at the time of actuation. This includes consideration of the effects of reduced insulation resistance due to accident temperatures on signal transmission components including cables, penetrations, splices, etc.

For Cycle 16 (Power Uprate) conditions, Westinghouse evaluated process conditions that would be present during a FWLB, taking credit for actuation on low SG level in the faulted generator using the NOTRUMP code. The analysis includes consideration of two-phase flow. Their analysis demonstrated that the direction in which steam and water densities change in a faulted SG remained within the range of pressures and densities considered with respect to establishment of the current setpoint. Dynamic flow induced uncertainties remained within allowances established for the current setpoint or the sign of the error was reversed such that actuation would occur more conservatively. For example, steam flow across the mid deck plate creates a positive bias such that, if the effect is not nulled out at full power flow conditions, the instrument will read high. As explained above the transmitter is calibrated to null out the normal, full power flow effect. However, accident induced flows are expected to be much higher than normal such that a positive bias error is expected and an allowance is incorporated within the setpoint calculation for this error. The Westinghouse analysis demonstrated that a FWLB in the faulted SG causes a flow reversal across the mid deck plate such that the error would actually be negative causing the actuation to occur conservatively sooner. Equipment error allowances remain essentially unchanged as the peak containment temperatures used for the Cycle 15 analysis will still apply to Cycle 16. Also the actuation channel hardware configuration is not being modified as a result of power uprate. In summary the Cycle 15 low SG level actuation setpoint uncertainty allowances will remain bounding for Cycle 16 when crediting actuation in the faulted SG for FWLB.

The limiting FWLB analysis for ANO-2 has always been determined to be a small break rather than a full guillotine rupture of the feedwater line. These smaller break sizes are considered limiting due to the delay in receiving a reactor trip signal and the reduced steam generator inventories available to mitigate the event at that time. A loss of offsite power is assumed coincident with the time of trip. A loss of offsite power causes the reactor coolant pumps to coast down resulting in a plant heatup and increase in RCS pressure. Having this loss of offsite power coincident with a FWLB break size that delays reactor trip on high pressurizer pressure when there is minimal inventory in the steam generators causes a limiting peak RCS pressure challenge. The combined effect of reduced heat removal capacity in the affected steam generator due to the minimal secondary inventory and the extra challenge of a loss of offsite power when the RCS pressure starts at the high pressurizer pressure trip setpoint results in the maximum RCS pressure. For larger break sizes, the low steam generator level trip occurs before the pressurizer pressure reaches the high pressure setpoint. This lower initial pressurizer pressure and quicker timing of trip reduces the RCS heatup prior to trip hence allowing more margin to accommodate the effects of a loss of offsite power.