GE Energy

Louis M. Quintana
Manager, Licensing

P.O. Box 780, M/C A-30
Wilmington, NC 28401
USA

T 910.675.6616
F 910.362.6616
Louis.Quintana@ge.com

MFN 05-028
April 8, 2005

U.S Nuclear Regulatory Commission
Document Control Desk
Washington, D.C. 20555-0001

Attention: Mel Fields, Project Directorate IV, Section 2
Senior Project Manager

Subject: Response to Request for Additional Information - Part 21 Notification Regarding Narrow Range Water Level Instrument Level 3 Trip

In Reference 1, the NRC requested addtional information (RAI) regarding a 10CFR Part 21 notification for a potential issue with the Level 3 trip from the narrow range water level instruments that initiate reactor scram. GE's responses to these RAIs are enclosed.

If you have any questions, please contact, Jason Post at (910) 675-6608 or myself.

Sincerely,

Louis M. Quintana

Louis M. Quintana
Manager, Licensing

Project No. 710

Reference:

1. MFN 05-007, Letter from Mel Fields (NRC) to James Klapproth (GE), February 1, 2005, *Request for Additional Information - Part 21 Notification Regarding Narrow Range Water Level Instrument Level 3 Trip*

DO65

Enclosure:

1. GE Responses to Request for Additional Information - Part 21 Notification Regarding Narrow Range Water Level Instrument Level 3 Trip

cc: J Post (GE/Wilmington)
JF Klapproth (GE/Wilmington)
MA Lalor (GE/San Jose)
GB Stramback (GE/San Jose)
Y Dayal (GE/San Jose)
eDRF 0000-0033-1159

ENCLOSURE 1

MFN 05-028

GE Responses to Request for Additional Information - Part 21 Notification Regarding Narrow Range Water Level Instrument Level 3 Trip

NRC RAI 1

Whether the dryer skirt is fully uncovered or not, the presence of steam flow under it would result in a two-phase "froth" in the annular region sensed by the level instrumentation. The relationship between the resulting measured differential pressure and the interpreted degree of submersion of the reactor core would therefore be different from the presumed design conditions, for which the instrument is assumed to be sensing solid water. Show that the presence of such"froth" in the area sensed by the level instrumentation is not credible, or show that the level instrument functions will not be adversely affected by it.

Response to NRC RAI 1

The water level instrument measures "collapsed" level, which is not dependent on how many bubbles there are in the annulus. The steam density is approximately 5% of the water density, so even though there is "froth" in the annular region, and the actual two-phase mixture level in the annulus is high because of it, the pressure at the variable leg tap is essentially unchanged because the density is essentially the same as it would be with no "froth". Moreover, the transient analyses that rely on water level trips also assume that the instrument is reading (and trips on) the "collapsed" level (or water mass / water head). The degree of submersion of the core that is pertinent to the transient system response (i.e., the head of water available for cooling the core in the event of an accident) is based on the "collapsed" level, which is essentially unchanged by the froth due to steam flow in the annular region. Therefore the level instrument functions would not be adversely affected by the presence of this "froth".

NRC RAI 2

Steam flow past the lower tap of the reactor vessel water level instrumentation, in addition to compromising the calibration of the instrument by altering the density of the sensed fluid, could result in dynamic effects similar to those postulated for the reference legs. Such effects could result in an increase or decrease in pressure depending upon flow dynamics. In addition, such effects would not be expected to be constant but rather to fluctuate significantly as steam bubbles form and collapse and as flow streams move unpredictably through the sensed volume. The resulting level measurement would then be significantly noisy, and the noise would not necessarily be zero-meaned and would therefore not amenable to dynamic filtering. Show that such dynamic effects and process noise are not credible, or show that the behavior and calibration of the instrumentation will not be adversely affected by them.

Response to NRC RAI 2

For water level measurements by either the "narrow" or "wide" range instruments, steam flow across the variable leg tap in the annular region, has either no effect or only a conservative effect on the measurement. The reasons are as follows:

1. For all BWR 2s, 3s, 4s, 5s, "narrow" range measurements (and all BWR "wide" range measurements), the variable leg nozzle is well below the bottom of the dryer skirt, so the steam that bypasses the dryer and enters the annulus region does not flow by the variable leg nozzle. So, this annular steam flow does not affect the pressure at the variable leg and causes no error in these measurements.

2. For most BWR 6s, the variable leg nozzle for the "narrow" range water level measurements is above the bottom of the dryer skirt, so the bypass steam does flow by the narrow range variable leg tap and could affect the pressure at the variable leg tap. For ABWRs and Grand Gulf (BWR 6) the variable leg is just below the bottom of the skirt so these plants may also see some slight effect due to steam flow by the variable leg tap. The impact of annular steam flow on the variable leg pressure is negligible in the early stages of the feedwater loss event when the level just decreases below the no-annular-steam-flow static head level because the steam flow velocity is insufficient to cause a significant Bernoulli error. At this time the steam merely bubbles through the water with a "buoyancy" velocity, which has a negligible effect on the variable leg pressure. Later in the feedwater loss event, when the water level decreases well below the no-annular-steam-flow static head level but before the L3 analytic limit is reached, significant steam can flow in the annulus between the skirt and vessel wall. Under these conditions the two-phase flow in the annulus has sufficient velocity to impact the variable leg pressure and cause an error in the indicated water level. This condition lasts for a very short time because the water in the annulus is quickly carried up by the steam and out through the main steam lines. During this time the predicted direction of the flow in the annular region is upward toward the main steam line nozzle where the pressure is lower. The flow streams past the face of the variable leg nozzle and does not impinge directly upon the opening. This flow past the variable leg nozzle reduces the pressure sensed by the variable leg which causes a conservative bias error because the reduced pressure has the effect of indicating a lower than true water level. Because of the process dynamics, the effect on the

variable leg pressure is also expected to be noisy, though the magnitude of the noise would be difficult to estimate. However, because the effect of flow on the variable leg is conservative, neglecting this effect altogether would be conservative, even in the presence of such noise. Thus, it is conservative to neglect the error from this source, and although the two-phase flow condition lasts for a short time, and cannot be well modeled, the indicated level will go through the L3 setpoint and scram will occur. Therefore, the behavior and calibration of the instrumentation will not be adversely affected by the steam flow past the variable leg tap.

NRC RAI 3

NRC staff observes that the existing Level 3 setpoints are close to the bottom of the calibrated range of the associated instrument channels. NRC staff also observes that, in general, instruments tend to have increased uncertainty near the ends of calibrated range relative to the degree of uncertainty specified by manufacturers, which generally apply to the middle of the calibrated range. Show that the effects discussed above, combined with the inherent uncertainties in the channel and in the calibration process, and considering the potential for increased uncertainty near the bottom of the calibrated range, will not result in setpoints which are off-scale or otherwise inconsistent with the limits assumed in the accident analyses.

Response to NRC RAI 3

The water level setpoint calculations are performed according to NRC approved setpoint methodologies and properly account for the applicable instrument and process errors. For the water level dP instruments, there is a small static pressure span and zero correction that needs to be considered. However, by following the procedure in the instrument vendor manual, the span and zero can be properly adjusted during instrument calibration and do not account for additional instrument error, regardless of where in the span the setpoint is. Other instrument errors are accounted for in the setpoint calculation and are determined from vendor specifications and ambient conditions. These errors are constant over the entire span and include errors from various sources (linearity, repeatability, hysteresis, temperature, etc). So regardless of whether the setpoint is at the bottom or top of the scale, the same instrument error is used in the setpoint calculation. The error is a larger percent of the setpoint when the setpoint is low, so as a percent of point (or setpoint) the error increases as the setpoint decreases. However, as a percent of full scale (or span) the error is constant throughout the range, and this is the error used in the setpoint calculation. The allowance made for instrument error in the setpoint calculations performed using NRC approved setpoint methodologies is generally conservative and assures that as long as the transient analyses is performed with an Analytic Limit which is on-scale, the setpoint will be reached before the instrument goes off-scale.