TOLEDO EDISON

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Docket No. 50-346

License No. NPF-3

Serial No. 1031

March 9, 1984

Director of Nuclear Reactor Regulation
Attention: Mr. John F. Stolz
Operating Reactor Branch No. 4
Division of Operating Reactors
United States Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Stolz:

This is in response to your letter dated September 6, 1983 (Log No. 1360), concerning the instrumentation to detect Inadequate Core Cooling (ICC). Toledo Edison provided the schedule for the response on August 9, 1983 (Serial No. 993). Toledo Edison's response for Items 2, 3, 6, 7, 8 and 11 in the Enclosure 2 of your letter was submitted on December 8, 1983 (Serial No. 1003). The response for Item No. 4, 5, 9, 10 and 12 in the same enclosure was submitted on February 10, 1984. Enclosed is the response for the only remaining item (No. 1).

This completes Toledo Edison's response to your original letter (Log No. 1360) for the Davis-Besse Nuclear Power Station Unit No. 1.

Very truly yours,

R P Crouse / [illegible]

RPC:FYC

Attachment

cc:
DB-1 NRC Resident Inspector

A002
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Attachment to TED Letter
Serial No. 1031

QUESTION 1:

Provide a detailed analysis of the measurement errors for coolant inventory in the hot legs and the RV. This analysis should include besides the overall estimate of the measurement uncertainty, a table with estimates of error, including limits of uncertainty for each contributing factor associated with the transducer. Explain how the individual errors were combined for the estimate of the overall error. Discuss the error in inventory with the respect to the quantity of coolant remaining to cool the core. Evaluate the possibility that a change in containment environment or other conditions affecting the instrument calibration can result in misleading information with respect to the direction (loss or gain) of coolant inventory.

RESPONSE:

The RCS liquid level in the hot leg can be represented by the equation:

$$L = \frac{\Delta Pi - \rho g H}{\rho f - \rho g}$$

where:

L	=	Actual level in hot leg
H	=	Vertical distance from the lower tap of the DP cell to the top of the reference leg
ΔPi	=	Indicated differential pressure from the DP cell
ρf	=	Liquid density in hot leg
ρg	=	Vapor density in hot leg
Li	=	Indicated level in hot leg
ρo	=	Liquid density in reference leg

Since $\Delta Pi = \rho o Li$, therefore:

$$L = \frac{\rho o Li - \rho g H}{\rho f - \rho g}$$

Based on this formula, the measurement errors for L can be derived.

$$\frac{dL}{H} = \frac{\rho o}{\rho f - \rho g}\left[\left(\frac{dLi}{H}\right)^2 + \left(\frac{d\rho o}{\rho o}\right)^2 + \left(\frac{d\rho f}{\rho o}\right)^2 + 2\left(\frac{d\rho g}{\rho o}\right)^2\right]^{\frac{1}{2}}$$

where:

dL	=	Uncertainties associated with the actual level in hot leg (L).

dLi = Uncertainty of the indicated level due to DP transmitter measurement error.

dρo = Uncertainty associated with ρo due to reference leg temperature measurement error.

dρf = Uncertainty of liquid density in hot leg due to T_{hot} measurement error.

dρg = Uncertainty of vapor density in hot leg due to pressure measurement error.

The uncertainties or accuracies associated with the DP transmitter is the largest contributing factor to the overall uncertainty of the level measurement. This is due to the fact that density of water is a rather weak function of temperature (10% variation in temperature such as 20°F in 200°F span translates to only 0.76% variation in water density).

For the DP transmitter the accuracies are:

±0.25% (of span)	for hysteresis, repeatability
±5.3%	for environmental temperature effect (200°F change in temperature)
±0.7%	for aging effect
±1.43%	for static pressure effect

Therefore,

$$\frac{dLi}{H} = \left[(0.25)^2 + (5.3)^2 + (0.7)^2 + (1.43)^2\right]^{\frac{1}{2}} \%$$

$$= \pm 5.54\%$$

Assume the inaccuracy due to density effects and other signal conditioning modules combined together is less than ±2%.

ρo (at 120°F) = 1/0.016204 = 61.71 lb/ft^3

ρf (at 614°F) = 1/0.02433 = 41.10 lb/ft^3

ρg (at 1700 psia) = 1/0.23607 = 4.24 lb/ft^3

Therefore,

$$\frac{dL}{H} = \frac{61.71}{41.1-4.24}\left[(5.54)^2 + (2)^2\right]^{\frac{1}{2}} \text{ in } \%$$

$$= \pm 9.86\%$$

dL = ±9.86% * H
= ±0.0986 * 918"
= ±90.52"
= ±7.54 ft.

This kind of inaccuracy (±7.54 ft. of water) in hot leg and the steam generator tubes translates to ±1870 gallons of volume per steam generator loop. Total volume in the RCS below the hot leg (and cold leg) center line elevation is approximately 20,600 gallons. Therefore, the inaccuracies (9.86%) in level amounts to a maximum of 1870/20600 = 9% of the minimum inventory. The inaccuracy as indicated above, ±9.86% includes the maximum effect from possible containment temperature changes (80° to 280°F).

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