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HAL B. TUCKER
VICE PRESIDENT
NUCLEAR PRODUCTION

TELEPHONE
(704) 373-4531

December 28, 1983

Mr. James P. O'Reilly, Regional Administrator
U. S. Nuclear Regulatory Commission
Region II
101 Marietta Street, NW, Suite 2900
Atlanta, Georgia 30303

Re: Catawba Nuclear Station
Units 1 and 2
Docket Nos. 50-413 and 50-414

Dear Mr. O'Reilly:

Pursuant to 10 CFR 50.55e, please find attached a final response to Significant Deficiency Report SD 413-414/79-02.

Very truly yours,

Hal B. Tucker

LTP/php

Attachment

cc: Director
Office of Inspection and Enforcement
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

NRC Resident Inspector
Catawba Nuclear Station

Palmetto Alliance
2135½ Devine Street
Columbia, South Carolina 29205

INPO Records Center
Suite 1500
1100 Circle 75 Parkway
Atlanta, Georgia 30339

Mr. Robert Guild, Esq.
Attorney-at-Law
P. O. Box 12097
Charleston, South Carolina 29412

Duke Power Company
Catawba Nuclear Station
Final Response to SD 413-414/79-02
Steam Generator Narrow Range Level Measurement Errors

Scope

The steam generator narrow range level instruments initiate reactor trip and auxiliary feedwater actuation at the low-low level setpoints. The steam generator narrow range level is also used for post-accident monitoring.

The problem of steam generator narrow range level measurement errors is identified in significant deficiency report SD 413, 414/79-02 and is discussed in Section 7.2.2.3 of the SER for Catawba Nuclear Station. These errors can be a result of steam generator fluid density changes, reference leg heat up or reference leg boiling. The following provides additional information and a resolution to the aforementioned deficiency.

Resolution

Reference Leg Heatup

High energy line breaks inside containment can result in the heating of level measurement reference legs. Increased reference leg water column temperature will result in a decrease of water column density. This decrease in water column density will cause an increase in indicated water level (indicated water level exceeds actual level).

As discussed in the SER, Section 7.2.2.3, the reference leg will be insulated to minimize measurement errors due to reference leg heatup. The installation of mirror insulation on the steam generator level measurement system for Unit 1 is to be completed prior to precritical testing.

A determination of low-low level trip setpoint error is as follows:

Bottom of Span	0
Normal Channel Accuracy	±5%
Transmitter Errors Due to Adverse Environment	+5%, -15%
Reference Leg Heatup Effects	+2%
Total Errors	+12%, -20% of Span
Minimum Trip Setpoint Required	+12%

The normal channel accuracy was achieved by a direct summation error analysis ensuring a conservative number. Barton Lot 2 transmitters will be temperature compensated statically to +5%, -15% of span. The temperature selected for this compensation is the temperature expected inside the electronics housing at five minutes into the event. The 2% error assumed for reference leg heatup effects is due to insulation of the reference leg with mirror insulation.

Attached is a correspondence with Diamond Power Specialty Company (vendor installing mirror insulation at Catawba Nuclear Station) complete with a time versus temperature graph of reference leg heatup. The graph is conservative in that it represents a faster water temperature rise than would actually be present. The reference leg heatup error was calculated to be less than 2 percent for 5 minutes following the accident.

The minimum low-low level trip setpoint is set at 12 percent of narrow range span. Negative errors provide an earlier trip and need not be considered. No margin of safety above the bottom of the narrow range trip is incorporated since all errors assumed are conservative and are arithmetically combined assuming simultaneous maximum values.

In order to avoid heatup of the reference leg during normal operation, a distance of 12 inches is not insulated down line of the condensate pot. This uninsulated length will be exposed to the adverse environment and will be a contributor to the total heatup error following an accident. This portion is uninsulated to allow condensate pots and reference legs to cool to ambient under normal operating modes.

Water Density Changes

An error in indicated water levels may also be introduced by changes in the steam generator pressure due to the changes in the density of the saturated water and steam in the vessels. The errors which would exist at low power under quiescent conditions is described in Table 1 and were calculated directly, using the following formula:

$$E = \frac{H_L}{H} \left(\frac{p_L,cal - p_L - p_g,cal + p_g}{p_f,cal - p_g,cal} \right) + \frac{L}{H} \left(\frac{p_f - p_g}{p_f,cal - p_g,cal} - 1 \right)$$

where:

E = level error due to density changes in both the vessel and the reference leg, as a fraction of level span,

L = true water level in the vessel, above the lower level tap,

p_f = saturated water density at the pressure of interest,

p_g = dry saturated steam density at the pressure of interest,

H = level span = vertical distance between narrow range taps on steam generator.

H_L = height of reference leg = maximum vertical distance from lower tap to water level in condensing pot on upper tap.

p_L,cal = water density at containment temperature and steam generator pressure for which the level indication system was calibrated.

Reference Leg Boiling

Boiling could conceivably occur in the reference leg in a single steam generator (affected by the break) with high containment temperature and depressurization of the steam generator to 42 psia. This condition could only occur following a steam line or feedline rupture inside containment and would be immediately detected by low steam line pressure indication with subsequent safety injection actuation. If such boiling were to occur, it would cause a major error in the indicated level of the affected steam generator for a short time period, in the extreme case indicating 100% level when the vessel is actually empty. Due to the extremely low probability of reference leg boiling, it is not included on Table I.

As a precaution, the plant operating instructions will inform operators of the possibility of erroneous water level indications of any depressurized steam generators due to reference leg flashings.

TABLE I

EFFECTS OF TEMPERATURE AND PRESSURE ON STEAM GENERATOR NARROW RANGE LEVEL INDICATION

STEAM PRESSURE (psia)		100	300	500	700	900	1100
Reference Leg Temperature (°F)	Actual Level	Error (fraction of span)					
90	0%	-.05	-.04	-.03	-.02	-.01	-.002
	100%	.24	.16	.11	.06	.02	-.012
120	0%	-.04	-.03	-.02	-.01	-.004	-.01
	100%	.25	.17	.12	.07	.03	-.004
280	0%	.05	.05	.06	.07	.08	.09
	100%	.33	.25	.20	.15	.11	.08
340	0%	1.37	.10	.11	.12	.13	.14
	100%	1.66	.30	.25	.20	.16	.13

Basis:

Level Calibration Pressure = 1050 psia

Reference Leg Calibration Temp = 100°F

Ratio of reference leg height to tap span (HL/H) = 1.00

Calibrated span = 233.79" @ 1050 psia, 100°F

Boiling in reference leg is not assumed

RECEIVED BY
SKD - M/N D
OCT 1 1 1983
DSJ
J K BERRY

Diamond Power Specialty Company

Babcock & Wilcox a McDermott company

P. O. Box 415
Lancaster, Ohio 43130
(614) 687-6500

October 7, 1983

590133-100783-1A

R F Day

Mr. S. K. Blackley, Jr.
Duke Power Company
422 South Church Street
Charlotte, North Carolina 28242

Please have filed

CENTRAL RECORDS/DIVISION USE

Attention: Mr. R. F. Day
Engineer

Gentlemen:

Subject: Catawba Nuclear Station
Unit #1
MPS Co. P.O. No. C-66733
DPSC Order No. 590133-R

Attached you will find a graph summarizing approximate calculation of temperature versus time for the situation discussed in the Day/Gilbert/Ehorn telecon of October 3, 1983. Please note that the solution should not be used above 200°F because the water properties begin to change drastically above that temperature. In making the calculation we assumed that there was no variation of water temperature with position, i.e. the model is a "lumped" heat transfer model. Also, the overall heat transfer coefficient is assumed constant with time when in fact it will decrease as the pipe wall temperature increases with time. This results in a faster water temperature rise than would actually be present.

The physical data used in the analysis is repeated below:

Initial Temperature = 120°F
Ambient Temperature (time greater than 0.0 minutes) = 330°F
Pressure in Line = ambient pressure (14.7 psia assumed)
Impulse line O.D. = 0.50 inches
Wall thickness = 0.065 inches
Insulation: metal reflective, 1/2" actual thickness, SS-4

If you have any questions, please don't hesitate to contact me.

Sincerely,

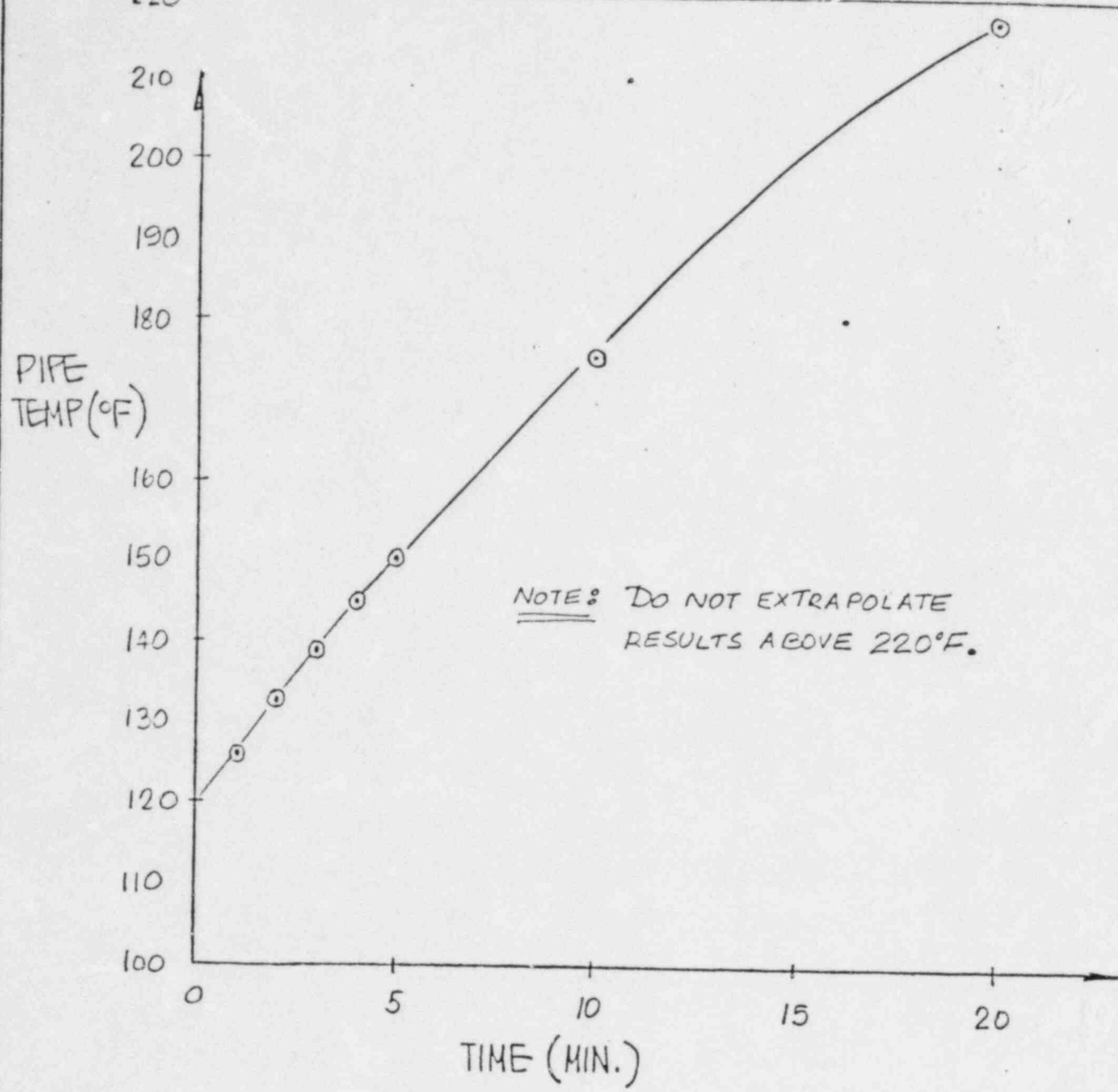
MIRROR INSULATION
Unit of Diamond Power

Robert R. Ehorn
Project Administrator

RRE:rm
Attachment
cc: E. B. Montague

MIRROR INSULATION
Unit of
DIAMOND POWER SPECIALTY COMPANY

ATTACHMENT



TIME VS. TEMPERATURE GRAPH

CONDITIONS:

- INITIAL AMBIENT TEMP - 120°F
- SUDDENLY AMBIENT TEMP. INCREASES TO 330°F.

.50" N.P.S.
.50" ACTUAL INSULATION THICKNESS
.25" LINER SPACING

ORIGINATOR S. R. SNOKE

DATE OCT 06 1983

CHECKED

D.P.S.C. ORDER NO. 540133-R