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TMI-2 PRELIMINARY

Discrepancy between Thermocouples and Outlet RTD Temperature Measurements. 4/9/79

Following the LOFW transient, the average of the thermocouples at the core outlet has been higher than hotleg RTD's. This memo provides some data on the thermocouple / RTD comparison prior to the LOFW transient.

Bill Bogdey and I reviewed the thermocouple data from PDO's prior to the transient to determine if a systematic bias existed. No isothermal, zero-power readings were found. However, we did locate several sets as a function of power. These were average two ways

1) weighting the 52 readings equally

2) weighting each reading according to the number of assemblies it represents.

These results and corresponding hotleg RTD readings are given in the attached table.

Note that the thermocouples give higher readings than the RTD's in all cases.

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It is reasonable to accept this difference may be due to normal bypass flow. Assuming this is correct, we can state the following appropriate formula:

$$P = (\dot{m}_T - \dot{m}_{BP})\, K\, (T_{T/C} - T_{IN})$$

and

$$P = (\dot{m}_T)\, K\, (T_{RTD} - T_{IN})$$

where

P = Power

$\dot{m}_T$ = Total flow

$\dot{m}_{BP}$ = Bypass flow

K = Average power per flow rate per degree ΔT

$T_{T/C}$ = Arithmetic average Thermocouple temperature

T_{RTD} = Hotleg (RTD)

T_{IN} = Inlet temperature

Setting power equal

$$(\dot{m}_T - \dot{m}_{BP})\, k\,(T_{OT/C} - T_{IN}) = \dot{m}_T\, k\,(T_{RTD} - T_{IN})$$

~~Solve~~ Solve for ~~Simplify~~ Simplifying we get

$$(1 - f)(T_{T/C} - T_{IN}) = T_{RTD} - B\,T_{IN}$$

where $f = \frac{\dot{m}_{BP}}{\dot{m}_T}$

a and

~~$T_{out} - T_{RTD} = f\ T_{T/C} - T$~~

$$T_{T/C} = T_{RTD} + f\,(T_{T/C} - T_{IN}) \quad \text{d}$$

Clearly if the system were isothermal, then (& zero power)

$T_{T/C} = T_{RTD} = T_{IN}$. Moreover, since the ~~ΔT~~ ΔT is proportional to power, the following ~~instance~~ should be true:

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$$T_{T/C} - T_{RTD} = \frac{f \cdot P}{K(\dot{m}_T \cdot \dot{m}_{BP})}$$

The plot of $\Delta T = T_{T/C} - T_{RTD}$ in the attached figure illustrates that, extrapolating to $P = 0$, the ΔT is not zero. This suggests a possible bias, prior to the transient, of $\pm 5^{\circ}F$ in the thermocouple readings. No explanation for the cause of the bias was found.

Table: Thermocouple / RTD Comparison

	Date	T*	T**	Outlet T (a)	Outlet T (b)	Power	ΔT
1	8/10/88	589.9	593.2	585.93	582.32	10%	6.26
2	8/30/88	590.10	600.94	591.76	592.05	5%	7.64
3	8/23/88	612.05	620.76	604.10	606.52	99%	10.78
4	8/24/88	612.02	620.61	602.31	601.61	99%	10.70

* weighted average

** straight average

FIGURE. Difference between $T_{T/C}$ and T_{RTD} versus Power