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Subject: San Onofre Nuclear Generating Station (SONGS) - Augmented Inspection Team Report - Thermal Hydraulic Analysis-Design Verification

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Document Information

Originator Name: David R. Buttemer

Originator Organization:

Addressee: R. W. Borchardt, EDO

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OEDO POC: Dan Merzke

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Mr. R. William Borchardt August 24,2012US

NRC Executive Director of Operations

Subject: SONGS II/III NRC Augmented Inspection Team Report 2012007, thermal hydraulic analysis-design verification using plant specific operational data.

Dear Mr. Borchardt:

Before getting into technical details, please let me briefly introduce myself. My name is Dave Buttemer and I am a retired mechanical and nuclear engineer with forty years of nuclear power plant design and analysis experience. In the early 1980s, while I was employed at the consulting firm Pickard, Lowe and Garrick, I was contracted by SCE to provide engineering analysis so as to obtain NRC permission to commence low power physics testing at SONGS II before the plant specific emergency response plan was approved. This was accepted by NRC, resulting a significantly less delay in plant startup.

In reading the referenced AIT report regarding the tube thinning issue at both plants, it occurred to me that one should be able to calculate the saturated water mass flow rate coming from the steam dryer with plant specific (full power) temperature data. The first principle analysis, given in the attachment, expresses what I term beta (β), the recirculation ratio, as a function of the feedwater temperature, the saturated liquid temperature at the steam generator pressure (ASME steam tables), and what I define as the mixed mean temperature (of the saturated water from the dryer and the feedwater) at the lower end of the downcomer annulus, where it enters the tube bundle. **If** this temperature is monitored (and recorded) then the recirculation ratio from the vendors T/H analysis (noted as 3.2 to 3.5 on page 22 of the AIT report) can be compared. The shell side mass flow rate through the tube bundle is then simply the feedwater flow rate times (beta +1). The forcing function for flow induced forces is likely density times velocity squared, or the mass flux (shell side mass flow divided by shell side flow area) squared divided by shell side fluid density. Thus, one would expect most damage near the top of the tube bundle where the density is lowest (I realize that this is a simplistic one dimensional observation, not the detailed 3D analysis with spacers, anti vibration bars, fluid mixing and the top bend of the tubes described in the AIT report). Also, is the thinning observed from the eddy current tests more prevalent on the hot leg side of the SGs due to enhanced heat transfer?

One last thing. It would be quite informative if the same calculation of the recirculation ratio could be done for the original CE SGs using full power data. This may give insight into any difference in the **hydraulic** design of the original and replacement SGs. Please feel free to contact me. Sincerely

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David R. Buttemer

EDO --G20120669

CALCULATION OF PWR STEAM GENERATOR SHEEL SIDE MASS FLOW RATE USING MEASURED PRESSURE AND TEMPERATURE DATA.

INPUT DATA: P_{SG} = S.G. SECONDARY SIDE PRESSURE (PSIA)
$\dot{m}_{FW}$ = FREDWATER MASS FLOW RATE (LBM/SEC)
T_{FW} = " INLET TEMP (°F)

THE ABOVE DATA IS WELL KNOW (@ FULL POWER). IF THE STEAM GENERATOR MIXED MEAN INLET TEMPERATURE IS MEASURED, T_{MMIN}, THEN THE MASS FLOW RATE OF SATURATED WATER FROM THE S.G. DRYER, $\dot{m}_{SWO}$, IS CALCULATED AS FOLLOWS:

$$T_{MMIN} = \frac{\dot{m}_{SWD}\cdot T_{SAT}(P_{SGS}) + \dot{m}_{FW}\cdot T_{FW}}{\dot{m}_{SWD} + \dot{m}_{FW}} \qquad (1)$$

DEFINE $\beta = \dot{m}_{SWD} / \dot{m}_{FW}$, THEN, ÷ R.S. OF (1) BY $\dot{m}_{FW}$ (2)

$$T_{MMIN} = \frac{\beta\cdot T_{SAT}(P_{SG}) + T_{FW}}{\beta+1} \qquad (3)$$

, OR

$$\beta = (T_{MMIN} - T_{FW}) / [T_{SAT}(P_{SG}) - T_{MMIN}] \qquad (4)$$

THE TOTAL SECONDARY SIDE MASS FLOW RATE THROUGH THE TUBE BUNDLE, $\dot{m}$ (SSTB) IS THEN

$$\dot{m}_{SSTB} = \dot{m}_{FW}\cdot(\beta+1) \qquad (5)$$

DAVID R. BUTTEMER (858)-455-1938 8/8/12

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25 AUG 2012 PM 3 0 1

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