NMC
Committed to Nuclear Excellence

Palisades Nuclear Plant
Operated by Nuclear Management Company, LLC

October 6, 2003 10 CFR 50.90

U S Nuclear Regulatory Commission
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PALISADES NUCLEAR PLANT
DOCKET 50-255
LICENSE No. DPR-20
LICENSE AMENDMENT REQUEST: INCREASE RATED THERMAL POWER – RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION
(TAC NO. MB9469)

By letter dated June 3, 2003, Nuclear Management Company, LLC (NMC), requested Nuclear Regulatory Commission (NRC) review and approval of a license amendment for the Palisades Nuclear Plant. NMC proposed to revise Appendix A, Technical Specifications, to increase rated thermal power by 1.4% from 2530 megawatts thermal (MWt) to 2565.4 MWt.

On September 10, 2003, the NRC issued a request for additional information (RAI) regarding the above license amendment request. Attached is NMC's response to the RAI.

This letter contains the following new commitments and no revisions to existing commitments:

- NMC will revise plant procedures to address operation with the plant process computer (PPC) feedwater flow indication or a PPC feedwater temperature indication out of service prior to implementation of the proposed power uprate.

- NMC will revise plant procedures to include at least 0.1% power conservatism when the UFM correction factors are established for use in the plant heat balance calculation prior to implementation of the proposed power uprate.

A001

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I declare under penalty of perjury that the foregoing is true and accurate. Executed on October 6, 2003.

Daniel J. Malone
Site Vice-President, Palisades Nuclear Plant

CC Regional Administrator, USNRC, Region III
Project Manager, Palisades Nuclear Plant, USNRC, NRR
NRC Resident Inspector – Palisades Nuclear Plant

Attachments

ATTACHMENT 1

NUCLEAR MANAGEMENT COMPANY
PALISADES NUCLEAR PLANT
DOCKET 50-255

October 6, 2003

LICENSE AMENDMENT REQUEST: INCREASE RATED THERMAL POWER – RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

12 Pages Follow

NUCLEAR REGULATORY COMMISSION (NRC) REQUEST - INTRODUCTION

By application dated June 3, 2003, the Nuclear Management Company, LLC (NMC), submitted a request to increase rated thermal power by 1.4 percent from 2530 megawatts thermal to 2565.4 megawatts thermal. This power level increase is considered a measurement uncertainty recapture (MUR) power uprate. Please provide the following additional information:

NRC REQUEST

1. Most power uprate applications use instrument uncertainties in terms of percent power from the plant data or provided by the instrument vendor for each parameter affecting power calorimetric, and combine those uncertainties using the square root sum of squares methodology to calculate total power measurement uncertainty. This calculated power measurement uncertainty was subtracted from the 2 percent (required by 10 CFR Part 50, Appendix K) to determine the proposed power uprate. For the proposed power uprate, NMC assumed measured values of various parameters, including feedwater flow. These assumed values from References 9.5, 9.6, and 9.10 were used to calculate power calorimetric uncertainty as per Attachment 1, "Uncertainty Calculation for the Secondary Calorimetric Heat Balance, EA-ELEC08-0001, Revision 1," to Enclosure 4 of the application. Enclosure 4 states that Crossflow system implementing procedures ensure the assumptions and requirements of the uncertainty calculation remain valid.

Please provide References 9.5, 9.6, and 9.10 for staff review. What is the plant-specific ultrasonic flow measurement (UFM) system measurement uncertainty for the assumed 11,357,000 lbm/hr feedwater flow with the assumption in Section 4.2.2 of Attachment 1, and how was it determined?

NUCLEAR MANAGEMENT COMPANY, LLC (NMC) RESPONSE

Attachment 1 to the June 3, 2003, application provided a calculation of the uncertainties associated with the secondary heat balance. Several plant instrument loops provide input to the plant process computer wherein the secondary heat balance calculation is performed. Many of these instrument loops are used in other applications and as such, instrument loop error analyses are contained within other engineering analyses. In order to not have the same calculation appear in multiple calculation packages, the errors associated with these loops were obtained from the existing calculation and referenced as input to the secondary heat balance calculation. To aid in the NRC staff's review of the secondary heat balance calculation, the requested references are provided as Attachments 2, 3, and 4 of this submittal.

The error associated with the UFM calculated feedwater flow is 0.44%. This value was determined on the as-built UFM installed at Palisades Nuclear Plant using the methodology described in section 5 of Topical Report CENPD-397-P-A Revision 1, "Improved Flow Measurement Accuracy Using CrossFlow Technology." This error is further combined with errors associated with feedwater flow differential pressure (from the flow venturi) and feedwater temperature instrument loops to determine a total feedwater flow error. This total error is then used in the secondary heat balance error analysis as described in Section 3.2.3 of Attachment 1 to the June 3, 2003, application. Calculation of the total feedwater flow error using the UFM is included in Attachment 3 of this submittal.

NRC REQUEST

2. *Section 8 of Attachment 1 states that the calorimetric calculations used the plant process computer (PPC) point indications of feedwater flow and temperature. However, it also states that the control room indications of feedwater flow and temperature with larger uncertainties than the PPC point indications, may also be used in the power calorimetric. Identify the affect of using control room indication, instead of PPC point indication, on power calorimetric results used for the proposed power uprate.*

NMC RESPONSE

In the event that the PPC feedwater flow indication or a PPC feedwater temperature indication is out of service, then a manual heat balance calculation would be required. The larger uncertainties associated with any of these conditions will require a 100% thermal power value of 2530 megawatts thermal (MWt) in the power calorimetric. NMC will revise plant procedures to address operation with the PPC feedwater flow indication or a PPC feedwater temperature indication out of service prior to implementation of the proposed power uprate.

NRC REQUEST

3. *In Section 7 of Attachment 1, the UFM corrected total calorimetric uncertainty is listed as "=+0.49 % Power –0.55% Power" and that for the uncorrected feedwater flow (venturi measurement) is listed as "=+1.13% Power –1.21% Power." Confirm that it respectively means +0.49% or -0.55% power and +1.13% or –1.21% power; otherwise explain.*

NMC RESPONSE

The correct interpretation of the conclusion of Attachment 1 is that when UFM corrected indicated power is 100% of rated thermal power, true power (P) is 99.45% ≤ P ≤ 100.49%. Using uncorrected feedwater flow, when indicated power is 100% of rated thermal power,
P is 98.79% ≤ P ≤ 101.13%.

NRC REQUEST

4. Item 1.G of Regulatory Issue Summary 2002-03 requires all licensees requesting an MUR power uprate to provide the basis for the proposed allowed outage time (AOT) for the UFM. Most applicants for power uprates propose AOTs ranging from 24 to 72 hours and quantify the maximum error in core power measurement due to venturi measurements during the AOT. NMC has proposed a 31-day AOT with an additional 25-percent grace period on the basis that this is currently specified in Palisades' procedures. Provide justification that the proposed AOT is not excessive and will only cause an acceptable error in core power measurement.

NMC RESPONSE

The term "allowed outage time" that is specified in NRC Regulatory Issue Summary (RIS) 2002-03, "Guidance on the Content of Measurement Uncertainty Recapture Power Uprate Applications," does not appropriately characterize the application of the Crossflow UFM system at the Palisades Nuclear Plant. This term is more appropriately used for plants that have a UFM system directly connected to their process computer. NMC included this term in the June 3, 2003, submittal to correspond to the requested information in RIS 2003-03.

The Crossflow UFM system at Palisades is not connected to the PPC. It is used as an offline calibration tool to calibrate the venturi feedwater flow indication on a monthly interval. Each month the ratio of UFM feedwater flow to venturi flow is determined. From this ratio, a conservative "UFM correction factor" is established that is manually input into the PPC to adjust the venturi feedwater flow measurement to the correct value. Also, a drift component of the feedwater flow transmitter is included in the uncertainty analysis included as Attachment 3 to this submittal. The procedure for completing the evaluation is treated like a technical specification (TS) surveillance and, therefore, includes a 25% grace period.

UFM correction factors have been in-use at Palisades Nuclear Plant since 1997. The original surveillance frequency was bi-weekly. After 3 1/2 years of operating experience, the surveillance period was increased from bi-weekly to monthly beginning with cycle 16 in May 2001. Since May 2001 there has been two instances where the calculated UFM correction factor was non-conservative with respect to the amount of correction applied in the heat balance calculation. The amount of non-conservatism in both cases was approximately 0.01% power (0.25 MWt). Neither case resulted in a violation of the licensed power level for the Palisades Nuclear Plant. From February 2002 to January 2003, the average calculated UFM correction factor change was approximately 0.05% power per month. In the two cases described above, the amount of conservatism (difference between the calculated correction and the value applied in the heat balance calculation) in the applied UFM correction factor was approximately 0.07% power. This was less than the 0.1% power conservatism typically applied by NMC to account for data scatter that can be seen in the UFM calculation from month to month. Since the second instance of being slightly non-conservative, at least 0.1% power conservatism has been included in determining the UFM correction factors that are applied to the heat balance calculation. NMC will revise plant procedures to include at least 0.1% power conservatism when the UFM correction factors are established for use in the plant heat balance calculation prior to implementation of the proposed power uprate.

Administrative controls exist to provide assurance that only acceptable errors in core power measurement occur between performances of the formal surveillance. For example, if the plant would be required to reduce power below 95%, procedural guidance is provided to remove the UFM correction factors from service. Once power is restored to near 100% then the UFM correction factors are recalculated to ensure that no changes have occurred due to the plant transient. In addition, HI and LO steam flow alarms on the PPC monitor for unanticipated changes in steady state reactor power between performances of the formal surveillance. These indications are provided on each steam generator and provide continuous monitoring of steam flow. The steam flow alarm setpoints are determined during the monthly determination of the UFM correction factors. Plant procedures describe actions required in response to HI or LO alarms or PPC inoperability. For example, if a HI steam flow alarm actuates and the cause is not known (i.e., not an instrument failure, etc.), plant power is reduced to the point where UFM correction factors may be removed from service. Also, if the PPC becomes inoperable and the continuous monitoring feature is lost, then daily verifications of the UFM feedwater flow is performed to verify no significant changes have occurred and that the UFM correction factors are still applicable. In general, if at any time a required UFM correction factor

verification cannot be performed when required by procedure, then power would be reduced and the UFM correction factors would be removed from service.

NRC REQUEST

5. Provide, in detail, the effect of the proposed power uprate on the environmental qualification of electrical equipment.

NMC RESPONSE

The proposed power uprate has no effect on the Palisades Nuclear Plant environmental qualification (EQ) program. The EQ evaluation parameters assume reactor power of at least 2580.6 MWt, 102% of the current rated thermal power of 2530 MWt. Therefore, the programs, activities, elements, and philosophy that are currently in place are not affected by the proposed 1.4% power uprate. No physical change to the facility is necessary; therefore, no equipment reviews are required.

NRC REQUEST

6. Provide details about the grid stability analysis, including assumptions, results, and conclusions for the proposed power uprate condition.

NMC RESPONSE

The purpose of the grid stability analysis is to document the Palisades Nuclear Plant licensing basis concerning plant stability and the reliability of offsite power. The analysis reflects the near term system conditions including scheduled system additions following completion of several major new power plants connected to the Michigan Electric Transmission Company (METC) system. New generation includes the Covert Generating Station, approximately one mile east of the Palisades Nuclear Plant, which is connected to the Palisades Nuclear Plant Substation. The study also includes the Zeeland Power Plant (connected to the 345kV transmission line between the Palisades and Tallmadge stations), the Jackson Power Plant, and the Renaissance Power Plant.

The analysis was performed using a power flow computer simulation of the Consumers Energy operating system including interconnections to other utilities. The computer simulation contains detailed models representing the Consumers Energy 46kV and higher voltage systems, the International Transmission Company (ITC), Detroit Edison (DECO) high voltage transmission system, and other East Central Area Reliability (ECAR) Council member full transmission representations or

equivalents. The study was based on both peak load and 80% peak load cases. The analysis covered the range of expected power imports into the METC from 4000 to 6000 MW.

Two specific offsite power supply criteria analyzed in the study to which Palisades was originally licensed are:

A. The sudden loss of the Palisades Nuclear Plant electrical output will not result in instability of the offsite power system.

B. A sudden 1000 MW drop of system load will not adversely affect the Palisades Nuclear Plant or the connected electric system.

The stability of the Palisades offsite power system was evaluated for the following situations:

- METC's Planning Criteria Disturbances (Includes various phase-to-ground faults in the switchyard)
- Sudden Loss of 1000 MW of Load
- Sudden Loss of the Palisades Generating Unit

The analysis resulted in the following conclusions:

- The Palisades Nuclear Plant and the offsite power system connected to Palisades Substation are stable for:
    - A three phase-to-ground fault, anywhere in the system, which will be cleared by primary relays and all transmission in-service before the disturbance.
    - A three phase-to-ground fault, anywhere in the system, which will be cleared by primary relays with the most critical element out of service before the disturbance.
    - A two phase-to-ground fault with subsequent breaker failure, anywhere in the system, with all transmission in service before the fault.
    - Inadvertent tripping of three Ludington units in the pumping mode, representing a 1020 MW of sudden load drop, or for sudden loss of 1000 MW of area load.
- The offsite power system connected to Palisades Substation is stable for inadvertent tripping of the Palisades or Covert Plant units.

The Covert Generating Station is rated at 1185 MWe and is connected to the Palisades Substation. Since the Covert Generating Station's output exceeds Palisades output, the transient resulting from the Covert Station tripping offline bounds the transient that would result from Palisades tripping even for Palisades power levels above the proposed power uprate.

NRC REQUEST

7. Provide, in detail, the effect of the proposed power uprate on the station blackout coping capability.

NMC RESPONSE

The evaluation of a station blackout event for the Palisades Nuclear Plant was performed in accordance with the requirements of Regulatory Guide 1.155, "Station Blackout." This evaluation determined an acceptable station blackout duration for Palisades of 4 hours. This 4-hour coping duration was based on the reliability and configuration of the off-site power system and the reliability of the diesel generators. To provide assurance that the plant could cope with a station blackout of 4 hours duration, several factors were considered. These areas included the following:

- Condensate Inventory
- Class 1E Battery Capacity
- Compressed Air
- Effects of Loss of Ventilation
- Containment Isolation
- Reactor Vessel Inventory

NMC has determined that the only factor potentially affected by the proposed power uprate is the condensate inventory required to provide decay heat removal for the 4-hour duration.

The station blackout analysis was approved in a letter from B. Holian (NRC) to G.B. Slade (CPCo), "Palisades Plant Station Blackout Analysis; Safety Evaluation (TAC No. 68578)," dated May 20, 1991. In that safety evaluation, the NRC calculated the minimum condensate inventory based on a power level of 102% of 2530 MWt (2580.6 MWt). This minimum inventory was determined to be 57,100 gallons. Palisades TS require maintaining an inventory of 100,000 gallons. Therefore, the proposed power uprate has no effect on the station blackout coping capability.

NRC REQUEST

8. *Provide, in detail, the existing ratings and the effect of the proposed power uprate on the following equipment:*

- *main generator*
- *isophase bus*
- *main power transformer*
- *start-up transformer*
- *station power transformer*

NMC RESPONSE

The table below provides the requested information. Note that the proposed power uprate has minimal impact on the electrical equipment at the plant. Following the 1.4% proposed power uprate, the plant output will remain well below the design rating of the main generator. The major effect will be a slight reduction in the capability to provide volt-amps reactive (VARs). The proposed power uprate has virtually no impact on the isophase bus, main transformer and startup/station power transformers.

Electrical Equipment Information

Equipment[1]	Design Rating	Current Value	Anticipated Value (1.4% Uprate)
Main Generator	955 MVA	823 MWe[2]	834.5 MWe[2]
	22 kV	22 kV	22 kV
	0.85 power factor (PF)	0.86 PF	0.87 PF
Isophase Bus	26,400 amp	25,062[3]	25,062[3]
Main Transformer	975 MVA	955 MVA[3]	955 MVA[3]
Station Power[4] Transformer 1-1	12.6 MVA	11.6 MVA	11.6 MVA
	12.6 MVA	11.7 MVA	11.7 MVA
Station Power Transformer 1-2	8.96 MVA	8.4 MVA	8.4 MVA
Station Power[4] Transformer 1-3	12.6 MVA	10.0 MVA	10.0 MVA
	12.6 MVA	10.0 MVA	10.0 MVA
Startup Transformer 1-1	12.6 MVA	12.2 MVA	12.2 MVA
	12.6 MVA	10.0 MVA	10.0 MVA

Equipment[1]	Design Rating	Current Value	Anticipated Value (1.4% Uprate)
Startup Transformer[4] 1-2	10.6 MVA	6.9 MVA	6.9 MVA
Startup Transformer[4] 1-3	12.6 MVA	11.9 MVA	11.9 MVA
	12.6 MVA	10.0 MVA	10.0 MVA
Safeguards Transformer	10.5 MVA	9.0 MVA	9.0 MVA

Notes: 1. Equipment ratings based on 65°C temperature rise.
2. MWe output based on the yearly average East Central Area Reliability (ECAR) Council rating and includes 38 MWe house loads.
3. The maximum rating of the isophase bus and main transformer exceed the design output rating of the main generator.
4. These transformers have dual secondary outputs.

NRC REQUEST

9. *Upon reviewing large-break loss-of-coolant accident [LOCA] models for power uprates, the Nuclear Regulatory Commission (NRC) recently found plants that require changes to their operating procedures because of inadequate hot leg switch-over times and boron precipitation modeling. Discuss how NMC's analyses account for boric acid buildup during long-term core cooling and discuss how your predicted time to initiate hot leg injection corresponds to the times in Palisades' operating procedures.*

NMC RESPONSE

The Palisades long-term cooling (LTC) analysis (hot leg switch-over times and boron precipitation modeling) was performed by Combustion Engineering using the NRC approved methods described in CENPD-254-P-A, "Post-LOCA Long Term Cooling Evaluation Model." Palisades plant specific analysis (P-CE-5627 dated May 8, 1981) was sent to Dennis Crutchfield, NRC, on October 9, 1981. Conservative plant operating parameters that increased core boron concentration and a core power level of 102% of 2530 MWt were used in the analysis.

In evaluating the LTC performance for the large break LOCA, the limiting break with respect to long-term boric acid accumulation in the reactor vessel is the double-ended break in the reactor coolant pump discharge leg. This break is most limiting because it has the smallest margin between the calculated maximum boric acid concentration and the associated precipitation limit of 32 wt% (solubility at 228 °F which is the saturation temperature at 20 psia). Core flushing flow provided by the

simultaneous hot side and cold side injection from a high pressure safety injection pump reduces the boric acid accumulation. The analysis maximizes the core boric acid concentration by assuming that only steam leaves the core. Sensible heat removal due to liquid flush when it occurs is always neglected. Charging pump flow from the boric acid storage tank (BAST) is deposited in the vessel before any consideration is given to other sources of boric acid. Also, the initial boric acid concentration in the vessel for large breaks is conservatively assumed to be equal to the safety injection tanks (SIT) or safety injection and refueling water (SIRW) tank concentration, whichever is higher.

The current administrative limit for the concentrated boric acid storage tanks is 8 wt% (13,987 ppm), which is less than the 12 wt% (20980 ppm) assumed in the LTC analysis. This higher value for boron injection into the vessel offsets the current higher TS limits for boron concentrations in the SIRW tank and the SIT tanks of 2500 ppm. The value used in the LTC analysis for SIRW and SIT tanks was 1.13% (1975 ppm). Since core boil-off is first replaced by charging pump flow from the BAST and then from the safety injection flow from the SIRW tank, the LTC results bound current Plant operation.

The results from the analysis concluded that there should be approximately 50/50 split between the hot leg and the cold leg injection paths and that the switch to long term cooling should occur between 5.5 and 6.5 hours. The initiation of hot and cold side injection between 5.5 and 6.5 hours post-LOCA is after any potential for hot leg entrainment has been terminated and more than 22 hours prior to the time which boric acid precipitation is predicted to occur if no core flushing flow is provided. The flow split is verified by a plant surveillance procedure. The LTC start time is controlled by plant Emergency Operating Procedures (EOPs).

The plant operating parameters used in the LTC analysis are equivalent with the expected Plant operating parameters following the proposed MUR power uprate. The analysis methodology maximizes the boric acid concentration in the core for the limiting cold leg break. The plant surveillance procedures and the EOPs are consistent with the LTC analysis. Therefore, the current LTC analysis remains valid for the proposed MUR power uprate.

NRC REQUEST

10. In the June 3, 2003, application, NMC indicates that all the accident and transient analyses of record remain bounding for the proposed power level. However, the NRC staff notes that when calculating departure from nucleate boiling (DNB), licensees typically use nominal power levels. These power levels typically do not bound the MUR uprated power levels. Provide the core power levels and the power uncertainties used in NMC's DNB analyses and explain why these input values bound the proposed power uprate.

NMC RESPONSE

Statistical minimum departure from nucleate boiling ratio analyses were performed for the current operating cycle (cycle 17) transient analyses at a nominal power level of 2565.4 MWt with a power uncertainty of 2580.6 MWt – 2565.4 MWt = 15.2 MWt, which is 0.6% of 2530 MWt, in accordance with the currently approved methodology.

NRC REQUEST

11. As stated on page 15 of Enclosure 4, axial and circumferential outside diameter stress-corrosion cracking (ODSCC) at the hot leg top of tubesheet are two of the six active damage mechanisms that have been identified in the steam generator tubing at Palisades.

On page 16 of Enclosure 4, NMC indicates that ODSCC at the top of the tubesheet has the greatest potential to be affected by the slight increase in T_{hot} (which will occur due to the power uprate). However, the NMC concludes that the onset of this damage mechanism will not occur until after the end of the license.

The information on these two pages conflicts. Please discuss the discrepancy and clarify whether ODSCC at the top of the tubesheet has been identified in the Palisades steam generator tubing, and what the impact of the proposed power uprate will have on this damage mechanism.

NMC RESPONSE

NMC acknowledges the discrepancy, which was not identified during the submittal review and approval process. This condition has been entered into the site corrective action process.

The following statements on page 16 of Enclosure 4 of the June 3, 2003, application no longer apply:

"A curve developed by the Electric Power Research Institute (EPRI), in conjunction with the 1999 refueling outage, predicts that the onset of this damage mechanism will not occur until after the end of the license. Since the T_{hot} value used in constructing the curve is the same T_{hot} value expected at proposed uprated conditions, the proposed uprate would not change this conclusion."

The following discussion replaces the statements above:

During the 2003 refueling outage, circumferential ODSCC at the hot leg top of the tubesheet and axial primary water stress corrosion cracking (PWSCC) within the expanded tubesheet region were identified as new active damage mechanisms. These new active damage mechanisms, as well as axial ODSCC at the hot leg top of the tubesheet, are affected by time and temperature, but not by an increase in secondary side steam flow. T_{hot} at Palisades of 582.7°F is low for Alloy 600 tubing per existing industry experience, and a 0.3°F increase is expected to have a negligible effect on these new active damage mechanisms. The greatest effect will be seen on mechanical tube wear.

ATTACHMENT 2

NUCLEAR MANAGEMENT COMPANY
PALISADES NUCLEAR PLANT
DOCKET 50-255

October 6, 2003

LICENSE AMENDMENT REQUEST: INCREASE RATED THERMAL POWER – REFERENCE 9.5: EA-AFZ-96-01, "Analysis of Various Heat Balance Input Inaccuracies," Revision 2

13 Pages Follow

Consumers Power
POWERING MICHIGAN'S PROGRESS

EA - AFZ- 96 - 01

Palisades Nuclear Plant
ENGINEERING ANALYSIS COVER SHEET

Total Number of Sheets 12

Title Analysis of Various Heat-Balance Input Inaccuracies

INITIATION AND REVIEW

Calculation Status	Preliminary	Pending	Final	Superseded
	☐	☐	☒	☐

Rev #	Description	Initiated By	Initiated Date	Init Appd By	Review method Alt Calc	Review method Detail Review	Review method Qual Test	Technically Reviewed By	Technically Reviewed Date	Revr Apprd By	CPCO Appd
0	Original Issue	AFZillins	4-18-96	BVV		X		DM Kennedy	4/29/96	DDC	
1	Skip the Rev # due to possible typo confusion on Rev 0										
2	Resolve initial S&L comments	AFZillins afZ	5-16-96	[illegible]		✓		[illegible]	[illegible]	DDC	

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Reference, Comments

1.0 OBJECTIVE

The purpose of this EA is to analyze and document various Heat-Balance input and calculation uncertainties that are necessary for an overall Heat-Balance uncertainty calculation. The scope of this EA includes the following only:

PPC contribution to Feedwater Flow and Temperature instrument uncertainties
Primary Coolant pump instrument uncertainties relative to Heat Balance
PPC Computational Accuracy as it relates to Heat-Balance
Steam Gen Pressure as it relates to the Heat-Balance.
Steam Generator Bottom Blowdown Flow instrument uncertainties as a function of Heat-Balance
Letdown and Charging Flow instrument uncertainties as it relates to the Heat-Balance
Letdown temperature instrument uncertainty relative to the Heat-Balance
Pressurizer Heater instrument uncertainties relative to PPC input and Heat Balance
Charging line temperature instrument uncertainty relative to the Heat-Balance

The inaccuracies analyzed are relative to performing a Heat-balance via Palisades Plant Computer (PPC) system inputs or by manually reading instrument indicator. The overall Heat-Balance uncertainty Calculation is not within the scope of this EA.

The major contribution to the Heat balance is from Feedwater flow which is analyzed in the TSSP Basis document RI-24 and is not within the scope of the EA.

2.0 REFERENCES

1 Ven. Man., M1-PA sh 1558, DALCAL tech. Manual
2 Ven. Man., M1-PA sh 1557, Universal Analog Input card set Tech. Manual.
3 Ven. Man., M1-PA sh 1553, G2™ Controller User Manual
5 E-2 sh 3, Generator and 4160 volt system
6 AE Buyers Guide, Instrument Transformers
7 NUREG/CR-3659, ...Model for assessing the uncertainties of Instrumentation .. For Power...
8 Tech. Spec. Surv. Proc. RI-5, Steam Gen. Pressure Channel Calibrations
9 Tech. Spec. Surv. Proc. RI-2, Primary System Temperature Calibrations
10 Ven. Man., M-1HK-2, Instruction Manual for Rosemount 1151 transmitter
11 Ven. Man., M-206-205, Instruction Manual for Rosemount 3051 transmitter
12 Calsheet Database for Installed Plant Equipment (IPI)
13 DEC Fortran User Manual, P/N AA-PUYPA-TE
14 Directrol Multiplexor, Tech. Info. Publication, Analog Input Module
15 M1-W sh 3-6, CFM Electrical Bill of Material
16 E-3 sh 1, 2400 volt system
17 ISA-RP67.04-Part II -1994, Methodology for the Determination of Setpoints ...Instrumentation
18 Square D catalog, CLE-20000 series transducers
19 ASME report, Fluid Meters, Their Theory and Application, sixth edition, 1971.
20 Burns Engineering Inc., Resistance Thermometers for all Environments
21 WO24416159 calibration sheets associated with PPAC PCS011

3.0 ATTACHMENTS

None

4.0 ANALYSIS INPUT

All References and Attachments provide analysis input into this Engineering Analysis.

	Reference, Comments
5.0 ASSUMPTIONS	
Vendor instrument Specifications are two sigma values.	Ref 7
6.0 ANALYSIS	
6.1 <u>Instrument Uncertainty and Calibration Methodology</u>	
Palisades typically performs loop calibrations and does not calibrate each loop component individually. Limits are established for As-Founds as part of this calibration program. These As-found limits are conservatively set in relation to the as-left calibration tolerance to account for instrument drift and reference accuracy. The As-founds historically have been shown to bound the drift and other related inaccuracies associated with instrument loop calibrations. Therefore, As-found limits have been shown to conservatively bound the overall accuracy of a loop with the exception of temperature and pressure related factors. For instrument loops having As-found calibration data, the limits of the As-found's is used as the loop inaccuracy. Other uncertainties due to environmental or other effects are added to the As-found inaccuracy where required.	
This EA may need to be re-evaluated or revised if configuration of analyzed instruments/loops is modified.	
Other errors considered in addition to As-found limits are sensor accuracy (e.g. RTDs and flow elements). and M&TE accuracies.	
Uncertainty calculations will be performed following methods of ISA standard RP67-04 and NUREG/CR-3659. The most applicable aspect of these standards is the use of the Square Root Sum of the Squares (SRSS) method of determining the total uncertainty of independent random uncertainties. Another is the method for determining the error associated with a flow related transfer function.	ref 7,17
Where applicable, analog meters are assumed to be readable to ½ of the smallest division. This is a general convention at Palisades.	
Where calibration or Vendor documentation is unavailable, typical error values will be used. These typical errors will be multiplied by at least a factor of 2. This should be conservative enough to cover unknown factors or less than perfect configurations. As there is a relatively small number of unknown instrument errors and these instrument make a relatively small contribution to the heat-balance, these estimations cannot have any significant impact on the total heat-balance uncertainty.	
Per ISA-RP67.04, independent instrument uncertainties which are less than 1/5 of the largest error are insignificant and therefore do not need to be accounted for in SRSS error calculations.	ref 7
Power supply voltage effects are typically very small (on order of 0.002% of span per volt deviation). This almost always works out to less than 1/5 of the largest error and therefore does not need to be accounted for in SRSS error calculations	ref 7
Plant computer A/D Temperature effects are negligible and will not be addressed in individual instrument uncertainties. 3 of the 4 PPC multiplexors are located in the control room which maintains a near constant temperature. Three of four multiplexors including the one multiplexor outside the control room are temperature effect limited by their DALCAL reference card which has a maximum temperature coefficient of ±10ppm/°C or .001%$_{span}$/°C. This effect is too small to be significant for any instrument uncertainty calculation.	see 6.2

Reference, Comments

Plant computer Dead-band effects are negligible and will not be addressed in individual instrument uncertainties. Only the G2vx based multiplexors uses an input dead-band to limit data traffic. This dead-band is set to one bit for all points. One bit in 2^{14} is equal to 0.006%. This value is too small to be of any significance.

6.2 PPC contribution to Feedwater Flow and Temperature instrument uncertainties

Note: This calculation is for input to Basis document RI-24 instrument uncertainty calculations. This should not be considered a completed calculation of instrument uncertainty.

Flow transmitter inputs:
The Transmitters are FT-0701 and FT-0703. The corresponding PPC inputs are FT_0701_D_AVG and FT_0703_D_AVG respectively. The engineering range for these inputs is 0 to 213.9 and 0 to 219.5 inches respectively. These are input to a Computer Products Based data acquisition system. The Analog to Digital converter along with a online calibration loop-back feature (DALCAL) provides an accuracy of 0.01% of the input card full scale range. Temperature effect is insignificant per section 6.1. Drift is less than 0.01% of full scale per year. Adjusting this accuracy to account for the portion of the analog card's full scale range occupied by the Flow transmitter's range, gives 0.025% for accuracy and 0.025% per year for drift limit. Adjusting the drift for a 18 month calibration cycle gives 0.038%. The sense resistor utilized by the PPC for these instruments has an accuracy of 0.25% or better. ref 1,2,3; ref 15

$$PPC_{accuracy\ fdwtr\ flow} = \sqrt{A/D_{acc}^2 + A/D_{drift}^2 + Sense\ Resistor_{acc}^2}$$
$$= \sqrt{.025^2 + .038^2 + .25^2}$$
$$= .25\%$$
$$= \pm\ .55\ inches$$
$$= \pm\ .3x10^6\ PPH\ @\ 430°F$$

Note: Uncertainty error associated with the Square Root transfer function and flow element are addressed in the Flow error analysis of Basis document RI-24

Temperature Transmitters inputs:

The transmitters are TT-0706A and TT-0708A. The calibrated range is 0 to 500 °F. The corresponding PPC inputs are TT_0706A_AVG and TT_0708A_AVG respectively. These are input to a Computer Products Based data acquisition system. The Analog to Digital converter along with a online calibration loop-back feature (DALCAL) provides an accuracy of 0.01% of the input card full scale range. Temperature effect is insignificant per section 6.1. Drift is less than 0.01% of full scale per year. Adjusting this accuracy to account for the portion of the analog's card full scale range occupied by the Temperature transmitter's range, gives 0.02% for accuracy and 0.02% for drift limit. Adjusting the drift for a 18 month calibration cycle gives 0.03%. The sense resistor utilized by the PPC for these instruments has an accuracy of 0.25% or better. ref 1,2,3

	Reference, Comments

$$PPC_{accuracy\ fdwtr\ temp} = \sqrt{A/D_{acc}^2 + A/D_{drift}^2 + Sense\ \ Resistor_{ac}^2}$$
$$= \sqrt{.02^2 + .03^2 + .25^2}$$
$$= .25\%$$
$$= \pm\ 1.3\ ^\circ F$$

6.3 Primary Coolant pump instrument uncertainties relative to Heat Balance

The PPC points are CURCP1A, CURCP1B, CURCP2A, and CURCP2B. These associated ammeters are EAI-2103, EAI-2203, EAI-2104, and EAI-2204 respectively.

Circuit Description: A Current Transformer (CT) on one phase of each PCP feeds a Ammeter and an I/I converter in the control room. The I/I converter in turn is run through a resistor to create a voltage which is input to one of the PPC Multiplexor Nodes. The calibrated span is 0 to 800 amps. — ref 5

Instrument Errors:

Current Transformer: No vendor or accuracy data could be found on this particular CT. However, per the Electrical System Engineer, this a fairly typical type of CT device. Other CTs with the same ratio of 800/5 have a worst case accuracy on the order of 0.6%. There is no calibration associated with this device. As this is a passive device, no drift should be expected. To be conservative, this error will be doubled. This works out to 1.2% uncertainty. — ref 5, ref 6

Current to Current Convertor: This is a Square-D, cat. No CLE-202001, converter. The catalog stated accuracy is 0.25%. This device is not calibrated. The four converters were calibrated in 1995 under a WO request. To account for the lack of calibration, the catalog stated error will be tripled. This works out to 0.75% uncertainty. Discrepancies between channels or between the PPC and meters beyond this should be noticeable by the operators. — ref 15, ref 18

PPC Accuracy: The only significant factor for this PPC input accuracy is the sense resistor. Those bought for the CFMS modification were typically 0.025%. The Cutler-Hammer multiplexor is accurate to 0.04% from 20 to 30 °C. As these error are significantly less than 1/5 of the largest error, they are insignificant for this instrument uncertainty. — Ref 15, ref 7

	Reference, Comments
Meter: This meter is calibrated per PPAC PCS011 every two years or Refout. Tolerance is ±3% full scale. This meter face is graduated in 20 amp increments. There is a large distance between increments such that the meter can be easily resolved to ± 5 amps or ±.625%	ref 21 observed

Total Error relative to PPC:

$$=\sqrt{I/I_{acc}^2+CT_{acc}^2}$$
$$=\sqrt{1.2^2+.75^2}$$
$$=1.42\%$$
$$=\pm\ 11\ amps$$

Total error relative to manual reading:

$$=\sqrt{CT_{acc}^2+Meter_{acc}^2+Meter_{readability}^2}$$
$$=\sqrt{1.2^2+3^2+.625^2}$$
$$=3.29\%$$
$$=\pm\ 26\ amps$$

6.4 PPC Computational Accuracy as it relates to Heat-Balance

The PPC has two computers which play a part in handling inputs and performing calculations related to the Heat-Balance. These are the G2™ input nodes and the Host computer system. The input nodes convert the analog to digital converter's 14 bit numerical value to a usable engineering unit value which is then sent up to the host for alarm processing, storage, and distribution. 14 bits is equivalent to approximately 5 digits of precision. Several points come in through the 12 bit Cutler-Hammer multiplexor and are converted to engineering units by the Host directly. Several calculated points are derived from the G2™ data such as Feedwater density and density compensated flow. (Ref 2; ref 14)

Both the G2™ and the Host computer handle math the same way and are subject to the same computational errors. The G2™ and the Host are based on the Digital Equipment Co. VAX architecture. All conversion and computations are performed using Floating point math. The minimum floating point storage size is 4 bytes or commonly referred to as REAL*4. Per the VAX FORTRAN manual, REAL*4 number have approximately 7 digits of precision. Floating-point math is carried out to a precision greater than the operands and thereby adds no significant round off error. (ref 13)

The accuracy of the Plant computer is several orders of magnitude greater than the resolution of any input or displayed output. Therefore, PPC conversions, math, and numerical precision add no significant error to the heat-balance or its inputs. A/D error is accounted for in each instruments uncertainty calculation. A/D temperature effects are addressed in section 6.1.

6.5 PT-0751B (PT-0752B) Steam Gen Pressure as it relates to the Heat-Balance

These transmitters are calibrated in TSSP RI-05. Control Room meters PIC-0751B, PIC-0752B and PPC points PT0751B, PT0752B are also checked in this procedure. This is a loop end to end test. The range of these transmitters and inputs is 0 to 1200 PSIA. The meters have an as-found tolerance of ±20 PSIA (1.7%). The PPC points have an as-found tolerance of ±20 PSIA (1.7%). However, it is points PT_07051B and PT_07052B which are used in the Heat-Balance. These are input through separate sense resistors and multiplexors. Both sets of inputs use the same conversion constants. A comparison of inputs shows that the Heat-Balance points are reading 6 PSI (.5%) less than the points checked in RI-5 at 99.6% power. (Ref 8)

Reference, Comments

The difference between the two sets of PPC inputs is mostly a function of different input module impedance. The isolation resistors in conjunction with the impedance of the PPC's input module form a voltage divider network which drops enough signal voltage to see a ½ percent lower value on the PPC. Adding .5% to the As-found tolerance in RI-5 gives a conservative error value for the steam gen. inputs used by the Heat-Balance calculation.

During a manual calculation or if these points are unavailable on the PPC, the four steam generator pressure channels for each steam generator are averaged together. These averaged values should be more accurate than the individual channels used by the PPC. As such, the error associated with one channel will bound the averaged error and will be used for this error calculation.

M&TE Error:	As this is loop end to end test, only M&TE error should normally be added to the total error. A DMM and pressure gage are used in the Loop end to end calibration. Both have an inaccuracy less than ±2 psi. Since these M&TE errors are less than 1/5 of the largest error (Temperature effect is ±28 psi), they are not significant.	ref 8
Transmitter drift Error	Drift error is ±3.6 psi over 30 months. Since this error is less than 1/5 of the largest error (Temperature effect is ±28 psi), it is insignificant.	Ref 8
Transmitter Temp. Effect:	Per RI-5 basis, Temperature effect error is ±(.75% URL + .5%span)/100°F. URL is 3000 psi and Span is 1200 psi. This works out to ±28.5 psi or 2.4% of the span range.	Ref 8
Head Pressure Effects:	Head pressure has been accounted for in the calibration procedure.	Ref 8
Meter Readability:	These meters are graduated in 20 PISA increments. These meters are little high on the panel and have a curved surface. We will assume that they can be read to ± 20 PSIA.	observed meter

PT-0751B/PT-0752B total accuracy:

(relative to PPC heat balance)

$$= \pm\sqrt{As\ Found_{PPC\ tol} + Temp\ Effect_{err}} - PPC_{bias}$$
$$= \pm\sqrt{20^2 + 28.5^2} - 6$$
$$= \pm 35\ -6\ PSI$$

PT-0751B/PT-0752B total accuracy:

(relative to meter and manual heat balance)

$$\pm\sqrt{As\ Found^2_{meter\ tol} + Temp\ Effect^2_{err} + Meter^2_{readab..}}$$
$$= \pm\sqrt{20^2 + 28.5^2 + 20^2}$$
$$= \pm\ 40\ PSI$$

6.6 <u>Steam Generator Bottom Blowdown Flow as a function of Heat-Balance</u>

Equipment ID: FI-6001A/FI-6001B

These inputs are read locally and then manually entered into the Heat-Balance calculation. This is a local rotometer type flow indicating device. Range is 0 to 60 KPPH. The Flow indicator is calibrated per IPI FI-6001A on a two year cycle as scheduled by PPAC MSS008.

	Reference, Comments
The indicator for these devices have different resolutions depending on the flow range. Graduation increments decrease in value as flow increases. Typical readings are in the medium and high range. The medium range's resolution and accuracy bound the higher range. It's tolerance will be used for this error calculation. Resolution or readability is assumed to be ½ of the medium range graduation or 0.833% of span.	Ref 12
FE-6001A/B: Orifice type. No calibration data or accuracy specification could be found for this flow element. To be conservative, we will assume a calibration span error value equivalent to three time the readability of the meter in the medium range. This works out to 3/2 of one division or 2.5%.	
FI-6001A/B: tolerance: As-Found $_{med\ rng}$ = ± 2 divisions = ± 2 KPPH = ± 3.3 %	ref 12
M&TE In: 0 - 1000 " H_2O gauge ± .1% or 1" H_2O Error: 500 " = 100% of range. Error = .1% * 1000/500 = .2%	per M&TE cal. tag

TOTAL ERROR =

$$=\sqrt{M\&TE_{err}^2+FI_{err}^2+FE_{err}^2+Meter_{readability}^2}$$

$$=\sqrt{.2^2+3.3^2+2.5^2+0.833^2}$$

$$=\pm\ 4.23\%\quad(\pm\ 2.5\ KPPH)$$

6.7 Letdown and Charging Flow as it relates to the Heat-Balance

These transmitters are calibrated in PPAC CVC035. Letdown Flow is FT-0202. Charging Flow is FT-0212. PPC input point FT0202 has a range of 0 to 160 GPM for a 4 to 20 ma signal input. PPC point FT0212 has a range of 0 to 140 GPM for a 10 to 50 ma signal input.	ref 12
Circuit Description: FT0202 feeds a signal to FIC-0202 and to the PPC multiplexor through a precision 250 ohm 0.025% resistor. FT0212 feeds a square root device which in turn feeds FIA-0212 and the PPC through a 100 ohm 0.025% resistor.	Ref 15
M&TE error: DMM and pressure source are accurate to better than .1% which is less that 1/5 of largest error and are therefore insignificant.	typical of tolerances
Transmitter: Both transmitters have as-found tolerance of ±0.32 ma. This works out to ± 2.0% error.	ref 12
Temp. Effect: FT0212: The ambient temperature effect is ±1.0% span per 100 °F. Ambient temperature is approximately 80°F. Will assume a 30°F delta from calibration temperature. Temp. effect works out to 30/100 * 1.0% = 0.3% span. As this is less than 1/5 of the largest error it is insignficant.	ref 10
FT0202: The ambient temperature effect is ±(0.025% URL +0.125% span) per 50°F. Ambient temperature is approximately 80°F. Will assume a 30°F delta from calibration temperature. Temp. effect works out to 30/50 *(0.00025*250" + .00125*100") = 0.188" H_2O or 0.188% of span. As this is less than 1/5 of the largest error it is insignficant.	ref 11

		Reference, Comments
Static Press Effects:	FT0212: The zero error is ± 2% of URL for 4500 PSI. This works out to 2% of span (.02 * 750"/400" * 2500/4500). Span error is ±.25% of reading per 1000 PSI. Error at typical reading of 9% of Dp span is 0.06% (.25 * 2500/1000 * 9/100). Span error is less than 1/5 of the largest error and is therefore insignificant.	ref 10 ref 7
	FT0202: The zero error is ± .1% of URL /1000 PSI. Zero error is less than 1/5 of the largest error and is insignificant compared to other errors Span error is ±.2% of URL per 1000 PSI. Span error is insignificant compared to other errors.	ref 11 ref 7.
Flow Element Error:	There was no data found to support the accuracy of these flow elements. They are both Orifice type elements, manufactured by Foxboro, and supplied by CE. Per ASME report, the discharge coefficient tolerance for an orifice will not exceed ±1.0% with an appropriately designed and installed configuration. To be conservative, we will assume ±2.0% for the FE error.	ref 19
Sqrt Transfer function	Charging flow was found to be 41 GPM on several different occasions while running at full power. This works out to ~30% of flow span. Letdown flow was found to be 38 GPM on several different occasions while running at full power. This works out to ~25% of flow span. We will assume that these are typical values and calculate the loop uncertainty at these points.	ref 17.
PPC error	Per schematic diagrams, the sense resistors are precision 0.1%. These signals are input through the Cutler-Hammer multiplexor which has an accuracy of 0.04%. As these inaccuracies are less than 1/5 of the largest error, they are insignificant.	
Sqrt Root Extr:	As - found tolerance of FY-0212 is ±0.8ma over a range of 10 to 50 ma. This works out to ± 2.0%. Sqrt extraction is performed internally to FT-0202.	ref 12
FIC-0202 error:	As-Found tolerance of ± 2 GPM. This works out to ± 1.3%	ref 12
FIA-0212 error:	As-Found tolerance of ± 2.8 GPM. This works out to ± 2%	ref 12

	Reference, Comments
Loop Uncertainty for FT0212 @ ~ 41 GPM	

$$Dp_{span} = (Flow_{span}/10)^2$$
$$=(30/10)^2 = 9_{\%DP\ ouput\ span}$$

ref 17

Flow Uncertainty

$$=\pm 10 * \sqrt{Dp} - 10 * \sqrt{Dp \pm \sqrt{FT_{AsF} \pm FT_{StPr} \pm FE_{err}}}$$
$$=\pm 10 * \sqrt{9} - 10 * \sqrt{9 - \sqrt{2^2 + 2^2 + 2^2}} \quad (worst\ case)$$
$$=\pm 6.47\%_{flowSpan}$$

ref 17

Total Loop Flow Uncertainty via PPC

$$PPC_{LoopError} = \pm\sqrt{FU^2 + FY_{AsF}^2}$$
$$=\pm\sqrt{6.47^2 + 2^2} = 6.77\% = \pm 9.5\ GPM_{at\ 41\ GPM\ actual\ Flow}$$

Total Loop Flow Uncertainty via FIA

$$FIA_{LoopError} = \sqrt{FU^2 + FY_{AsF}^2 + FIA_{AsF}^2}$$
$$=\sqrt{6.47^2 + 2^2 + 2^2} = \pm 7.06\% = \pm 9.9\ GPM_{at\ 41\ GPM\ actual\ Flow}$$

Loop Uncertainty for
FT0202 @ ~ 38 GPM

$$Dp_{span} = (Flow_{span}/10)^2$$
$$=(25/10)^2 = 6.25_{\%DP\ ouput\ span}$$

ref 17

Flow Uncertainty

$$=\pm 10 * \sqrt{Dp} - 10 * \sqrt{Dp \pm \sqrt{FT_{AsF} \pm FE_{err}}}$$
$$=10 * \sqrt{6.25} - 10 * \sqrt{6.25 - \sqrt{2^2 + 2^2}}$$
$$=6.50\%_{flowSpan}$$

ref 17

Total Loop Flow Uncertainty via PPC

$$PPC_{LoopError} = Flow\ Uuncertainty = 6.50\% = \pm 10\ GPM_{at\ 38\ GPM\ actual\ Flow}$$

Total Loop Flow Uncertainty via FIC

$$FIC_{LoopError} = \sqrt{FU^2 + FIC_{AsF}^2}$$
$$=\sqrt{6.50^2 + 1.3^2} = \pm 6.63\% = \pm 11\ GPM_{at\ 38\ GPM\ actual\ Flow}$$

Reference, Comments

6.8 Letdown Temperature Instrument Uncertainties relative to Heat Balance

This is equipment ID TT-0122CD. The range is 515 to 615 °F. Per RI-2 basis, the loop end-to-end calibration as-found is ± 1% (± 1 °F). This temperature is a manual input to the PPC heat balance calculation. TSSP RI-2 performs a loop end-to-end calibration of this transmitter. ref 9

Meter readability: This meter has 2°F increments. Will assume that the meter is readable to ½ of this or ± 1°F.

RTD: RI-2 uses the specific calibration curve for each individual RTD to check its accuracy. This eliminates any significant RTD error.

Temp. & P/S effects: Per RI-2, supply voltage effect is ±0.15°F. Per RI-2, Ambient temp. effect is ±0.00362°F. Both of these effects are less than 1/5 of the largest error and are therefore insignificant.

Total Error:

$$= \pm\sqrt{Temp.\ Loop^2_{As\text{-}F\ tol} + Meter^2_{readability}}$$
$$= \pm\sqrt{1^2+1^2}$$
$$= \pm\ 1.4\ ^\circ F$$

6.9 Pressurizer Heater instrument uncertainties relat:ve to Heat Balance

The PPC points are AI0103 and AI0104. These are in the same circuit as ammeters EAI-1305 and EAI-1211 respectively.

Circuit Description: A Current Transformer (CT) off of the heater breaker feeds a Ammeter and an I/I converter in the control room. The I/I converter in turn is run through a resistor to create a voltage which is input to one of the PPC Multiplexor Nodes. The range of the ammeter, I/I, and the PPC input as a function of engineering units is 0 to 200 amps. ref 5

	Reference, Comments
Instrument Errors:	
Current Transformer: No vendor or accuracy data could be found on this particular CT. However, this a fairly typical type of CT device. Other CTs with the same ratio of 200/5 have an accuracy on the order of 4.8%. There is no calibration associated with this device. As this is a passive device, no drift should be expected. To be conservative, this error will be doubled. This works out to 9.6% uncertainty.	ref 5 ref 6
Current to Current Convertor: This is a Square-D, cat. No CLE-202001, converter. The catalog stated accuracy is 0.25%. This device is not calibrated. The four converters were calibrated in 1995 under a WO request. To account for the lack of calibration, the catalog stated error will be tripled. This works out to 0.75% uncertainty. Discrepancies between the channels or between the PPC and meters beyond this should be noticeable by the operators.	ref 18
Meter: This meter is calibrated per PPAC PCS011 every two years or Refout. Tolerance is ±3% full scale. This meter face is graduated in 20 amp increments. There is a large distance between increments such that the meter can be easily resolved to ± 5 amps or ±2.5%	ref 21
PPC Accuracy: The only significant factor for this PPC input accuracy is the sense resistor. Those bought for the CFMS modification were typically 0.025%. The Cutler-Hammer multiplexor is accurate to 0.04% from 20 to 30 °C. As these errors are significantly less than 1/5 of the largest error, they are insignificant with respect to this instrument uncertainty.	ref 14, 15 ref 7.
Temp. Effect: None. CT has no temp. effect. Other devices are located in the control room.	

Total Error relative to PPC:

$$=\pm\sqrt{I/I_{acc}^2+CT_{acc}^2}$$
$$=\pm\sqrt{.75^2+9.6^2}$$
$$=\pm 9.6\%$$
$$=\pm\ 19\ amps$$

Total error relative to manual reading:

$$=\sqrt{CT_{acc}+Meter_{acc}+Meter_{readability}^2}$$
$$=\sqrt{9.6^2+3^2+2.5^2}$$
$$=\pm 10.36\%$$
$$=\pm\ 21\ amps$$

6.10 Charging Line Temperature instrument uncertainties relative to Heat Balance

Plant Equipment IDs are TE-0212 / TI-0212. This temperature is a manual entry to the Heat balance. The temperature indicator is calibrated per IPI data-sheet using the impedance curve for a platinum RTD.

Circuit Description: A platinum RTD feeds TI-0212 in the Control room. The RTD is a Burns Engineering model 9486.

		Reference, Comments
TE-0212 accuracy:	Burns catalog information for Platinum RTDs gives a worst case interchangeability of ±3°F at 600°F. As this catalog did not directly address a model 9486, the interchangeability will be doubled and used as the TE error. This works out to ±6°F.	ref 20
TI-0212 accuracy:	As-found tolerance of ± 10 °F.	ref 12
Temperature Effect:	No ambient temperature effect was noted in the Burns catalog other than a wide operating range limit. The TI is located in control room.	ref 20
M&TE:	Decade impedance box has accuarcy better than ½% of reading. This is approximately ½% of 600 °F range which works out to ±0.6°F. This is less than 1/5 of the largest error and is therefore insignificant.	ref 7

TOTAL ACCURACY:

$$= \pm \sqrt{TE_e^2 + TI_e^2}$$
$$= \pm \sqrt{6^2 + 10^2}$$
$$= \pm\ 12°F$$

7.0 CONCLUSION

This EA contains instrument uncertainties that are acceptably accurate for input to a heat-balance uncertainty analysis. Where specific vendor accuracy data was unavailable, conservative estimations were made.

ATTACHMENT 3

NUCLEAR MANAGEMENT COMPANY
PALISADES NUCLEAR PLANT
DOCKET 50-255

October 6, 2003

LICENSE AMENDMENT REQUEST: INCREASE RATED THERMAL POWER – REFERENCE 9.6: EA-ELEC08-0004, "Uncertainty Calculation for UFM Corrected, Density Compensated Total Feedwater Flow Measurement (PPC Only)," Revision 1

30 Pages Follow

REFERENCE 9.6

CONSUMERS ENERGY

PALISADES NUCLEAR PLANT
ENGINEERING ANALYSIS COVER SHEET

EA-ELEC08-0004

Total Number of Sheets 30 RMH 8/15/02

Title Uncertainty Calculation for UFM Corrected, Density Compensated, Total Feedwater Flow Measurement (PPC Only)

INITIATION AND REVIEW

Calculation Status	Preliminary ☐	Pending X	Final ☐	Superseded ☐

Rev #	Description	Initiated By	Initiated Date	Init Appd By	Review Method: Alt Calc	Review Method: Detail Rev'w	Review Method: Qual Test	Technically Reviewed By	Technically Reviewed Date	Rev'r Appd By	Sup'v & S/DR Appd
0	Original Issue	R.A. Bischoff	3/20/02	RMB		✔		D.M. Kennedy	5/14/0		RMB 5/14/02
1	See Record Of Revisions Sheet	RM Hamm	7/12/02	RMB		✓		DMKennedy	8/15/02		RMB 8/21/02

RECORD OF REVISION

Revision Number	Description Of Change
1	The indicated calculation status on the cover sheet has been changed to Pending. Section 3.5.6, change the minimum calibration temperature to 70°F and the maximum temperature to 110°F. Changed TE_{TT} to 2.5224°F. Added Assumption 4.1.1 to reflect expected plant parameters following the power uprate. Added Assumption 4.2.7 Changed TE_{TT} to 2.5224°F Changed TLU_{FWT} to ±3.6251°F Changed T_1 to 437.0749°F Changed D_1 to 52.1810 lbm/ft^3 Changed T_2 to 444.3251°F Changed D_2 to 51.8424 Changed F_1 to 5.6902 Mlb/hr Changed FE_T to 11.7000 Klbm/hr Changed F2 to 5.6667 Mlbm/hr Changed FE_T to -11.8000 Klbm/hr Changed FE_{TEMP} to ±11.8000 Klbm/hr Changed $TLU_{FW(each\ SG)}$ to ± 28.6149 Klbm/hr Changed TLU_{FW} to ± 40.468 Klbm/hr Changed Reference 9.3 to RI-24B Rev.0 Changed Reference 9.7 revision to Rev.1 Added Reference 9.17 Rev.0

1.0 OBJECTIVE / SCOPE

In order to perform a minor power up-rate, the uncertainties associated with the Secondary Calorimetric computation must be determined. A significant portion of the uncertainties associated with this computation stem from the measurement of Feedwater Flow. In order to reduce these uncertainties, Ultrasonic Flow Measurement (UFM) techniques are used to correct the readings from the Feedwater Flow venturis during full power operation.

This calculation determines the uncertainty associated with the Feedwater Flow measurement used in the secondary calorimetric heat balance calculation, with the UFM correction. This calculation is only intended to be valid for the Feedwater Flow Measurement on the Palisades Plant Computer (PPC) during full power operations after the minor power up-rate. See Section 8.0 for further restrictions on the usage of information from this calculation.

2.0 FUNCTIONAL DESCRIPTION

Per Reference 9.2, the Feedwater Flow indication is temperature (density) compensated within the PPC. The instrumentation channels monitor Feedwater Flow to each of the steam generators. Per References 9.2, 9.10 and 9.11, the signals are supplied to the Feedwater Regulator System and PPC, as well as to the Control Room for remote indication. Per Reference 9.2, the Feedwater Temperature channels monitor Feedwater Temperature at the E-6A and B outlet to the steam generators. Per References 9.2 and 9.8, this signal is supplied to the PPC and a Control Room recorder.

Per Reference 9.2, "PPC flow indication may be calibration compensated at full power via a correction factor calculated using alternative Ultrasonic Flow Measurement (UFM) technique." This process is addressed in Reference 9.12. Each steam generator Feedwater Flow signal is density compensated by an associated Feedwater Temperature signal and is UFM Corrected separately.

This calculation only addresses the PPC indication of Feedwater Flow, after temperature (density) compensation and UFM correction.

3.0 ANALYSIS INPUTS

3.1 TEMPERATURE COMPENSATION EQUATIONS

Per Reference 9.2, the Feedwater Flow indication in the PPC is temperature (density) compensated. The Feedwater Flow computation is performed by the PPC, and the following equation is used for each steam generator Feedwater Flow signal.

$$F = G\left[1 + \frac{0.043}{130}(T - 430)\right]\frac{1}{7.48} \times 60 \times D$$

Where: F = Feedwater Flow in lb_m/hr

G = Feedwater Flow in gal/min

T = Feedwater Temperature in °F

D = Density Based on Feedwater Temperature

The Feedwater Flow in GPM is obtained from the flow element ΔP and Feedwater Flow calibration curves. The non-density-compensated Feedwater Flow values, G, for each steam generator is computed in the PPC, as determined in Reference 9.2, as follows.

$$G = 14.237\sqrt{\frac{\%INPUT}{100}} \times 10^3\,GPM$$

3.2 FLOW ELEMENT AND FLUID DENSITY CONSIDERATIONS

TAG NUMBER:	FE-0701	[9.2]
	FE-0703	[9.2, 9.4.e]
MANUFACTURER:	BADGER METER CO.	[9.4.e]
CALIBRATED BY:	ALDEN LABS	[9.2]

3.2.1 Per Reference 9.12, the UFM correction to the Feedwater Flow measurement is made every 31 days when operating at or above 95%. This correction is performed during full power operation, and this calculation does not apply to low power conditions, or accident conditions. Therefore, this correction negates the effects of fouling on the feedwater venturis, thermal expansion factor of the venturis, and piping configuration effects. Therefore:

$Errors_{FE}$ = N/A

3.2.2 Per Reference 9.2, the Feedwater Flow reading is temperature (density) compensated within the PPC. Therefore, the errors due to changes in density are corrected for in the temperature (density) compensation algorithm. The only related residual uncertainty is with respect to the errors in the temperature measurement, which are evaluated in later sections. Therefore, the process effects relating to density changes are negligible.

PE = N/A

3.3 FLOW TRANSMITTER CONSIDERATIONS

TAG NUMBER:	FT-0701	[9.2]
	FT-0703	[9.2]
MANUFACTURER:	ROSEMOUNT	[9.2]
MODEL NUMBER:	3051CD2	[9.2]
FT-0701 SPAN:	0 – 213.9 "H_2O	[9.2]
FT-0703 SPAN:	0 – 219.5 "H_2O	[9.2]

3.3.1 Per Reference 9.4.a, the Reference Accuracy of the flow transmitter is given as ±0.075% Span. Therefore, the flow transmitter Reference Accuracy (RA_{FT}) is given as:

RA_{FT} = ± 0.0750% ΔP Span

3.3.2 Setting Tolerance effects are errors introduced during the calibration process and are constant at a given point on the calibration curve throughout an operating cycle. The UFM correction to the Feedwater Flow signal in the PPC compensates for any Setting Tolerance effect on the transmitter. Therefore,

ST_{FT} = ± 0% ΔP Span

3.3.3 Measurement and Test Equipment (MTE) effects are errors introduced during the calibration process and are constant at a given point on the calibration curve throughout an operating cycle. The UFM correction to the Feedwater Flow signal in the PPC compensates for any Measurement and Test Equipment effect on the transmitter. Therefore,

MTE_{FT} = ± 0% ΔP Span

3.3.4 Per Reference 9.4.a, the flow transmitter stability term is specified as ± 0.125% Upper Range Limit (URL) for 5 years for ± 50°F temperature changes and up to 1000 psi line pressure. This term inherently covers three standard uncertainty terms; drift, temperature effect, and static pressure effect. Sections 3.3.5 and 3.3.7 below specifically address the temperature effect and static pressure effects, but do not address drift. Drift is not specified separately within Reference 9.4.a, so for conservatism, the drift is assigned the full stability value. Per Reference 9.4.a, the Upper Range Limit for these transmitters is 250 "H_2O. For conservatism, the transmitter with the least span is used. Therefore, the Drift term is established as follows.

DR_{FT} = ± 0.125% x (250 "H_2O / 213.9 "H_2O)
= ± 0.1461% ΔP Span

3.3.5 Per Reference 9.4.a, the flow transmitter has specifications for static pressure zero and span effect. The zero term can be calibrated out completely, and the span term can be generally corrected for in the calibration of the transmitter. The residual static pressure span effect is due to the fact that each transmitter responds slightly differently with respect to the span effect, and the correction procedure given merely corrects for the average transmitter response of the all transmitters manufactured. However, in this case, the Feedwater Flow signal is UFM corrected at operating conditions every 31 days, thus correcting these specific transmitters for their static pressure span effect as well. Additionally, since the correction is done at full power operating conditions, only very minor pressure changes need consideration, which have a negligible effect on error. Therefore, the static pressure effect is negligible.

SPE_{FT} = N/A

3.3.6 Per Reference 9.4.a, the flow transmitter Power Supply Effect (PSE_{FT}) is given as less than ±0.005% Span per Volt. Per Reference 9.6, the power supplies for the flow transmitters are regulated to within ± 5 VDC. Therefore, the flow transmitter Power Supply Effect (PSE_{FT}) is given as:

PSE_{FT} = ± (0.005% Span / VDC)(5 VDC)
PSE_{FT} = ± 0.0250% ΔP Span

Per Section 7.6.1 of Reference 9.6, random errors less than ± 0.05% Span have a negligible impact on the overall uncertainty determination and may be omitted from the loop uncertainty analysis. Therefore,

PSE_{FT} = N/A

3.3.7 Per Reference 9.4.a, the flow transmitter Temperature Effect (TE_{FT}) is given as ± (0.0125% URL + 0.0625% Span) / 50°F. Use of the transmitter with the least calibrated span maximizes this uncertainty term; therefore, the span for FT-0701 is used to compute this term. Per plant walkdown, the transmitters are located in the Containment "air room." Therefore, per Reference 9.6, the required temperature difference to be considered is 60°F.

TE_{FT} = ± [[(0.0125%)(250 "H_2O / 213.9 "H_2O)] + 0.0625% Span](60°F/50°F)
TE_{FT} = ± 0.0925% ΔP Span

3.4 TEMPERATURE ELEMENT CONSIDERATIONS

TAG NUMBER:	TE-0706	[9.2]
	TE-0708	[9.2]
MANUFACTURER:	BURNS ENGINEERING, INC.	[9.2, 9.4.b]
TYPE:	200 Ω RTD	[9.2]

3.4.1 Per Reference 9.4.b, the standard accuracy for platinum temperature elements is ± 0.10% of Resistance at 0°C. This is a bias term for a given RTD. However, since the Feedwater Flow reading is corrected at power operating conditions, this term is negated during the UFM correction process. Also, per Reference 9.4.b, the Repeatability for these RTDs is ± 0.10°F over the range from 32°F to 900°F. Per Reference 9.5, the Feedwater Temperature is anticipated to be approximately 438.5°F after the power up-rate. Therefore, the Reference Accuracy (RA) of the temperature element is established as its Repeatability.

RA_{TE} = ± 0.1000°F

3.4.2 The RTD has no adjustment and therefore cannot be calibrated. Therefore, the errors that can be introduced during calibration (Setting Tolerance and M&TE) do not apply to this device.

ST_{TE} = N/A
MTE_{TE} = N/A

3.4.3 Per Reference 9.4.b, the temperature element has a specification for RTD Interchangeability. At the operating condition of 438.6°F, the interchangeability specification is determined from interpolating from the Table in Reference 9.4.b to be as follows:

INT_{TE} = ± 2.1925°F

3.4.4 Per Section 10.3 of Reference 9.6, RTD lead wire effects are negligible with 3-wire RTDs. Per Reference 9.8, these are 3-wire RTDs. Therefore, RTD Lead Wire Effects are negligible for this application.

LW_{TE} = N/A

3.4.5 Per Section 10.4 of Reference 9.6, RTD Self-Heating Effects are generally considered negligible if used with flowing fluids. In addition, since the UFM correction is performed during operating conditions, any Self-Heating errors are removed during the correction process. Therefore, Self-Heating Effects are considered negligible for this application.

SH_{TE} = N/A

3.5 TEMPERATURE TRANSMITTER CONSIDERATIONS

TAG NUMBER:	TT-0706A	[9.2]
	TT-0708A	[9.2]
MANUFACTURER:	RIS	[9.2]
MODEL NUMBER:	SC-1374	[9.2]
SPAN:	500°F	[9.2]

3.5.1 Per Reference 9.4.c, the Linearity of the temperature transmitter is given as ±0.1% Span, and the Repeatability is shown as ±0.1% Span. The span of the transmitters is 500°F per Reference 9.2. These two terms are combined to produce the overall temperature transmitter Reference Accuracy (RA_{TT}) is given as:

$$RA_{TT} = \pm [(0.1\%\ Span)^2 + (0.1\%\ Span)^2]^{1/2} \times (500°F / 100\%\ Span)$$
$$RA_{TT} = \pm 0.7071°F$$

3.5.2 Per Reference 9.6, the Setting Tolerance (ST) term is set equal to the Final Setting Tolerance for the device. Per Reference 9.3, a loop calibration is performed on the temperature transmitters and the associated PPC points. The setting tolerance on the loop calibration is conservatively assigned as the Setting Tolerance for the Temperature Transmitter, since adjustments are not made to the PPC based on this calibration.

$$ST_{TT} = \pm 0.7500°F$$

3.5.3 Per Reference 9.6, Palisades Plant requires that total equivalent accuracy of the test equipment used in the calibration of instrumentation be at least as accurate as the Final Setting Tolerance of the instrument being calibrated. Therefore, the Measurement and Test Equipment effect (MTE) is conservatively set equal to the as-left calibration tolerance of the temperature transmitter. Therefore, per Section 3.5.2 and Reference 9.3,

MTE_{TT} = ± 0.7500°F

3.5.4 Per Reference 9.4.c, no time dependent drift term is specified for the temperature transmitters. Most frequently, drift for these components is very small in relation to the other uncertainty terms specified. Therefore, the Drift term is considered negligible for the temperature transmitters.

DR_{TT} = N/A

3.5.5 Per Reference 9.4.c, the temperature transmitter Power Supply Effect (PSE_{TT}) is given as less than ±0.15% Span per 20% voltage variation. Per Reference 9.8, the instruments are powered by 120 VAC instrument power from Y01. Per Reference 9.6, the power supplies are regulated to within ± 10%. Therefore, the temperature transmitter Power Supply Effect (PSE_{TT}) is given as:

PSE_{TT} = ± (0.15% Span / 20%)(10%)(500 °F / 100% Span)
PSE_{TT} = ± 0.3750°F

3.5.6 Per Reference 9.4.c, the temperature transmitter Temperature Effect (TE_{TT}) (Zero) is given as ± [((RTDmin(Ω)x0.002%)/span (Ω)) + 0.008%] / °F maximum. The span effect is defined as ±0.008% / °F maximum. Per plant walkdown, the transmitters are located in the Turbine Building. Per Reference 9.16, the maximum ambient temperature is 110°F. Per Reference 9.17, the minimum ambient temperature during a calibration is 70°F. Therefore, the required temperature difference to be considered is 40°F. Per Reference 9.2, the span is 500°F. Using 0°F and 500°F ohm values from Reference 9.15, the temperature effect is computed as follows:

TE_{TTZ} = ± [(185.88 Ω x 0.002% / (398.04 Ω -185.88 Ω)) + 0.008%] x (40°F) x (500°F / 100% Span)

TE_{TTZ} = ± 1.95 °F

TE_{TTS} = ± (0.00008 / °F) x (40°F) x (500°F)

TE_{TTS} = ± 1.6 °F

$TE_{TT} = \pm (TE_{TTZ}^2 + TE_{TTS}^2)^{1/2}$

TE_{TT} = ± 2.5224°F

3.6 PPC INPUT UNCERTAINTIES (FLOW AND TEMPERATURE SIGNAL INPUTS)

For conservatism, the uncertainties of the PPC analog input cards are based on the specifications for the 12-bit A/D.

3.6.1 Per Reference 9.4.d, the Linearity of the input A/D card is given as ±0.04% Span. The Gain Accuracy is shown to be ± 0.025% Full Scale. Reference 9.4.d states, "The full scale ranges are user programmable." Therefore, no adjustment must be made to correct the % Span values to the % full-scale values for the inputs. Therefore, the Reference Accuracy of the PPC input cards are computed as follows:

$RA_{PPC} = \pm [(0.04\%\ Span)^2 + (0.025\%\ Span)^2]^{1/2}$

$RA_{PPC} = \pm 0.0472\ \%\ Span$

Per Section 7.6.1 of Reference 9.6, random errors less than ± 0.05% Span have a negligible impact on the overall uncertainty determination and may be omitted from the loop uncertainty analysis. Therefore,

$RA_{PPC} =$ N/A

3.6.2 Per Reference 9.4.d, the PPC input cards should not require adjustment or periodic maintenance. Setting Tolerance effects are errors introduced during the calibration process only. If adjustment is required for the input cards, high precision equipment are used with extremely tight tolerances to ensure that very accurate readings are obtained. Therefore, the effects of Setting Tolerance and Measurement & Test Equipment are negligible with respect to the other uncertainty terms.

$ST_{PPC} =$ N/A

$MTE_{PPC} =$ N/A

3.6.3 Per Reference 9.4.d, no drift is specified for the PPC cards. As stated therein, periodic maintenance should not be required for the input cards. Therefore, drift is negligible with respect to the other uncertainty terms.

$DR_{PPC} =$ N/A

3.6.4 Per Reference 9.4.d, the PPC input card gain stability is shown to be ±100ppm/°C and the zero stability is shown as ±0.5µV / °C for the Gate card and ±45µV / °C for the A/D card. This is a temperature effect (TE_{PPC}) specification. (A 1.25 VDC full-scale value is used for conservatism). The plant computer inputs are located in an environment similar to that in the control room. Therefore, per Reference 9.6, the temperature difference for consideration is 15°F. Therefore, the temperature effect is converted to correct units and combined to determine the following total Temperature Effect expression:

$TE_{SPEC} = \pm [(100/1{,}000{,}000)^2 + (((0.5)^2 + (45)^2)^{1/2} \times 10^{-6} / 1.25)^2]^{1/2} \times 100\%/°C$
$TE_{PPC} = \pm 0.010628\%$ Span / °C x [1°C/1.8°F] x [15°F]
$TE_{PPC} = \pm 0.0886\%$ Span

$TE_{PPCF} = \pm 0.0886\%$ Span

$TE_{PPCT} = \pm 0.0886 \times 500°F / 100\%$ Span
$TE_{PPCT} = \pm 0.4428°F$

3.6.5 Per Reference 9.4.d, the quantizing error for the PPC input card is given as ± ½ LSB. This term is treated as Resolution (RES). Conservatively using a 12-bit A/D card, the value is computed in terms of % Span as follows:

$RES_{PPC} = \pm 0.5 \times [1/(2)^{12}] \times 100\%$ Span
$= \pm 0.0122\%$ Span

Per Section 7.6.1 of Reference 9.6, random errors less than ± 0.05% Span have a negligible impact on the overall uncertainty determination and may be omitted from the loop uncertainty analysis. Therefore,

RES_{PPC} = N/A

3.6.6 The UFMs are used within Reference 9.12 to correct the Feedwater Flow (venturi) reading to equate to the UFM reading. This requires that the Correction Factor be computed manually. Per Reference 9.12, the display resolutions of the UFM value and the PPC flow values are equivalent to 5 and 6 decimal places for MPPH indications, respectively. Using ½ the least significant digit as the resolution of these terms, the resolutions are 0.5 and 5 lbm/hr, respectively. Therefore, combining these terms into a Correction Factor (CF) Resolution,

$RES_{CF} = \pm ((0.5\ lb_m/hr)^2 + (5\ lb_m/hr)^2)^{1/2}$
$= \pm 5.025\ lb_m/hr$

This equates to approximately 0.0001% Span, which is negligible per Section 7.6.1 of Reference 9.12 (i.e. <0.05% Span).

3.7 ULTRASONIC FLOW METER (UFM) UNCERTAINTY CONSIDERATIONS

3.7.1 Per Section 4.3.1 of Reference 9.7, the UFM uncertainty (ε_ω) is established as ±0.4445%. Per Assumption 4.2.2, this uncertainty value is assumed to be valid after power up-rate. Therefore,

$$\varepsilon_\omega \quad = \quad \pm\, 0.4445\ \%\ \text{Actual Flow}$$

4.0 ASSUMPTIONS

4.1 MAJOR ASSUMPTIONS

4.1.1 Per Reference 9.5, the following plant parameters are anticipated after the power up-rate project. If actual plant conditions are similar to these, this calculation remains valid.

P_{SG} = Steam Generator Pressure (psia)
P_{SG} = 765.8 psia

T_{FW} = Feedwater Temperature (°F)
T_{FW} = 440.7°F

F_{FW} = Feedwater Flow (Mlb_m / hr)
F_{FW} = 11.357 Mlb_m / hr

4.2 MINOR ASSUMPTIONS

4.2.1 Per Reference 9.7, the PPC updates Feedwater Flow readings once per second. A rolling average of these one second snapshots is used to filter the values. The hour averages are composed of ten minute averages which are composed of snapshots taken at a one minute interval. Each level requires 90% of the points being averaged to be valid. The rate of sampling is appropriate for the determination of a valid Feedwater Flow signal.

4.2.2 The error introduced into the measurement of Feedwater Flow due to the numerical development of a square root and other computations within the PPC is negligible with respect to the other error terms. The internal resolution of the PPC Feedwater Flow value is adequate to impart a negligible overall effect on the secondary calorimetric computation.

4.2.3 Differences in Feedwater density determined by the PPC and Feedwater density from ASME Steam Tables are a minor bias that is nullified each month when the UFM correction is made. The temperature remains relatively constant from month to month, so any induced uncertainty is negligible.

4.2.4 Per Reference 9.7, all uncertainties associated with the Ultrasonic Flow Meter (UFM) are random and independent. No bias uncertainties are present in the ultrasonic Feedwater Flow measurement.

4.2.5 The uncertainties derived per Reference 9.7 for the UFM measurement apply at the full power and full Feedwater Flow values used after this power up-rate.

4.2.6 Per Reference 9.12, density correction is performed for the UFM measurement, when determining the correction factor to use in the PPC. Reference 9.7 derives an overall uncertainty value for the UFM measurement. This derivation includes a density uncertainty factor, but gives no specific details as to the origin of that term. The uncertainty computation for the UFM measurement within Reference 9.7 properly considers the density correction process as applied in Attachment 2 of Reference 9.12, Steps D and J.

4.2.7 RI-24, "Steam Generator Feedwater Flow Instrument Loop Calibration," Procedure, has been revised to remove the calibration of the feedwater temperature channels. A new procedure, RI-24A was created for the temperature channel calibrations. This will ensure the transmitters are calibrated with an ambient temperature of 70°F or greater.

5.0 ANALYSIS

Computations are performed to an accuracy of several significant digits, but presented in this calculation rounded to four decimal places in most cases. Hand verification of this calculation utilizing the rounded values yields slightly different results, due to round off errors. The final result is rounded to three decimal places for use as input to the Secondary Calorimetric uncertainty calculation.

This analysis is performed in two segments. The first segment assesses the potential error of the Feedwater Temperature, as measured in the PPC, and determines the affect of this error on the flow reading. The second segment then combines the errors of the Feedwater Flow measurement with any required errors from the Feedwater Temperature and UFM Correction, to determine a final uncertainty of the Feedwater Flow value in the PPC, with UFM correction applied.

5.1 FEEDWATER TEMPERATURE UNCERTAINTY ANALYSIS

Per Analysis Input Sections 3.4, 3.5, and 3.6, the following non-zero values are derived, which require uncertainty consideration for the Feedwater Temperature measurement within the PPC.

RA_{TE} =	± 0.1000°F	[3.4.1]
INT_{TE} =	± 2.1925°F	[3.4.3]
RA_{TT} =	± 0.7071°F	[3.5.1]
ST_{TT} =	± 0.7500°F	[3.5.2]
MTE_{TT} =	± 0.7500°F	[3.5.3]
PSE_{TT} =	± 0.3750°F	[3.5.5]
TE_{TT} =	± 2.5224°F	[3.5.6]
TE_{PPCT} =	± 0.4428°F	[3.6.4]

All of the above errors are random and independent, and expressed in common units. Therefore, in order to determine the uncertainties of the plant computer indication of Feedwater Temperature, with respect to the computation of UFM Corrected Feedwater Flow, the terms are combined by SRSS.

$$TLU_{FWT} = \pm [RA_{TE}^2 + INT_{TE}^2 + RA_{TT}^2 + ST_{TT}^2 + MTE_{TT}^2 + PSE_{TT}^2 + TE_{TT}^2 + TE_{PPCT}^2]^{1/2}$$

$$TLU_{FWT} = \pm 3.6251°F$$

In order to evaluate these errors in terms of their affect on the flow measurement, a case study is performed at the anticipated flow rates during normal operation after the power up-rate. Given ideal inputs, the flow equation in the Plant Computer is implemented. Then, errors are applied to the temperature inputs, and a difference in flow measurements is observed, holding all other values constant.

Per Section 3.1, the following is the PPC equation used to perform the temperature compensation for the Feedwater Flow instrumentation:

$$F = G\left[1 + \frac{0.043}{130}(T - 430)\right]\frac{1}{7.48} \times 60 \times D$$

Per Reference 9.5, the Main Feedwater Flow anticipated at 101.4% power, after power up-rate, is 11.357 Mlb_m/hr. Splitting this between the two steam generators equally, we obtain Feedwater Flows for each steam generator of:

$$F_{INIT} = F_{TOTAL} / 2 = 11.357/2 = 5.6785 \text{ Mlb}_m\text{/hr}$$

Also per Reference 9.5, the main Feedwater Temperature anticipated at 101.4% power, after power up-rate, is 438.5°F.

$$T_{INIT} = 440.7°F$$

Per Reference 9.13, a pressure of 700 psia was used in obtaining the densities since this pressure is close to the 100% power value and density is not highly dependent on pressure. Density is calculated using the following equation per Reference 9.13:

$$D = 61.2257 - (0.0000585417)(T^2)) + (0.00489334)(T)$$ Thus,

$$D_{INIT} = 52.01243\ lb_m/ft^3$$

Therefore, the equations are worked as follows to determine the ideal measured flow rate.

$$G_{INIT} = F_{INIT} / \{[1+(0.043/130)(T_{INIT}-430)] \times [60D_{INIT}/7.48]\}$$

$$G_{INIT} = 13{,}562.59\ GPM$$

The only parameters in the Flow equation that change are T, the measured Feedwater Temperature, and D, the density from the PPC computation, based on the measured Feedwater Temperature. The total loop uncertainty for the temperature reading on the PPC is established as ±3.6251°F for the evaluation.

In order to account for any errors in the density algorithm of the PPC, the densities from the erroneous temperatures are computed with the PPC algorithm, to specifically acquire what the PPC would compute for these items. Per Reference 9.13, the density equation in the PPC is as follows:

$$D = 61.2257 - (0.0000585417)(T^2)) + (0.00489334)(T)$$

Where: T = PPC input temperature of TT-0706A or TT-0708A
D = Feedwater Density

The temperature and density figures (as would be derived in the PPC) for this assessment are as follows:

Case 1:

$$T_1 = 437.0749\ °F$$

$$D_1 = 61.2257 - (0.0000585417)(T_1^2)) + (0.00489334)(T_1)$$

$$D_1 = 52.1810\ lb_m/ft^3$$

Case 2:

T_2 = 444.3251 °F
D_2 = 61.2257 - (0.0000585417)(T_2^2)) + (0.00489334)(T_2)
D_2 = 51.8424 lb_m/ft^3

From Section 3.1,

$$F = G\left[1 + \frac{0.043}{130}(T - 430)\right]\frac{1}{7.48} \times 60 \times D$$

Substituting the values for Case 1 into the flow equation yields the following erroneous flow reading (F_1).

F_1 = 5.6902 Mlbm/hr

Thus, the temperature induced flow error (FE_{T+}) is shown for Case 1 as follows:

FE_{T+} = $F_1 - F_{INIT}$
FE_{T+} = +11.7000 Klbm/hr

Substituting the values for Case 2 into the flow equation yields the following erroneous flow reading (F_2).

F_2 = 5.6667 Mlbm/hr

Thus, the temperature induced flow error (FE_{T-}) is shown for Case 2 as follows:

FE_{T-} = $F_2 - F_{INIT}$
FE_{T-} = -11.8000 Klbm/hr

Although the error is slightly skewed in the negative direction, the errors did originate from random errors with equal positive and negative magnitudes. For conservatism, the errors are treated as equal in each direction, with the largest magnitude in both directions.

FE_{TEMP} = ± 11.8000 Klbm/hr

5.2 FLOW INSTRUMENTATION UNCERTAINTY ANALYSIS

Per Analysis Input Sections 3.2, 3.3, and 3.6, the following non-zero values are derived, which require uncertainty consideration for the Feedwater Flow differential pressure measurement within the PPC.

RA_{FT} = ± 0.0750% ΔP Span [3.3.1]
DR_{FT} = ± 0.1461% ΔP Span [3.3.4]
TE_{FT} = ± 0.0925% ΔP Span [3.3.7]

TE_{PPCF} = ± 0.0886% ΔP Span [3.6.4]

All of the above errors are random and independent, and expressed in common units. Therefore, in order to determine the uncertainties of the plant computer indication of Feedwater Flow (in percent of ΔP Span), with respect to the computation of UFM Corrected Feedwater Flow, the terms are combined by SRSS.

$$LU_{FWDP} = \pm [RA_{FT}^2 + DR_{FT}^2 + TE_{FT}^2 + TE_{PPCF}^2]^{1/2}$$
$$= \pm 0.2083\% \ \Delta P \text{ Span}$$
$$= \pm 0.002083 \text{ of } \Delta P \text{ Span}$$

Per Reference 9.1, these errors are converted to units of flow as follows:

$$C = A^{1/2} \text{, and}$$

$$e_{C(SRSS)} = \pm e_{A(R)} / 2(A)^{1/2}$$

Where: A is the normalized input differential pressure value, expressed as a fraction of the input span.
C is the normalized output signal in terms of fraction of Flow Span.
e_C is the error of the flow signal (% Flow Span)
e_A is the error of the differential pressure signal (% ΔP Span)

$$LU_{FW} = \pm LU_{FWDP} / 2(A)^{1/2}$$

This analysis is performed only at full power conditions after power up-rate. Per Section 5.1 above, the Feedwater Flow rate of concern is:

G_{INIT} = ± 13,562.59 GPM [5.1]

Per Section 3.1,

$$G = 14.237\sqrt{\frac{\%INPUT}{100}} \times 10^3 \,GPM$$

In this equation, A is equal to the %INPUT term expressed as a fraction.

$A = \%INPUT/100 = [G_{INIT} / (14.237 \times 10^3)]^2$
$A = 0.9075$

The resulting equation from Reference 9.1 expresses the result in terms of % Flow Span. In order to express the error in process units, the equation is adjusted. The equation is divided by the normalized flow rate, C (which equals $A^{1/2}$), to obtain units of % Actual Flow, and then multiplied by the actual flow to obtain process units.

$LU_{FW} = \pm [(LU_{FWDP} / 2 (A)^{1/2}) / (A)^{1/2}] \times (F_{INIT})$
$LU_{FW} = \pm (LU_{FWDP} / 2A) \times (F_{INIT})$
$LU_{FW} = \pm [0.002083 / (2 \times (0.9075))] \times (5{,}678{,}500)$
$LU_{FW} = \pm 6.5170$ Klbm/hr

This is the total loop uncertainty of the differential pressure loop input to the corrected Feedwater Flow computation, expressed in terms of process units.

5.3 TOTAL UNCERTAINTY COMPUTATION FOR UFM CORRECTED FEEDWATER FLOW MEASUREMENT

In order to develop the uncertainty of the total measurement of Feedwater Flow, using the UFM correction, one must combine the errors of the different inputs. The errors for each of the components are combined for each flow loop, and then combined to obtain a total Feedwater Flow measurement uncertainty.

There is a separate UFM correction factor applied to each flow loop, with an associated uncertainty as shown in Analysis Input 3.7.1.

$\varepsilon_{\omega} = \pm 0.4445\%$ Actual Flow [3.7.1]
$\varepsilon_{\omega} = \pm 0.004445$ Actual Flow

This is converted to process units as follows:

$\varepsilon_{\omega p} = \pm \varepsilon_{\omega} * F_{INIT}$
$\varepsilon_{\omega p} = \pm 0.004445 * 5678500$ Klb_m/hr
$\varepsilon_{\omega p} = \pm 25.2409$ Klb_m/hr

Each of the three errors below can now be combined in process units to determine the error for the Feedwater Flow measurement for each steam generator.

$\varepsilon_{\omega p}$ = ± 25.2409 Klb_m/hr
LU_{FW} = ± 6.5170 Klb_m/hr
FE_{TEMP} = ± 11.8000 Klb_m/hr

$TLU_{FW(Each\ SG)} = \pm [\varepsilon_{\omega p}^2 + LU_{FW}^2 + FE_{TEMP}^2]^{1/2}$
$TLU_{FW(Each\ SG)} = \pm [(25.2409)^2 + (6.5170)^2 + (11.8000)^2]^{1/2}$
$TLU_{FW(Each\ SG)} = \pm 28.6149\ Klb_m/hr$

Total uncertainty of the Feedwater Flow measurement with UFM correction is figured by combining the flow errors from each SG in SRSS fashion. This is shown as follows:

$TLU_{FW} = \pm [TLU_{FW(Each\ SG)}^2 + TLU_{FW(Each\ SG)}^2]^{1/2}$
$TLU_{FW} = \pm [(28.6149)^2 + (28.6149)^2]^{1/2}$
$TLU_{FW} = \pm 40.468\ Klbm/hr$

6.0 SETPOINT EVALUATION

No setpoints are addressed by this calculation.

7.0 SUMMARY OF RESULTS

The instrument uncertainty of the total Feedwater Flow measurement within the PPC, with temperature compensation based on Feedwater Temperature, and Ultrasonic Flow Meter Correction every 31 days, is determined to be:

$TLU_{FW} = \pm 40.468\ Klbm/hr$

8.0 CONCLUSION

The total loop uncertainty shown in Section 7.0 above can be used in the determination of uncertainties for the Secondary Calorimetric computation.

The intermediate values within the calculation are NOT valid for use independently for other applications, as these are developed only as they apply to a corrected FW flow measurement in the PPC. Therefore, many terms that are compensated for in the FW flow measurement (and are therefore eliminated from this calculation) actually exist in the measurement when used for other purposes.

This calculation is only valid at full power operation after the associated power up-rate. It is not valid at significantly lesser flow rates or power levels. These uncertainty values only apply to the PPC Feedwater Flow measurement in the PPC. They do not apply to situations where other indicating devices are used to determine temperature and flow rate.

9.0 REFERENCES

9.1 ISA-RP67.04, Part II - 1994, "Methodologies for the Determination of Setpoints for Nuclear Safety Related Instrumentation," May 1995.

9.2 RI-24, "Steam Generator Feedwater Flow and Temperature Instrument Loop Calibration," Basis Document, Revision 9.

9.3 RI-24B, "Steam Generator Feedwater Flow Instrument Loop Calibration," Procedure, Revision 0.

9.4 Vendor Manuals

a. Flow Transmitter: Rosemount Product Data Sheet 00813-0100-4001, "Model 3051 Transmitter," (Excerpts Included as Attachment B).

b. Temperature Elements: M206 Sheet 115, "Burns Engineering Inc. Product Specification Bulletin for Resistance Thermometers for All Environments," VTD-0622-006, Revision 3.

c. Temperature Transmitters: RIS / Ametek Signal Conditioning Spec Sheet (Excerpts Included as Attachment A).

d. PPC Analog Input Cards: M0001PA Sheet 1557, "Computer Products Technical Manual for RTP7436 Series Universal Analog Input Card Set," VTD-2016-0008.

e. Flow Element: M252 Sheet 0032, "Alden Research Laboratories Calibration of Two 16.500" Lo-Loss Tubes," VTD-1154-0002.

9.5 EA-RCH-01-05, "Calculation of Chapter 14 Safety Analysis Parameter Changes Due to FC-977 Power Uprate," Revision 0.

9.6 EGAD-ELEC-08, "Instrument Loop Uncertainty and Setpoint Methodology," Revision 0.

9.7 EA-UFM-97-01, "Feedwater Flow Uncertainty with UFM Correction Factor," Revision 1.

9.8 Drawing E-76, Sheet 7, "Schematic Diagram, Feedwater and Turbine Driver Instrumentation," Revision 17.

9.9 ASME Steam Tables, 1967, 5th Edition.

9.10 Drawing E-69, Sheet 1, "Schematic Diagram, Feedwater Flow Control Instrumentation," Revision 31.

9.11 Drawing E-69, Sheet 1A, "Schematic Diagram, Feedwater Flow Control Instrumentation," Revision 5.

9.12 MT-15, "UFM Data Collection, Analysis, and Implementation," Revision 1.

9.13 EA-FC-933-05-01, "SPI System Replacement," Revision 1.

9.14 Deleted

9.15 Instrument Calibration Sheets for TT-0706A and TT-0708A, dated 12/13/01

9.16 Palisades Nuclear Plant Final Safety Analysis Report Chapter 9, Table 9-13 Revision 23, "Design Basis Ambient Conditions".

9.17 RI-24A,_ "Steam Generator Feedwater Temperature Instrument Loop Calibration,"_ Procedure, Revision 0.

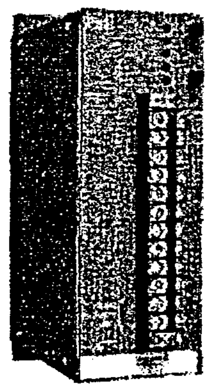
RTD and Slidewire Transmitters

SC-1300R

- Slidewire inputs
- High output load option

SC-1372, SC-1374

- RTD inputs
- Optional input/output isolation
- Differential RTD inputs
- High output load option



SC-1300R, SC-1372, and SC-1374

The SC-1300R accepts a direct potentiometer input and converts it to a current or voltage signal.

The SC-1372 accepts an input from an RTD and converts it to a current or voltage signal. The SC-1372 accepts two or three-wire RTD's with lead wire compensation. Differential RTD measurement is available. This unit is isolated between the input, output and power for AC or isolated DC powered units.

The SC-1374 is similar to the SC-1372 but is not isolated between the input and power for AC powered units.

SC-1372 and SC-1374 Specifications

Inputs: 100Ω platinum, 10Ω copper and 120Ω nickel, standard. Consult factory for other available ranges. 3Ω to 1260 Ω spans with differential measurement.

Ambient Temperature Effect:
For 25°F to 125°F (-4°C to 52°C):
Zero:

$$\frac{\text{RTD min.}(\Omega) \times 0.002\%}{\text{span }(\Omega)} + 0.006\%/°F \text{ max.}$$

Span: 0.006%/°F maximum
For 10Ω span with 100Ω RTD minimum:
0.026%/°F zero drift
0.006%/°F span drift maximum

Response Time:
SC-1372: less than 400 mS (10-90%)
SC-1374: less than 50 mS (10-90%)

Isolation:
SC-1372: 600 VAC or 1000 VDC input/output/power for AC or isolated DC powered units.
SC-1374: 600 VAC or 1000 VDC input/power for AC or isolated DC powered units.

SC-1300R Specifications

Input:
from 10Ω to 20,000Ω spans. Total slidewire resistance must be specified when ordering.

Slidewire Power Dissipation:
less than 175 microwatts

Slidewire Constant Current Source:

Slidewire Range*		Slidewire Current
Min.	Max.	Maximum
0-10Ω	0-50Ω	10 mA
0-50Ω	0-100Ω	10 mA
0-100Ω	0-199Ω	10 mA
0-200Ω	0-399Ω	5 mA
0-400Ω	0-799Ω	2 mA
0-800Ω	0-1499Ω	1 mA
0-1500Ω	0-2999Ω	0.5 mA
0-3000Ω	0-5999Ω	0.25 mA
0-5999Ω	0-10,000Ω	0.15 mA

*Total slidewire resistance must be specified when ordering.

Response Time:
less than 50 milliseconds (10-90%)

Isolation:
600 VAC or 1000 VDC input/power isolation for AC or isolated DC powered units

Ambient Temperature Effect:
for 25° to 125°F (-4° to 52°C):
±0.01%/°F (±0.018%/°C) maximum,
±0.004%/°F (±0.007%/°C) typical

AMETEK

Signal Conditioning

SC-1300R, SC-1372, and SC-1374 Specifications

Linearity: ±0.1% of span, maximum error; ±1°C max. for Ni and Pt RTDs, 0.3°C typical

Repeatability: ±0.1% of span, maximum error

Ambient Temperature Range: 0° to 140°F (-18° to 60°C)

Output Signals:

mA	Output Drive Capability
10-50 mA	320Ω
4-20 mA	800Ω
2-10 mA	1600Ω
1-5 mA	3200Ω
0.2-1 mA	16,000Ω

VDC	Output Impedance
2-10 VDC	500Ω
1-5 VDC	250Ω
0.2-1 VDC	50Ω
0-100 mVDC	5Ω
0-10 mVDC	0.5Ω

Any of the above ranges can be zero based.

Lead Compensation Error:

$$\frac{\text{Lead Resistance } (\Omega)}{\text{Span } (\Omega)} \times 1\% \text{ maximum}$$

This error may be nulled by zero adjustment.

Controls: multiturn zero and span potentiometers

Common Mode Rejection (SC-1372): 130 dB @ 60 Hz

Power Supply Effect: ±0.15% for a ±20% power variation maximum with 800 ohm load and 4-20 mA output (H3, H4, H5 options ±10%)

Power Supplies:

a. 115 VAC ±20%, 50/60 Hz, 5 watts (standard)
b. 24 VDC ±20%, 3.5 watts (H suffix; non-isolated)
c. 230 VAC ±20%, 50/60 Hz, 5 watts (H2 suffix)
d. 115 VAC ±10%, 60 Hz, 5 watts, (H3 suffix; P-11 or A-12 option)
e. 115 VAC ±10%, 50/60 Hz, 5 watts (H4 suffix; P-11 or A-12 option)
f. 230 VAC ±10%, 50/60 Hz, 5 watts (H5 suffix; P-1 or A-12 option)
g. 24 VDC ±20%, 4.5 watts (I suffix; isolated)
h. 48 VDC ±20%, 5 watts, (I1 suffix; isolated)

Net Weight (Approximate): 3.4 lbs. (1.54 kg)

Enclosures:

a. single unit surface mount (standard)
b. P-11, high density, 19" rack mount (with rear access terminal blocks)
c. A-12, high density, 19" rack and surface mount (with front access terminal blocks)
d. NEMA 4 and 12 (from one to 24 units)
e. explosion-proof single unit, FM approved for Class 1, Division 1, Groups C and D

High Load Drive Option (HO):

mA Capability	Output Drive
10-50 mA	800Ω
4-20 mA	1600Ω
2-10 mA	3200Ω
1-5 mA	6400Ω
0.2-1 mA	32,000Ω

Note: any analog output may also be zero based

True Voltage Output Option (VO):

VDC	Minimum Drive Impedance
0-10 VDC	300Ω
0-5 VDC	150Ω

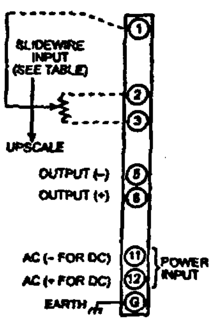
Agency Approvals: FM approved for ordinary locations and hazardous locations Divisions I and 2, Class 1, Groups C & D; Class II, Groups E, F & G. Ametek explosion-proof housing required for hazardous locations.

CSA approved for ordinary locations, all unit types with either 117 VAC, 24 VDC isolated or 24 VDC non-isolated power versions.

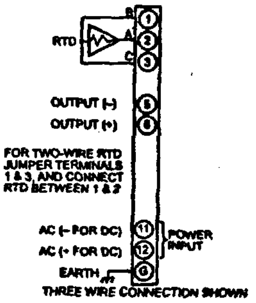
Ordering Information:
see page 7.56, 7.57

Dimensions:
see page 7.58

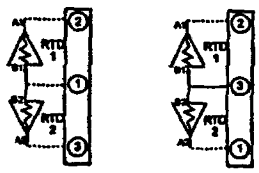
SC-1300R Connections



SC-1372 and SC-1374 Connections



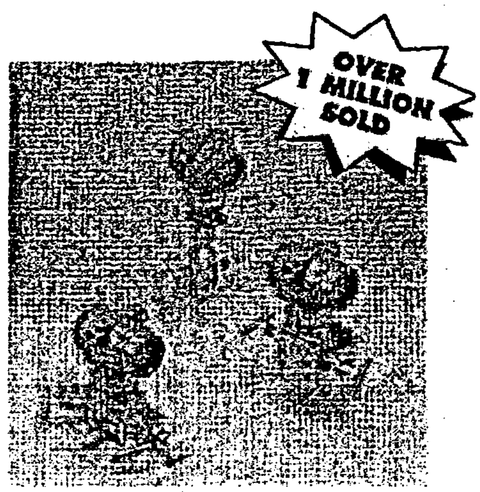
Differential Input Connections



Product Data Sheet *00813-0100-4001*

Model 3051 Transmitter

For Flow, Level, and Pressure Measurement



PERFORMANCE

- *Industry's best total performance of 0.15% maximizes loop performance*
- *Five year stability of 0.125% dramatically reduces calibration and maintenance costs*
- *Faster dynamic response performance reduces process variability*
- *100:1 Rangeability reduces inventory costs*

COMPLETE POINT SOLUTIONS™

- *Compact, lightweight Coplanar™ design optimizes performance and minimizes on-site inventory requirements.*
- *Integral mount manifold Model 305/306 can save over 20% on installation costs by allowing Rosemount Inc. to install, leak check, and calibrate the transmitter/manifold system.*
- *Model 1199 "tuned" direct mount diaphragm seals can save over 20% on procurement and installation costs, while improving performance and response time over 10%.*
- *Integral mount Annubar™ flow element can save over 50% on installation costs by allowing Rosemount Inc. to assemble, leak check, and calibrate the flow meter system, and by reducing pipe penetration.*
- *Direct mount Hookups™ system for flow and level installation can reduce purchasing specification and installation cost 30%, and reduce maintenance over 20%.*

PATHWAY TO THE FUTURE

- *Plantweb™ architecture, enabled with HART® or FOUNDATION™ fieldbus, increases access to field information to improve plant performance*
- *Asset Management Solutions (AMS) plant management software cuts costs by streamlining maintenance tasks*
- *Provides a platform for advanced diagnostics and "control anywhere"*
- *Continuous design improvement assures superior performance and savings*

The World's Best Transmitter Keeps Getting Better...

- ***Total Performance Improved 2X***
- ***Stability Improved 1.5X***

ROSEMOUNT

FISHER-ROSEMOUNT Managing The Process Better

The Model 3051: Superior Performance

A TRADITION OF EXCELLENCE

With the introduction of the Model 1151 Pressure Transmitter in 1969, Rosemount Inc. established itself as the industry leader in transmitter technology. The Model 1151 transmitter introduced revolutionary process control technology with the capacitance sensor, a new and highly accurate method of measuring pressure.

Rosemount Inc. invented HART communication protocol, which is used in over 70% of smart field devices. Carrying this tradition into the 1990s and beyond, Rosemount Inc. continues to offer improved performance, economical upgrades, and advanced diagnostic systems (such as AMS Performance™ software), and Rosemount Inc. is the first in the process control industry to install FOUNDATION fieldbus networks.

THE MODEL 3051 TRANSMITTER: CARRYING ON THE TRADITION

With the introduction of the Model 3051 transmitter in 1988, Rosemount Inc. continued its tradition of excellence. The Model 3051 transmitter established a new standard of performance. With its patented Coplanar platform and Rosemount Complete Point Solutions™ package, the Model 3051 transmitter offers the most advanced measurement capabilities available. Today, the Model 3051 transmitter is the world's most popular flow, level, and pressure transmitter with over one million sold. The key to its unparalleled success lies in the ability of Rosemount Inc. to consistently meet and exceed customer needs in performance, value, and continuous improvement.

Value

The Model 3051 transmitter yields a high return on investment in several ways:

Five year stability without calibration
reduces maintenance costs by approximately $140.00 per point per year.

Total Performance of 0.15%
reduces process variability and manufacturing costs and can increase profitability up to 30%.

Rosemount Complete Point Solutions
provides complete factory-calibrated, pressure-tested, configured measurement systems right out of the box. Just install, and the Model 3051 transmitter is ready to go to work for you.

The Coplanar Platform
reduces parts costs and spares inventory by reducing the total number of parts needed for installation and operations. Versatility is inherent in the Model 3051 Coplanar platform design. Customers choose the sensor module, process connection, remote seal, and primary element that best fits their need, assuring Complete Point Solutions every time.

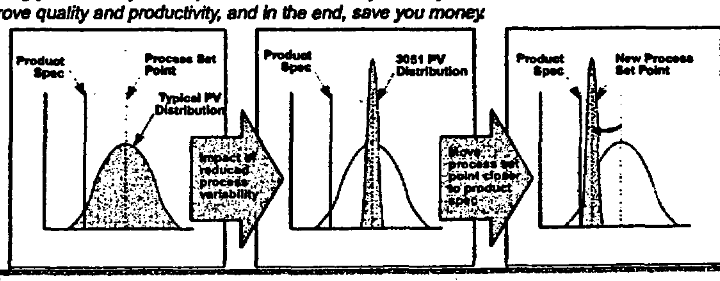
Compatibility
with advanced diagnostic tools such as Plantweb field architecture, AMS software, and FOUNDATION fieldbus provide additional paths to process control, increased uptime, and increased profitability.

Continuous Improvement: An Investment in the Future

Upgradeable technology and continuous design improvement assures that the Model 3051 transmitter is ready to work for you now and in the future.

Save Money with Better Performance!

The industry-leading performance of the Model 3051 transmitter helps reduce process variability, allowing you to shift your set point closer to where you really want it. This can reduce scrap cost, improve quality and productivity, and in the end, save you money.



3051-3051_15A

Specifications

PERFORMANCE SPECIFICATIONS

Total Performance is based on combined errors of reference accuracy, ambient temperature effect, and static pressure effect.

For detailed performance specifications, see page 14.

Model 3051C (Ranges 2–5), Model 3051T

Reference Accuracy
±0.075% of span.

Total Performance Improved!
±0.15% of span for ±50 °F (28 °C) temperature changes, up to 1000 psi (6,9 MPa) line pressure (CD only), from 1:1 to 5:1 rangedown.

Stability Improved!
±0.125% of URL for 5 years for ±50 °F (28 °C) temperature changes, and up to 1000 psi (6,9 MPa) line pressure.

Dynamic Performance
Total Response Time ($T_d + T_c$)
100 ms

Model 3051CD, Low/Draft Range (Ranges 0–1)

Reference Accuracy
±0.10% of span.

Stability
±0.2% of URL for 1 year.

Model 3051P—Reference Class

Reference Accuracy
±0.05% of span.

Total Performance Improved!
±0.1% of span for ±50 °F (28 °C) temperature changes, up to 1000 psi (6,9 MPa) line pressure, from 1:1 to 5:1 rangedown.

Stability Improved!
±0.125% of URL for 5 years for ±50 °F (28 °C) temperature changes, and up to 1000 psi (6,9 MPa) line pressure.

Dynamic Performance
Total Response Time ($T_d + T_c$)
100 ms

Model 3051L—Liquid Level

Reference Accuracy
±0.075% of span.

Model 3051H—High Process Temperature

Reference Accuracy
±0.075% of span.

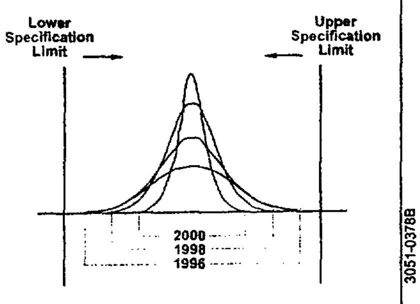
Stability
±0.1% of URL for 12 months for Ranges 2 and 3.
±0.2% of URL for 12 months for Ranges 4 and 5.

Rosemount Conformance to Specifications

When you buy a Rosemount transmitter, you can be confident you are getting a transmitter that not only meets, but most likely greatly exceeds, the published specifications. Our advanced manufacturing techniques and implementation of statistical process control provides specification conformance to at least 3σ[1].

Our commitment to continual improvement ensures that product design, reliability and performance get better every year. By focusing on our manufacturing process, we are able to reduce product variability, and our specifications have improved accordingly. The Model 3051 transmitter specifications have improved every year since introduction in 1988.

While most of these changes do not affect its outward appearance, all of the changes increase the value of each Model 3051 transmitter shipped. The transmitters that Rosemount Inc. ships tomorrow will be even better than units shipped today. The result: you always get the best possible transmitter from *Rosemount Inc.*



(1) Sigma (σ) is a statistical symbol to designate the standard deviation from the mean value of a normal distribution.

DETAILED PERFORMANCE SPECIFICATIONS

Zero-based spans, reference conditions, silicone oil fill, 316 SST isolating diaphragms, 4–20 mA analog output, and digital trim values equal to the span setpoints.

Reference Accuracy

Stated reference accuracy includes hysteresis, terminal-based linearity, setability, and repeatability.

3051CD Ranges 2–5 and 3051CG

±0.075% of span.
For spans less than 10:1, accuracy =

$$\pm\left[0.025 + 0.005\left(\frac{URL}{Span}\right)\right]\% \text{ of Span}$$

3051CD Range 1

±0.10% of span.
For spans less than 15:1, accuracy =

$$\pm\left[0.025 + 0.005\left(\frac{URL}{Span}\right)\right]\% \text{ of Span}$$

3051CD Range 0

±0.10% of span.
For spans less than 2:1, accuracy =
±0.05% of URL.

3051T/CA Ranges 1–5

±0.075% of span.
For spans less than 10:1, accuracy =

$$\pm\left[0.0075\left(\frac{URL}{Span}\right)\right]\% \text{ of Span}$$

3051CA Range 0

±0.075% of span.
For spans less than 5:1, accuracy =

$$\pm\left[0.025 + 0.01\left(\frac{URL}{Span}\right)\right]\% \text{ of Span}$$

3051H/3051L

±0.075% of span. For spans less than 10:1, accuracy =

$$\pm\left[0.025 + 0.005\left(\frac{URL}{Span}\right)\right]\% \text{ of Span}$$

3051P

±0.05% of span.

Ambient Temperature Effect per 50 °F (28 °C)

3051CD/CG
±(0.0125% URL + 0.0625% span) from 1:1 to 5:1
±(0.025% URL + 0.125% span) from 5:1 to 100:1

Range 0: ±(0.25% URL + 0.05% span)
Range 1: ±(0.1% URL + 0.25% span)

3051P
±(0.006% URL + 0.03% span)

3051H
±(0.025% URL + 0.125% span + 0.35 inH$_2$O)

For spans below 30:1 rangedown:
±(0.035% URL + 0.125% span + 0.35 inH$_2$O)

3051L
See the Rosemount Instrument Toolkit™ or SOAP 2000 software.

3051T and 3051CA
±(0.025% URL + 0.125% span) from 1:1 to 30:1
±(0.035% URL + 0.125% span) from 30:1 to 100:1

Range 0: ±(0.1% URL + 0.25% span)
Range 5: ±(0.1% URL + 0.15% span)

Model 3051T Range 1:
±(0.025% URL + 0.125% span) from 1:1 to 10:1
±(0.05% URL + 0.125% span) from 10:1 to 100:1

Static Pressure Effect per 1000 psi (6,9 MPa)

3051CD

Zero Error (can be calibrated out at line pressure)
±0.05% of URL for line pressures from 0 to 2000 psi (0 to 13,7 MPa)

For static pressures above 2000 psi (13,7 MPa), see user manual (Rosemount publication number 00809-0100-4001)

Range 0: ±0.125% of span/100 psi (689 kPa)
Range 1: ±0.25% of URL

Span Error
±0.1% of reading

Range 0: ±0.125% of span/100 psi (689 kPa)
Range 1: ±0.4% of reading

3051P

Zero Error (can be calibrated out at line pressure)
±0.04% of URL

Span Error
±0.10% of reading

3051HD

Zero Error (can be calibrated out at line pressure)
±0.1% of URL for line pressures from 0 to 2000 psi (0 to 13,7 MPa)

For static pressures above 2000 psi (13,7 MPa), see user manual (Rosemount publication number 00809-0100-4001)

Span Error
±0.1% of reading

Dynamic Performance

Dead Time and Update Rate applies to all models and ranges, analog output only.

Dead Time (T_d): 45 milliseconds (nominal)
Update Rate: 22 times per second
Total Response Time ($T_d + T_c$):
3051C/P
100 milliseconds for ranges 2–5
255 milliseconds for range 1
700 milliseconds for range 0
3051T
100 milliseconds for ranges 1–6
3051H/3051L
Consult factory

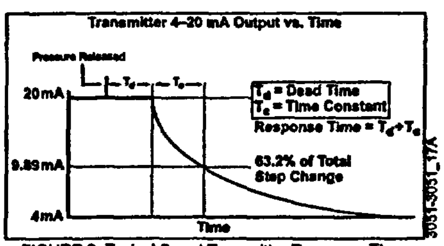


FIGURE 3. Typical Smart Transmitter Response Time

Mounting Position Effects

3051C/P

Zero shifts up to ±1.25 inH_2O (0,31 kPa), which can be calibrated out. No span effect.

3051H

Zero shifts up to ±5 inH_2O (127 mmH_2O), which can be calibrated out. No span effect.

3051L

With liquid level diaphragm in vertical plane, zero shift of up to 1 inH_2O (25,4 mmH_2O).

With diaphragm in horizontal plane, zero shift of up to 5 inH_2O (127 mmH_2O) plus extension length on extended units. All zero shifts can be calibrated out. No span effect.

3051T/CA

Zero shifts up to 2.5 inH_2O (63,5 mmH_2O), which can be calibrated out. No span effect.

Vibration Effect

All Models

Measurement effect due to vibrations is negligible except at resonance frequencies. When at resonance frequencies, vibration effect is less than ±0.1% of URL per g when tested between 15 and 2000 Hz in any axis relative to pipe-mounted process conditions.

Power Supply Effect

All Models

Less than ±0.005% of calibrated span per volt.

RFI Effects

All Models

±0.1% of span from 20 to 1000 MHz and for field strenth up to 30 V/m.

Transient Protection (Option Code T1)

All Models

Meets IEEE Standard 587, Category B

1 kV crest (10 × 1 000 microseconds)
3 kV crest (8 × 20 microseconds)
6 kV crest (1,2 × 50 microseconds)

Meets IEEE Standard 472,
Surge Withstand Capability

SWC 2,5 kV crest, 1 MHz wave form

General Specifications:

Response Time	< 1 nanosecond
Peak Surge Current	5000 amps to housing
Peak Transient Voltage	100 V dc
Loop Impedance	< 25 ohms
Applicable Standards	IEC 801-4, IEC 801-5

Note:
Calibrations at 68 °F (20 °C) per ASME Z210.1 (ANSI).

FUNCTIONAL SPECIFICATIONS

Range and Sensor Limits

TABLE 1. Model 3051CD, 3051CG, 3051P, 3051L, and 3051H Range and Sensor Limits

Range	Minimum Span		Range and Sensor Limits							
	Model 3051 CD, CG, L, H	Model 3051P	Upper (URL)	Lower (LRL)						
				3051C Differential	3051C/P Gage	3051P Differential	3051L Differential	3051L Gage	3051H Differential	3051H Gage
0	0.1 inH$_2$O (25 Pa)	NA	3.0 inH$_2$O (750 Pa)	–3.0 inH$_2$O (–750 Pa)	NA	NA	NA	NA	NA	NA
1	0.5 inH$_2$O (0,12 kPa)	NA	25 inH$_2$O (6,22 kPa)	–25 inH$_2$O (–6,22 kPa)	NA	NA	NA	NA	NA	NA
2	2.5 inH$_2$O (0,62 kPa)	25 inH$_2$O (6,22 kPa)	250 inH$_2$O (62,2 kPa)	–250 inH$_2$O (–62,2 kPa)	–250 inH$_2$O (–62,2 kPa)	–250 inH$_2$O (–62,2 kPa)	–250 inH$_2$O (–62,2 kPa)	–250 inH$_2$O (–62,2 kPa)	–250 inH$_2$O (–62,2 kPa)	–250 inH$_2$O (–62,2 kPa)
3	10 inH$_2$O (2,48 kPa)	100 inH$_2$O (24,8 kPa)	1000 inH$_2$O (248 kPa)	–1000 inH$_2$O (–248 kPa)	0.5 psia (3,5 kPa abs)	–1000 inH$_2$O (–248 kPa)	–1000 inH$_2$O (–248 kPa)	0.5 psia (3,5 kPa abs)	–1000 inH$_2$O (–248 kPa)	0.5 psia (3,5 kPa abs)
4	3 psi (20,7 kPa)	30 psi (207 kPa)	300 psi (2 070 kPa)	–300 psi (–2 070 kPa)	0.5 psia (3,5 kPa abs)	–300 psi (–2 070 kPa)	–300 psi (–2 070 kPa)	0.5 psia (3,5 kPa abs)	–300 psi (–2 070 kPa)	0.5 psia (3,5 kPa abs)
5	20 psi (138 kPa)	200 psi (1 380 kPa)	2000 psi (13 800 kPa)	– 2000 psi (–13 800 kPa)	0.5 psia (3,5 kPa abs)	– 2000 psi (–13 800 kPa)	NA	NA	– 2000 psi (–13 800 kPa)	0.5 psia (3,5 kPa abs)

TABLE 2. Model 3051CA Range and Sensor Limits

Range	Minimum Span	Range and Sensor Limits	
		Upper (URL)	Lower (LRL)
0	0.167 psia (8,6 mmHga)	5 psia (260 mmHga)	0 psia (0 mmHga)
1	0.3 psia (2,07 kPa)	30 psia (206,8 kPa)	0 psia (0 kPa)
2	1.5 psia (10,34 kPa)	150 psia (1 034,2 kPa)	0 psia (0 kPa)
3	8 psia (55,16 kPa)	800 psia (5 515,8 kPa)	0 psia (0 kPa)
4	40 psia (275,8 kPa)	4000 psia (27 580 kPa)	0 psia (0 kPa)

TABLE 3. Model 3051T Range and Sensor Limits

Range	Minimum Span	Range and Sensor Limits		
		Upper (URL)	Lower (LRL) (Abs.)	Lower[(1)] (LRL) (Gage)
1	0.3 psi (2 kPa)	30 psi (207 kPa)	0 psia (0 kPa)	–14.7 psig (–101 kPa)
2	1.5 psi (10 kPa)	150 psi (1 034 kPa)	0 psia (0 kPa)	–14.7 psig (–101 kPa)
3	8 psi (55 kPa)	800 psi (5 516 kPa)	0 psia (0 kPa)	–14.7 psig (–101 kPa)
4	40 psi (276 kPa)	4000 psi (27 579 kPa)	0 psia (0 kPa)	–14.7 psig (–101 kPa)
5	2000 psi (13 790 kPa)	10000 psi (68 948 kPa)	0 psia (0 kPa)	–14.7 psig (–101 kPa)

(1) Assumes atmospheric pressure of 14.7 psig.

Zero and Span Adjustment Requirements

- Zero and span values can be set anywhere within the range limits stated in Tables 1–3.
- Span must be greater than or equal to the minimum span stated in Tables 1–3.

Service
Liquid, gas, and vapor applications.

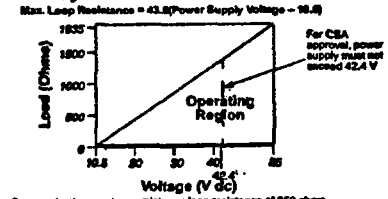
4–20 mA (Output Code A)

Output
Two-wire 4–20 mA, user-selectable for linear or square root output. Digital process variable superimposed on 4–20 mA signal, available to any host that conforms to the HART protocol.

Power Supply
External power supply required. Standard transmitter (4–20 mA) operates on 10.5 to 55 V dc with no load.

Load Limitations
Maximum loop resistance is determined by the voltage level of the external power supply, as described by:

Max. Loop Resistance = 43.5(Power Supply Voltage – 10.5)



Communication requires a minimum loop resistance of 250 ohms.

ATTACHMENT 4

NUCLEAR MANAGEMENT COMPANY
PALISADES NUCLEAR PLANT
DOCKET 50-255

October 6, 2003

LICENSE AMENDMENT REQUEST: INCREASE RATED THERMAL POWER – REFERENCE 9.10: EA-RCH-01-05, "Calculation of Chapter 14 Safety Analysis Parameter Changes Due to FC-977 Power Uprate," Revision 1

36 Pages Follow

REFERENCE 9.10

EA-RCH-01-05

PALISADES NUCLEAR PLANT
ENGINEERING ANALYSIS COVER SHEET

Total Pages 38

Title:CALCULATION OF CHAPTER 14 SAFETY ANALYSIS PARAMETER CHANGES DUE TO FC-977 POWER UPRATE

INITIATION AND REVIEW											
Calculation Status		Preliminary	Pending X	Final	Superseded						
		Initiated			Review Method			Technically Reviewed			
Rev.	Description	By	Date	Init. Appd. By	Alternate Calc	Detailed Review	Qual Test	By	Date	Revr. Appd. By	Sup'v & SDR Appd. By
0	Original Issue	R.C. Harvill	9/27/2001	RSH		X		J.A. Meincke	9/27/2001		
1	New MFW Temperature	R.C. Harvill	7/30/2002	3AB		✓		DH Kennedy	7/30/02		BAB

PURPOSE:

1) To identify and quantify all safety analysis inputs that are affected by the 1.4% power uprate associated with FC-977

PROCEDURE UTILIZED:
Admin 9.11

SUMMARY OF RESULTS:

The proposed power uprate impacts several plant parameters that are inputs into safety analysis. The affected parameters are listed below with their values at 100% power and at 101.4% power.

	100%	101.4%
Reactor Power	2530 MW_t	2,565.4 MW_t
Cold Leg Temperature	537.3°F	537.0°F
Hot Leg Temperature	582.7°F	583.0°F
Steam Generator Pressure	770 psia	765.8 psia
Main Feedwater Temperature	439.5°F	440.7°F
Main Steam Flow	11.114 Mlb_m/hr	11.297 Mlb_m/hr
Main Feed Flow	11.174 Mlb_m/hr	11.357 Mlb_m/hr
Steam Generator Liquid Inventory	133,593 lb_m	132,531 lb_m
Steam Generator Vapor Inventory	8,545 lb_m	8,534 lb_m

This calculation is to be considered Pending until the predicted parameters can be validated following implementation of the power uprate.

SPECIAL MEDIA ATTACHED (DRAWINGS, MICROFICE, MAGNETIC TAPE, ETC...)
X No ___ Yes - List of Attachments Included.

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1.0 OBJECTIVE

As a result of uncertainty in thermal power measurement, the NRC established a 2% margin in Appendix K. The thermal power measurement equipment currently installed in nuclear plants is far more accurate than 2%. The NRC is permitting plants to execute small power uprates based on the difference between the 2% margin and the justifiable accuracy of the instrumentation (Reference 1). It is Palisades' intention to perform a 1.4% power uprate (FC-977). The objective of this analysis is to identify and quantify all safety analysis inputs that are affected by this modification.

Furthermore, during the 2001 Refueling Outage, the Palisades high pressure turbine was replaced. After start-up, this resulted in a consistently elevated Main Feedwater temperature in excess of the temperature predicted for uprate conditions. The primary purpose of Revision 1 is to calculate a new Main Feedwater temperature for uprate conditions. A secondary purpose is to correct an incorrect assumption. In Revision 0 of this analysis, Assumption 3.10 stated that "The pressurizer proportional heaters are assumed to be 50% energized. Discussions with an SRO indicated that while the proportional heaters are almost always energized, at 2060 psia only 50% of the proportional heaters are energized." This assumption is incorrect in that all of the heaters are almost always energized and the primary means of pressure control is Pressurizer spray.

2.0 REFERENCES

1. Small Power Uprates Under Appendix K – Benefits and Considerations, EPRI Technical Report, November 2000.

2. Palisades Updated Final Safety Analysis Report, Revision 22.

3. Combustion Engineering Analysis 82688-ST-602, Steam Generator Secondary Inventory.

4. ASME Steam Tables, Fourth Edition, 1979, The American Society of Mechanical Engineers, New York.

5. Marks' Standard Handbook for Mechanical Engineers, 10th Edition, McGraw Hill, Boston, 1996.

6. Letter from J.C. Lowry to P.W. Wellhouer, Palisades Replacement Steam Generator Parameters, ATH-89-238, November 1, 1989.

7. Letter from G.E. Jarka (Palisades) to R. Wescott (Siemens Power Corporation), New PCS and Core Flow Assumptions, GEJ97*17, October 24, 1997.

8. EA-PPD-00-01, Revision 1, Palisades Cycle 16 Principal Plant Parameters.

9. Letter from T.A. Garvin to Burt Stacks, HP Turbine Replacement – Thermal Kit, February 21, 2001.

10. Letter from T.A. Garvin to Burt Stacks, HP Turbine Replacement – Correct 100% HB and Correction Curves, May 1, 2001.

11. EA-RCH-02-04, Revision 0, Calculation of Palisades Main Feedwater Temperature and Flowrate and Main Steam Flowrate due to Secondary System Changes Resulting from High Pressure Turbine Replacement.

3.0 ASSUMPTIONS

3.1 Major Assumptions

3.1.1 The PCS temperature differential across the core is assumed to be the difference between hot leg temperature and cold leg temperature.

3.1.2 Primary coolant leaving the reactor is assumed not to cool down on its way to the steam generator. Hence, the PCS temperature entering the steam generator is the same as hot leg temperature.

3.1.3 PCS mass flow is assumed to be equally divided among the PCS loops.

3.1.4 While the overall steam generator u-tube heat transfer coefficient may vary slightly with a change in power, Palisades does not have the capability to model the change. Because a 1.4% increase in power is small, the change in heat transfer coefficient is small. For the purpose of this analysis, the overall heat transfer coefficient is assumed to be a constant.

3.1.5 Steam generator pressure at 100% power is assumed to be 770 psia. It is listed as 770 psia in Table 4-4 of Reference 2 and in Reference 3. However, a review of plant operating records indicates that steam generator pressure typically is between 780 and 790 psia. This is not considered to be a problem because the current steam generator tube plugging is between 4% and 5%. Safety analysis credits 15% tube plugging. The saturation temperature associated with 770 psia is 513.8°F (Reference 4).

3.1.6 Primary Coolant Pump power is assumed to be unchanged by the power uprate.

3.1.7 Steam Generator Blowdown flow is assumed to be at is maximum allowed value and at saturated conditions.

3.1.8 The pressurizer proportional heaters are assumed to be 100% energized. Discussions with the Primary Coolant system engineer indicated that the proportional heaters are almost always energized.

3.1.9 In the heat balance used to calculate the new Main Steam and Main Feedwater flows, ambient heat losses and losses to the Non-Regenerative Heat Exchanger in the CVCS system are not modeled because they are not modeled in Reload safety analyses.

3.2 Minor Assumptions

3.2.1 The incoming Main Feedwater is assumed to be at Steam Generator pressure.

3.2.2 While the specific heat capacity, c_p, of primary coolant is moderately temperature dependent, it is assumed to be constant for the purpose of this calculation.

4.0 INPUTS

4.1 100% reactor power is 2530 MW_t (Reference 2, Table 4-1).

4.2 At 100% power, T_{AVE}, T_{Cold} and T_{Hot} are 560.0°F, 537.3°F and 582.7°F, respectively (Reference 2, Figure 4-9).

4.3 At 100% power, the programmed pressurizer level is 57% (Reference 2, Figure 4-10).

4.4 The power associated with all four primary coolant pumps is 15 MW_t (Reference 2, Table 4-1).

4.5 The power associated with the pressurizer back-up heaters is 1,350 kW. The power associated with the pressurizer proportional heaters is 150 kW (Reference 2, Section 4.3.7).

4.6 Steam Generator maximum blowdown flow at 100% power is 30,000 lb_m/hr per steam generator (Reference 2, Section 10.2.1.5).

4.7 The conversion factor from MW_t to BTU/hr is 1 BTU/hr = 0.293 W (Reference 5).

4.8 The enthalpy of Main Steam at the pressure calculated in Section 5.4 is 1200.3 BTU/lb_m (Reference 4).

4.9 The enthalpy of Blowdown at the pressure calculated in Section 5.4 is 503.7 BTU/lb_m (Reference 4).

4.10 The enthalpy of Main Feedwater at the pressure calculated in Section 5.5 (Minor Assumption 3.2.1) and at the temperature determined in Section 5.6 is 420.1 BTU/lb_m (Reference 4).

4.11 The liquid mass of each steam generator is 203,783 lb_m at 0% power and 133,593 lb_m, at 100% power. The total mass inventory of each steam generator is (Reference 6)

% Power	Total Mass (lb_m)
0	210,759
25	188,925
50	168,583
75	153,910
100	142,138

4.12 The Main Feedwater temperature at 100% power, 2530 MW, is 439.5°F (Reference 12).

4.13 Attachments 1 through 7 show the behavior of Main Feedwater temperature during Ultrasonic Flowmeter (UFM) correction factor implementation for the following dates: July 14, 2000; August 10, 2000; September 22, 2000; November 1, 2000; February 6, 2001; May 25, 2001; and February 20, 2002. These dates represent the times within the past two years in which UFM correction factors were implemented from an uncorrected state. The basis for the past two years is that that is the available data on the Plant Process Computer.

5.0 ANALYSIS

5.1 Calculation of Reactor Power

As discussed in Input 4.1, reactor power is 2530 MW_t at 100% power. The power uprate calls for a 1.4% increase in reactor power. The resulting power is 2565.4 MW_t.

5.2 Calculation of PCS Temperatures

One option to address the impact of the power uprate on PCS temperature is to linearly extrapolate the PCS temperature curves of Reference 2, Figure 4-9, from 100% power to 101.4% power. Because this would require changing the plant's PCS temperature program as a function of power and could impact the risk level of Alloy 600 nozzle cracking by increasing hot leg temperature, the decision was made to leave the temperature programming as it currently is. However, T_{Cold} and T_{Hot} will change as a result of the increase in core differential temperature associated with an increase in core power without an increase in core flow.At 100% power, T_{Cold} and T_{Hot} are 537.3°F and 582.7°F, respectively (Input 4.2). The core differential temperature at 101.4% power is

$$(\Delta T_{Core})_{101.4\%} = \frac{101.4\%}{100\%}(T_{Hot} - T_{Cold})_{100\%}. \quad [1]$$

Cold Leg Temperature at 101.4% power is

$$(\Delta T_{Cold})_{101.4\%} = \frac{1}{2}\Delta T_{Core} + T_{AVE}. \quad [2]$$

Hot Leg Temperature at 101.4% power is

$$(\Delta T_{Hot})_{101.4\%} = T_{AVE} - \frac{1}{2}\Delta T_{Core}. \quad [3]$$

Use of [1], [2] and [3] yields T_{Cold} and T_{Hot} of 537.0°F and 583.0°F, respectively, at 101.4% power.

5.3 Determination of Maximum Core Inlet Temperature

Per Reference 7, the maximum core inlet temperature allowed by the T_{Inlet} LCO equation is 543.64°F. Palisades Safety Analysis assumes a maximum core inlet temperature of 544°F (Reference 8). From Section 5.2, the power uprate decreases T_{cold} from 537.3°F to 537.0°F. The maximum inlet temperature assumption remains bounding.

5.4 Determination of Pressurizer Level

Because of the decision not to modify the PCS temperature curves as a result of the power uprate, it is appropriate to maintain Pressurizer level programming as is. Hence, Pressurizer level at 101.4% power is unchanged from the 57% level at the current 100% power (Input 4.3).

5.5 Calculation of Steam Generator Pressure and Temperature

Heat transfer from the primary coolant to the steam generator is

$$Q_{SG} = UA(T_{PC} - T_{SG}), \quad [4]$$

where Q_{SG} is the heat transfer rate from the primary coolant to the steam generator, U is a heat transfer coefficient, A is the heat transfer area, T_{PC} is average temperature of the primary coolant passing through the steam generator and T_{SG} is the temperature of the steam generator water. The average primary coolant temperature used in this calculation, as opposed to the industry standard T_{AVE}, is

$$T_{PC} = \frac{T_{SGin} + T_{SGout}}{2}, \quad [5]$$

where T_{SGin} is the temperature of the primary coolant entering the steam generator and T_{SGout} is the temperature of the primary coolant leaving the steam generator. As discussed in Major Assumption 3.1.2, T_{SGin} is the same as T_{Hot}. T_{SGout}, however, is not identical to T_{Cold} because there is heat addition from the primary coolant pumps. It is

$$T_{SGout} = T_{Cold} - \Delta T_{PCP}, \quad [6]$$

where ΔT_{PCP} is the change in PCS temperature due to heat addition from the primary coolant pumps. The relationship between reactor power and core differential temperature is

$$Q_{Rx} = \dot{m}c_p(T_{Hot} - T_{Cold}), \quad [7]$$

where Q_{Rx} is the 100% reactor power of 2530 MW (Input 4.1), $\dot{m}$ is the flow rate of PCS water through the reactor and c_p is the specific heat capacity of the PCS water (Minor Assumption 3.2.2). Likewise, the relationship between coolant pump power and pump differential temperature is

$$Q_{PCP} = \dot{m}c_p(T_{PCPout} - T_{PCPin}), \quad [8]$$

where Q_{PCP} is the primary coolant pump power of 15 MW (Input 4.4), m is the flow rate of PCS water through the reactor coolant pumps (Major Assumption 3.1.3). T_{PCPout} is identical to T_{Cold}, and T_{PCPin} is identical to T_{SGout}.

Because the collective flow rate through the coolant pumps is identical to the flow rate through the reactor and because heat capacity is assumed to be a constant,

$$(\dot{m}c_p)_{Rx} = (\dot{m}c_p)_{PCP} = k, \qquad [9]$$

where k is a constant. [7] and [8] can be ratioed to become

$$\frac{Q_{Rx}}{Q_{PCP}} = \frac{k(T_{Hot} - T_{Cold})}{k(T_{PCPout} - T_{PCPin})}. \qquad [10]$$

With substitution and simplification, [10] becomes

$$T_{SGout} = T_{Cold} - \frac{Q_{PCP}}{Q_{Rx}}(T_{Hot} - T_{Cold}). \qquad [11]$$

Application of a ratio of 101.4% power and 100% power to [4] yields

$$\frac{[Q_{SG}]_{101.4\%}}{[Q_{SG}]_{100\%}} = \frac{[UA(T_{PC} - T_{SG})]_{101.4\%}}{[UA(T_{PC} - T_{SG})]_{100\%}}. \qquad [12]$$

A is a constant because heat transfer area is not affected. As discussed in Major Assumption 3.1.4, U is assumed to be a constant. [12] simplifies to

$$[T_{SG}]_{101.4\%} = [T_{PC}]_{101.4\%} - 1.014 * [T_{PC} - T_{SG}]_{100\%}. \qquad [13]$$

Application of Inputs 4.1, 4.2 and 4.4 to [11] yields a T_{SGout} of 537.0°F at 100% power. As discussed in Major Assumption 3.1.2, T_{SGin} is the same as T_{Hot}, 582.7°F at 100% power. From [5], T_{PC} is 559.9°F at 100% power. As discussed in Major Assumption 3.1.5, T_{SG} is 513.8°F at 100% power. Application of Major Assumption 3.1.6 and the results of Section 5.2 to [11] yields a T_{SGout} of 536.7°F. From Major Assumption 3.1.2 and the results of Section 5.2, T_{SGin} is 583.0°F. From [5], T_{PC} is 559.9°F. Application of [13] yields a T_{SG} of 513.2°F. From Reference 4, the corresponding saturation pressure is 765.8 psia.

5.6 Determination of Main Feedwater Temperature

As discussed in Input 4.12, the Main Feedwater temperature is 439.5°F at 100% power, 2530 MW. Revision 0 of this analysis had predicted a temperature of 438.5°F, which is an obsolete value. The means of predicting the increase in Main Feedwater temperature as a result of the 1.4% uprate relies on Main Feedwater temperature behavior when Ultrasonic Flowmeter (UFM) correction factors are implemented. At plant start-up, the UFMs are uncorrected such that the correction factor is 1.00. Application of a correction factor of 0.986 reduces indicated Main Feedwater flow by 1.4% and results in calculated calorimetric power being reduced by 1.4%, permitting a 1.4% (1.00 / 0.986 = 1.014) increase in reactor power. Comparison of Main Feedwater temperature before and after implementation of the UFM correction factor allows for prediction of Main Feedwater temperature behavior as a result of a 1.4% power uprate. As discussed in Input 4.13, data is available regarding Main Feedwater temperature before and after a UFM correction factor implementation. The data are shown in the table below. Each date has two sets of data. The upper set is for the "A" Steam Generator, and the lower set is for the "B" Steam Generator. Note that only once in this data set has a UFM been corrected to 0.986.

Date	MFW Temperature (Before)	MFW Temperature (After)	Difference	Correction Factor
July 14, 2000	432.3	434.1	1.8	0.984
	432.4	434.5	2.1	0.981
August 10, 2000	431.8	433.6	1.8	0.984

	431.9	433.6	1.7	0.981
September 22, 2000	432.3	433.9	1.6	0.985
	432.4	434.0	1.6	0.982
November 1, 2000	432.3	432.5	0.2	0.985
	432.5	432.7	0.2	0.982
February 6, 2001	429.2	434.0	4.8	0.984
	429.5	434.3	4.8	0.982
May 25, 2001	437.5	438.7	1.2	0.989
	437.9	439.2	1.2	0.983
February 20, 2002	438.0	439.2	1.2	0.986
	438.2	439.4	1.2	0.983

The data from November 1, 2001, represent a situation in which reactor power was not increased to the new 100% power following implementation of UFM correction factors. The data from February 6, 2001 represent a situation in which power was 96.3% prior to implementation of UFM correction factors and 99.6% following implementation. The rise in power was in excess of 3%, resulting in a significant difference in Main Feedwater temperature before and after implementation of UFM correction factors. The one time, February 20, 2002, that the correction factor was 0.986, the change in Main Feedwater temperature was 1.2°F, the same change seen when a correction factor of 0.989 was implemented on May 25, 2001. While the analyst would expect the change in temperature to be 1.4°F for a correction factor of 0.986 (The temperature change for a correction factor of 0.984 was 1.8°F, and the change for a correction factor of 0.985 was 1.6°F.), the only data point available shows a temperature change of 1.2°F. For this reason, the predicted increase in Main Feedwater temperature due to a 1.4% power uprate is 1.2°F, resulting in a Main Feedwater temperature of 440.7°F.

5.7 Calculation of Main Feedwater and Main Steam Flow Rate

To obtain the Main Steam and Main Feedwater flows at 101.4% power, a mass balance and an energy balance must be performed. The fundamental equation for either balance is

$$Input - Output = Storage . \qquad [14]$$

For a steady state system, the storage term is zero. For the mass balance, the input is Main Feedwater flow, $\dot{m}_{fw}$. The output terms are Main Steam flow, $\dot{m}_{stm}$, and Blowdown flow, $\dot{m}_{bld}$ (Major Assumption 3.1.7). Hence, the mass balance is

$$\dot{m}_{fw} - \dot{m}_{stm} - \dot{m}_{bld} = 0 . \qquad [15]$$

For the energy balance, the inputs are Reactor power, P_{RX}, the Primary Coolant Pump power, P_{PCP}, the Pressurizer proportional heaters' power, P_{PZR}, and the energy associated with the incoming feedwater. The outputs are the energy associated with the outgoing steam and blowdown flow. The energy balance is

$$P_{RX} + P_{PCP} + P_{PZR} + \dot{m}_{fw} h_{fw} - \dot{m}_{stm} h_{stm} - \dot{m}_{bld} h_{bld} = 0 . \qquad [16]$$

From [15] and [16], the reactor power calculated in Section 5.1, the pump power of Input 4.4, the pressurizer heater power of Input 4.5 and Major Assumption 3.1.8, the Blowdown flow of Input 4.6 and Major Assumption 3.1.7, and the enthalpies of Inputs 4.8, 4.9 and 4.10, the Main Steam and Main Feedwater flows are calculated as follows:

$$\dot{m}_{stm} = \frac{(60{,}000\ lbm/hr)(503.7\ BTU/lbm - 420.7\ BTU/lbm) - (2530\ MW + 15\ MW + 1.5\ MW)(1\ BTU/lbm/0.293\ W)(10^6\ W/MW)}{420.7\ BTU/lbm - 1200.3\ BTU/lbm} = 11{,}297{,}000\ lbm/hr \quad [17]$$

and

$$\dot{m}_{fw} = 11{,}297{,}000\ lbm/hr + 60{,}000\ lbm/hr = 11{,}375{,}000\ lbm/hr. \quad [18]$$

5.8 Determination of Steam Generator Mass Inventory

The vapor mass inventory of each steam generator is the difference between the total mass inventory and the liquid mass inventory. From Input 4.11, the vapor mass inventory is 6,976 lb_m for 0% power and 8,545 lb_m for 100% power, and the liquid mass inventory is 210,759 lb_m for 0% power and 142,138 lb_m for 100% power. The steam generator mass inventory is 6.01% vapor at 100% power and 3.31% vapor at 0% power, with the vapor percentage increasing at a rate of 0.027% per percent power. As discussed in Section 5.5, steam generator pressure decreases from 770 psia to 765.8 psia and temperature decreases from 513.8°F to 513.2°F. At 770 psia and 513.8°F, liquid density is 48.17 lb_m/ft^3 and vapor density is 1.69 lb_m/ft^3. At 765.8 psia and 513.2°F, liquid density is 48.20 lb_m/ft^3 and vapor density is 1.68 lb_m/ft^3. At 100% power, the vapor volume is 5,056.2 ft^3, and the liquid volume is 2,773.4 ft^3. The total volume is 7829.6 ft^3. At 101.4% power, the steam generator mass is 6.05% (6.01% + 1.4 * 0.027%) vapor and 93.95% liquid. The total steam generator mass is

$$m_{total} = m_{liquid} + m_{vapor} = \rho_{liquid} * V_{liquid} + \rho_{vapor} * V_{vapor}. \quad [19]$$

where m is mass, ρ is density and V is volume. As discussed above,

$$m_{liquid} = 0.9395 * m_{total} \quad [20]$$

and

$$m_{vapor} = 0.0605 * m_{total}. \quad [21]$$

It is also known that

$$V_{total} = V_{liquid} + V_{vapor}. \quad [22]$$

[19], [20], [21] and [22] can be combined into the simultaneous equations

$$0.9395 * m_{total} = \rho_{liquid} * V_{liquid}$$
$$0.0605 * m_{total} = \rho_{vapor} * (V_{total} - V_{liquid}). \quad [23]$$

Using a liquid density of 48.20 lb_m/ft^3, a vapor density of 1.68 lb_m/ft^3 and a total volume of 7829.6 ft^3, the liquid volume is determined to be 2749.6 ft^3. The vapor volume is subsequently determined to be 5080 ft^3. With the above volumes and densities, the liquid mass is 132,531 lb_m, and the vapor mass is 8,534 lb_m. These steam generator masses are expected to be the correct values at 101.4% power.

5.9 Disposition of Steam Generator Recirculation Ratio

The steam generator recirculation ratios listed in Reference 6 were calculated using the CRIBE code. Current Framatome safety analysis uses RELAP to model the primary and secondary systems. The preparer of this calculation has experience in modeling steam generators in RELAP. While it is possible for RELAP to match liquid inventory and downcomer level with the CRIBE results, which is very important for the Loss of Normal Feedwater analysis, it is impossible to match recirculation ratio. In addition, the recirculation ratio is a very unimportant parameter and, at best, might be used to compare the RELAP steam generator model with the CRIBE model . For this reason, the recirculation ratio at 101.4% power is not calculated in this analysis.

6.0 CONCLUSIONS

The proposed power uprate impacts several plant parameters that are inputs into safety analysis. The parameters are listed below with their values at 100% power and at 101.4% power.

	100%	101.4%
Reactor Power	2530 MW_t	2,565.4 MW_t
Cold Leg Temperature	537.3°F	537.0°F
Hot Leg Temperature	582.7°F	583.0°F
Steam Generator Pressure	770 psia	765.8 psia
Main Feedwater Temperature	439.5°F	440.7°F
Main Steam Flow	11.114 Mlb_m/hr	11.297 Mlb_m/hr
Main Feed Flow	11.174 Mlb_m/hr	11.357 Mlb_m/hr
Steam Generator Liquid Inventory	133,593 lb_m	132,531 lb_m
Steam Generator Vapor Inventory	8,545 lb_m	8,534 lb_m

7.0 LIST OF ATTACHMENTS

Attachment 1 – Plant Process Computer Data for July 14, 2000, UFM Correction Factor Implementation
Attachment 2 – Plant Process Computer Data for August 10, 2000, UFM Correction Factor Implementation
Attachment 3 – Plant Process Computer Data for September 22, 2000, UFM Correction Factor Implementation
Attachment 4 – Plant Process Computer Data for November 1, 2000, UFM Correction Factor Implementation
Attachment 5 – Plant Process Computer Data for February 6, 2001, UFM Correction Factor Implementation
Attachment 6 – Plant Process Computer Data for May 25, 2001, UFM Correction Factor Implementation
Attachment 7 – Plant Process Computer Data for February 20, 2002, UFM Correction Factor Implementation
Attachment 8 – Administrative Required Documents

PALISADES NUCLEAR PLANT
ENGINEERING ANALYSIS CONTINUATION SHEET

Attachment 1
Plant Process Computer Data for July 14, 2000, UFM Correction Factor Implementation

219 DEVIATION REPORT

GROUP 21 PAL
PAGE 1 07/23/2002 09:26:35

DEVIATION GROUP 21

1 UFM_CORR_SGA ratio
2 UFM_CORR_SGB ratio
3 HB_PWR_STEADY percent
4

07/04/2000	DEV 1	AVE	DEV 2	AVE	DEV 3	AVE	DEV 4	AVE
07/04	0.000?	1.000	0.000?	1.000	1.328	6.180		
07/05	0.000?	1.000	0.000?	1.000	0.199	3.740		
07/06	0.000?	1.000	0.000?	1.000	4.078	8.789		
07/07	0.000?	1.000	0.000?	1.000	0.000	5.482		
07/08	0.000?	1.000	0.000?	1.000	0.000#	0.000		
07/09	0.000?	1.000	0.000?	1.000	18.897	26.712		
07/10	0.000?	1.000	0.000?	1.000	10.737	89.629		
07/11	0.000?	1.000	0.000?	1.000	0.100	99.730		
07/12	0.000?	1.000	0.000?	1.000	0.049	99.830		
07/13	0.000?	1.000	0.000?	1.000	0.041	99.797		
07/14	0.008?	0.991	0.009?	0.989	0.500	99.513		
07/15	0.000?	0.984	0.000?	0.981	0.051	99.778		
07/16	0.000?	0.984	0.000?	0.981	0.047	99.813		
07/17	0.000?	0.984	0.000?	0.981	0.039	99.805		
07/18	0.000?	0.984	0.000?	0.981	0.041	99.805		
07/19	0.000?	0.984	0.000?	0.981	0.037	99.808		
07/20	0.000?	0.984	0.000?	0.981	0.040	99.802		
07/21	0.000?	0.984	0.000?	0.981	0.044	99.800		
07/22	0.000?	0.984	0.000?	0.981	0.041	99.806		
07/23	0.000?	0.984	0.000?	0.981	0.041	99.812		
07/24	0.000?	0.984	0.000?	0.981	0.043	99.805		
07/25	0.000?	0.984	0.000?	0.981	0.699	99.298		
07/26	0.000?	0.984	0.000?	0.981	0.260	99.656		
07/27	0.000?	0.984	0.000?	0.981	0.071	99.839		
07/28	0.000?	0.984	0.000?	0.981	0.040	99.904		
07/29	0.000?	0.984	0.000?	0.981	0.044	99.891		
07/30	0.000?	0.984	0.000?	0.981	0.048	99.904		
07/31	0.000?	0.984	0.000?	0.981	0.049	99.894		
08/01	0.000?	0.984	0.000?	0.981	0.042	99.916		
08/02	0.000?	0.984	0.000?	0.981	0.065	99.875		
08/03	0.000?	0.984	0.000?	0.981	0.047	99.887		

F13 DEV PAGES | F14 SHIFT <<<-- | F15 SHIFT -->>> | OK

219 DEVIATION REPORT

GROUP 20 PAGE 1 PAL 07/23/2002 09:11:46

DWT-8 / MT-15

1 TT_0708A deg F
2 TT_0706A deg F
3 FEEDWTR_FLOW_SGA_AVG lbm/hr
4 FEEDWTR_FLOW_SGB_AVG lbm/hr

07/04/2000	DEV 1	AVE	DEV 2	AVE	DEV 3	AVE	DEV 4	AVE
07/04	0.774	70.865	0.784	70.849	34192.0	118852	106604	320689
07/05	1.242	70.425	1.223	70.399	26959.1	67746.7	30936.3	156116
07/06	1.180	69.450	1.184	69.414	298876	395807	90345.7	181381
07/07	18.183	89.958	22.668	93.899	0.000	138297	0.000	185245
07/08	2.338	129.839	1.467	123.382	0.000#	0.000	0.000#	0.000
07/09	112.749	243.619	109.077	247.874	1002123	1209583	1013088	1287959
07/10	11.191	422.173	11.148	422.226	635565	4866886	651571	4930974
07/11	0.223	432.219	0.219	432.265	7199.12	5466386	7763.25	5552585
07/12	0.149	432.357	0.139	432.414	4156.11	5469356	4226.60	5557325
07/13	0.131	432.346	0.116	432.389	4212.93	5463045	4076.88	5550988
07/14	0.747	433.083	0.884	433.244	47791.0	5507500	50523.2	5597758
07/15	0.099	434.058	0.102	434.461	3942.28	5571645	4172.98	5665268
07/16	0.101	434.081	0.121	434.490	3851.27	5573120	3788.66	5668021
07/17	0.092	434.090	0.117	434.479	3503.73	5573129	3632.56	5667111
07/18	0.091	434.048	0.096	434.431	4315.96	5569615	4203.96	5664117
07/19	0.107	433.979	0.096	434.389	3412.23	5568568	3478.01	5661896
07/20	0.092	433.990	0.125	434.405	3588.35	5566505	3807.93	5660027
07/21	0.109	434.054	0.112	434.461	3699.04	5566124	3685.65	5659270
07/22	0.131	434.022	0.123	434.425	3549.75	5566032	3602.75	5659158
07/23	0.118	434.028	0.124	434.449	3682.94	5565653	3871.81	5660299
07/24	0.114	434.071	0.114	434.467	3651.09	5565292	3617.74	5660180
07/25	0.324	433.747	0.331	434.129	39900.7	5535786	41520.7	5628698
07/26	0.277	433.966	0.222	434.232	16273.2	5557231	16123.4	5650100
07/27	0.122	434.195	0.197	434.413	4941.08	5568436	4940.71	5660489
07/28	0.103	434.237	0.123	434.594	3564.75	5571180	3462.56	5664402
07/29	0.102	434.223	0.092	434.585	3507.93	5570861	3797.94	5663132
07/30	0.101	434.186	0.095	434.543	3909.72	5570595	4156.38	5664568
07/31	0.101	434.164	0.084	434.544	3829.30	5570102	4000.90	5663848
08/01	0.104	434.248	0.104	434.592	3624.36	5571771	3844.12	5665571
08/02	0.126	434.239	0.096	434.597	4729.41	5569020	4795.81	5663382
08/03	0.110	434.173	0.096	434.556	4213.12	5569528	3613.98	5663618

F6 F7 F8 F9 F10 F11 F12 F13 DEV PAGES F14 SHIFT <<<-- F15 SHIFT -->>> OK

PALISADES NUCLEAR PLANT
ENGINEERING ANALYSIS CONTINUATION SHEET

Attachment 2
Plant Process Computer Data for August 10, 2000, UFM Correction Factor Implementation

219 DEVIATION REPORT

GROUP 21 PAGE 1 | PAL 07/23/2002 09:28:05

DEVIATION GROUP 21
1 UFM_CORR_SGA ratio
2 UFM_CORR_SGB ratio
3 HB_PWR_STEADY percent
4

08/04/2000	DEV 1	AVE	DEV 2	AVE	DEV 3	AVE	DEV 4	AVE
08/04	0.000?	0.984	0.000?	0.981	0.039	99.896		
08/05	0.004?	0.985	0.004?	0.982	2.962	98.666		
08/06	0.000?	1.000	0.000?	1.000	0.082	92.660		
08/07	0.000?	1.000	0.000?	1.000	0.053	92.640		
08/08	0.000?	1.000	0.000?	1.000	1.066	92.197		
08/09	0.000?	1.000	0.000?	1.000	1.843	99.043		
08/10	0.008?	0.991	0.009?	0.989	0.524	99.375		
08/11	0.000?	0.984	0.000?	0.981	0.051	99.213		
08/12	0.000?	0.984	0.000?	0.981	0.045	99.252		
08/13	0.000?	0.984	0.000?	0.981	0.041	99.237		
08/14	0.000?	0.984	0.000?	0.981	0.041	99.237		
08/15	0.000?	0.984	0.000?	0.981	0.092	99.288		
08/16	0.000?	0.984	0.000?	0.981	0.047	99.416		
08/17	0.000?	0.984	0.000?	0.981	0.040	99.444		
08/18	0.000?	0.984	0.000?	0.981	0.042	99.415		
08/19	0.000?	0.984	0.000?	0.981	0.042	99.416		
08/20	0.000?	0.984	0.000?	0.981	0.043	99.410		
08/21	0.000?	0.984	0.000?	0.981	0.048	99.400		
08/22	0.000?	0.984	0.000?	0.981	0.042	99.397		
08/23	0.000?	0.984	0.000?	0.981	0.100	99.396		
08/24	0.000?	0.984	0.000?	0.981	0.212	99.078		
08/25	0.000?	0.984	0.000?	0.981	0.255	99.265		
08/26	0.000?	0.984	0.000?	0.981	0.041	99.383		
08/27	0.000?	0.984	0.000?	0.981	0.055	99.410		
08/28	0.000?	0.984	0.000?	0.981	0.041	99.449		
08/29	0.000?	0.984	0.000?	0.981	0.045	99.398		
08/30	0.000?	0.984	0.001?	0.981	0.041	99.440		
08/31	0.000?	0.984	0.000?	0.982	0.044	99.431		
09/01	0.000?	0.984	0.000?	0.982	0.037	99.417		
09/02	0.000?	0.984	0.000?	0.982	0.041	99.399		
09/03	0.000?	0.984	0.000?	0.982	0.049	99.444		

OK

F6 | F7 | F8 | F9 | F10 | F11 | F12 | F13 DEV PAGES | F14 SHIFT <<<-- | F15 SHIFT -->>>

219 DEVIATION REPORT

GROUP 20 PAL
PAGE 1 07/23/2002 08:54:48

DWT-8 / MT-15
1 TT_0708A deg F
2 TT_0706A deg F
3 FEEDWTR_FLOW_SGA_AVG lbm/hr
4 FEEDWTR_FLOW_SGB_AVG lbm/hr

08/04/2000	DEV 1	AVE	DEV 2	AVE	DEV 3	AVE	DEV 4	AVE
08/04	0.129	434.162	0.130	434.540	3500.74	5569526	3634.94	5664293
08/05	3.640	432.675	3.870	432.974	198932	5486884	207254	5578098
08/06	0.142	424.403	0.185	424.284	6386.25	5024175	6616.60	5092945
08/07	0.104	424.474	0.109	424.373	4761.49	5023624	5383.74	5090383
08/08	0.963	424.380	0.977	424.292	62781.0	4995757	62704.6	5064109
08/09	1.499	431.838	1.487	431.905	109786	5415943	112532	5499418
08/10	0.569	432.982	0.540	433.048	32883.8	5496849	34112.2	5582828
08/11	0.116	433.581	0.128	433.619	3922.08	5533840	4262.38	5621500
08/12	0.116	433.542	0.129	433.612	3807.18	5536113	3791.34	5623343
08/13	0.115	433.583	0.117	433.644	3213.07	5534996	3641.86	5623093
08/14	0.100	433.633	0.121	433.669	3455.44	5532491	3691.63	5621227
08/15	0.152	433.721	0.163	433.751	6498.68	5536465	6519.01	5623954
08/16	0.107	433.831	0.121	433.667	3827.73	5544050	4042.28	5630866
08/17	0.097	433.735	0.076	433.589	3386.76	5545097	3625.69	5631696
08/18	0.104	433.766	0.112	433.633	3816.32	5542373	3869.50	5629717
08/19	0.111	433.704	0.099	433.583	3491.39	5541602	3580.94	5628297
08/20	0.120	433.674	0.114	433.581	3609.56	5541131	3610.43	5628253
08/21	0.115	433.678	0.104	433.536	4047.38	5540998	3644.49	5626733
08/22	0.132	433.763	0.130	433.646	3556.57	5541933	3636.61	5627033
08/23	0.129	433.790	0.139	433.657	6572.70	5542317	7022.11	5626678
08/24	0.135	433.527	0.131	433.412	12328.4	5523477	12704.0	5605929
08/25	0.152	433.722	0.182	433.633	14852.6	5535295	15297.8	5618469
08/26	0.116	433.848	0.123	433.709	3595.99	5542668	3613.93	5625776
08/27	0.115	433.776	0.115	433.634	3959.23	5543740	4111.90	5626452
08/28	0.122	433.695	0.103	433.585	3679.44	5545643	3621.08	5628208
08/29	0.106	433.719	0.102	433.615	6115.48	5538900	5525.71	5623109
08/30	0.117	433.698	0.121	433.591	4982.33	5545221	4889.74	5629373
08/31	0.107	433.716	0.125	433.617	3822.53	5542120	3912.95	5624674
09/01	0.108	433.720	0.188	433.864	3607.91	5541358	3522.27	5625258
09/02	0.101	433.689	0.091	433.925	3550.85	5540189	3737.01	5624497
09/03	0.110	433.718	0.095	433.924	3673.15	5543634	4371.54	5626744

OK

F8 F9 F10 F11 F12 F13 DEV PAGES F14 SHIFT <<<-- F15 SHIFT -->>>

PALISADES NUCLEAR PLANT
ENGINEERING ANALYSIS CONTINUATION SHEET

Attachment 3
Plant Process Computer Data for September 22, 2000, UFM Correction Factor Implementation

EA-RCH-02-04 Attachment 3 Page 2

219 DEVIATION REPORT GROUP 21 PAL
PAGE 1 07/23/2002 09:34:26

DEVIATION GROUP 21
1 UFM_CORR_SGA ratio
2 UFM_CORR_SGB ratio
3 HB_PWR_STEADY percent
4

09/04/2000	DEV 1	AVE	DEV 2	AVE	DEV 3	AVE	DEV 4	AVE
09/04	0.000?	0.984	0.000?	0.982	0.050	99.447		
09/05	0.000?	0.984	0.000?	0.982	20.151	91.375		
09/06	0.003?	0.999	0.003?	0.999	0.000#	0.000		
09/07	0.000?	1.000	0.000?	1.000	0.000	2.689		
09/08	0.000?	1.000	0.000?	1.000	0.000#	0.000		
09/09	0.000?	1.000	0.000?	1.000	0.000#	0.000		
09/10	0.000?	1.000	0.000?	1.000	0.000#	0.000		
09/11	0.000?	1.000	0.000?	1.000	0.000#	0.000		
09/12	0.000?	1.000	0.000?	1.000	0.000#	0.000		
09/13	0.000?	1.000	0.000?	1.000	0.000	4.562		
09/14	0.000?	1.000	0.000?	1.000	0.000#	0.000		
09/15	0.000?	1.000	0.000?	1.000	0.554	4.656		
09/16	0.000?	1.000	0.000?	1.000	0.380	3.143		
09/17	0.000?	1.000	0.000?	1.000	15.886	32.609		
09/18	0.000?	1.000	0.000?	1.000	9.901	90.917		
09/19	0.000?	1.000	0.000?	1.000	0.071	99.873		
09/20	0.000?	1.000	0.000?	1.000	0.042	99.911		
09/21	0.000?	1.000	0.000?	1.000	0.041	99.907		
09/22	0.008?	0.992	0.009?	0.991	0.504	99.663		
09/23	0.000?	0.985	0.000?	0.982	0.045	99.897		
09/24	0.000?	0.985	0.000?	0.982	0.047	99.911		
09/25	0.000?	0.985	0.000?	0.982	0.042	99.899		
09/26	0.000?	0.985	0.000?	0.982	0.043	99.903		
09/27	0.000?	0.985	0.000?	0.982	0.043	99.910		
09/28	0.000?	0.985	0.000?	0.982	0.414	99.591		
09/29	0.000?	0.985	0.000?	0.982	0.068	99.871		
09/30	0.000?	0.985	0.000?	0.982	0.042	99.899		
10/01	0.000?	0.985	0.000?	0.982	0.047	99.918		
10/02	0.000?	0.985	0.000?	0.982	0.045	99.899		
10/03	0.000?	0.985	0.000?	0.982	0.045	99.917		
10/04	0.000?	0.985	0.000?	0.982	0.042	99.903		

OK

F6 | F7 | F8 | F9 | F10 | F11 | F12 | F13 DEV PAGES | F14 SHIFT <<<-- | F15 SHIFT -->>>

219 DEVIATION REPORT GROUP 20 PAL
PAGE 1 07/23/2002 08:51:09

DWT-8 / MT-15

1 TT_0708A deg F
2 TT_0706A deg F
3 FEEDWTR_FLOW_SGA_AVG lbm/hr
4 FEEDWTR_FLOW_SGB_AVG lbm/hr

09/04/2000	DEV 1	AVE	DEV 2	AVE	DEV 3	AVE	DEV 4	AVE
09/04	0.120	433.531	0.126	433.765	4033.90	5542592	4417.03	5625678
09/05	34.202	420.650	32.614	421.120	1276003	5008151	1301719	5080301
09/06	28.673	216.355	98.287	338.930	0.000	107111	61648.4	173336
09/07	9.884	142.966	10.791	152.776	24221.6	102803	0.000#	0.000
09/08	3.074	126.403	2.839	137.490	0.000#	0.000	0.000#	0.000
09/09	1.953	118.351	2.283	128.830	0.000#	0.000	0.000#	0.000
09/10	1.627	112.145	1.950	121.448	117458	249474	0.000#	0.000
09/11	10.030	110.183	11.174	115.772	0.000#	0.000	0.000#	0.000
09/12	3.463	194.532	4.438	188.789	0.000#	0.000	142869	291481
09/13	6.355	176.561	5.848	171.159	23169.8	69334.7	0.000	229197
09/14	4.515	158.014	4.231	153.937	0.000#	0.000	0.000#	0.000
09/15	3.584	144.118	3.033	141.553	0.000#	0.000	75002.4	199823
09/16	10.590	137.787	8.917	138.749	10137.7	141344	18489.9	60379.0
09/17	78.221	308.090	66.255	313.246	878588	1571488	900539	1566621
09/18	10.489	423.416	10.604	423.719	591630	4940044	604667	5001578
09/19	0.148	432.442	0.147	432.820	5055.71	5473847	5553.12	5555702
09/20	0.118	432.413	0.093	432.529	3399.46	5474970	3766.49	5555989
09/21	0.115	432.334	0.121	432.443	3638.61	5476758	3849.89	5558427
09/22	0.749	432.762	0.743	432.911	48125.6	5516197	49840.2	5599322
09/23	0.124	433.905	0.096	434.040	3416.23	5582068	3968.99	5668520
09/24	0.099	433.843	0.119	433.975	3923.78	5582174	3766.34	5668754
09/25	0.114	433.719	0.087	433.851	3621.41	5580226	3800.48	5667712
09/26	0.113	433.783	0.112	433.911	3875.31	5580809	3373.10	5668503
09/27	0.117	433.851	0.110	433.982	3769.20	5581972	3742.42	5669223
09/28	0.321	433.456	0.311	433.601	24740.8	5561209	25573.0	5648473
09/29	0.162	433.852	0.147	434.015	4762.81	5577364	4681.58	5664794
09/30	0.128	433.954	0.098	434.100	3598.84	5578300	3776.15	5666037
10/01	0.129	434.065	0.117	434.167	3926.39	5579526	3820.32	5668469
10/02	0.116	434.024	0.119	434.094	4387.32	5575721	4169.21	5663730
10/03	0.115	434.047	0.116	434.125	3642.06	5574667	3563.78	5663656
10/04	0.123	433.907	0.103	434.034	3470.29	5573588	3787.85	5661483

OK

F5 F7 F8 F9 F10 F11 F12 F13 DEV PAGES F14 SHIFT <<<-- F15 SHIFT -->>>

PALISADES NUCLEAR PLANT
ENGINEERING ANALYSIS CONTINUATION SHEET

Attachment 4
Plant Process Computer Data for November 1, 2000, UFM Correction Factor Implementation

219 DEVIATION REPORT

GROUP 21 PAL
PAGE 1 07/23/2002 09:38:51

DEVIATION GROUP 21
1 UFM_CORR_SGA ratio
2 UFM_CORR_SGB ratio
3 HB_PWR_STEADY percent
4

10/05/2000	DEV 1	AVE	DEV 2	AVE	DEV 3	AVE	DEV 4	AVE
10/05	0.000?	0.985	0.000?	0.982	0.048	99.911		
10/06	0.000?	0.985	0.000?	0.982	0.046	99.904		
10/07	0.000?	0.985	0.000?	0.982	0.043	99.916		
10/08	0.000?	0.985	0.000?	0.982	0.043	99.918		
10/09	0.000?	0.985	0.000?	0.982	0.043	99.914		
10/10	0.000?	0.985	0.000?	0.982	0.043	99.923		
10/11	0.000?	0.984	0.001?	0.982	0.053	99.913		
10/12	0.000?	0.984	0.000?	0.981	0.041	99.916		
10/13	0.000?	0.984	0.000?	0.981	0.047	99.914		
10/14	0.000?	0.984	0.000?	0.981	0.046	99.912		
10/15	0.000?	0.984	0.000?	0.981	0.042	99.913		
10/16	0.000?	0.984	0.000?	0.981	0.042	99.900		
10/17	0.000?	0.984	0.000?	0.981	0.040	99.899		
10/18	0.000?	0.984	0.000?	0.981	0.040	99.906		
10/19	0.000?	0.984	0.000?	0.981	0.045	99.903		
10/20	0.000?	0.984	0.000?	0.981	0.044	99.919		
10/21	0.000?	0.984	0.000?	0.981	0.043	99.913		
10/22	0.000?	0.984	0.000?	0.981	0.039	99.914		
10/23	0.000?	0.984	0.000?	0.981	0.046	99.911		
10/24	0.000?	0.984	0.000?	0.981	0.041	99.910		
10/25	0.000?	0.984	0.000?	0.981	0.719	99.273		
10/26	0.000?	0.984	0.000?	0.981	0.070	99.877		
10/27	0.006?	0.987	0.007?	0.984	20.246	87.376		
10/28	0.000?	1.000	0.000?	1.000	0.922	50.631		
10/29	0.000?	1.000	0.000?	1.000	13.814	61.685		
10/30	0.000?	1.000	0.000?	1.000	3.371	97.308		
10/31	0.000?	1.000	0.000?	1.000	0.067	99.900		
11/01	0.008?	0.993	0.009?	0.992	0.841	99.131		
11/02	0.000?	0.985	0.000?	0.982	0.046	98.332		
11/03	0.000?	0.985	0.000?	0.982	0.047	98.308		
11/04	0.000?	0.985	0.000?	0.982	0.052	98.260		

OK

F6 F7 F8 F9 F10 F11 F12 F13 DEV PAGES F14 SHIFT <<<-- F15 SHIFT -->>>

219 DEVIATION REPORT GROUP 20 PAL
PAGE 1 07/23/2002 11:42:16

DWT-8 / MT-15
1 TT_0708A deg F
2 TT_0706A deg F
3 FEEDWTR_FLOW_SGA_AVG lbm/hr
4 FEEDWTR_FLOW_SGB_AVG lbm/hr

10/05/2000	DEV 1	AVE	DEV 2	AVE	DEV 3	AVE	DEV 4	AVE
10/05	0.126	433.871	0.107	434.028	4730.18	5571250	4480.95	5658965
10/06	0.123	433.848	0.098	434.028	3810.86	5568920	4031.21	5657298
10/07	0.116	433.868	0.092	434.050	3940.24	5569937	3689.68	5657843
10/08	0.117	433.744	0.088	433.823	3722.16	5568421	3722.18	5656696
10/09	0.137	433.890	0.135	433.972	4021.79	5569165	3824.53	5658016
10/10	0.116	433.986	0.112	434.129	3464.67	5571181	3705.34	5658830
10/11	0.123	433.999	0.116	434.156	5666.04	5578347	5488.20	5666160
10/12	0.119	433.984	0.113	434.131	3663.84	5583958	3521.47	5671717
10/13	0.135	434.039	0.131	434.184	3936.42	5585976	3982.99	5673471
10/14	0.132	434.075	0.119	434.230	3790.40	5586535	3869.38	5673365
10/15	0.132	434.045	0.126	434.195	3838.59	5587103	4016.38	5674348
10/16	0.131	433.942	0.104	434.085	3339.91	5587753	3283.68	5675628
10/17	0.141	433.874	0.120	434.038	3555.49	5587665	3415.09	5674684
10/18	0.135	433.871	0.105	434.050	3960.83	5589253	4253.83	5676647
10/19	0.142	433.931	0.116	434.084	3978.95	5591202	4392.93	5679205
10/20	0.135	433.973	0.120	434.119	3939.79	5593867	3389.61	5681485
10/21	0.146	433.949	0.110	434.095	3578.66	5593423	3920.80	5680741
10/22	0.186	433.895	0.164	434.040	3597.55	5592205	3827.55	5681094
10/23	0.152	433.980	0.130	434.121	4013.53	5593512	3718.17	5681006
10/24	0.127	434.001	0.096	434.152	3952.29	5593234	3503.69	5681768
10/25	0.390	433.465	0.381	433.622	41466.6	5554704	43285.2	5641224
10/26	0.154	433.951	0.132	434.087	5306.16	5590714	5053.83	5679413
10/27	26.260	418.166	26.116	418.399	1228174	4829497	1253356	4900936
10/28	1.572	370.389	1.564	370.880	51414.6	2587786	51435.3	2614416
10/29	19.611	386.690	19.576	387.157	806698	3227488	818164	3267680
10/30	3.010	429.834	2.920	430.083	201216	5324818	204722	5397359
10/31	0.148	432.300	0.134	432.480	5265.93	5474429	5090.86	5553933
11/01	0.141	432.354	0.137	432.539	5465.63	5470418	5148.51	5550087
11/02	0.117	432.496	0.111	432.684	3706.15	5474726	3982.28	5554857
11/03	0.121	432.408	0.077	432.599	3868.42	5472494	4009.40	5552550
11/04	0.118	432.292	0.120	432.486	4280.71	5469069	3925.84	5549136

OK

F6 | F7 | F8 | F9 | F10 | F11 | F12 | F13 DEV PAGES | F14 SHIFT <<<-- | F15 SHIFT -->>>

EA-RCH-02-04 Attachment 4 Page 4

219 DEVIATION REPORT

GROUP 21 PAL
PAGE 1 07/23/2002 09:40:33

DEVIATION GROUP 21

1 UFM_CORR_SGA ratio
2 UFM_CORR_SGB ratio
3 HB_PWR_STEADY percent
4

11/05/2000	DEV 1	AVE	DEV 2	AVE	DEV 3	AVE	DEV 4	AVE
11/05	0.000?	0.985	0.000?	0.982	0.054	98.273		
11/06	0.000?	0.985	0.000?	0.982	0.051	98.294		
11/07	0.000?	0.985	0.000?	0.982	0.066	98.293		
11/08	0.000?	0.985	0.000?	0.982	0.476	99.313		
11/09	0.000?	0.984	0.001?	0.982	0.050	99.568		
11/10	0.000?	0.984	0.000?	0.981	0.047	99.605		
11/11	0.000?	0.984	0.000?	0.981	0.046	99.611		
11/12	0.000?	0.984	0.000?	0.981	0.043	99.595		
11/13	0.000?	0.984	0.000?	0.981	0.047	99.609		
11/14	0.000?	0.984	0.000?	0.981	0.045	99.598		
11/15	0.000?	0.984	0.000?	0.981	0.049	99.592		
11/16	0.000?	0.984	0.000?	0.981	0.044	99.593		
11/17	0.000?	0.984	0.000?	0.981	0.050	99.593		
11/18	0.000?	0.984	0.000?	0.981	0.048	99.590		
11/19	0.000?	0.984	0.000?	0.981	0.051	99.604		
11/20	0.000?	0.984	0.000?	0.981	0.044	99.601		
11/21	0.000?	0.984	0.000?	0.981	0.043	99.593		
11/22	0.000?	0.984	0.000?	0.981	0.048	99.610		
11/23	0.000?	0.984	0.000?	0.981	0.052	99.604		
11/24	0.000?	0.984	0.000?	0.981	0.044	99.622		
11/25	0.000?	0.984	0.000?	0.981	0.050	99.640		
11/26	0.000?	0.984	0.000?	0.981	0.043	99.627		
11/27	0.000?	0.984	0.000?	0.981	0.046	99.632		
11/28	0.000?	0.984	0.000?	0.981	0.055	99.626		
11/29	0.000?	0.984	0.000?	0.981	0.049	99.615		
11/30	0.000?	0.984	0.000?	0.981	0.413	99.347		
12/01	0.000?	0.984	0.000?	0.981	0.043	99.605		
12/02	0.000?	0.984	0.000?	0.981	0.049	99.610		
12/03	0.000?	0.984	0.000?	0.981	0.049	99.627		
12/04	0.000?	0.984	0.000?	0.981	0.049	99.607		
12/05	0.000?	0.984	0.000?	0.981	0.050	99.615		

OK

F6 | F7 | F8 | F9 | F10 | F11 | F12 | F13 DEV PAGES | F14 SHIFT <<<-- | F15 SHIFT -->>>

EA-RCH-02-04 Attachment 4 Page 5

219 DEVIATION REPORT   GROUP 20 PAGE 1   PAL 07/23/2002 08:48:31

DWT-8 / MT-15

1 TT_0708A deg F
2 TT_0706A deg F
3 FEEDWTR_FLOW_SGA_AVG lbm/hr
4 FEEDWTR_FLOW_SGB_AVG lbm/hr

11/05/2000	DEV 1	AVE	DEV 2	AVE	DEV 3	AVE	DEV 4	AVE
11/05	0.132	432.291	0.117	432.497	4327.07	5469759	4520.13	5550120
11/06	0.123	432.336	0.116	432.553	3951.29	5469684	4248.10	5550120
11/07	0.128	432.377	0.102	432.588	4740.56	5468721	4601.47	5549957
11/08	0.470	433.284	0.462	433.495	29666.4	5531587	31045.0	5615295
11/09	0.163	433.549	0.143	433.766	5456.89	5549860	5736.30	5634466
11/10	0.144	433.649	0.115	433.863	3684.57	5556202	3592.40	5640351
11/11	0.143	433.632	0.112	433.851	3687.96	5556091	3682.40	5641262
11/12	0.152	433.576	0.118	433.792	3792.72	5554853	3293.27	5639613
11/13	0.157	433.525	0.127	433.775	3794.92	5555995	3748.26	5639618
11/14	0.178	433.618	0.153	433.855	3470.90	5555737	3752.46	5640111
11/15	0.154	433.739	0.120	433.961	3452.34	5555289	3474.65	5641689
11/16	0.156	433.759	0.123	433.966	2711.50	5555416	2412.19	5641660
11/17	0.158	433.764	0.124	433.967	2996.39	5555858	2990.26	5641608
11/18	0.156	433.744	0.125	433.952	2978.75	5555543	2976.37	5641231
11/19	0.174	433.790	0.127	433.978	3249.62	5556297	2999.98	5642379
11/20	0.160	433.771	0.124	433.955	2495.09	5556642	2845.28	5641821
11/21	0.165	433.772	0.112	433.971	6002.52	5555756	7566.30	5642121
11/22	0.149	433.760	0.105	433.961	2852.91	5557675	2658.47	5641840
11/23	0.168	433.769	0.117	433.959	3613.59	5556394	3056.38	5642499
11/24	0.166	433.815	0.127	434.004	2551.92	5558606	2694.18	5643198
11/25	0.165	433.861	0.125	434.069	3022.03	5559718	2530.95	5645173
11/26	0.166	433.902	0.122	434.107	2597.49	5559525	2724.32	5644248
11/27	0.185	433.935	0.120	434.151	2725.56	5559798	2664.43	5645172
11/28	0.180	433.867	0.111	434.067	3161.87	5558782	3174.27	5644479
11/29	0.181	433.831	0.112	434.047	2867.12	5558109	3076.03	5643542
11/30	0.326	433.605	0.302	433.833	23086.5	5543111	24740.6	5625933
12/01	0.176	433.775	0.120	434.006	2587.75	5557339	2634.85	5642723
12/02	0.181	433.712	0.127	433.953	3239.75	5556873	2582.70	5642851
12/03	0.178	433.748	0.123	433.995	3130.08	5558606	2595.79	5643869
12/04	0.181	433.754	0.118	433.986	2956.85	5556702	2917.75	5643353
12/05	0.190	433.656	0.137	433.897	3037.76	5556588	2852.74	5643096

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F13 DEV PAGES | F14 SHIFT <<<-- | F15 SHIFT -->>>

Attachment 5
Plant Process Computer Data for February 6, 2001, UFM Correction Factor Implementation

EA-RCH-02-04 Attachment 5 Page 2

219 DEVIATION REPORT

GROUP 21 PAL
PAGE 1 07/23/2002 09:43:27

DEVIATION GROUP 21

1 UFM_CORR_SGA ratio
2 UFM_CORR_SGB ratio
3 HB_PWR_STEADY percent
4

01/06/2001	DEV 1	AVE	DEV 2	AVE	DEV 3	AVE	DEV 4	AVE
01/06	0.000?	0.983	0.000?	0.982	0.048	99.906		
01/07	0.000?	0.983	0.000?	0.982	0.050	99.913		
01/08	0.000?	0.983	0.000?	0.982	0.049	99.907		
01/09	0.000?	0.983	0.000?	0.982	0.052	99.900		
01/10	0.000?	0.983	0.000?	0.982	0.051	99.907		
01/11	0.000?	0.983	0.000?	0.982	0.480	99.511		
01/12	0.000?	0.983	0.000?	0.982	0.047	99.904		
01/13	0.000?	0.983	0.000?	0.982	0.051	99.912		
01/14	0.000?	0.983	0.000?	0.982	0.051	99.888		
01/15	0.000?	0.983	0.000?	0.982	0.050	99.910		
01/16	0.000?	0.983	0.000?	0.982	0.050	99.901		
01/17	0.000?	0.983	0.000?	0.982	0.052	99.923		
01/18	0.000?	0.983	0.000?	0.982	0.047	99.896		
01/19	0.000?	0.983	0.000?	0.982	0.046	99.911		
01/20	0.000?	0.983	0.000?	0.982	0.047	99.916		
01/21	0.000?	0.983	0.000?	0.982	0.047	99.912		
01/22	0.000?	0.983	0.000?	0.982	0.512	99.579		
01/23	0.000?	0.983	0.000?	0.982	0.064	99.887		
01/24	0.000?	0.983	0.000?	0.982	0.050	99.904		
01/25	0.009?	0.991	0.009?	0.991	4.789	94.678		
01/26	0.000?	1.000	0.000?	1.000	3.967	96.219		
01/27	0.007?	0.996	0.008?	0.995	0.484	99.620		
01/28	0.000?	0.983	0.000?	0.982	0.117	99.840		
01/29	0.000?	0.983	0.000?	0.982	0.041	99.903		
01/30	0.000?	0.983	0.000?	0.982	0.051	99.906		
01/31	0.000?	0.983	0.000?	0.982	0.050	99.912		
02/01	0.000?	0.983	0.000?	0.982	0.047	99.913		
02/02	0.006?	0.986	0.006?	0.984	21.735	86.030		
02/03	0.000?	1.000	0.000?	1.000	2.158	53.083		
02/04	0.000?	1.000	0.000?	1.000	8.482	58.146		
02/05	0.000?	1.000	0.000?	1.000	5.078	96.381		

F13 DEV PAGES | F14 SHIFT <<<-- | F15 SHIFT -->>> | OK

EA-RCH-02-04 Attachment 5 Page 3

219 DEVIATION REPORT

GROUP 20 PAGE 1 PAL 07/23/2002 08:17:31

DWT-8 / MT-15

1 TT_0708A deg F
2 TT_0706A deg F
3 FEEDWTR_FLOW_SGA_AVG lbm/hr
4 FEEDWTR_FLOW_SGB_AVG lbm/hr

01/06/2001	DEV 1	AVE	DEV 2	AVE	DEV 3	AVE	DEV 4	AVE
01/06	0.255	434.011	0.148	434.290	2966.36	5575392	2639.04	5662913
01/07	0.270	434.035	0.150	434.303	3050.75	5576257	2871.82	5663102
01/08	0.260	433.950	0.146	434.224	3118.18	5575338	2344.13	5662087
01/09	0.263	433.875	0.140	434.152	3067.43	5573942	3108.29	5661048
01/10	0.266	433.991	0.143	434.227	2970.30	5575160	2783.34	5662371
01/11	0.404	433.724	0.341	433.960	27338.4	5551264	29142.2	5638179
01/12	0.262	434.084	0.144	434.331	2940.27	5576261	2660.42	5662864
01/13	0.263	434.089	0.149	434.322	2929.61	5575904	2909.94	5663888
01/14	0.263	434.069	0.147	434.298	2968.45	5575328	2836.50	5661394
01/15	0.265	434.124	0.142	434.350	3209.40	5577066	2775.89	5663059
01/16	0.268	434.097	0.137	434.349	3037.60	5576571	2460.89	5662230
01/17	0.264	434.105	0.134	434.356	3088.11	5577663	2931.59	5663943
01/18	0.265	434.039	0.136	434.283	2826.60	5575589	2533.66	5661627
01/19	0.272	434.069	0.134	434.316	3455.93	5578038	2511.32	5664498
01/20	0.270	433.984	0.146	434.241	2941.19	5579522	2620.65	5664624
01/21	0.267	433.995	0.142	434.239	3476.65	5580547	3177.57	5665917
01/22	0.391	433.771	0.320	433.995	29119.1	5563830	29979.2	5648261
01/23	0.274	434.055	0.154	434.288	3696.45	5581678	4770.50	5668847
01/24	0.268	434.031	0.138	434.264	4575.61	5584771	4511.90	5671197
01/25	5.467	427.688	5.480	427.882	343884	5217579	351550	5295463
01/26	3.841	428.836	3.834	429.043	242283	5258914	245746	5334371
01/27	0.592	432.286	0.543	432.514	32813.0	5490811	33448.4	5574729
01/28	0.304	433.826	0.193	434.050	8543.20	5588690	8195.95	5676606
01/29	0.283	433.953	0.144	434.162	4076.51	5593989	3301.15	5681883
01/30	0.281	434.021	0.157	434.228	4469.37	5594430	3651.10	5682665
01/31	0.281	433.930	0.140	434.146	4184.45	5592478	4119.07	5684081
02/01	0.282	433.903	0.145	434.124	4071.77	5593176	3778.84	5683411
02/02	28.228	416.208	28.086	416.508	1310674	4751256	1338477	4822503
02/03	3.393	374.724	3.377	375.152	117262	2727272	122272	2758782
02/04	12.362	382.553	12.385	382.938	493575	3016281	501418	3054789
02/05	4.600	429.221	4.545	429.487	303061	5266002	310617	5344857

F13 DEV PAGES | F14 SHIFT <<<-- | F15 SHIFT -->>> | OK

EA-RCH-02-04 Attachment 5 Page 4

219 DEVIATION REPORT

GROUP 21 PAGE 1 | PAL 07/23/2002 09:45:11

DEVIATION GROUP 21
1 UFM_CORR_SGA ratio
2 UFM_CORR_SGB ratio
3 HB_PWR_STEADY percent
4

02/06/2001	DEV 1	AVE	DEV 2	AVE	DEV 3	AVE	DEV 4	AVE
02/06	0.008?	0.991	0.009?	0.990	0.503	99.673		
02/07	0.000?	0.984	0.000?	0.982	0.049	99.897		
02/08	0.000?	0.984	0.000?	0.982	0.046	99.917		
02/09	0.000?	0.984	0.000?	0.982	0.051	99.916		
02/10	0.000?	0.984	0.000?	0.982	0.049	99.907		
02/11	0.000?	0.984	0.000?	0.982	0.043	99.907		
02/12	0.000?	0.984	0.000?	0.982	0.044	99.908		
02/13	0.000?	0.984	0.000?	0.982	0.044	99.913		
02/14	0.000?	0.984	0.000?	0.982	0.043	99.902		
02/15	0.000?	0.984	0.000?	0.982	0.045	99.891		
02/16	0.000?	0.984	0.000?	0.982	0.045	99.910		
02/17	0.000?	0.984	0.000?	0.982	0.044	99.904		
02/18	0.000?	0.984	0.000?	0.982	0.047	99.903		
02/19	0.000?	0.984	0.000?	0.982	0.043	99.894		
02/20	0.000?	0.984	0.000?	0.982	0.045	99.903		
02/21	0.000?	0.984	0.000?	0.982	0.046	99.893		
02/22	0.000?	0.984	0.000?	0.982	0.042	99.899		
02/23	0.000?	0.984	0.000?	0.982	0.051	99.904		
02/24	0.000?	0.984	0.000?	0.982	0.043	99.912		
02/25	0.000?	0.984	0.000?	0.982	0.183	99.868		
02/26	0.000?	0.984	0.000?	0.982	0.392	99.701		
02/27	0.000?	0.984	0.000?	0.982	0.044	99.893		
02/28	0.000?	0.984	0.000?	0.982	0.044	99.912		
03/01	0.000?	0.985	0.000?	0.981	0.046	99.889		
03/02	0.000?	0.985	0.000?	0.981	0.047	99.910		
03/03	0.000?	0.985	0.000?	0.981	0.044	99.907		
03/04	0.000?	0.985	0.000?	0.981	0.050	99.913		
03/05	0.000?	0.985	0.000?	0.981	0.045	99.900		
03/06	0.000?	0.985	0.000?	0.981	0.041	99.902		
03/07	0.000?	0.985	0.000?	0.981	0.046	99.914		
03/08	0.000?	0.985	0.000?	0.981	0.045	99.899		

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F6 | F7 | F8 | F9 | F10 | F11 | F12 | F13 DEV PAGES | F14 SHIFT <<<-- | F15 SHIFT -->>>

EA-RCH-02-04 Attachment 5 Page 5

219 DEVIATION REPORT

GROUP 20 PAGE 1

PAL 07/23/2002 08:15:54

DWT-8 / MT-15

1 TT_0708A deg F
2 TT_0706A deg F
3 FEEDWTR_FLOW_SGA_AVG lbm/hr
4 FEEDWTR_FLOW_SGB_AVG lbm/hr

02/06/2001	DEV 1	AVE	DEV 2	AVE	DEV 3	AVE	DEV 4	AVE
02/06	0.838	433.034	0.815	433.300	47742.3	5515309	49492.3	5602548
02/07	0.268	434.016	0.129	434.286	4245.91	5573616	3844.22	5663244
02/08	0.267	434.133	0.141	434.396	4134.75	5575506	3734.16	5665346
02/09	0.280	434.086	0.155	434.361	4333.60	5575117	3844.63	5664976
02/10	0.265	433.867	0.127	434.143	4246.15	5572379	3751.61	5662860
02/11	0.169	433.949	0.109	434.096	3551.56	5573830	3714.37	5661560
02/12	0.118	433.988	0.093	434.087	3855.22	5574183	3836.62	5661460
02/13	0.120	434.096	0.123	434.192	4252.55	5574404	3898.08	5662190
02/14	0.106	434.189	0.099	434.259	3682.17	5572186	3908.54	5660435
02/15	0.112	434.211	0.099	434.265	3860.95	5568174	3630.27	5663765
02/16	0.117	434.248	0.096	434.289	3761.04	5570111	3775.59	5664684
02/17	0.108	434.134	0.098	434.185	3880.68	5568835	3625.79	5663200
02/18	0.118	434.135	0.104	434.208	4160.43	5568777	3364.95	5663425
02/19	0.123	434.223	0.090	434.289	3775.94	5568419	3589.68	5664203
02/20	0.114	434.244	0.085	434.300	3942.01	5569999	3570.99	5663931
02/21	0.111	434.089	0.100	434.161	3857.12	5567983	3807.50	5662090
02/22	0.111	434.090	0.122	434.155	3918.57	5567659	3436.23	5663117
02/23	0.113	434.138	0.117	434.213	3989.21	5568714	4155.57	5663832
02/24	0.112	434.225	0.100	434.297	3404.44	5569666	3582.07	5665109
02/25	0.242	434.171	0.235	434.215	11916.1	5567559	11952.8	5661391
02/26	0.394	434.054	0.410	434.124	23915.2	5557474	25401.2	5651223
02/27	0.101	434.259	0.118	434.326	4037.03	5569825	3611.82	5663233
02/28	0.104	434.238	0.099	434.289	4006.54	5572231	3682.11	5667383
03/01	0.114	434.272	0.098	434.339	3998.57	5570728	4234.24	5664152
03/02	0.116	434.312	0.097	434.366	3609.58	5571076	3905.78	5664776
03/03	0.111	434.418	0.098	434.469	3948.71	5571909	3574.32	5665202
03/04	0.119	434.405	0.110	434.451	3970.27	5572032	3988.84	5665481
03/05	0.127	434.260	0.116	434.326	3833.88	5570539	3455.69	5663475
03/06	0.124	434.286	0.112	434.397	3709.58	5570521	3461.62	5664249
03/07	0.113	434.381	0.077	434.455	3684.53	5572079	3764.22	5665246
03/08	0.114	434.364	0.089	434.415	3886.91	5571238	3795.81	5664113

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F9 F10 F11 F12 F13 DEV PAGES F14 SHIFT <<<-- F15 SHIFT -->>

PALISADES NUCLEAR PLANT
ENGINEERING ANALYSIS CONTINUATION SHEET

Attachment 6
Plant Process Computer Data for May 25, 2001, UFM Correction Factor Implementation

EA-RCH-02-04 Attachment 6 Page 2

219 DEVIATION REPORT

GROUP 21 PAL
PAGE 1 07/23/2002 12:45:31

DEVIATION GROUP 21
1 UFM_CORR_SGA ratio
2 UFM_CORR_SGB ratio
3 HB_PWR_STEADY percent
4

05/15/2001	DEV 1	AVE	DEV 2	AVE	DEV 3	AVE	DEV 4	AVE
05/15	0.000?	1.000	0.000?	1.000	10.595	53.462		
05/16	0.000?	1.000	0.000?	1.000	0.121	49.709		
05/17	0.000?	1.000	0.000?	1.000	0.057	49.685		
05/18	0.000?	1.000	0.000?	1.000	11.648	59.121		
05/19	0.000?	1.000	0.000?	1.000	2.232	88.345		
05/20	0.000?	1.000	0.000?	1.000	2.323	98.717		
05/21	0.000?	1.000	0.000?	1.000	0.049	99.911		
05/22	0.000?	1.000	0.000?	1.000	0.070	99.904		
05/23	0.000?	1.000	0.000?	1.000	0.057	99.901		
05/24	0.000?	1.000	0.000?	1.000	0.047	99.902		
05/25	0.005?	0.994	0.008?	0.991	0.416	99.728		
05/26	0.000?	0.989	0.000?	0.983	0.056	99.896		
05/27	0.000?	0.989	0.000?	0.983	0.048	99.924		
05/28	0.000?	0.989	0.000?	0.983	0.046	99.916		
05/29	0.000?	0.989	0.000?	0.983	0.044	99.905		
05/30	0.000?	0.989	0.000?	0.983	0.044	99.901		
05/31	0.000?	0.989	0.000?	0.983	0.052	99.902		
06/01	0.000?	0.989	0.000?	0.983	0.044	99.905		
06/02	0.000?	0.989	0.000?	0.983	0.048	99.909		
06/03	0.000?	0.989	0.000?	0.983	0.050	99.914		
06/04	0.000?	0.989	0.000?	0.983	0.043	99.910		
06/05	0.000?	0.989	0.000?	0.983	0.044	99.917		
06/06	0.000?	0.989	0.000?	0.983	0.043	99.919		
06/07	0.000?	0.989	0.000?	0.983	0.047	99.935		
06/08	0.000?	0.989	0.000?	0.983	0.046	99.918		
06/09	0.000?	0.989	0.000?	0.983	0.052	99.914		
06/10	0.000?	0.989	0.000?	0.983	0.048	99.911		
06/11	0.000?	0.989	0.000?	0.983	0.049	99.911		
06/12	0.001?	0.988	0.000?	0.983	0.048	99.910		
06/13	0.000?	0.988	0.000?	0.982	0.043	99.906		
06/14	0.000?	0.988	0.000?	0.982	0.050	99.916		

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F13 DEV PAGES | F14 SHIFT <<<-- | F15 SHIFT -->>>

EA-RCH-02-04 Attachment 6 Page 3

219 DEVIATION REPORT

GROUP 20 PAL
PAGE 1 07/23/2002 12:48:29

DWT-8 / MT-15

1 TT_0708A deg F
2 TT_0706A deg F
3 FEEDWTR_FLOW_SGA_AVG lbm/hr
4 FEEDWTR_FLOW_SGB_AVG lbm/hr

05/15/2001	DEV 1	AVE	DEV 2	AVE	DEV 3	AVE	DEV 4	AVE
05/15	16.567	376.631	16.093	377.685	611604	2747531	628849	2807498
05/16	0.226	370.973	0.226	372.258	6967.77	2529039	7570.76	2582090
05/17	0.114	370.879	0.080	372.178	3885.38	2527085	3349.70	2580920
05/18	17.804	386.700	17.482	387.761	674780	3074591	693443	3144220
05/19	2.536	425.879	2.588	425.861	135984	4783668	140326	4904157
05/20	2.119	436.649	2.168	436.809	140730	5415581	146333	5562258
05/21	0.131	437.716	0.104	437.972	3859.64	5484358	3975.86	5634200
05/22	0.118	437.531	0.115	437.901	5271.88	5482136	5168.18	5633267
05/23	0.106	437.560	0.097	437.944	3969.26	5482569	4350.25	5633471
05/24	0.099	437.540	0.092	437.929	3635.98	5482737	3691.99	5633676
05/25	0.585	438.022	0.607	438.441	41171.9	5518706	42056.0	5670749
05/26	0.119	438.694	0.099	439.176	4425.75	5569724	4300.14	5723162
05/27	0.098	438.692	0.123	439.193	3694.75	5571587	3904.12	5724985
05/28	0.112	438.693	0.086	439.196	3776.80	5571573	3330.16	5723986
05/29	0.106	438.705	0.088	439.189	3548.74	5570515	3547.87	5723543
05/30	0.113	438.660	0.096	439.161	3413.63	5569995	3809.68	5723215
05/31	0.125	438.721	0.118	439.211	4206.44	5570771	3845.82	5723718
06/01	0.110	438.680	0.082	439.170	3780.46	5570593	3338.81	5723619
06/02	0.136	438.737	0.121	439.227	3733.96	5571682	4027.08	5723959
06/03	0.150	438.961	0.130	439.328	4191.13	5572662	3749.69	5726135
06/04	0.127	439.144	0.106	439.401	3906.05	5570258	4440.79	5724828
06/05	0.114	439.225	0.075	439.466	3475.62	5569772	3703.08	5723877
06/06	0.114	439.253	0.081	439.487	3719.08	5569656	3542.81	5724502
06/07	0.105	439.252	0.112	439.505	4134.96	5568606	4654.88	5722305
06/08	0.113	439.232	0.111	439.483	3966.50	5565721	3804.90	5718842
06/09	0.120	439.168	0.095	439.427	3851.54	5564865	4098.98	5718536
06/10	0.111	439.155	0.091	439.410	4016.83	5564906	3586.15	5717738
06/11	0.121	439.158	0.104	439.421	3911.33	5564657	3509.90	5717903
06/12	0.112	439.218	0.117	439.488	4904.96	5567773	5186.09	5720920
06/13	0.132	439.356	0.126	439.616	3882.52	5570307	3770.10	5723590
06/14	0.119	439.421	0.110	439.667	3923.99	5570354	3926.69	5723122

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F6 | F7 | F8 | F9 | F10 | F11 | F12 | F13 DEV. PAGES | F14 SHIFT <<<-- | F15 SHIFT -->>>

Attachment 7
Plant Process Computer Data for February 20, 2002, UFM Correction Factor Implementation

219 DEVIATION REPORT GROUP 21 PAL PAGE 1 07/23/2002 11:38:33

DEVIATION GROUP 21
1 UFM_CORR_SGA ratio
2 UFM_CORR_SGB ratio
3 HB_PWR_STEADY percent
4

02/18/2002	DEV 1	AVE	DEV 2	AVE	DEV 3	AVE	DEV 4	AVE
02/18	0.000?	1.000	0.000?	1.000	0.041	99.993		
02/19	0.000?	1.000	0.000?	1.000	0.051	99.989		
02/20	0.007?	0.994	0.008?	0.993	0.561	99.658		
02/21	0.000?	0.986	0.000?	0.983	0.053	99.957		
02/22	0.000?	0.986	0.000?	0.983	0.042	99.980		
02/23	0.000?	0.986	0.000?	0.983	0.049	99.995		
02/24	0.000?	0.986	0.000?	0.983	0.044	99.993		
02/25	0.000?	0.986	0.000?	0.983	0.043	100.006		
02/26	0.000?	0.986	0.000?	0.983	0.045	100.005		
02/27	0.000?	0.986	0.000?	0.983	0.049	99.998		
02/28	0.000?	0.986	0.000?	0.983	0.043	99.994		
03/01	0.000?	0.986	0.000?	0.983	0.045	99.986		
03/02	0.000?	0.986	0.000?	0.983	0.047	100.015		
03/03	0.000?	0.986	0.000?	0.983	0.046	99.984		
03/04	0.000?	0.986	0.000?	0.983	0.050	100.007		
03/05	0.000?	0.986	0.000?	0.983	0.046	100.004		
03/06	0.000?	0.986	0.000?	0.983	0.044	99.985		
03/07	0.000?	0.986	0.000?	0.983	0.042	99.995		
03/08	0.000?	0.986	0.000?	0.983	0.046	99.990		
03/09	0.000?	0.986	0.000?	0.983	0.041	100.004		
03/10	0.000?	0.986	0.000?	0.983	0.044	99.999		
03/11	0.000?	0.986	0.000?	0.983	0.045	99.989		
03/12	0.000?	0.986	0.000?	0.983	0.047	99.998		
03/13	0.000?	0.986	0.000?	0.983	0.042	99.995		
03/14	0.000?	0.986	0.000?	0.983	0.182	99.937		
03/15	0.000?	0.986	0.000?	0.983	0.045	99.467		
03/16	0.000?	0.986	0.000?	0.983	0.049	99.435		
03/17	0.000?	0.986	0.000?	0.983	0.040	99.481		
03/18	0.000?	0.986	0.000?	0.983	0.045	99.464		
03/19	0.000?	0.986	0.000?	0.983	0.046	99.486		
03/20	0.000?	0.986	0.000?	0.983	0.043	99.489		

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F13 DEV PAGES | F14 SHIFT <<<-- | F15 SHIFT -->>>

EA-RCH-02-04 Attachment 7 Page 2

219 DEVIATION REPORT. GROUP 20 PAGE 1 PAL 07/23/2002 11:39:47

DWT-8 / MT-15

1 TT_0708A deg F
2 TT_0706A deg F
3 FEEDWTR_FLOW_SGA_AVG lbm/hr
4 FEEDWTR_FLOW_SGB_AVG lbm/hr

02/18/2002	DEV 1	AVE	DEV 2	AVE	DEV 3	AVE	DEV 4	AVE
02/18	0.108	437.966	0.111	438.095	3801.10	5471266	3903.42	5643776
02/19	0.095	438.031	0.105	438.182	4032.86	5469986	4010.88	5642763
02/20	0.459	438.339	0.482	438.488	35312.2	5489532	35733.7	5663453
02/21	0.100	439.232	0.106	439.420	4130.16	5561701	4289.54	5736705
02/22	0.089	439.285	0.077	439.471	3856.73	5562908	3803.16	5739009
02/23	0.102	439.356	0.096	439.502	3915.02	5563930	3614.93	5740251
02/24	0.110	439.357	0.125	439.509	3769.17	5564560	3733.30	5739639
02/25	0.116	439.306	0.126	439.497	3659.01	5564996	4123.79	5740036
02/26	0.106	439.198	0.090	439.405	3829.36	5563877	3410.26	5739570
02/27	0.127	439.098	0.129	439.343	3705.79	5562949	4157.35	5738311
02/28	0.093	439.135	0.103	439.423	3717.99	5563568	3488.62	5738108
03/01	0.145	439.084	0.128	439.351	3927.24	5562096	3748.07	5737539
03/02	0.109	439.054	0.101	439.307	4356.90	5563529	3419.18	5739281
03/03	0.120	439.077	0.110	439.298	3602.94	5560937	4130.77	5738376
03/04	0.102	439.140	0.067	439.367	3821.54	5563296	3741.41	5740944
03/05	0.107	439.141	0.078	439.371	3769.32	5564749	3508.71	5742396
03/06	0.127	439.229	0.128	439.480	3708.33	5566682	3615.57	5742752
03/07	0.100	439.292	0.109	439.504	3614.47	5566510	3886.36	5744562
03/08	0.107	439.300	0.089	439.499	4624.93	5569937	4521.01	5746800
03/09	0.113	439.237	0.152	439.379	3744.71	5573080	3751.22	5748342
03/10	0.136	439.007	0.092	439.232	3674.95	5570957	3514.37	5747153
03/11	0.116	439.215	0.109	439.447	3767.35	5571901	3683.31	5749033
03/12	0.116	439.326	0.098	439.501	4244.09	5571496	4031.46	5749650
03/13	0.107	439.337	0.104	439.545	3836.18	5571463	3599.55	5748456
03/14	0.229	439.161	0.215	439.404	11755.7	5567278	12084.8	5743289
03/15	0.114	438.689	0.094	438.939	3698.44	5537345	3625.93	5713021
03/16	0.116	438.685	0.101	438.950	3766.39	5535485	3909.24	5710795
03/17	0.125	438.755	0.085	438.998	3564.43	5538647	3321.00	5714236
03/18	0.107	438.872	0.107	439.059	3545.09	5538336	3531.13	5713835
03/19	0.121	438.886	0.114	439.055	3724.15	5539492	3752.61	5715648
03/20	0.113	438.892	0.108	439.040	3833.44	5540998	3548.33	5715110

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F6 F7 F8 F9 F10 F11 F12 F13 DEV PAGES F14 SHIFT <<<--- F15 SHIFT --->>>

Attachment 8
Administrative Required Documents