6

INSTALLATION AND INITIAL OPERATING EXPERIENCE WITH THE CROSSFLOW ULTRASONIC FLOW AND TEMPERATURE SYSTEMS AT SONGS UNITS 2 AND 3

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temperature, and transients during startup. The interface software also made a comparison of the calculated and measured parameter values and demonstrated the system's excellent performance, sensitivity, and robustness under various operating conditions. The actual increase in power generation was approximately half the expected amount due to an unanticipated, non-conservative error in the final feedwater process temperature.

Nomenclature

In the discussions that follow, "correction factor" (Cf) is used in reference to the output of the CROSSFLOW UFM and CORRTEMP UTM systems. The correction factors are calculated for feedwater and steam flows as follows. The correction factors for blowdown flow and temperatures are similar.

$$C_f(feedwater) = \frac{FW_{ufm}}{FW_{venturi}} \tag{1}$$

$$C_f(steam) = \frac{(FW_{ufm} - Blowdown_{ufm})}{Steam_{venturi}} \tag{2}$$

INTRODUCTION

CROSSFLOW & CORRTEMP PIPING HARDWARE CONFIGURATION

The TYPICAL locations of installed CROSSFLOW (UFM) and CORRTEMP (UTM) brackets on both feedwater lines are shown in Figure 1. For each unit a total of 8 brackets were installed (4 UFM and 4 UTM). All of the feedwater brackets were installed downstream of the venturi on a long straight run of 18" Schedule 100 pipe. The Blowdown brackets were installed on very long straight runs of 4" piping in the same area of the feedwater bracket installations. The location of the Blowdown brackets was decided in part on using a common junction box with the feedwater transmitters.

The two ultrasonic brackets for each line, the UTM and UFM, were installed very close to each other with a clear spacing of 5 inches. The close spacing made it possible to use the same cable conduit and a single insulation assembly on both brackets in each line. Each insulation assembly consisted of a metallic cover and insulation blanket was used to protect the transducers. The metallic insulation helped to minimize mechanical damage to the transducers and associated cables, for instance by people walking on the insulation. Figure 2 shows a completed installation on the blowdown lines.

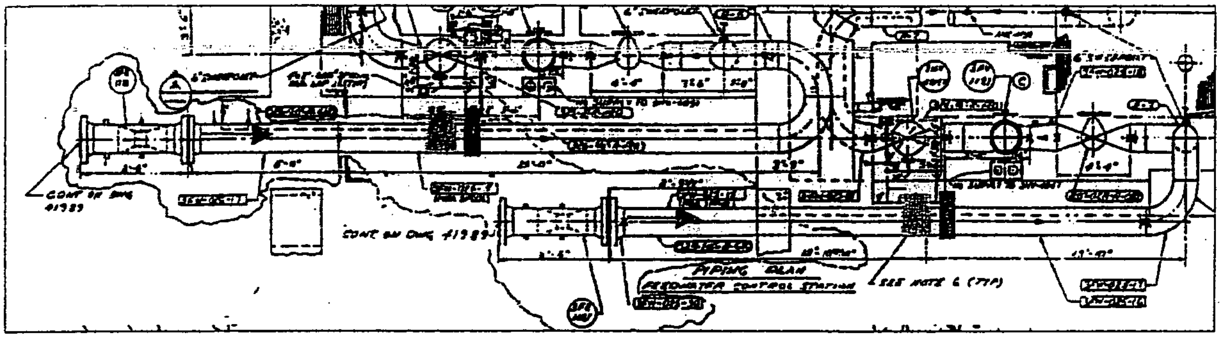

Figure 1: SONGS, typical UFM and UTM installations

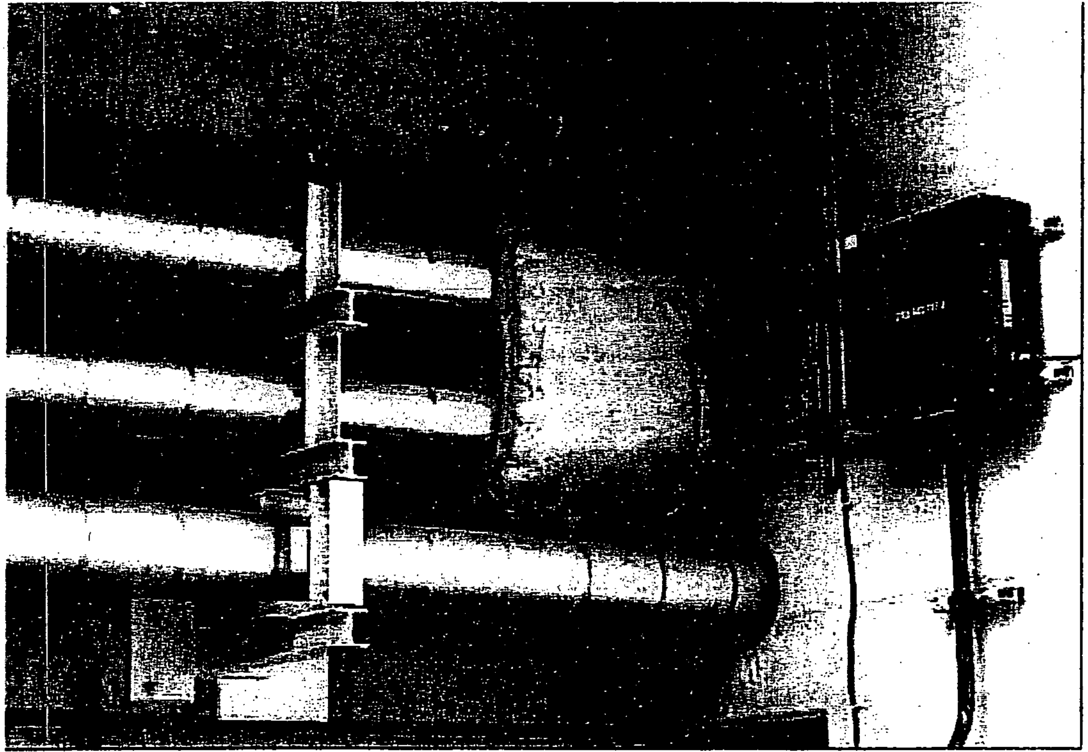

Figure 2: Insulated UFM & UTM installations on blowdown lines

The CROSSFLOW UFM and CORRTEMP instruments and interface with the plant computer are described in more detail in Reference (4).

INSTALLATION AND STARTUP CHALLENGES

The major challenges were the U2 feedwater UFM bracket location, UFM Blowdown flow measurement, ACL configuration, and software interface at the plant computer. U2 bracket location, blowdown flow and ACL configuration are discussed below. The software interface at the plant computer was not ready for the scheduled the power uprate, necessitating manual implementation, which is discussed below. It should be noted that, with the exception of one ultrasonic temperature probe failure and a "National Instruments data acquisition card" driver anomaly during the U2 UTM system startup, there have been no UFM or UTM equipment or software problems.

Unit 2 Feedwater UFM Bracket Location

During the pipe bracket installation and test phases at Unit 2, the steel piping at the preferred location >15 L/Ds downstream of the feedwater venturis was found to have poor acoustic properties. The CROSSFLOW UFM technology employs the pipe wall in acoustic transmission and reception and requires the pipe to transmit a strong acoustic signal. The acoustic properties of the piping at the planned location were not suitable even with a pre amplifier for the 600+ feet transducer cable. The brackets were moved upstream to chrome-moly piping installed due to flow accelerated corrosion (FAC). UFM measurements at the new locations, 7 to 9 L/Ds downstream of the FW venturis and >84-90 L/Ds downstream of elbows, were found to be biased, necessitating a cross calibration only after ruling out other potential contributing factors. (This is an example of Murphy's Law applied to a project with a tight schedule and great management visibility.)

In this cross calibration, the permanent CROSSFLOW meters were installed just downstream of the feedwater venturi at about 7 to 9 L/D and temporary CROSSFLOW meters at >15 L/D downstream concurrently. The >15 L/D location was found to be suitable for short transducer cable lengths with pre amplification. Precautions were taken to minimize total error in the cross calibration factors. These included multiple sets of piping measurements, UFM instrumentation in multiplex mode for concurrent upstream and downstream flow measurement, and long data runs. The cross calibration factors were developed and applied to both feedwater lines.

UFM Blowdown Flow

SONGS utilizes both a feedwater and a steam based calorimetric calculation of reactor power. The steam based calorimetric of reactor power is the preferred indication because it is independent of the feedwater venturi, is not susceptible to rapid changes in condition, and provides a signal with less noise than the feedwater calorimetric calculation. The steam flow correction factor is the ratio of UFM feedwater minus UFM blowdown to the process plant steam flow. UFM blowdown flow availability was found to be a function of plant conditions and blowdown flow rate.

At each Unit, the blowdown piping runs from two steam generators through containment isolation valves and check valves several hundred feet to control valves at the inlet to the Blowdown flash tank. The system has a fluid resonance and piping vibration in the range of 10 to 15 Hz, which is in the same frequency range as the demodulated signals from the ultrasonic flow measurement. The background noise from the resonance and vibration interfere with the cross correlation process. Sometimes the blowdown flow is so great that there is two phase flow in the piping at the measurement location which interrupts both the UFM and UTM.

Successful UFM measurement was accomplished through selective tuning of blowdown transducer frequency ranges at selected Blowdown flow rates. Outlying data points were eliminated through a CROSSFLOW software modification which would exclude data outside of a 3 sigma band based upon the previous ten data points. In the near future, the Algorithm and Communication Layer (ACL) software will be modified such that a default blowdown correction factor can be applied to plant blowdown flow in the steam correction factor algorithm. A default blowdown correction will allow the ACL to calculate steam flow correction factors when UFM blowdown is not available. Review of the manual calculation data and CROSSFLOW system generated correction factor data show that the blowdown correction factors are relatively steady and very stable, i.e., typical change over a several day/week period is in the 4th decimal place. In the long term, the CROSSFLOW software will be modified to provide a selectable window for the cross correlation frequency range.

Algorithm & Communication Layer (ACL)

The CROSSFLOW UFM and CORRTEMP UTM measurements are not used as instantaneous indications of the plant process. Rather, the measurements are applied as long term averages of several hours of data in order to meet uncertainty requirements. The ACL performs automatic calculation of correction factors for both the CROSSFLOW UFM and CORRTEMP UTM measurements, and provides these to the plant computer every 4 minutes. Refer to Reference (TBD) for a more detailed description of ACL operation. The calculations are based upon data sets in long-term buffers.

The initial buffer size was set for about 8 hours and the final setup was about 30 hours. The buffer size was extended to provide smoothed correction factors and, therefore, indication of reactor power. Figure 3 shows the calculated variations of the correction factors using various buffer sizes. Figure 4 shows the calculated main steam calorimetric reactor power level using the final buffer size of 450 points versus the real power level. The criterion used for buffer size was that the correction factor variation be the same or less than the variation in indicated reactor power.

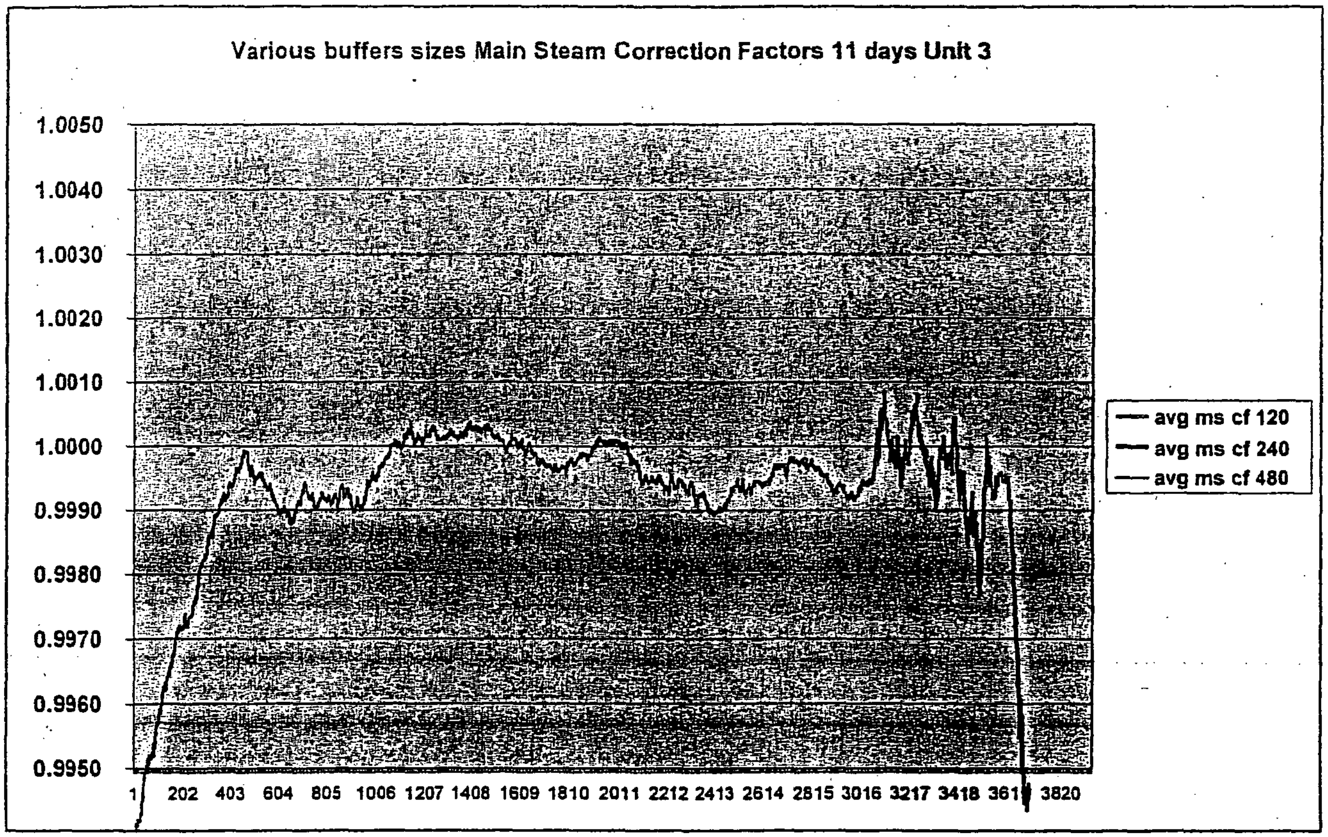

Figure 3: Main Steam Correction Factor Trends as a Function of Buffer Size

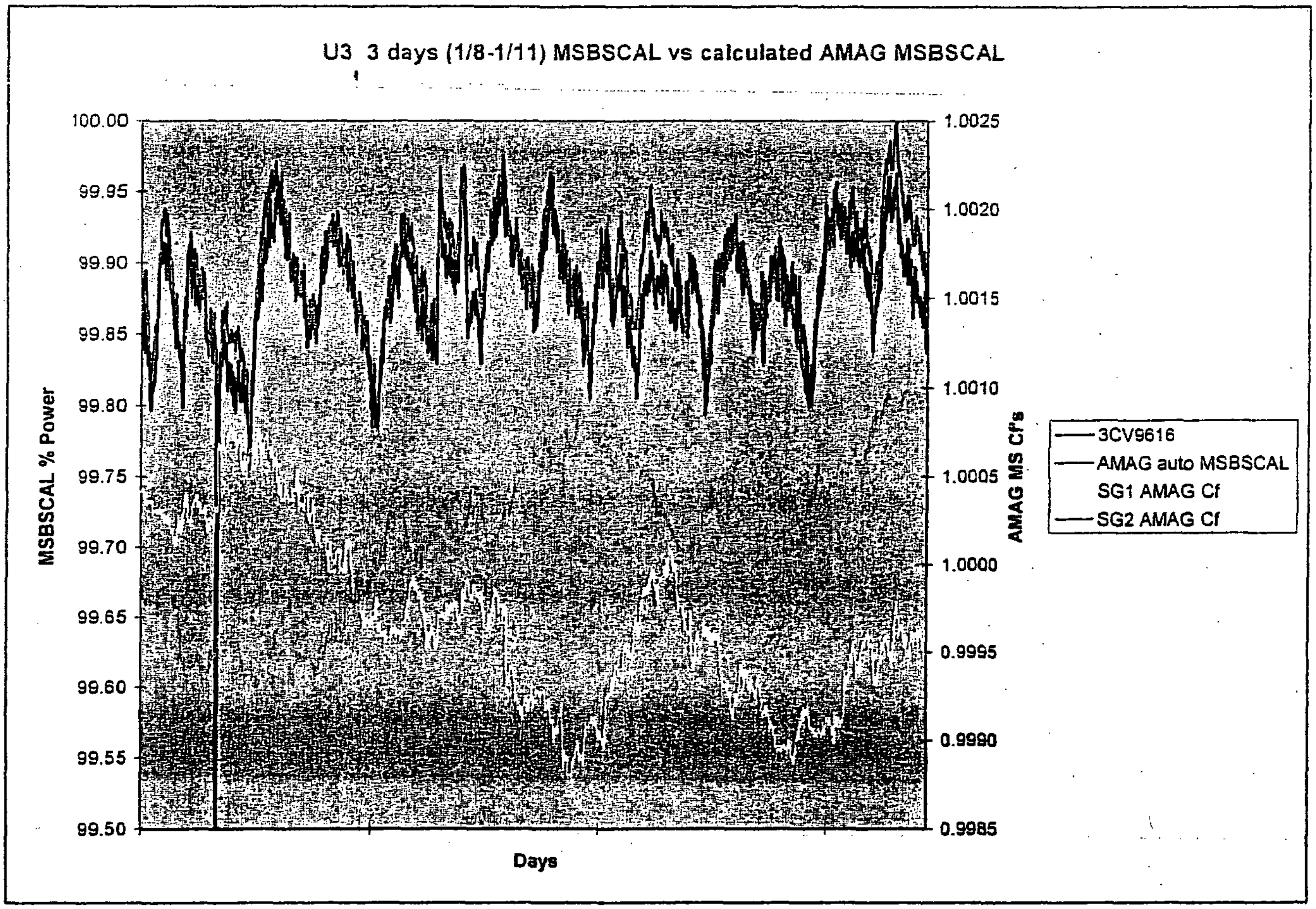

Figure 4: MSBSCAL with 30 Hour Buffer

POWER UPRATE HISTORY

The uprate history and manual implementation are discussed in the following sections.

Unit 3

The U3 power uprate of 1.4% was implemented successfully 8/16/01. The uprate was made possible by manual calculation and utilization of new feedwater venturi coefficients and MSBIAS terms, and Blowdown flow and feedwater temperatures based upon the highly accurate ultrasonic flow and temperature measurements. In this new process, the reactor power calorimetric total loop uncertainty is approximately 0.5%. The uncertainty of the old process was greater than 1.5%.

The chart below shows a visual picture of the implementation process. The correction factors were manually installed in the plant computer about 11am. The controlling reactor power at implementation was based upon FWBSCAL (CV9615), and the indication increased about 0.8% immediately with no increase in generation. This immediate change was due to the fact that the old FWBSCAL reactor power indication with its 1.5% uncertainty was indicating 0.8% less than the new more accurate process. MSBSCAL (CV9616), the reactor power based upon steam flowsteam flow, was calibrated at power uprate time, and this is the reason for the large step change.

The component errors of this 0.8% error in FWBSCAL were as follows:

Temperature error, 0.16% on FW flow and 0.37% on enthalpy change, for a total of 0.53%.

Pipe area error (flow) associated with old UFM test methodology, 0.39%. (We had used the UFM with the old style aluminum brackets, circa 1997 test equipment, to calibrate the U3 FW venturis at start of this operating cycle.)

Blowdown error, - 0.11%.

The power increase was started about 1230 and Unit 3 reached full power about 1315. The chart shows a 9 to 10 MWe increase in generation from the starting point of 98.3% to full reactor power, nominally 1153 to 1162 Mwe (JT8000, right axis). SONGS Unit 3 had an unrealized benefit of 8 MWe due to process error from the start of operating cycle to this time to power uprate time, and an additional benefit of 8 MWe as a result of the power uprate using the new ultrasonic flow and temperature instrumentation. Unit 3 would have realized a 16 MWe at implementation of the power uprate had the old process been indicating true reactor power.

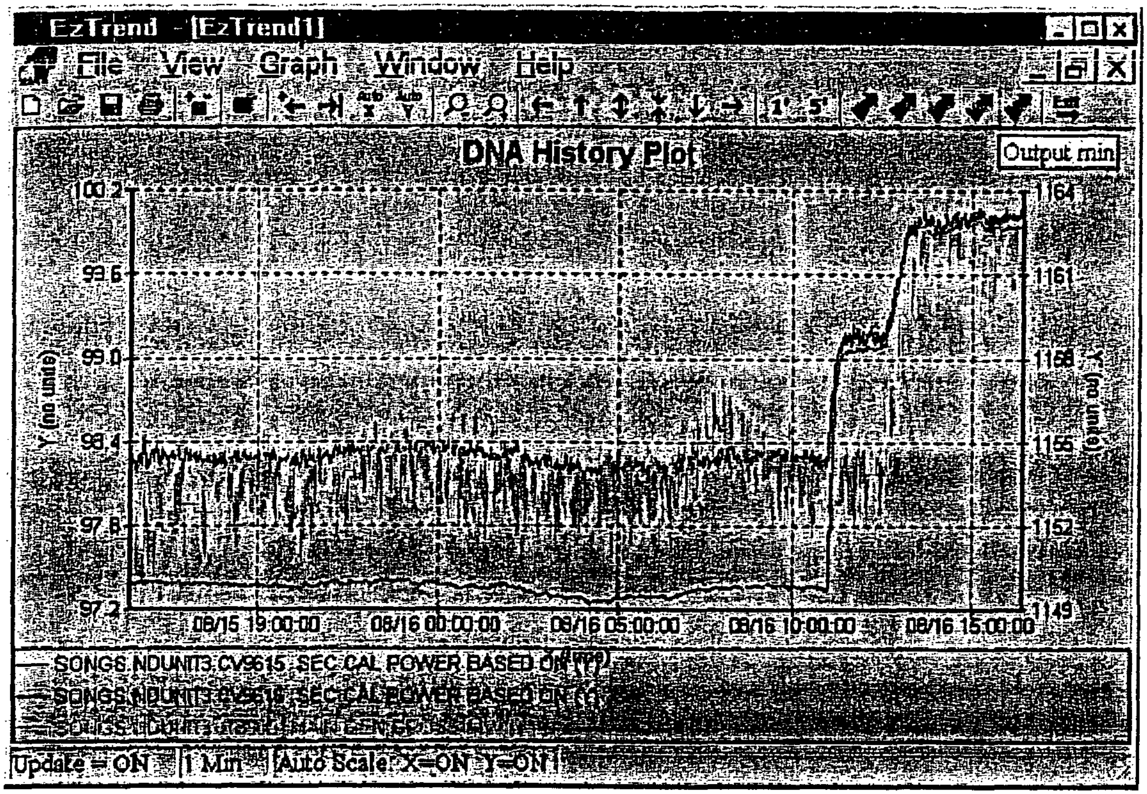

Figure 5: Unit 3 Power Uprate

Unit 2

U2 Power uprate was implemented shortly after noon on 12/12/01. MSBSCAL (CV9616) changed exactly as expected. Indicated reactor power changed 0.7 to 0.8% step change with the new FW venturi coefficients, MSBIAS change, and Blowdown and FW temperature corrections, similar to U3 with no increase in generation. Most of the correction was in final feedwater temperature. The small spread in the two reactor power indications shown in the chart was due to feedwater coefficient calculation methodology and was eliminated with subsequent application of feedwater correction factors.

SONGS Unit 2 realized about 10 MWe at power uprate time as shown in the chart below. Megawatts (JT8000), the right vertical axis in this chart, increased from 1177.5 to 1187.5. As in Unit 3, Unit 2 would have realized 16 MWe at implementation of the power uprate had the old process been indicating true reactor power.

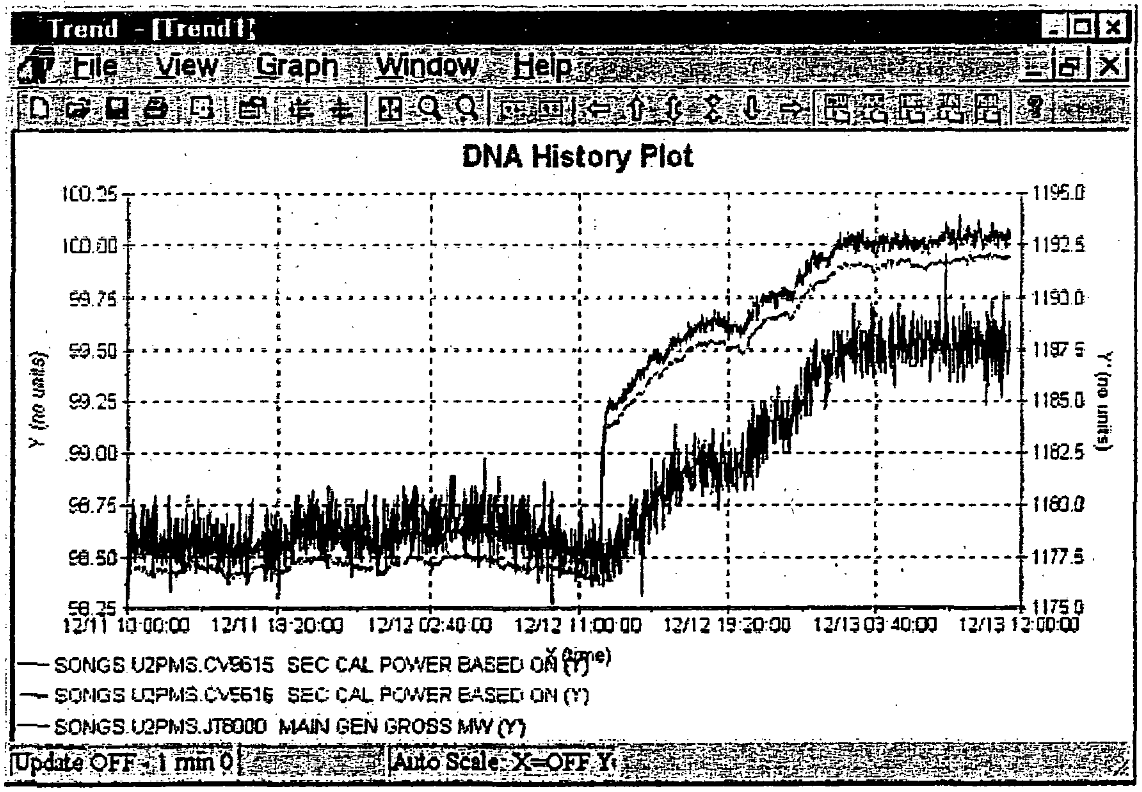

Figure 6: Unit 2 Power Uprate History

Manual Implementation and Correction Factor History

The plant computer software interface was not ready when SONGS was licensed for the 1.42% power uprate. A process was developed to provide for manual calculation of correction factors based upon the new ultrasonic flow and temperature instruments and implementation in the plant computer. The process has the following elements:

<u>Verification of initial conditions:</u> The unit is steady state full power lineup, plant computer and UFM/UTM systems operable for >24 hours.

<u>Retrieval of UFM and UTM data files</u>: The UFM and UTM files are converted to ASCII format and copied to a floppy disk or transferred via modem.

<u>Verification of UFM and UTM statistical criteria</u>: The UFM and UTM data is copied into Excel spreadsheets where the standard deviation and confidence interval are calculated and verified to meet the design basis.

<u>Retrieval of plant data</u>: The data is downloaded from DNA long-term history servers using Excel spreadsheets.

Correction of UFM flows and UTM temperatures: Nominal pressures and temperatures are used in the CROSSFLOW and CORETEMP configuration settings. Minor corrections are needed for actual plant conditions.

Calculation of correction factors, venturi coefficients and main steam bias: Correction factors are the ratio of corrected flows and temperatures to the respective plant parameter. Other coefficients and bias terms are based upon algorithms.

Reactor power verification: The temperature correction factors are based upon data obtained in the primary computer. These factors are adjusted, if necessary, to prevent nonconservative power indication in the backup computer.

Independent Review: Reactor engineers perform an independent review of the data and calculations.

Implementation of correction factors: The correction factors are manually input into their respective addressable constant registers in the plant computers.

The manual calculations were performed the day before the power uprate and implemented on the day of power uprate. Manual calculations were performed and implemented the day after and then at 3, 7 and 14 days after, and thereafter at approximately 14 day intervals. Correction factors are considered good for 31 days based upon worst-case venturi instrumentation drift errors applied to available total loop uncertainty (TLU) calculation margin. A 14 day update allows time to resolve emergent issues. Manual calculations were performed for both units from power uprate through May 2002 when automatic operation was initiated. Unit 2 trend charts of the correction history are shown below. Note the stability of the feedwater and steam flow and feedwater temperature correction factors, AK2000, 2004 and 2006 respectively in Figure 7, AK2001, 2005 and 2007 in the Figure 8. Unit 3 trends are similar.

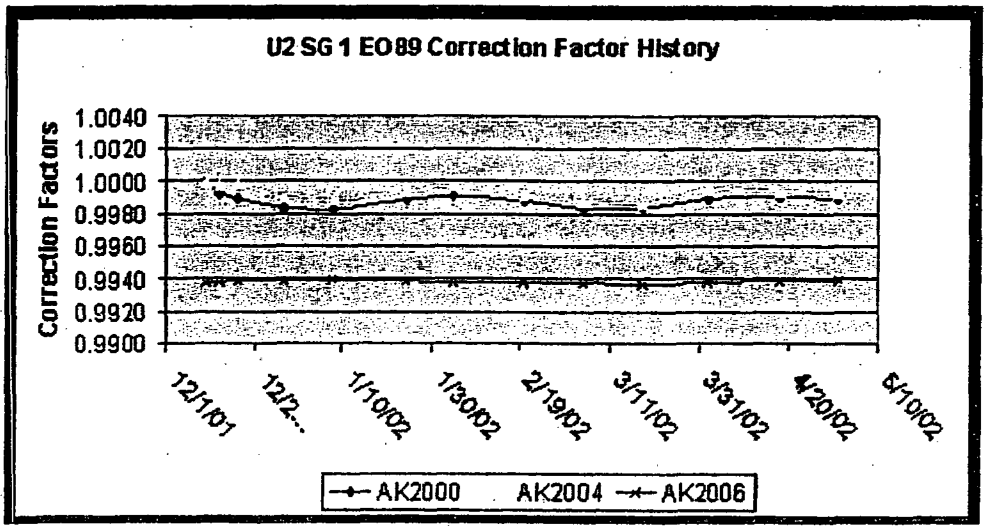

Figure 7

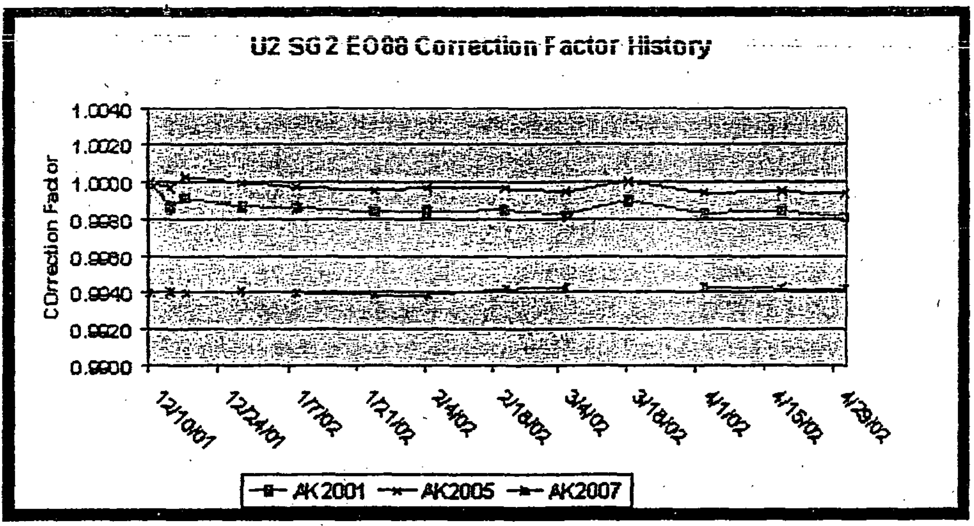

Figure 8

SYSTEM PERFORMANCE UNDER VARIOUS PLANT OPERATING CONDITIONS

CROSSFLOW Correction Factor Sensitivity and Variation In SONGS Unit 2 during Startup Plant Startup

The plant startup in October 2001 provided an opportunity to observe the sensitivity and variation of the CROSSFLOW correction factors during power ascension. The results show that for power levels greater than approximately 60%, the correction factors are stable with changes in power level.

The October 2001 Songs Unit 2 startup data was used for analyzing the sensitivity of the correction factor at different power levels (80% to 100%). The CROSSFLOW digital feedwater data, called Xflow, was collected manually and plant temperatures and pressures were used to correct the collected data for to actual plant process conditions. These corrections are for density, spacing, correction factor, and pipe ID. The adjusted CROSSFLOW data then was compared with flow rates from the feedwater plant instruments, which are based on venturi, and a ratio of Xflow/Plant Flow was calculated. This ratio is equivalent to the process correction factors developed by the CROSSFLOW ACL software.

Figure 9 and 10 show the calculated ratio of Xflow/Plant Flow during the startup period. The variation is due to fast transients in the startup period and inherent venturi characteristics. A regression analysis was performed on data from both feedwater loops in order to calculate the 95% confidence interval for the change in correction factor from a change in feedwater flow rate. Table 1 and Table 2 show the regression results. The regression analysis results support the fact that there are no significant changes in the feedwater correction factors due to flow changes from 80% to 100% with temperature changes 420^0 F to 440^0 F. The consistency of the calculated ratio

(Xflow/Plant flow) at even lower power levels (~60%) also indicates that there is no significant change in correction factor due to changes in feedwater temperature above 400^0 F.

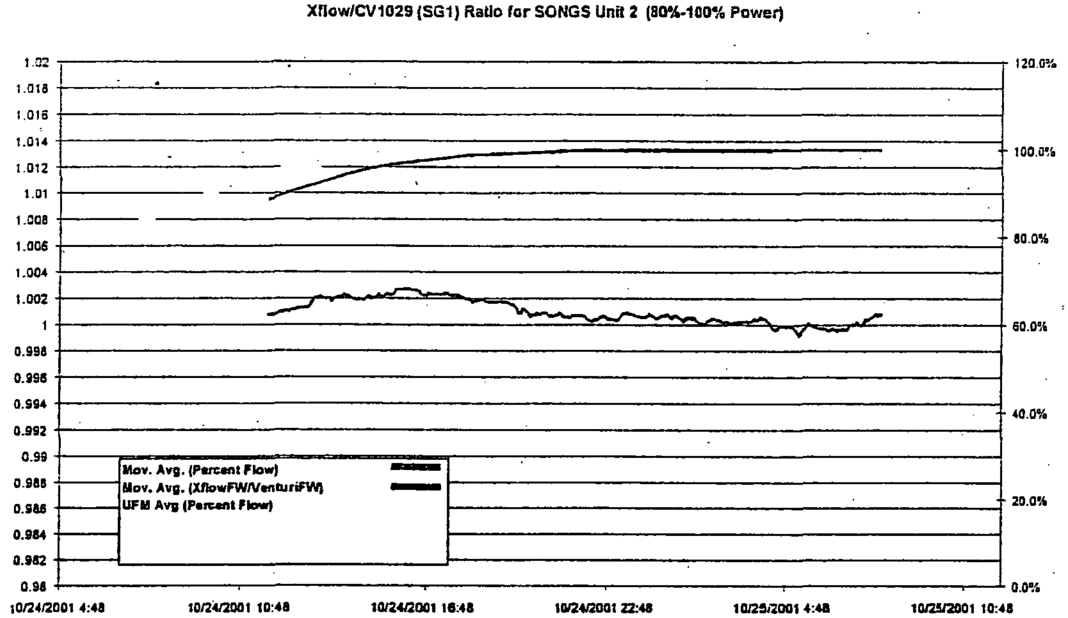

Figure 9: SG1 Feedwater Flow and Correction Factor vs. % Flow

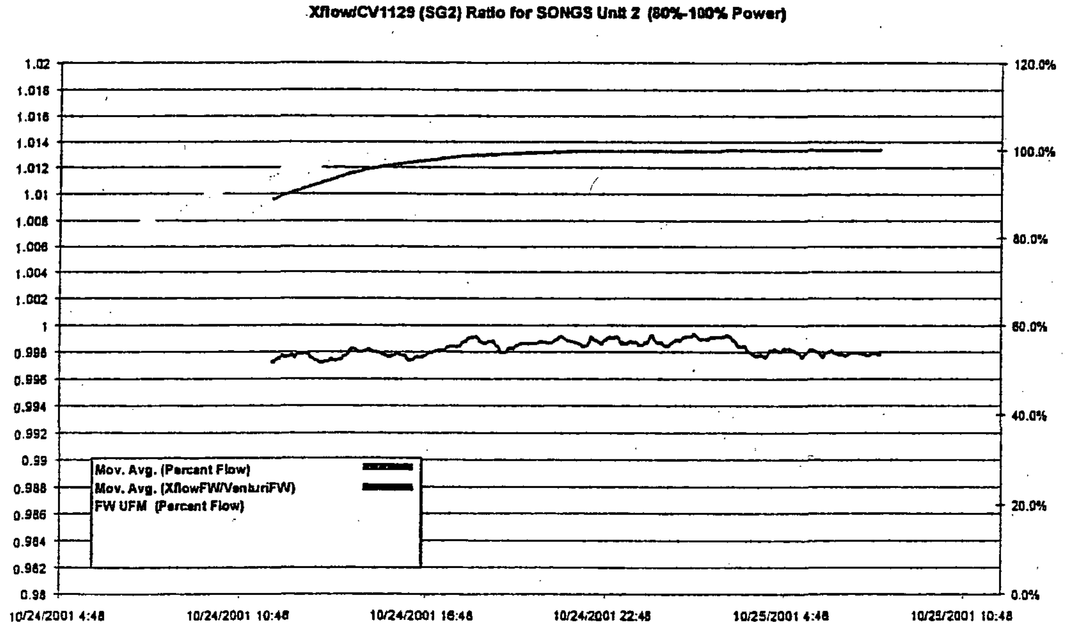

Figure 10: SG2 Feedwater Flow and Correction Factor Vs % Flow

Table 1. Songs unit 2 FP1111

Regression result for SG1 for 80%-100% power range	
% change in CF due to 1% change in flow (% / %)	0.0001%
Upper 95% confidence limit for % change (% / %)	0.0075%
Lower 95% confidence limit for % change (% / %)	-0.0072%

Table 2. Songs unit 2 FP1121

Regression result for SG2 for 80%-100% power range	
% change in CF due to 1% change in flow (% / %)	0.0119%
Upper 95% confidence limit for % change (% / %)	0.0191%
Lower 95% confidence limit for % change (% / %)	0.0048%

Figure 11 and Figure 12 show both the feedwater and steam flow correction factors, C_f, during the October 2001 startup period for both steam generators. The correction factors were calculated as described above. The steam venturi correction factor was based upon the process blowdown flow indication since UFM blowdown flow was not available. The results show that the correction factor is very consistent. The variation at low flow is due to nonlinearity in venturi reading.

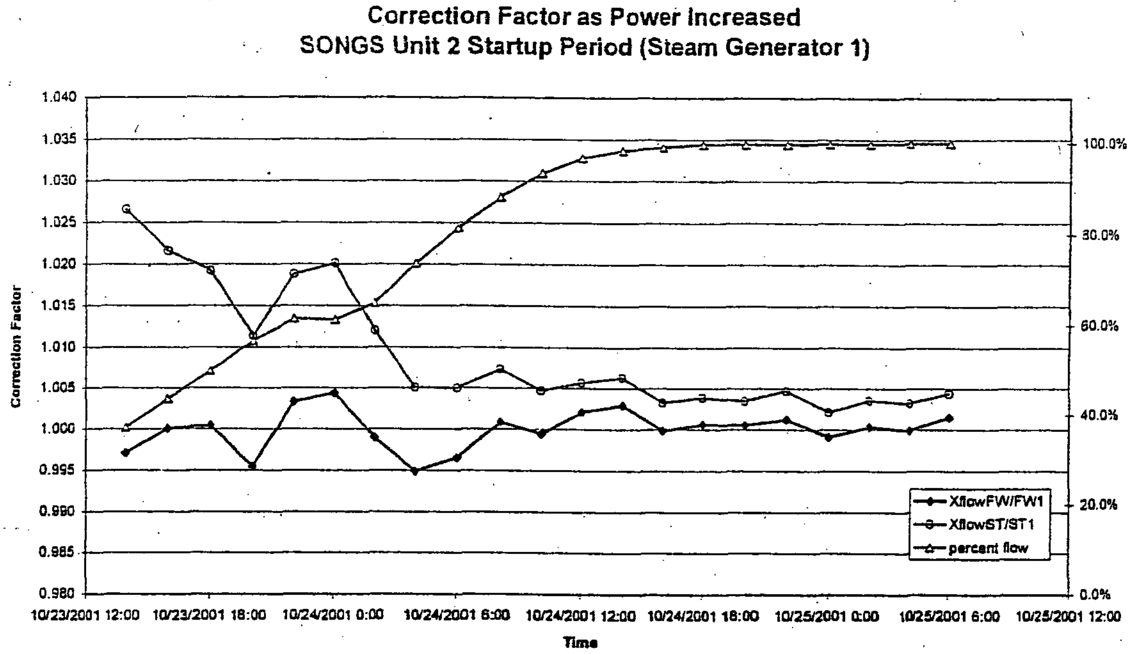

Figure 11: SG1 Correction Factor Variation during Unit 2 October 2001 Startup

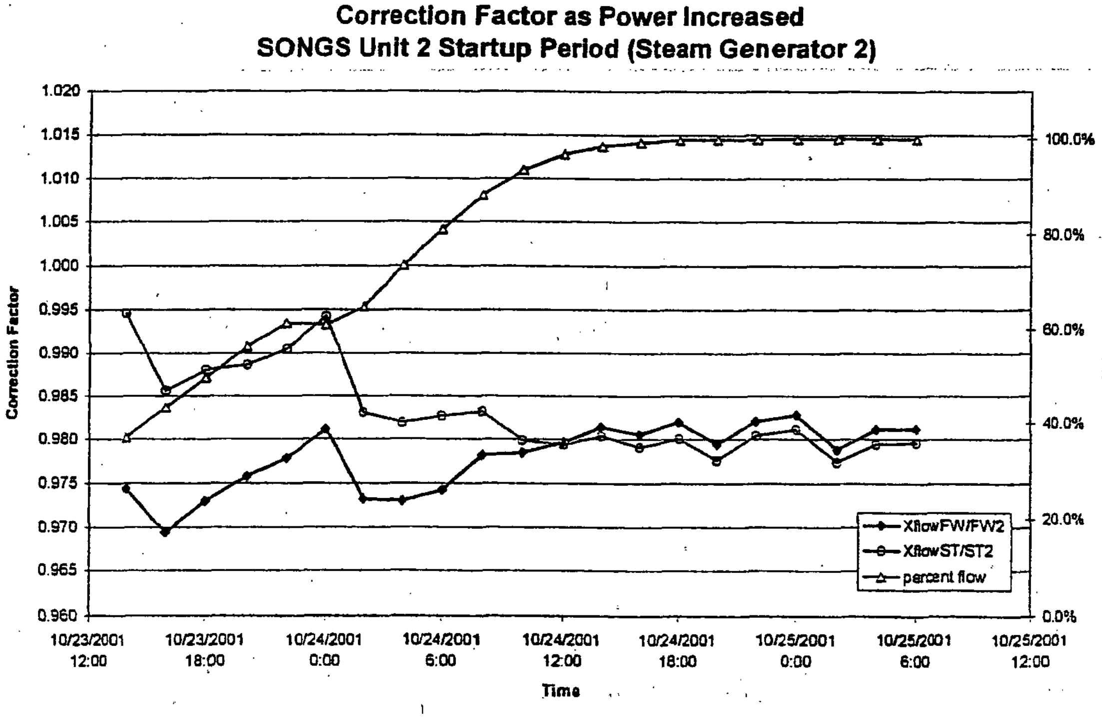

Figure 12: SG2 Correction Factor Variation during Unit 2 October 2001 Startup

For the Unit 2 Cycle 12 startup in early July 2002, the CROSSFLOW and CORRTEMP systems were operating with communication to the pant computer. In this mode, the correction factors are generated by the ACL, sent to the plant computer, and stored in the plant history DNA server. Figure 13 shows an actual trend in the correction factors versus flow (% reactor power).

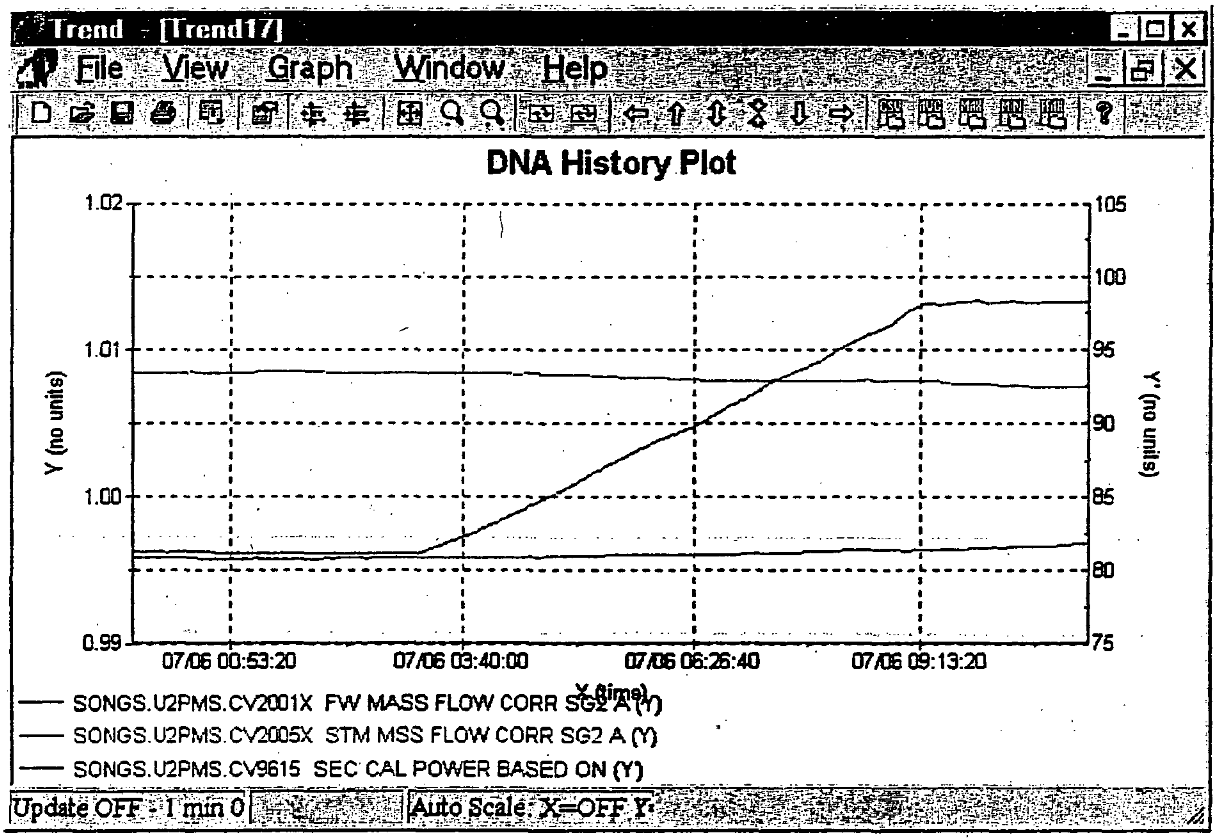

Figure 13: Unit 2 SG2 Correction Factor Startup Trends

EXAMPLE CORRECTION FACTOR HISTORY FOR SONGS UNIT 3, SG #2

Figure 14 shows the slow change in Unit 3 steam generator 2 feedwater correction factor over a six-month period. Note that the corresponding steam correction factor has remained relatively steady over this same period, which indicates that the feedwater venturi flow is drifting high, an indication of venturi fouling. The combination of plant process feedwater and steam instrumentation, along with the CROSSFLOW UFM, provides the ability to easily identify these kinds of changes. Figure 15 shows both Unit 3 feedwater correction factors from August 2001 to present. The timing of the ACL buffer length change can be seen clearly. About 1/3 of the way into this trend, the correction factors variation decreases significantly. Towards the end, the two correction factors are drifting apart.

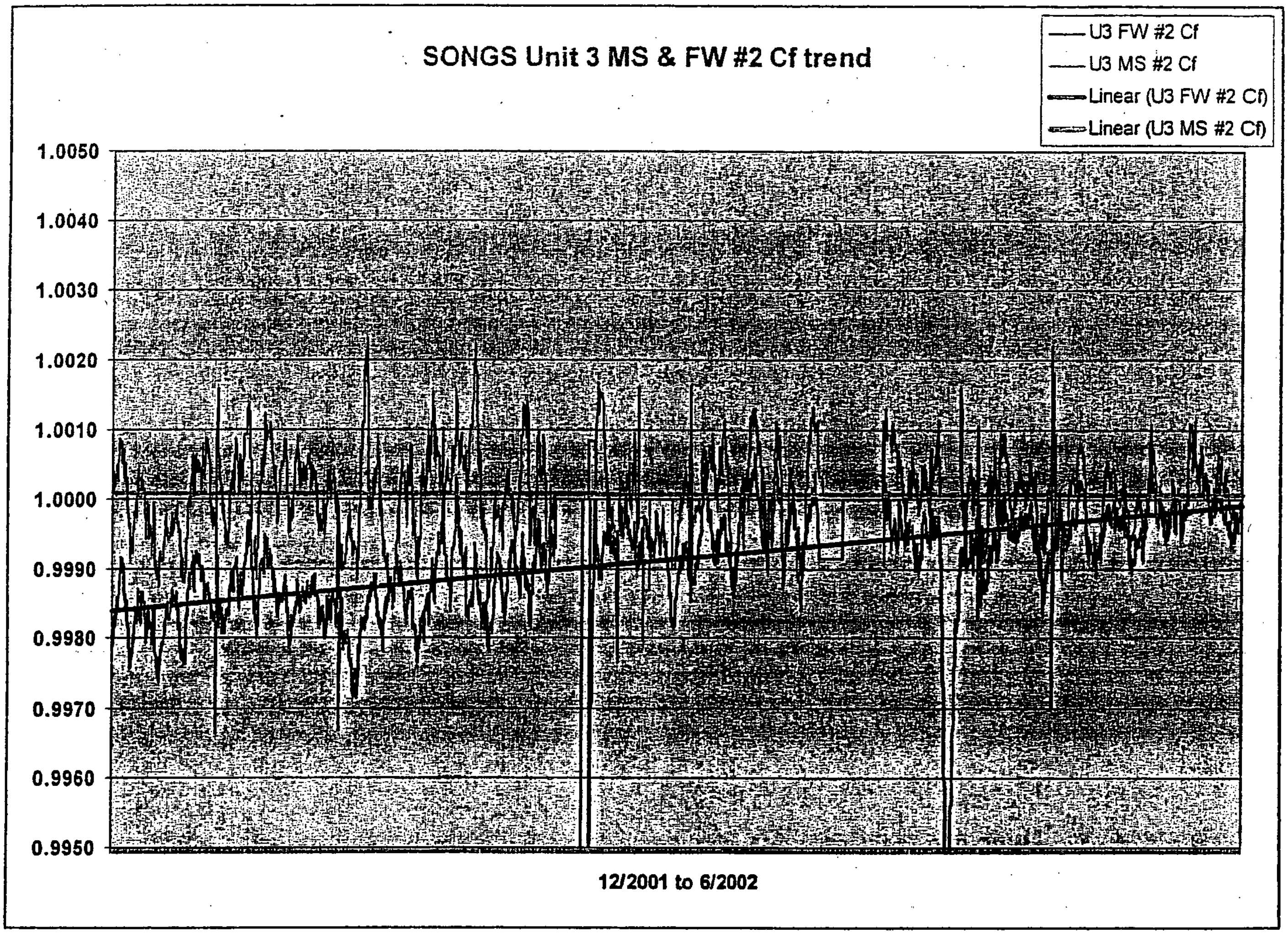

Figure 14: U3 SG2 Long Term Feedwater Fouling Trend

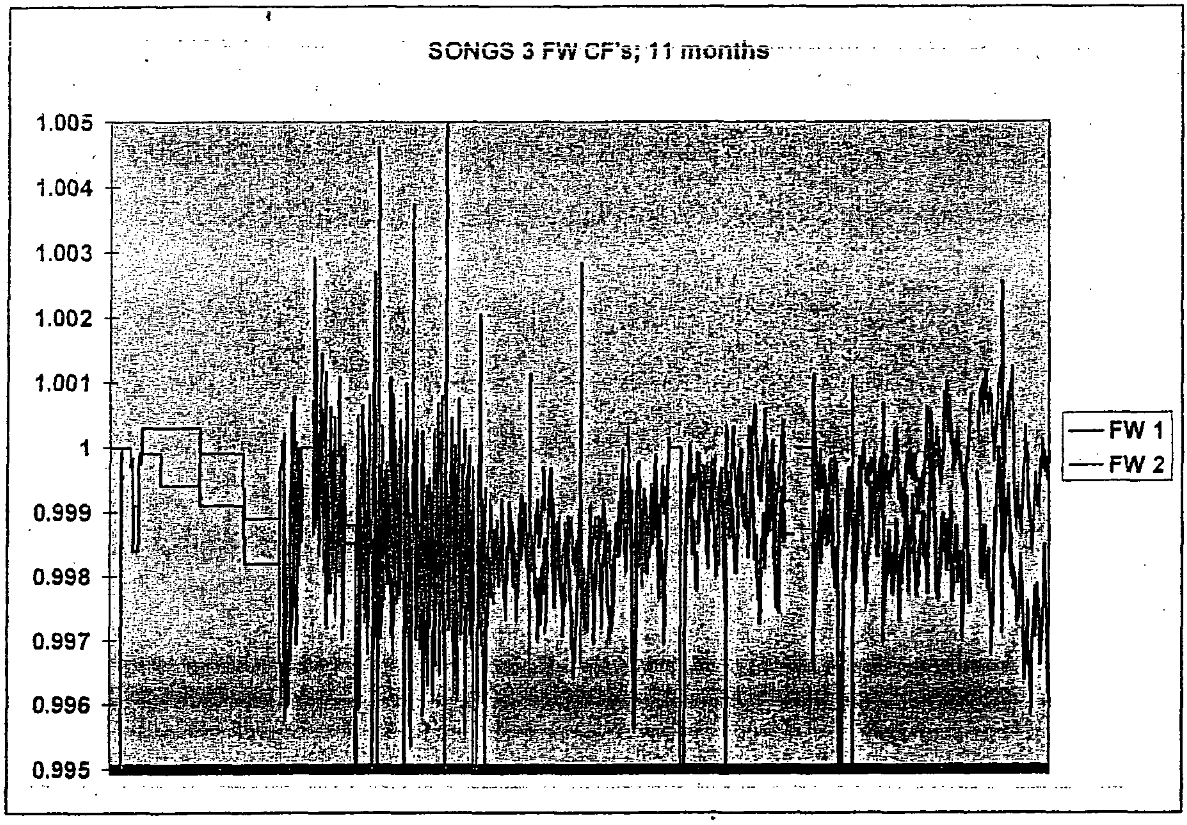

Figure 15: U3 Feedwater Correction Factor Trends

Lessons Learned

Among the many lessons learned in the process of this power uprate, anticipated benefits from such a major expenditure need to be expressed accurately. At SONGS, the anticipated benefit from this Appendix K uprate was based upon the original indication of reactor power being accurate, which turned out to be a poor assumption. For other plants, the new instrumentation could show a similar finding, that the plant is part way or already operating at the new uprate power level.

References

1. Westinghouse-CE Topical Report CENPD-397-P-A, Revision 01, "Improved Flow Measurement Accuracy Using Crossflow Ultrasonic Flow Measurement Technology," May 2000.

2. Advanced Measurement & Analysis Group (AMAG), "AMAG-MAN-EN-006-00 Users Manual for CORRTEMP 1.0.x UTM System," Revision 0, August 2001.

3. Advanced Measurement & Analysis Group (AMAG), "Software Requirements Specifications SRS-7137-06-Rev02," January 2002.

4. "A Description of the CROSSFLOW System to Support 1.4% Power Uprate at SONGS," Vahid Askari, AMAG, Inc, Joseph G. Murray, SONGS/SCE, and Michael J. Schwaebe, SONGS/SCE, presented to EPRI NPPI Conference July 2002.

SONGS UFM/UTM Installation and Initial operating experience

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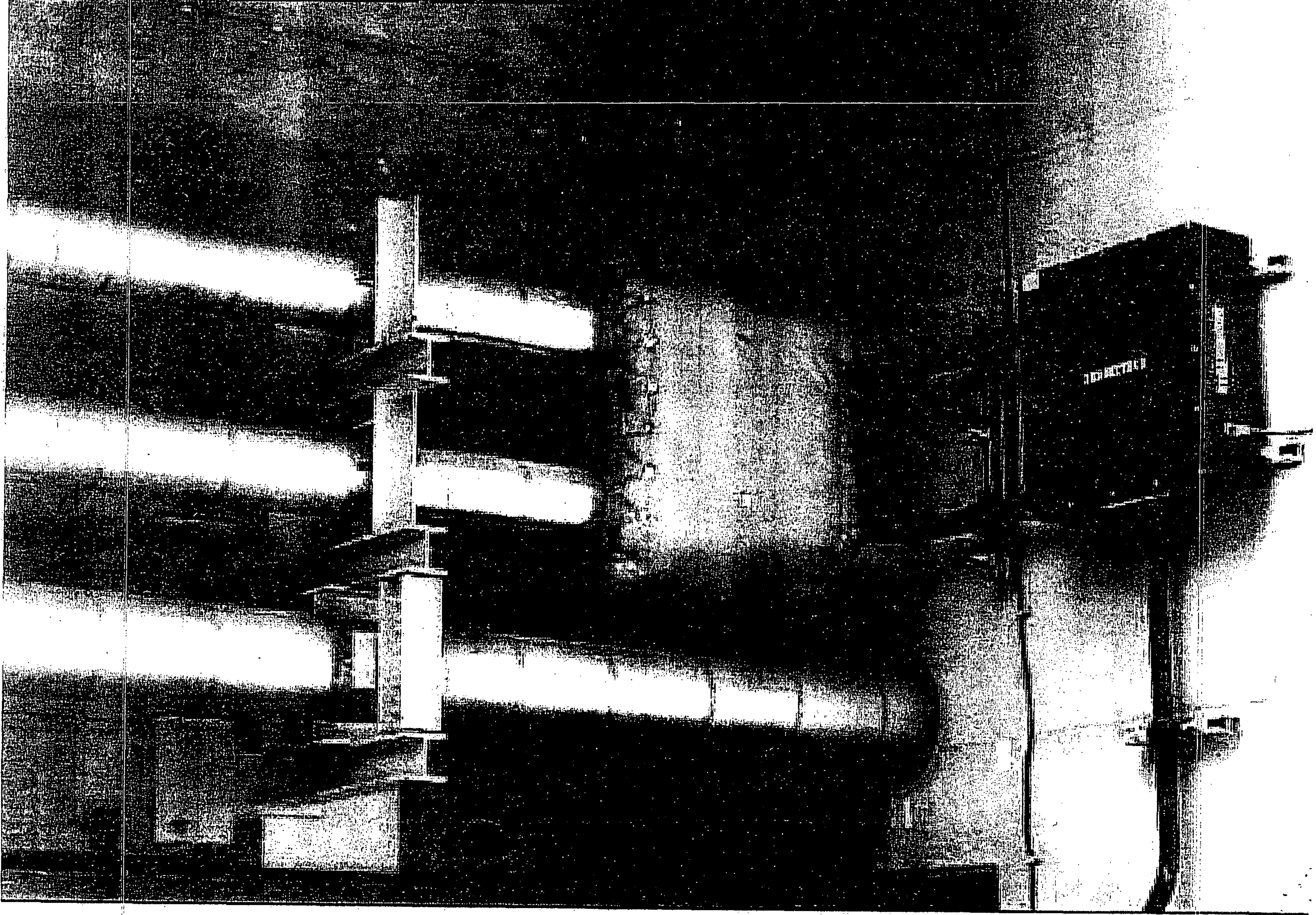
SONGS Power Uprate Configuration

- AMAG UFM and UTM on feedwater and blowdown
- CROSSFLOW ACL software calculates FW, BD and steam flow CFs and FW temperature CFs, determines quality, and provides alarms.
- CROSSFLOW ACL interface between both the primary and backup process computers, with independent calculation of CFs.
- Two reactor power calorimetrics, FW and <u>main steam</u>
- Main steam calorimetric reactor power is preferred. The steam venturis are not subject to rapid fouling and de-fouling like the FW.
- Plant process computer de-fouling alarm based upon FW and main steam calorimetrics.

Piping Hardware

- 4 UFM and 4 UTM per Unit
- UTM located next to UFM to minimize cable/conduit routing
- Proper insulation and mechanical protection is needed
    - SONGS had insulated cans covered by insulation blankets



Installation and Startup Challenges

- Unit 2 FW UFM location
  - Original position had poor acoustic properties
  - Signal strength insufficient for the 600+ feet cable runs
  - Brackets relocated to upstream Chrome-Moly piping recently installed for FAC
  - Cross Calibration performed due to lowered L/Ds

Installation and Startup Challenges (cont.)

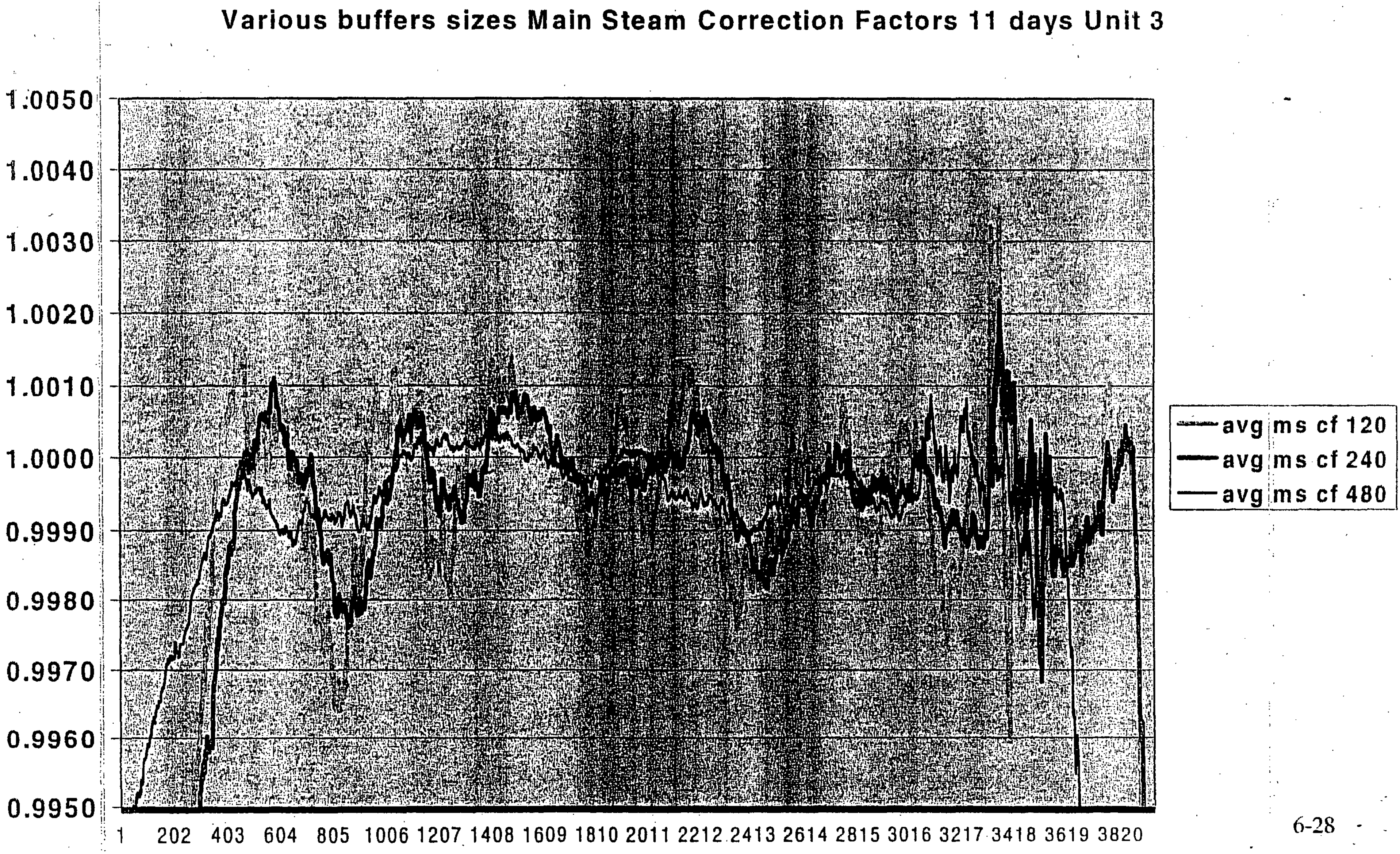
- UFM Blowdown Flow
  - Steam flow calculated from FW minus blowdown
  - Fluid resonance & piping vibrations in the range of 10-15 Hz, interferes with UFM
  - Two-phase flow at high flow rates
  - Selective tuning for selected flowrates, future software mods

Installation and Startup Challenges (cont.)

- Algorithm & Communication Layer
  - CF's calculated on same size buffers of UFM and plant instrument data
  - Initial buffer size 8 hours
  - Final buffer size 30 hours
  - Final buffer size used to ensure that indicated plant power was at least as stable as original

Home Sessions Session I

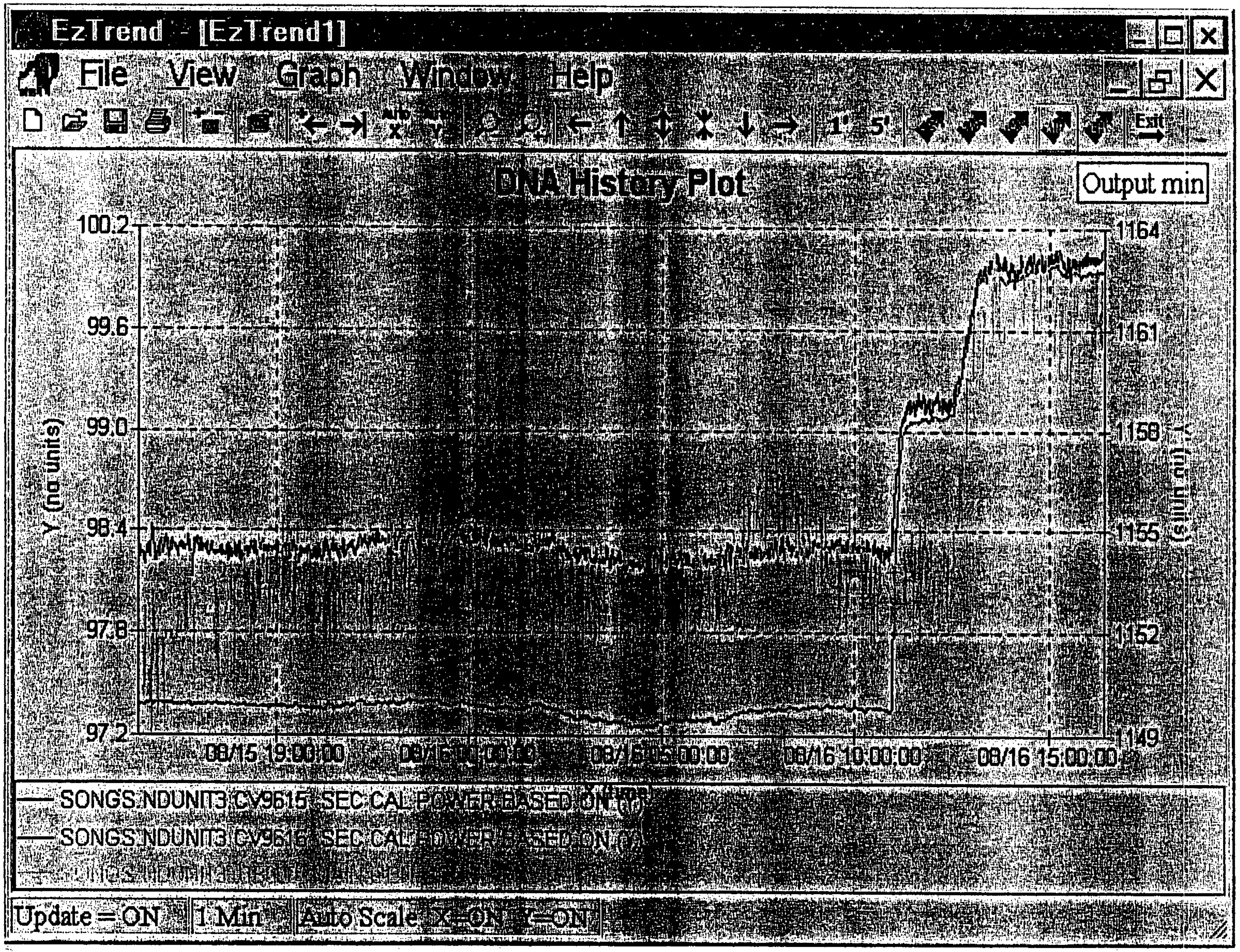
Graph for buffer size determination



Unit 3

- Uprate 8/16/02, Manual Mode
- At implementation, reactor power increased about 0.8% immediately
- The component errors of this 0.8% error in BSCAL were as follows:
- Temperature error, 0.16% on FW flow and 0.37% on enthalpy change, for a total of 0.53%
- Pipe area error (flow) associated with old UFM test methodology, 0.39% (We used the UFM test equipment to calibrate the U3 FW venturis at start of C11)
- Blowdown error, - 0.11%

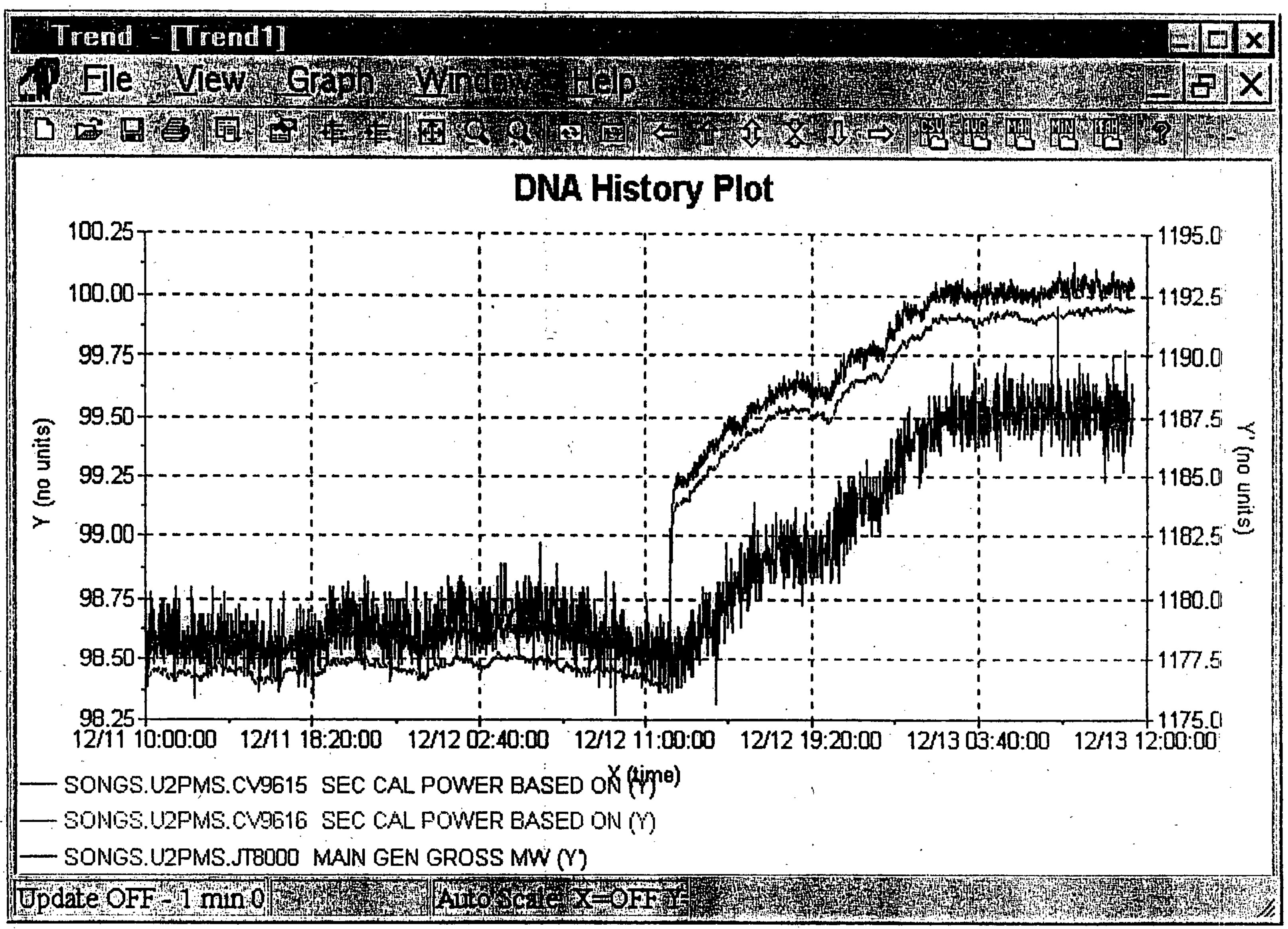
Unit3 @power uprate



Unit 2

- Uprate 12/12/02, Manual Mode
- At implementation, reactor power increased about 0.75% immediately
- The primary component of the BSCAL increase was a 2.7 degree error in final feedwater temperature

Unit 2 @ power uprate



Manual Mode UFM Calibration

- Frequency, BI-weekly per SONGS procedure SO23-V-2.12.
- Calculation of correction factors:
- Use excel spreadsheet, book format for UFM, plant data and calculations
- Integrate UFM QA calc acceptance criteria into spreadsheet
- Use 24 to 36 hour data sets to smooth the correction factors
- FW coefficients and main steam bias terms were changed at uprate to make the initial corrections 1.0

Manual Mode Data qualification

Part 1, Statistical Verification, Procedure Section 6.1.4		
Calculation Step	Description	Spreadsheet Function, Algorithm, or Source
1A	Date	=(beg of Date range)
1B	Start Time	=(beg of Time range)
2	End Time	=(end of Time range)
3	Sample Count (N)	=COUNT(Time range)
4	Time Delay (TD) Mean	=AVERAGE(TD range)
5	TD Standard Deviation	=STDEV(TD range)
6	TD - 3(STDEV)	=TD - 3*STDEV
7	TD + 3(STDEV)	=TD + 3*STDEV
8	Student T distribution	=TINV(0.05, N-1)
9	95% confidence interval	(Student T*STDEV/TD/SQRT(N)*100
10U2	95% Conf Int Criteria	From Ref 2.2.1
	Criteria Verification	Step 9 is = or < than Step 10, Y or N

Manual Mode Flow Correction

Part 2 UFM Flow Correction, Procedure Section 6.2		
Calculation Step	Description	Spreadsheet Function, Algorithm, or Source
12	FE1127U Mean UFM Flow	=AVERAGE(UFM Flow Range)
13 **	TE1127 Corrected FW Temp	Attachment 11 Step 16, see comments
14	CV9924X FW Pressure	Attachment 13 Step 9
15	Steam Table Density	Nist Steam Tables, steps 13 and 14
16	FE1127 Density	=AVERAGE(Density Range)
17	FE1127 Temperature (Tsetup)	=AVERAGE(Temperature Range)
18	Density Correction (DENcor)	=Steam table Density/FE1127 Density
19U2	Trans Spacing Correction (Lcor)	=(1+7.793E-6*(TE1127-Tsetup))
20U2	Pipe ID Correction (Dcor)	=(1+7.735E-6*(TE1127-Tsetup))^2
21	FE1127 Corrected UFM Flow	=FE1127*DENcor*Lcor*Dcor
** If TE1127 is bad, use TE1117 from Attachment 9 Step 16		

Manual Mode Correction factor Calculation

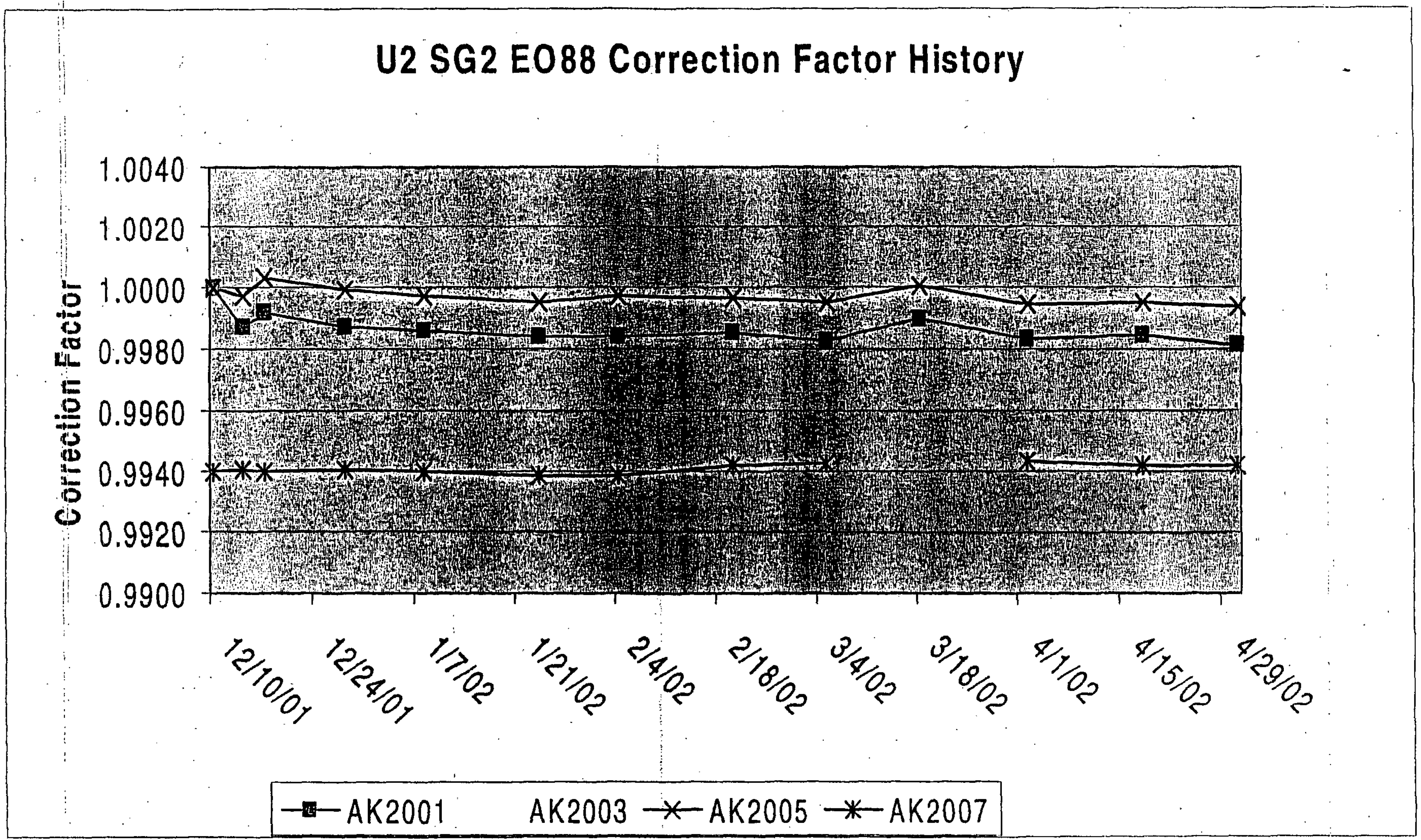
Part 3 Correction Factor Calculation, Procedure Section 6.3

Calculation Step	Description	Spreadsheet Function, Algorithm, or Source
22	CV1129U FW Flow	From Attachment 13 Step 11
23	CV9610U Steam Flow	From Attachment 13 Step 13
24	FE4095 Corrected BD Flow	From Attachment 8 Step 21
25	AK2001 (FW CF for SG2)	=FE1127 /CV1129U
26	AK2005 (STM CF for SG2)	=(FE1127-FE4095)/CV9610U

Part 4 Feedwater Venturi Coefficients and MSBIAS Calculation, Procedure Section 6.3

Calculation Step	Description	Spreadsheet Function, Algorithm, or Source
27	K9661 FW Venturi2old	K9661 from COLSCONS Printout
28	K9663 FW VenturiTempCOEFF2	K9663 from COLSCONS Printout
29	K9661 FW Venturi2new	=(AK2001-1)*K9663*TE1127+AK2001*K9661
30	K9946 MSBIAS2 old	K9946 from COLSCONS Printout
31	K9946 MSBIAS2 new	=AK2005*K9946

Unit 2 SG2 Correction Factor History (blowup)



System Performance

- Sensitivity during plant startup
  - UFM data only used >80% power
  - Plant startup data shows stability of UFM data above 60% power was within claimed accuracy
  - No significant changes in CF's due to FWQ temps lowered from 440 to 400 (low limits)

Results of startup analysis

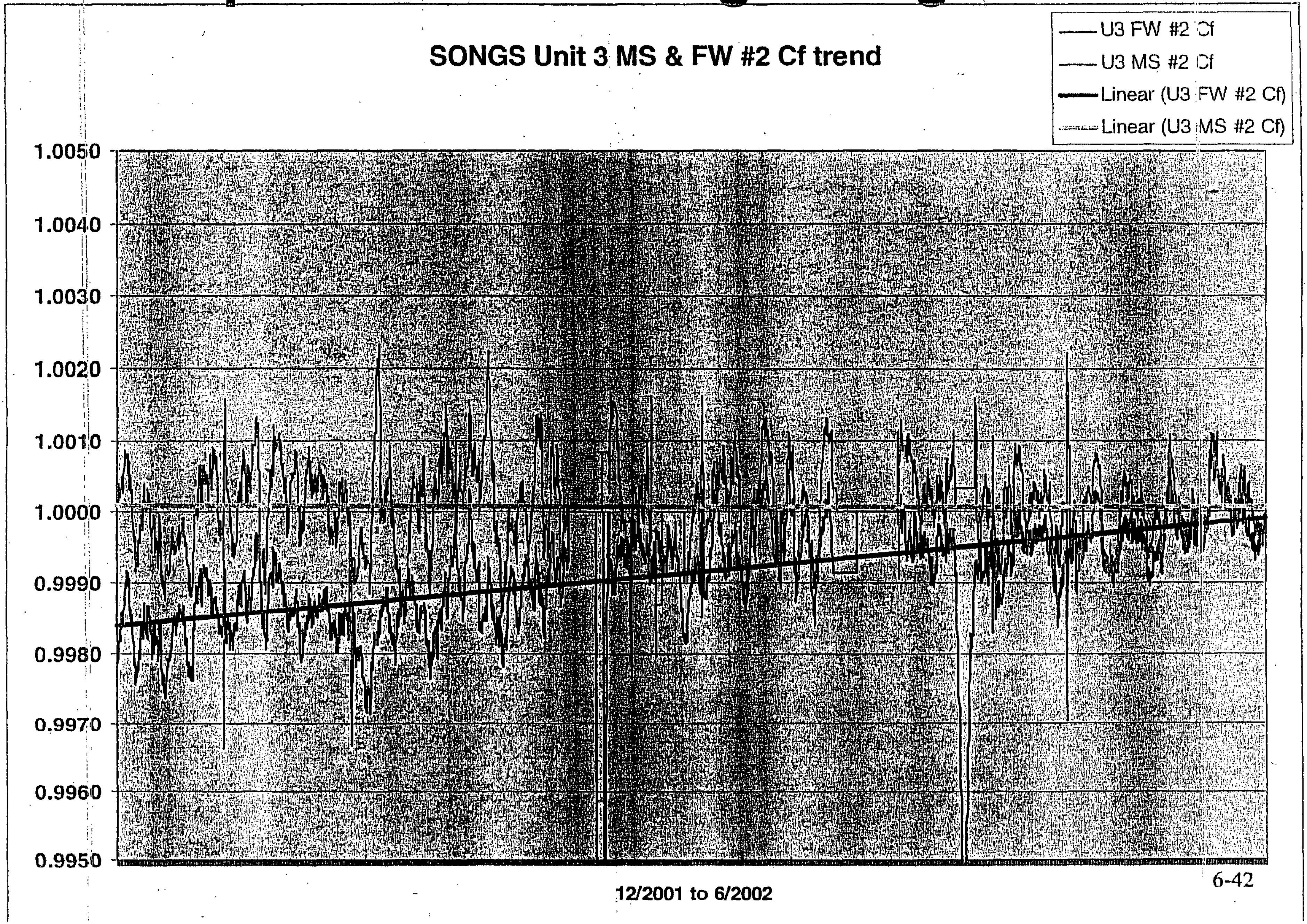
Regression result for SG1 for 80%-100% power range	
% change in CF due to 1% change in flow (% / %)	0.0001%
Upper 95% confidence limit for % change (% / %)	0.0075%
Lower 95% confidence limit for % change (% / %)	-0.0072%

Regression result for SG2 for 80%-100% power range	
% change in CF due to 1% change in flow (% / %)	0.0119%
Upper 95% confidence limit for % change (% / %)	0.0191%
Lower 95% confidence limit for % change (% / %)	0.0048%

CF history

- Temperature has been extremely stable, with high accuracy
- FW has been stable
- One Unit 3 FW line showing signs of small calibration changes. (next slide)
- Having UFM/UTM and existing plant instr. Allows good cross verfication of flow

Example of CF showing changes in FW



Lesson learned

- Blowdown instrumentation could have been calibrated by UFM, followed by a fixed blowdown correction factors for steam flow calculations.
- TLU hit with this method would be acceptable, and overall claimed TLU unchanged.

BIG Lesson learned

- App. K uprate is based on increased accuracy of calorimetric.
  - YOUR uprate will be a number assuming you are NOW at a real 100% power.
  - Present inaccuracies will add or subtract from you increase % goal in Mwe.