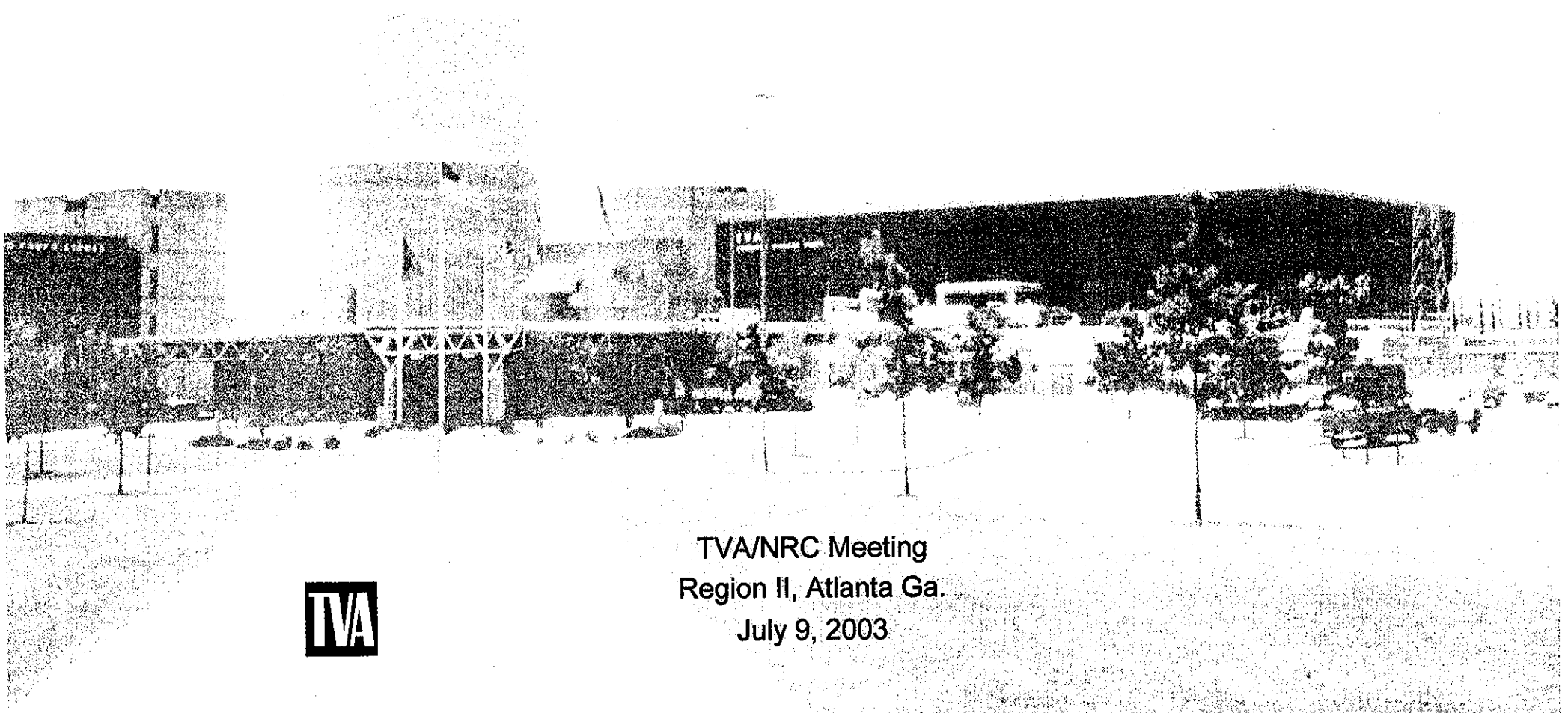
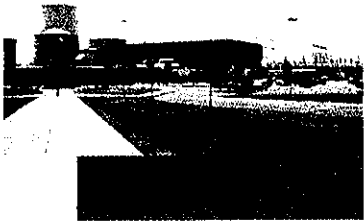


# Sequoyah Nuclear Plant

## Plant Performance



TVA/NRC Meeting  
Region II, Atlanta Ga.  
July 9, 2003



# Agenda

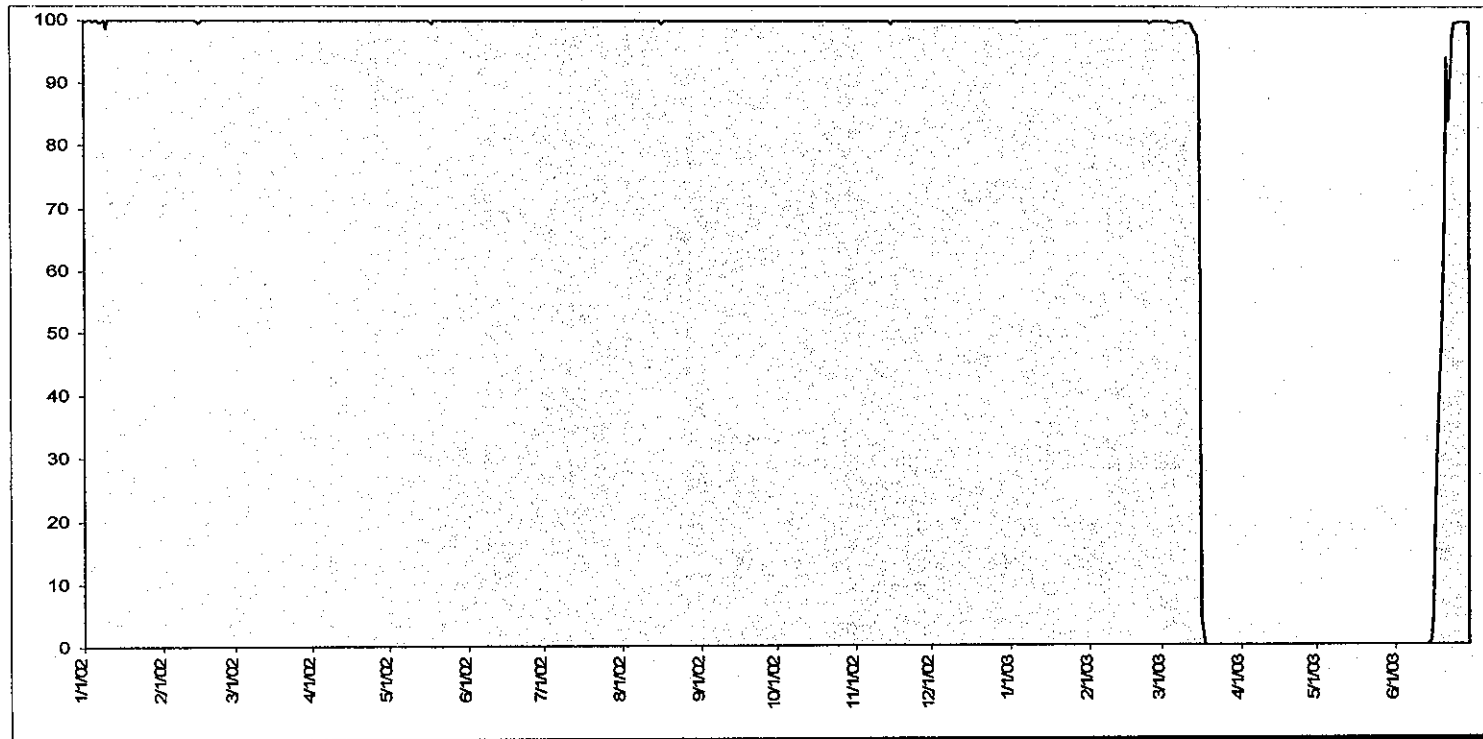
- Introduction R. T. Purcell
- Plant Performance D. L. Koehl
- Steam Generator Replacement Outage
  - Overview R. R. Rausch
  - Ulchin 4 (Korea) Operating Experience R. R. Rausch
  - RPV Head Inspections D. L. Lundy
  - RCS Debris D. L. Lundy
  - Startup Testing D. L. Lundy
  - Occupational Radiation Safety C. E. Kent
- Equipment Reliability Improvement Plan
  - Objective/ Immediate Actions D. L. Koehl
  - Process M. Gillman
  - Culture M. Gillman
  - Hardware D. L. Lundy
  - Outage Improvements D. L. Lundy
  - PII D. L. Lundy
- Corrective Action Program D. L. Koehl
- Licensing P. Salas
- Conclusions R. R. Purcell



# Plant Performance

## Unit 1 Daily Rx Power Level Averages

1

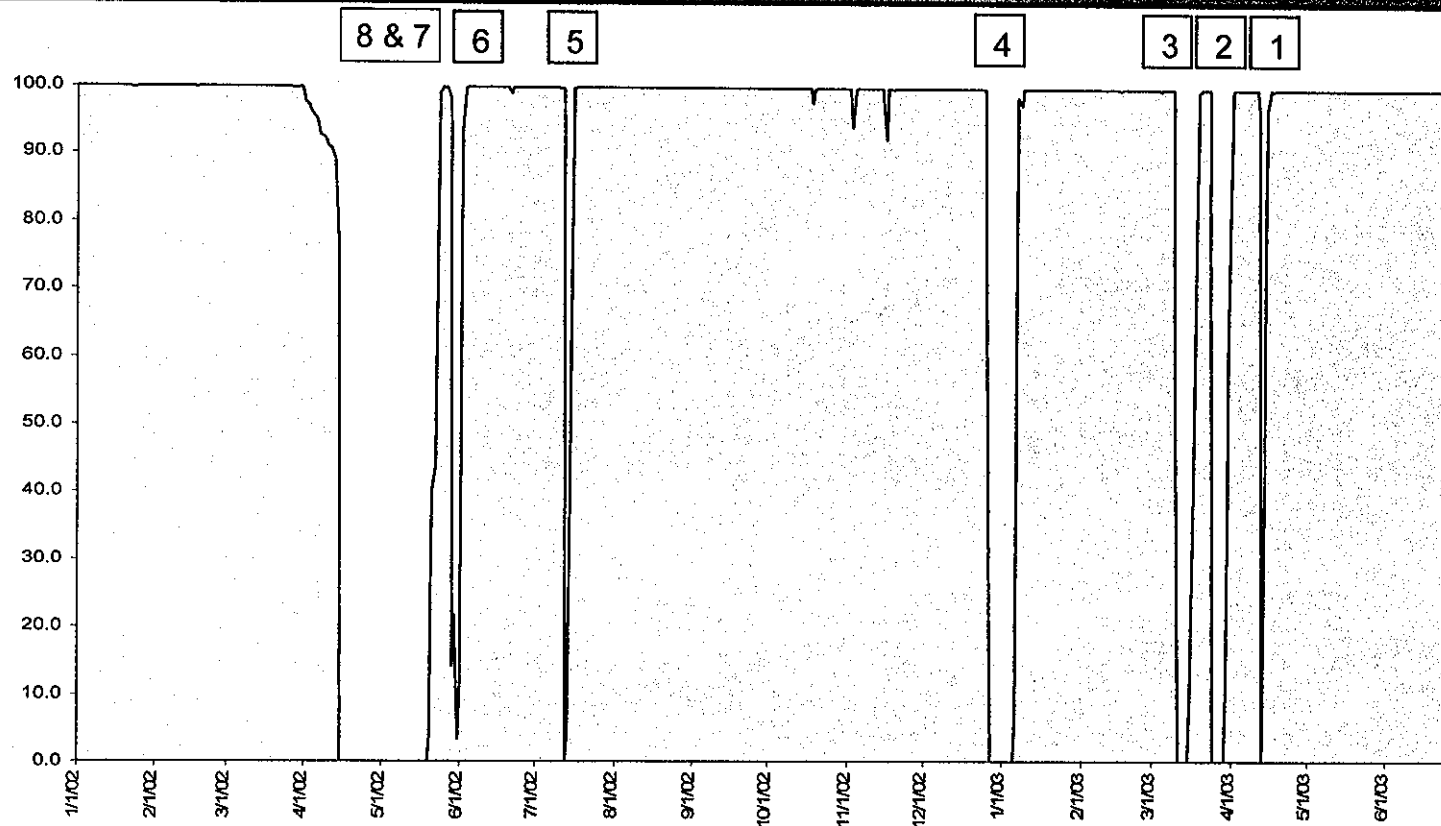


1. March 17, 2003 U1C12 Steam Generator Replacement and Refueling Outage



# Plant Performance

## Unit 2 Daily Rx Power Level Averages



1. April 12, 2003
2. March 10, 2003
3. March 24, 2003
4. December 26, 2002
5. July 12, 2002
6. May 31, 2002
7. May 19, 2002

- Automatic Reactor Trip
- Manual Reactor Trip
- Unit 2 Forced Outage
- Automatic Reactor Trip
- Automatic Reactor Scram
- Automatic Reactor Trip
- Manual Reactor Trip

8. April 14, 2002 U2C11

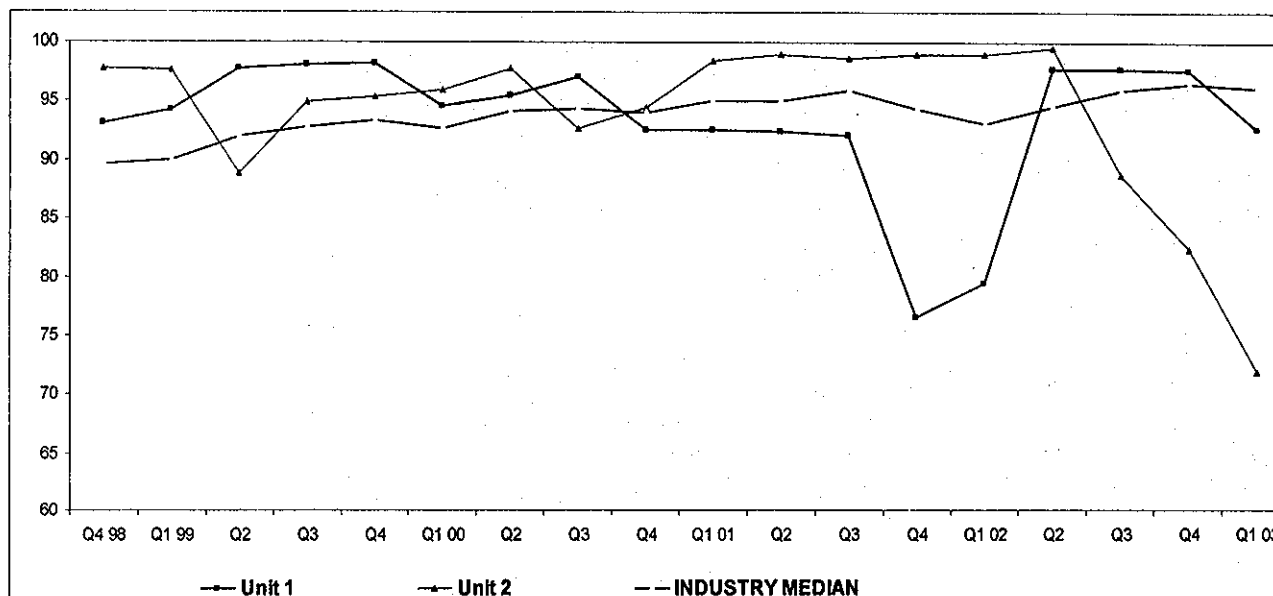
- Refueling Outage

- Spurious Turbine Vibration Trip Signal
- Trip of a Hotwell Pump and Heater Drain Tank Pumps
- Main Generator Hydrogen Leak
- Loss of a Reactor Coolant Pump
- Bus Undervoltage to Reactor Coolant Pumps
- Loss of Stator Cooling Water
- Rod Control Urgent Failure Shutdown Bank B and Control Bank D (Occurred during power ascension following the U2C11 Refueling Outage before tie onto grid)



# Plant Performance

## INPO Performance Index



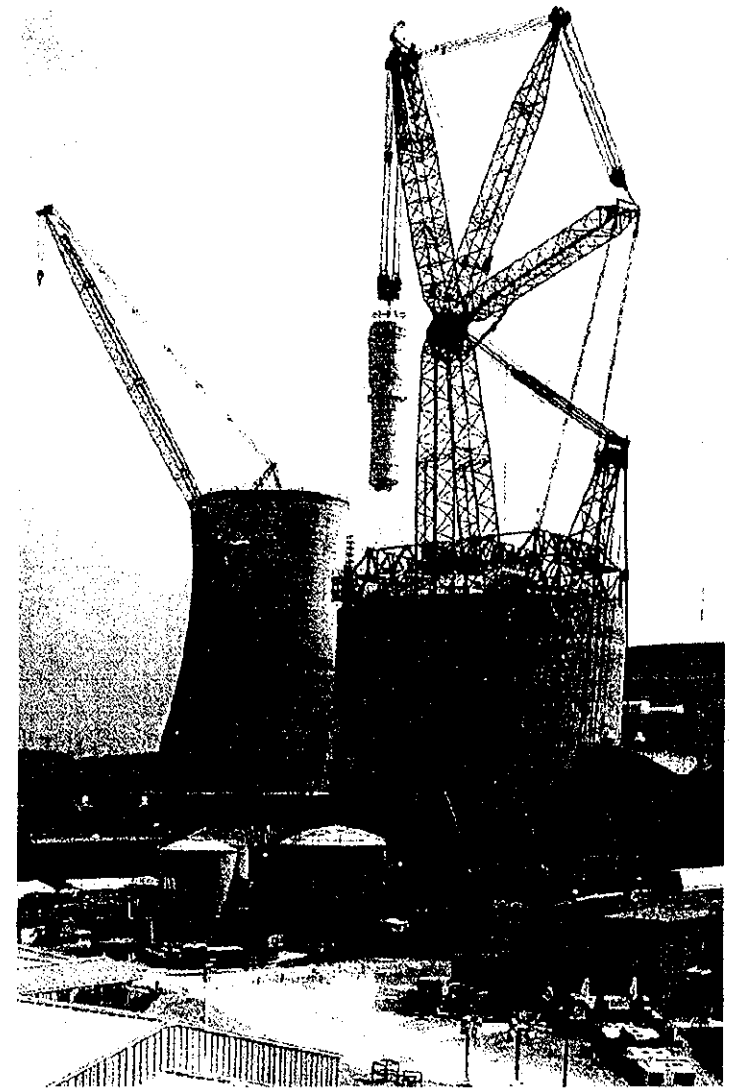
MAY 2003		SQN UNIT 1			SQN UNIT 2		
PERFORMANCE INDICATOR	WEIGHT	VALUE	INDEX	PRODUCT	VALUE	INDEX	PRODUCT
Unit Capability Factor (18 MNTH)	0.16	85.9	67.8	10.9	86.5	72.1	11.5
Forced Loss Factor (18 MNTH)	0.16	0.2	100.0	16.0	7.1	36.4	5.8
Unplanned Automatic Scrams (24 MNTH)	0.10	0.000	100.0	10.0	1.700	25.5	2.6
Safety System Performance:							
PWR High Press. Inj. (3 YR)	0.10	0.003	100.0	10.0	0.004	100.0	10.0
PWR Aux. Feedwater (3 YR)	0.10	0.005	100.0	10.0	0.004	100.0	10.0
Emergency AC Power (3 YR)	0.10	0.017	100.0	10.0	0.017	100.0	10.0
Fuel Reliability (Most recent qtr)	0.11	0.0000	100.0	11.0	0.0052	0.0	0.0
Chemistry Indicator (18 MNTH)	0.07	1.00	100.0	7.0	1.02	100.0	7.0
Collective Rad. Exposure (18 MNTH)	0.10	193.85	4.6	0.5	75.40	92.3	9.2
<b>INPO PERFORMANCE INDEX</b>				<b>85.3</b>			<b>66.1</b>



# SG Replacement Outage

## Overview

- Steam Generator Replacement Project Successful
  - Performed Heavy Load Lifts and Implemented Compensatory Measures
  - Plant Restoration Completed as Expected
  - Start-up Testing
    - Low Power Testing Complete with Satisfactory Results
    - Higher Power Level Load Rejection Testing Scheduled for July 2003





# SG Replacement Outage

Ulchin 4 (Korea) Experience (April 5, 2002 Tube Rupture)

- Sequoyah and Ulchin 4 SGs have different features
- Hydraulic expansion employed to avoid explosive expansion problems
- Profilometry (100-percent of the tubes) revealed no bulges
- Tube Exams
  - 100% of tubes examined with a bobbin coil probe
  - 100% of the U-bend region tubes in Rows 1 through 3 with a +Point coil
  - 100% of the top of tubesheet region (+3-inches to -3-inches) hot-leg tubes with a +Point coil
  - Approximately 100 special interest locations examined with a +Point coil.
- Sequoyah does not have the same conditions present in Ulchin 4

	Ulchin 4	Sequoyah
Tube Material	Alloy 600	Alloy 690
Tube Manufacturer	B&W Special Products	Sandvic
Tube Expansion into Tubesheet	Explosive	Hydraulic



# SG Replacement Outage

## RPV Head Inspections

### • Top Head

- Completed remote camera bare metal visual inspection of 100% of the head and penetrations on Units 1 and 2
- Inspections identified boric acid deposits on Unit 1 at penetration No. 3
- Full volumetric inspection performed on 6 Unit 1 penetrations (Nos. 3, 53, 64, 65, 72, and 73); no indications identified
- Dye penetrant test performed on Unit 1 penetration No. 3 at the J-groove weld; no indications identified
- Repeat bare metal visual inspections scheduled for every 3<sup>rd</sup> refueling outage or 5 Years (whichever is first)
- Volumetric examination of head penetrations scheduled for U2C14 and U1C15
- Repeat volumetric examinations scheduled for every 4<sup>th</sup> refueling outage or 7 Years (whichever is first)
- Completed Unit 1 head cleaning; better baseline for future inspections.





# SG Replacement Outage

## RPV Head Inspections

- Bottom Head

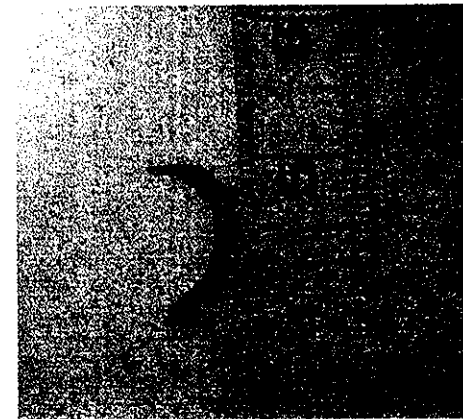
- Completed remote camera visual inspection of the Unit 1 bottom head and penetrations
- Inspection identified 2 streaks from the upper compartment
- Streak areas were cleaned and no surface indications found
- No indications found on bottom head penetrations
- Unit 2 bottom head inspection is scheduled for the upcoming Cycle 12 refueling outage



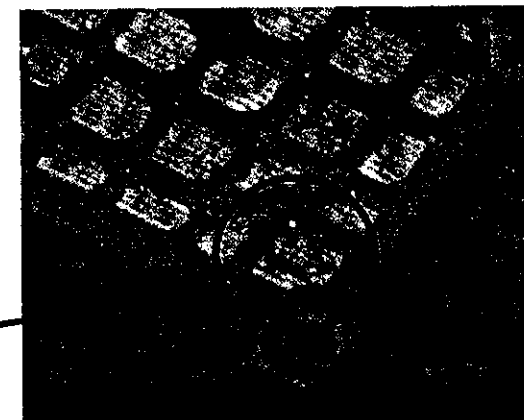
# SG Replacement Outage

## RCS Debris

- 26 Crescent shaped objects identified in the Reactor Pressure Vessel (RPV)
  - 19 objects removed from RPV
  - 7 objects remain below the lower core plate of the RPV
- 1 Dowel pin observed and remains below the lower core plate of the RPV
- 1 Cap screw observed and remains below the lower core plate of the RPV
- 6 Crescent shaped objects removed from 139 fuel assembly filter nozzles



Typical Object Shape



Debris Captured By Filter Nozzle



# SG Replacement Outage

## RCS Debris

- Analysis indicates material is Type 302 or Type 304 spring tempered austenitic stainless steel
- Objects appear to be part of a helical spring
- Source paths and each component in those systems evaluated. Major components such as the emergency core cooling system (ECCS) pumps eliminated as a source. Foreign objects appear to be from maintenance tooling
- The fracture surface of several pieces representative of fatigue failure
  - Spring entered the bottom of the reactor pressure vessel at some time after the last core barrel removal, at the end of Cycle 6. Pieces were lodged against the fuel for a minimum of 88 to 106 days
  - During operation, the spring impacted the lower head, core barrel supports, and fuel assembly bottom nozzle filters. At some point, during Cycle 12 operation, the spring broke into segments that were trapped by the fuel assembly bottom filters
- Completed an operability analysis which considered as found conditions and potential effect from those objects that were not removed
- Debris filters worked as designed



# SG Replacement Outage

## Startup Testing

- Major Tests Completed

- Steel containment vessel pressure test @ rated pressure
- Thermal expansion, hot shimming
- RCS, FW, MS pipe vibration
- RCS flow test @ NOTP and @ 100% Power
- 3% load reduction test @ 40% reactor power
- Calorimetric @100% power

- Major Tests Remaining

- 10% and 20% load reduction tests @ 85% reactor power: 7/12
- Moisture carryover (MCO) test: 7/30



# SG Replacement Outage

## Occupational Radiation Safety – Dose (REM)

- Measured dose rates were 20% to 30% lower than U1C11 due to source-term reduction initiatives
- Nearly 300,000 pounds of temporary shielding installed
- Total collective radiation exposure over target as result of outage scope expansion

Planned Scope	250.0 REM
Planned Scope Actual	246.4 REM
Added Scope (e.g, Head on Stand, Head Inspections, Core Plate Debris)	47.5 REM
Total Outage Actual	293.9 REM



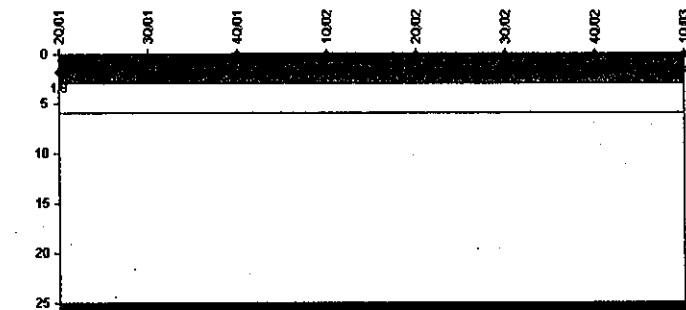
# Equipment Reliability Improvement Plan

## Performance Indicator Impact

- Equipment reliability challenged recent Unit 2 operation
- Unit 2 challenges followed a 513 days continuous run
- Unit 1 completed a breaker to breaker run (478 Days) prior to SG replacement outage
- Equipment reliability improvements implemented during Unit 1 outage to insure sustained performance
- Sequoyah developed and is implementing an Equipment Reliability Improvement Plan
- Our Objective:
  - Unit 2 - sustained improvement in performance
  - Unit 1 – good post-SG replacement operation

### Unit 1

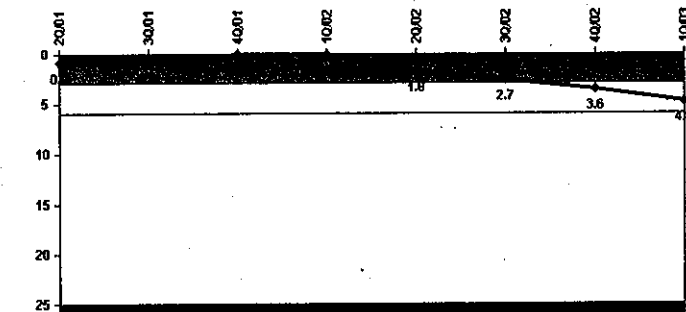
Unplanned Scrums per 7000 Critical Hrs



Thresholds: White > 3.0 Yellow > 6.0 Red > 25.0

### Unit 2

Unplanned Scrums per 7000 Critical Hrs



Thresholds: White > 3.0 Yellow > 6.0 Red > 25.0



# Equipment Reliability Improvement Plan

- Focus
  - Process
  - Culture
  - Hardware
- Senior VP Operations led corporate assessment
- INPO senior level assist visit
- PII risk informed review of equipment reliability - trip sensitive component project



# Equipment Reliability Improvement Plan

## Immediate Actions

- Develop a Sequoyah Reliability Improvement Plan to integrate site efforts to immediately improve reliability
- Increase field oversight of the Transmission Power Supply (TPS)
- Improve the sensitive activities review process
- Immediately raise standards
- Ensure reliable operation once Unit 1 returns to service





# Equipment Reliability Improvement Plan

## Process

- Specific process improvements or barriers have been addressed as a result of specific event root cause analysis
- INPO high-level assist visit, drawing on the strength of the industry, to improve rigor of equipment reliability programs, including recommendations on the implementation of AP-913, Equipment Reliability Process Description
- Strengthening the forum for system health reviews with management team
  - Transform system health reviews to be forward looking as opposed to critiques
  - Assure planning process places correct priorities to equipment reliability



# Equipment Reliability Improvement Plan

## Culture

- Limited success recognizing and identifying early warning symptoms of pending equipment failures
- Equipment aging will be a continuous challenge
- Change behaviors to better predict, recognize, and identify early warning signs of equipment failure
- Major departments have implemented self-critiques of their current behaviors that have failed to identify symptoms of impending equipment failure
- Action plans to change behavior (INPO team assistance)



# Equipment Reliability Improvement Plan

## Hardware

- Identify specific lessons learned on equipment reliability issues
  - Maintenance
  - Corrective action program
  - System health programs
- Prioritized equipment reliability maintenance and design changes to take advantage of the longer steam generator replacement outage
- Industry expert performing risk informed evaluation to identify components that impact equipment reliability
- Results of industry expert review (expected to take three to five months) will provide immediate output on identifying any issues or actions warranted on a component-by-component basis



# Equipment Reliability Improvement Plan

## Unit 1 Cycle 12 Outage Material Condition Improvements

### Original Scope Design Changes

- Feed Pump Modifications
- Heater Drain Tank Modifications
- CCW Pump Motor Bearing Cooler Piping Modifications
- Start Bus Transfer Interlock
- Exciter Cooling System Piping and Control Valves
- Electrical Penetrations
- Hand Switches for Critical Safety Related Motors
- CRDM Duct Expansion Joints
- EHC Controls
- Generator Hydrogen Flow Integrators
- High Pressure Rotor on Main Turbine

### Added Scope Design Changes

- ECCS High Point Vents
- Feed Pump Modifications
- Condensate Booster Pumps and the #3 and #7 Heater Drain Tank Pumps Flex Couplings
- Reactor Coolant Pump Seal Leak-off Drain
- Main Turbine Vibration Trip Relay
- Heater Drain Tank Level Controllers
- TDAFW Pump Low Pressure Steam Traps

### Added Scope Major Maintenance

- Large Motors
- MSIV's
- Main Feed Pump and Heater Drain Tank Pumps
- Corrected 129 Boron Leaks
- Inspected Unit Trip Sensitive Drawers for Wire Damage



# Equipment Reliability Improvement Plan

## Unit 2 Cycle 12 Outage Material Condition Improvements

### Planned Scope Additions Design Changes

- ECCS High Point Vents
- Feed Water Pumps
- Condensate Booster Pumps and #7 and #8 Heater Drain Tank Pumps
- Main Turbine Vibration Trip Relay
- Heater Drain Tank Controllers
- TDAFW Pump

### Planned Scope Additions Major Maintenance

- Large Motors
- Main Feed Pump and Heater Drain Tank Pumps
- MSIV's
- Inspected Unit Trip Sensitive Drawers for Wire Damage
- Inspect/replace Cast Iron Henry Pratt Valves



# Equipment Reliability Improvement Plan

## PII Trip Sensitive Component Project

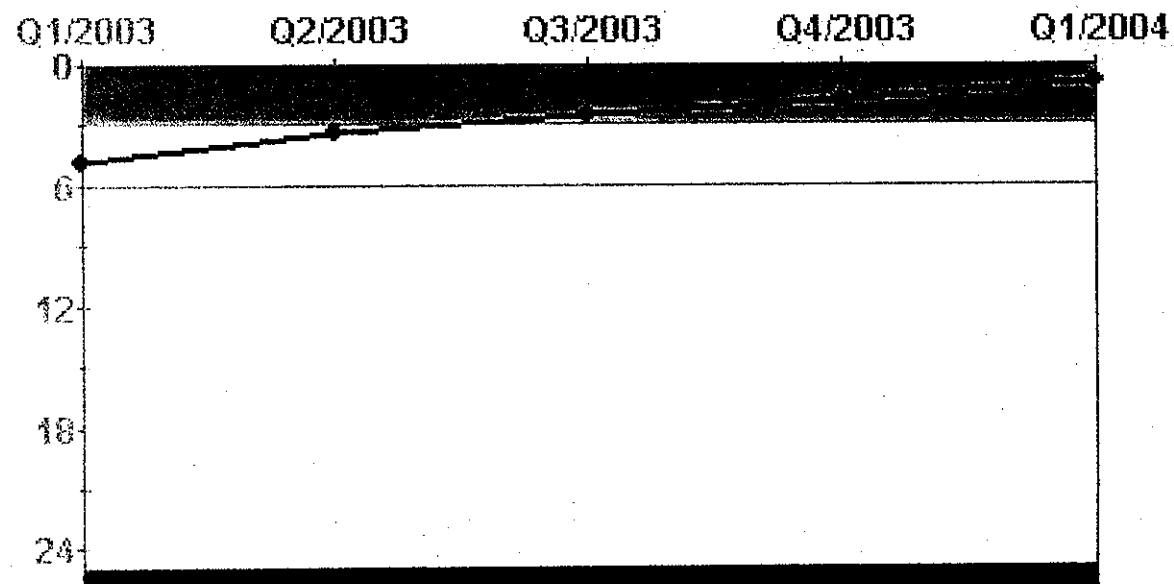
- Identifies trip sensitive components that can affect PI related to # of trips per 7,000 hrs
- Focuses on age dependent failure modes that affect equipment reliability
- Analyzes both industry and Sequoyah specific vulnerabilities
- System Engineering develops Prevention, Detection & Correction (PDC) activities to significantly increase reliability
- Extensive Operating Experience review, including ~1200 EPIX Failure Reports & LERs
- Identified ~ 650 events for further applicability analysis by Sequoyah System Engineering
- Results to date identified areas for improvement
  - Nuclear Instrumentation
  - Main & Service Transformers
  - EHC
  - Voltage Regulator



# Equipment Reliability Improvement Plan

## Performance Indicator Projections

Projected Unit 2 Trend  
Unplanned Scrams per  
7000 Critical Hours  
(Fall Refueling Outage)





# Cross Cutting Issues

## Problem Identification & Resolution

### Corrective Action Program (CAP)

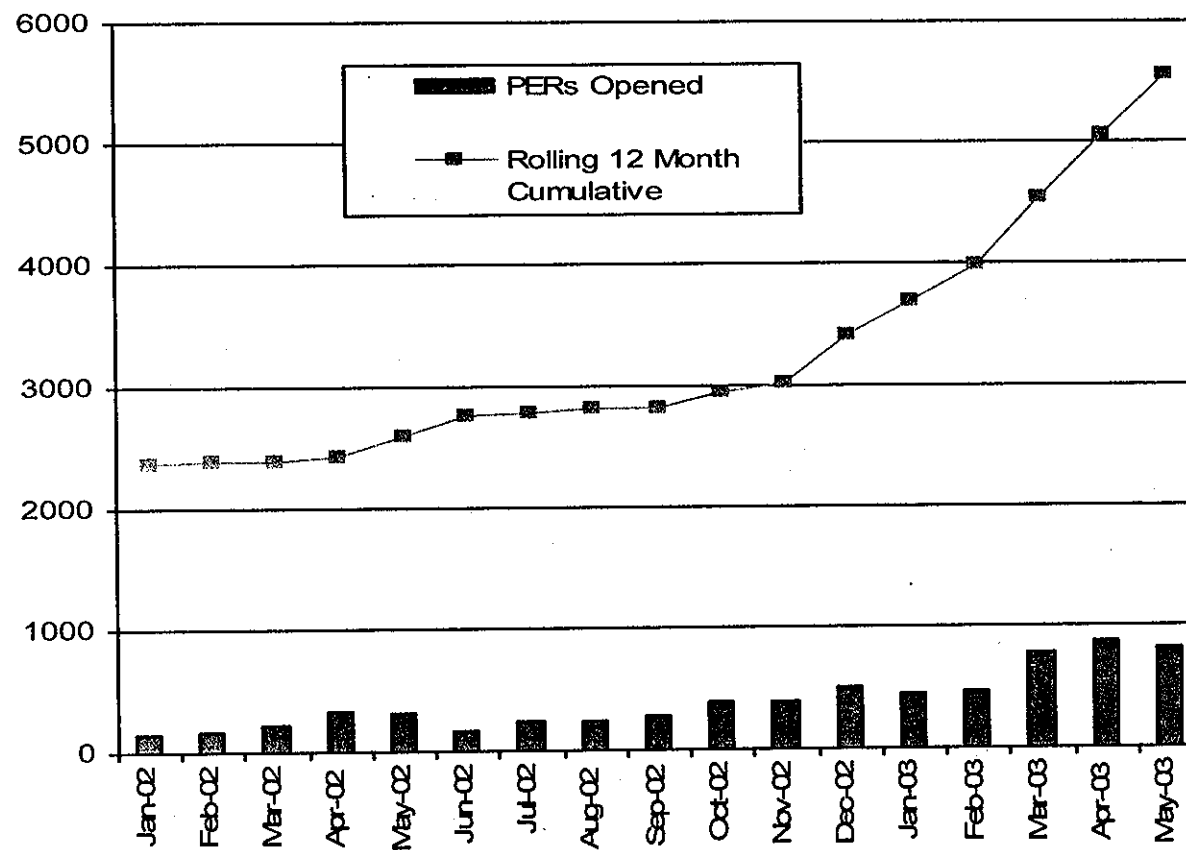
- Efforts to increase craft and technician engagement with the CAP have been effective
- Increased PER generation per month
- Key Initiatives
  - Established department backlog health bands and monitor performance
  - Develop action plans and milestone schedules for resolving issues
  - Re-allocated resources to support work-off plans
  - Instituted review boards for CAP/closure documentation quality
  - Reviewed open A, B and C level PERs to ascertain which are related to unit reliability issues (i.e., trip potential, transient potential or shutdown LCO less than or equal to 72 hrs.)
  - Continue to communicate to plant staff the value of the CAP





# Cross Cutting Issues

## Problem Identification & Resolution



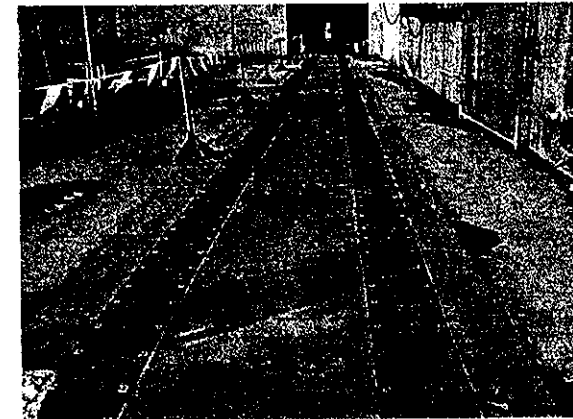
PERs Initiated



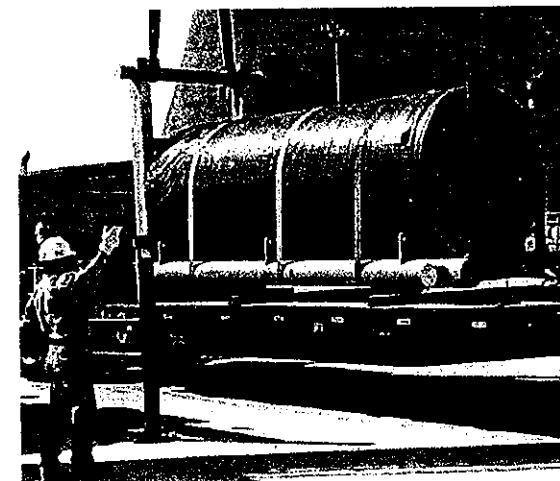
# Licensing

## Dry Cask Storage

- Concluding Construction Phase of Project
- Administrative and Technical Procedures in Development
  - Regulatory Evaluations and Reviews
  - Training Lesson Plans
- Equipment Procurement and Receipt on Site is Ongoing
  - Multi Purpose Canister Received on Site
  - Over-pack Receipt Scheduled for 8/2003
  - Crawler Receipt Scheduled for 11/2003



Auxiliary Building  
Cask Egress Pad



Off Loading of MPC  
and Up-ENDER



# Licensing

## Notice of Enforcement Discretion (NOED)

- Lessons Learned
  - Validate use of correct NOED checklist revision
  - Risk neutrality
    - Careful integration of every potential risk increase
    - Compensatory measures provide the best counterbalance to increases in risk
    - Compensatory measures do not have to be limited to the area of concern that created need for NOED
    - TVA has compiled available operating experience to aid in future requests
- Communication Protocol
  - Early communication with resident inspectors if anticipating potential need
  - Schedule preliminary conference call
    - Describe condition and basis for request
    - Explain risk neutrality arguments and associated compensatory arguments under consideration
    - Identify basis for NOED duration
  - Telephone conference call requesting NOED
    - Only one opportunity to get risk neutrality argument right



# Conclusions

