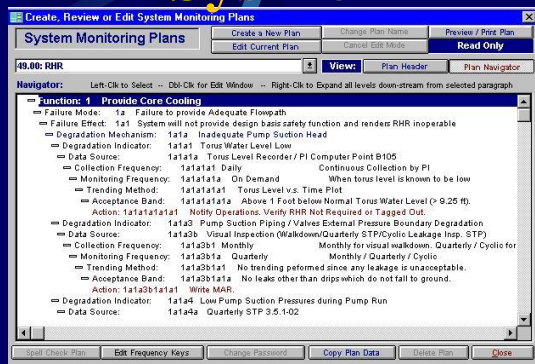


# System Monitoring at the DAEC

## SysMon



## SMART

**S. M. A. R. T.**  
System Monitoring And Reporting Tool

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01.00 Switch Yard	02.00 125 VDC	03.00 Start-up Transducers	04.00 4150 V 1400 VAC Pump Rotated Two-Sides	05.00 Class 1E 400V MCCs	06.00 Lighting Power (Lower Supply)	07.00 Emergency Lights (10/10)	08.00 Emergency Lights
09.00 Well Water Supply	10.00 River Water Supply	11.00 Chemical Injection	12.00 Pumphouse HVAC	13.00 Fan Control	14.00 Condenser Water	15.00 Reactor Cooling Water	16.00 Instrument Air
17.00 Diesel Fuel Oil System	18.00 Standby Diesel Generators	19.00 CB HVAC	20.00 CB HVAC	21.00 CB HVAC	22.00 Fuel Pool Building HVAC	23.00 Fuel Pool Cooling & Cleanup	24.00 Building Leak
25.00 Circulating Water System	26.00 Main Condensers	27.00 Condensate Pumps	28.00 Reactor Coolant System	29.00 Reactor Coolant System	30.00 Reactor Coolant System	31.00 Reactor Coolant System	32.00 High Pressure Containment Injection
33.00 Standby Liquid Control	34.00 Emergency Service Water	35.00 Control Rod Drive	36.00 Reactor Manual Control	37.00 Instrument Air and UAC	38.00 Reactor Protection	39.00 Reactor Protection	40.00 Reactor Protection
41.00 Primary Containment HVAC	42.00 Reactor Water Cleanup	43.00 Reactor Water	44.00 Reactor Water	45.00 Standby Gas Treatment	46.00 Standby Gas Treatment	47.00 Standby Gas Treatment	48.00 Standby Gas Treatment
49.00 Radiation Monitoring	50.00 Non Radioactive Instrumentation	51.00 Fuel Handling	52.00 Main Steam Generator of MSIV	53.00 Low Low Standby Gas Treatment	54.00 Standby Gas Treatment	55.00 Standby Gas Treatment	56.00 Standby Gas Treatment
57.00 Condensate Air Removal	58.00 Turbine	59.00 Steam Suck & Drains	60.00 Standby Gas Treatment	61.00 Standby Gas Treatment	62.00 Standby Gas Treatment	63.00 Standby Gas Treatment	64.00 Standby Gas Treatment
65.00 Standby Gas Treatment	66.00 Standby Gas Treatment	67.00 Standby Gas Treatment	68.00 Standby Gas Treatment	69.00 Standby Gas Treatment	70.00 Standby Gas Treatment	71.00 Standby Gas Treatment	72.00 Standby Gas Treatment
73.00 Standby Gas Treatment	74.00 Standby Gas Treatment	75.00 Standby Gas Treatment	76.00 Standby Gas Treatment	77.00 Standby Gas Treatment	78.00 Standby Gas Treatment	79.00 Standby Gas Treatment	80.00 Standby Gas Treatment
81.00 Standby Gas Treatment	82.00 Standby Gas Treatment	83.00 Standby Gas Treatment	84.00 Standby Gas Treatment	85.00 Standby Gas Treatment	86.00 Standby Gas Treatment	87.00 Standby Gas Treatment	88.00 Standby Gas Treatment
89.00 Standby Gas Treatment	90.00 Standby Gas Treatment	91.00 Standby Gas Treatment	92.00 Standby Gas Treatment	93.00 Standby Gas Treatment	94.00 Standby Gas Treatment	95.00 Standby Gas Treatment	96.00 Standby Gas Treatment
97.00 Standby Gas Treatment	98.00 Standby Gas Treatment	99.00 Standby Gas Treatment	100.00 Standby Gas Treatment	101.00 Standby Gas Treatment	102.00 Standby Gas Treatment	103.00 Standby Gas Treatment	104.00 Standby Gas Treatment

Teaming up to get  
the most out of  
System Monitoring!

# SysMon

- Result of 2 EPRI Task Group efforts published in March 1997 and March 1998.
- Past tendency was to trend a parameter because it *can* be trended.
- EPRI methodology provides a consistent, proactive approach based on the ability to predict degradation and preclude failure of specific system functions.

# Basic Methodology

- Focuses on selecting important parameters for monitoring based on primary system functions and degradation mechanisms that can defeat primary functions.
- Stresses system level monitoring by the integrated use of tools, technologies, and data obtained from many sources.

# Elements of Effective Programs

- Program Scope Definition
- Define System Performance Goals and Indicators
- Define Importance of System Functions
- Define Degradation Mechanisms and Indicators
- Identify Data Requirements
- Identify Actions Required
- Establish Communication Methods
- System Monitoring Documentation
- Perform System Monitoring

# Types of Monitoring

- **Indirect** - The periodic review of historical, programmatic system information for the purpose of predicting future system performance.
- **Direct** - A periodic review of physical parameters to assess current system performance and to identify system degradation.

# Layers in Direct Monitoring

- Function
- Failure Modes
- Failure Effects
- Degradation Mechanisms
- Degradation Indicators
- Data Source
- Data Collection Frequency
- Monitoring Frequency
- Trending Method
- Acceptance Bands
- Action Required



# Typical SysMon Layout

Create, Review or Edit System Monitoring Plans

System Monitoring Plans

Create a New Plan Change Plan Name Preview / Print Plan

Edit Current Plan Cancel Edit Mode Read Only

49.00: RHR View: Plan Header Plan Navigator

Navigator: Left-Click to Select -- Dbl-Click for Edit Window -- Right-Click to Expand all levels down-stream from selected paragraph

Function: 1 Provide Core Cooling

- Failure Mode: 1a Failure to provide Adequate Flowpath
- Failure Effect: 1a1 System will not provide design basis safety function and renders RHR inoperable
  - Degradation Mechanism: 1a1a Inadequate Pump Suction Head
    - Degradation Indicator: 1a1a1 Torus Water Level Low
      - Data Source: 1a1a1a Torus Level Recorder / PI Computer Point B105
        - Collection Frequency: 1a1a1a1 Daily Continuous Collection by PI
        - Monitoring Frequency: 1a1a1a1a On Demand When torus level is known to be low
        - Trending Method: 1a1a1a1a1 Torus Level v.s. Time Plot
        - Acceptance Band: 1a1a1a1a1a Above 1 Foot below Normal Torus Water Level (> 9.25 ft).  
Action: 1a1a1a1a1a1 Notify Operations. Verify RHR Not Required or Tagged Out.
      - Degradation Indicator: 1a1a3 Pump Suction Piping / Valves External Pressure Boundary Degradation
      - Data Source: 1a1a3b Visual Inspection (Walkdown/Quarterly STP/Cyclic Leakage Insp. STP)
        - Collection Frequency: 1a1a3b1 Monthly Monthly for visual walkdown. Quarterly / Cyclic for
        - Monitoring Frequency: 1a1a3b1a Quarterly Monthly / Quarterly / Cyclic
        - Trending Method: 1a1a3b1a1 No trending performed since any leakage is unacceptable.
        - Acceptance Band: 1a1a3b1a1a No leaks other than drips which do not fall to ground.  
Action: 1a1a3b1a1a1 Write MAR.
      - Degradation Indicator: 1a1a4 Low Pump Suction Pressures during Pump Run
      - Data Source: 1a1a4a Quarterly STP 3.5.1-02

Spell Check Plan Edit Frequency Keys Change Password Copy Plan Data Delete Plan Close

SMART  
retrieves  
the actual  
data and  
provides  
it to the  
System  
Engineer.


# S.M.A.R.T.

*An important part of your system monitoring toolbox.*

S.M.A.R.T. - [Overall Annunciator]

File Edit View Insert Format Records Tools Window Help

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Manual Data  
[Run Pl](#)  


01.00 Switch Yard	02.00 125 VDC	03.00 Start-up Transformer	04.00 4160 V Safety Related Sw. Gear	05.00 Class 1E 480 VAC Power	06.00 480V MCCs	07.00 Lighting Panel Power Supply	07.01 Emergency Lights (S/D path)	07.02 Emergency Lights
08.00 Well Water	10.00 River Water Supply	11.01 General Service Water	11.03 Pumphouse HVAC	13.02 Fire Service - Carbon Dioxide	14.00 RB Closed Cooling Water	16.00 RHR Service Water	18.00 Instrument Air	20.04 Drywell Sumps
23.00 Diesel Fuel Oil System	24.00 Standby Diesel Generators	25.00 Remote Shutdown System	30.00 CB HVAC	30.03 CB/SBGT Instrument Air Compressr	34.00 Reactor Building HVAC	35.00 Fuel Pool Cooling & Cleanup	40.00 Turbine Lube Oil	41.00 Cooling Towers
42.00 Circulating Water System	43.00 Main Condenser	44.00 Condensate	45.01 Feedwater	46.00 Extraction Steam	49.00 RHR	50.00 Reactor Core Isolation Cooling	51.00 CORE SPRAY	52.00 High Pressure Coolant Injection
53.00 Standby Liquid Control	54.00 Emergency Service Water	55.00 Control Rod Drive	56.02 Reactor Manual Control	57.00 Instrument AC and UAC Cntl Pwr	58.01 Reactor Protection	58.02 Primary Containment Isolation	58.03 Steam Leak Detection	59.00 Primary Containment
60.00 Primary Containment HVAC	61.00 Reactor Water Cleanup	62.00 Nuclear Boiler	64.01 Reactor Recirculation	70.00 Standby Gas Treatment	72.00 Off-Gas	73.03 Containment Atmosphere Dilution	75.00 24 VDC	78.01 Neutron Monitoring
79.00 Radiation Monitoring	80.00 Non-Nuclear Instrumentati on	81.00 Fuel Handling	83.01 Main Steam	83.02 Main Steam downstrm of MSIVs	83.04 Low-Low Set & ADS	86.00 Stand by Transformer	87.00 Auxiliary and Main Transformers	88.00 250 VDC
91.00 Condenser Air Removal	92.00 Turbine Steam Seals & Drains	93.00 Turbine	95.00 Seal Oil / Hydrogen Cooling	97.00 Stator Cooling	98.00 Main Generator & Excitation	99.11 Reactor Bldg Crane & Elevator	99.27 Doors	99.28 Buildings & Structures



# The History of SMART

- March 1997 - EPRI issues “Guideline for System Monitoring by System Engineers”
- June 1997 - AR written to review effectiveness and use of the System Health and Status reports on the LAN.
- March 1998 - EPRI issues 37 System Monitoring Plans and software.

# The History of SMART

- June 1998 - Project Team convenes to develop an effective system monitoring program.
- June 1998 - All system engineers trained on EPRI methodology and SysMon software.
- October 1998 - First system plan declared ready and implemented into SMART.

# Requirements for SMART

- Data is easily gathered with little or none performed by the System Engineer
- Use is made of expertise outside of Systems Engineering
- Computer programs are reliable
- Current and historical analyses of trends are included

# Requirements for SMART

- The system can be monitored remotely
- The System Engineer and other users are alerted to problem areas
- The System Engineer is properly trained on the program
- Output from the program is well communicated and reported

# Requirements for SMART

- Use of the program is uniform across all systems
- The basis for trending specific parameters is documented
- The program is easy to use

# Purposes of SMART

- *Automatically collect and make readily accessible to the System Engineer data which is important to trend (as determined by the EPRI methodology).*
- *Provide the medium for the System Engineer to share subsequent analyses with plant personnel.*



# SMART and SysMon

- *SMART taps into the SysMon database to extract stored information regarding monitoring bases.*

# How does it work?



# Structure of SMART

- *Main Features Include:*
  - *Main Annunciator Window*
  - *Health & Status (Information)*
  - *Direct Monitoring Annunciator Window*
  - *Direct Monitoring Detail Screen*
  - *Auto (Indirect) Monitoring Screen*
  - *Parameter Maintenance*

# Sources of Data


- *Plant Information (PI)*
  - *In-plant Transmitters*
  - *Operator Rounds via Handheld Dataloggers*
- *Equipment Monitoring Database*
  - *Vibration Analysis*
  - *Oil Analysis*
  - *Thermography*
  - *Inservice Testing (IST)*
- *Instrument Trending Program*
- *Surveillance Test Procedures*
- *Manual Input*

# Main Screen

**S. M. A. R. T. - [Overall Annunciator]**

File Edit View Insert Format Records Tools Window Help

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Manual Data  
[Run Pl](#)  


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## System Health Assessment Rating Guideline

System Health Assessments use a four level rating scheme to evaluate overall health of the system. “Key Parameters” are used to assess the overall health of the system. Consider safety significance of issues involved when selecting a Key Parameter rating. If any Key Parameter is Marginal (Yellow), the overall rating should be Marginal (Yellow) or Needs Improvement (Red). If any Key Parameter is Needs Improvement (Red), the overall rating should be Needs Improvement (Red).

Key Parameter	Exemplary (Green)	Satisfactory (White)	Marginal (Yellow)	Needs Improvement (Red)
Unplanned Reactor Trip	None in previous 2 years due to System equipment	None in previous 2 years due to System equipment	None in previous 12 months due to System equipment	One or more in previous 12 months due to System equipment
Unplanned Safety System Actuation	None in previous 2 years due to System equipment failure	None in previous 2 years due to System equipment failure	None in previous 12 months due to System equipment failure	One or more in previous 12 months due to System Equipment Failure
Unplanned Capability Loss (UCL)	None in previous 2 years due to System equipment	<0.2% UCL in previous 12 months due to system equipment	<0.5% UCL in previous 12 months due to system equipment	>0.5% UCL in previous 12 months due to system equipment
Planned Capability Losses (Excludes down-powers for required testing)	None in previous 2 years due to System equipment	<2500 MW-hr planned losses in previous 12 months are due to System equipment	<20,000 MW-hr planned losses in previous 12 months are due to System equipment	>20,000 MW-hr planned losses in previous 12 months are due to System equipment
System Equipment Issues	Zero (0) Workarounds, Degraded Instruments, Temp Mods, or Long Term Tagouts	Two (2) or less Workarounds, Degraded Instruments, Temp Mods or Long Term Tagouts	Four (4) or less Workarounds, Degraded Instruments, Temp Mods or Long Term Tagouts	Five (5) or more Workarounds, Degraded Instruments, Temp Mods or Long Term Tagouts
NRC Violations/INPO Findings/Significant Adverse Conditions (Level 1 or 2 AR's) due to System equipment	None in previous 2 years	One (1) in previous 12 months with actions complete and system health trending positively	One (1) in previous 12 months with actions not complete <b>OR</b> Two (2) or more in previous 6 months with actions done	One (1) or more in previous 12 months and no actions taken
NRC/WANO Availability Performance Indicators (Applies to SBDG, HPCI, RCIC, RHR only)	WANO score of full credit <b>AND</b> NRC performance Green and stable or improving	WANO score of full credit <b>AND</b> NRC performance Green and stable or improving	WANO score predicted to be less than full credit <b>OR</b> NRC performance indicator trending towards white	WANO score less than full credit <b>OR</b> NRC Performance Indicator identified as “White”, “Yellow”, or “Red”
Maintenance Rule	Classified as (a)(2) (Green)	Classified as (a)(2) (Green)	Classified as near (a)(1) (Yellow)	Classified as (a)(1) (Red)
Open Corrective Work Orders	Consider and evaluate the number, age, and type of Corrective Work Orders (CWO's) Tailor rating based on historical trend, safety significance of issues, System Engineer expectations, etc.			
Open Action Requests	Consider and evaluate the number, age, and type of Action Requests (AR's) Tailor rating based on historical trend, safety significance of issues, System Engineer expectations, etc.			
Deferred Preventive Work Orders	Consider and evaluate the number, age, and type of Preventive Work Orders (PWO's) Tailor rating based on historical trend, safety significance of issues, System Engineer expectations, etc.			
SMART Direct Monitoring	Consider and evaluate direct monitoring parameters in SMART Tailor rating based on historical trend, safety significance of issues, System Engineer expectations, etc.			



# Information Screen

**S.M.A.R.T. - [System Information]**

File Edit View Insert Format Records Tools Window Help

18.00: Instrument Air

System Assigned To: Jim Swales Phone: 7686

Startup Systems: Pager:

Status

RED

Parameter Maintenance

Direct Monitoring

Edit System

SMART Switchboard

System Auto Monitoring

**Status:** 01/17/2002 1:43:44 PM

System status is red due to Instrument Air being classified as MR (a)(1). There are no excessive backlogs or equipment issues. A slight increase in air usage has been noted. Leak checks will be performed to determine source of increased usage.

**Operating Experience**

01/17/2002 1:29:25 PM

Attended Compressed Air Nuclear Users Group Meeting during January 2002. Will be applying lessons learned from this meeting in the next few months.

Received an e-mail from the instrument air users group about a plant trip on July 2, 2001 at Beaver Valley that was caused by a failure of their air dryer purge valve. They got a loss of air

**Significant Improvements/Enhancements**

12/13/2001 9:18:39 AM

1. Instrument air dryer pre-filters and after-filters have been replaced.

2. Sampling for particles in instrument air was accomplished on 10/18/01. The results of these samples showed that the air quality continues to meet maintenance rule condition monitoring limits.

**Health and Status Report**

**System Performance**

01/17/2002 1:33:52 PM

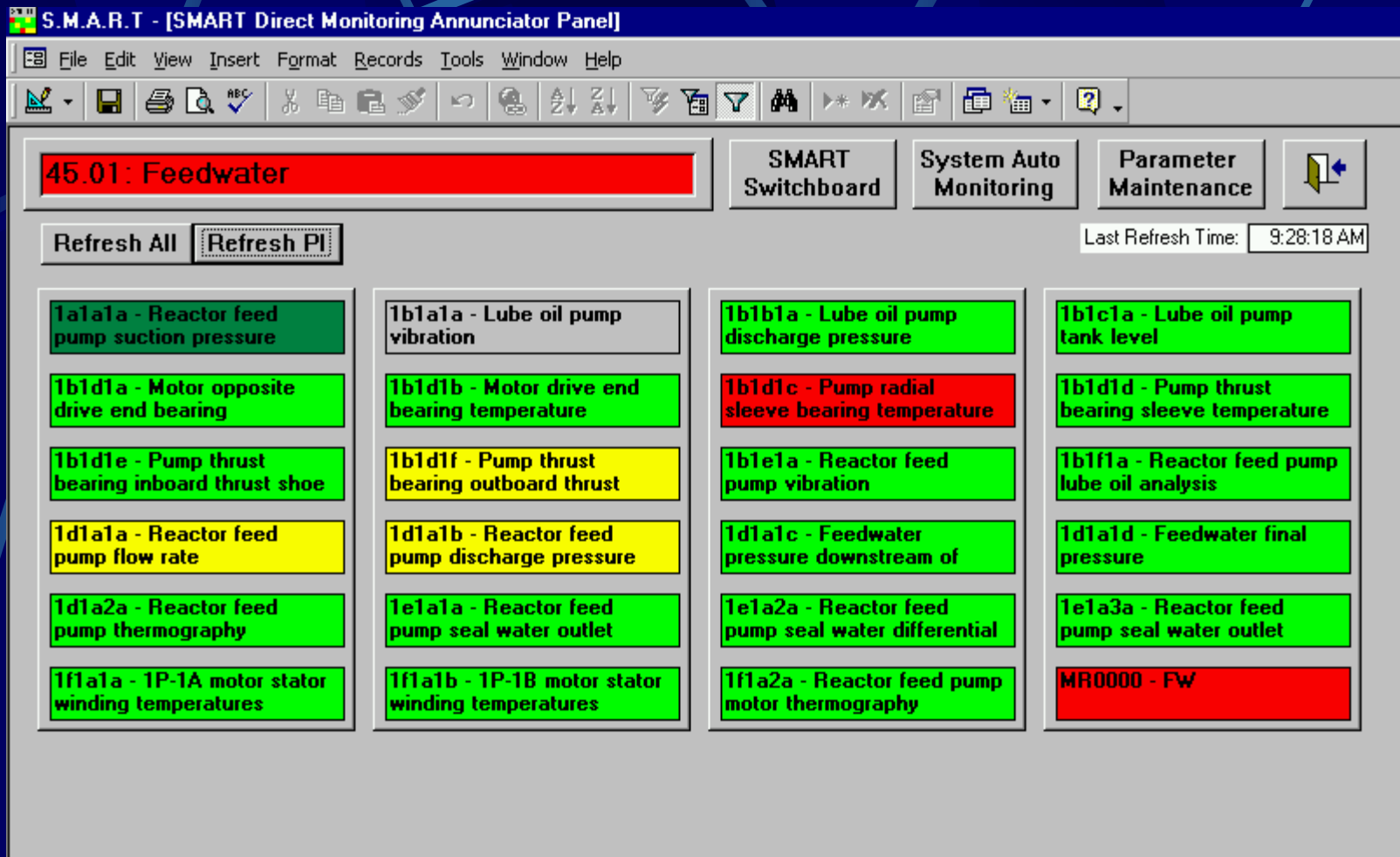
The Instrument Air system is red due to being classified as maintenance rule (a)(1). We currently are in the monitoring phase. April and October sampling per STP NS 180001 showed that instrument air now meets the required quality standard for particulates. In the most recent set of samples no particles greater than 3 microns in size were detected. The next sampling will be performed during April 2002. If the

**System Priorities**

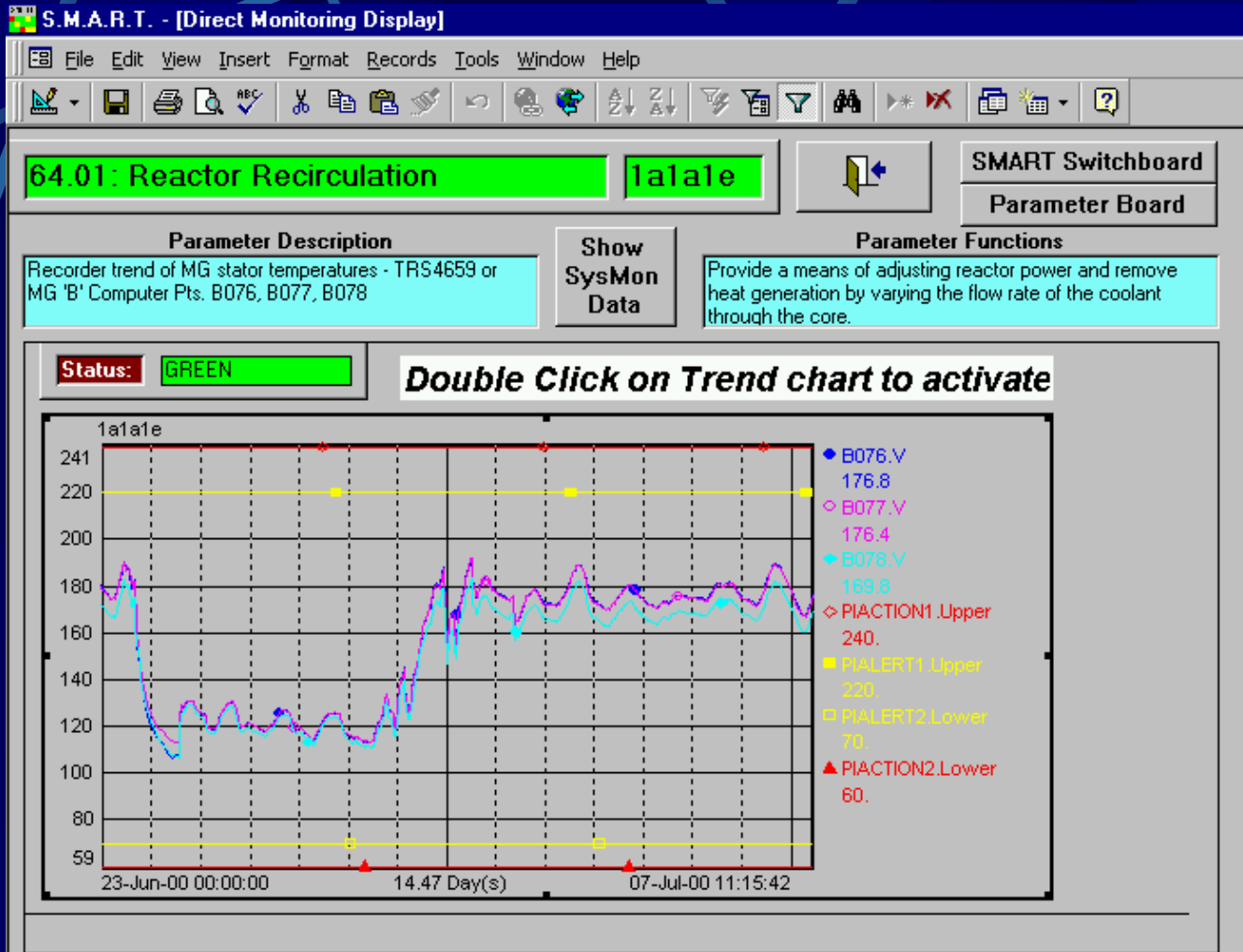
12/13/2001 9:17:33 AM

1. Root cause for AR 24015 on instrument air quality testing failure has been completed. ARs 25989 through 25996 were initiated in response to this root cause. These actions include initiating a PM for the dryer pre and after-filters and creating an STP to document air quality testing results. All actions have been completed except for performing three successful surveillance tests. This will be done in April 2002 when the

# Direct Monitoring



# Parameter Window



# Parameter Maintenance

**S.M.A.R.T - [Parameter Maintenance]**

File Edit View Insert Format Records Tools Window Help

Parameter Maintenance For **64.01: Reactor Recirculation**

Parameter Selection: **1a1a1e**

Show SysMon Data Add New Parameter SMART Switchboard

Description: **B' MG Set Stator Phase Temps** SUS: **64.01** Source: **PI**

Server: **daecnt01**

TagName: **B076.V, B077.V, B078.V**

Parameter	Limit Type	Limit Value
▶ 1a1a1e	UPPER ACTION	240
1a1a1e	UPPER ALERT	220
1a1a1e	LOWER ALERT	70
1a1a1e	LOWER ACTION	60
* 1a1a1e		0

Legend for graph:

- B076.V 183.6
- B077.V 182.7
- ◀ B078.V 175.7
- ◇ PI ACTION 1.Upper() 240
- PI ALERT 1.Upper() 220
- PI ALERT 2.Lower() 70
- ▲ PI ACTION 2.Lower() 60
- ◆ RRP MG SET B STR TEMP P1
- RRP MG SET B STR TEMP P1
- ◀ RRP MG SET B STR TEMP P3
- ◇ PI Upper Action
- PI Lower Alert
- PI Lower Alert
- ▲ PI Lower Action

# Auto (Indirect) Monitoring

S.M.A.R.T. : [SystemAutoMon/frm : Form]

File Edit View Insert Format Records Tools Window Help

System Auto Monitoring

*(This form takes a few minutes to load data)*

Preview Health and Status Report SMART Switchboard

Print Health and Status Report

45.01: Feedwater

Maintenance Rule

44.00 FW Red Maintenance Rule Database

Equipment Issues

1 Workarounds 1 Temp Mods 1 Equipment Issues Closed in Last 90 Days

0 Degraded Instruments 0 Tagouts (long-term) 1 Equipment Issues Opened in Last 90 Days

0 Operability Evaluations

Open Equipment Issues Sorted by Age

Installation Date	Issue	Issue No.	Equipment ID	SUS	Plant Mode
05/24/2001	AR	26120	CV1579	45.01	REFUEL OUTAGE
7/16/2001 2:00:00 AM	TM	01-068	V07-0026	45.01	FORCED OUTAGE

Record: 1 of 2

Action Requests

Open ARs

AR_NBR	INITIATED DATE	SUS	AR_SHK
22396	10/03/2000	45.01	RFO 18 Control Room Indication Mo
24979	04/06/2001	45.01	Re-evaluate FW Pump GSW outlet t
25108	05/29/2001	45.02	22 inch difference between LT4541(F

Record: 1 of 24

CWOs

Priority 1 and 2

5 CWOs Open

4 CWOs In Planning

1 CWOs Ready

3 CWOs Open - not planned within 30 days

WORK ORDER	ORIGINATION DATE	EQUIPMENT ID	SUS
A55437	05/20/2001	1P002A	45.01
A55474	05/23/2001	CV1621	45.01
A55475	05/23/2001	CV1579	45.01

Priority 3

12 CWOs Open

7 CWOs In Planning

5 CWOs Ready

4 CWOs Open - not planned within 90 days

WORK ORDER	ORIGINATION DATE	EQUIPMENT ID	SUS
A53291	05/02/2001	1E039A	45.01
A53292	05/02/2001	1E039B	45.01
A56700	10/21/2001	CV1622	45.01
A54937	05/23/2001	SUS45.01	45.01

PWOs

10 PWOs Open

6 PWOs In Planning

4 PWOs Ready

0 PWOs Open - beyond scheduled due date

WORK ORDER	SCHEDULED DUE DATE	EQUIPMENT ID	SUS
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