CEMS Automation Field Evaluation
San Diego, CA
May 16, 2003

Russell S. Berry
RMB Consulting & Research, Inc.

Introduction

- 50 - 70% of a CEMS Technician's Time Can be Eliminated

- Time Currently Spent Recording Pressures, Temperatures, Flow Rates, etc. on Daily Logs

Introduction

- Current Practices Provide Limited Benefit for Dedicated CEMS Technicians
- EVEN LESS for “Non-dedicated” Personnel
- Information becomes “Lost” in CEMS Files or Maintenance Logs

Solution -- Automate

- Let the Computer do the Recordkeeping & Trending
- Let the Technicians do the Maintenance
- All of the Important Data Points can be Recorded Electronically
- All of the Data Points can be Assigned Meaningful Warning and Alarm Limits
- If not, the Data Probably Should not be Recorded

Automation Implementation

- Is it too good to be true?
  - Will it just be another headache?
- Worth a Try! Depending on $
- Midland Cogeneration Venture and RMB Decided to Give Automation a Try
- Seemed Smart to Try Automating a CT CEMS First
- Included an Automation Option in the Bid Specification
- Incremental Cost -- ≈$20K for all 12 CEMS

Automation Implementation

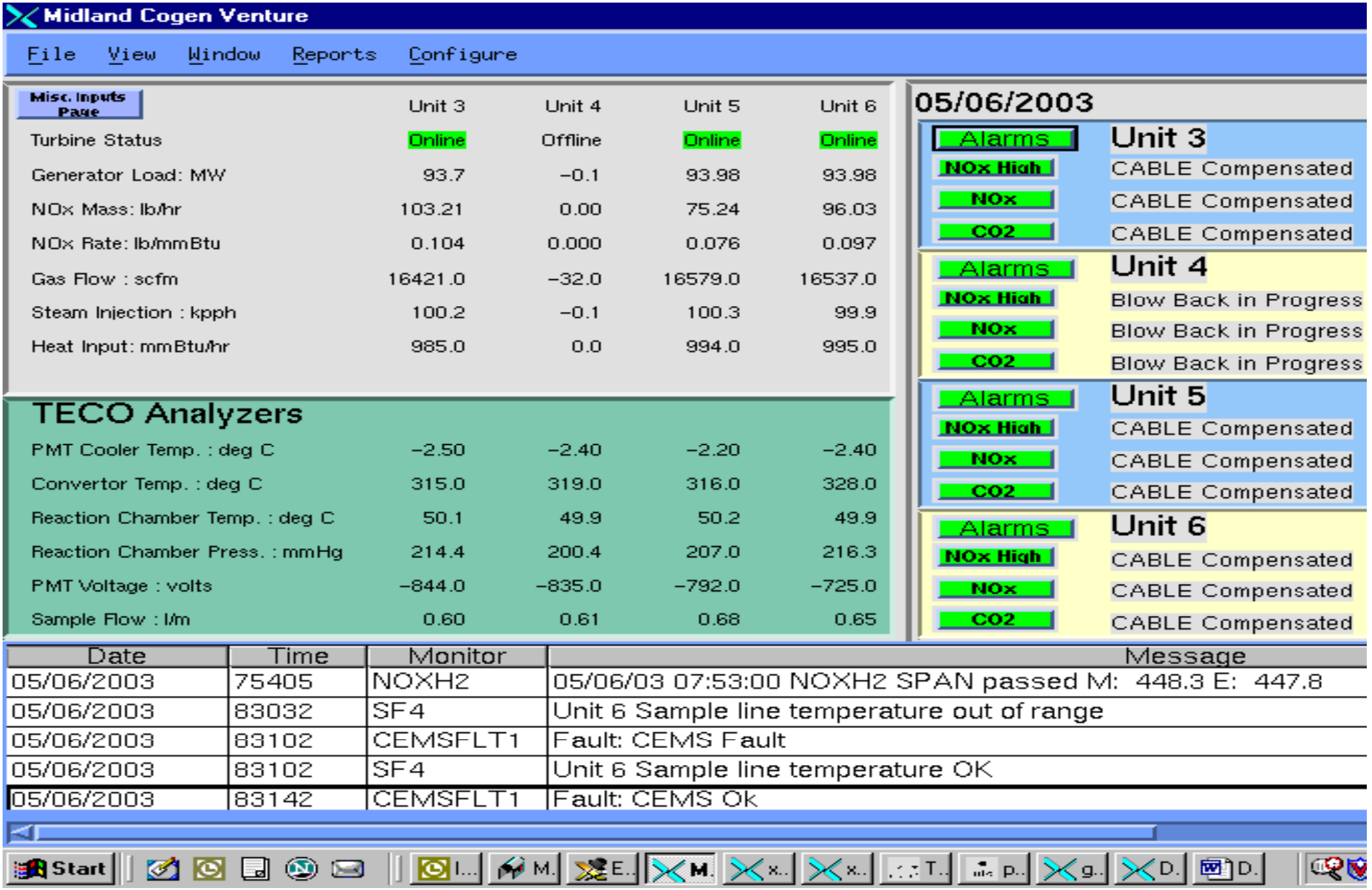
- 12 Combined Cycle Combustion Turbines
  - Located in Midland Michigan
  - ABB 11NM, Gas-fired
  - Use Steam Injection
  - 6 With Duct Burners
  - 1 With Low NO_x Burners
  - 6 Rated at 103 MW
  - 5 Rated at 127 MW
  - 1 Rated at 117 MW

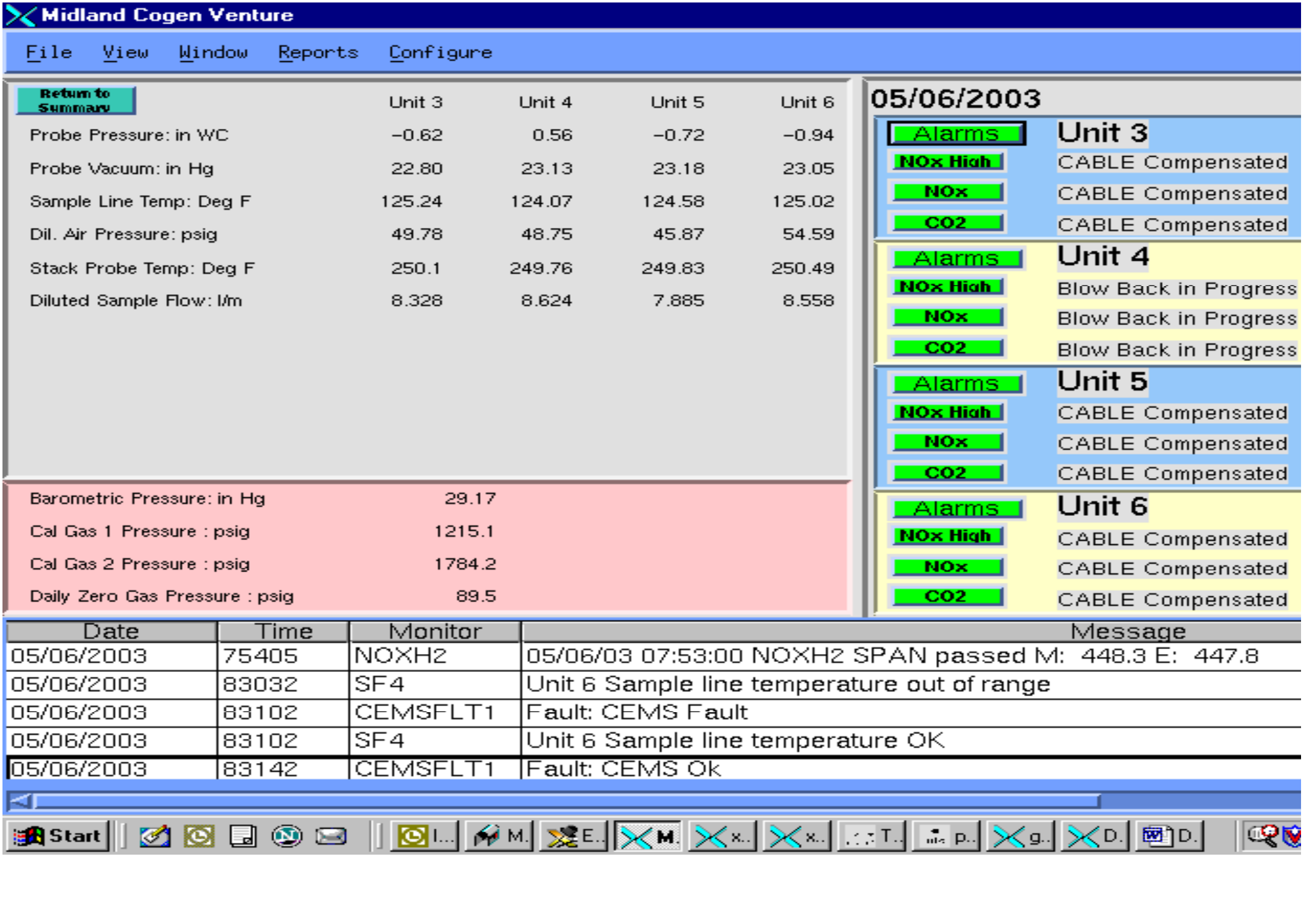
Automation Implementation

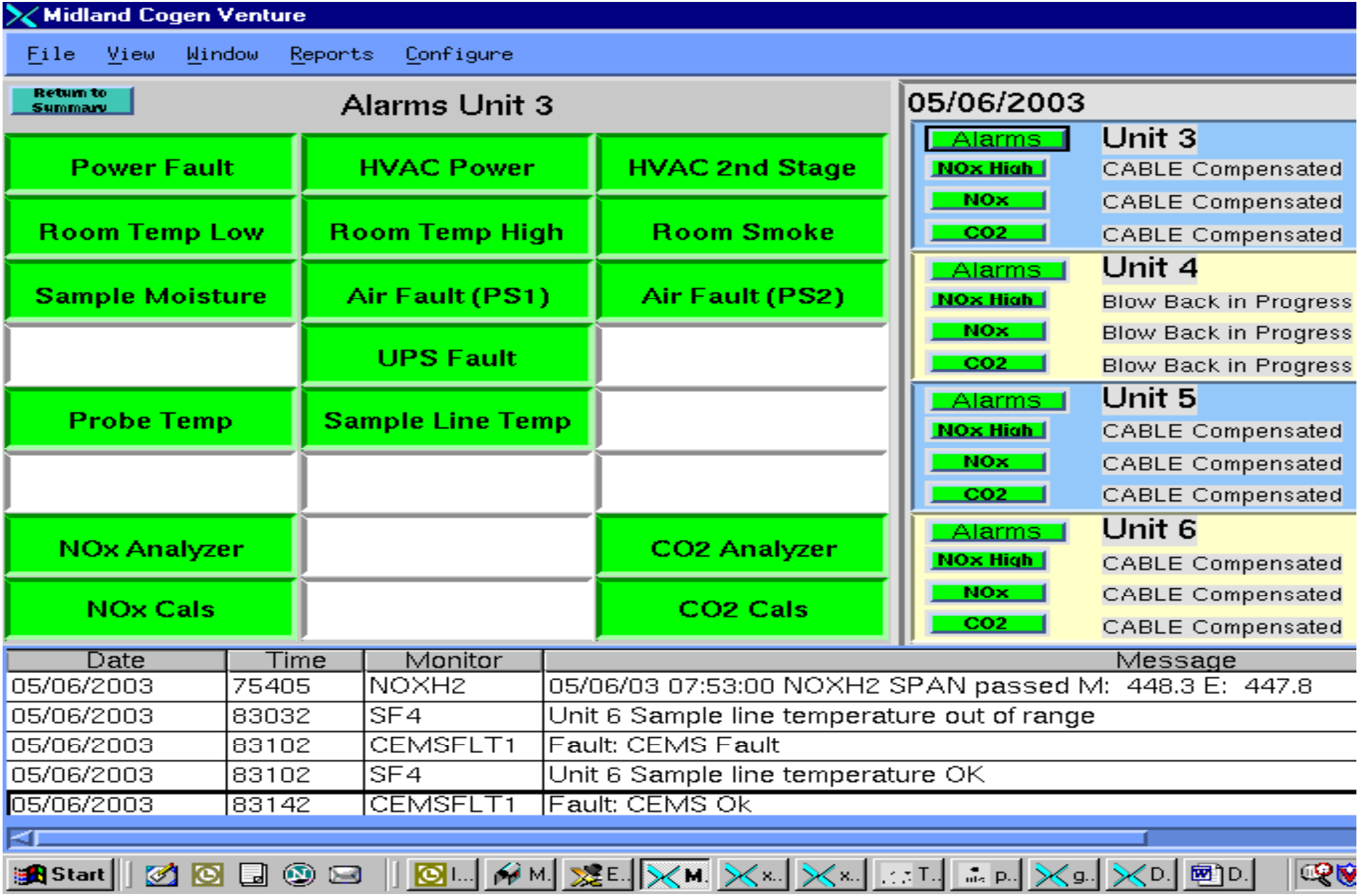
- All 12 CEMS are Identical (Except for NO_x Ranges)
  - All 12 CEMS are 50:1 dilution CEMS
  - Monitoring for NO_x and CO_2 with Appendix D
  - All Equipment, DAHS Software and Automation Software was Provided by Spectrum Systems
- CEMS are Housed in a Total of Three Shelters
  - Four CEMS per Shelter

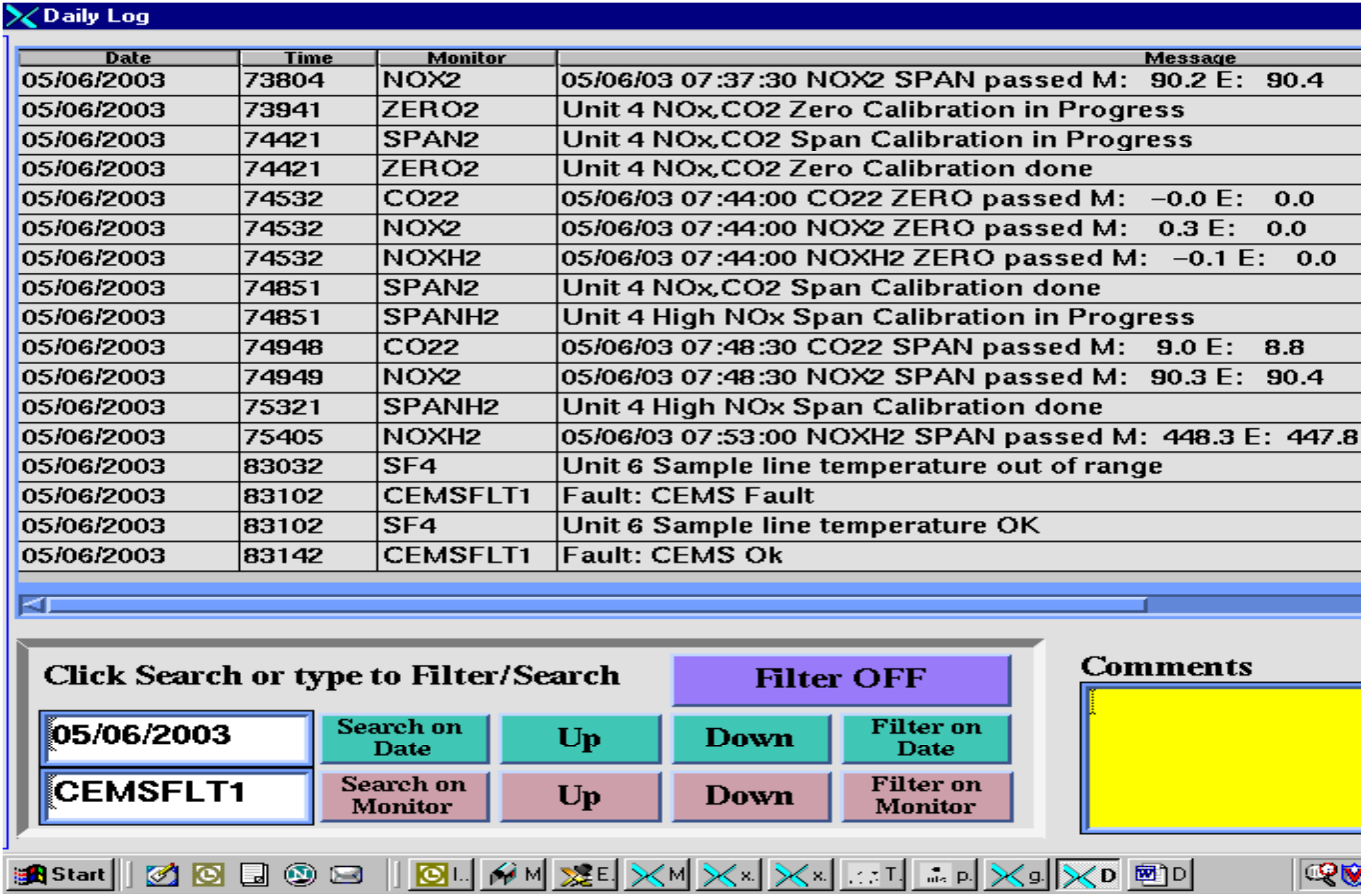
Operating Parameters

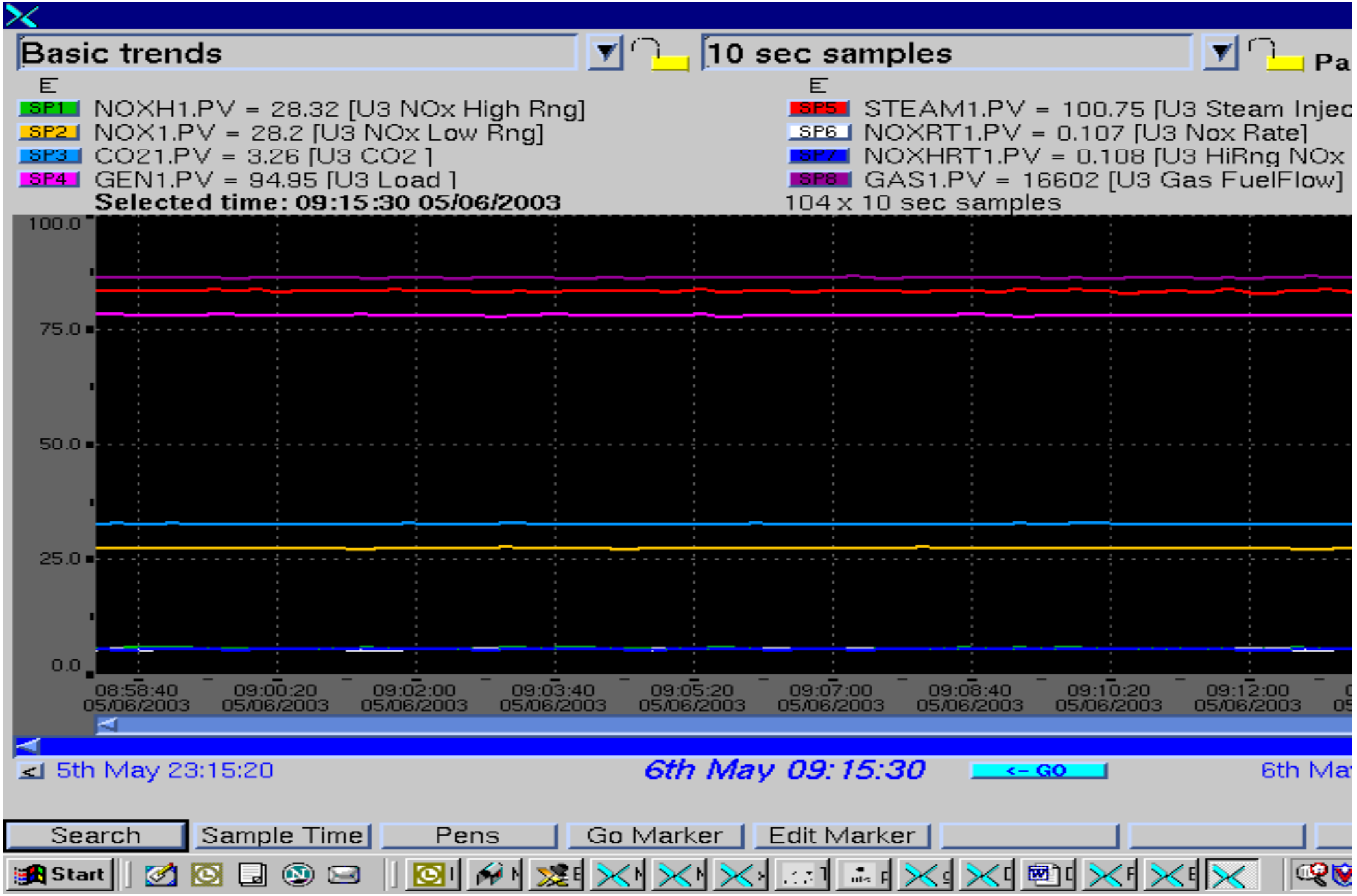
Parameter
Unit online/offline
Unit load
Zero-level calibration gas pressure
High-level calibration gas pressure
Dilution air pressure
Orifice vacuum
Sample flow
Umbilical temperature
Probe temperature
Orifice pressure
Calibration status (pass/fail) for each analyzer
Water-to-fuel ratio
NO_x cooler temperature
NO_x converter temperature
NO_x reaction chamber temperature
NO_x sample pressure
CO_2 S/R ratio*
CO_2 light intensities (4 values)*
CO_2 sample pressure*
CO_2 sample cell temperature*


Midland Cogen Venture
File View Window Reports Configure
Misc. Inputs Page
Unit 3 Unit 4 Unit 5 Unit 6
Turbine Status Online Offline Online Online
Generator Load: MW 93.7 -0.1 93.98 93.98
NOx Mass: lb/hr 103.21 0.00 75.24 96.03
NOx Rate: lb/mmBtu 0.104 0.000 0.076 0.097
Gas Flow : scfm 16421.0 -32.0 16579.0 16537.0
Steam Injection : kpph 100.2 -0.1 100.3 99.9
Heat Input: mmBtu/hr 985.0 0.0 994.0 995.0
TECO Analyzers
PMT Cooler Temp. : deg C -2.50 -2.40 -2.20 -2.40
Convertor Temp. : deg C 315.0 319.0 316.0 328.0
Reaction Chamber Temp. : deg C 50.1 49.9 50.2 49.9
Reaction Chamber Press. : mmHg 214.4 200.4 207.0 216.3
PMT Voltage : volts -844.0 -835.0 -792.0 -725.0
Sample Flow : l/m 0.60 0.61 0.68 0.65
05/06/2003
Alarms Unit 3
NOx High CABLE Compensated
NOx CABLE Compensated
CO2 CABLE Compensated
Alarms Unit 4
NOx High Blow Back in Progress
NOx Blow Back in Progress
CO2 Blow Back in Progress
Alarms Unit 5
NOx High CABLE Compensated
NOx CABLE Compensated
CO2 CABLE Compensated
Alarms Unit 6
NOx High CABLE Compensated
NOx CABLE Compensated
CO2 CABLE Compensated
Date Time Monitor Message
05/06/2003 75405 NOXH2 05/06/03 07:53:00 NOXH2 SPAN passed M: 448.3 E: 447.8
05/06/2003 83032 SF4 Unit 6 Sample line temperature out of range
05/06/2003 83102 CEMSFLT1 Fault: CEMS Fault
05/06/2003 83102 SF4 Unit 6 Sample line temperature OK
05/06/2003 83142 CEMSFLT1 Fault: CEMS Ok
Start


Midland Cogen Venture
File View Window Reports Configure
Return to Summary
Unit 3 Unit 4 Unit 5 Unit 6
Probe Pressure: in WC −0.62 0.56 −0.72 −0.94
Probe Vacuum: in Hg 22.80 23.13 23.18 23.05
Sample Line Temp: Deg F 125.24 124.07 124.58 125.02
Dil. Air Pressure: psig 49.78 48.75 45.87 54.59
Stack Probe Temp: Deg F 250.1 249.76 249.83 250.49
Diluted Sample Flow: l/m 8.328 8.624 7.885 8.558
Barometric Pressure: in Hg 29.17
Cal Gas 1 Pressure : psig 1215.1
Cal Gas 2 Pressure : psig 1784.2
Daily Zero Gas Pressure : psig 89.5
05/06/2003
Alarms Unit 3
NOx High CABLE Compensated
NOx CABLE Compensated
CO2 CABLE Compensated
Alarms Unit 4
NOx High Blow Back in Progress
NOx Blow Back in Progress
CO2 Blow Back in Progress
Alarms Unit 5
NOx High CABLE Compensated
NOx CABLE Compensated
CO2 CABLE Compensated
Alarms Unit 6
NOx High CABLE Compensated
NOx CABLE Compensated
CO2 CABLE Compensated
Date Time Monitor Message
05/06/2003 75405 NOXH2 05/06/03 07:53:00 NOXH2 SPAN passed M: 448.3 E: 447.8
05/06/2003 83032 SF4 Unit 6 Sample line temperature out of range
05/06/2003 83102 CEMSFLT1 Fault: CEMS Fault
05/06/2003 83102 SF4 Unit 6 Sample line temperature OK
05/06/2003 83142 CEMSFLT1 Fault: CEMS Ok
Start


Midland Cogen Venture
File View Window Reports Configure
Return to Summary
Alarms Unit 3
Power Fault
HVAC Power
HVAC 2nd Stage
Room Temp Low
Room Temp High
Room Smoke
Sample Moisture
Air Fault (PS1)
Air Fault (PS2)
UPS Fault
Probe Temp
Sample Line Temp
NOx Analyzer
CO2 Analyzer
NOx Cals
CO2 Cals
05/06/2003
Alarms Unit 3
NOx High CABLE Compensated
NOx CABLE Compensated
CO2 CABLE Compensated
Alarms Unit 4
NOx High Blow Back in Progress
NOx Blow Back in Progress
CO2 Blow Back in Progress
Alarms Unit 5
NOx High CABLE Compensated
NOx CABLE Compensated
CO2 CABLE Compensated
Alarms Unit 6
NOx High CABLE Compensated
NOx CABLE Compensated
CO2 CABLE Compensated
Date Time Monitor Message
05/06/2003 75405 NOXH2 05/06/03 07:53:00 NOXH2 SPAN passed M: 448.3 E: 447.8
05/06/2003 83032 SF4 Unit 6 Sample line temperature out of range
05/06/2003 83102 CEMSFLT1 Fault: CEMS Fault
05/06/2003 83102 SF4 Unit 6 Sample line temperature OK
05/06/2003 83142 CEMSFLT1 Fault: CEMS Ok
Start


Daily Log
Date
Time
Monitor
Message
05/06/2003 73804 NOX2 05/06/03 07:37:30 NOX2 SPAN passed M: 90.2 E: 90.4
05/06/2003 73941 ZERO2 Unit 4 NOx,CO2 Zero Calibration in Progress
05/06/2003 74421 SPAN2 Unit 4 NOx,CO2 Span Calibration in Progress
05/06/2003 74421 ZERO2 Unit 4 NOx,CO2 Zero Calibration done
05/06/2003 74532 CO22 05/06/03 07:44:00 CO22 ZERO passed M: -0.0 E: 0.0
05/06/2003 74532 NOX2 05/06/03 07:44:00 NOX2 ZERO passed M: 0.3 E: 0.0
05/06/2003 74532 NOXH2 05/06/03 07:44:00 NOXH2 ZERO passed M: -0.1 E: 0.0
05/06/2003 74851 SPAN2 Unit 4 NOx,CO2 Span Calibration done
05/06/2003 74851 SPANH2 Unit 4 High NOx Span Calibration in Progress
05/06/2003 74948 CO22 05/06/03 07:48:30 CO22 SPAN passed M: 9.0 E: 8.8
05/06/2003 74949 NOX2 05/06/03 07:48:30 NOX2 SPAN passed M: 90.3 E: 90.4
05/06/2003 75321 SPANH2 Unit 4 High NOx Span Calibration done
05/06/2003 75405 NOXH2 05/06/03 07:53:00 NOXH2 SPAN passed M: 448.3 E: 447.8
05/06/2003 83032 SF4 Unit 6 Sample line temperature out of range
05/06/2003 83102 CEMSFLT1 Fault: CEMS Fault
05/06/2003 83102 SF4 Unit 6 Sample line temperature OK
05/06/2003 83142 CEMSFLT1 Fault: CEMS Ok
Click Search or type to Filter/Search
Filter OFF
05/06/2003
Search on Date
Up
Down
Filter on Date
CEMSFLT1
Search on Monitor
Up
Down
Filter on Monitor
Comments
Start


Basic trends
10 sec samples
SP1 NOXH1.PV = 28.32 [U3 NOx High Rng]
SP2 NOX1.PV = 28.2 [U3 NOx Low Rng]
SP3 CO21.PV = 3.26 [U3 CO2]
SP4 GEN1.PV = 94.95 [U3 Load]
SP5 STEAM1.PV = 100.75 [U3 Steam Injec
SP6 NOXRT1.PV = 0.107 [U3 Nox Rate]
SP7 NOXHRT1.PV = 0.108 [U3 HiRng NOx
SP8 GAS1.PV = 16602 [U3 Gas FuelFlow]
Selected time: 09:15:30 05/06/2003
104 x 10 sec samples
100.0
75.0
50.0
25.0
0.0
08:58:40 05/06/2003
09:00:20 05/06/2003
09:02:00 05/06/2003
09:03:40 05/06/2003
09:05:20 05/06/2003
09:07:00 05/06/2003
09:08:40 05/06/2003
09:10:20 05/06/2003
09:12:00 05/06/2003
5th May 23:15:20
6th May 09:15:30
<- GO
6th Ma
Search
Sample Time
Pens
Go Marker
Edit Marker
Start

Automation Software

- Has User Configurable Warning and Alarm Limits
- Monitors Parameters Continuously
- Saves Hourly Averages Long-term
- Accessible From Plant-wide Network
- Stores User-specified Hourly Average for Daily Log
- Can Save Daily Logs Electronically and/or Print the Daily Records for Hardcopy Filing.

Conclusions

- Significantly Reduces Recordkeeping Effort, While Significantly Increasing the Value of the Information Being Recorded
- Currently Using 1 Technician for 12 Turbines -- With 2 Backup Personnel
- Improves O&M Efficiency and Prioritization
- Provides Valuable Diagnostic Assistance
- REDUCES CEMS PROGRAM COSTS

Ongoing Activities

- EPRI will be Conducting Follow-up Activities to Refine Previously Developed Guidance on CEMS Automation Implementation and to Assess the Type and Design of Equipment Used to Automate CEMS

- NEXT STOP -- COAL-FIRED UNITS