



Implementation of PI Historian for Substation Equipment Assessment at PECO Energy

*A encore presentation
(plus some new stuff)*

John R. Baranowski, P.E.

Agenda

- Maintenance Data Analysis System
 - Background and Goals
 - Current System Architecture
- PI system configuration and history
- Process Book Displays
 - Equipment summary displays
 - Power System 'batches'
 - IEEE Transformer Standard in Process Book
 - PI Perfmon and PI Ping examples
 - AMR data in PI
 - PI on the intranet
- Lessons learned to date
- Next steps

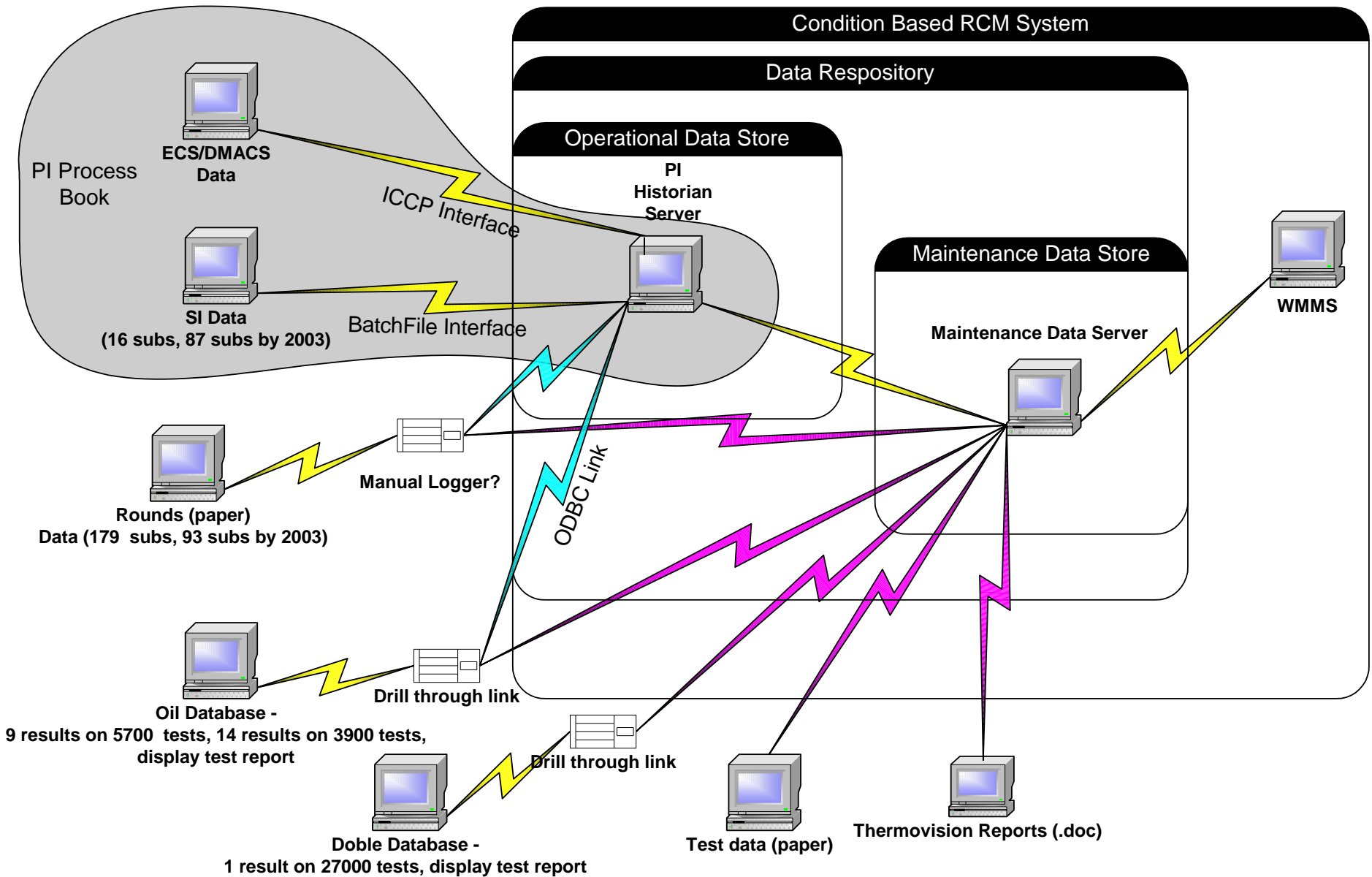
Transmission & Substation Maintenance Data Analysis System (MDAS)

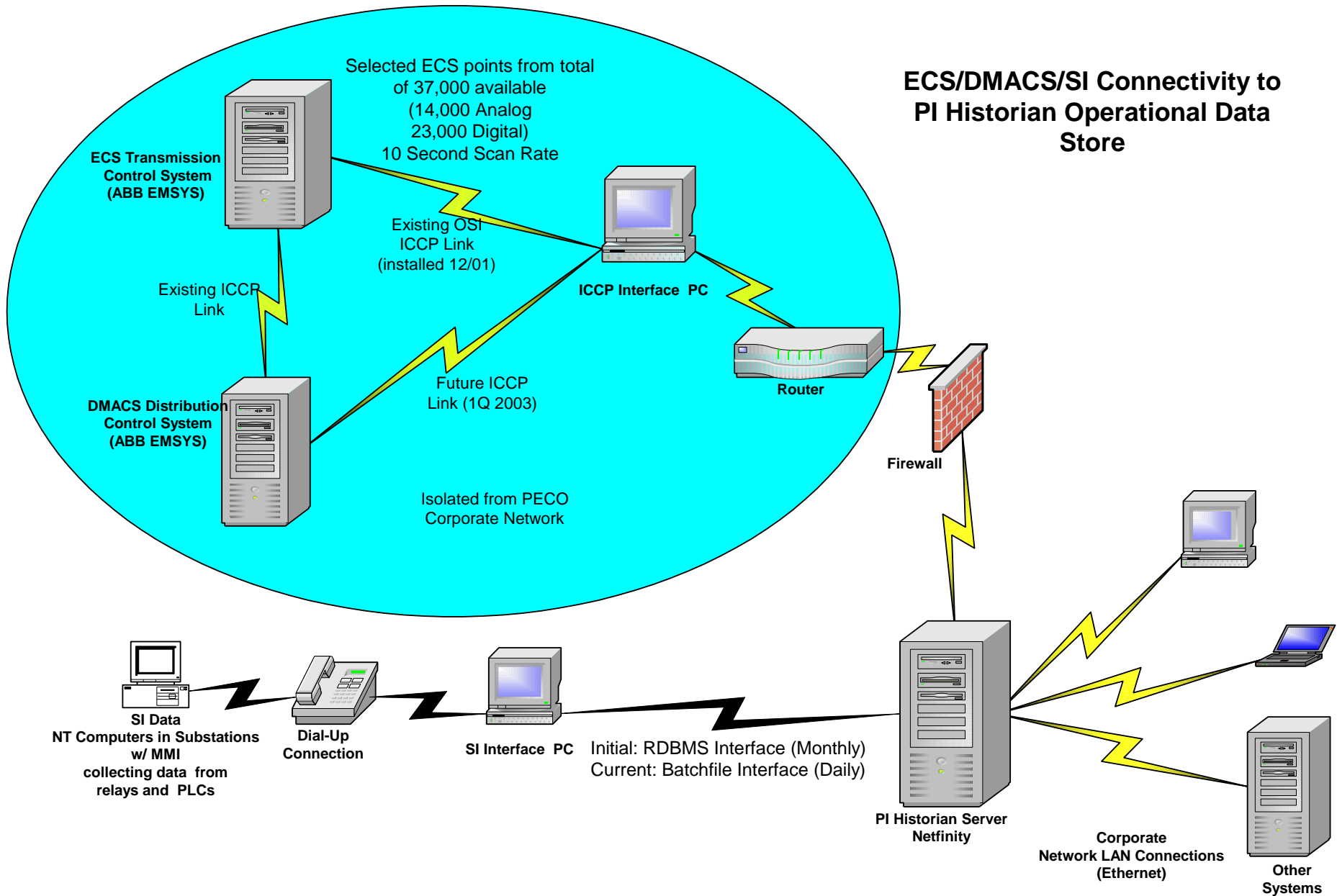
- The current maintenance methodology is one that is time based.
- The data analysis system will allow us to store pertinent information (data warehouse) used by the knowledge management system (expert rules) to determine when a piece of equipment requires maintenance.
- Moves us from time based maintenance to condition based maintenance.
- Currently collecting over 48 Million data points per year from 9 Substation Integration (SI) substations.

The Business Case



Maintenance Data Analysis System (MDAS) Overview



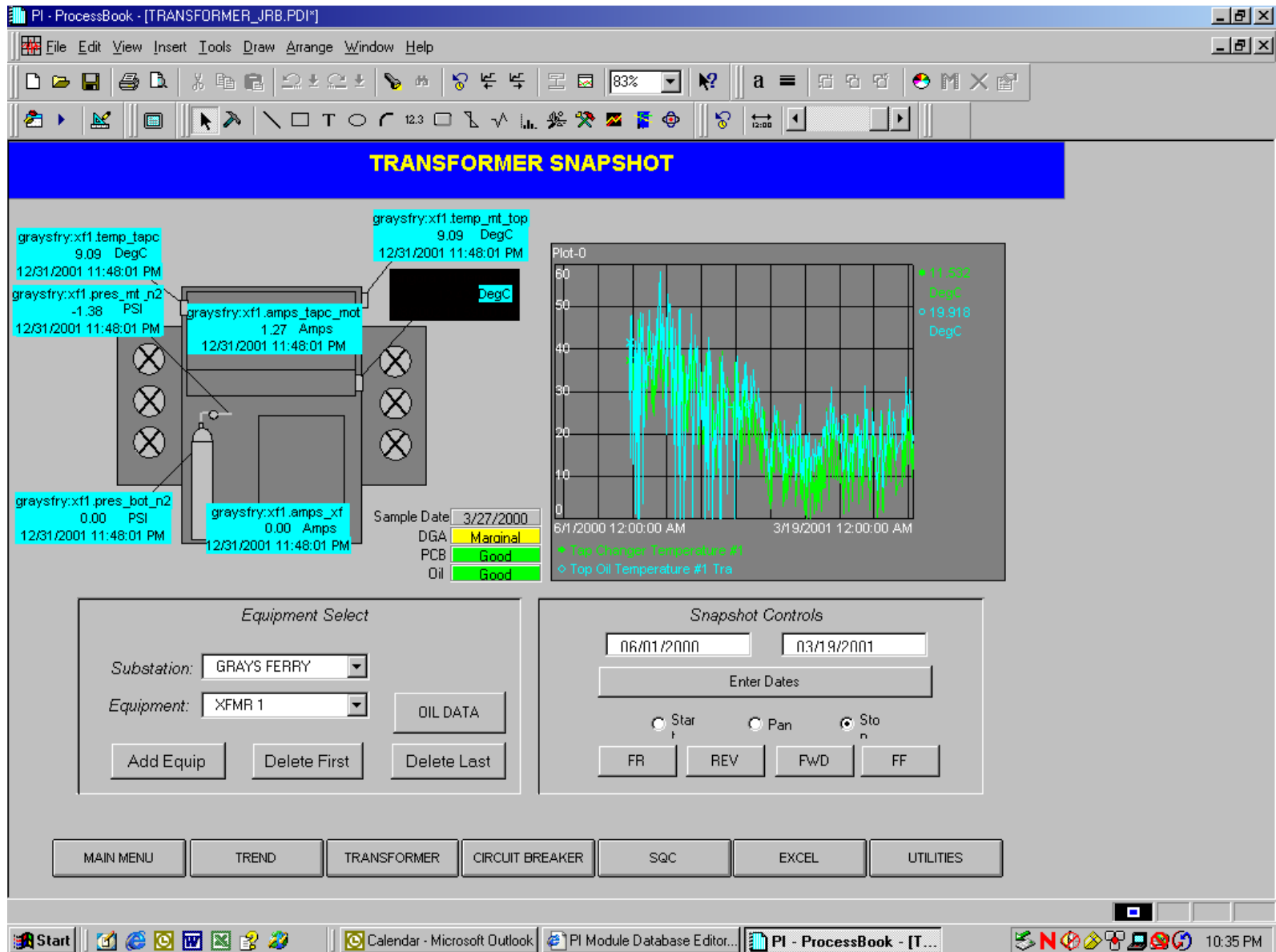


PI Historian Implementation

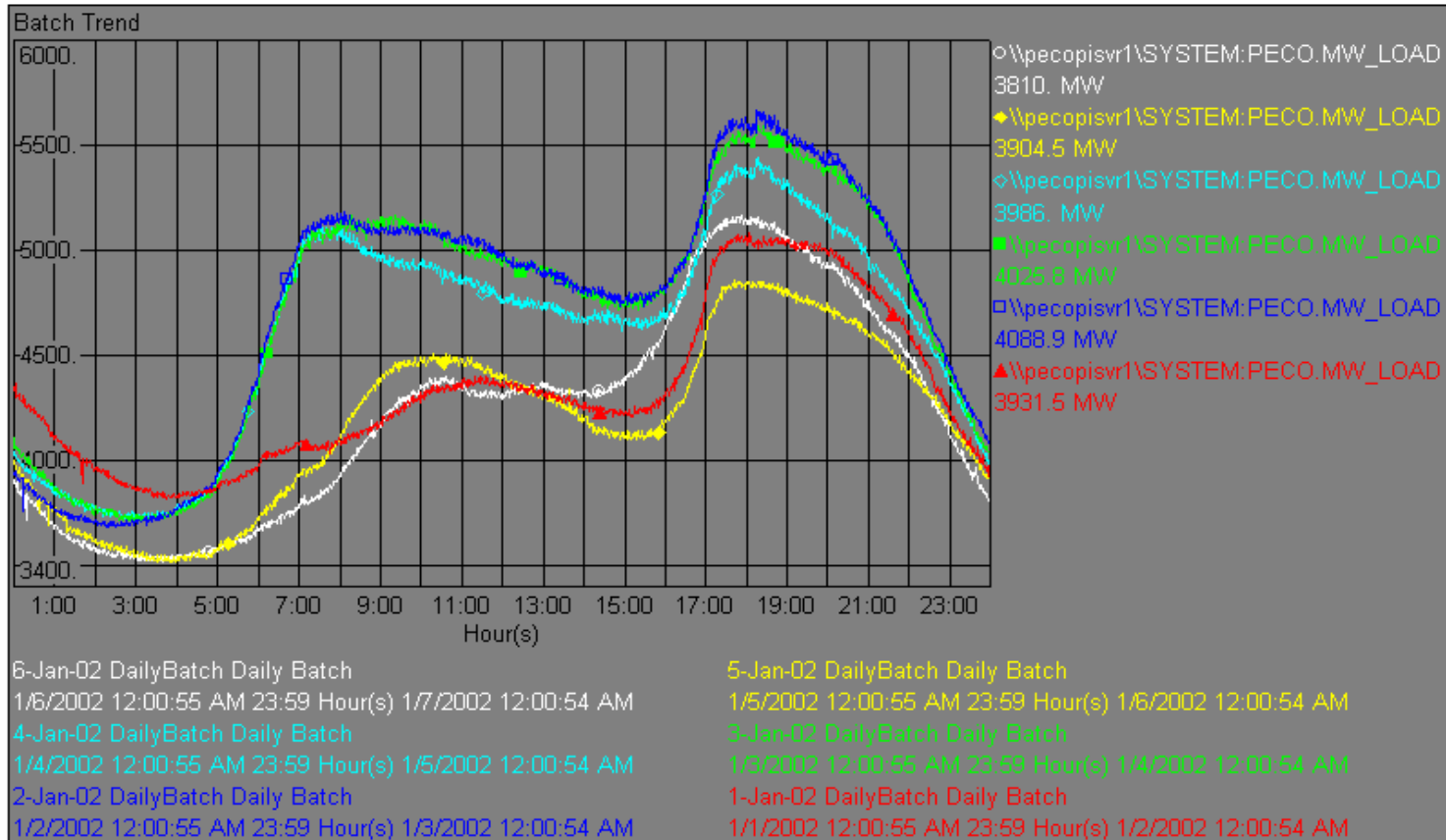
A short history

- Test server (v3.2) delivered from vendor in February 2001.
- Test server rebuilt (v3.3) in July 2001
- Production server configured in August 2001.
- Production server databases rebuilt in November 2001.
- ICCP interface installed in December 2001.
- PI-Ping and Perfmon purchased in December 2001.
- Batchfile interface begins use in January 2002.
- AMR data using Batchfile in July 2002.
- PI Web Page using devnet example in August 2002.
- PI Data Access Pack purchased in September 2002.

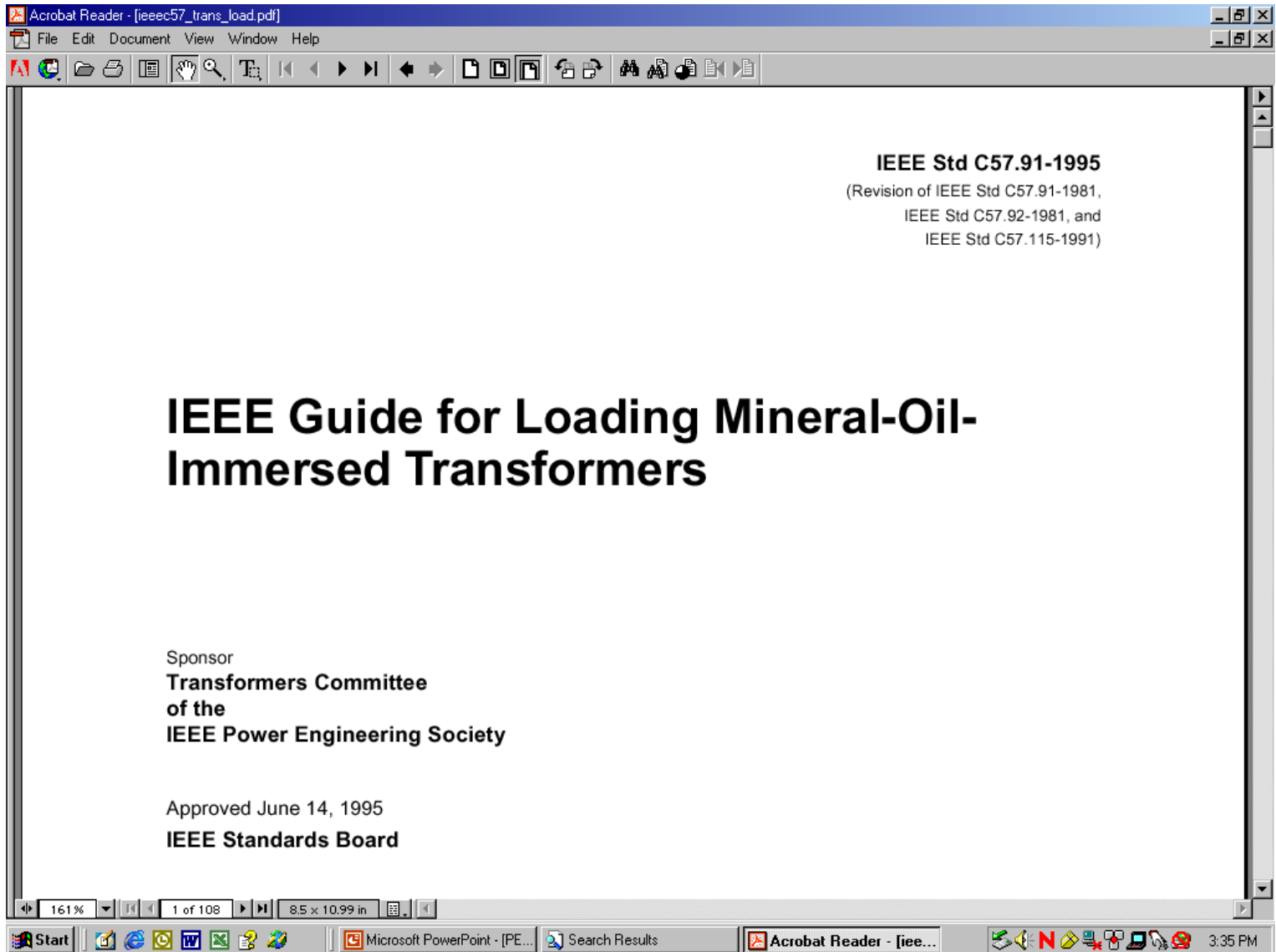
Transformer Process Book Display with ODBC links



Batch Trends



IEEE C57.91 Standard



IEEE Loading Program

Acrobat Reader - [ieeec57_trans_load.pdf]

File Edit Document View Window Help

IEEE Std C57.91-1995 IEEE GUIDE FOR LOADING

TEMPERATURES DURING LOAD CYCLE:
MAX. HOT SPOT TEMP. = 130.0855 AT 16.08333 HOURS
MAX. TOP FLUID TEMP. = 100.7999 AT 16.85 HOURS

FINAL HOT SPOT TEMP. = 89.9446
FINAL AVE. WIND. TEMP. = 73.36386
FINAL TOP OIL TEMP. = 74.08505
FINAL DUCT OIL TEMP. = 69.60123
FINAL BOT. OIL TEMP. = 48.01001

EQUIVALENT AGING = 36.22312 HOURS
LOAD CYCLE DURATION = 24 HOURS
EQUIVALENT AGING FACTOR = 1.509297 PER UNIT

Program listing:

```
10 REM PROGRAM LOADT,9-15-1993
20 DEFINT I-N:DIM TIM(100),PUL(100),AMB(100),TIMP(1500)
30 PRINT "ENTER INPUT DATA FILENAME"
40 INPUT F2$
50 PRINT "ENTER OUTPUT FILENAME"
60 INPUT F1$
70 OPEN F2$ FOR INPUT AS #2
80 OPEN F1$ FOR OUTPUT AS #1
90 INPUT #2, LN,XKVA1,TKVA1,PW, PE,PS,PC
100 INPUT #2, LN, XKVA2,THKVA2,THEWA,THEHSA,THETOR,THEBOR,TAR
110 INPUT #2, LN,MC,PUELHS,TAUW,HHS
120 INPUT #2, LN,WCC,WTANK,MF,GFLUID
130 INPUT #2, LN,MCORE,TIMCOR, PCOE
140 INPUT #2, LN, LCAS
```

161% 88 of 108 8.5 x 10.99 in

Start Microsoft PowerPoint - [PE... Search Results Acrobat Reader - [iee... 3:37 PM

IEEE Loading Program in PB

The screenshot displays a Windows 95 desktop with two open applications. On the left is a spreadsheet titled "PI - ProcessBook - [PI IEEE.X.PDI]" with a blue header "Testing PI Implementat". It contains a grid of input fields for various parameters. On the right is a Visual Basic code editor titled "Microsoft Visual Basic - c:\pipo\pi_pb_demo\pi_ieeex.pdi - [ThisDisplay (Code)]", showing the source code for the "PerfCalc" subroutine.

Testing PI Implementat

XKVA1	28000	TAR	30	LCAS
TKVA1	75	MC	2	THS
PW	51690	PUELHS	0	TW
PE	0	TAUW	5	TTO
PS	21078	HHS	1	TTDO
PC	36986	WCC	75600	TBO
XKVA2	52267	WTANK	31400	MA
THKVA2	65	MF	1	MPR1
THEWA	63	GFLUID	4910	DTP
THEHSA	80	MCORE	0	JJ
THETOR	55	TIMCOR	0	
THEBOR	25	PCOE	36986	

Time point Ambient Temp Per Unit Load

8/16/

PerfCalc

```

'10 Rem PROGRAM LOADT,9-15-1993
'20 DefInt I-N: Dim TIM(100), PUL(100), AMB(100), TIMP(1500)
'30 Print "ENTER INPUT DATA FILENAME"
'40 INPUT F2$
'50 Print "ENTER OUTPUT FILENAME"
'60 INPUT F1$
'70 Open F2$ For Input As #2
'80 Open F1$ For Output As #1
'90 Input #2, LN, XKVA1, TKVA1, PW, PE, PS, PC
'100 Input #2, LN, XKVA2, THKVA2, THEWA, THEHSA, THETOR, THEBOR, TAR
'110 Input #2, LN, MC, PUELHS, TAUW, HHS
'120 Input #2, LN, WCC, WTANK, MF, GFLUID
'130 Input #2, LN, MCORE, TIMCOR, PCOE
'140 Input #2, LN, LCAS
150 On LCAS GoTo 170, 160
'160 Input #2, LN, THS, TW, TTO, TTDO, TBO
160 THS = Me.ITHS.Value
TW = Me.ITW.Value
TTO = Me.ITTO.Value
TTDO = Me.ITTDO.Value
TBO = Me.ITBO.Value
'170 Input #2, LN, MA, MPR1, DTP, JJ
170 MA = Me.IMA.Value
MPR1 = Me.IMPR1.Value
DTP = Me.IDTP.Value
JJ = Me.IJJ.Value
'180 For J = 1 To JJ
'190 Input #2, LN, TIM(J), AMB(J), PUL(J)
'200 TIM(J) = 60! * TIM(J)
'210 Next J
    Dim Count As Long
    Count = 97
    Dim temp
    Dim t2
    Dim t3
    StartTime = Me.InputDate.Value 'set the start date
    temp = Format(StartTime, "dd-mm-yy")
    
```

IEEE Standard in Process Book

PI - ProcessBook - [PI IEEEEX.PDI*]

File Edit View Insert Tools Draw Arrange Window Help

88%

Testing PI Implementation IEEE Standard C57.91-1995 Appendix C

XKVA1	28000	TAR	30	LCAS	1
TKVA1	75	MC	2	THS	
PW	51690	PUELHS	0	TVV	
PE	0	TALVV	5	TTO	
PS	21078	HHS	1	TTDO	
PC	36986	WCC	75600	TBO	
XKVA2	52267	WTANK	31400	MA	2
THKVA2	65	MF	1	MPR1	1
THEWA	63	GFLUID	4910	DTP	15
THEHSA	80	MCORE	0	JJ	97
THETOR	55	TIMCOR	0		
THEBOR	25	PCOE	36986		

Test Date: 8/16/00

Time	Per Unit Load	Ambient Temp	Calculated		Measured	
			Hot Spot Temp	Top Oil Temp	Hot Spot Temp	Top Oil Temp
16-Aug-00 00:00	0.266	31.5	47.84	44.8	42.75	41.82
16-Aug-00 01:00	0.253	31.0	47.11	44.2	41.82	41.66
16-Aug-00 02:00	0.247	30.7	47.62	44.7	41.66	41.66
16-Aug-00 03:00	0.243	30.3	47.80	45.0	40.48	40.66
16-Aug-00 04:00	0.243	29.5	47.87	45.0	40.08	40.66
16-Aug-00 05:00	0.254	29.3	47.71	44.8	39.44	40.66
16-Aug-00 06:00	0.279	29.1	48.06	44.6	40.66	40.66
16-Aug-00 07:00	0.307	29.3	48.61	44.7	41.63	40.66
16-Aug-00 08:00	0.329	30.1	49.50	45.1	41.07	40.66
16-Aug-00 09:00	0.362	29.3	51.19	46.1	41.63	40.66
16-Aug-00 10:00	0.373	29.5	52.03	46.5	42.62	40.66
16-Aug-00 11:00	0.383	29.5	52.84	47.1	44.34	40.66
16-Aug-00 12:00	0.379	31.7	52.90	47.2	46.02	40.66
16-Aug-00 13:00	0.374	33.0	53.89	48.5	46.14	40.66
16-Aug-00 14:00	0.370	32.6	55.09	49.7	47.32	40.66
16-Aug-00 15:00	0.367	32.9	55.49	50.1	48.22	40.66
16-Aug-00 16:00	0.358	33.2	55.55	50.4	47.66	40.66
16-Aug-00 17:00	0.347	32.2	55.74	50.7	47.16	40.66
16-Aug-00 18:00	0.321	31.4	54.72	50.2	46.61	40.66
16-Aug-00 19:00	0.296	30.4	53.27	49.2	45.52	40.66
16-Aug-00 20:00	0.292	30.2	51.94	48.0	44.99	40.66
16-Aug-00 21:00	0.289	29.7	51.11	47.3	43.30	40.66
16-Aug-00 22:00	0.294	29.0	50.64	46.8	43.95	40.66
16-Aug-00 23:00	0.259	27.9	49.50	46.0	42.79	40.66

0.0212 Equilivant Aging 24 Load Cycle Duration 0.0009 Eq. Aging Factor

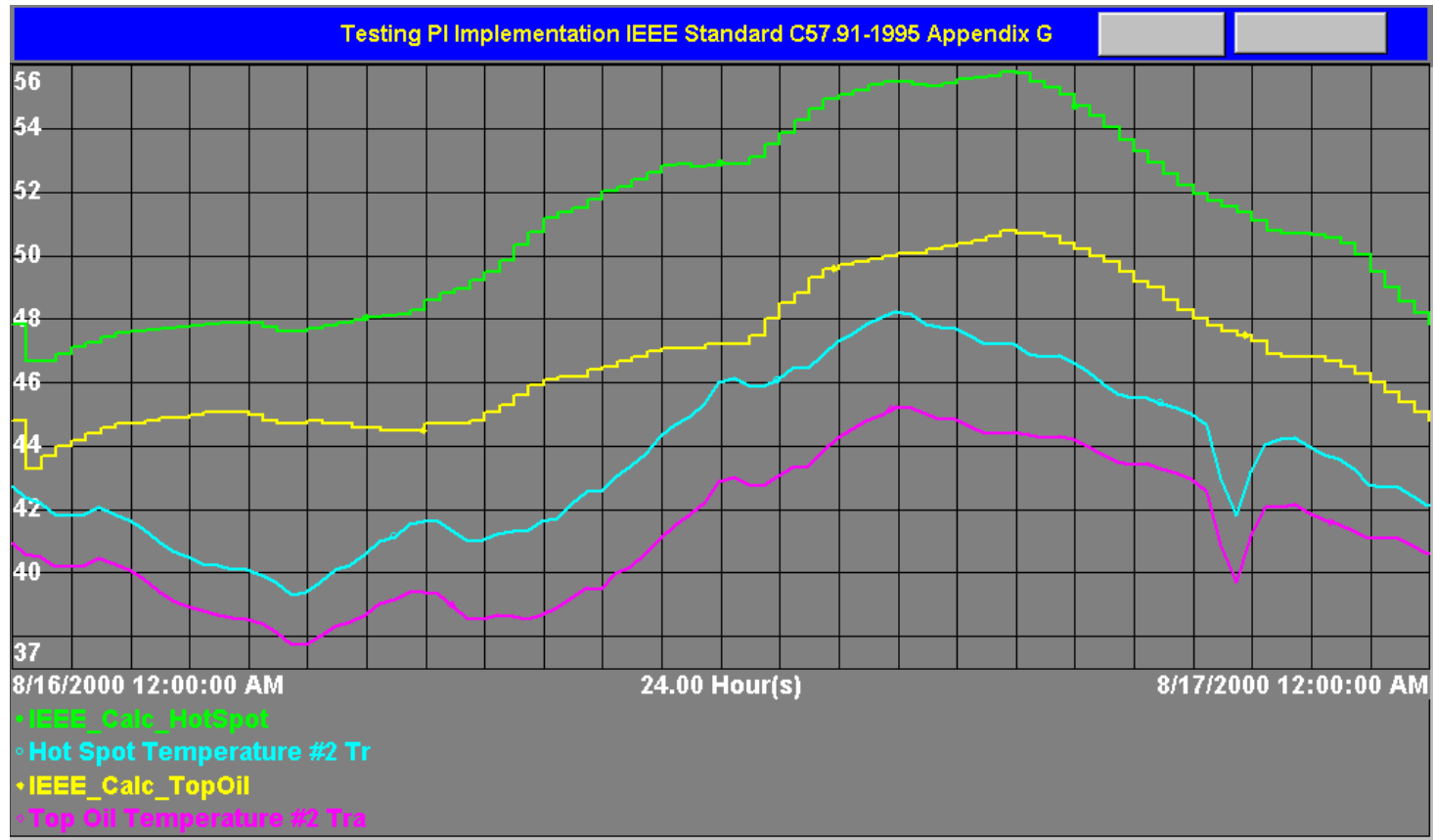
Time point	Ambient Temp	Per Unit Load
0	31.5	0.266
15	31.4	0.263
30	31.2	0.259
45	31.0	0.255
60	31.0	0.253
75	30.9	0.250
90	30.7	0.248
105	30.6	0.248
120	30.7	0.247
135	30.7	0.245
150	30.6	0.245
165	30.5	0.243

View Trends Clear

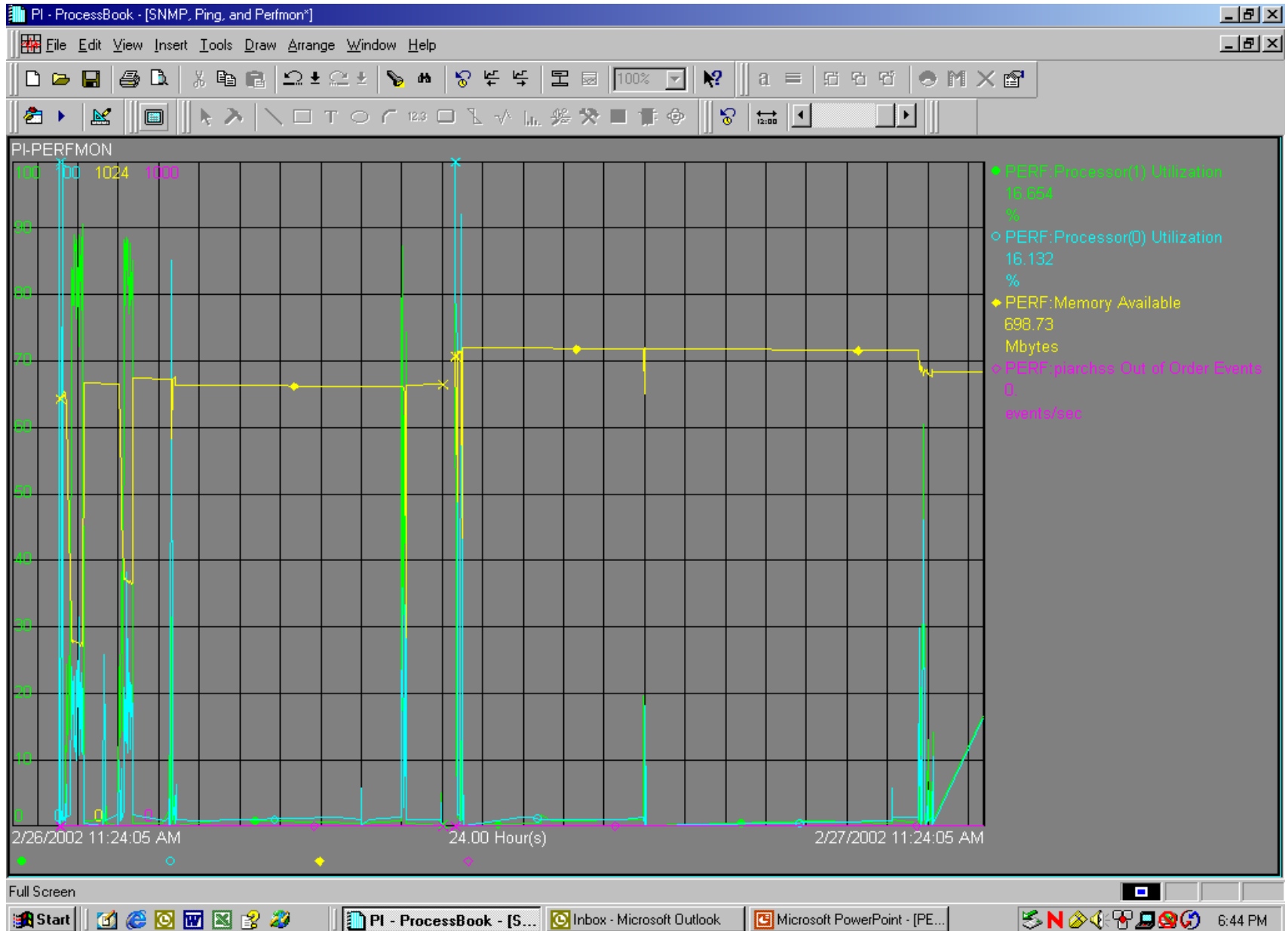
Ready

Start Calendar - Microsoft... PI Module Database... PI - ProcessBoo... Microsoft PowerPoin... 10:41 PM

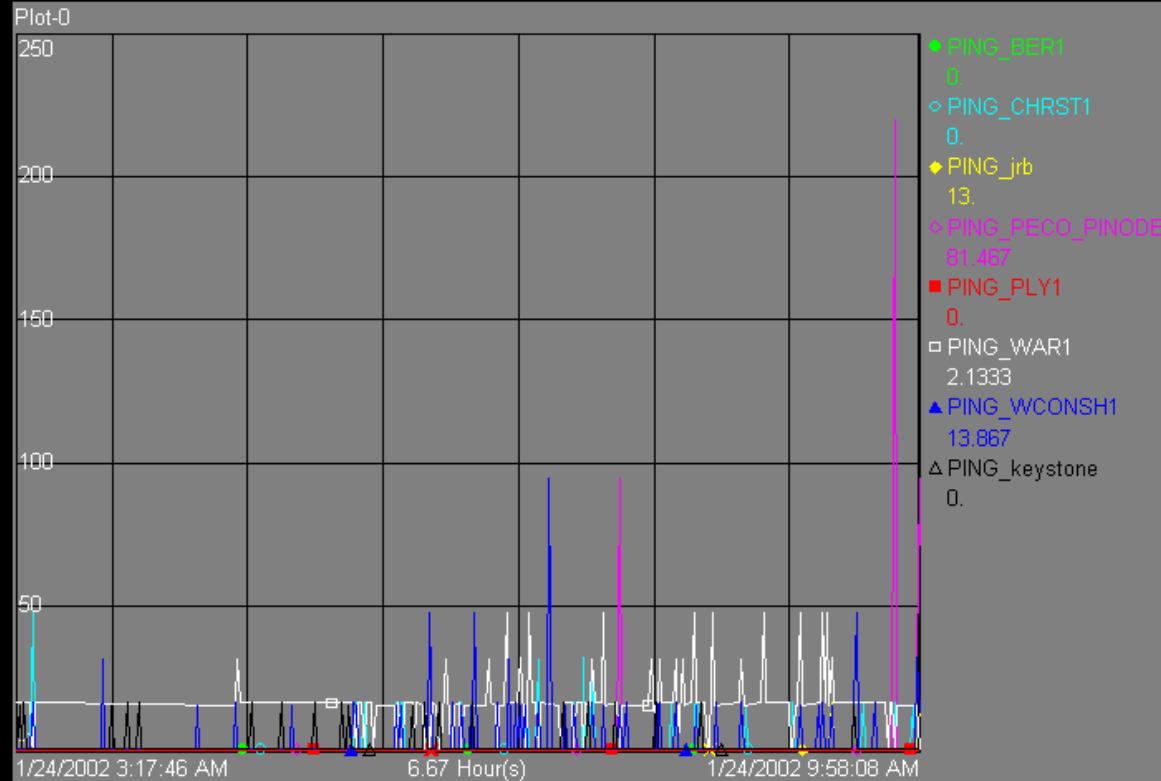
IEEE Standard Graph



PI Perfmon for PI Server Status



PI Ping for Server Status



1/24/2002 9:58:08 AM

PING_BER1 0

PING_CHRST1 0

PING_PLY1 0

PING_WCONSH1 14

PING_PECO_PINODE 81

PING_WAR1 2

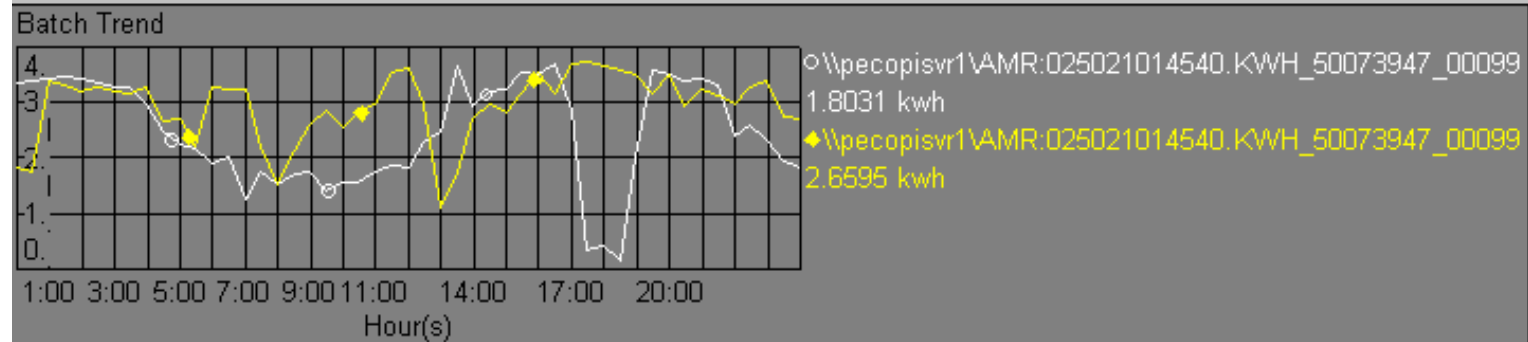
PING_jrb 13

PING_keystone 0

Perfmon & Batch for OMS Analysis



AMR Data (A/C Cycling)



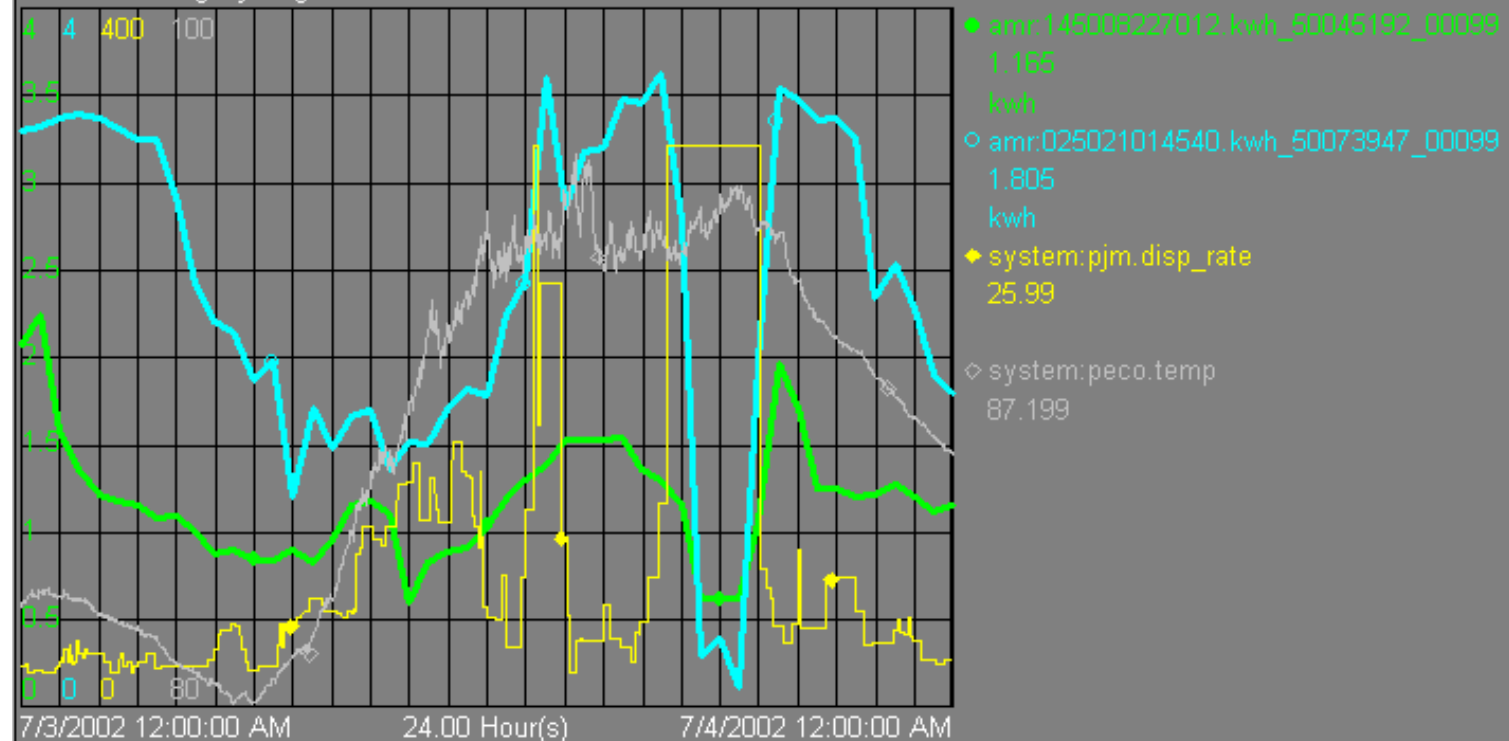
3-Jul-02 DailyBatch Daily Batch

7/3/2002 12:00:34 AM 23:59 Hour(s) 7/4/2002 12:00:33 AM

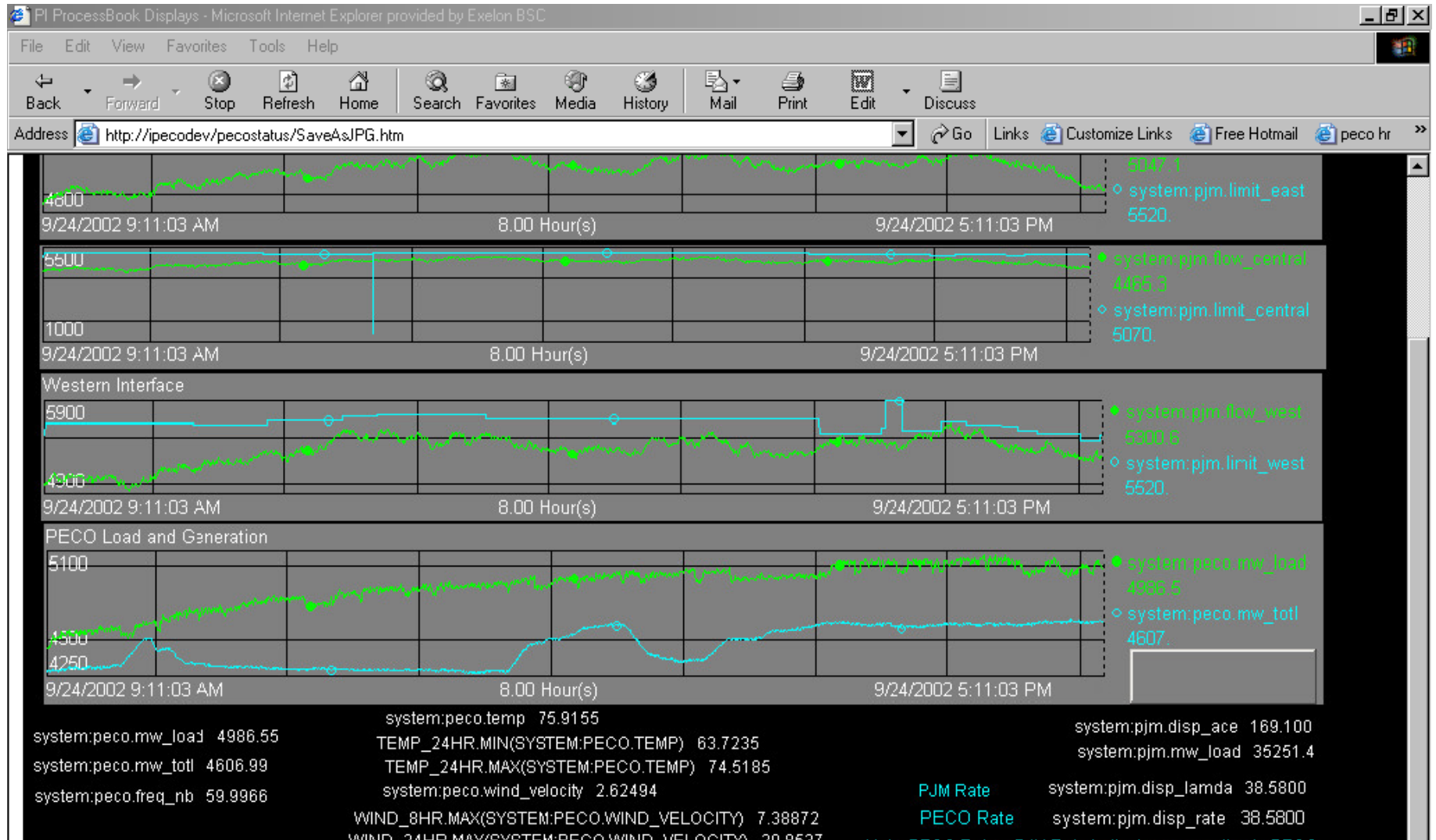
4-Jul-02 DailyBatch Daily Batch

7/4/2002 12:00:34 AM 23:59 Hour(s) 7/5/2002 12:00:33 AM

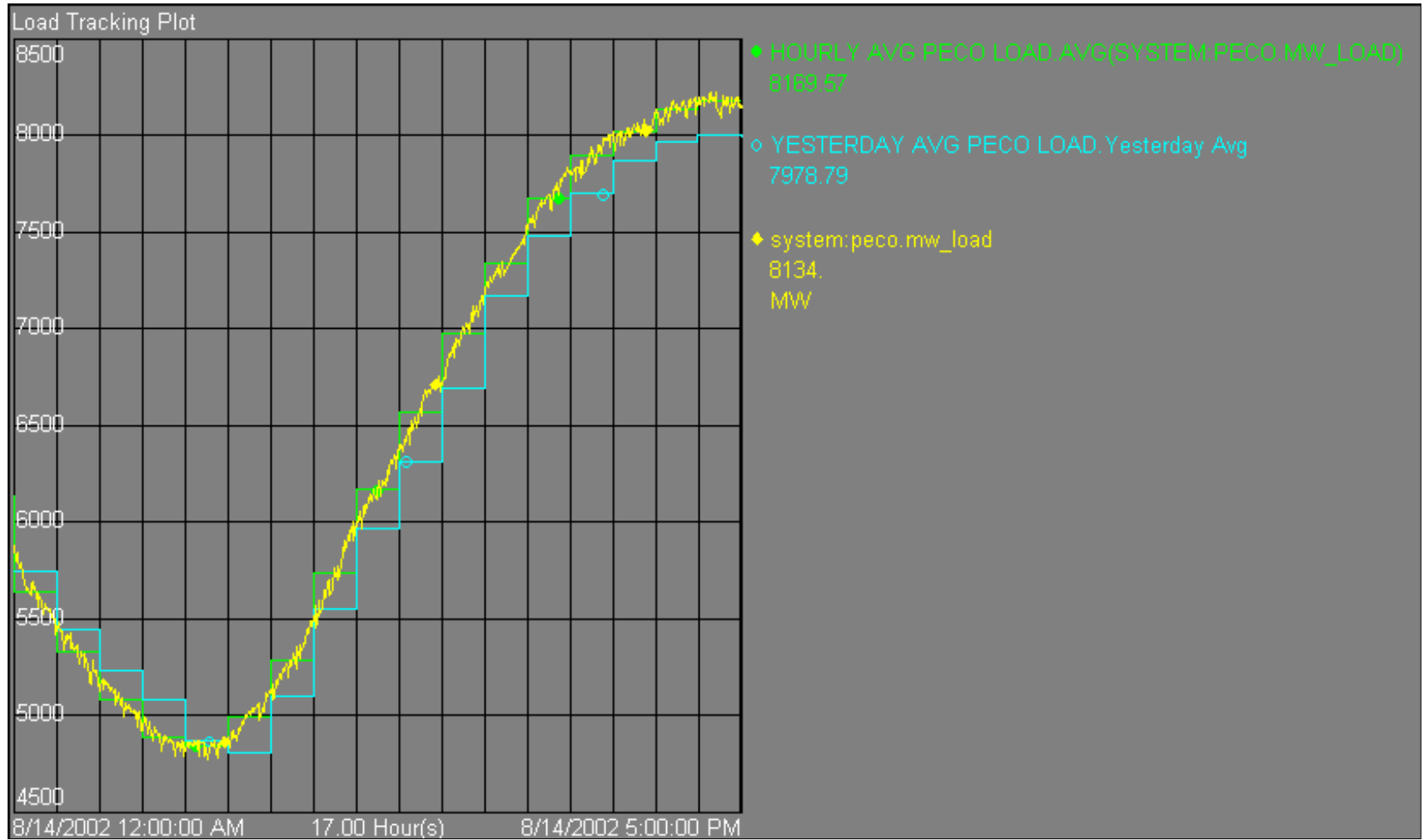
Air Conditioning Cycling



System Status Web Page (Using devnet example)



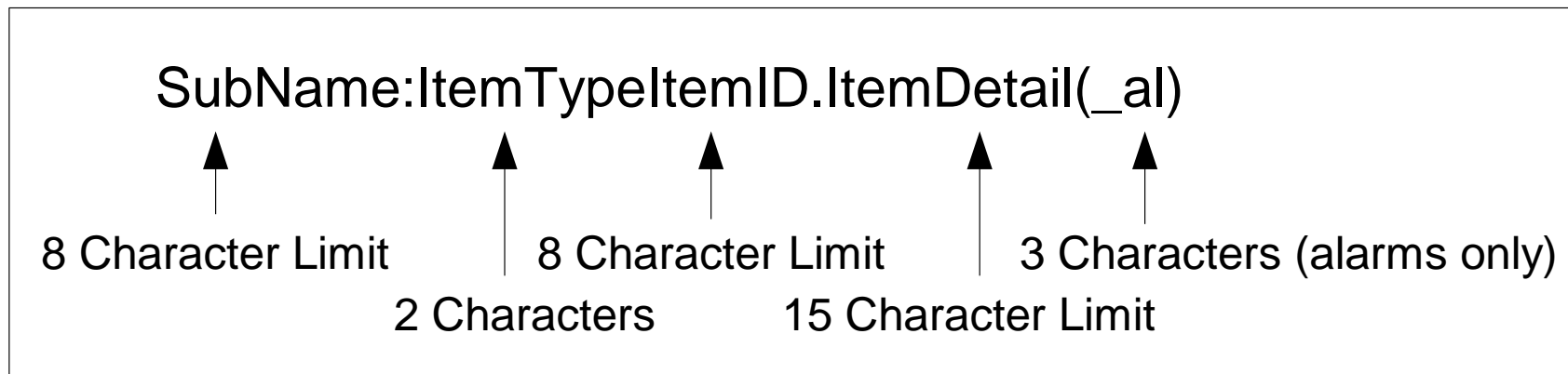
A better load display (next steps)



Lessons Learned

- Train early and often.
 - Initial training held, but ongoing training needed.
- Define PI point naming convention earlier and develop change management process.
- Spend the time up front to verify all data and compression settings.
 - OSI provides a good set of tools to modify and update archives.
 - Data Access Pack can help build auditing reports.
- Use DevNet to jumpstart development.
- Build Process Books, not individual displays.
 - Easier to maintain and distribute.
- ICCP link is difficult to set-up initially, but once configured it runs well.
 - Be sure to have access to EMS vendor during install.
- Batchfile interface is simple and reliable.

PECO's Point Naming Convention



Sample tag names (from Grays Ferry)

-graysfry:cb025.pres_hi_sf6

-graysfry:xf1.temp

-graysfry:xf1.temp_al

Sample pattern tag searches:

-*:xf*.temp*

-*_al

Next Steps

- Use Module Database for ODBC links to other systems and aliasing for algorithms
- Use Module Database for common equipment displays
- PI ACE for algorithm development/links to other systems?
- Develop Web displays for summary data (executive information/storm response)
- Use Data Access Pack to send data to Cascade, and write audit reports
- Use AMR and PI for unit substation & network monitoring ('poor man's SCADA')



Questions???