



**Asset Optimization
and
Condition-Based Maintenance (CBM)**

Improving Reliability and Quality

Ann Moore – Business Development Executive

Agenda

- Asset Management Issues and Trends
- Utility Use Cases
 - PSE&G CMMS
 - SDG&E RtCBM
- Benefits and ROI
- Summary and Q&A

Asset Management

1. Traditional asset management approaches

- *Issues*
- *Limitations*

2. Evolution of maintenance practices

Past Present Future



- Interval based
 - *Time based*
 - *Counter based*
- Condition based
- Real-time Condition based
- Future Asset Management Practice

PSE&G

(Public Service Electric & Gas)

CMMS

**(Computerized Maintenance
Management System)**

WHY? Asset Management

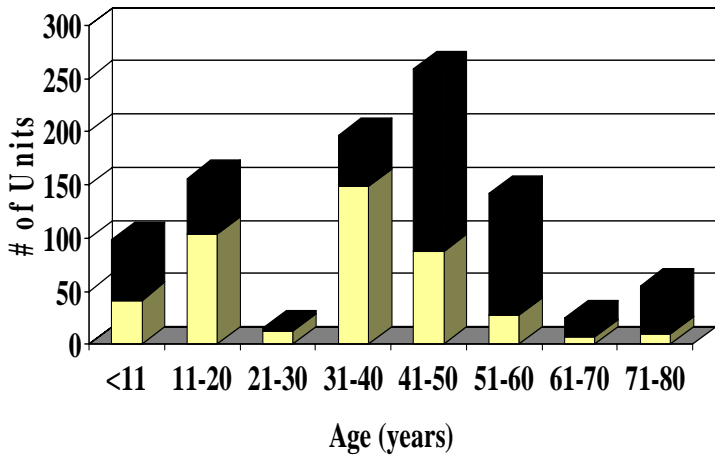
- Inside Plant

What do you do when...

- You have **\$1.5B** of installed plant with a replacement value of **\$5.4B**
- Average age of the assets exceeds **40** years
- All equipment is expected to be **used and useful** all the time, and
- Maintenance expenditures **erode earnings** and capital replacement provides for no new revenue?

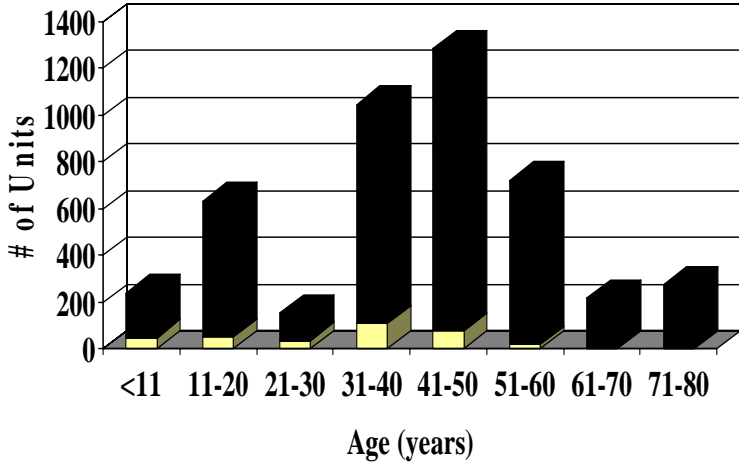
Equipment Age Profile in Utility

Transformers
Total - 955 units



Transmission Distribution

Breakers
Total - 4578 units



Transmission Distribution

Average Age- **37.4** Years

Average Age- **40.6** Years

The Mission

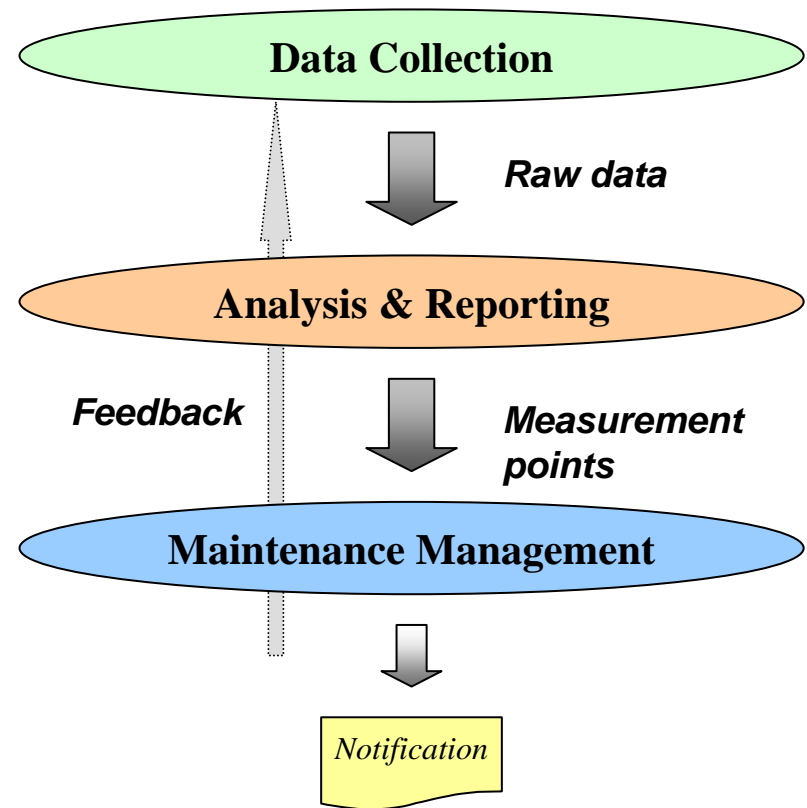
To optimize the investment in assets while *Improving* the overall system *reliability* of Electric Delivery

The Vision

To perform the right maintenance at the right time, based on the *consistent* analysis of *data* to ensure a safe, reliable, cost effective approach

Functional Areas of CMMS

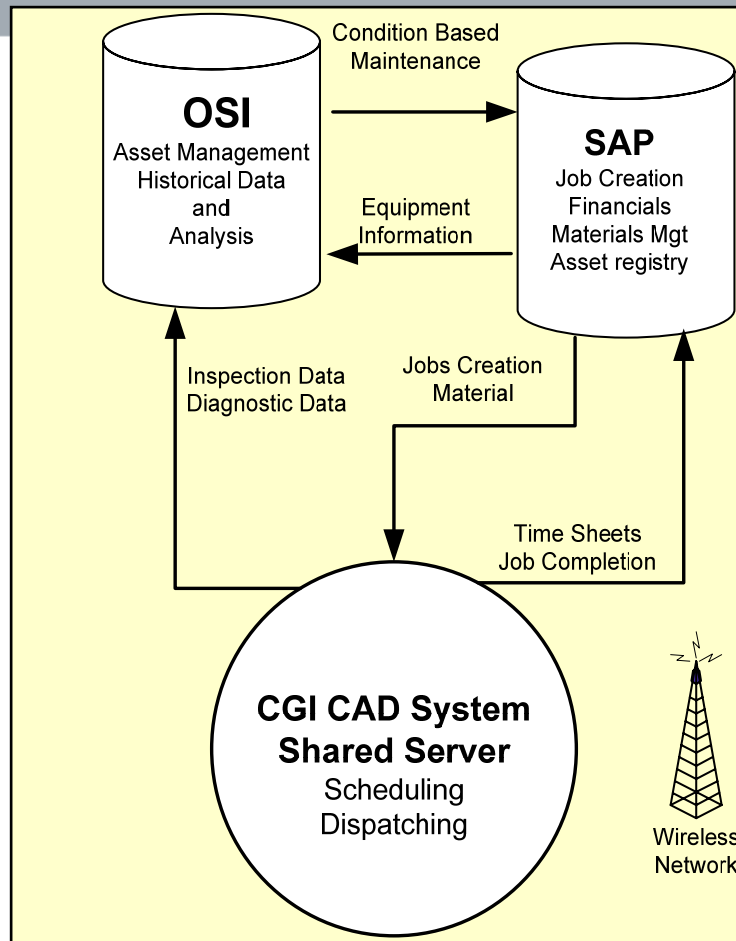
- Data Collection and Consolidation
 - Diagnostic and Inspection Data
 - Time-series Data
 - Relational Data
- Asset Analysis and Reporting
 - Condition Assessment
 - Criticality Assessment
 - Work Priorization
- Maintenance Management
 - Measurement Points
 - Work Order Generations
 - Maintenance Planning



Integrated for Success



People



+ Process

System Integration

Service Assurance
(Outage Management)

Work Management
(Crew Management)

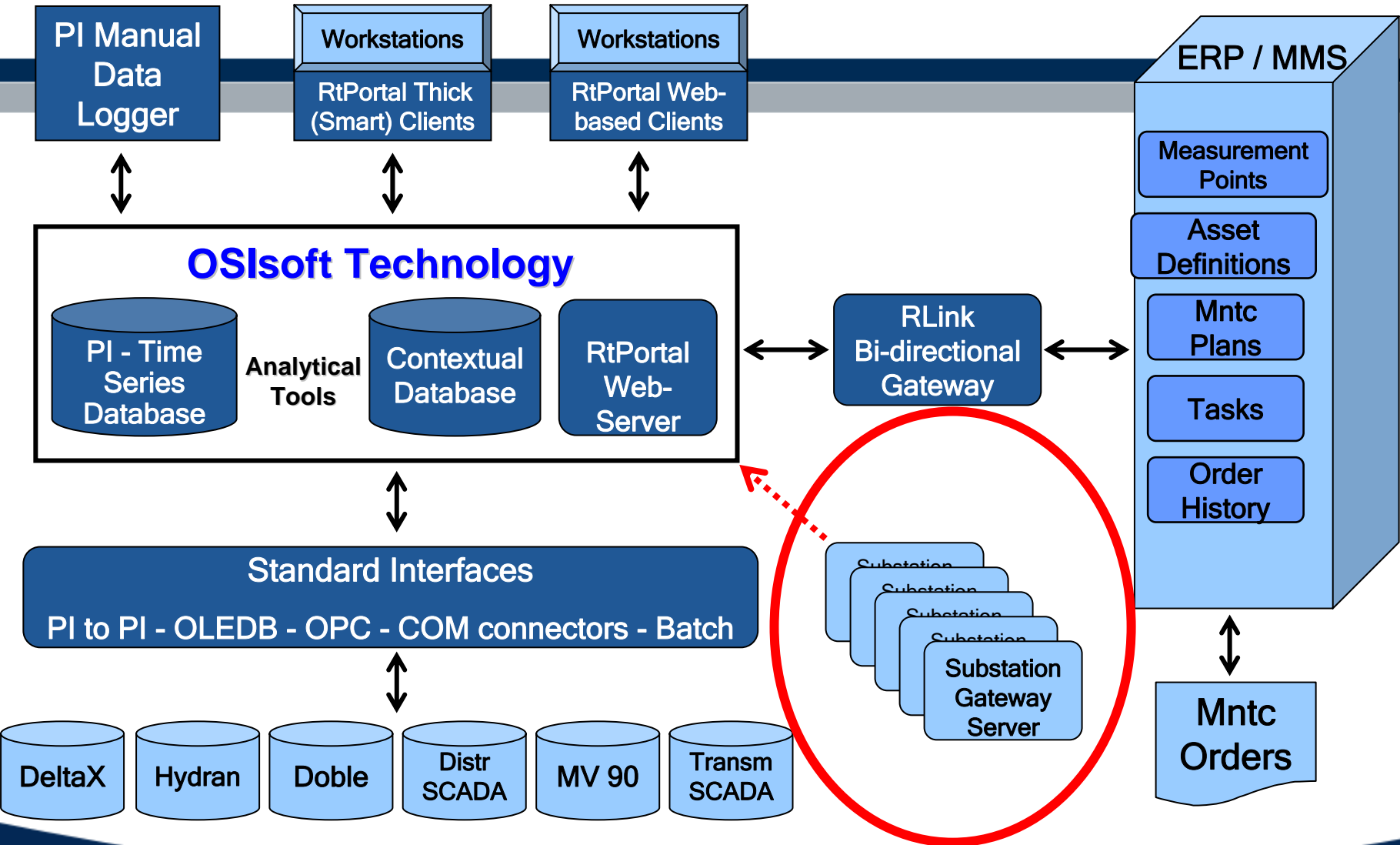
Wireless Communications

Graphic Information
(AM/FM)

Decision Support
(Data driven decisions)

+ Platform

Implementation Overview



Data Correlation

Condition Assessment

Score

Relational Attri

ies Points

PI Module Database Editor - Microsoft Internet Explorer

00000000010503860 Power Transformer

Folder Items

- BAY
- BEN
 - COM-RLY
 - T1
 - T2
 - 00000000010503860 Power Transformer
 - IPE-CE-BEN -T2 -7259
 - IPE-CE-BEN -T2 -7261
 - IPE-CE-BEN -T2 -7261M
 - IPE-CE-BEN -T2 -7262L
 - IPE-CE-BEN -T2 -7262V
 - BOU

PIProperty Name Value

- EQ NUMBER 000000
- EQ DESCR Power
- FLOC DESCR # 2 Tr
- FLOC NUMBER IPE-CE
- FC Summer Normal 51.19
- EC Summer Normal 33.80
- NORMAL RATING 24000
- Secondary Voltage 13
- TRF CONFIG 3-PHAS
- SERIAL NUMBER RAR66

1 Objects Type: PIModule Aliases: 5 Properties: 10 Effective Date: 12/31/1969 7:00:01 PM Query

Done

Peer Group: Model 9 Assign ... Algorithm: CA LTC MODEL 1 Assign ...

Score	FLOC	EQ Name	Description	Serial Num
8.41	IPE-PA-NEW -T30	00000000010542736 Load Tap	Model 9/0000000001054	A0296T
8.41	IPE-SO-CAS -UNIT 1	00000000010520986 Load Tap	Model 9/0000000001052	A1171X
8.41	IPE-SO-SNF -4TRX	00000000010523972 Load Tap	Model 9/0000000001052	ALM22911
7.51	IPE-PA-MAY -T2	00000000010542731 Load Tap	Model 9/0000000001054	6311166
7.21	IPE-PA-MAY -T1	00000000010542730 Load Tap	Model 9/0000000001054	6311169
7	IPE-SO-CAS -UNIT 2	00000000010520987 Load Tap	Model 9/0000000001052	A1181X
6.7	IPE-PA-WAD -T20	00000000010542776 Load Tap	Model 9/0000000001054	6311168
6.7	IPE-SO-THO -T1	00000000010524357 Load Tap	Model 9/0000000001052	6311165
6.4	IPE-SO-THO -T2	00000000010524358 Load Tap	Model 9/0000000001052	6311170
6.02	IPE-PA-WAD -T10	00000000010542773 Load Tap	Model 9/0000000001054	6311167
4.7	IPE-SO-SCA -T2	00000000010523481 Load Tap	Model 9/0000000001052	M102315

Scores for Individual Factors

Factor	Raw Value	Case	Multiplier	Score	Error
Water Content	44	10	0.15	1.5	
CM Costs		10	0.05	0.5	
Oil Physical	2	3	0.17	0.51	
CM Count	0	0	0.05	0	
LTC THRU NEUTRAL	0	2	1	2	
LTC Operations	578	10	0.2	2	
PM Performance	.33	2	0.1	0.2	

Ready 07/17/2002 3:26 PM

Sub-Modules PI Aliases PI Properties

Alias Name	Tag Name	Server	Snapshot Va
ESOC LOAD IN MVA	BEN:TRF.E004.Q	rjnw.aps65	38.9892
MV90 KIAR IN	BEN:TRF.E011.Q	rjnw.aps65	0
MV90 KIAR OUT	BEN:TRF.E013.Q	rjnw.aps65	8960
MV90 KW	BEN:TRF.E017.W	rjnw.aps65	18060
MV90 VOLTS	BEN:TRF.E015.V	rjnw.aps65	120.476
OIL LEVEL	BEN:TRF.L002.M	rjnw.aps65	25C
MAX OIL TEMP	BEN:TRF.T003.M	rjnw.aps65	79
MAX WINDING TEMP	BEN:TRF.T004.M	rjnw.aps65	BROKEN
FLUID CONDITION	BEN:TRF.Q002.YX	rjnw.aps65	Pt Created
GAS CONDITION	BEN:TRF.Q004.YX	rjnw.aps65	Pt Created

12/31/1969 7:00:01 PM Query Date: 07/15/2002 11:49:22 AM

My Computer

Condition Assessment =

$$f_1(m_1) + f_2(m_2) + f_3(m_3) \dots + f_n(m_n)$$

Data Correlation (cont'd)

Operational Data

PI Module Database Editor - Microsoft Internet Explorer

File Edit View Favorites Tools Help

00000000010047622 Power Transformer A

Folder Items

- SBB
 - 101H
 - 110X
 - 122X
 - 1T
 - 1TRX
 - 00000000010047622 Power Transformer A
 - 00000000010504816 Disconnect Switch Deluge System A
 - 00000000010504817 Disconnect Switch Deluge System C
 - 00000000010504818 Disconnect Switch Deluge System B
 - 00000000010504827 Disconnect Switch 500-1 230Kv Disc
 - 00000000010504828 Disconnect Switch 500-1 230Kv Grd
 - 00000000010504850 Disconnect Switch 500-1 BS 1
 - 00000000010504851 Circuit Switcher
 - 00000000010504852 Disconnect Switch Ground
 - 00000000010504853 Disconnect Switch Auto Ground
 - 00000000010504920 Power Transformer B
 - 00000000010504921 Power Transformer C
 - IPE-CE-SBB -1TRX -7259 Transformer Differential Relays
 - IPE-CE-SBB -1TRX -7261 BKR Trip Checks & Megger
 - IPE-CE-SBB -1TRX -7303 Transf. Tertiary Relays -
 - 230BS1
 - 230BS2
 - 230BS3
 - 230BS4

Sub-Modules PI Aliases PI Properties

PIAlias Name	Tag Name	Server	Snapshot Value
ESOC LOAD IN MVA	SBB:TRF.E003.Q	njnwaps65	498.7145
230KV MAX WINDING	SBB:TRF.T014.M	njnwaps65	65
500KV MAX WINDING	SBB:TRF.T004.M	njnwaps65	65
OIL TEMPERATURE	SBB:TRF.T032.M	njnwaps65	65
TANK OIL LEVEL	SBB:TRF.L001.M	njnwaps65	25C
TOP OIL TEMPERATU...	SBB:TRF.T001.M	njnwaps65	60
HYDRAN PPM	SBB:TRF.Q012.M	njnwaps65	37
HYDRAN ROC	SBB:TRF.Q012.N1	njnwaps65	0
220-1 GAS	SBR:TRF.Q014.M	njnwaps65	63
220-2A GAS	SBR::TRF.Q015.M	njnwaps65	142
500-1 PHASE A GAS	SBB:TRF.Q014.M	njnwaps65	118

1 Objects Type: PIModule Aliases: 11 Properties: 53 Effective Date: 12/31/1969 7:00:01 PM Query Date: 8/4/2005 1:35:49 PM Creator: piadmin ParentCount: 3

Done My Computer

Data Correlation (cont'd)

Characteristic Data

PI Module Database Editor - Microsoft Internet Explorer

File Edit View Favorites Tools Help

00000000010047622 Power Transformer A

Folder Items

- SBB
 - 101H
 - 110X
 - 122X
 - 1T
 - 1TRX
 - 000000000010047622 Power Transformer A
 - 000000000010504816 Disconnect Switch Deluge System A
 - 000000000010504817 Disconnect Switch Deluge System C
 - 000000000010504818 Disconnect Switch Deluge System B
 - 000000000010504827 Disconnect Switch 500-1 230Kv Disc
 - 000000000010504828 Disconnect Switch 500-1 230Kv Grd
 - 000000000010504850 Disconnect Switch 500-1 BS 1
 - 000000000010504851 Circuit Switcher
 - 000000000010504852 Disconnect Switch Ground
 - 000000000010504853 Disconnect Switch Auto Ground
 - 000000000010504920 Power Transformer B
 - 000000000010504921 Power Transformer C
 - IPE-CE-SBB -1TRX -7259 Transformer Differential Relays
 - IPE-CE-SBB -1TRX -7261 BKR Trip Checks & Megger
 - IPE-CE-SBB -1TRX -7303 Transf. Tertiary Relays -
 - 230BS1
 - 230BS2
 - 230BS3
 - 230BS4

Sub-Modules PI Aliases PI Properties

PIProperty Name	Value	Datatype
EQ NUMBER	00000000010047622	String
EQ DESCR	Power Transformer A	String
FLOC NUMBER	IPE-CE-SBB -1TRX	String
FLOC DESCR	500-1 Transformer	String
EQUIP CLASS	E-TRANSF-CL	String
EQUIP TYPE	E-TRF-TRF	String
MANUFACTURER	Smit	String
SERIAL NUMBER	220826	String
CONSTRUCTION YEAR	2004	String
INSTALL DATE	7/20/2004	String
SORT BY	1452	String
ABC	C	String
REPL-COST	2.80	String
INST-COST	0.70	String
TRANS-COST	2.10	String
FC-SUM-30MIN-EMER	560.19	String
FC-SUM-4HR-EMER	498.31	String
FC-SUM-24HR-EMER	461.10	String
FC-SUM-1WK-EMER	457.50	String
FC-SUM-1MO-EMER	449.70	String
FC-SUM-NORMAL	401.20	String
SC-SUM-24HR-EMER	285.70	String
FC-EXP-N	1.00	String
FC-HOT-SPOT-GRAD	21.80	String
FC-AVG-COP-RISE	39.50	String

1 Objects Type: PIModule Aliases: 11 Properties: 53 Effective Date: 12/31/1969 7:00:01 PM Query Date: 8/4/2005 1:35:49 PM Creator: piadmin ParentCount: 3

Done My Computer

Algorithms

PI Module Database Editor - Microsoft Internet Explorer

File Edit View Favorites Tools Help

CM Costs

Folder Items

- My Module Databases
 - njnwkaps65
 - PI BatchDB
 - PI ModuleDB
 - %OSI
 - CMMS
 - ALGORITHMS
 - CA BREAKER
 - CA BREAKER - REPLACEMENT
 - ATB 26-765KV
 - CM Costs
 - CM Count
 - Compressor Motor Run Time
 - Compressor Oil Addition Frequency
 - Compressor Oil Addition Quantity
 - Ductor
 - Gas Addition Quantity
 - Incorrect Operations
 - Megger
 - Timing

Sub-Modules PI Aliases PI Properties

PIProperty Name	Value	Datatype
Multiplier	0.15	Double
Select	sum(actual_cost)	String
From	hdw_order	String
Where	equip_num={&EQ N...	String
Case		String
Type	DB SQL Query	String
Database	cmms	String
Server	njnwksql12	String

0 Objects Type: PIModule Aliases: 0 Properties: 8 Effective Date: 12/31/1969 7:00:01 PM Query Date: 8/4/2005 1:59:49 PM Creator: pia

Score Generator

Equipment Condition Assessment Module

File View Records Help

! Save Print Sort Asc Sort Desc Print Help

Peer Group **Algorithm**

Score	FLOC	EQ Name	Description	Serial Number
2.1	IPE-PA-SBE -16FA	000000000010516999 Oil Circuit B	BKR TEST/00000000000'	0139A7678-20
2.1	IPE-PA-SBE -8FB	000000000010517030 Oil Circuit B	BKR TEST/00000000000'	0139A7637-20
0.9	IPE-PA-SBE -7FB	000000000010517027 Oil Circuit B	BKR TEST/00000000000'	K-6566177-ZK
0.9	IPE-PA-SBE -14FA	000000000010516998 Oil Circuit B	BKR TEST/00000000000'	K-6566177-WT
0.9	IPE-PA-SBE -7FA	000000000010517026 Oil Circuit B	BKR TEST/00000000000'	K-6566177-ZK
0.9	IPE-PA-SBE -6FB	000000000010517024 Oil Circuit B	BKR TEST/00000000000'	0141A3196-20
0	IPE-PA-SWK -41H	000000000010600558 Gas Circuit	BKR TEST/00000000000'	B002910-11

Scores for Individual Factors

Factor	Raw Value	Case	Multiplier	Score	Error
Age	54	7	0.3	2.1	
Operations - 12m	6	0	0.35	0	
Operations - 6m	4	0	0.35	0	
Overall Score				2.1	

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Work Prioritization

Microsoft Excel - MECHworkPrioritybyDiv.xls

File Edit View Insert Format Tools Data Window PI P-SMT Help

A1 = orderNum

	A	B	C	E	G	H	I	K	L	M	N	Q	R
1	orderNum	workCenter	status	eqType	floc	desc	voltage	ca	criticality	daysLate	priority	eqRanking	
2	000100198305	PA-ME	OPEN	E-RECL	IPE-PA-RECL-ZSHOP	Pal. Recloser Control Inspection				424 B		50000.00	
3	000100307948	CE-ME	OPEN	E-BAT	IPE-CE-GED -COM-MEC	Cen. Battery (Transm.Dept.)				118 B		25000.00	
4	0001002255900	PA-ME	OPEN	E-BAT	IPE-PA-MAL -COM-MEC	Pal. Battery (Dist.Dept.)				53 B		15000.00	
5	000100270059	CE-ME	OPEN	E-RECL	IPE-CE-RECL-MIN24F -13F	Cen. Recloser Control Inspection				-22 B		5000.00	
6	000100294817	PA-ME	OPEN	E-BAT	IPE-PA-SWK -COM-MEC	Pal. Battery (Transm.Dept.)				-162 B		5000.00	
7	000100283073	PA-ME	OPEN	E-BAT	IPE-PA-SER -M1	Pal. Battery (Transm.Dept.)				-122 B		5000.00	
8	000100279368	PA-ME	OPEN	E-BAT	IPE-PA-SER -COM-MEC	Pal. Battery (Transm.Dept.)				-100 B		5000.00	
9	000100246821	ME-ME	OPEN	E-BATCHG	IPE-ME-SNVV -COM-MEC	Met. Battery Charger (Transm.Dept.				118 1		2500.00	
10	000100246822	ME-ME	OPEN	E-BATCHG	IPE-ME-SNVV -COM-MEC	Met. Battery Charger (Transm.Dept.				118 1		2500.00	
11	000100246625	PA-ME	OPEN	E-BATCHG	IPE-PA-MAL -COM-MEC	Pal. Battery Charger (Dist.Dept.)				130 1		2500.00	
12	000100168685	SO-ME	OPEN	E-BKR-OCB	IPE-SO-SNF -41X	So.GCB BKR 500 KV (12yr)	500.00	2.5	6.7	784 1		1675.00	
13	000100256197	PA-ME	OPEN	E-BKR-OCB	IPE-PA-SMA -2PM	Pal.OCB BKR 138 KV (Transm. Dept.)	138.00	2.9	5.5	405 1		1595.00	
14	000100251300	ME-ME	OPEN	E-BATCHG	IPE-ME-SES -COM-MEC	Met. Battery Charger (Transm.Dept.				94 1		1500.00	
15	000100251301	ME-ME	OPEN	E-BATCHG	IPE-ME-SES -COM-MEC	Met. Battery Charger (Transm.Dept.				94 1		1500.00	
16	000100255379	PA-ME	OPEN	E-EMGEN	IPE-PA-SNM -COM-MEC	Pal. Emerg. Gen. w/ drive (Trans.Dept.)				53 1		1500.00	
17	000100255375	PA-ME	OPEN	E-EMGEN	IPE-PA-SWK -COM-MEC	Pal. Emerg. Gen. w/ drive (Trans.Dept.)				53 1		1500.00	
18	000100194085	SO-ME	OPEN	E-TRF-UNT	IPE-SO-COL -UNIT 3	So. Transf.-4kv -69KV (10yr)	26-4	4.1	3.4	467 1		1394.00	
19	000100188794	SO-ME	OPEN	E-TRF-TRF	IPE-SO-WRVY -T3	So. Transf.-4KV-26KV (10yr)	26-4	3.46	3.4	473 1		1176.40	
20	000100193118	SO-ME	OPEN	E-TRF-TRF	IPE-SO-AUD -T1	So. Transf.-4KV-26KV (10yr)	26-4	3.08	3	431 1		924.00	
21	000100278943	CE-ME	OPEN	E-BKR-ATB	IPE-CE-SBB -41H	Cen. ATB BKR 138KV-500KV (Transm.Dept.)	230.00	4	6.05	95 1		726.00	
22	000100220487	PA-ME	OPEN	E-BKR-OCB	IPE-PA-RFL -230BS3-4	Pal.GCB BKR 138 KV (Transm. Dept.)	230.00	1.75	5.85	260 1		716.63	
23	000100296359	ME-ME	OPEN	E-TRF-TRF	IPE-ME-GRE -T2	Met. Transf.-4KV-69KV (Dist.Dept.)	26-4	3.92	3.4	102 1		666.40	
24	000100015768	PA-ME	OPEN	E-CKTSWR	IPE-PA-SHU -20H90	Pal.Circuit Sw.-138KV-500KV(Transm.Dept)	230.00	6.5		1744 1		650.00	
25	000100255820	PA-ME	OPEN	E-TRF-TRF	IPE-PA-MAY -T2	Pal. Transf.-138kv -500KV (Transm.Dept.)	230-13	4.44	4.4	62 1		586.00	
26	000100027784	CE-ME	OPEN	E-LTC	IPE-CE-WFL -UNIT2	Cen. Load Tap Changers 1 Yr. & 4 Yr	13	5.8		1836 1		580.00	
27	000100246700	PA-ME	OPEN	E-BKR-OCB	IPE-PA-SWK -12WV	Pal.GCB BKR 138 KV (Transm. Dept.)	345.00	1.85	6.2	121 1		573.50	
28	000100126105	PA-ME	OPEN	E-BKR-OCB	IPE-PA-SBE -90P	Pal.GCB BKR 138 KV (Transm. Dept.)	138.00	0	5.65	1202 1		565.00	
29	000100246374	ME-ME	OPEN	E-TRF-TRF	IPE-ME-SAT -132-2	Met. Transf.-138kv -500KV (Transm.Dept.)	138-26-11	3.1	3.6	107 1		558.00	
30	000100255739	PA-ME	OPEN	E-TRF-TRF	IPE-PA-MAY -T3	Pal. Transf.-138kv -500KV (Transm.Dept.)	230-13	4.4	4.2	53 1		554.40	
31	000100278945	CE-ME	OPEN	E-BKR-ATB	IPE-CE-SBB -72H	Cen. ATB BKR 138KV-500KV (Transm.Dept.)	230.00	3.05	6.05	95 1		553.58	
32	000100193561	CE-ME	OPEN	E-BKR-OCB	IPE-CE-RAH -L1	Cen.GCB BKR-4KV-69KV (Dist.Dept.)	26.00	4	4.6	453 3		552.00	
33	000100002469	CE-ME	OPEN	E-BKR-OCB	IPE-CE-SLI -86F	Cen.GCB BKR-4KV-69KV (Dist.Dept.)	26.00	4	4.6	1256 3		552.00	
34	000100252609	PA-ME	OPEN	E-BKR-OCB	IPE-PA-SMA -3TR	Pal.OCB BKR 138 KV (Transm. Dept.)	138.00	0	5.4	405 1		540.00	
35	000100239563	SO-ME	OPEN	E-TRF-TRF	IPE-SO-CLN -T2	So. Transf.-4KV-69KV (Dist.Dept.)	26-4	3.12	3.4	143 1		530.40	
36	000100246400	ME-ME	OPEN	E-TRF-TRF	IPE-ME-SAT -132-3	Met. Transf.-138kv -500KV (Transm.Dept.)	138-26-11	2.92	3.6	107 1		525.60	
37	000100239477	SO-ME	OPEN	E-TRF-TRF	IPE-SO-BOR -T1	So. Transf.-4KV-69KV (Dist.Dept.)	26-4	3.08	3.4	156 1		523.60	
38	000100239574	SO-ME	OPEN	E-TRF-TRF	IPE-SO-LIB -T2	So. Transf.-4KV-69KV (Dist.Dept.)	26-4	3.08	3.4	143 1		523.60	
39	000100251265	ME-ME	OPEN	E-BKR-OCB	IPE-ME-SES -20H	Met.GCB BKR 138 KV (Transm. Dept.)	230.00	2.75	6.3	83 1		519.75	
40	000100251133	CE-ME	OPEN	E-BKR-OCB	IPE-CE-SBB -92X	Cen.GCB BKR 138 KV (Transm. Dept.)	500.00	2.5	6.8	97 1		510.00	
41	000100224948	SO-ME	OPEN	E-BKR-OCB	IPE-SO-GSA -30X	So.GCB BKR 500 KV (12yr)	500.00	0	7.25	263 1		507.50	
42	000100274255	CE-ME	OPEN	E-FHYD	IPE-CE-SBR -COM-MEC	Cen. Misc.Fire Fight Equip(Trans.Dept.)				-73 1		500.00	

Ready CAPS NUM

ACE (Advanced Computing Engine)

- Groups equipment by aliases in PI Module
- Apply set of equations to groups of equipment
- Generate email notifications or trigger for transfer of measurement docs or creation of notifications
- Event-based and periodic calculations
- Easily turn on or off equations for individual equipment
- 55 class modules and over 6000 contexts

Notification Calculations

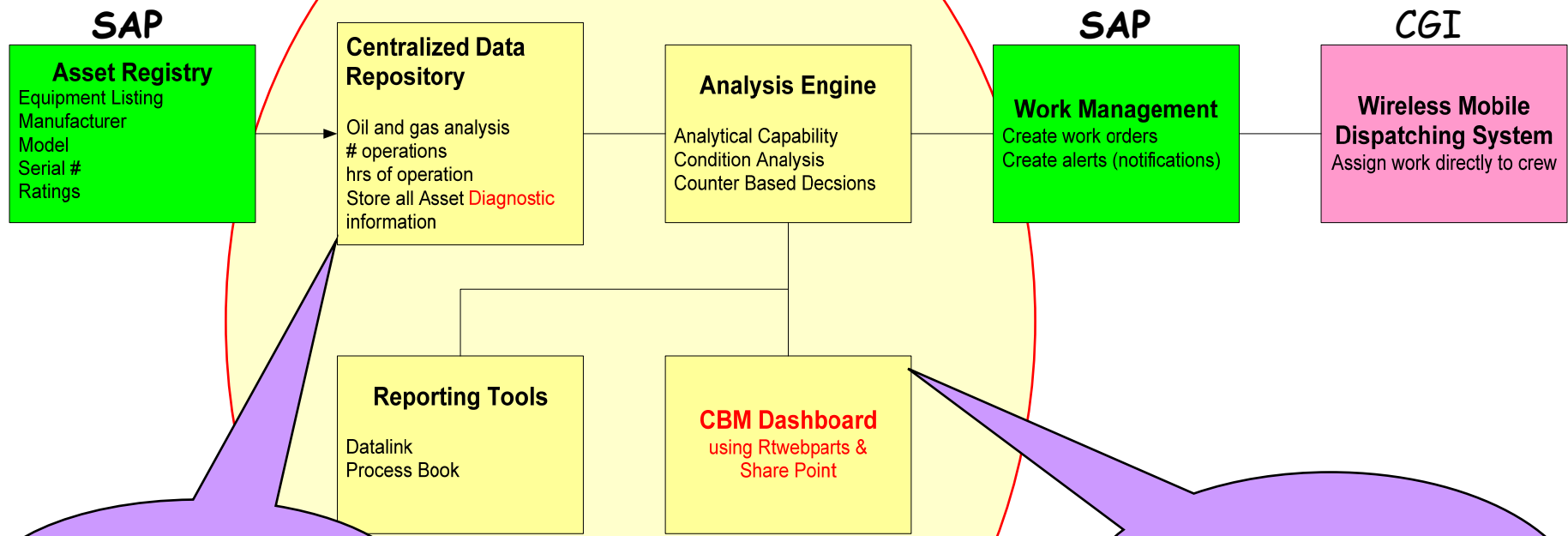
- Hydran PPM Rate of Change
- Excessive LTC Operations
- Excessive Runtime Readings
- High Breaker Temperatures
- Breaker Filling Pressure
- High or Low Transformer Oil Levels
- Low Transformer Nitrogen Cylinder Pressure
- Low Transformer Nitrogen Pressure

Interfacing with Data Sources

- SAP PM Module
- Lab Systems – DeltaX & Doble
- Breaker Diagnostic Data Web Pages
- Transmission SCADA
- Distribution SCADA
- MV-90 13kv Transformer Load Data
- SDC 4-26kv Metering
- Hydran Transformer PPM Monitoring
- SAP PM Measurement Documents

Configuration

The PI System



Enterprise License

RtWebParts Drill down capability

OSIsoft

CA Tangible Results

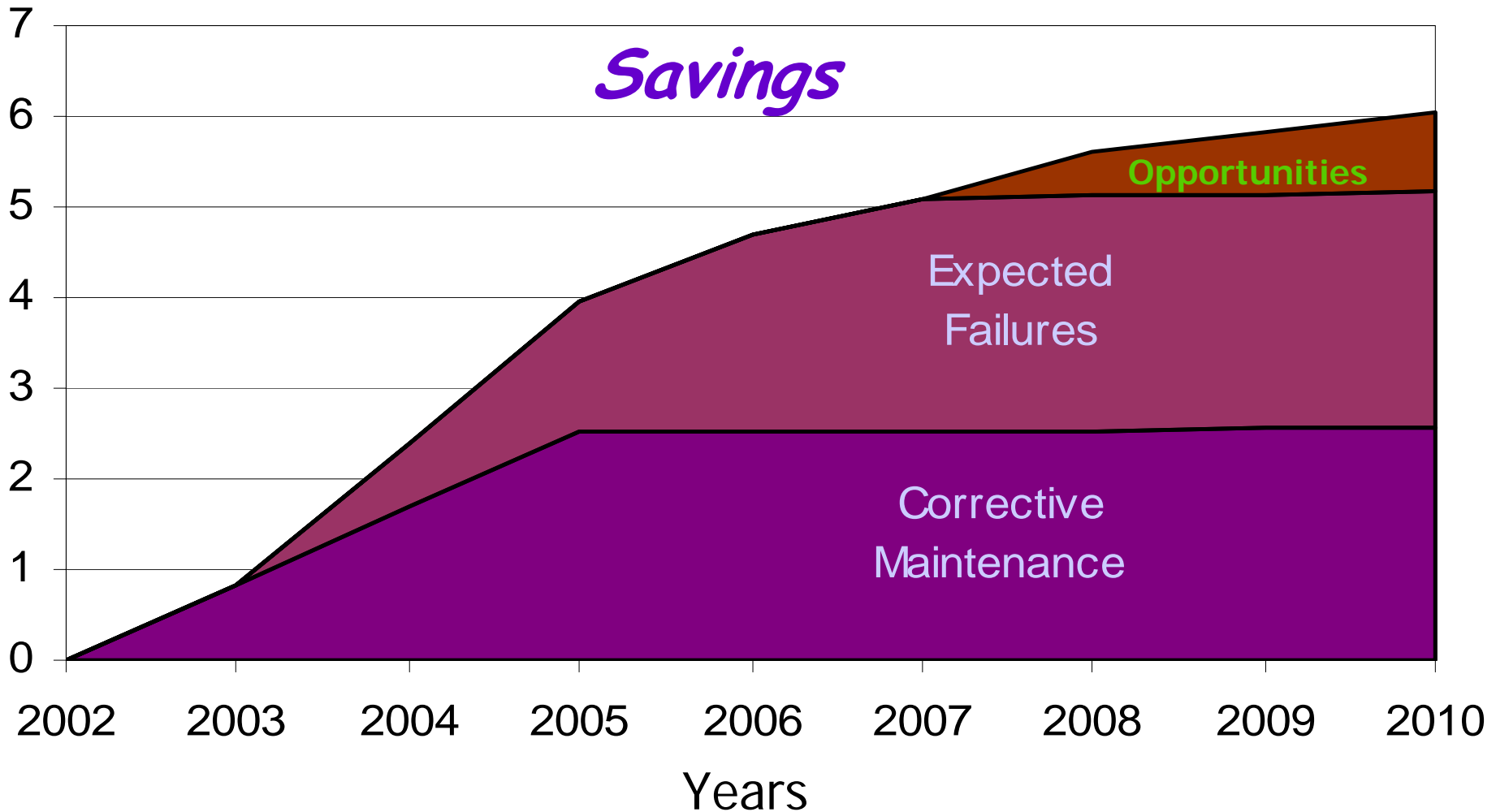
- 2003 Pre-emptive Intervention based on CMMS Oil Diagnostics targeted 16 LTC's (5 found to have contact problems indicating high potential for major problem)
 - **Estimated Cost Saving ~ \$300,000**
- In 2004 at least 10 LTC's were drained, maintained and refilled. One of these LTC's was caught before major damage occurred to the LTC/transformer
- In 2004, 5 Transformers were also targeted and 2 were identified to have major issues
 - **Estimated Cost Saving > \$1.2M**
- **2005 Cost Savings > \$2M**

Notification Tangible Results

- Problems discovered from CMMS Notifications
 - Controls out of Calibration
 - Leaky Blast Values
 - Incorrect CMV Setting
 - Defective Controls on older LTC
 - Defective Counters
 - Low Oil Levels
 - Cylinder Leaks
 - Hydran PPM
- 2003 Estimated Cost savings for 9 LTC's and 2 GCB's is **\$264,600**
- 2004 Estimated Cost saving for 5 Transformers is **\$800,000**
- **2005 Cost Savings > \$1M**

Conclusion: Proactive Approach Enables:

\$ (Million)



Conclusion: Proactive Approach Enables:

Drive Actionable Results!

Savings are derived from:

Maintenance Plan Extensions	36 %
Condition Assessment Algorithms	26 %
Counter Based Notifications	39 %

Dashboard

Home Documents and Lists Create Site Settings Help

PSEG Equipment Dashboard Modify Shared Page

Equipment Age

Age: 39

Order Cost History

Details	Total PM Cost	Total CM Cost	Total CM Count
	41502	19020	27

Equipment Nameplate

Details	Nameplate	Value
	CONSTRUCTION YEAR	1067
	MANUFACTURER	Highhouse
	MODEL NUMBER	URT
	OPER-KV	230-13
	RATING	24000.00
	SERIAL NUMBER	RAR66902

DeltaX Information

Details	Location	Desig	Serial Num	Sample Date	Temp(C)	Acetylene	Ethane	Ethylene	Methane	Water
	ADAMS	No. 1 TS	RAR66902	6/30/2006		8403	402	4322	1702	54
	ADAMS	No. 1	RAR66902	6/30/2006		0	13	2	6	11
	ADAMS	No. 1 SS	RAR66902	6/30/2006		0	196	194	74	40

Open Order Information

Details	Order	Descr	Status	Planned Cost
	000100381836	Cen. Transf.-138kv-500kva	OPEN	1306.7

Asset Load

No. 2 Transformer = 9730.00 ;
9/9/2006 5:15:00 AM

Condition Assessment Score

Details	Peer Group	Algorithm Group	Score	maxScore	Ranking(%)
	230-344KV	Transformers	4.36	6.38	68
	230-344KV	Transformers-Action	3.12	5.48	56

Details	Floc Number	Criticality	MaxScore	Ranking(%)
	IPE-CE-ADA -T1	5.85	8.2	71

Weekly Inspection Points

Details	Name	Units	Time	Value
	GAS LEVEL	ppm	9/6/2006 3:00:00 PM	NOT EXIST
	HYDRAN PPM	ppm	9/6/2006 3:00:00 PM	NOT EXIST
	MAX WINDING #1 TEMPERATURE	Deg C	9/6/2006 3:00:00 PM	60
	NITROGEN CYLINDER PRESSURE	PSI	9/6/2006 3:00:00 PM	1500
	NITROGEN PRESSURE	PSI	9/6/2006 3:00:00 PM	3.3
	TANK OIL LEVEL		9/6/2006 3:00:00 PM	25C
	TOP OIL TEMPERATURE	Deg C	9/6/2006 3:00:00 PM	60

Other PI Data Points

Details	Name	Units	Source	Time	Value
	MV90 KVAR (IN)	KVAR	MV90	9/8/2006 11:45:00 PM	1010
	MV90 KVAR (OUT)	KVAR	MV90	9/8/2006 11:45:00 PM	0
	MV90 KW	KW	MV90	9/8/2006 11:45:00 PM	20580
	MV90 VOLTS	VOLTS	MV90	9/8/2006 11:45:00 PM	120
	T1 BUS VOLT	VOLTS	DAQ	9/13/2006 8:03:37 AM	122.6214
	T1 MVA	MVA	DAQ	9/13/2006 8:03:33 AM	-0.292968
	T1 MVAR	MVAR	DAQ	9/13/2006 8:02:33 AM	0.195312
	T1 MW	MW	DAQ	9/13/2006 8:01:13 AM	15.23434

Criticality Score

Actual Loading

Condition Score

Drill down to details

PSEG
PI Point Details
Modify Shared Page ▾

Archive Readings ▾

Time	Status	Value
11/23/2005 10:00:00 AM	Good	28.0003
11/30/2005 5:00:00 PM	Good	30.0000
12/7/2005 12:00:00 PM	Good	27.0004
12/13/2005 1:00:00 PM	Good	24.0008
12/28/2005 4:00:00 PM	Good	39.9988
1/2/2006 11:00:00 AM	Good	30.0000
1/10/2006 9:00:00 AM	Good	49.9976
1/25/2006 12:00:00 PM	Good	49.9976
2/1/2006 10:00:00 AM	Good	46.9980
2/7/2006 11:00:00 AM	Good	44.9982
2/15/2006 11:00:00 AM	Good	44.9982
2/22/2006 3:00:00 PM	Good	39.9988
3/1/2006 10:00:00 AM	Good	27.0004
3/8/2006 8:00:00 AM	Good	26.0005
3/15/2006 4:00:00 PM	Good	25.0006
3/29/2006 9:00:00 AM	Good	30.0000
4/5/2006 4:00:00 PM	Good	39.9988
4/12/2006 12:00:00 PM	Good	39.9988
4/19/2006 10:00:00 AM	Good	49.9976
4/26/2006 9:00:00 AM	Good	52.9972
5/3/2006 1:00:00 PM	Good	34.9994
5/17/2006 1:00:00 PM	Good	54.9970
5/24/2006 11:00:00 AM	Good	42.9984
5/30/2006 1:00:00 PM	Good	51.9973
6/14/2006 12:00:00 PM	Good	60.0025
6/20/2006 1:00:00 PM	Good	51.9973
6/28/2006 9:00:00 AM	Good	60.0025
7/5/2006 12:00:00 PM	Good	80.0001
7/12/2006 10:00:00 AM	Good	60.0025
7/19/2006 8:00:00 AM	Good	49.9976
7/25/2006 11:00:00 AM	Good	54.9970
8/2/2006 8:00:00 AM	Good	89.9988
8/9/2006 8:00:00 AM	Good	57.0029
8/16/2006 9:00:00 AM	Good	58.0027
8/22/2006 8:00:00 AM	Good	56.0030
8/30/2006 9:00:00 AM	Good	49.9976
9/6/2006 3:00:00 PM	Good	60.0000

Tag Properties ▾

TagName	Descriptor	Units	Source
ADA:TRF.T001.M	#1 TRF TOP OIL TMP	Deg C	Inspection

RTTimeRange ▾

Start Time: End Time:

RTTrend ▾

Legend: ADA:TRF.T001.M (Green), #1 TRF TOP OIL TMP (Green)

299.96 Day(s)

Max Reading ▾

Time	Max
8/2/2006 8:00:00 AM	89.9988

Min Reading ▾

Time	Min
12/13/2005 1:00:00 PM	24.0008

Average Reading ▾

Time	Average
9/13/2006 8:07:06 AM	46.1394

Standard Deviation ▾

Time	Standard Deviation
9/13/2006 8:07:06 AM	13.6737

Gas and Oil Results

PS&G DeltaX Gas and Fluid History

Modify Shared Page

Location	Designation	Serial_Num	Equipment Type	Manufacturer Year	Model	Rated Kv	Rated MVA
ADAMS	No. 1 SS	RAR66902	SS	1967	URT 3 Phase	230	40
ADAMS	No. 1	RAR66902	TRN	1967	URT 3 phase	230	40
ADAMS	No. 1 TS	RAR66902	TS	1967	URT 3 phase	230	40

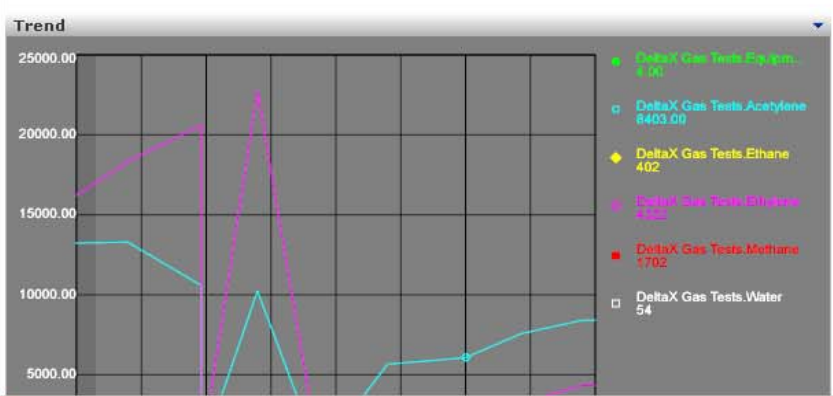
Equipment Type	Sample Date	Sampled By	Reason	Fluid Temp (C)	Equipment Condition	Acetylene	Ethane	Ethylene	Methane	Water	Total Gas	Comment
SS	6/30/2006 12:00:00 AM	STEVE DAROCI	ROUTINE	55		4	0	196	194	74	40	0.93 LT=55; RS=19.4%
TRN	6/30/2006 12:00:00 AM	STEVE DAROCI	ROUTINE	55		1	0	13	2	6	11	0.021 LT=55; RS=5.3%
TS	6/30/2006 12:00:00 AM	STEVE DAROCI	ROUTINE	55		4	8403	402	4322	1702	54	22.315 LT=55; RS=26.3%
SS	7/25/2005 12:00:00 AM	STEVE DAROCI	ROUTINE	50		4	0	152	159	63	44	0.951 LT=50 ; RS=25.4%
TRN	7/25/2005 12:00:00 AM	STEVE DAROCI	ROUTINE	50		1	0	18	6	7	12	0.053 LT=50 ; RS=6.9%
TS	7/25/2005 12:00:00 AM	STEVE DAROCI	ROUTINE	50		4	7577	330	3302	1456	53	20.455 LT=50 ; RS=30.6%
SS	9/8/2004 12:00:00 AM	STEVE DAROCI	ROUTINE	85		4	0	173	173	62	43	0.927 LT=85 ; RS=8.3%
TRN	9/8/2004 12:00:00 AM	STEVE DAROCI	ROUTINE	50		1	0	21	22	7	33	0.084 LT=50 ; RS=19.0%
TS	9/8/2004 12:00:00 AM	STEVE DAROCI	ROUTINE	82		4	6058	267	2575	1136	56	17.712 LT=82 ; RS=11.8%
SS	7/1/2003 12:00:00 AM	STEVE DAROCI	ROUTINE	35		4	0	174	182	64	38	0.972 LT=35 ; RS=37.8%

Showing 1 to 10 of 30

Serial Number	Location	Designation	Equipment Type	Sample Date	Sampled By	Reason	Fluid Condition	Water
RAR66902	ADAMS	No. 1 SS	SS	6/11/2002 12:00:00 AM	KAHLER	DIAGNOSTIC	2	45
RAR66902	ADAMS	No. 1	TRN	6/11/2002 12:00:00 AM	KAHLER		2	34
RAR66902	ADAMS	No. 1 SS	SS	4/8/1994 12:00:00 AM	KAHLER	DIAGNOSTIC	2	
RAR66902	ADAMS	No. 1	TRN	4/8/1994 12:00:00 AM	KAHLER		1	

RTTimeRange

Start Time: 9/13/1998 8:11:50 AM End Time: 9/13/2006 8:11:50 AM Apply [Refresh] [Previous] [Next]



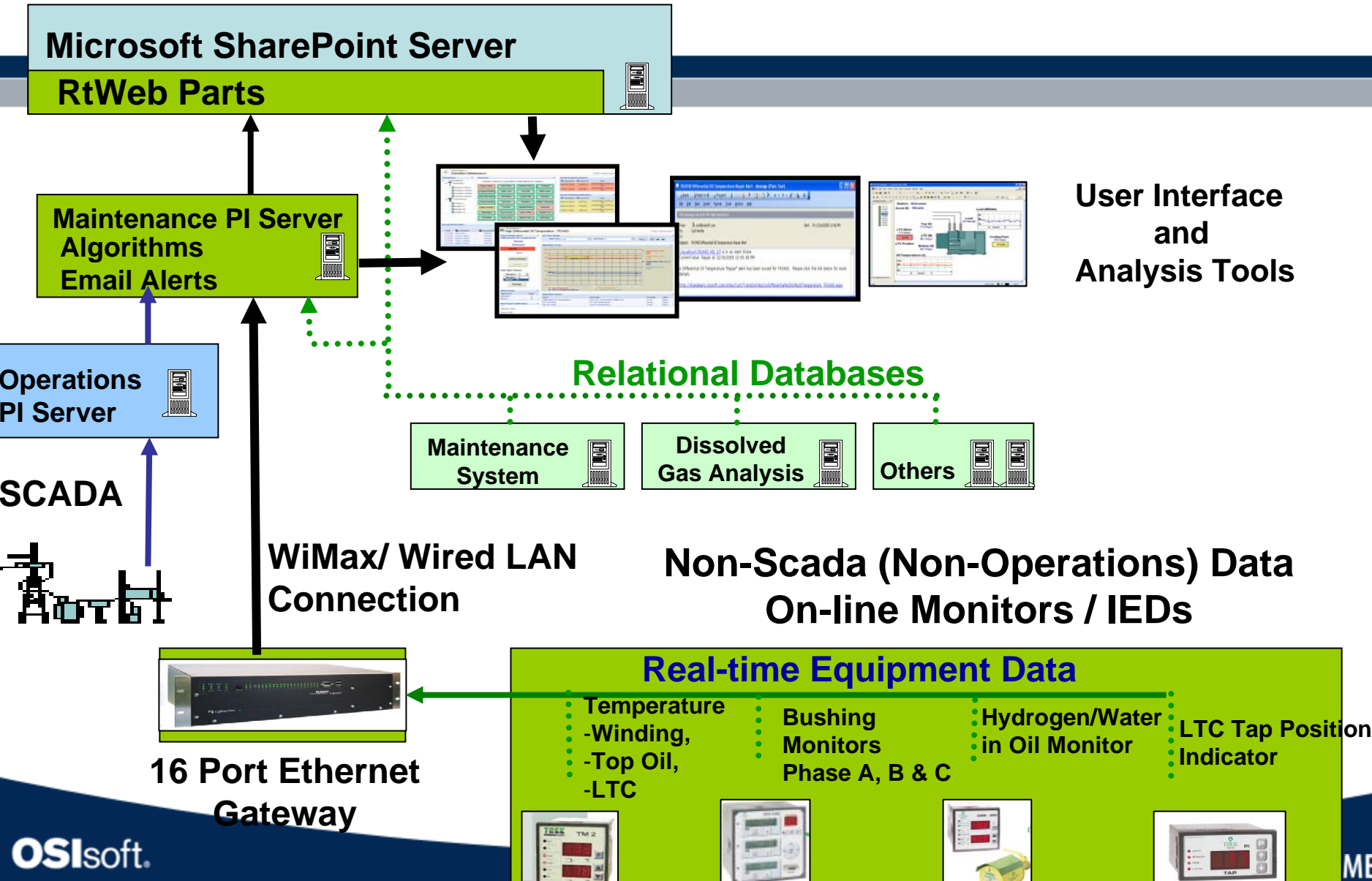
SDG&E

(San Diego Gas & Electric)

RtCBM Program

(Real-time Condition Based Maintenance)

SDG&E RtCBM Architecture



RtCBM – Data Integration

- Weekly general inspections
 - *LTC operations*
 - *Alarms, temperature, visual*
- Monthly equipment inspections
 - *Operation counters*
 - *Temperature, Pressure*
 - *Voltage*
 - *Functional check*
- General asset
 - *Rating*
 - *Age, Type, Design*
 - *Operating limits*
- Operational
 - *Relays & Digital fault recorders*
 - *PQ Monitors*
- Specific equipment
 - *Operating conditions*
 - *Stress factors*
 - *Trouble history*
 - *Maintenance data*
 - *Oil test data*
 - *Electrical test data*
 - *Operating speed*
- Real-time
 - *Voltage & Current*
 - *Temperature*
 - *Bushing On-line Power Factor*
 - *Hydrogen in Oil*
- System & Engineering
- Simulated

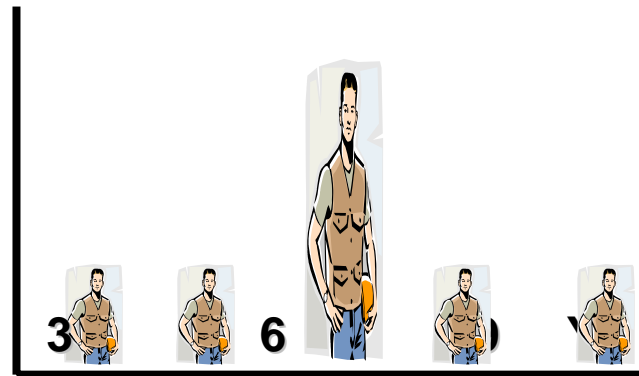
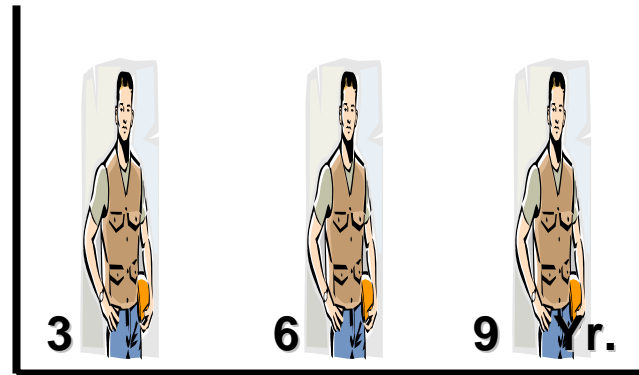
Time-based to RtCBM

- Circuit Breakers

Data Available

- Weekly safety inspections
- Monthly equipment insp.
- Asset Data
- Historical Data
 - Operating conditions
 - Stress factors
 - Trouble
 - Maintenance data
 - Test data (insul & elec)
- Operational data
 - Relays & Digital fault recorders
 - PQ Monitors
- Real-time data
 - Voltage & Current
 - I²T and Contact Wear
 - Operations Counter

Maintenance Intervals



Planned Approach



Circuit Breaker Operations

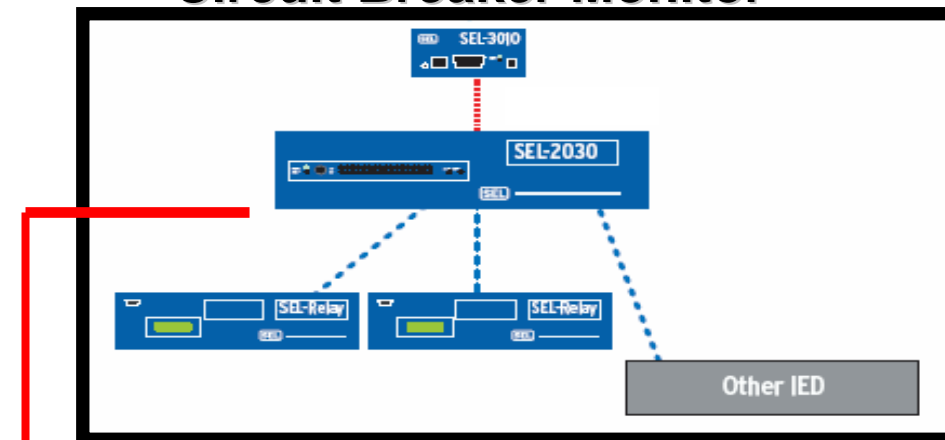
Concerns

- Proper fault clearing
- Fault testing with a circuit breaker

Solution

- Verify the health of CB
 - Contact wear
 - Insulation medium integrity
 - Bushings and accessories
 - Operating history
- Use historical and real-time contact wear data (I^2T) to make a decision

Substation Relays with Circuit Breaker Monitor



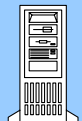
16 Ports Ethernet Gateway



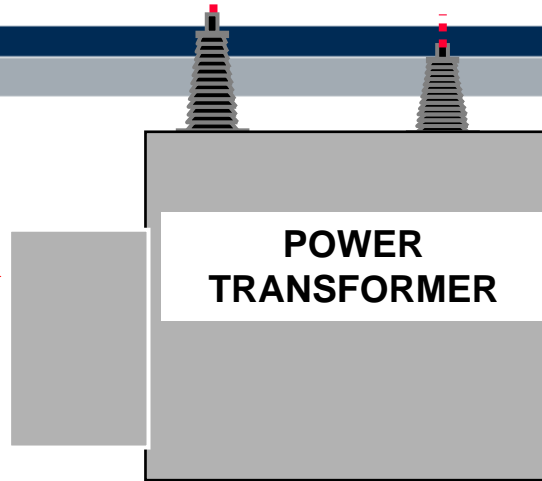
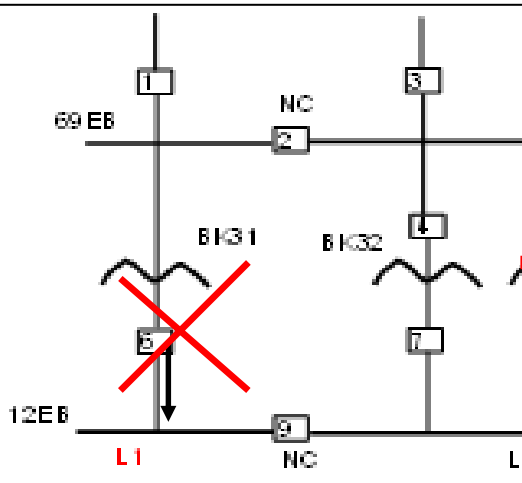
On-line Monitors

Ops. & Maintenance PI Server

Algorithms
Email Alerts



Transformer at Emergency Rating



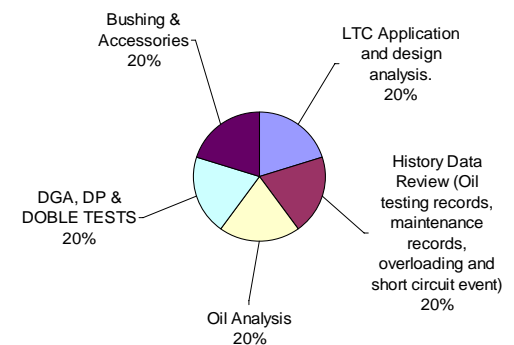
TRANSFORMER Health Indices

- *Insulation Power Factor*
- *LTC Application & Design*
- *Oil Conditions*
- *Bushing & Accessories*
- *Operating History & Conditions*

Paper Insulation Health

Location of Paper Sample	Degree of Polymerization (DP)
NLTC – Phase A	586
NLTC – Phase B	737
69kV Bushing C	688

New Insulation Paper: $1000 < DP_v < 1300$
Middle Aged Insulation Paper: $DP_v = 500$
Old Age Insulation Paper: $DP_v < 251$
Severely Degraded Insulation Paper: $DP_v < 151$



Transformer at Emergency Rating

PTLOAD-Design - ...ion_Assessment\leprisoft\El Cajon Bk33 64 mva.run

File Edit Tools Options Help

Transformer	Cooling	Ambient Cycle	Load Cycle	Bubbles	Calc Type	Results
-------------	---------	---------------	------------	---------	-----------	----------------

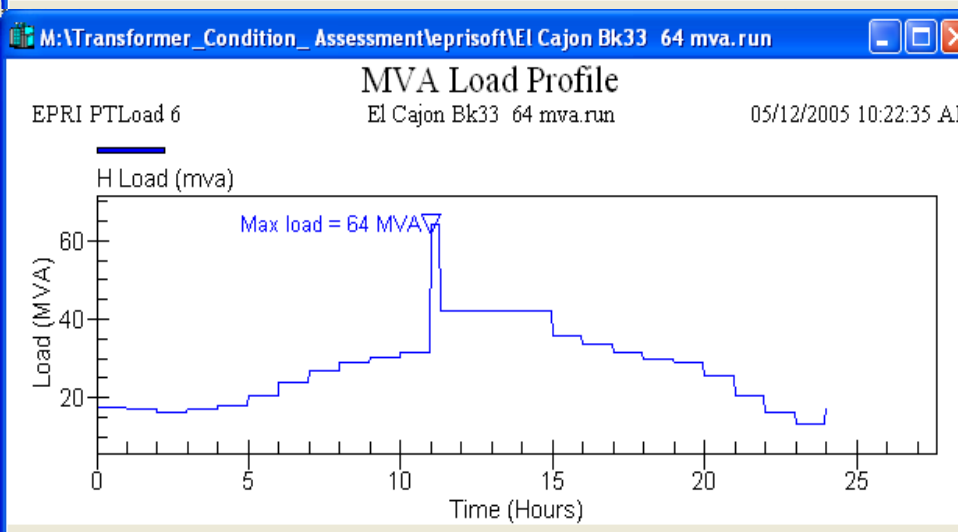
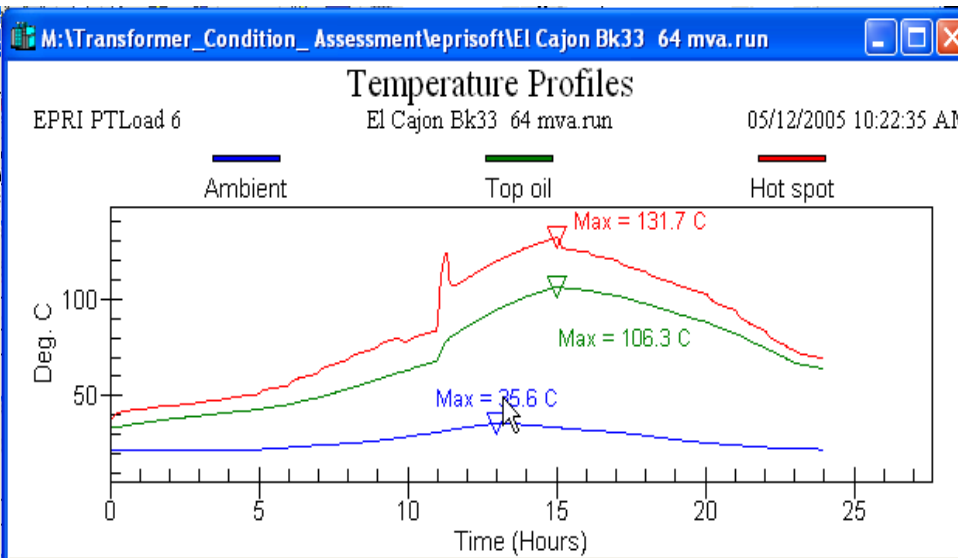
A. OUTPUT SUMMARY

Date of Calculation = 05/12/2005 10:22:35 AM
 Number Iterations = 6
 Limiting factor = Fixed upper limit
 Contingency Load (Amps) = 2963.145
 Peak Load (MVA) = 64
 Peak Load (Amps) = 2963.145
 Peak Load (PU) = 2.285714

** Warning: ratings in excess of 2.0 P.U. are not supported by IEEE guidelines and the results may be unreliable.

Max Hot Spot (Deg C) = 131.64
 Max Top Oil (Deg C) = 106.19
 Peak Age Accel Factor = 8.1068
 Cumulative % Loss of Life = 0.01401
 Max Bubble Risk (mmHg) = -799.5175

Bubbles are not likely to form given the temperature and load profile



Comparison of hot spot rise over top oil simulated versus actual

	<u>Top Oil</u>	<u>Hot Spot</u>	<u>LOL</u>
IEEE	105	176	.149
Ptload	105	145	.039
Actual HS rise	106	131	.014

Decision: Based on Transformer Unit Health and Real Time Conditions

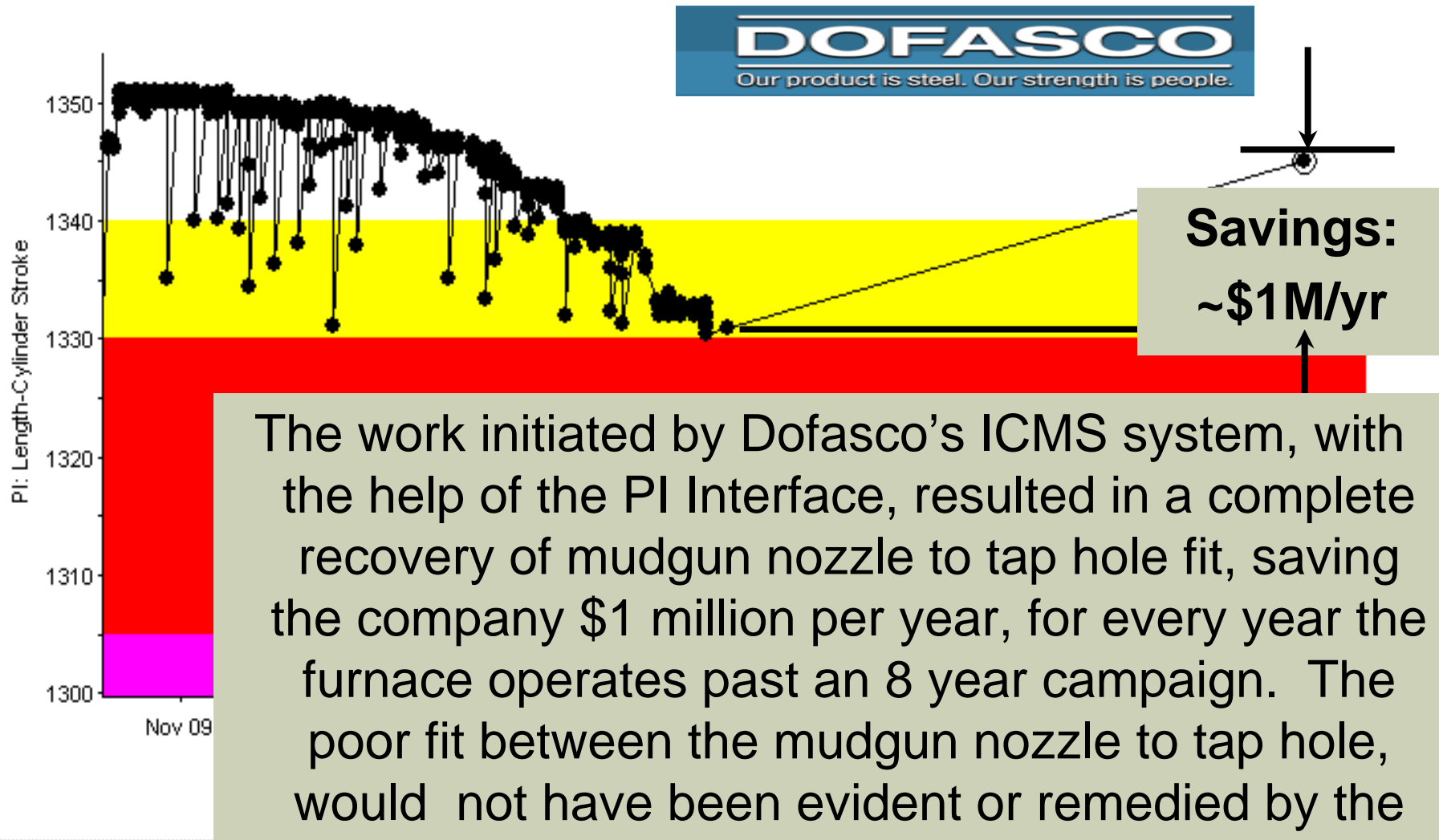
Summary of RtCBM Benefits

- **Operations Benefits**
 - Avoid potential equipment failure
 - Increase asset availabilities
 - Respond to equipment alarms according to priorities
 - Maximize asset loading capabilities
- **Maintenance Benefits**
 - Early warning and indication to address conditions
 - Reduce overtime on reactive maintenance
 - Minimize equipment outages
- **Asset Planning Benefits**
 - Improve future equipment specification and application to maximize utilization and performance.

More Customer Testimonials/ROI

Improve Control Room Operations

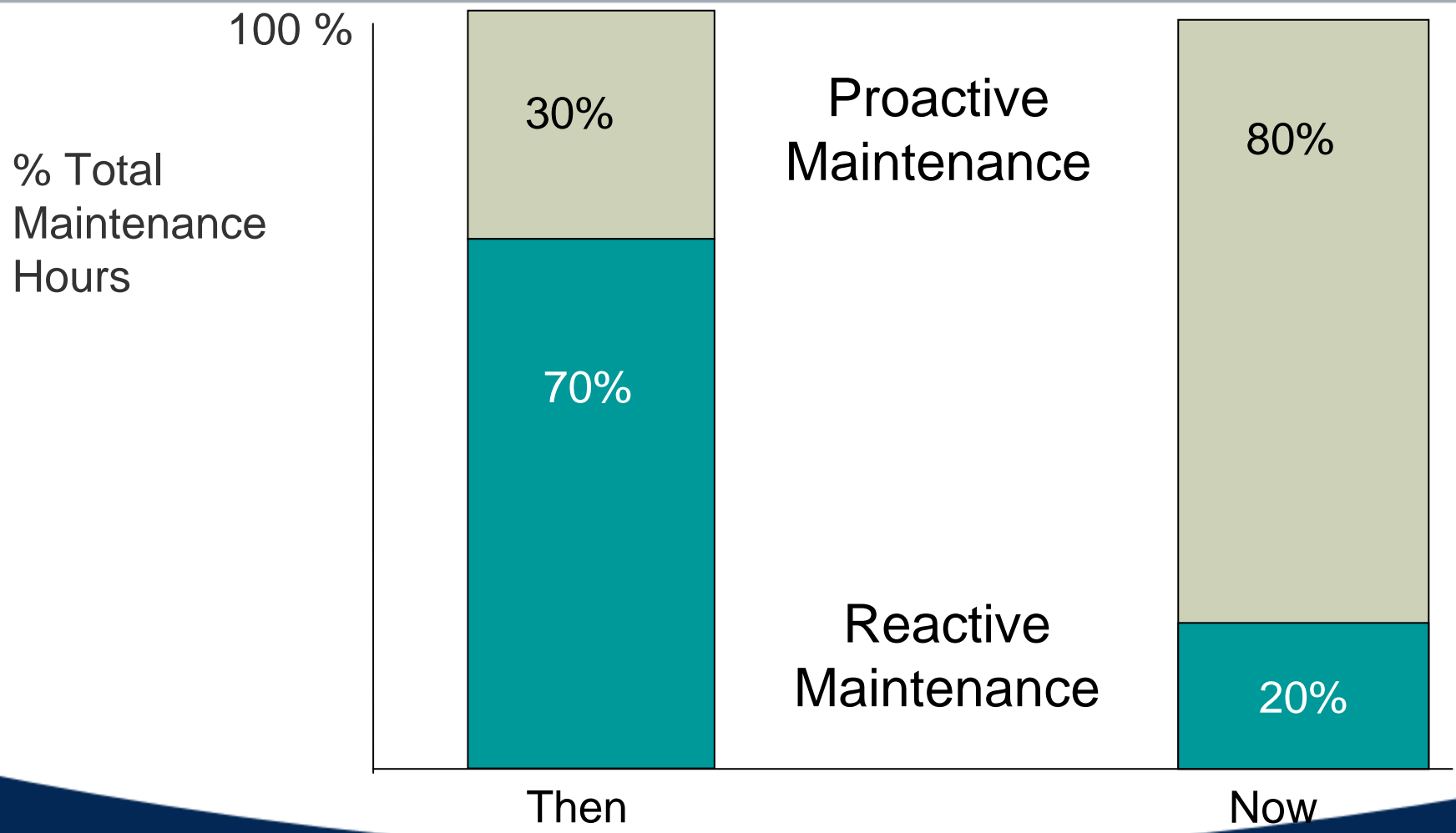
Graph - BAYN.PROC.IRON.BF4.CAST.GUDR.EGUN.SWIN.CYL: PI: Length-Cylinder Stroke vs Date



The work initiated by Dofasco's ICMS system, with the help of the PI Interface, resulted in a complete recovery of mudgun nozzle to tap hole fit, saving the company \$1 million per year, for every year the furnace operates past an 8 year campaign. The poor fit between the mudgun nozzle to tap hole, would not have been evident or remedied by the operators, based on existing control room data.

Dofasco's Change in Maintenance Culture

From 78% to 91% Equipment Availability



Dofasco-Canada, Reliability Manager

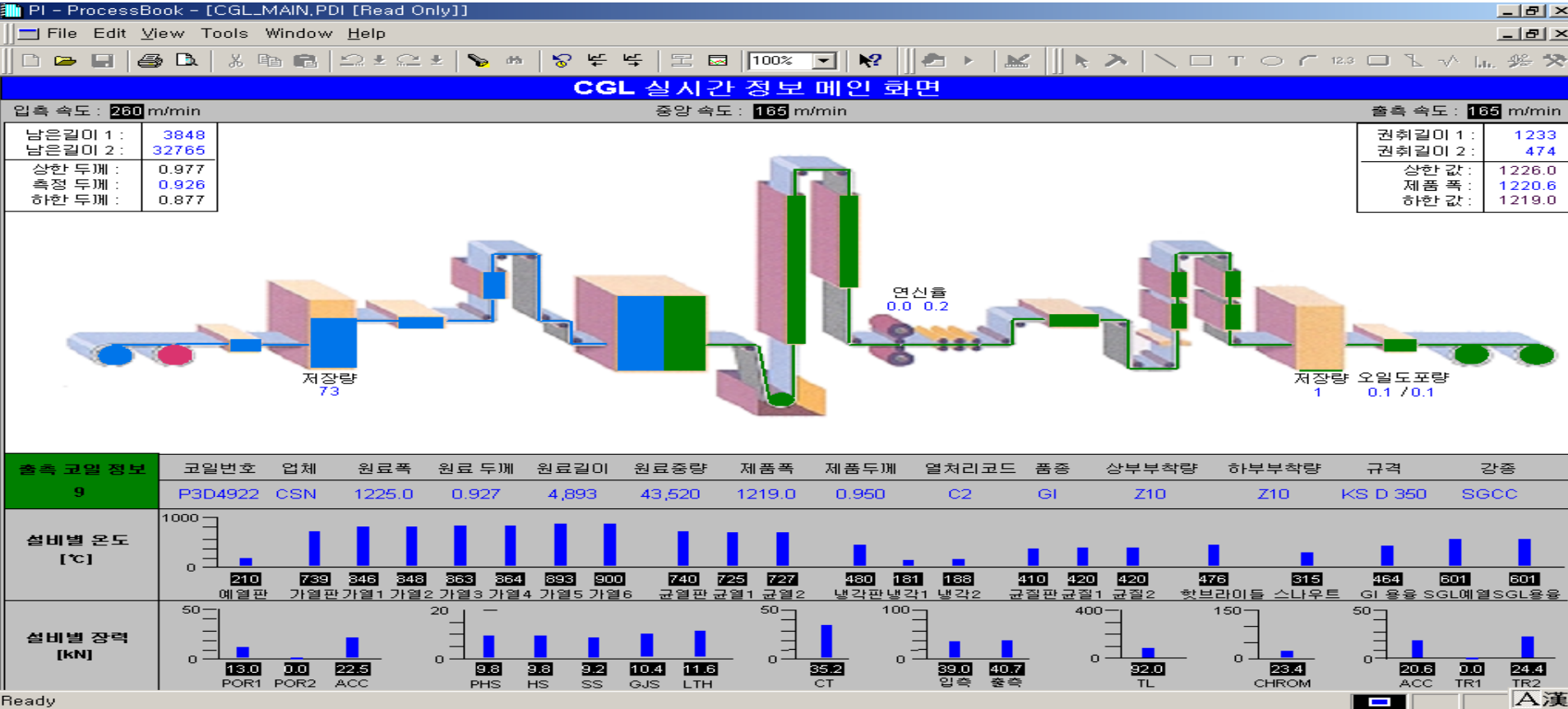
“In Blast Furnace #4, we have extended the furnace campaign from 8 years to 15 years, resulting in a savings of \$1MM per year, or **\$7 MM** for 7 years. For Blast Furnace #3 we have extended the campaign from 8 years to 20 years, resulting in a savings of \$1MM per year, which results in a savings of **\$12MM** for 12 years. The projected savings are **\$19 MM** just for this case...”



Vlad Djuric,
Reliability Manager
Dofasco, Canada



Reduce Costs and Improve Quality



- ### Major Measuring Devices
- * Thickness Gauge
 - * Zinc Coating Weight

- * Furnace Thermometers
- * Tension Meters
- * Pin Hole Detector

OSIsoft Enabling Technology

PI Working by Exception

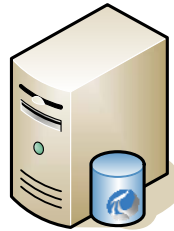
Configuration
 Name: TR1123 Differential Oil Temperature Repair Alert
 Message Definition: [Details]
 Alert Trigger: [Details]
 Digital States: [Details]

**Alert Notification
(PI Notification
RtAlerts)**

High Differential Oil Temperature - TR3450
 Acknowledge, Cancel, [Status]
 Algorithm based
 Alert Values: [Details]
 Alert Level: [Details]

Current Operation - Wolverine TR3450 \ LTC2001
 Load (MWatts): [Graph]
 Top Oil: 77.3 Deg C
 LTC Oil: 88.4 Deg C
 Bottom Oil: 88.0 Deg C
 LTC Motor: 18.8 Amps
 LTC Position: [Details]

**Integrated Asset
Information
(RtWebParts)**



**Real-time Rule
Assessment
(PI ACE)**



Dissolved Gas Analysis

Sample Date	H2	CH4	C2H6	C2H4	C2H2	CO2	CO
09/26/90	193	115	137	38	<1	3004	223
08/01/94	279	185	164	51	<1	4213	341
03/06/95	489	399	320	109	<1	1652	315
03/28/96	1258	1980	590	369	<1	6524	530
03/21/98	1390	2568	790	561	<1	5952	554

**Asset Information
Structure
(MDB and AF)**

TransDistribCo - Asset Maintenance Report
 Reporting Period: 12/05/05 04:04 PM through 02/03/06 04:04 PM
 Asset ID: TR3450 Substation: Wolverine
 Serial No. Manufacturer Year Model MVA Rating kV Rating Fluid Capacity
 X9945 SIEMENS 1959 G-4567 50 120 3440
 Maintenance Algorithm Status Summary
 Time In Hours: Good, Attention, Attention (ACK), Repair, Repair (ACK)
 Asset Status: 311, 73, 953, 103
 Differential Oil Temperature: 0, 2, 23, 999, 414
 Elevated Oil Temp: [Details]
 Station Reliability
 Asset: TR6676, TR5493, TR4085, TR3450, TR1123
 Good, Attention, ack, Repair, ack
 0.0%, 100.0%, 0.0%, 0.0%, 0.0%, 0.0%, 0.0%, 1.2%, 98.8%, 0.0%, 0.0%

**Asset Reliability
(PI OLEDB and
RtReports)**

**Improve Reliability
and Quality**

Summary

- Leveraging your investment and resources by utilizing **The PI System** to provide more value to your organization
- Expanding the benefits from Operations to Engineering, Planning, Protection, Maintenance and Asset Management

THANK YOU!!