

Applied Advanced Pattern Recognition Technology

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Presentation Topics

- Overview of Midwest Generation's Monitoring Plan – "Work in Progress"
- Technology Evaluation
- Monitoring Focus
- Advanced Pattern Recognition Technology Deployment
- Project Status January 2009









Our Mix of Generation: Thermal

- 8 coal-fired plants
 - 6 in Illinois (MWGen)
 - 1 in Pennsylvania
 - 1 in West Virginia







 9 gas-fired plants in California and Washington





About Edison Mission Group

- A major Independent Power Producer (IPP), headquartered in Irvine, CA
- 30 Power Plants, 10,634 megawatts
- Energy marketing and trading center in Boston, MA
- Sister company to Southern California Edison







Wind: A New Generation in Generation!

- 18 Wind farms in Iowa, Minnesota, New Mexico, Oklahoma, Pennsylvania, Texas and Wyoming.
- Projects are pending in Illinois, Maine, Maryland, Nebraska, New York, Pennsylvania, Utah, West Virginia, Wisconsin and Wyoming.
- We are one of the fastest growing developers of renewable energy.









Midwest Generation WT Monitoring Objectives

- 1. Obtain an earlier warning on impending problems before a failure occurs
 - Prioritize tower inspections and analysis trouble shooting
 - Schedule Maintenance Reduce unplanned events
 - Optimize crane usage
 - Reduce costs
 - Improve Availability
- 2. Remote monitoring
- **3.** Apply technology WT fleet-wide







Pilot Effort - Technology Evaluations

Purpose

- Determine if advanced pattern recognition technology could be effectively applied to wind-turbine monitoring
- Find the optimal vendor

Approach

- Evaluate various vendors' offerings through simultaneous 3 month pilot efforts
- Evaluate: ease of use, application features, reliability, accuracy, deployment costs, and vendor support

Project Results

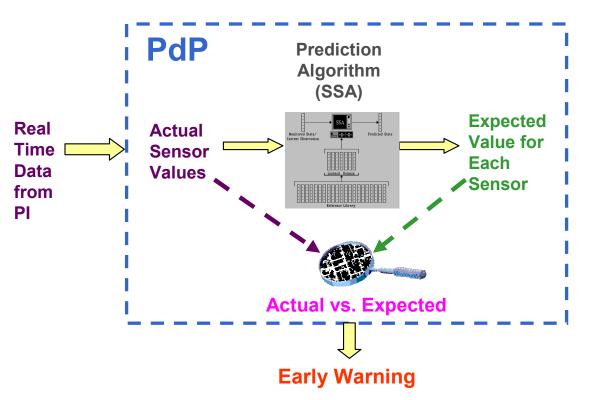
- Scientech's PdP was chosen for Wind fleet-wide deployment
- Also decided to deploy at all Coal sites





PdP – Predictive Pattern Recognition

- Utilizes a statistical state algorithm for analysis
- Compares current state to learned or referenced states based upon related historical information
- Used as a collective signal (component) monitoring tool for anomaly detection
- Can determine very subtle condition changes
- Model & signal status indications

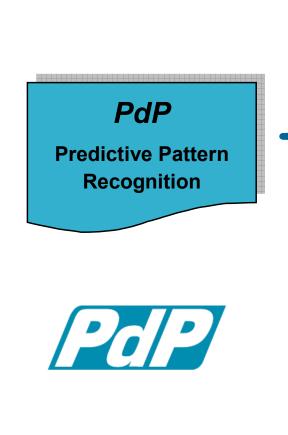








PdP - "Ins and Outs"



• Primary inputs:

- Process data from PI
- Other real-time data sources
- Outputs:
 - Normal / Abnormal status indicators
 - Data plots and drill down
 - Sensor integrity information
 - Various reports







PdP - Displays

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3B SBAC NORMAL 1 3C SBAC NORMAL 1 3	WATER CHEM NORMAL 2 NOTE: Click on Status ina additional component info	INPUT POINT DESCRIPTION WTG40.ACTIVEPOWER ACTIVE POWER WTG40.C.BLADEANGLE AVERAGE BLADE ANGLE WTG40.BLADEANGLE PITCH POSITION B WTG40.BLADEANGLE PITCH POSITION B WTG40.BLADEANGLE PITCH POSITION B WTG40.BLADEANGLE PITCH POSITION B WTG40.BLADEANGLE PITCH POSITION C WTG40.BLADEANGLE PITCH POSITION C WTG40.CURRENTA PHASE AMPS A WTG40.CURRENTA PHASE AMPS B WTG40.CURRENTE PHASE AMPS C WTG40.CURRENTE PHASE AMRS C WTG40.CURRENTE PHASE AMRS C WTG40.CURRENTE PHASE AMRS D WTG40.CURRENTC PHASE AMRS D WTG40.CURRENTC PHASE AMRS D WTG40.CURRENTC PHASE AMRS D WTG40.GENEARDETE CERMEATOR BEARING HON PMYE END TEMP WTG40.GENEARDETE CERMEATOR BEARING HON PMYE END TEMP WTG40.AGNEARDETE CERMEATOR BEARING TEMP 1 WTG40.AGNEARDETE CERMEATOR BEARING TEMP 1 WTG40.AGNEARDETE CERMEATOR BEARING TEMP 1 WTG40.AGNEARDERCT WTG40.AGNEARDERCETEM CEMERATOR TO MAYE END TEMP	UNITS KW 2 DEG DEG DEG DEG DEG DEG PSIG AMPS 1 AMPS 1 AMPS 1 AMPS 1 AMPS 1 DEG C DEG C DEG C DEG C DEG C DEG C BEG C RPM	ACTUAL PREDIC 2160.000 2270. 5.000 1.84 19.000 1.90 0.900 1.29 0.900 1.54 0.900 1.54 0.900 1.54 0.900 1.54 0.900 1.54 0.900 1.50 1722.00 1923. 60.020 60.00 42.000 44.7 63.000 62.9 68.000 67.3 55.000 49.6	VARIANCE 22 0.614 88 1.743 70 0.043 89 0.646 73 0.084 26 0.492 90 0.169 97 1.992 47 0.210 98 0.440 10 0.38 11 0.448 95 1.505 97 0.312 91 0.402 96 0.402 91 0.402 96 0.301 48 0.381	RESIDUAL 54.776 1.118 -0.070 0.0653 0.0053 0.0053 0.0097 15.528 3.024 2.903 0.0011 -3.796 0.997 -0.591 2.639 4.394	RESID HI 125.00 3.00 0.00 1.00 1.00 1.00 1.00 1.00 1	RESID LO -1225.00 -3.00 0.00 -1.00 -1.00 -1.00 -1.00 -1.00 -1.00.00 -100.00 -100.00 -100.00 -100.00 -100.00 -5.00 -5.00 -5.00	SIG ACT TREND Yes Lac Yes Lac
3E SBAC NORMAL 1 3C SBAC NORMAL 1 3	WATER CHEM NORMAL 2 NOTE: Click on Status ina additional component info	INPUT POINT DESCRIPTION WTG40-ACTIVEPOWER ACTIVE POWER WTG40-ACTIVEPOWER ACTIVE POWER WTG40-ALACTIVEPOWER ACTIVE POWER WTG40-BLADEANGLE PITCH POSITION A WTG40-BLADEANGLEA PITCH POSITION A WTG40-BLADEANGLEA PITCH POSITION A WTG40-BLADEANGLEA PITCH POSITION C WTG40-BLADEANGLER PITCH POSITION C WTG40-CURRENTA PHASE AMPS A WTG40-CURRENTA PHASE AMPS A WTG40-CURRENTE CENERATOR BEARING DRIVE END TEMP WTG40-CURRENTE PHASE AMPS A WTG40-CURRENTE PHASE AMPS A WTG40-CURRENTE PHASE AMPS A WTG40-CURRENTE PHASE AMPS A WTG40-MINGEARBRGTI MIS GEAR BEARING DRIVE END TEMP WTG40-HISEARBRG2T MIS GEAR BEAR	UNITS KW 2 DEG DEG DEG DEG DEG DEG PSIG AMPS 1 AMPS 1 AMPS 1 AMPS 1 AMPS 1 DEG C DEG C DEG C DEG C DEG C DEG C BEG C RPM	ACTUAL PREDIC 2180.000 2270. 5.000 1,84 9.000 19.0 0.900 1,54 0.900 1,54 0.900 1,54 0.900 1,54 0.900 1,54 0.900 1,64 1678.000 232.9 1678.000 1907. 1752.000 1923. 0.002 60.0 60.020 60.0 63.000 62.9 63.000 60.3 55.000 49.6 16.300 41.1	VARIANCE 22 0.614 88 1.743 70 0.043 89 0.646 73 0.084 26 0.492 90 0.169 97 1.992 47 0.210 98 0.440 10 0.38 11 0.448 95 1.505 97 0.312 91 0.402 96 0.402 91 0.402 96 0.301 48 0.381	RESIDUAL 54.776 1.118 -0.700 0.403 0.053 0.307 0.3097 15.528 3.024 2.033 -0.001 -3.795 -0.597 -0.597 -0.597 -0.597 -0.597 -0.597 -0.597 -0.597 -0.597 -0.597 -0.591 2.639 4.394 -20.149 -0.197	RESID HI 125.00 3.00 0.00 1.00 1.00 1.00 5.00 100.00 100.00 100.00 100.00 4.00 4.00 4.00 4.00 1.00	RESID L 0 -125.00 -3.00 0.00 -1.00 -1.00 -1.00 -1.00 -1.00 -1.00 -1.00 -0.03 -0.00 -0.03 -5.00 -5.0	SIG ACT TREND Yes Lac Yes Lac
3E SBAC NORMAL 1 3C SBAC NORMAL 1 3	WATER CHEM NORMAL 2 NOTE: Click on Status ina additional component info	INPUT POINT DESCRIPTION WTG40-ACTIVEPOWER ACTIVE POWER WTG40-ACTIVEPOWER ACTIVE POWER WTG40-ALDEANGLE AVERAGE BLADE ANGLE WTG40-BLADEANGLE PITCH POSITION B WTG40-BLADEANGLE PITCH POSITION B WTG40-BLADEANGLE PITCH POSITION B WTG40-BLADEANGLE PITCH POSITION B WTG40-BLADEANGLE PITCH POSITION C WTG40-BLADEANGLE PITCH POSITION B WTG40-BLADEANGLE PITCH POSITION C WTG40-CRREATA PHASE AMPS A WTG40-CRREATA PHASE AMPS A WTG40-CRREATA PHASE AMPS C WTG40-CRREATA PHASE AMPS C WTG40-CRREATA PHASE AMPS C WTG40-CRREATA PHASE AMPS C WTG40-CREATENCE PHASE AMPS C WTG40-CREATENCE WTG40-CREATOR PREQUENCY WTG40-CREATENCE PHASE AMPS C WTG40-CREATENCE WTG40-CREATOR PREQUENCY WTG40-CREATENCE PHASE AMPS C WTG40-CREATENCE WTG40-CREATOR PREQUENCY WTG40-CREARERATE CENTENCTOR PREATOR BEARING DRIVE END TEMP	UNITS KW 2 DEG DEG DEG DEG DEG DEG PSIG AMPS 1 AMPS 1 AMPS 1 AMPS 1 AMPS 1 DEG C DEG C DEG C DEG C DEG C DEG C BEG C RPM	ACTUAL PREDIC 2160.000 2270. 5.000 1.84 19.000 1.90 0.900 1.29 0.900 1.29 0.900 1.54 0.900 1.54 0.900 1.50 1.72 232.90 1678.000 1933. 60.020 60.00 42.000 44.7 63.000 62.9 68.000 67.5.3 55.000 49.6 399.000 411.1 16.300 16.1 412.600 411.8	VARIANCE 22 0.614 88 1.743 70 0.043 89 0.646 73 0.084 26 0.492 90 0.169 97 1.992 47 0.210 98 0.440 10 0.38 11 0.448 95 1.505 97 0.312 91 0.402 96 0.402 91 0.402 96 0.301 48 0.381	RESIDUAL 54.776 1.118 -0.700 0.403 0.053 0.307 0.3097 15.528 3.024 2.033 -0.001 -3.795 -0.597 -0.597 -0.597 -0.597 -0.597 -0.597 -0.597 -0.597 -0.597 -0.597 -0.591 2.639 4.394 -20.149 -0.197	RESID HI 125.00 3.00 0.00 1.00 1.00 1.00 1.00 1.00 0.00 100.00 100.00 100.00 4.00 4.00 4.00 4.00 4.00 4.00 4.00 100.00 10	RESID L 0 -125.00 -3.00 0.00 -1.00 -1.00 -1.00 -1.00 -1.00 -1.00 -1.00 -0.03 -0.00 -0.03 -5.00 -5.0	SIG ACT TREND Yes Lac Yes Lac





PdP - Web Displays

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and House

Telling Product (1991 1) 1000

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el Status ormal Points	ABNORMAL 3	Alarm	On	Variance			Ve					Unit: sci3 (Sc	ientech 3) 🛛 🔽	Model ID	 Description 	Status	Signals in Alarm	Health
a mat roma			M	ain Plot	4 Point			1		1				31HPFWHp	31 HP FWH	NORMAL	0	0,992
												Gross MW	122.49	32HPFWHp	32 HP FWH	NORMAL	0	0.996
Sensor	Description	Unit	Actual	Prediction	Variance	Residual	Roy Uinh	Res-Low	Active	In Alarm	Trend	#Notifications	19	33LPFWHp	33 LP FWH	ABNORMAL	1	0.997
gendur	U3 A BFP	Source	Cocanar	President	varianese	eveninger	NGS- ringo	N23- LUM	octive	40 Amile		#Notifications	19	34LPFWHp	34 LP FWH	ABNORMAL	1	0.996
3PI2105A	BRG OIL PRESS	PSIG	15.828	16.641	6.553	-0.812	0	0	Yes	Yes	Trend			35LPFWHp	35 LP FWH	ABNORMAL	2	0.988
3TI2102AI	A BFP IB SW TEMP	DEG F	0	150.629	13.268	-150.629	o	0	Yes	Yes	Trens			36LPFWHp	36 LP FWH	ABNORMAL	1	0.996
3TI2102AO	A BFP OB SW	DEG F	0	165.235	9.909	-165.233	0	0	Yes	Yes	Trend			37LPFWHp	37 LP FWH	NORMAL	0	0,999
	TEMP U3 A BFP													3aAHTRp	3A AIR HEATER	NORMAL	0	0.997
3FI1201A	SUCTION FLOW	KLB/HI	1414.097	1351.453	0.227	67.904	0	0	Yes	No	Trend			3aBFPPp	3A BOILER FEED PUMP	ABNORMAL	3	0.839
3PI1201A	U3 A BFP SUCTION	PSIG	534.821	566.542	0.347	-27.353	0	o	Yes	No	Trend			3aBFPTp	3A BOILER FEED PUMP TURB	ABNORMAL	2	0.994
	PRESS US A BFP													3aCONDPp	3A COND PUMP	INACTIVE	0	0.000
3TI1204A	SUCTION	DEG F	318,281	307.33	0.571	10,952	a	o	Yes	No	Trend			3aFDFANp	3A FD FAN	ABNORMAL	1	0.997
3PI1202A	U3 A BFP DISCHARGE	PSIG	2536.523	2557.74	0.119	-21,217	o	0	Yes	No	Trend			3aIDFANp	3A ID FAN	ABNORMAL	1	0.995
	PRESS													3aPULFDp	3A PULV & FEEDER	INACTIVE	0	0.000
														3aSBACp	3A SBAC	ABNORMAL	1	0.998
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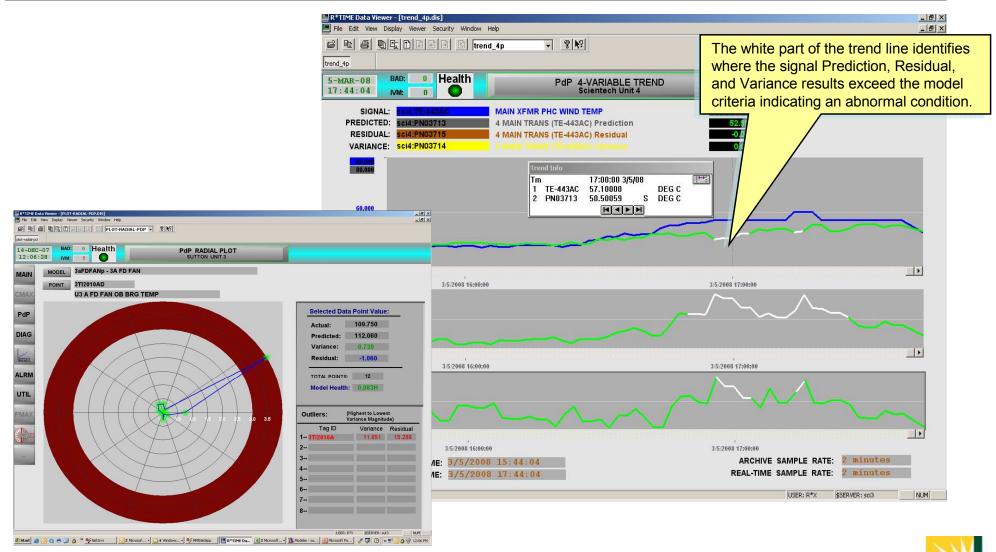
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PdP - Result Views

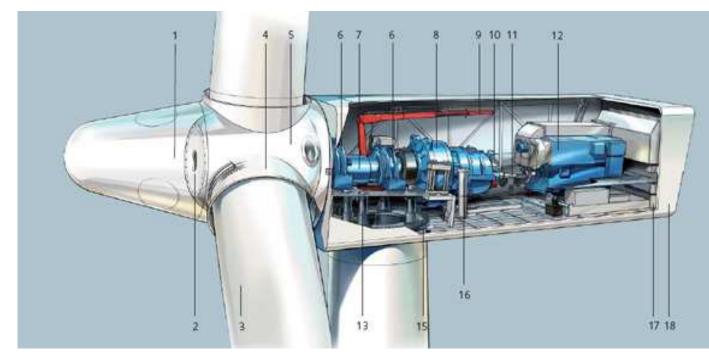








The Nacelle – What's inside the box



Ref: Siemens SWT36107 Wind Turbine

- 1 Spinner
- 2 Spinner Bracket
- 3 Blade
- 4 Pitch Bearing
- 5 Rotor Hub
- 6 Main Bearing
- 7 Main Shaft
- 8 Gear Box
- 9 Service Crane
- 10 Brake Disc
- **11 Coupling**
- 12 Generator
- 13 Yaw Gear
- 14 Tower
- 15 Yaw Ring
- 16 Oil Filter
- 17 Generator Fan
- 18 Canopy / Nacelle





Typical Monitored Parameters

Critical Components

Rotor

Blades

Pitch Mechanism

Nacelle

Gear Box

Main Gear

Generator

Hydraulic System

Yaw System

PITCH SYSTEM

- Pitch angle
- Current to blade pitch servomotor
- Pitch angle velocity
- Pitch angle set point
- Servo speed set point
- Servo motor temperature
- Status signal servo brake

TURBINE SYSTEM

- Rotor speed
- Electrical power
- Wind speed at met tower
- Wind speed wind turbine
- Wind direction at met tower
- Yaw alignment
- Air temperature

GENERATOR

- Stator Temperatures
- Stator Currents
- Bearing Temperatures
- Bearing Vibrations

MAIN BEARING & GEAR

- Bearing Temperature
- Bearing Vibration
- Gear Vibration





Wind-Turbine (WT) Modeling Approach

Model Configurations

- Presently configured one model type (generic) for all WTs
- Models are each comprised of 12-26 real-time sensor signals
- Models calculate bogey wind speed for comparison to actual
- PI utilizes this value to calculate a WTG efficiency

Monitoring

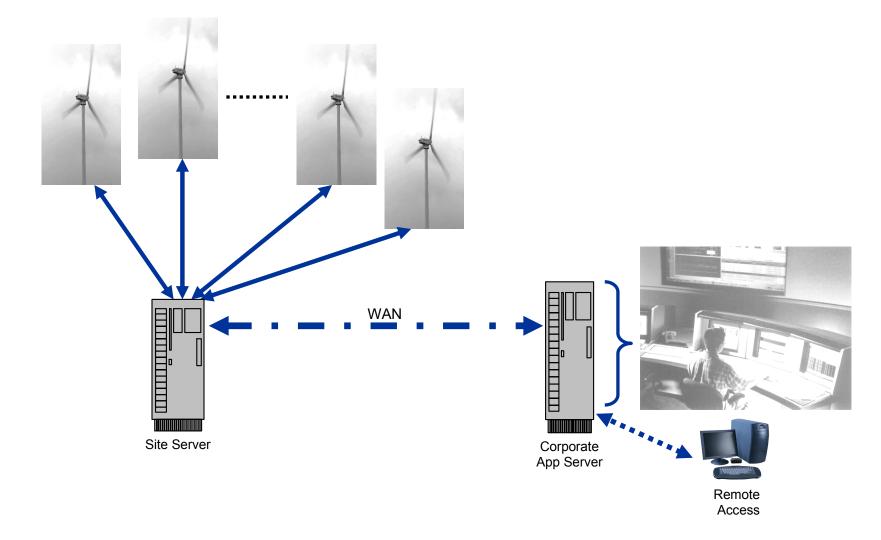
- PdP application server interfaced with common WT PI server
- Models processed every five minutes
- Results reported to responsible engineer and wind management persons
- Using web features for reporting findings
- PdP results exported to PI







Application Deployment









Case Study - Generator NDE Bearing Temps Higher than predicted

28-0CT-08 BAD: 0A Health 8:47:31 IVM: 0A	PdP POINT	SUMMAR	۲				_	_	_
CATEGORY OK DESCRIPTION MODEL STATUS ABNORMAL Action	RAMTR 0.90	PNTS in Me va R	POINTS 29 ALARM 1 LUE 1782.00 V LIMIT 50. Y = 12	GROU		AB ONS		NORMAL a Miner ESSMEN	
INPUT POINT DESCRIPTION	UNITS	ACTUAL	PREDICTD	VARIANCE	RESIDUAL	RESID HI	RESID LO	SIG ACT	r tren
WTG04-ACTIVEPOWER ACTIVE POWER	кw	1782.000	1778.84	0.490	49.157	125.000	-125.000	Yes	-
WTG04.C.BLADEANGLE AVERAGE BLADE ANGLE	DEG	-0.867	-1.3012	0.503	0.435	3.000	-3.000	Yes	-
WTG04-AMBTEMP AMBIENT TEMPERATURE	DEF C	9.000	11.963	2.064	-2.963	0.000	0.000	Yes	-
WTG04-BLADEANGLEA PITCH POSITION A	DEG	-0.400	-0.3864	0.017	-0.014	1.000	-1.000	Yes	1-
WTG04-BLADEANGLEB PITCH POSITION B	DEG	-1.100	-0.7087	0.506	-0.391	1.000	-1.000	Yes	-
WTG04-BLADEANGLEC PITCH POSITION C	DEG	-1.500	-0.3574	1.469	-1.143	1.000	-1.000	Yes	-
WTG04-BLADEANGLERE BLADE REFERENCE	DEG	-1.000	-0.8357	0.204	-0.164	1.000	-1.000	Yes	-
WTG04-BLADEPRESSUFBLADE HYDRAULIC PRESSURE	PSIG	240.000	240.688	5.909	4.312	5.000	-5.000	Yes	-
WTG04-CURRENTA PHASE AMPS A	AMPS	1435.000	1427.93	0.399	33.065	100.000	-100.000	Yes	-
WTG04-CURRENTB PHASE AMPS B	AMPS	1495.000	1476.16	0.334	27.842	100.000	-100.000	Yes	-
WTG04-CURRENTC PHASE AMPS C	AMPS	1534.000	1518.72	0.238	20.279	100.000	-100.000	Yes	-
WTG04-FREQUENCY GENERATOR FREQUENCY	HZ	60.000	59.994	1.381	0.006	0.030	-0.030	Yes	-
WTG04-GENBEARDETEN GENERATOR REARING DRIVE END TEMP	DECIC	30,000	44.049	1.102	-2.918	4.000	-5.000	Yes	-
WTG04-GENBEARNDETE GENERATOR BEARING NON DRIVE END TEM	DEG C	74.000	61.789	3.348	12.211	4.000	-5.000	Yes	-
WTG04-HSGEARBRGTTTNION SPEED GEAR DEARING TEMP 4	DECIC	00.000	07.322	1.070	-1.522	4.000	-5.000	Yes	-
WTG04-IMSGEARBRG1TIMS GEAR BEARING TEMP 1	DEG C	58.000	57.297	0.601	0.703	4.000	-5.000	Yes	-
WTG04-IMSGEARBRG2TIMS GEAR BEARING TEMP 2	DEG C	47.000	46.066	0.991	0.934	4.000	-5.000	Yes	-
WTG04-REACTIVEPOWI REACTIVE POWER	KVAR	123.000	234.032	1.246	-73.032	100.000	-100.000	Yes	-
WTG04-ROTORRPM ROTOR RPM	RPM	16.000	15.824	0.379	0.176	1.000	-1.000	Yes	-
WTG04-VOLTAGEA PHASE VOLTAGE A	VOLTS	406.100	407.941	3.167	-3.741	4.000	-4.000	Yes	-
WTG04-VOLTAGEB PHASE VOLTAGE B	VOLTS	400.800	403.721	1.101	-1.121	4.000	-4.000	Yes	-
WTG04-VOLTAGEC PHASE VOLTAGE C	VOLTS	399.500	403.632	0.611	0.768	4.000	-4.000	Yes	-
WTG04-WINDSPEED WIND SPEED	MPS	10.400	10.564	0.208	-0.164	0.000	0.000	Yes	-
WTG04-WINDSPEED-SE WIND SPEED SECONDARY	MPS	10.200	10.412	0.271	-0.212	0.000	0.000	Yes	-





Another example of previous slide (this time WTG05)

UNIT MODE WTG05 WI CATEGO MODEL ST MODEL HE INPUT I	ND TURBINE Ry Ok Atus Abi	G05	VALDATN PA CUTOFF POIN	300 second ARAMTR 0.90		. POINTS 29	4.Pt	Trend 🛛 🛹	St	atus Legen	<i>d</i> •	
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MODEL HE	- All - A		CUTOFF: I	HIGH LIMIT 100	INN. LO	W LIMIT 50				ASSI	ESSMEN	
INPUT I	1	Assign	reason and a second	MS: X out of Y	X = 9		A	larm nowledge	Alarm on: Residual		Pag	e 1 c
	OINT	DESCRIPTION		UNITS	ACTUAL	PREDICTD	VARIANCE	RESIDUAL	RESID HI	RESID LO	SIG AC	r tre
WTG05-A	CTIVEPOWE	R ACTIVE POWER		KW	1729.000	1720.31	0.218	-20.311	125.000	-125.000	Yes	1
WTG05.C	BLADEANGL	E AVERAGE BLADE ANGLE		DEG	-0.767	-0.8995	0.712	0.499	3.000	-3.000	Yes	i
WTG05-A	MBTEMP	AMBIENT TEMPERATURE		DEG C	9.000	11.082	1.348	-2.082	0.000	0.000	Yes	-
WTG05-E	LADEANGLE	A PITCH POSITION A		DEG	-1.500	-0.6719	0.389	0.272	1.000	-1.000	Yes	1-
WTG05-E	LADEANGLE	B PITCH POSITION B		DEG	-0.400	-0.4471	0.069	0.047	1.000	-1.000	Yes	1
WTG05-E	LADEANGLE	C PITCH POSITION C		DEG	-1.400	-0.7188	0.975	-0.681	1.000	-1.000	Yes	1_
WTG05-E	LADEANGLE	RE BLADE REFERENCE		DEG	-2.000	-0.7100	1.006	0.710	1.000	-1.000	Yes	1_
WTG05-E	LADEPRESS	UFBLADE HYDRAULIC PRESSUF	Æ	PSIG	238.000	234.896	3.185	-1.896	5.000	-5.000	Yes	1
	URRENTA	PHASE AMPS A		AMPS	1414.000	1382.34	0.083	-6.340	100.000	-100,000	Yes	1_
	URRENTB	PHASE AMPS B		AMPS	1473.000	1465.73	0.427	-33.730	100.000	-100.000	Yes	1_
	URRENTC	PHASE AMPS C		AMPS	1482.000	1461.58	0.339	-26.576	100.000	-100.000	Yes	-
	REQUENCY	GENERATOR FREQUENCY		HZ	59.980	59.992	2.620	-0.012	0.030	-0.030	Yes	
100000 BBC/000000000000000000000000000000		EN CEMEDATOR READING PRIVE		DEGIC	30,000	07.454	0.636	1 454	4.000	-5.000	Yes	_ <u></u>
		TE GENERATOR BEARING NON D		100000000	71.000	60.007	3.150	10.993	4.000	5.000	Yes	
	SUEANDINO		TEMD 4	DEC.C	65.000	05,570	0.440	-0.579	4.000	-5.000	Yes	
		11 IMS GEAR BEARING TEMP 1		DEG C	57.000	56.162	0.827	0.838	4.000	-5.000	Yes	
		2TIMS GEAR BEARING TEMP 2		DEG C	42.000	42.897	1.450	-0.897	4.000	-5.000	Yes	
		MEREACTIVE POWER		KVAR	-237.000	-155.471	2.149	-66.529	100.000	-100.000	Yes	
	OTORRPM	ROTOR RPM		RPM	15.900	15.844	0.122	0.056	1.000	-1.000	Yes	
	OLTAGEA	PHASE VOLTAGE A		VOLTS	403.400	406.898	2.781	-3.398	4.000	-4.000	Yes	
A DAMA STATISTICS	OLTAGEB	PHASE VOLTAGE B		VOLTS	402.100	402.325	1.984	1.875	4.000	-4.000	Yes	
	OLTAGEC	PHASE VOLTAGE C		VOLTS	404.300	403.004	0.622	0.696	4.000	-4.000	Yes	
	ANDSPEED	WIND SPEED		MPS	10.000	10.206	0.398	-0.306	0.000	0.000	Yes	
WIG05-V	NNDSPEED-S	SE WIND SPEED SECONDARY		MPS	9.800	10.030	0.313	-0,230	0.000	0.000	Yes	





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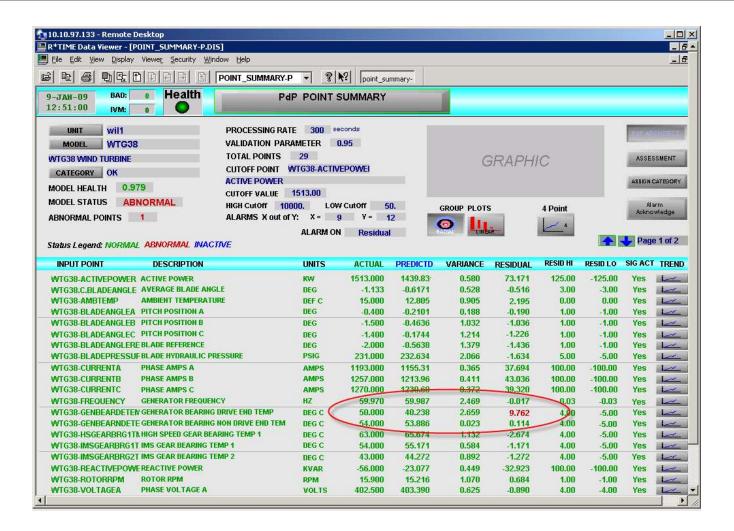
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WTG16 Generator Bearing Drive End Temp (Actual in Blue, Predicted in Green)





Gearbox High Speed Shaft Bearing Temp High



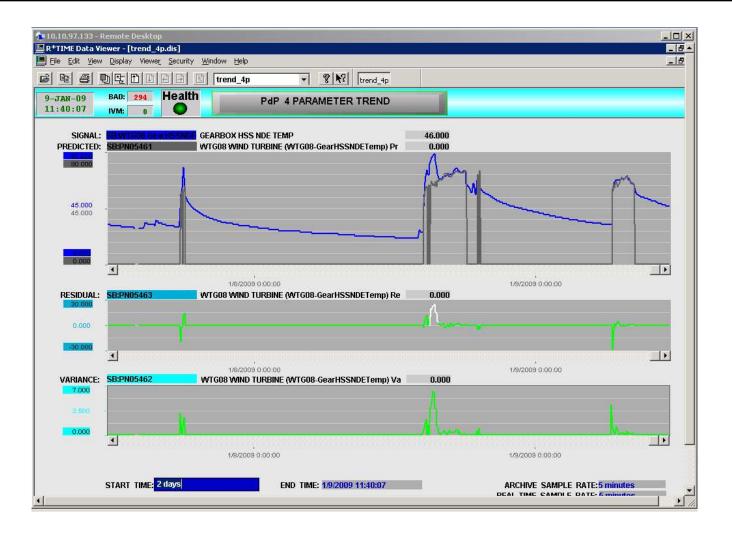




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Gearbox High Speed Shaft – Actual vs Predicted







Another Gearbox Bearing Temp Spike

UNIT SB	PROCESSING RATE	E 300 seco	onds						PdP AF	CHITECT
MODEL WTG08	VALIDATION PARA	METER 0.9	95							
VTG08 WIND TURBINE	TOTAL POINTS	54			G	RAPH	IC .		ASSE	SSMENT
CATEGORY OK	CUTOFF POINT 🧧	TG08-ACTIVE	POWEI		0	///////////////////////////////////////				_
	ACTIVE POWER								ASSIGN	CATEGORY
MODEL HEALTH 0.972	CUTOFF VALUE	370.24								
MODEL STATUS ABNORMAL	HIGH CutOff 100	00. LOW (CutOff 50).	GROUP PLOTS	:	4 Point			arm
ABNORMAL POINTS 10	ALARMS X out of Y	Y: X = 9	Y = 1				4 FOIIR		Ackno	owledge
		ALARM ON	Residual			-	4			
Itatus Legend: NORMAL ABNORMAL INAC		UNITE	ACTUAL	DDEDICTD	MADIANCE	DECIDINA			SIC ACT	
INPUT POINT DESCRIPTION		UNITS	ACTUAL	PREDICTD	VARIANCE	RESIDUAL	RESID HI	RESID LO	SIG AC	TREN
INPUT POINT DESCRIPTION WTG08-TempIGBTBlade TEMP IGBT PITCH DRI	VE BLADE 1	UNITS DEGC	ACTUAL 27.000	PREDICTD 27.215 [.]	VARIANCE 0.086	-0.215	3.00	-3.00	SIG ACT	
INPUT POINT DESCRIPTION WTG08-TempIGBTBlade TEMP IGBT PITCH DRI WTG08-TempIGBTBlade TEMP IGBT PITCH DRI	VE BLADE 1 VE BLADE 2		27.000 28.000	27.215 [.] 27.720	0.086 0.288		3.00 3.00	-3.00 -3.00	Yes Yes	1-
INPUT POINT DESCRIPTION WTG08-TempIGBTBlade TEMP IGBT PITCH DRI WTG08-TempIGBTBlade TEMP IGBT PITCH DRI WTG08-TempIGBTBlade TEMP IGBT PITCH DRI	VE BLADE 1 VE BLADE 2	DEGC DEGC DEGC	27.000 28.000 26.000	27.215 [.] 27.720 25.857	0.086 0.288 0.058	-0.215 -0.720 0.143	3.00 3.00 3.00	-3.00 -3.00 -3.00	Yes Yes Yes	
INPUT POINT DESCRIPTION WTG08-TempIGBTBlade TEMP IGBT PITCH DRI WTG08-HubBraTemp HUB BEARING TEMP	VE BLADE 1 VE BLADE 2	DEGC DEGC DEGC DEGC	27.000 28.000 26.000 21.000	27.215 27.720 25.857 29.575	0.086 0.288 0.058 4.415	-0.215 -0.720 0.143 -8.575	3.00 3.00 3.00 3.00	-3.00 -3.00 -3.00 -3.00	Yes Yes Yes Yes	
INPUT POINT DESCRIPTION WTG08-TempIGBTBlade TEMP IGBT PITCH DRI WTG08-HubBraTemp HUB BEARING TEMP WTG08-UntwistInd UNTWIST INDICATOR	VE BLADE 1 VE BLADE 2	DEGC DEGC DEGC	27.000 28.000 26.000 21.000 187.200	27.215 27.720 25.857 29.575 278.279	0.086 0.288 0.058 4.415 1.227	-0.215 -0.720 0.143 -8.575 -91.079	3.00 3.00 3.00 3.00 100.00	-3.00 -3.00 -3.00 -3.00 -100.00	Yes Yes Yes Yes Yes	
INPUT POINTDESCRIPTIONWTG08-TempIGBTBladeTEMP IGBT PITCH DRIWTG08-TempIGBTBladeTEMP IGBT PITCH DRIWTG08-TempIGBTBladeTEMP IGBT PITCH DRIWTG08-HubBratempHUB BEARING TEMPWTG08-UntwistIndUNTWIST INDICATORWTG08-NacelleTempNACELLE TEMP	VE BLADE 1 VE BLADE 2 VE BLADE 3	DEGC DEGC DEGC DEGC DEG DEGC	27.000 28.000 26.000 21.000 187.200 23.000	27.215 [.] 27.720 25.857 29.575 278.279 23.178	0.086 0.288 0.058 4.415 1.227 0.371	-0.215 -0.720 0.143 - 8.575 -91.079 -1.178	3.00 3.00 3.00 3.00 100.00 2.00	-3.00 -3.00 -3.00 -3.00 -100.00 -2.00	Yes Yes Yes Yes Yes Yes	
INPUT POINTDESCRIPTIONWTG08-TempIGBTBladeTEMP IGBT PITCH DRIWTG08-TempIGBTBladeTEMP IGBT PITCH DRIWTG08-TempIGBTBladeTEMP IGBT PITCH DRIWTG08-HubBratempHUB BEARING TEMPWTG08-UntwistIndUNTWIST INDICATORWTG08-NacelleTempNACELLE TEMPWTG08-DriveTrainVibDRIVE TRAIN VIBRATI	VE BLADE 1 VE BLADE 2 VE BLADE 3 ON	DEGC DEGC DEGC DEGC DEGC M/SEC^2	27.000 28.000 26.000 21.000 187.200 23.000 0.100	27.215 27.720 25.857 29.575 278.279 23.178 0.0375	0.086 0.288 0.058 4.415 1.227 0.371 4.222	-0.215 -0.720 0.143 -8.575 -91.079 -1.178 0.062	3.00 3.00 3.00 3.00 100.00 2.00 0.10	-3.00 -3.00 -3.00 -3.00 -100.00 -2.00 -0.10	Yes Yes Yes Yes Yes Yes Yes	
INPUT POINTDESCRIPTIONWTG08-TempIGBTBladeTEMP IGBT PITCH DRIWTG08-TempIGBTBladeTEMP IGBT PITCH DRIWTG08-TempIGBTBladeTEMP IGBT PITCH DRIWTG08-HubBraTempHUB BEARING TEMPWTG08-UntwistIndUNTWIST INDICATORWTG08-NacelleTempNACELLE TEMPWTG08-DriveTrainVibDRIVE TRAIN VIBRATIWTG08-GearHSSDETemGEARBOX HSS DE TEM	VE BLADE 1 IVE BLADE 2 IVE BLADE 3 ON AP	DEGC DEGC DEGC DEGC DEG DEGC M/SEC*2 DEGC	27.000 28.000 26.000 21.000 187.200 23.000 0.100 67.000	27.215 27.720 25.857 29.575 278.279 23.178 0.0375 67.785	0.086 0.288 0.058 4.415 1.227 0.371 4.222 0.858	-0.215 -0.720 0.143 -8.575 -91.079 -1.178 0.062 -3.785	3.00 3.00 3.00 100.00 2.00 0.10 3.00	-3.00 -3.00 -3.00 -3.00 -100.00 -2.00 -0.10 -3.00	Yes Yes Yes Yes Yes Yes Yes Yes	
INPUT POINTDESCRIPTIONWTG08-TempIGBTBladeTEMP IGBT PITCH DRJWTG08-TempIGBTBladeTEMP IGBT PITCH DRJWTG08-TempIGBTBladeTEMP IGBT PITCH DRJWTG08-HubBratempHUB BEARING TEMPWTG08-UntwistIndUNTWIST INDICATORWTG08-NacelleTempNACELLE TEMPWTG08-DriveTrainVibDRIVE TRAIN VIBRATIWTG08-GearHSSDETem GEARBOX HSS NDE TEM	VE BLADE 1 IVE BLADE 2 IVE BLADE 3 ON MP	DEGC DEGC DEGC DEGC DEG DEGC M/SEC ² DEGC	27.000 28.000 26.000 21.000 187.200 23.000 0.100 67.000 88.000	27.215 27.720 25.857 29.575 278.279 23.178 0.0375 67.785 63.666	0.086 0.288 0.058 4.415 1.227 0.371 4.222 0.858 5.386	-0.215 -0.720 0.143 -8.575 -91.079 -1.178 0.062 -3.785 23.334	3.00 3.00 3.00 100.00 2.00 0.10 3.00 3.00	-3.00 -3.00 -3.00 -3.00 -100.00 -2.00 -0.10 -3.00 -3.00	Yes Yes Yes Yes Yes Yes Yes Yes	
INPUT POINTDESCRIPTIONWTG08-TemplGBTBladeTEMP IGBT PITCH DRJWTG08-TemplGBTBladeTEMP IGBT PITCH DRJWTG08-TemplGBTBladeTEMP IGBT PITCH DRJWTG08-HubBroTempHUB BEARING TEMPWTG08-UntwistIndUNTWIST INDICATORWTG08-NacelleTempNACELLE TEMPWTG08-DriveTrainVibDRIVE TRAIN VIBRATIWTG08-GearHSSDETemGEARBOX HSS DE TEMWTG08-GearIMSDETem GEARBOX HSS NDE TEWTG08-GearIMSDETem GEARBOX IMS DE TEM	VE BLADE 1 IVE BLADE 2 IVE BLADE 3 ON AP EMP	DEGC DEGC DEGC DEGC DEGC M/SEC ² DEGC DEGC DEGC DEGC	27.000 28.000 26.000 21.000 187.200 23.000 0.100 67.000 88.000 52.000	27.215 27.720 25.857 29.575 278.279 23.178 0.0375 67.785 63.666 53.624	0.086 0.288 0.058 4.415 1.227 0.371 4.222 0.858 5.386 0.569	-0.215 -0.720 0.143 -8.575 -91.079 -1.178 0.062 -3.785 23.334 -2.624	3.00 3.00 3.00 100.00 2.00 0.10 3.00 3.00 3.00	-3.00 -3.00 -3.00 -100.00 -2.00 -0.10 -3.00 -3.00 -3.00	Yes Yes Yes Yes Yes Yes Yes Yes Yes	
INPUT POINTDESCRIPTIONWTG08-TempIGBTBladeTEMP IGBT PITCH DRJWTG08-TempIGBTBladeTEMP IGBT PITCH DRJWTG08-TempIGBTBladeTEMP IGBT PITCH DRJWTG08-HubBratempHUB BEARING TEMPWTG08-UntwistIndUNTWIST INDICATORWTG08-NacelleTempNACELLE TEMPWTG08-DriveTrainVibDRIVE TRAIN VIBRATIWTG08-GearHSSDETem GEARBOX HSS NDE TEM	VE BLADE 1 VE BLADE 2 VE BLADE 3 ON AP MP MP	DEGC DEGC DEGC DEGC DEG DEGC M/SEC ² DEGC	27.000 28.000 26.000 21.000 187.200 23.000 0.100 67.000 88.000	27.215 27.720 25.857 29.575 278.279 23.178 0.0375 67.785 63.666	0.086 0.288 0.058 4.415 1.227 0.371 4.222 0.858 5.386	-0.215 -0.720 0.143 -8.575 -91.079 -1.178 0.062 -3.785 23.334	3.00 3.00 3.00 100.00 2.00 0.10 3.00 3.00	-3.00 -3.00 -3.00 -3.00 -100.00 -2.00 -0.10 -3.00 -3.00	Yes Yes Yes Yes Yes Yes Yes Yes	





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Reactive Power Measurement - Issue

R*TIME Data Viewer - [POINT_SUMMARY-P.D] File Edit View Display Viewer Security Wir	-								_ 8 _ 8
	POINT_SUMMARY-P V	Point_sur	mmary-						
6-JAN-09 BAD: 13 13:17:18 IVM: 0	PdP POINT	SUMMARY							
UNIT WII1 MODEL WTG23 WTG23 WIND TURBINE CATEGORY Generic Reference F MODEL HEALTH 0.930	TROCESSING THTE SOU	econds D.95 /EPOWEI	.	G	GRAPH	IC		ASSE	CHITECT SSMENT CATEGORY
MODEL STATUS ABNORMAL ABNORMAL POINTS 4	HIGH CutOff 10000. LOW	VCutOff 51 9 Y= 1		GROUP PLOTS	5	4 Point			arm owledge
Status Legend: NORMAL ABNORMAL INAC	ALARM OF				a R —	4		🕂 Pag	e 1 of 2
INPUT POINT DESCRIPTION	UNITS	ACTUAL	PREDICTD	VARIANCE	RESIDUAL	RESID HI	RESID LO	SIG AC	TREND
WTG23-ACTIVEPOWER ACTIVE POWER WTG23.C.BLADEANGLE AVERAGE BLADE AND WTG23-AMBTEMP AMBIENT TEMPERATU WTG23-BLADEANGLEA PITCH POSITION A		1829.000 -1.500 4.000 -1.500	2300.56 ⁻ 0.0334 2.3334 -0.0966	0.036 0.056 0.327 0.001	12.436 -0.133 1.667 -0.003	125.00 3.00 0.00 1.00	-125.00 -3.00 0.00 -1.00	Yes Yes Yes Yes	
WTG23-BLADEANGLEB PITCH POSITION B WTG23-BLADEANGLEC PITCH POSITION C WTG23-BLADEANGLERE BLADE REFERENCE WTG23-BLADEPRESSUF BLADE HYDRAULIC PI	DEG DEG DEG RESSURE PSIG	-1.500 -1.400 -1.000 238.000	-0.0427 0.5670 0.3297 232.080	0.023 0.265 0.515 1.122	-0.057 -0.667 -1.330 -2.080	1.00 1.00 1.00 5.00	-1.00 -1.00 -1.00 -5.00	Yes Yes Yes Yes	
WTG23-CURRENTA PHASE AMPS A WTG23-CURRENTB PHASE AMPS B WTG23-CURRENTC PHASE AMPS C	AMPS AMPS AMPS	2150.000 2232.000 2209.000	1902.42 1987.36 1981.36	0.833 0.825 0.862	237.585 250.635 254.644	100.00 100.00 100.00	-100.00 -100.00 -100.00	Yes Yes Yes	
WTG23-FREQUENCY GENERATOR FREQUEN WTG23-GENBEARDETEN/GENERATOR BEARING WTG23-GENBEARNDETE GENERATOR BEARING WTG23-HSGEARBRG1TA HIGH SPEED GEAR BEA	DRIVE END TEMP DEG C Non drive end tem deg C	59.970 27.000 43.000 64.000	59.982 29.248 46.523 64.235	0.799 0.290 0.301 0.040	-0.012 -2.248 -3.523 -0.235	0.03 4.00 4.00 4.00	-0.03 -5.00 -5.00 -5.00	Yes Yes Yes Yes	
WTG23-IMSGEARBRG1T IMS GEAR BEARING TI WTG23-IMSGEARBRG2T IMS GEAR BEARING TI WTG23-REACTIVEPOWE REACTIVE POWER	EMP 1 DEG C EMP 2 DEG C KVAR	55.000 43.000 -1771.00	54.649 43.659 -481.473	0.079 0.215 3.222	0.351 -0.659 -820.527	4.00 4.00 100.00	-5.00 -5.00 -100.00	Yes Yes Yes	
WTG23-ROTORRPM ROTOR RPM	RPM	16.200	15.930	0.302	0.470	1.00	-1.00	Yes	





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Project Status

- ✓ 3 Wind-Farms are utilizing PdP Monitoring System, 6 more in deployment stages (to expand to 13 total wind-farm sites)
- ✓ 235 Wind-Turbines being monitored by PdP (to expand to >500 wind-turbines)
- Expect to complete this summer
- Preliminary Findings; Some problems, Most sensor related.





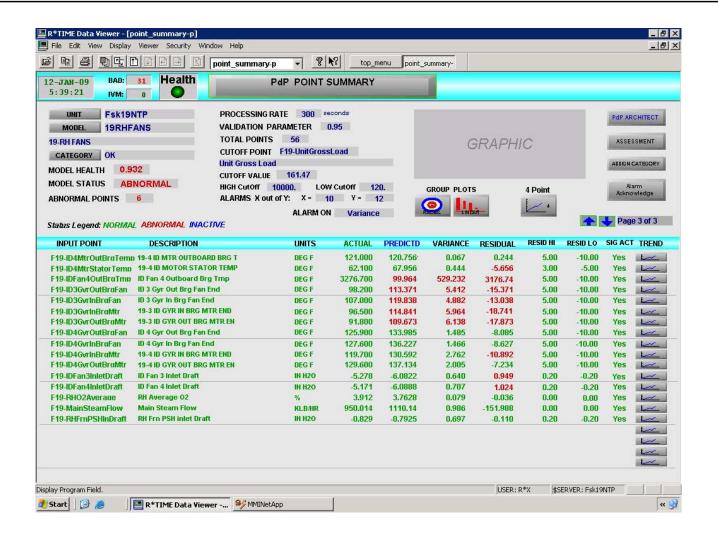
Coal Fleet Monitoring

- Modeling all Coal Units over 200 MW's
- 15 Units
- 254 Models
- Began in 11/08
- Lessons learned already
- Issues Identified
- Plan to complete modeling by March





Coal Unit – ID Fan Thermocouple Failure



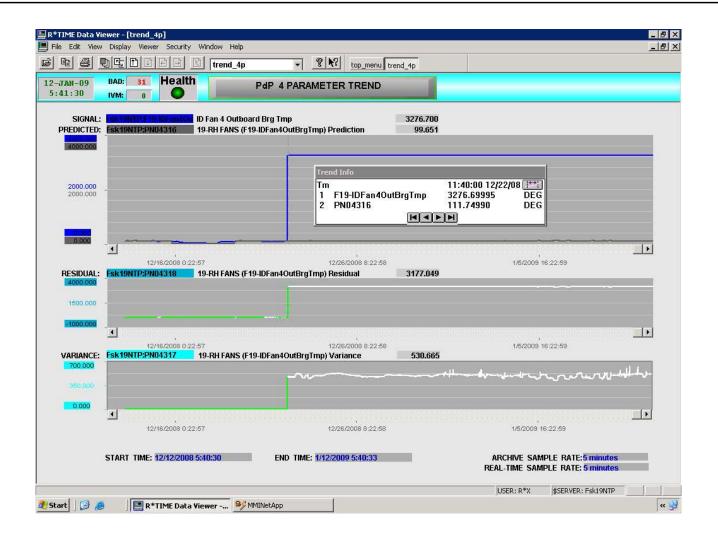




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1. 1.1

ID Fan Thermocouple – Actual vs Predicted









Coal Unit Boiler feed Pump Bearing Temp

	POINT_SUMMARY-P	- ?	top_m	ienu point_	summary-					
BAD: 18 Health 1:16:09 IVM: 0	PdP	POINT S	UMMARY		1					
UNIT Craw8NTP	PROCESSING RATE	300 sec	conds						PdP AR	CHITECT
MODEL 81BFP	VALIDATION PARAM	ETER 0.	.95						Energenerg	
8 81 BFP	TOTAL POINTS	9			6	RAPHI	C		ASSES	SMENT
CATEGORY OK	CUTOFF POINT CR8	-81BFPSpe	ed		C	211/4/11	0		-	
	BFP 81 SPEED								ASSIGN	CATEGORY
IODEL HEALTH 0.957	CUTOFF VALUE 28	63.38								
IODEL STATUS ABNORMAL	HIGH CutOff 10000	LOW	CutOff 50	0.	GROUP PLOTS	6	4 Point			arm
BNORMAL POINTS 2	ALARMS X out of Y:	X = 10	Y = 1	2	<u> </u>		F		Ackno	wiedge
		ALARM ON	Variance			AR-	4			
tatus Legend: NORMAL ABNORMAL INA			Variance						🖖 Page	e 1 of 1
-										
INPUT POINT DESCRIPTION		UNITS	ACTUAL	PREDICTD	VARIANCE	RESIDUAL	RESID HI	RESID LO	SIG ACT	TREND
		MW	188.683	169.635	0.853	18.466	0.00	0.00	Yes	
CR8-81BFPSpeed BFP 81 SPEED		RPM	2863.375	2853.20	0.012	1.174	30.00	-30.00	Yes	-
CR8-81BFPSpeed BFP 81 SPEED CR8-81BFPMtrKW BFP 81 MOTOR POV	WER	RPM MW	2863.375 2.903	2853.20 2.8889	0.012 0.049	1.174 -0.012	30.00 0.10	-30.00 -0.10	Yes Yes	<u></u>
CR8-81BFPSpeed BFP 81 SPEED CR8-81BFPMtrKW BFP 81 MOTOR POV CR8-81BFPHvCbIPos BFP 81 HYD COUP II	MER NC POS	RPM MW %	2863.375 2.903 54.018	2853.20 2.8889 54.553	0.012 0.049 0.110	1.174 -0.012 -0.536	30.00 0.10 3.00	-30.00 -0.10 -3.00	Yes Yes Yes	NN
CR8-81BFPSpeed BFP 81 SPEED CR8-81BFPMtrKW BFP 81 MOTOR POW CR8-81BFPHvCpIPos BFP 81 MVD COUP II CR8-81BFPSuctFlow BFP 81 SUCTION FL	NER NC POS OW	RPM MW % KLB/HR	2863.375 2.903 54.018 663.079	2853.20 2.8889 54.553 671.007	0.012 0.049 0.110 0.356	1.174 -0.012 -0.536 -30.444	30.00 0.10 3.00 100.00	-30.00 -0.10 -3.00 -100.00	Yes Yes Yes Yes	RKK
CR8-81BFPSpeed BFP 81 SPEED CR8-81BFPMtrKW BFP 81 MOTOR POW CR8-81BFPHvCpIPos BFP 81 MOTOR POW CR8-81BFPSuctFlow BFP 81 SUCTION FL CR8-81BFPSuctFlow BFP 81 SUCTION FL CR8-81BFPSuctFlow BFP 81 SUCTION FL	MER NC POS OW VESSURE	RPM MW % KLB/HR PSIG	2863.375 2.903 54.018 663.079 71.395	2853.20 2.8889 54.553 671.007 71.688	0.012 0.049 0.110 0.356 0.040	1.174 -0.012 -0.536 -30.444 -0.293	30.00 0.10 3.00 100.00 5.00	-30.00 -0.10 -3.00 -100.00 -5.00	Yes Yes Yes Yes Yes	KKKK
CR8-81BFPSpeed BFP 81 SPEED CR8-81BFPMtrKW BFP 81 MOTOR POV CR8-81BFPMtrKD BFP 81 MOTOR POV CR8-81BFPSuctPices BFP 81 SUCTION FL CR8-81BFPSuctFices BFP 81 SUCTION PR CR8-81BFPSuctFices BFP 81 SUCTION PR CR8-81BFPSuctFices BFP 81 SUCTION PR CR8-81BFPSuctFices BFP 81 SUCTION VATI	NER NC POS OW RESSURE ER TEMP	RPM MW % KLB/HR PSIG DEG F	2863.375 2.903 54.018 663.079 71.395 292.985	2853.20 2.8889 54.553 671.007 71.688 293.509	0.012 0.049 0.110 0.356 0.040 0.065	1.174 -0,012 -0,536 -30,444 -0,293 -0,524	30.00 0.10 3.00 100.00 5.00 5.00	-30.00 -0.10 -3.00 -100.00 -5.00 -5.00	Yes Yes Yes Yes Yes Yes	KKKK
CR8-81BFPSpeed BFP 81 SPEED CR8-81BFPMtrKW BFP 81 MOTOR POW CR8-81BFPhyCpiPos BFP 81 MOTOR POW CR8-81BFPSuctflow BFP 81 MUD COUP1 CR8-81BFPSuctFlow BFP 81 SUCTION FL CR8-81BFPSuctFlow BFP 81 SUCTION PR CR8-81BFPSuctFlow BFP 81 SUCTION PR CR8-81BFPSuctFlow BFP 81 SUCTION WATH CR8-81BFPDischPrs BFP 81 DISCHARGE	NER NC POS OW EESSURE ER TEMP PRESS	RPM MW % KLB/HR PSIG DEG F PSIG	2863.375 2.903 54.018 663.079 71.395 292.985 2086.721	2853.20 2.8889 54.553 671.007 71.688 293.509 2069.43	0.012 0.049 0.110 0.356 0.040 0.065 0.082	1.174 -0.012 -0.536 -30.444 -0.293 -0.524 7.048	30.00 0.10 3.00 100.00 5.00 5.00 50.00	-30.00 -0.10 -3.00 -100.00 -5.00 -5.00 -50.00	Yes Yes Yes Yes Yes Yes Yes	KKKKK
CR8-81BFPSpeed BFP 81 SPEED CR8-81BFPMtrKW BFP 81 MOTOR POW CR8-81BFPMcChIPos BFP 81 MVD COUP II CR8-81BFPSuctFlow BFP 81 SUCTION FL CR8-81BFPSuctPress BFP 81 SUCTION PM CR8-BFPSuctWhT Femb BFP 81 DISCHARGE CR8-B1BFPDischPress 8 BFP 81 DISCHARGE F	NER NC POS OW EESSURE ER TEMP PRESS PRESSURE	RPM MW % KLB/HR PSIG DEG F	2863.375 2.903 54.018 663.079 71.395 292.985	2853.20 2.8889 54.553 671.007 71.688 293.509	0.012 0.049 0.110 0.356 0.040 0.065	1.174 -0,012 -0,536 -30,444 -0,293 -0,524	30.00 0.10 3.00 100.00 5.00 5.00	-30.00 -0.10 -3.00 -100.00 -5.00 -5.00	Yes Yes Yes Yes Yes Yes	KKKK
CR8-81BFPSpeed BFP 81 SPEED CR8-81BFPMtrKW BFP 81 MOTOR POV CR8-81BFPMtrKW BFP 81 MOTOR POV CR8-81BFPSuctFlow BFP 81 SUCTION FL CR8-81BFPSuctFlow BFP 81 SUCTION PR CR8-81BFPSuctFlow BFP 81 SUCTION ANTI CR8-81BFPDischPress 8FP 81 DISCHARGE F CR8-81BFPDischPress 8FP 81 PUISCHARGE F CR8-81BFPPmblbBra BFP 81 PUMP INBRC	NER NC POS OW VESSURE ER TEMP PRESS PRESS PRESSURE D BEAR TMP	RPM MW % KLB/HR PSIG DEG F PSIG PSIG	2863.375 2.903 54.018 663.079 71.395 292.985 2086.721 2095.621	2853.20 2.8889 54.553 671.007 71.688 293.509 2069.43 2084.66	0.012 0.049 0.110 0.356 0.040 0.065 0.082 0.131	1.174 -0.012 -0.536 -30.444 -0.293 -0.524 7.048 10.959	30.00 0.10 3.00 100.00 5.00 5.00 50.00 50.00	-30.00 -0.10 -3.00 -100.00 -5.00 -5.00 -50.00 -50.00	Yes Yes Yes Yes Yes Yes Yes	KKKKKK
CR8.81BFPSpeed BFP 81 SPEED CR8.81BFPMtrKW BFP 81 MOTOR POV CR8.91BFPMtrKW BFP 81 MOTOR POV CR8.91BFPSucFlow BFP 81 MOTOR POV CR8.91BFPSucFlow BFP 81 SUCTION FL CR8.91BFPSucFlow BFP 81 SUCTION PR CR8.91BFPSucFlow BFP 81 SUCTION VATI CR8.91BFPDischPres BFP 81 DISCHARGE F CR8.91BFPDischPress 8 BFP DISCHARGE F CR8.91BFPPminlbBra BFP 81 PUMP INBRE CR8.91BFPPminlbBra BFP 81 PUMP INBRE	WER NIC POS OW RESSURE ER TEMP PRESS PRESSURE D BEAR TMP BEAR TEMP	RPM MW % KLB/HR PSIG DEG F PSIG PSIG DEG F	2863.375 2.903 54.018 663.079 71.395 292.985 2086.721 2095.621 132.637	2853.20 2.8889 54.553 671.007 71.688 293.509 2069.43 2084.66 151.223	0.012 0.049 0.110 0.356 0.040 0.065 0.082 0.131 5.585	1.174 -0.012 -0.536 -30.444 -0.293 -0.524 7.048 10.959 -18.587	30.00 0.10 3.00 100.00 5.00 5.00 50.00 50.00 5.00	-30.00 -0.10 -3.00 -100.00 -5.00 -5.00 -50.00 -50.00 -10.00	Yes Yes Yes Yes Yes Yes Yes Yes Yes	KKKKKKK
CR8-81BFPSpeed BFP 81 SPEED CR8-81BFPMtrKW BFP 81 MOTOR POV CR8-81BFPMtrKW BFP 81 MOTOR POV CR8-81BFPSuctFlow BFP 81 SUCTION FL CR8-81BFPSuctFlow BFP 81 SUCTION PR CR8-81BFPSuctFlow BFP 81 SUCTION VATI CR8-81BFPDischPrs BFP 81 DISCHARGE CR8-81BFPDischPrs 8FP 81 DISCHARGE CR8-81BFPDischPrs 8FP 81 DISCHARGE CR8-81BFPPmblnbBra 8FP 81 PUMP NUTB CR8-81BFPPmbDubBra BFP 81 PUMP OUTB CR8-81HCMtrGdeBraTm BFP 81 HC MTR GDI	NER NC POS OW VESSURE ER TEMP PRESS PRESSURE D BEAR TMP B BEAR TEMP E BEAR TMP	RPM MW % KLB/HR PSIG DEG F PSIG DEG F DEG F	2863.375 2.903 54.018 663.079 71.395 292.985 2086.721 2095.621 132.637 134.445	2853.20 2.8889 54.553 671.007 71.688 293.509 2069.43 2084.66 151.223 136.863	0.012 0.049 0.110 0.356 0.040 0.065 0.082 0.131 5.585 0.591	1.174 -0.012 -0.536 -30.444 -0.293 -0.524 7.048 10.959 -18.587 -2.324	30.00 0.10 3.00 100.00 5.00 50.00 50.00 5.00 5.00 5.	-30.00 -0.10 -3.00 -100.00 -5.00 -50.00 -50.00 -10.00 -10.00	Yes Yes Yes Yes Yes Yes Yes Yes Yes Yes	KKKKKKK
CR8-81BFPSpeed BFP 81 SPEED CR8-81BFPMtrKW BFP 81 MOTOR POV CR8-81BFPMtrKW BFP 81 MOTOR POV CR8-81BFPSuctFloss BFP 81 SUCTION FL CR8-81BFPSuctFloss BFP 81 SUCTION PR CR8-81BFPSuctFloss BFP 81 SUCTION VATI CR8-81BFPSuctWrTerms BFP 81 DISCHARGE CR8-81BFPDischPress 8 BFP 0ISCHARGE CR8-81BFPDischPress 8 BFP 0ISCHARGE CR8-81BFPPmoDutbBra BFP 81 PUMP INBRE CR8-81BFPPmoDutbBra BFP 81 PUMP OUTB CR8-81HCMtrGdeBraTm BFP 81 HC MTR GDI CR8-81HCMtrThrBraTm BFP 81 HC MTR HI	NER NC POS OW EESSURE EESSURE PRESS PRESSURE D BEAR TMP E BEAR TMP E BEAR TMP E BEAR TMP	RPM MW % KLB/HR PSIG DEG F PSIG DEG F DEG F DEG F	2863.375 2.903 54.018 663.079 71.395 292.985 2086.721 2095.621 132.637 134.445 126.553	2853.20 2.8889 54.553 671.007 71.688 293.509 2069.43 2084.66 151.223 136.863 130.360	0.012 0.049 0.110 0.356 0.040 0.065 0.082 0.131 5.585 0.591 0.755	1.174 -0.012 -0.536 -30.444 -0.293 -0.524 7.048 10.959 -18.587 -2.324 -3.755	30.00 0,10 3.00 5.00 5.00 50.00 50.00 5.00 5.00 5	-30.00 -0.10 -3.00 -5000 -50.00 -50.00 -50.00 -10.00 -10.00 -10.00	Yes Yes Yes Yes Yes Yes Yes Yes Yes Yes	RKKKKKKK
CR8-81BFPSpeed BFP 81 SPEED CR8-81BFPMtrKW BFP 81 MOTOR POW CR8-81BFPMcDiPos BFP 81 MOTOR POW BFP 81 MD COUPI BFP 81 MD COUPI CR8-81BFPSuctFlow BFP 81 SUCTION FL CR8-81BFPSuctFress BFP 81 SUCTION VATI CR8-81BFPDischPress BFP 81 DISCHARGE CR8-81BFPDischPress 8 BFP 10 DISCHARGE F CR8-81BFPPmolnbBra BFP 81 PUMP NIBBC CR8-81BFPPmolnbBra BFP 81 PUMP NIBBC CR8-81HCMtrGeBraTim BFP 81 HC MTR CDI CR8-81HCMtrGeBraTim BFP 81 HC MTR CDI	NER NC POS OW EESSURE ER TEMP PRESS PRESSURE D BEAR TMP BEAR TEMP E BEAR TMP E BEAR TMP E BEAR TMP	RPM MW % KLB/HR PSIG DEG F PSIG DEG F DEG F DEG F	2863.375 2.903 54.018 663.079 71.395 2982.985 2086.721 2095.621 132.637 134.445 126.553 131.051	2853.20 2.8889 54.553 671.007 71.688 293.509 2069.43 2084.66 151.223 136.863 130.360 135.847	0.012 0.049 0.110 0.356 0.040 0.065 0.082 0.131 5.585 0.591 0.755 1.338	1.174 -0.012 -0.536 -30.444 -0.293 -0.524 7.048 10.959 -18.587 -2.324 -3.755 -4.796	30.00 0.10 3.00 100.00 5.00 50.00 50.00 5.00 5.00 5.	-30.00 -0.10 -3.00 -100.00 -5.00 -50.00 -50.00 -10.00 -10.00 -10.00 -10.00 -10.00	Yes Yes Yes Yes Yes Yes Yes Yes Yes Yes	KKKKKKKKKKK
CR8.81BFPSDeed BFP 81 SPEED CR8.81BFPMtrKW BFP 81 MOTOR POV CR8.81BFPMtrKW BFP 81 MOTOR POV CR8.81BFPSuctFlow BFP 81 MUCTON FL CR8.81BFPSuctFlow BFP 81 SUCTION FL CR8.81BFPSuctFlow BFP 81 SUCTION VATI CR8.81BFPDischPres BFP 81 DISCHARGE CR8.81BFPDischPres 8FP 81 DISCHARGE CR8.81BFPPminlbBra BFP 81 DISCHARGE CR8.81BFPPminlbBra BFP 81 HC MTR GDI CR8.81BFPPminlbBra BFP 81 HC MTR GDI CR8.81HCMtrThrBraTim BFP 81 HC MTR GDI CR8.81HCPmPGBeraTisFP 81 HC PMP GDI CR8.81HCPmPThrBraTisFP 81 HC PMP GDI CR8.81HCPmPThrBraTisFP 81 HC PMP GDI CR8.81HCPmPThrBraTisFP 81 HC PMP GDI CR8.81HCPmPThrBraTisFP 81 HC PMP GDI CR8.81HCPmPThrBraTisFP 81 HC PMP GDI CR8.81HCPmPThrBraTisFP 81 HC PMP GDI CR8.81HCPmPThrBraTisFP 81 HC PMP GDI CR8.81HCPmPThrBraTisFP 81 HC PMP GDI CR8.81HCPmPThrBraTisFP 81 HC PMP GDI CR8.81HCPmPThrBraTisFP 81 HC PMP GDI	NER NC POS OW VESSURE ER TEMP PRESS PRESSURE D BEAR TMP B BEAR TMP E BEAR TMP E BEAR TMP E BEAR TMP BEAR TMP BEAR TEMP	RPM MWV % KLB/HR PSIG DEG F DEG F DEG F DEG F DEG F DEG F	2863.375 2.903 54.018 663.079 71.395 292.985 2086.721 2095.621 132.637 134.445 126.553 131.051 122.709 131.988 161.715	2853.20 2.8889 54.553 671.007 71.688 293.509 2069.43 2084.66 151.223 136.863 130.360 135.847 135.847 135.847 137.094 138.985	0.012 0.049 0.110 0.356 0.040 0.065 0.082 0.131 5.585 0.591 0.755 1.338 0.689 1.255 5.853	1.174 -0.012 -0.536 -30.444 -0.293 -0.524 7.048 10.959 -18.587 -2.324 -3.755 -4.796 -3.570 -5.106 22.729	30.00 0.10 3.00 5.00 5.00 5.00 5.00 5.00 5.00 5.0	-30.00 -0.10 -3.00 -5.00 -5.00 -50.00 -50.00 -10.00 -10.00 -10.00 -10.00 -10.00 -10.00 -10.00	Yes Yes Yes Yes Yes Yes Yes Yes Yes Yes	KKKKKKKKKKK
CR8-81BFPSDeed BFP 81 SPEED CR8-81BFPMtrKW BFP 81 MOTOR POV CR8-81BFPMtrKW BFP 81 MOTOR POV CR8-81BFPSuctFlow BFP 81 SUCTION FL CR8-81BFPSuctFlow BFP 81 SUCTION FL CR8-81BFPSuctFlow BFP 81 SUCTION VATI CR8-81BFPDischPrs BFP 81 DISCHARGE CR8-81BFPDischPrs 8FP 81 DISCHARGE CR8-81BFPDischPrs 8FP 81 DISCHARGE CR8-81BFPPmblnbRa 8FP 81 PUMP NUTB CR8-81BFPPmbDubBra BFP 81 PUMP OUTB CR8-81HCMtrGdeBraTm BFP 81 HC MTR GDI CR8-81HCMtrThrBraTm BFP 81 HC PMP FM CR8-81HCPmPhotBra BFP 81 HC PMP FM CR8-81HCPmPhotBraTm BFP 81 HC PMP FM CR8-81HCPmPhotBraTm BFP 81 HC PMP FM CR8-81HFPMtrlnbBra BFP 81 MOTOR INB CR8-81BFPMtrOutbBra BFP 81 MOTOR OTE	NER NC POS OW VESSURE ER TEMP PRESS PRESSURE D BEAR TMP B BEAR TMP E BEAR TMP E BEAR TMP E BEAR TMP B BEAR TMP B BEAR TEMP 3 BEAR TEMP	RPM MWV % KLB/MR PSIG DEG F PSIG DEG F DEG F DEG F DEG F DEG F DEG F DEG F DEG F	2863.375 2.903 54.018 663.079 71.395 292.985 2086.721 2095.621 132.637 134.445 126.553 131.051 122.709 131.988 161.715 134.336	2853.20 2.8889 54.553 671.007 71.688 293.509 2069.43 2084.66 151.223 136.863 130.360 135.847 126.279 137.094 138.985 128.347	0.012 0.049 0.110 0.356 0.040 0.065 0.092 0.131 5.585 0.591 0.755 1.338 0.689 1.255 5.853 2.640	1.174 -0.012 -0.536 -30.444 -0.293 -0.524 7.048 10.959 -18.587 -2.324 -3.755 -4.796 -3.570 -5.106 22.729 5.946	30.00 0.10 3.00 5.00 5.00 5.00 5.00 5.00 5.00 5.0	-30.00 -0.10 -3.00 -5.00 -5.00 -50.00 -50.00 -10.00 -10.00 -10.00 -10.00 -10.00 -10.00 -10.00 -10.00 -10.00	Yes Yes Yes Yes Yes Yes Yes Yes Yes Yes	KKKKKKKKKKKK
CR8-81BFPSpeed BFP 81 SPEED CR8-81BFPMtrKW BFP 81 MOTOR POW CR8-81BFPMtrKW BFP 81 MOTOR POW CR8-81BFPSuctFlows BFP 81 SUCTION FL CR8-81BFPSuctFlows BFP 81 SUCTION PR CR8-81BFPSuctFlows BFP 81 SUCTION VATI CR8-81BFPSuctWrTerms BFP 81 DISCHARGE CR8-81BFPDischPress 8 BFP 0ISCHARGE CR8-81BFPDischPress 8 BFP 0ISCHARGE CR8-81BFPPmoDutBbra BFP 81 DISCHARGE CR8-81BFPPmoDutBra BFP 81 HC MTR GDI CR8-81HCMtrGdeBraTin BFP 81 HC MTR GDI CR8-81HCPmPGdeBraTin BFP 81 HC CMP DHI CR8-81HCPmPGdeBraTin BFP 81 HC MTR GDI CR8-81HCPmPGdeBraTin BFP 81 HC MTR GDI CR8-81HCPmPGdeBraTin BFP 81 HC ORD FIMB CR8-81HCPmPGdeBraTin BFP 81 HC ORD FIMB CR8-81HCPmPGdeBraTin BFP 81 HC TOR FIMB CR8-81HCPmPGtabra BFP 81 MOTOR INB CR8-81HCPmPGtabra BFP 81 MOTOR OFE CR8-81HCPmPGtabra BFP 81 MOTOR INB CR8-81HCPmPGtabra BFP 81 MOTOR OFE CR8-81HCPmPGtabra<	NER NC POS OW ESSURE ESSURE PRESS DBAR TMP BBAR TMP E BEAR TMP E BEAR TMP E BEAR TMP E BEAR TMP B BEAR TMP B BEAR TEMP B BEAR TEMP B BEAR TEMP	RPM MWV % KLB/MR PSIG DEG F PSIG DEG F DEG F DEG F DEG F DEG F DEG F DEG F DEG F	2863.375 2.903 54.018 663.079 71.395 292.985 2086.721 2095.621 132.637 134.445 126.553 131.051 122.709 131.998 161.715 134.336 1125.176	2853.20 2.8889 54.553 671.007 71.688 293.509 2069.43 2084.66 151.223 136.863 130.360 135.847 126.279 137.094 138.985 128.347 1101.57	0.012 0.049 0.110 0.356 0.040 0.065 0.082 0.131 5.585 0.591 0.755 1.338 0.689 1.255 5.853 2.640 0.046	1.174 -0.012 -0.536 -30.444 -0.293 -0.524 7.048 10.959 -18.587 -2.324 -3.755 -4.796 -3.570 -5.106 22.729 5.946 6.885	30.00 0.10 3.00 100.00 5.00 50.00 5.00 5.00 5.00 5.0	-30.00 -0.10 -3.00 -50.00 -50.00 -50.00 -50.00 -10.00 -10.00 -10.00 -10.00 -10.00 -10.00 -10.00 -0.00 -0.00	Yes Yes Yes Yes Yes Yes Yes Yes Yes Yes	KKKKKKKKKKKKKKKK
CR8-81BFPSDeed BFP 81 SPEED CR8-81BFPMtrKW BFP 81 MOTOR POV CR8-81BFPMtrKW BFP 81 MOTOR POV CR8-81BFPSuctFlow BFP 81 SUCTION FL CR8-81BFPSuctFlow BFP 81 SUCTION FL CR8-81BFPSuctFlow BFP 81 SUCTION VATI CR8-81BFPDischPrs BFP 81 DISCHARGE CR8-81BFPDischPrs 8FP 81 DISCHARGE CR8-81BFPDischPrs 8FP 81 DISCHARGE CR8-81BFPPmblnbRa 8FP 81 PUMP NUTB CR8-81BFPPmbDubBra BFP 81 PUMP OUTB CR8-81HCMtrGdeBraTm BFP 81 HC MTR GDI CR8-81HCMtrThrBraTm BFP 81 HC PMP FM CR8-81HCPmPhotBra BFP 81 HC PMP FM CR8-81HCPmPhotBraTm BFP 81 HC PMP FM CR8-81HCPmPhotBraTm BFP 81 HC PMP FM CR8-81HFPMtrlnbBra BFP 81 MOTOR INB CR8-81BFPMtrOutbBra BFP 81 MOTOR OTE	NER NC POS OW ESSURE ESSURE PRESS DBAR TMP BBAR TMP E BEAR TMP E BEAR TMP E BEAR TMP E BEAR TMP B BEAR TMP B BEAR TEMP B BEAR TEMP B BEAR TEMP	RPM MWV % KLB/MR PSIG DEG F PSIG DEG F DEG F DEG F DEG F DEG F DEG F DEG F DEG F	2863.375 2.903 54.018 663.079 71.395 292.985 2086.721 2095.621 132.637 134.445 126.553 131.051 122.709 131.988 161.715 134.336	2853.20 2.8889 54.553 671.007 71.688 293.509 2069.43 2084.66 151.223 136.863 130.360 135.847 126.279 137.094 138.985 128.347	0.012 0.049 0.110 0.356 0.040 0.065 0.092 0.131 5.585 0.591 0.755 1.338 0.689 1.255 5.853 2.640	1.174 -0.012 -0.536 -30.444 -0.293 -0.524 7.048 10.959 -18.587 -2.324 -3.755 -4.796 -3.570 -5.106 22.729 5.946	30.00 0.10 3.00 5.00 5.00 5.00 5.00 5.00 5.00 5.0	-30.00 -0.10 -3.00 -5.00 -5.00 -50.00 -50.00 -10.00 -10.00 -10.00 -10.00 -10.00 -10.00 -10.00 -10.00 -10.00	Yes Yes Yes Yes Yes Yes Yes Yes Yes Yes	KKKKKKKKKKKKKK







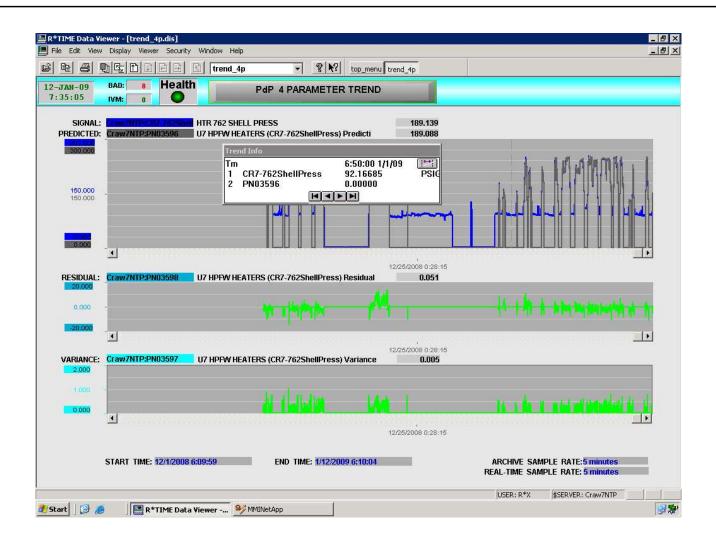
Coal Unit Boiler Feed Pump Inboard Bearing Temperature - High

	D Gz D D D D K Trend_4p	
JAN-09 15:02	BAD: 18 Health PdP 4 PARAMETER TREND	
SIGNAL: PREDICTED:	Craweint Theorem UTBER H BFP 81 MOTOR INB BEAR TEMP 161.715 Craweint Theorem UTBER H U8 81 BFP (CR8-81BFPMtrInbBrg) Prediction 138.985	
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100.000 100.000		n⊶itaaning-noni 119°° ng −19+4 gung-ng ng n
0.000		n de la companya de l
RESIDUAL:	12/25/2008 0.28.15 Craw8NTP:PN05557 U8 81 BFP (CR8-81BFPMtrInbBrg) Residual 22.729	
10.000		week when we have a start
40.000	12/25/2008 0:28:15	
VARIANCE:		
10.000	and the second	- adate Tuble - Manager and
	▲	000000000000000000000000000
	START TIME: 12/1/2008 6:09:59 END TIME: 1/12/2009 6:10:04 ARCHI	VE SAMPLE RATE:5 minutes





Coal Unit Feedwater Heater Shell Pressure "Lesson learned" : Include entire load range in Model







Questions ?







10-0-

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