CampusEnergy2016 | The Changing Landscape

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USING INTELLIGENT PREDICTIVE CONDITION-BASED MONITORING FOR DETECTING & PREDICTING EQUIPMENT FAILURE AT THE UNIVERSITY OF TEXAS-AUSTIN

SPEAKER

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Need at UT-UEM

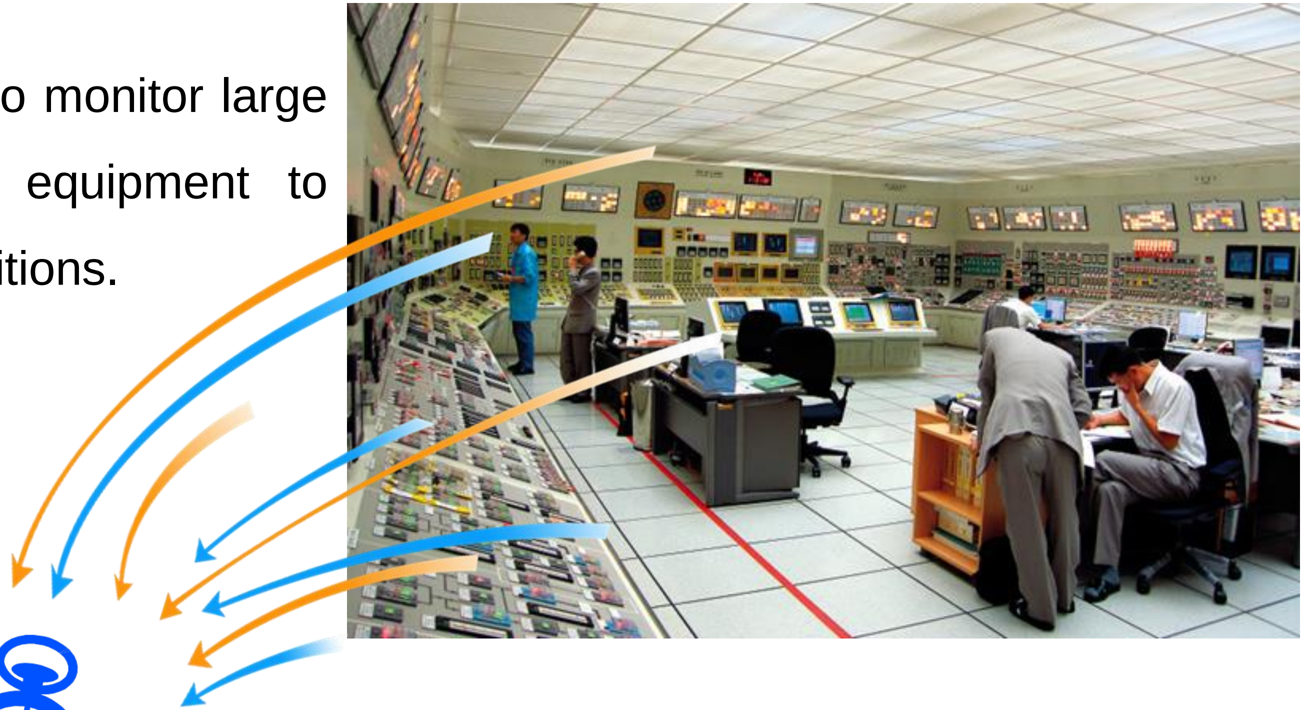
- University of Texas at Austin, Utility and Energy Management (UT-UEM) decided to adopt predictive maintenance based innovative solution which would help them in achieving their goal of providing un-interrupted and cost effective power supply for university campus.

- With the aim of this, UT-UEM has deployed condition based predictive monitoring solution called PHI.

- **Predictive monitoring solution-Value creation**
  - Improve stability of sensors
  - Improve stability of equipment
  - Improve availability and reliability of a plant

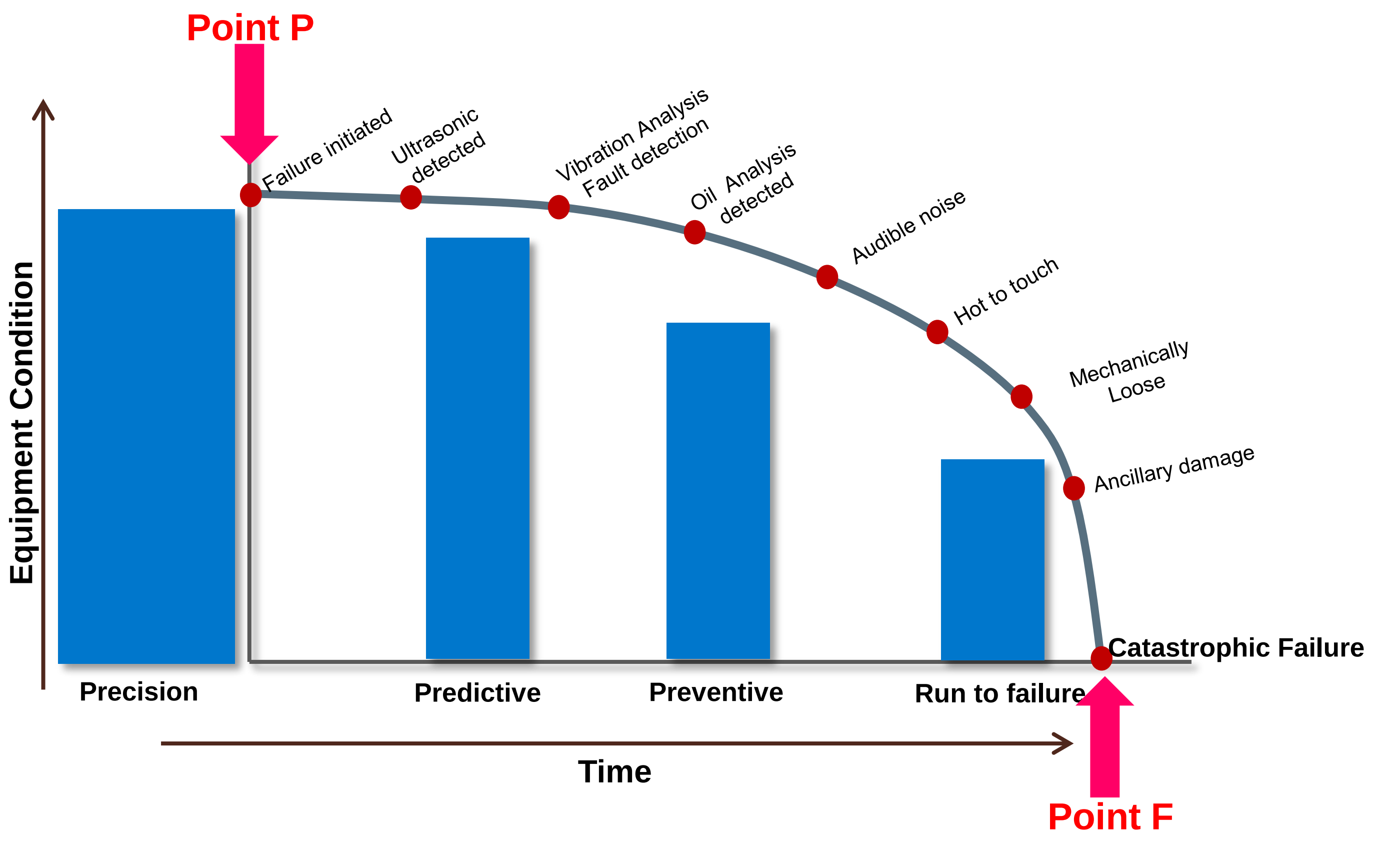
Technology Background

- In our plant, We have to monitor large number of data and equipment to identify abnormal conditions.



Technology Background

- How can you detect a failure early enough to provide time to plan and schedule with work without panic or reactivity?

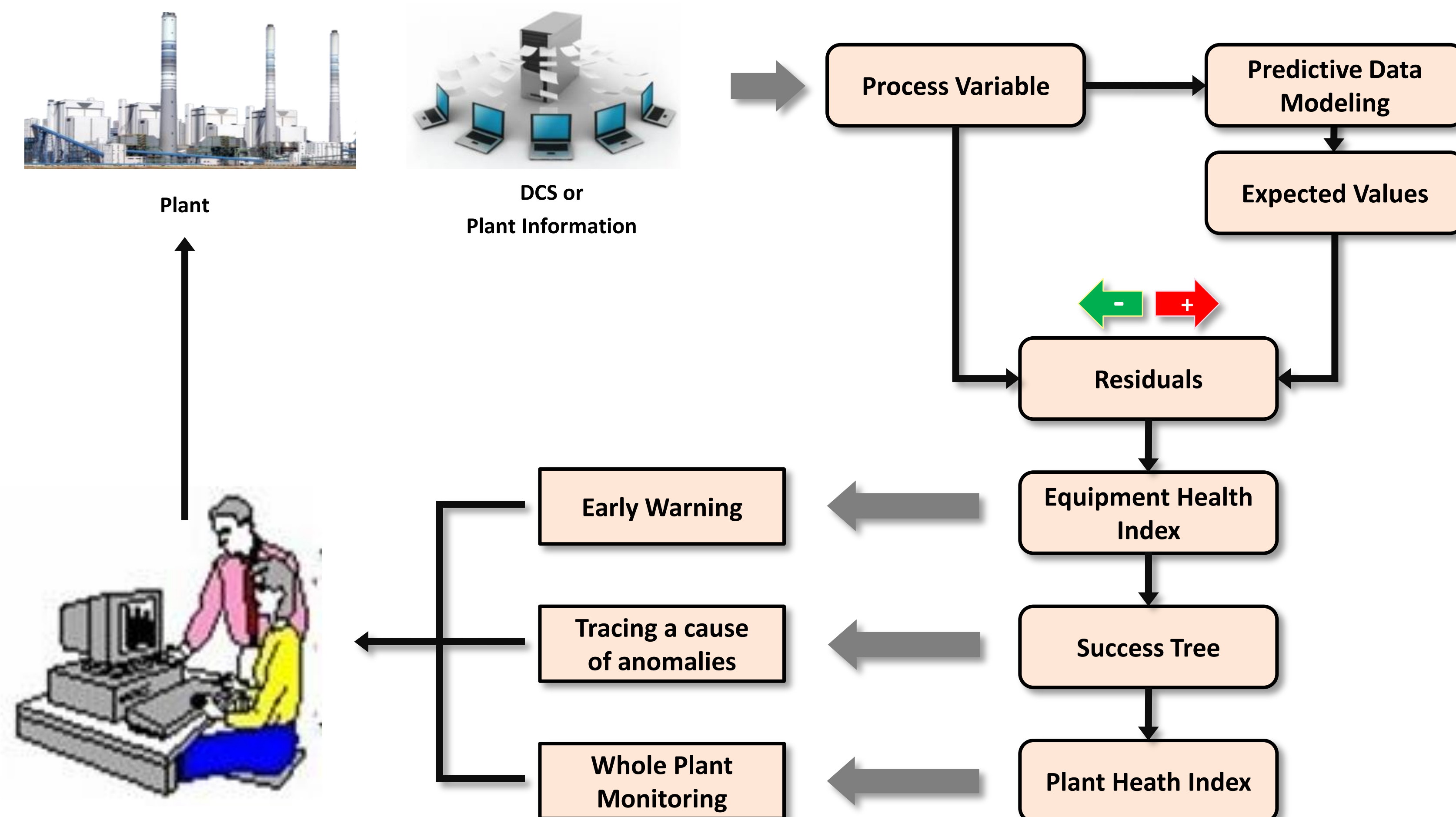


Predictive Monitoring Solution

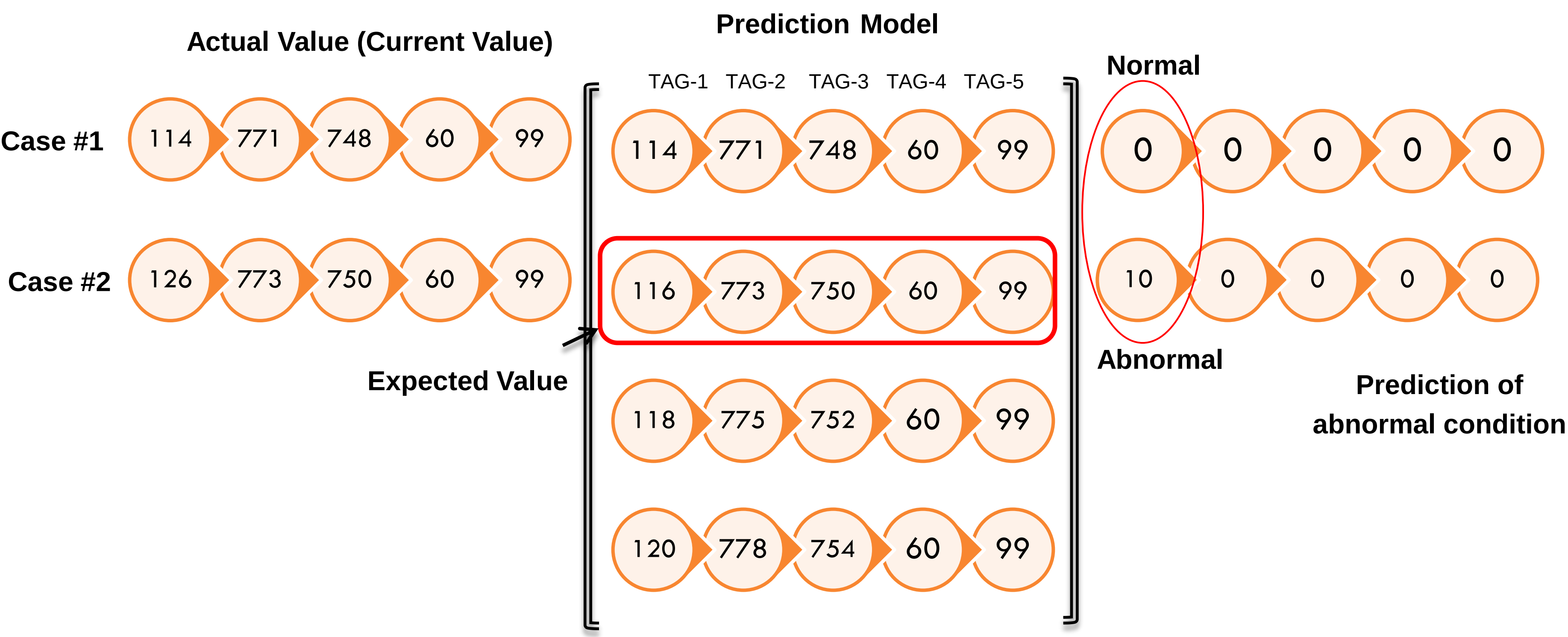
- The real-time predictive monitoring solution to identify equipment failure in advance

- What you can identify with help of Predictive Monitoring Solution?
  - Sensor failure
  - Potential equipment failure
  - Process failure
- Quick Recognition
  - Recognize anomalies for a plant health condition with health index number
  - Scrutinize abnormal equipment within a second
- Value Creation
  - Improve stability of sensors
  - Improve stability of equipment
  - Improve availability and reliability of a plant

Predictive Monitoring Solution



Predictive Monitoring Solution



Tag 1- S1_TT_SLFD (Temp) -TE-3420D seal oil feed temp

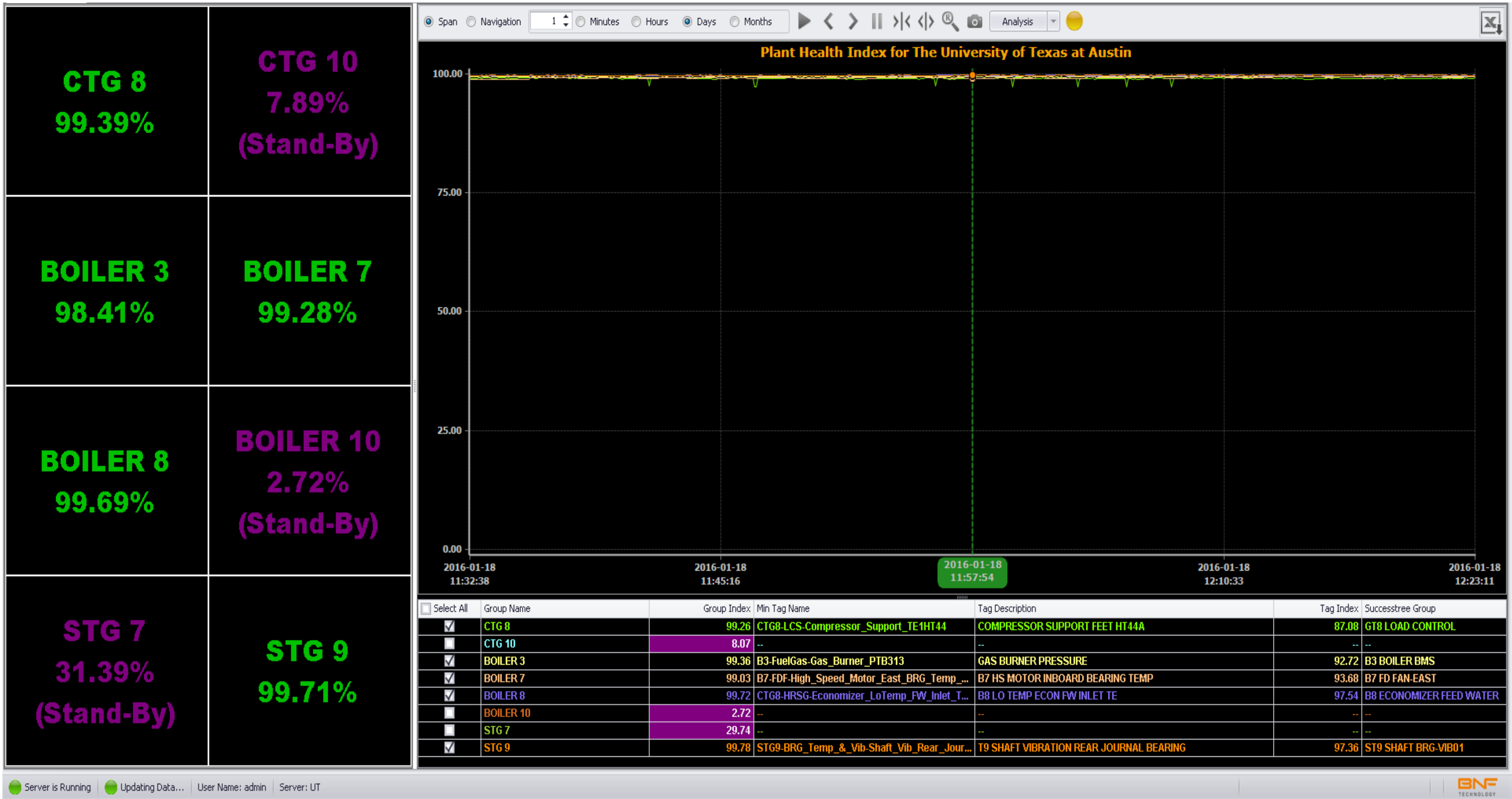
Tag-2 - S1_DWATT (Watt) - Generator Watt

Tag-3 - S1_TT_SSH(Temp) - Inlet Steam Temperature

Tag 4- S1_DF (Frequency) - Generator Frequency

Tag 5- S1_DV (Volts) - Generator Volts

Predictive Monitoring Solution

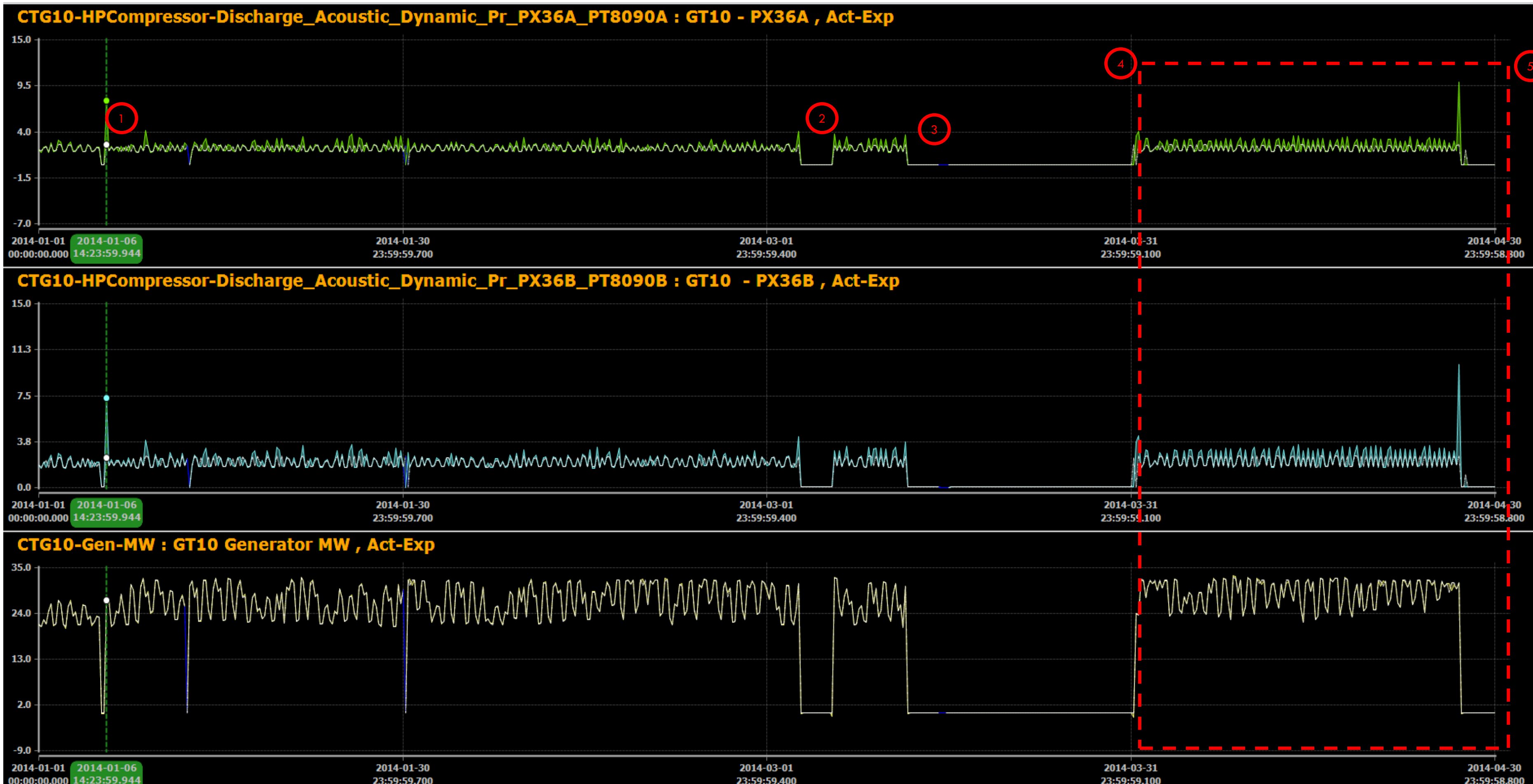


Case Study

- **Plant :** UT-UEM
- **Issue :** CTG10 – Compressor Inlet Temperature Control – T2
- **Anomalies Observed :** HP Compressor Discharge Acoustic Dynamic Pressure was unstable and changing between 1.7 to 10.5 (PSID) during 21:45 to 22:00 hours on 27th April 2014. Large fluctuations in CTG10 speed and acoustic vibration levels were also observed. after that the CTG10 was stopped/tripped.
- **Action:** GE Aero was contacted to discuss reason for trip which was related to unit speed. According to GEK 112767 Volume I; the VSV system senses gas generator speed and compressor inlet temperature, and positions the VSV's. For any temperature and any speed, the VSV's take one position and remain in that position until the NGG or T2 changes. After the failure UT-UEM, corrected the control logic to control T2 at a steady temperature.

Time	Tag Name	Act Value	Exp. Value	Res. Value	Operating Value		EU Range		Unit
					Min	Max	Low	High	
2014-04-27 21:46:38	CTG10-HPCompressor-Discharge_Acoustic_Dynamic_Pr_PX36A_PT8090A	5.4	1.7	-3.8	1.634	2.9653	-1	10	PSID
	CTG10-HPCompressor-Discharge_Acoustic_Dynamic_Pr_PX36A_PT8090B	6.5	1.7	-4.8	1.680	3.0147	0	10	PSID

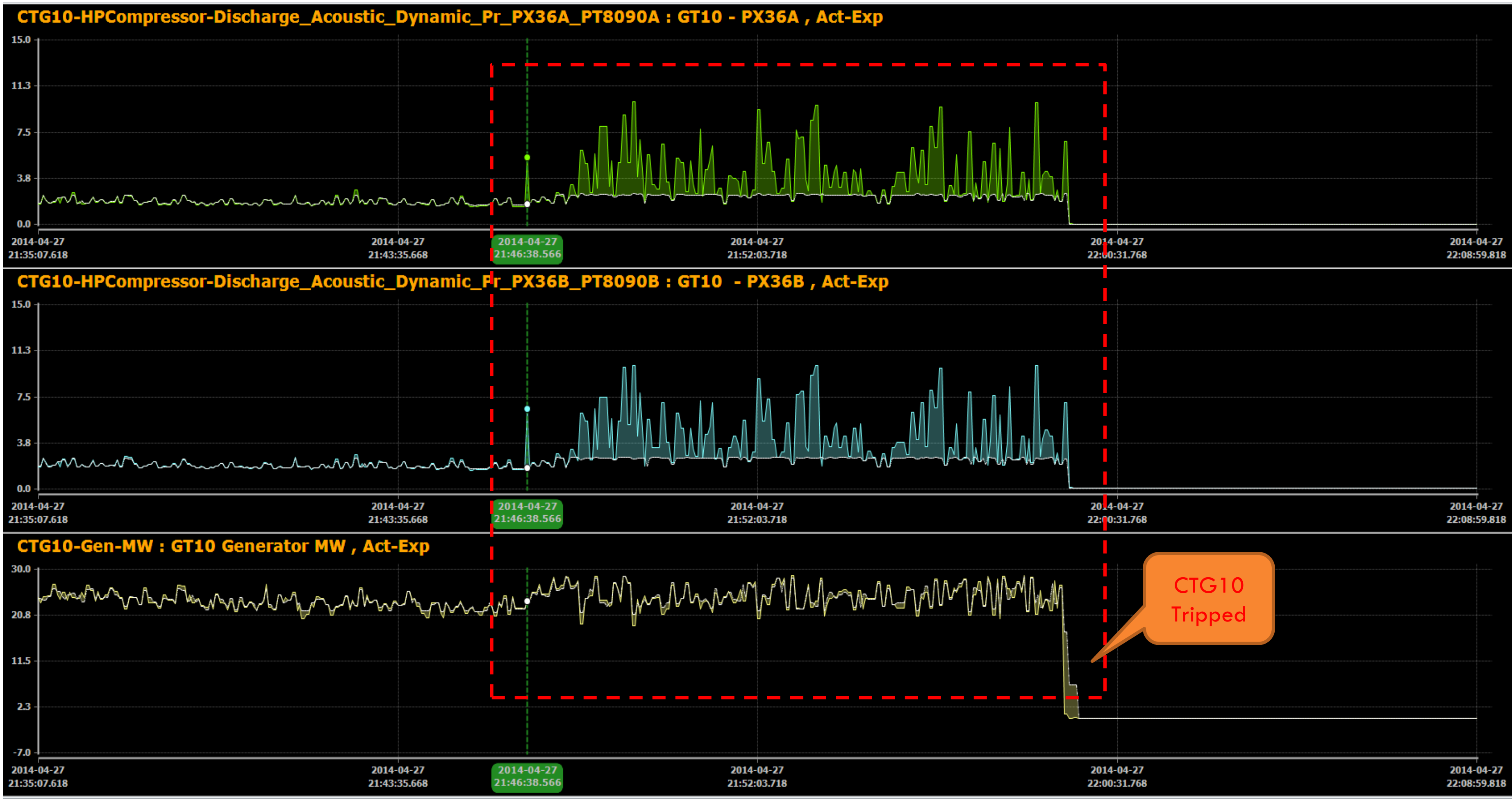
Case Study



Trend Details

Select All	Tagname	Description	Act Value	Exp Value	Res Value	Low	High	Unit	Remove
☑	CTG10-HPCompressor-Discharge_Acoustic_Dynamic_Pr_PX36A_PT8090A	GT10 - PX36A - PT-8090A - Acoustic/Dynamic Pressure Sensor A	7.7	2.5	-5.2	-1	10	psid	✗
☑	CTG10-HPCompressor-Discharge_Acoustic_Dynamic_Pr_PX36B_PT8090B	GT10 - PX36B - PT-8090B - Acoustic/Dynamic Pressure Sensor B	7.3	2.5	-4.9	0	10	psid	✗
☑	CTG10-Gen-MW	GT10 Generator MW	27.2	27.1	-0.1	-1	40	MW	✗

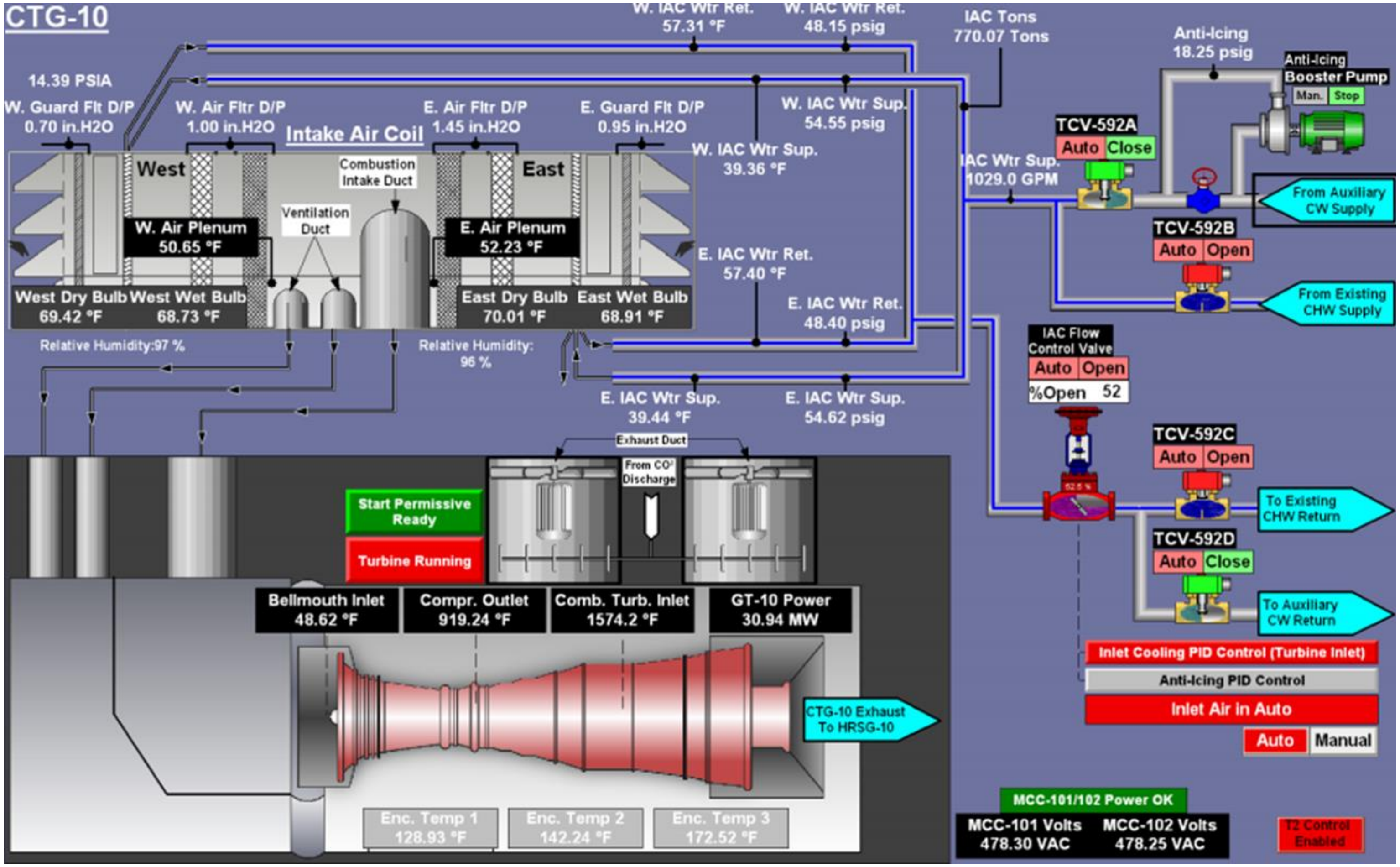
Case Study



Trend Details

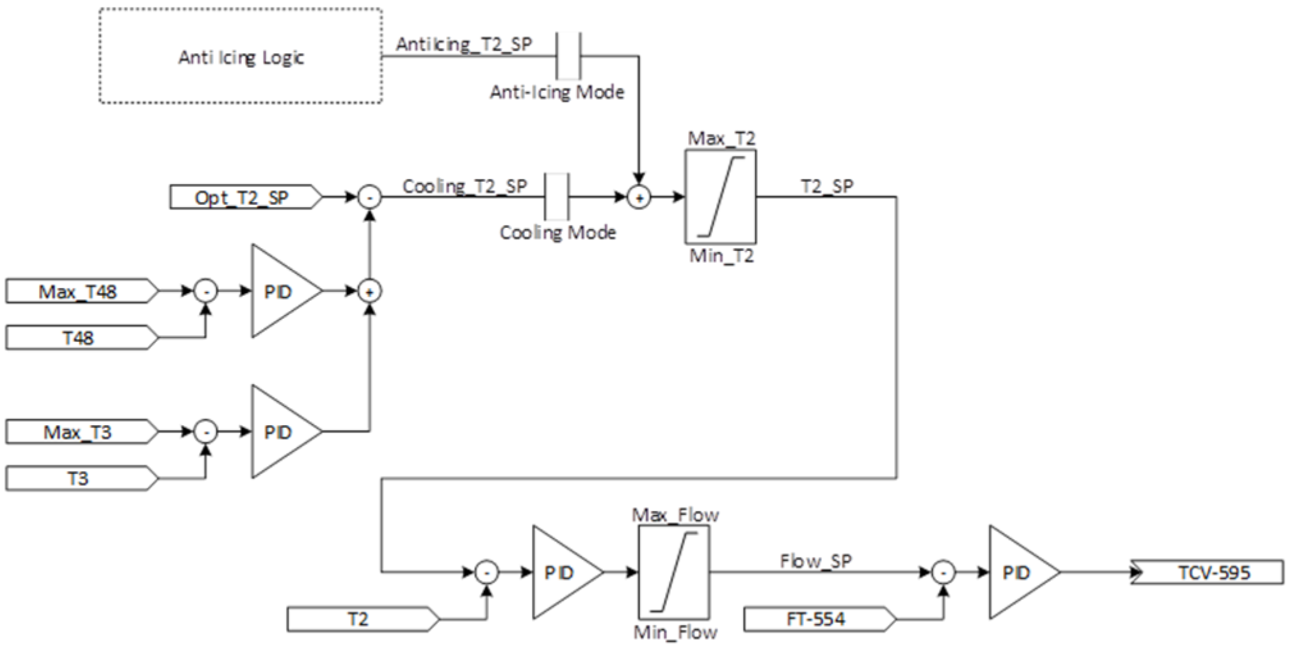
Select All	Tagname	Description	Act Value	Exp Value	Res Value	Low	High	Unit	Remove
☑	CTG10-HPCompressor-Discharge_Acoustic_Dynamic_Pr_PX36A_PT8090A	GT10 - PX36A - PT-8090A - Acoustic/Dynamic Pressure Sensor A	5.4	1.7	-3.8	-1	10	psid	✗
☑	CTG10-HPCompressor-Discharge_Acoustic_Dynamic_Pr_PX36B_PT8090B	GT10 - PX36B - PT-8090B - Acoustic/Dynamic Pressure Sensor B	6.5	1.7	-4.8	0	10	psid	✗
☑	CTG10-Gen-MW	GT10 Generator MW	23.6	23.5	-0.1	-1	40	MW	✗

Case Study


CTG-10
W. IAC Wtr Ret.
57.31 °F
W. IAC Wtr Ret.
48.15 psig
IAC Tons
770.07 Tons
Anti-Icing
18.25 psig
Anti-Icing
Booster Pump
Man.
Stop
14.39 PSIA
W. Guard Flt D/P
0.70 in.H2O
W. Air Fltr D/P
1.00 in.H2O
Intake Air Coil
E. Air Fltr D/P
1.45 in.H2O
E. Guard Flt D/P
0.95 in.H2O
W. IAC Wtr Sup.
54.55 psig
W. IAC Wtr Sup.
39.36 °F
IAC Wtr Sup.
1029.0 GPM
TCV-592A
Auto
Close
From Auxiliary
CW Supply
West
East
Combustion
Intake Duct
Ventilation
Duct
W. Air Plenum
50.65 °F
E. Air Plenum
52.23 °F
TCV-592B
Auto
Open
E. IAC Wtr Ret.
57.40 °F
From Existing
CHW Supply
West Dry Bulb
69.42 °F
West Wet Bulb
68.73 °F
East Dry Bulb
70.01 °F
East Wet Bulb
68.91 °F
E. IAC Wtr Ret.
48.40 psig
Relative Humidity:97 %
Relative Humidity:
96 %
IAC Flow
Control Valve
Auto
Open
%Open
52
E. IAC Wtr Sup.
39.44 °F
E. IAC Wtr Sup.
54.62 psig
Exhaust Duct
TCV-592C
Auto
Open
Start Permissive
Ready
To Existing
CHW Return
Turbine Running
TCV-592D
Auto
Close
Bellmouth Inlet
48.62 °F
Compr. Outlet
919.24 °F
Comb. Turb. Inlet
1574.2 °F
GT-10 Power
30.94 MW
To Auxiliary
CW Return
Inlet Cooling PID Control (Turbine Inlet)
Anti-Icing PID Control
CTG-10 Exhaust
To HRSG-10
Inlet Air in Auto
Auto
Manual
MCC-101/102 Power OK
Enc. Temp 1
128.93 °F
Enc. Temp 2
142.24 °F
Enc. Temp 3
172.52 °F
MCC-101 Volts
478.30 VAC
MCC-102 Volts
478.25 VAC
T2 Control
Enabled

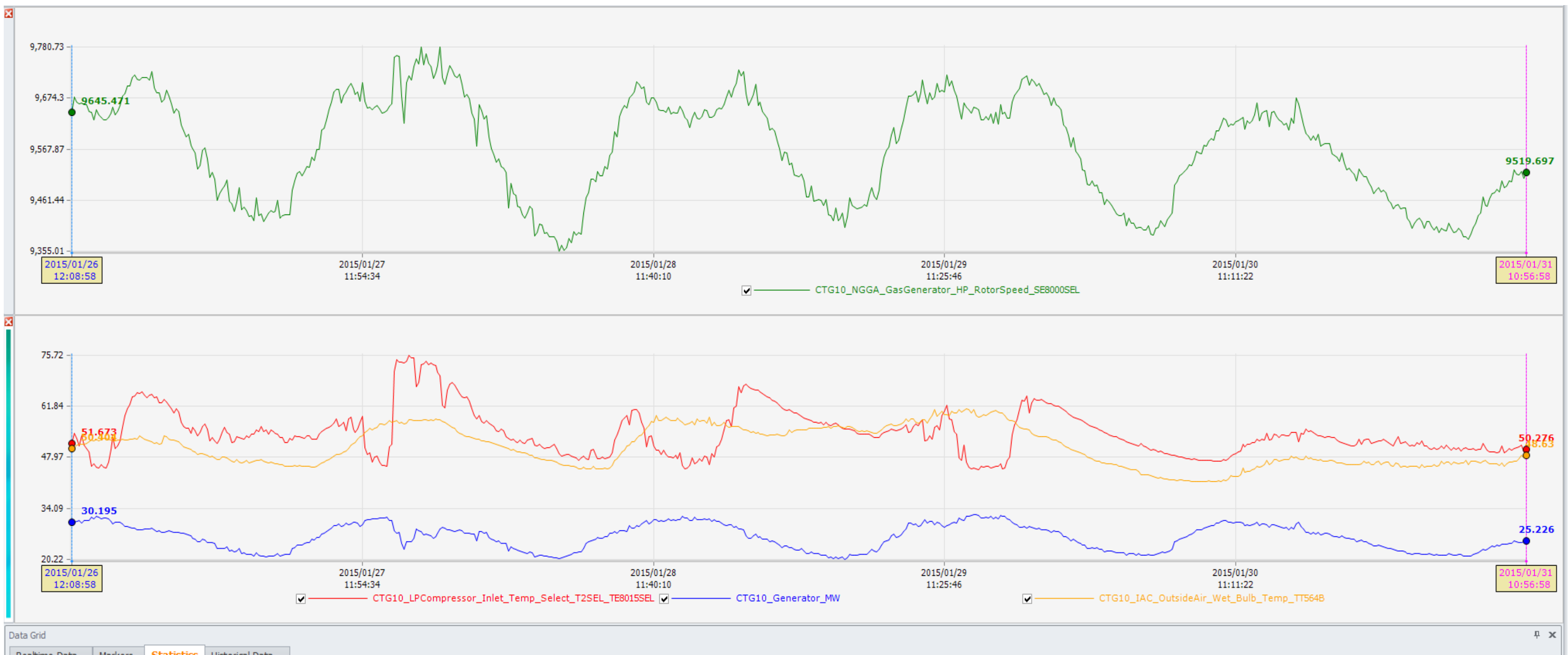
Case Study

- The control diagram below depicts what was implemented to control T2 at a steady temperature.



Case Study

- The trend below depicts behavior before control scheme implementation



Color	Tag Name	Unit	Time 1	Time 2	Min	Max	Average	Std Dev
Red	CTG10_LPCompressor_Inlet_Temp_Select_T2SEL_TE8015SEL		2015/01/26 12:08:58	2015/01/31 10:56:58	44.676	75.716	54.589	6.244
Blue	CTG10_Generator_MW		2015/01/26 12:08:58	2015/01/31 10:56:58	20.216	32.339	26.216	3.505
Orange	CTG10_IAC_OutsideAir_Wet_Bulb_Temp_TT564B		2015/01/26 12:08:58	2015/01/31 10:56:58	41.37	61.17	50.816	5.319

Case Study

- The trend below depicts behavior after control scheme implementation

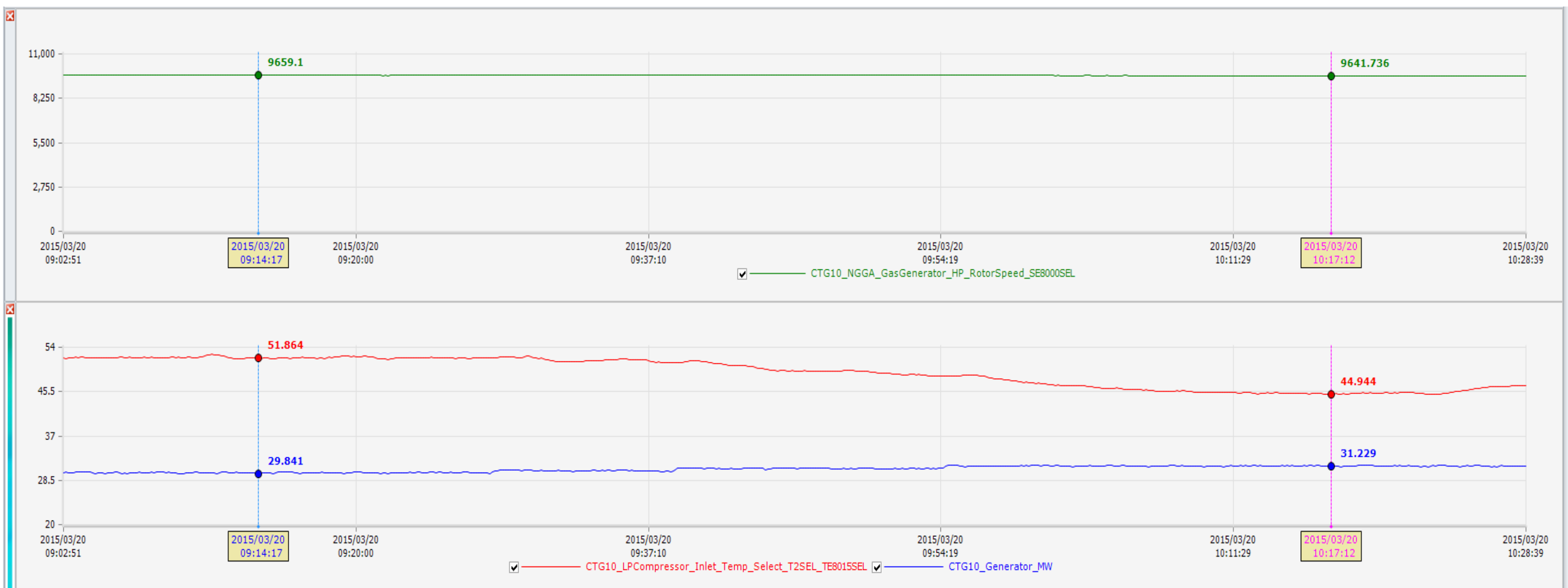
Data Grid

Realtime Data | Markers | Statistics | Historical Data

Color	Tag Name	Unit	Time 1	Time 2	Min	Max	Average	Std Dev
	CTG10_LPCompressor_Inlet_Temp_Select_T2SEL_TE8015SEL		2015/03/20 00:43:39	2015/03/21 15:35:51	44.971	52.481	51.427	1.771
	CTG10_Generator_MW		2015/03/20 00:43:39	2015/03/21 15:35:51	19.364	32.076	25.815	2.873
	CTG10_IAC_OutsideAir_Wet_Bulb_Temp_TT564B		2015/03/20 00:43:39	2015/03/21 15:35:51	55.319	69.194	61.026	4.738

Case Study

- The trend below depicts behavior after control scheme implementation - detailed



Data Grid

Realtime Data | Markers | Statistics | Historical Data

Color	Tag Name	Unit	Time 1	Time 2	Min	Max	Average	Std Dev
Red	CTG10_LPCompressor_Inlet_Temp_Select_T2SEL_TE8015SEL		2015/03/20 09:14:17	2015/03/20 10:17:12	44.944	52.317	49.279	2.545
Blue	CTG10_Generator_MW		2015/03/20 09:14:17	2015/03/20 10:17:12	29.785	31.427	30.704	0.511

Case Study

- More stable T2 control advantages
  - Better CTG10 operation
  - Less stress in unit components
  - Better CS (source of cooling) performance
  - PHI continues to be looked at daily – UEM has hired an additional Engineer to manage this process
  - Q& A

Contact Information

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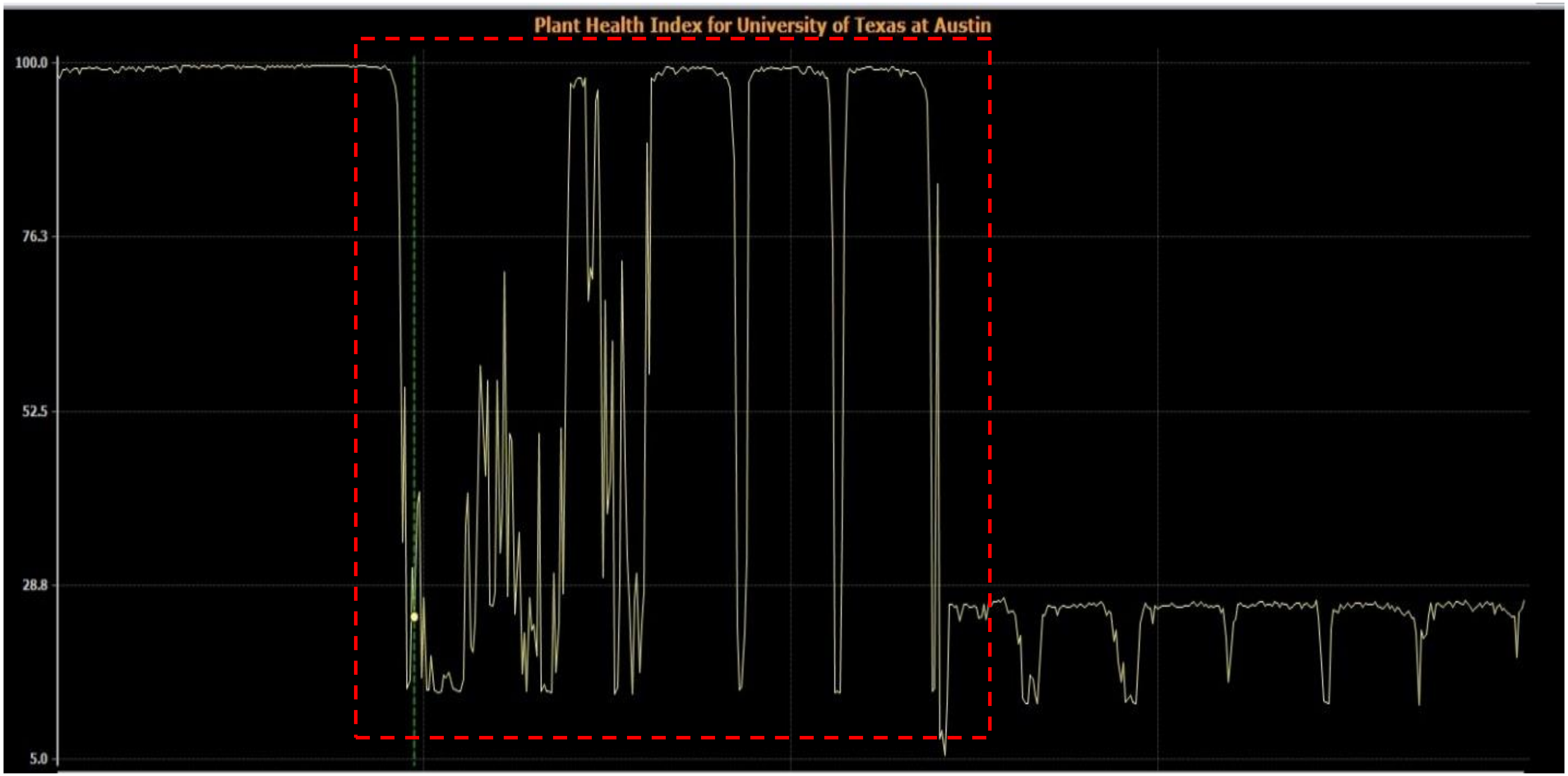
Sunil Warke: Sunil@bnftech.com

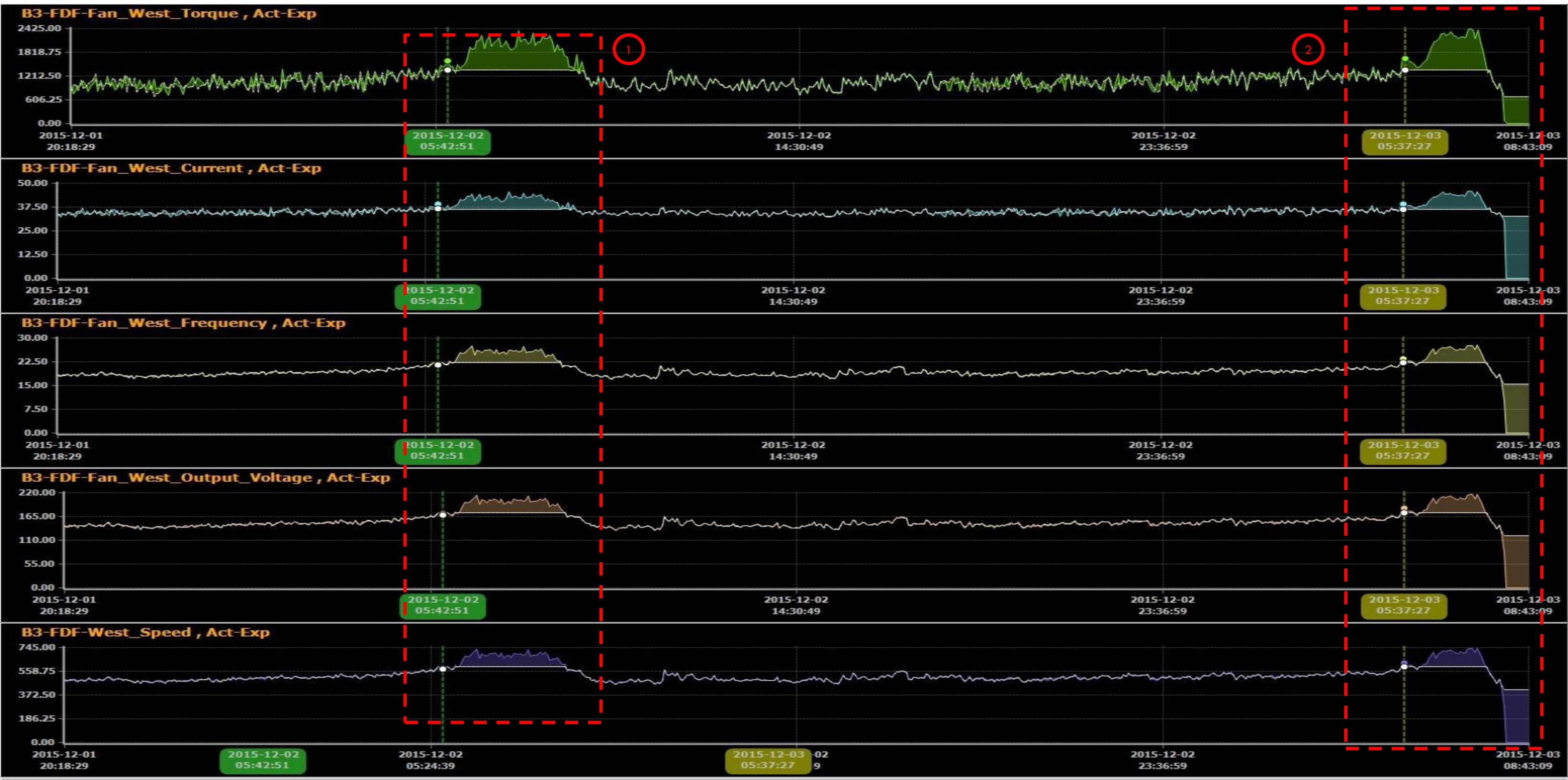

Q
&
A

Case Study

- System: Boiler 3 , FD Fan –Main Index Trend



Case Study



Trend Details

Select	Tag Name	Description	Low	High	Act Cursor1	Exp Cursor1	Res Cursor1	Act Cursor2	Exp Cursor2	Res Cursor2	Unit	...
☑	B3-FDF-Fan_West_Torque	FD FAN WEST TORQUE	0	1000	1610.00	1360.92	-249.08	1657.00	1369.00	-288.00	FTLBS	✕
☑	B3-FDF-Fan_West_Current	WEST VFD FAN CURRENT	0	250	39.20	36.55	-2.65	39.00	36.50	-2.50	AMPS	✕
☑	B3-FDF-Fan_West_Frequency	WEST VFD FAN FREQ	0	100	21.81	21.57	-0.24	23.51	22.29	-1.22	HZ	✕
☑	B3-FDF-Fan_West_Output_Voltage	WEST VFD FAN OUTPUT VOLTAGE	0	500	172.00	168.43	-3.57	184.00	174.00	-10.00	VOLTS	✕
☑	B3-FDF-West_Speed	FD FAN WEST SPEED	0	2500	581.46	576.23	-5.23	628.14	595.48	-32.67	RPM	✕

Case Study

- System: Boiler 3 , FD Fan

- It was observed that the quality of the main trend was dropped down to 25% on November 22, 2015 again about the same time after four days. This occurrence is observed on October 12, 2015 and December 14, 2015 after the fans were swapped.

Case Study

- FD-FAN speed and torque Actual-Expected Trend

Case Study

- A low health index was observed on boiler 3 and after analysis it was discovered that there were variation in west fan torque and the current as shown on actual-expected trend.
- This kind of behavior did alarm the system and was not observed in the plant historian database. According to the instrumentation team, there were two differential pressure transmitters were not in the same position hence the difference in readings.

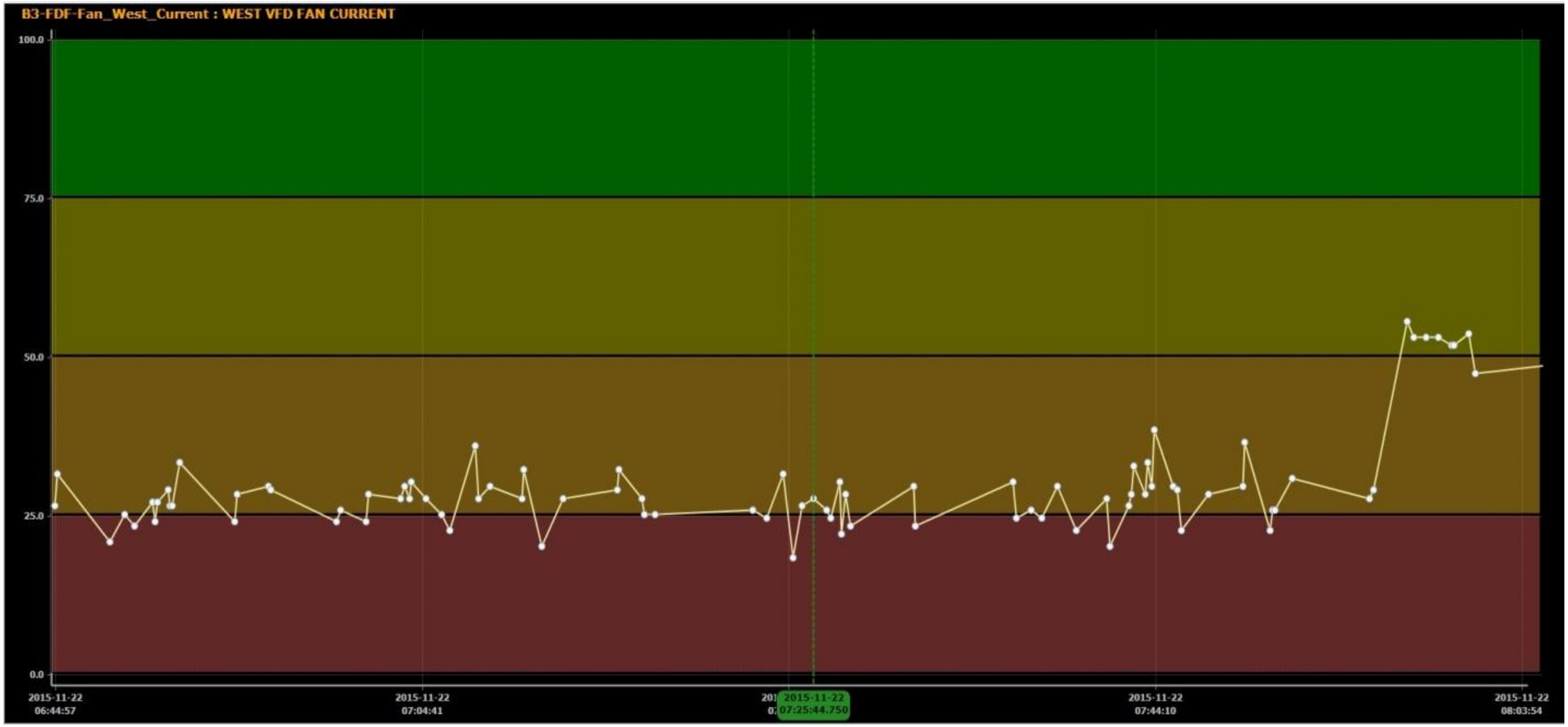
Case Study

- FD-FAN Torque tag detail table for October 12, 2015

Time	Tag Name	Description	Actual Value	Expected Value	Operating Value (KSCFH)		EU Range (KSCFH)	
					Min	Max	Low	High
12/10/2015 7:26am	B3-FDF-Fan West_Torque	FD Fan west Torque	0	681	45	1686	0	1000

Case Study

- Alarm Trend



Case Study

- There is disparate between the instrument readings, ideally the readings from both instrument should be exactly same. It was about 180 % more than the other one. The boiler was shut down and calibrated the meters.
- After the calibration the difference in reading has improve remarkably, although the difference in reading is not equal, its improvement is tremendous. There is the need to calibrate instruments for further accurate reading.