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USING PREDICTIVE ANALYTIC SOFTWARE SOLUTION FOR IDENDIFYING EQUIPMENT FAILURE IN ADVANCE; THE UNIVERSITY OF TEXAS AT AUSTIN

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ABSTRACT

The University of Texas at Austin is well known for its quality of education and research. In order to maintain a high standard of education, the uninterrupted and cost-effective power, steam and cooling supply plays an important role. To meet this need, the University of Texas at Austin – Utilities and Energy Management Department decided to adopt an innovative predictive maintenance based solution.

A technology wise Predictive Maintenance approach promises cost savings and improvement in both stability and performance compared to a routine or time based Preventive Maintenance program. UT-UEM has deployed the Predictive Analytic Software Solution; PHI (Plant Health Index) to improve Operational Excellence by using the early detection feature of the system that captures anomalies in the behaviours of sensors, equipment and the operation of process plant systems. PHI also helps analyse process uncertainty using statistical learning by modelling the operational history in a simple setup.

This paper explains how UT-UEM achieves its goals and identifies hidden problems in advance before they become catastrophic failures with the help of PHI. The case studies shows how UT-UEM used the Predictive Analytic Software Solution to provide an early warning of anomalies that could result in system and operational failures in its systems. The studies also shows how UT-UEM identified the abnormal behaviour and hidden problems from the sensor level to the associated equipment level for Gas Turbines, Steam Turbines and Boilers systems.

INTRODUCTION

The increase of energy consumption which is at the convergence of green policy, IT and operations has changed how process plants are operated. There is a great deal of emphasis on reducing operating costs which has caused process operational variability. Demand uncertainty and global competition from low cost energy sources increases need for plant operators and maintenance people to maximize operation excellence.

Process plants have been using various maintenance approaches to minimize cost and improve efficiency. The initial approach was called break down maintenance then later it advanced to preventive maintenance which was later changed to proactive maintenance. It has shifted to predictive maintenance approach which has been found to be the most efficient among all the practices.

Break down maintenance or corrective maintenance approaches required large maintenance budgets to maintain a plant. While this approach provides the best utilization of components in a plant, the high cost lead the forced the use of the preventive maintenance approach.

The preventive maintenance objective was to keep the plant in a good operating condition components often had to be replaced with new one or refurbished parts to avoid major plant trips. However the approach was not adequate enough to improve the availability, operational excellence while minimizing maintenance cost.

The proactive maintenance approach was considered expensive maintenance because it was based on mean time between failures to replace the components in the plant. So the necessity to reduce cost and improve performance paved the way to the predictive maintenance approach.

The predictive maintenance approach is currently widely used by the process industry today because it reduces unnecessary maintenance activities, improves stability and performance by providing an early detection of a decreasing reliability of plant equipment. This is accepted by the plants as the best available maintenance practice at a lower cost.

As University of Texas at Austin has a large R&D infrastructure and UT-UEM has the responsibility to stably electricity, steam and chilled water to the campus. So, UT-UEM decided to adopt an innovative predictive maintenance based solution to help them achieve its performance goals for the campus.

BACKGROUND

PHI's plant condition monitoring and predictive analytics solution provides an early warning of potential, hidden and functional failures of sensors, transmitters, equipment and plant operational processes before catastrophic failures occur. To predict failures in advance, the system uses algorithms based on advanced empirical models. It utilizes historical data gathered during normal plant operational periods to design empirical models with fault free normal operational data of a plant and system groups to correlate it to the actual real-time equipment signals.

The prediction models designed by PHI measure discrepancies between the real-time operating condition and the predicted operating condition. Discrepancies in current conditions of the plant are indicated as a percentage that correlates to the plant's health condition.

When the health is seen deteriorating (dropping below 100%) and needs to be analysed both historical and real-time data can be trended to track the anomalies using the success tree along with the plant's hierarchical chart. To facilitate noting the condition, an alarm can be set up to note when a safety or efficiency set point is exceeded.

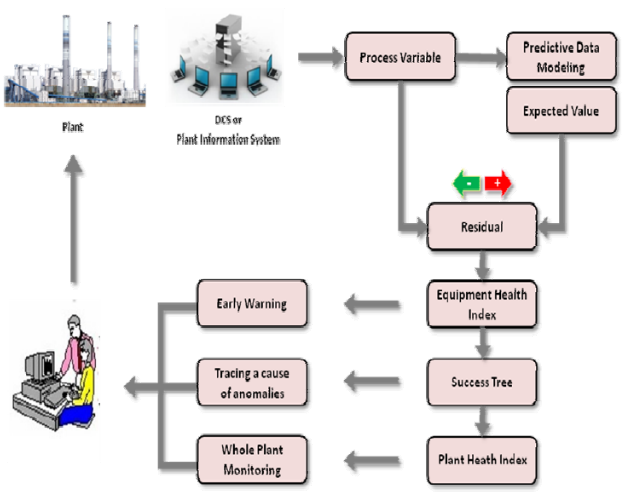

Figure 1 Diagram explaining the working of PHI

RESULTS

PHI has been installed in UT UEM since 2013 to monitor Boilers 3 & 7, Heat Recovery Steam Generators 8 & 19, Combustion Turbine Generators 8, 10 and Steam Turbine Generators 7 & 9.

Case 1

HP compressor discharge acoustic dynamic pressure was unstable and changing 1.7 to 10.5 (Unit: PSID) during 21:45 to 2:00 hours on 27th April 2014 (Refer Table 1). Large fluctuations in CTG10 speed and acoustic vibration levels were also observed after that the CTG10 was stopped and tripped.

Table 1

Tag Name	Act. Value	Exp. Value	EU Range	
			Low	High
HPCompressor-Discharge_Acoustic_Dynamic_Pr_PX36A_PT8090A	5.4	1.7	-1	10
HPCompressor-Discharge_Acoustic_Dynamic_Pr_PX36A_PT8090B	6.5	1.7	0	10

The earliest indication of the problem was alerted by PHI on the 14th January 2014. Until the CTG10 stopped and tripped, there were five (5) early warnings of the potential anomalies (Refer Figure 1).

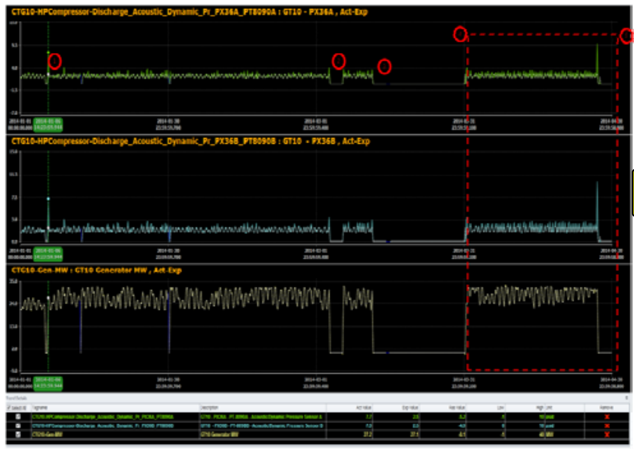

Figure 2. Trend Analysis

To define and fix the problem, the manufacturer of the equipment 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 takes one position and remains in that position until the NGG or T2 changes.

As a result, the T2 control logic at a steady temperature was corrected and the CTG10 has been operated with better CS (Source of Cooling) performance. The PHI system has continued to monitor the systems conditions.

Case 2

On 12th October 2015, the health index of FD Fan of the Boiler 3 has been dropped down to 25%. On 22nd November 2015, the same situation happened again. The vibration in the torque of the Boiler 3 West FD Fan was identified by PHI (Refer Figure 3). It detected the West FD Fan torque was varying.

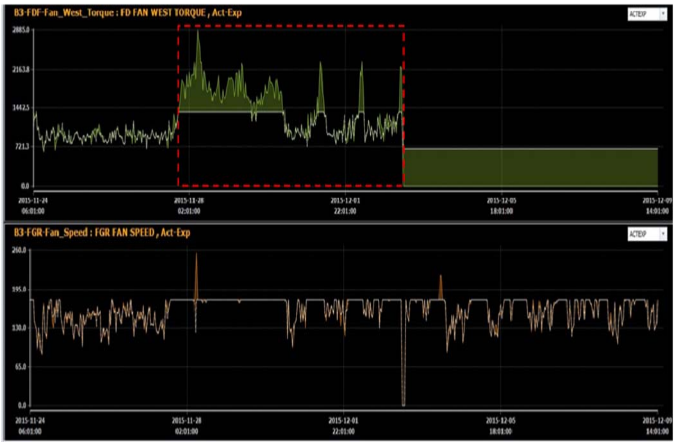

Figure 3. The vibration in the torque of the Boiler 3 West FD Fan

The same behavior was repeated on 2nd and 3rd December 2015 until the boiler 3 was shut down for repairing.

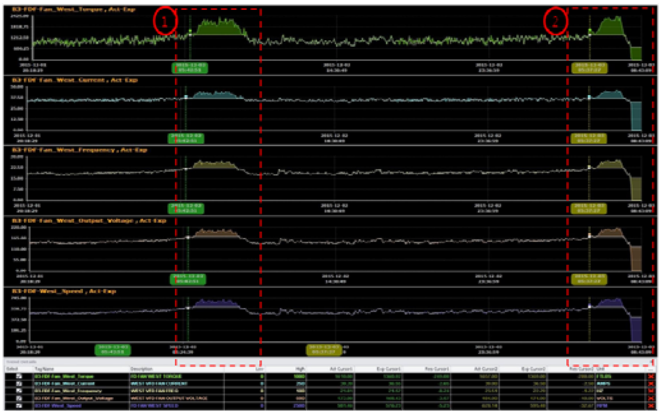

Figure 4. Discrepancies between the predicted and actual values

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 behavior alerted by PHI, but was not observed the plant HMI system and historian. There were two differential pressure transmitters which were not in the same position hence the difference in readings. Ideally the readings from both instruments should be exactly same however it was about 180% more than the other one. As s maintenance, the boiler was shutdown and calibrated the meters.

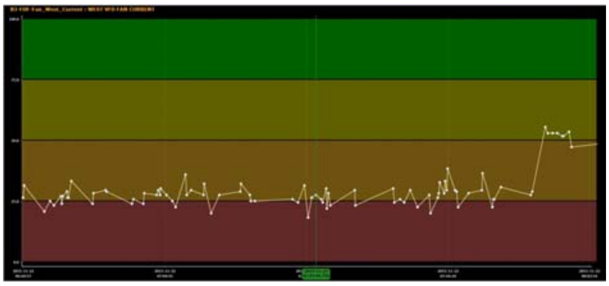

Figure 5. Alarm Trend for analyzing the problem

After calibration the difference in readings has been improved remarkable, there is need to calibrate those instruments for further accurate reading.

CONCLUSION

For achieving operational excellence of a plant, it is very important to find out hidden failures in advance, prevent catastrophic failures in advance, and improve operation and process.

As a result, UT-UEM has adopted the advanced technology such as predictive analytics and it alerts sensors, transmitters, equipment and operation failures before it happens.

Based on the system, UT-UEM has kept reducing unexpected equipment failures, and unplanned maintenance activities and outage time.