PowerPlant
PerformanceMonitoring Services

ACTSYS
Process management consultants

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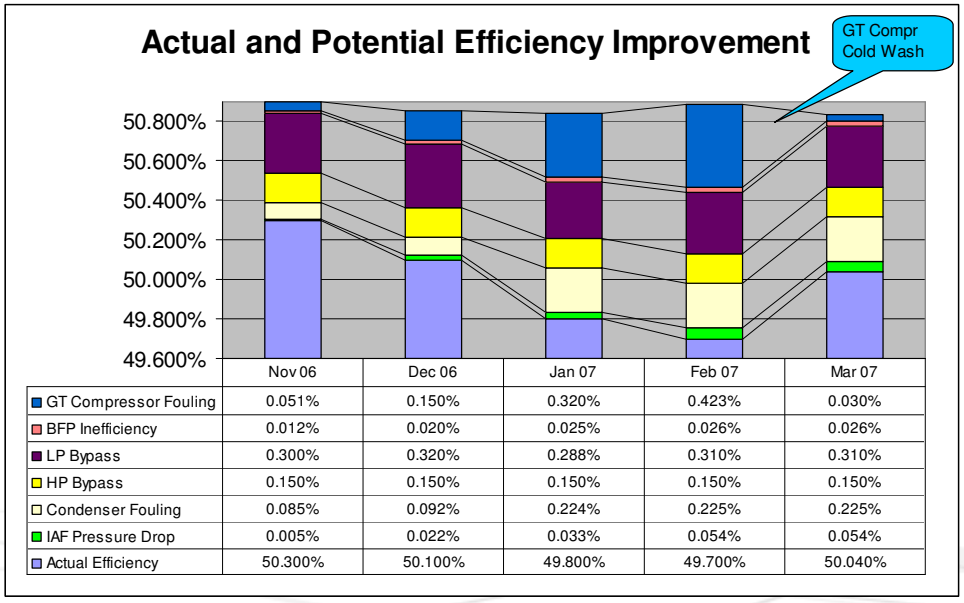
PerformanceMonitoring Overview

Systematic performance monitoring and analysis of power plant equipment has become an essential activity in today's increasingly energy intensive and competitive power industry. Understanding the impact of individual equipment behavior on overall plant performance is essential for optimizing plant operation and maintenance which would ensure efficient and reliable plant operation. Successful execution of this performance monitoring task demands the proper tools and methodology and is a collective effort with plant engineers from the various disciplines such as asset management, operation, boiler / turbine specialists, instrumentation and finance. Such performance monitoring when implemented will make transparent the measurement of plant efficiency and the respective component losses which can then be used to drive operational adjustments and an efficiency condition-based predictive maintenance program.

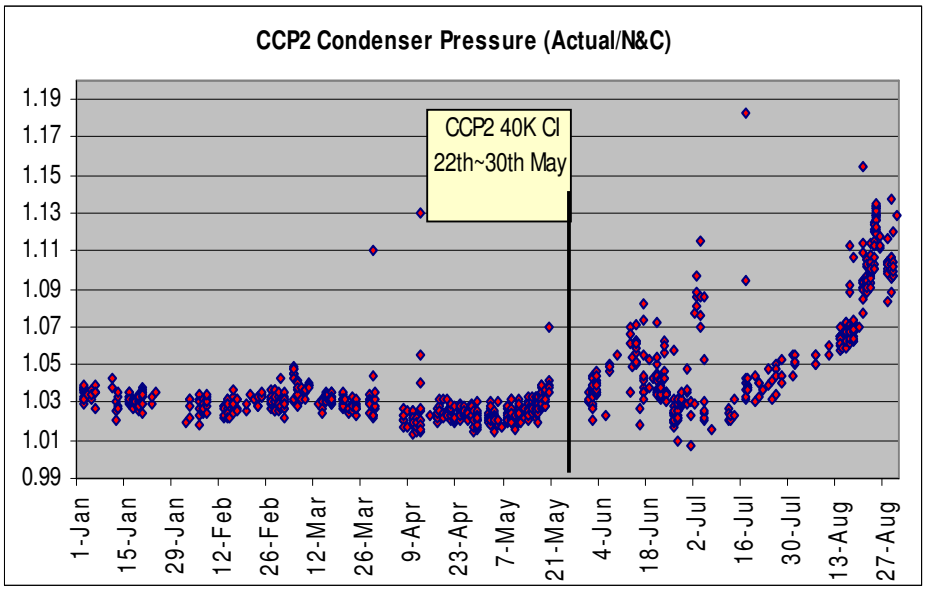


	Nov 06	Dec 06	Jan 07	Feb 07	Mar 07
GT Compressor Fouling	0.051%	0.150%	0.320%	0.423%	0.030%
BFP Inefficiency	0.012%	0.020%	0.025%	0.026%	0.026%
LP Bypass	0.300%	0.320%	0.288%	0.310%	0.310%
HP Bypass	0.150%	0.150%	0.150%	0.150%	0.150%
Condenser Fouling	0.085%	0.092%	0.224%	0.225%	0.225%
IAF Pressure Drop	0.005%	0.022%	0.033%	0.054%	0.054%
Actual Efficiency	50.300%	50.100%	49.800%	49.700%	50.040%

Chart shows the deterioration in plant thermal efficiency of a combined cycle power plant over a period of time. During this period, different component losses as quantified by performance monitoring are correspondingly increasing. With appropriate maintenance on the degraded component(s), thermal efficiency of the plant was partially restored.

How does this compare with traditional online performance monitoring systems which have been implemented in most power plants today? The above described capability to quantify component losses goes well beyond what online systems can do, which are mainly limited to calculating "expected values" for chosen plant parameters. As the gaps are not translated into effect on overall plant efficiency or baseload capability, they are usually not useful as decision support for determining operational or maintenance activities. Furthermore online systems suffer from the black box effect which does not help in terms of instilling confidence with the plant engineers to accept the results.

For timely corrective actions – Equipment performance deterioration like fouling of GT Compressor, Condenser, Economizer, Steam Turbine sections (HP, IP & LP), Boiler radiant and convection sections, Feedwater Heaters, etc can be monitored using time trends and their impacts on overall plant performance loss can be quantified. Also, equipment malfunctioning like passing HP, LP bypass valves, Feedwater PreHeater bypass valves, Condenser air ingress, etc can be identified and their impacts on overall plant performance loss similarly quantified. This helps in taking timely action to restore the performance of individual component/system.



Condenser performance is monitored by comparing the actual condenser pressure with target condenser pressure N&C (New and Clean) value which is calculated by a thermodynamic model of the design condenser. Chart shows the condenser performance deterioration after May when the ratio of Actual / N&C condenser pressure dramatically increases.

To assess the effectiveness of corrective actions – Evaluating the performance of the individual equipment and plant before and after the maintenance would help in ascertaining the effectiveness of maintenance actions such compressor wash, soot blowing of economizer, cleaning of condenser tubes, etc.

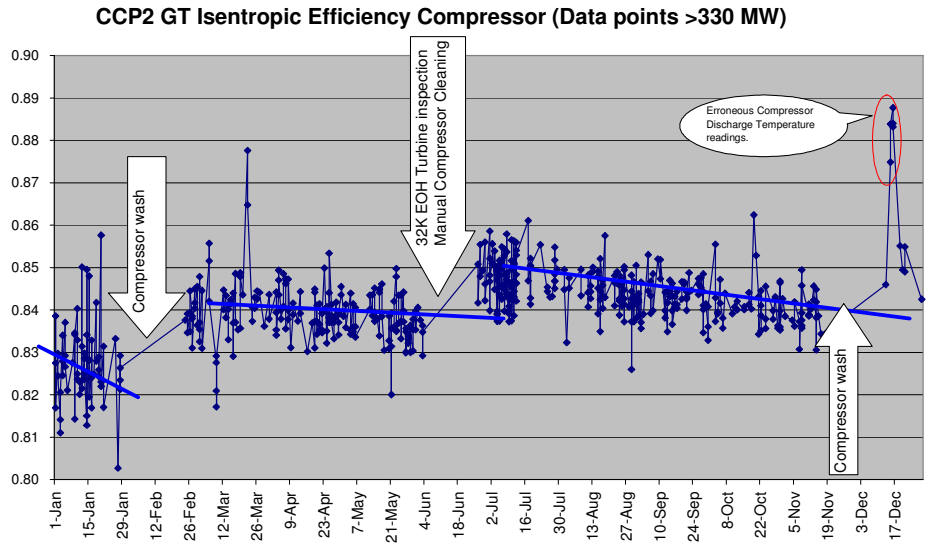
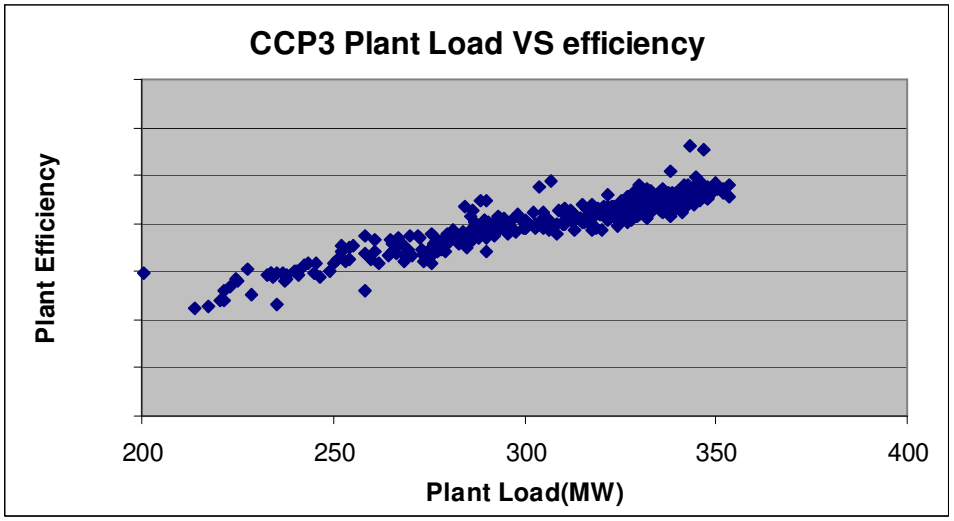


Chart shows GT compressor performance monitoring by tracking its isentropic efficiency. The effectiveness of each cold wash can be quantified in terms of the improvement in isentropic efficiency achieved.

Examples of PerformanceMonitoring Analyses

To track Plant efficiency versus load performance – Due to degradation of plant components, this characteristic will vary over time. By having regular updates of the efficiency versus load curve of each unit, the planning department will be able to preferentially load units during part load operation. The lower efficiency unit will be loaded less therefore maximizing overall production efficiency.



To countercheck various online measurements – through heat balance calculations, measured flows of selected streams can be verified in terms of being consistent with overall plant heat balance. For example, performing heat and mass balance analysis around GT enables independent calculation of the GT heat consumption which in turn enables calculation of the GT fuel consumption. The calculated fuel consumption can be used to countercheck the measured fuel consumption.

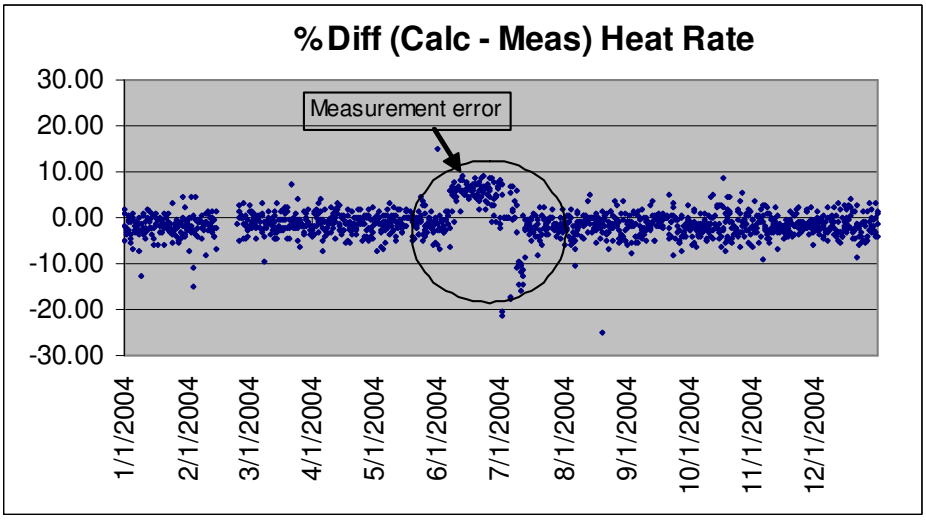
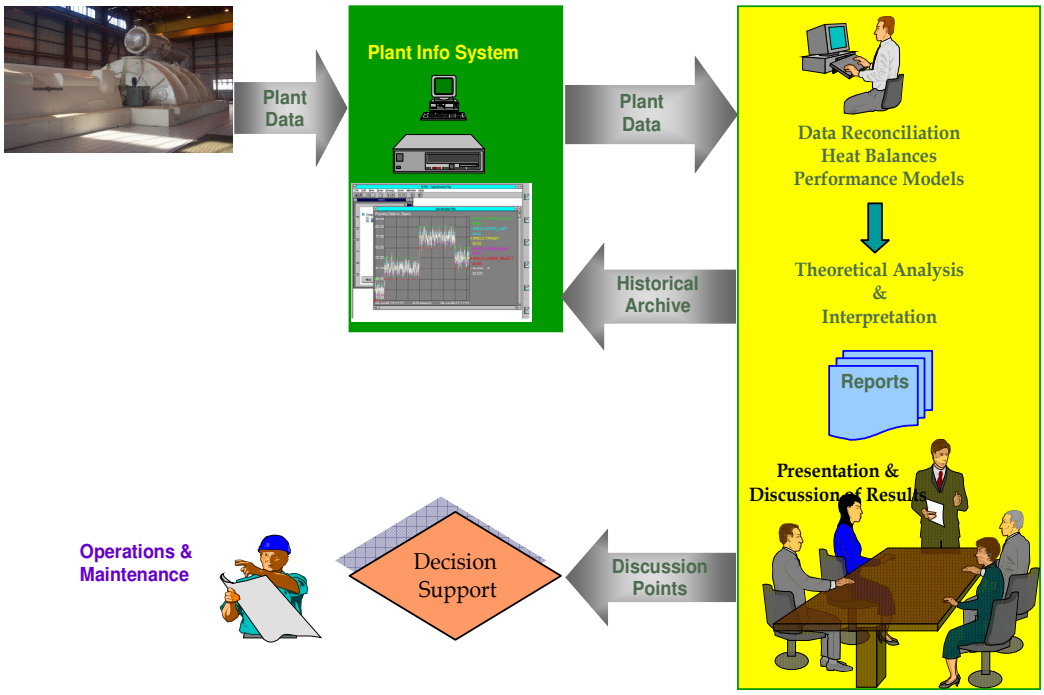


Chart shows the fuel measurement error which was identified using the calculated fuel consumption in GT. Subsequent to the calibration equipment, the abnormal deviation in the trend was resolved

PerformanceMonitoring **ProjectOverview**

Actsys Process Management Consultants Pte Ltd (ACTSYS) was started up in 2001 and consists of a team of industry experienced specialists who can help power plant customers with performance monitoring (processes as shown in the yellow box) either directly outsourced or via enhancing the capabilities of plant engineers with methodology and tools for them to carry out performance monitoring by themselves.



For setting up and carrying out such performance monitoring in a plant the following steps are typically taken

- *Parameters which are measured at site and required for the analysis are identified and included into data collection templates*
- *Using design and commissioning data, the necessary thermodynamic models are configured to perform heat balance and N&C calculations (the thermodynamic modeling software for power plants Gatecycle™ from General Electric is used)*
- *Regular plant data are analyzed*
- *Analysis results are discussed with in-house engineers and action plans in terms of maintenance corrections, operational corrections and instrument calibrations are formulated*
- *Performance monitoring methodologies and models are shared with in-house engineers to get their buy-in and where specifically contracted detailed training is given for them to carry out performance monitoring by themselves.*

The result of implementing such a performance monitoring system is that a much more focused discussion between management, operations and maintenance takes place due to the higher level of performance quantification.

ReferenceProjects

ACTSYS has extensive experience in implementing performance monitoring projects in combined cycle and thermal power plants. To date these total 14 power plant units in Singapore, Malaysia, Thailand and Indonesia.

- Performance Monitoring at Tanjung Bin Coal Fired Power Plant (3 x 700 MW), Malakoff Malaysia 2007-2009 service contract
- Performance Monitoring at Prai Power CCP (1 x 370 MW), Malakoff Malaysia 2007-2009 service contract
- Efficiency Quantification at Repowered Combined Cycle Block (1 x 360 MW), Senoko Power, Singapore 2007
- Performance Monitoring at Combined Cycle Block 10 and 20 (2 x 370 MW), Power Seraya, Singapore 2007
- Energy Audit and Plant efficiency performance monitoring at Power Seraya – Steam Plant 1 x 250 MW, Singapore 2006
- Performance monitoring at Combined Cycle Block I & II (2 x 367 MW) of Tuas Power, Singapore 2004 onwards till date.
- Performance monitoring at Combined Cycle Block III & IV (2 x 367 MW) of Tuas Power, Singapore 2005 onwards till date
- Plant efficiency, performance monitoring and optimization at Muara Karang Power plant – thermal power station (2 x 200 MW), Indonesia 2003
- Plant efficiency, performance monitoring and optimization at Muara Karang Power plant – Combined Cycle 3+3+1 (1 x 500 MW), Indonesia 2003
- Implementation of GE Enter Efficiency Map online performance monitoring & optimization system at Gulf Electric at Samutprakarn Thailand 2002
- Implementation of GE Enter Efficiency Map online performance monitoring & optimization system at Gulf Electric NongKhae, Thailand 2003
- Plant efficiency, performance monitoring and optimization at Gresik Power Plant, Indonesia – thermal power station 2 x 200 MW – 2004 to 2005
- Plant efficiency, performance monitoring and optimization at Gresik Power Plant, Indonesia – Combined Cycle plant 3+3+1 1 x 480 MW – 2004 to 2005
- Plant efficiency, performance monitoring and optimization at Paiton Power Plant, Indonesia – coal fired thermal power station 2 x 400 MW – 2005 to 2006