# Thermodynamic
# **PerformanceMonitoring** AppreciationTraining
## **- Combined Cycle Power Plant**

ACTSYS
Process management
consultants

## about **ACTSYS** process management consultants pte ltd

ACTSYS focus on power plant performance monitoring (both at combined cycle plant and conventional thermal power plant) using thermodynamic simulation tool, GateCycle. ACTSYS also conducts training to operational engineers to familiarize the thermodynamic basics of power plant equipments and systems. Typical training methodology and contents are detailed in this document.

## **thermodynamic** performance monitoring appreciationtraining

*In the competitive power sector, it is imperative for operational and maintenance engineers working in the power plant to have knowledge of their plant efficiency and performance factors. Such knowledge would enable them to understand the influence of various parameters on the equipment/system performance, which is vital for making correct interpretation of the equipment/system behavior and to take necessary trouble shooting actions in case of malfunctioning of system/equipment/instrument.*

*This training aims to expose operational and maintenance engineers to various thermodynamic analysis that are pertaining to power plant performance analysis using hands-on excel based heat balance exercise and using thermodynamic simulation tool runs. This helps engineers to have better understanding of thermodynamic behavior of power plant equipments and systems.*

**methodology:** The training contents are customized according to the profiles of participants and also to match specific needs, if any. In general, the training program would cover the basics theory, detailed thermodynamic calculation procedures, application of simulation models and discussion on real-time case studies.

various **key steps** are explained below:

- Fundamental basic thermodynamic first-principles of individual equipment would be highlighted to illustrate the significance of individual thermodynamic parameter. Energy and mass balance analysis of individual equipment and system would be discussed.

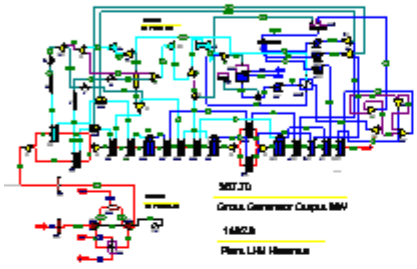
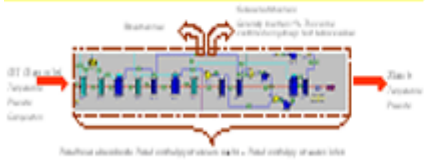
- Discussion on individual equipment theory would be supported with hands-on excel based exercise. With these exercises, engineers would see clearly the importance of individual parameters on individual equipment performance.

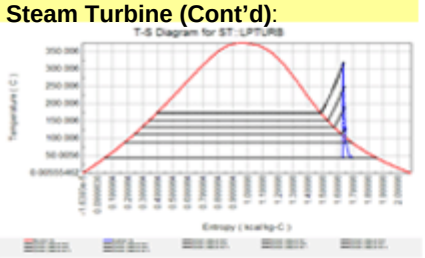
- Actsys would arrange temporary license of Thermodynamic simulation tool, GateCycle to provide the hands on experience of doing sample heat balance model runs. This would help engineers to get familiarized in using the simulation model heat balance analysis. During the process, the engineers would also learn the approach to perform thermodynamic analysis using real time data.

- At the end, real time case studies would be discussed to illustrate the data validation, heat balance analysis methods, calculation of performance factors of various factors, significance of various performance indices and performance monitoring methodology.

details of **training contents**:

Following are the broad outline of training module of various sections of a combined cycle power plant.

| modules | key topics | details |
|---|---|---|
| **Gas Turbine**: Performing Heat and mass balance of Gas turbine and understanding importance of key thermodynamic parameters such as turbine inlet temperature, specific heat capacity, GT compressor discharge temperature would be covered in this module. Usage of GT correction curves and plant correction curves would also be covered. | **Basic Concept** | * Heat and mass balance of Gas Turbine<br>* Significance of inlet air filter, inlet air temperature, GT compressor discharge temperature, GT compressor discharge pressure, turbine inlet temperature would be discussed.<br>* Usage of GT correction curves and the plant correction curves. |
| | **Excel Based Exercise** | * GT compressor efficiency<br>> Isentropic efficiency<br>> Polytropic efficiency<br>> GT compressor power consumption<br>* Combustor energy balance<br>* GT turbine efficiency<br>> Isentropic efficiency<br>> Polytropic efficiency<br>> Turbine shaft power<br>* Heat loss transfer at Nozzle air cooler |
|  | **GateCycle Based Exercise** | * Heat & mass balance using simulation run<br>* Understanding the influence of various operating parameters on thermodynamic performance of GT section<br>> GT Compressor discharge temperature<br>> GT turbine exhaust temperature and Turbine inlet temperature |
| **HRSG**: Heat and mass balance of Heat Recovery Steam Generator. Understand the various parameters that would affect the individual components of HRSG such as economizer, evaporator, superheater, reheater and feedwater preheater. | **Basic Concept** | * Energy balance of HRSG<br>* Thermodynamic behavior of Evaporator, Economiser, superheater/reheater and feedwater preheater at various condition |
| | **Excel Based Exercise** | * GT exhaust flow calculation<br>* Establishing the temperature profile across the entire section of HRSG<br>* Effectiveness calculation of economizer, evaporator, superheater/reheater and feedwater preheater<br>* Understanding the influence of various operating parameters on thermodynamic performance of HRSG<br>> GT exhaust temperature<br>> GT exhaust flow<br>> Feedwater preheater recirculation |
|  | **GateCycle Based Exercise** | * Heat and mass balance using simulation run<br>* Predictive performance of individual heat transfer element such as economizer, evaporator, superheater/reheater and feedwater preheater using simulation |
| **Steam Turbine**: Interpretation of steam pressure, temperature and flow data to understand the impact of possible steam path performance deterioration factors such as stage fouling and leakage would be discussed along with the efficiency calculation. | **Basic Concept** | * Energy conversion in steam turbine<br>* Steam turbine behavior at various operating conditions<br>* Various performance indices (efficiency) |
| | **Excel Based Exercise** | * Steam turbine efficiency<br>> Enthalpy drop efficiency<br>> Exhaust loss calculation<br>> Control valve and stage loss<br>* Steam turbine power generation calculation |

| modules | key topics | details |
|---|---|---|
| **Steam Turbine (Cont'd)**:  | **GateCycle Based Exercise** | * Heat and mass balance simulation model run<br>* Understanding the influence of various operating parameters on thermodynamic performance of steam turbine<br>> Steam flow and extraction flow<br>> Exhaust pressure and sliding pressure<br>> HP Bypass operation<br>* Demonstration of predictive model usage |
| **Condenser**: Influence of condenser performance on steam turbine power output and various factors that influence the condenser would be discussed. Engineers would be introduced to basics of HEI equation to calculate and predict the condenser performance at various operating scenarios. Hands-on calculations using excel sheets to find out the heat transfer coefficient and surface area of condenser would bring in much clarity in performance analysis of condenser. | **Basic Concept** | * Energy balance calculation of condenser<br>* Condenser behavior at various severe operating conditions such as air ingress, low CW flow, high CW temperature, plugged tubes, etc. |
| | **Excel Based Exercise** | * Condenser effectiveness<br>* Calculation to find out heat transfer coefficient using HEI 8th & 9th Edition method.<br>* Calculation of circulating water flow |
| | **GateCycle Based Exercise** | * Heat and mass balance simulation model run<br>* Understanding the influence of various operating parameters on thermodynamic performance of condenser<br>> CW temperature<br>> CW flow<br>> Air ingress<br>> Tube plugging<br>* Demonstration of predictive model usage |
| **Boiler Feed Pump**: Feed pump performance calculation to find out the power/steam consumption of the pump and efficiency interpretation would be discussed using excel based exercise. | **Basic Concept** | * Boiler feed pump performance<br>* System performance<br>* Boiler feed pump efficiency calculation |
| | **Excel Based Exercise** | * Boiler feed pump power consumption<br>* Boiler feed pump efficiency |
| | **GateCycle Based Exercise** | * Heat and mass balance simulation model run<br>* Demonstration of predictive model usage |

**who** should attend? The course can customized to suit Combined Cycle Plant staffs from operational, maintenance and instrumentation sections.

- Training of maintenance & operational engineers
  - Tuas Power Plant
  - Combined Cycle Power Plant
  - 4 x 367 MW
  - Singapore
- Training of performance engineers & operational staffs
  - Muara Karang Power plant
  - Oil fired thermal power plant
  - 2 x 200 MW
  - Indonesia
- Training of performance engineers and operational staffs
  - Gresik Power Plant
  - Oil fired thermal power plant
  - 2 x 200 MW
  - Indonesia
- Training of performance engineers and operational staffs
  - Paiton Power Plant
  - Coal fired thermal plant
  - 2 x 400 MW
  - Indonesia
- Training of performance engineers and operational staffs
  - Prai Power Plant
  - Combined Cycle Power Plant
  - 3 x 367 MW
  - Malaysia
- Training of performance engineers and operational staffs
  - Tanjung Bin Power Plant
  - Coal fired thermal plant
  - 1 x 700 MW
  - Malaysia