EXPERIENCE WITH IMPLEMENTATION AND USAGE OF A THERMODYNAMIC PERFORMANCE MONITORING METHODOLOGY AT PRAI POWER

Teknik Janakuasa Sdn Bhd.

October 2008

Outlines

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- Performance Monitoring Program
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    - Selection of Service Provider
    - Issues at Model Development Stage
    - Working Methodology
    - Plant Performance Results
- Prai Project Implementation
- Schedule for Development of Performance Monitoring Tools and Methodology
- Prai Project Outcome

About Prai Power Plant

- Operated by TJSB (Teknik Janakuasa Sdn Bhd)
  - ❖ Located at Prai, Penang.
  - ❖ COD on 20 June 2003.
  - ❖ O&M subsidiary of Malakoff Corp Berhad, Malaysia's largest IPP operator
- 350MW combined cycle power plant
  - ❖ MS9001FA gas turbine (1 GT+1 ST + 1 HRSG)
  - ❖ Triple pressure HRSG
- Fuelled primarily by natural gas

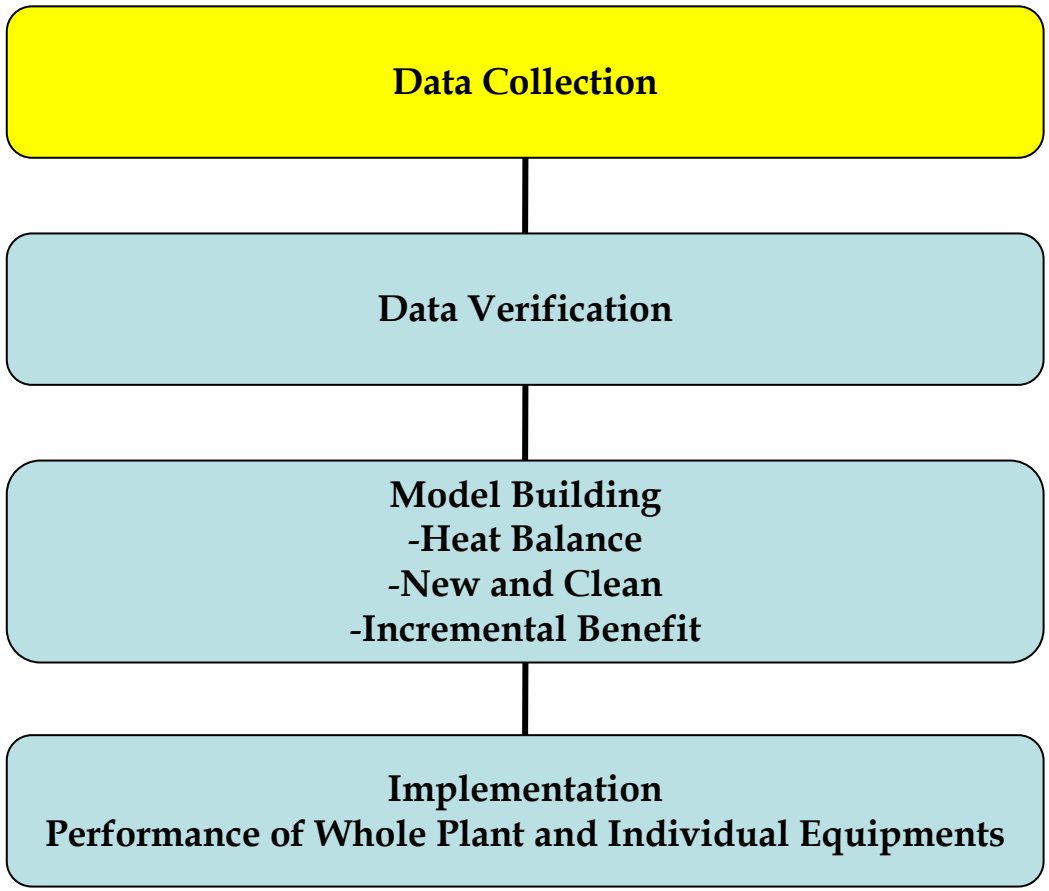
Performance Monitoring Program

- Objective of Performance Monitoring Program
  - ❖ To develop a predictive capability to pinpoint thermal efficiency loss
  - ❖ To proactively carry out corrective maintenance
  - ❖ Internal Benchmarking of Malakoff Power Generation Units
  - ❖ To develop In-house skill - training of In-house engineers
  - ❖ Offline system vs. Online system – technology transfer

Performance Monitoring Program

- Selection of Service Provider
  - …Actsys Process Management Consultants…..
    - Local presence – located in Singapore
    - Provide ***Technology Transfer***
    - Have developed performance monitoring methodology
    - Experience in similar projects

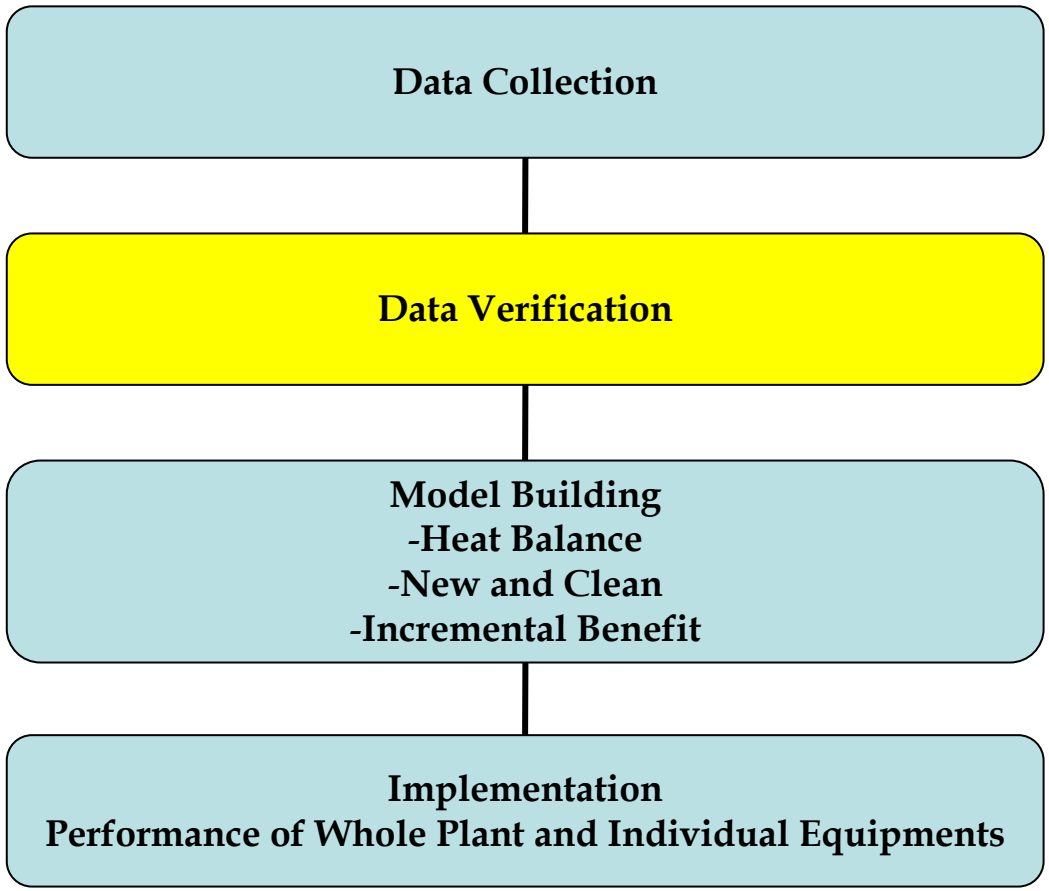
Working Methodology



Performance Monitoring Methodology

- Data Collection
  - ❖ Collection of all required plant design data and drawings
  - ❖ Identification of Plant operating Parameters for heat balance calculations

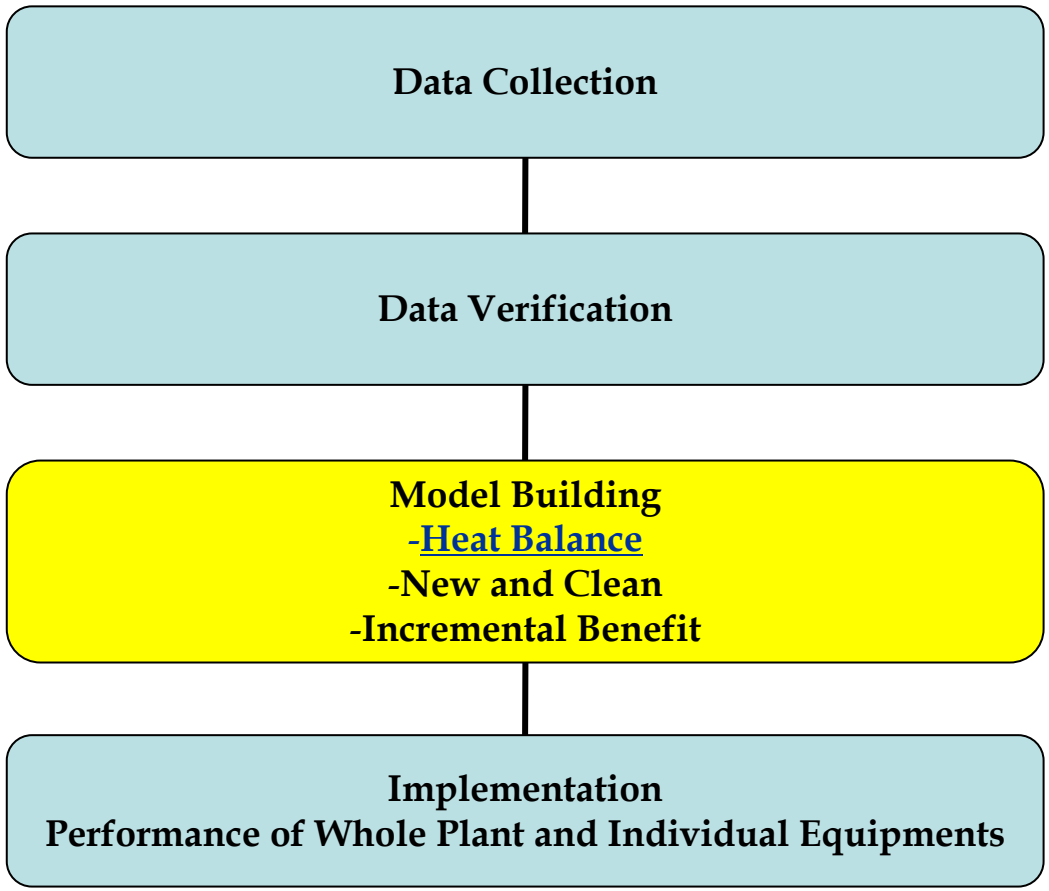
Working Methodology



Performance Monitoring Methodology

- Data Verification
  - ❖ Identification of erroneous and faulty instruments
  - ❖ Rectify the instrument or arrange for alternative readings.

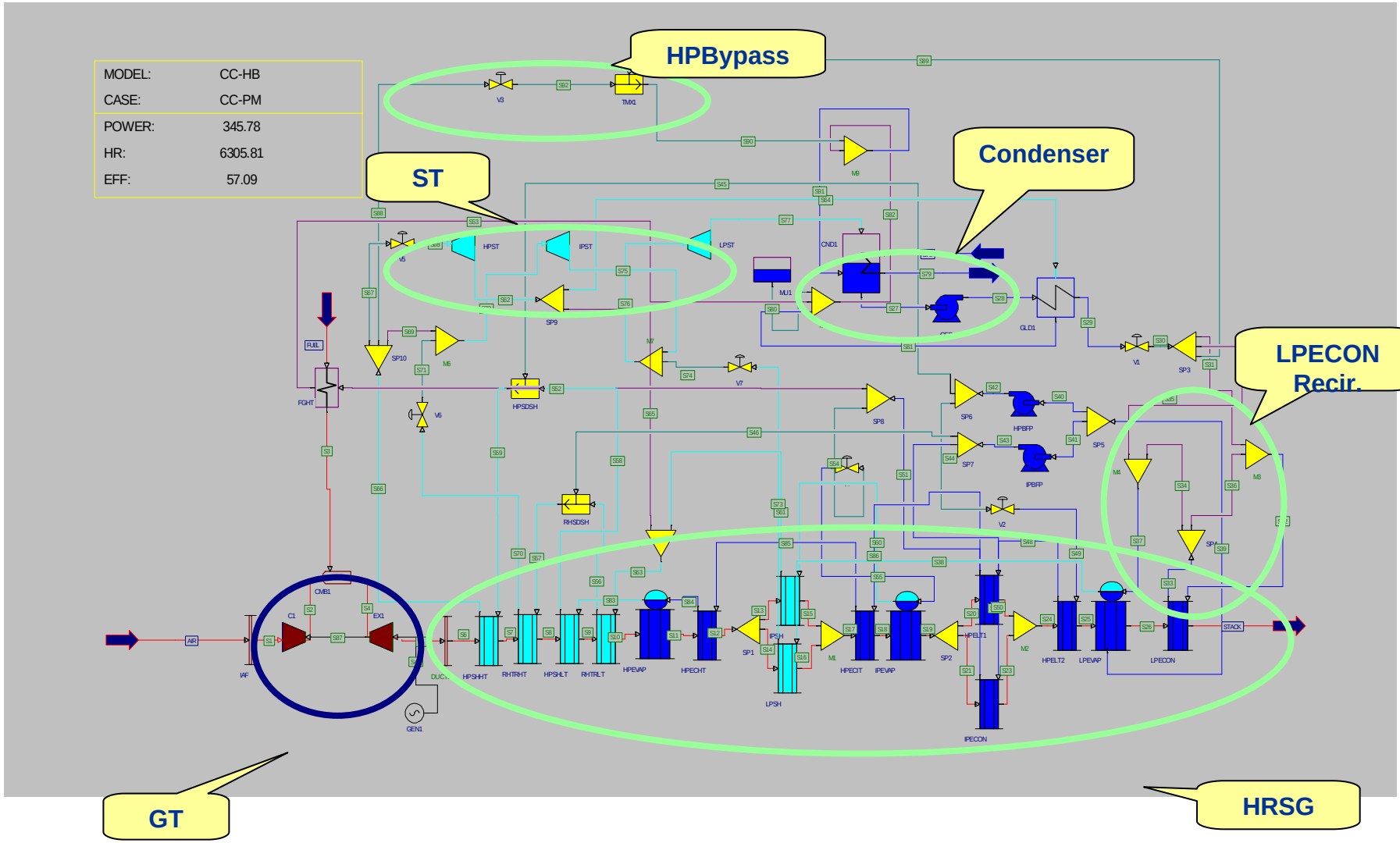
Working Methodology



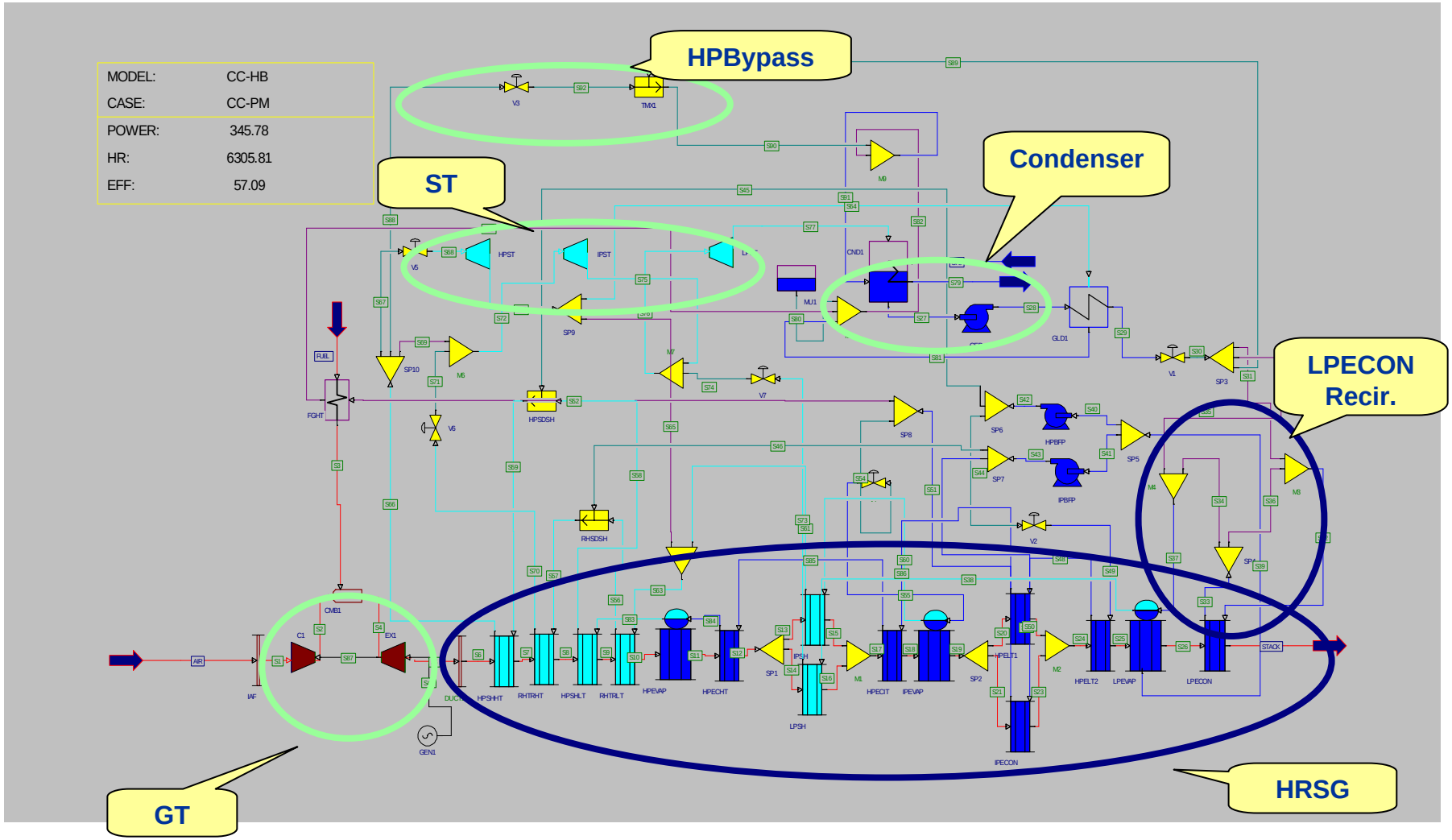
Performance Monitoring Methodology

- Performing Heat and Mass Balance Analysis on the plant using Thermodynamic Simulation Tools
  - ❖ To reveal most of the unknown parameters
  - ❖ To establish the current "actual" performance level of various components and the total system
  - ❖ To detect erroneous measurement data using the model results
  - ❖ To cross check the fuel flow measurement with the model calculated value to ascertain the meter accuracy

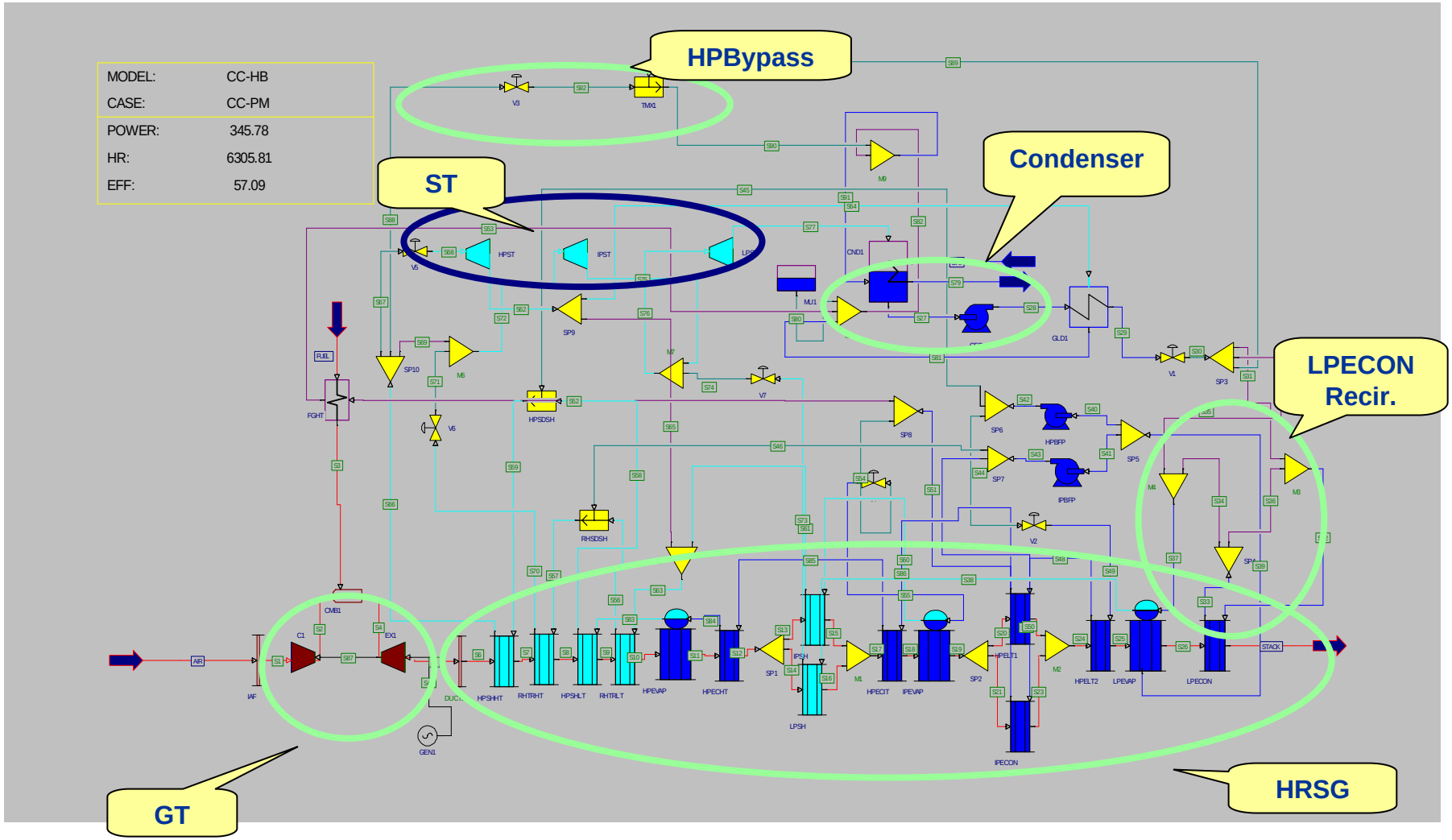
Performance Monitoring Heat Balance Model



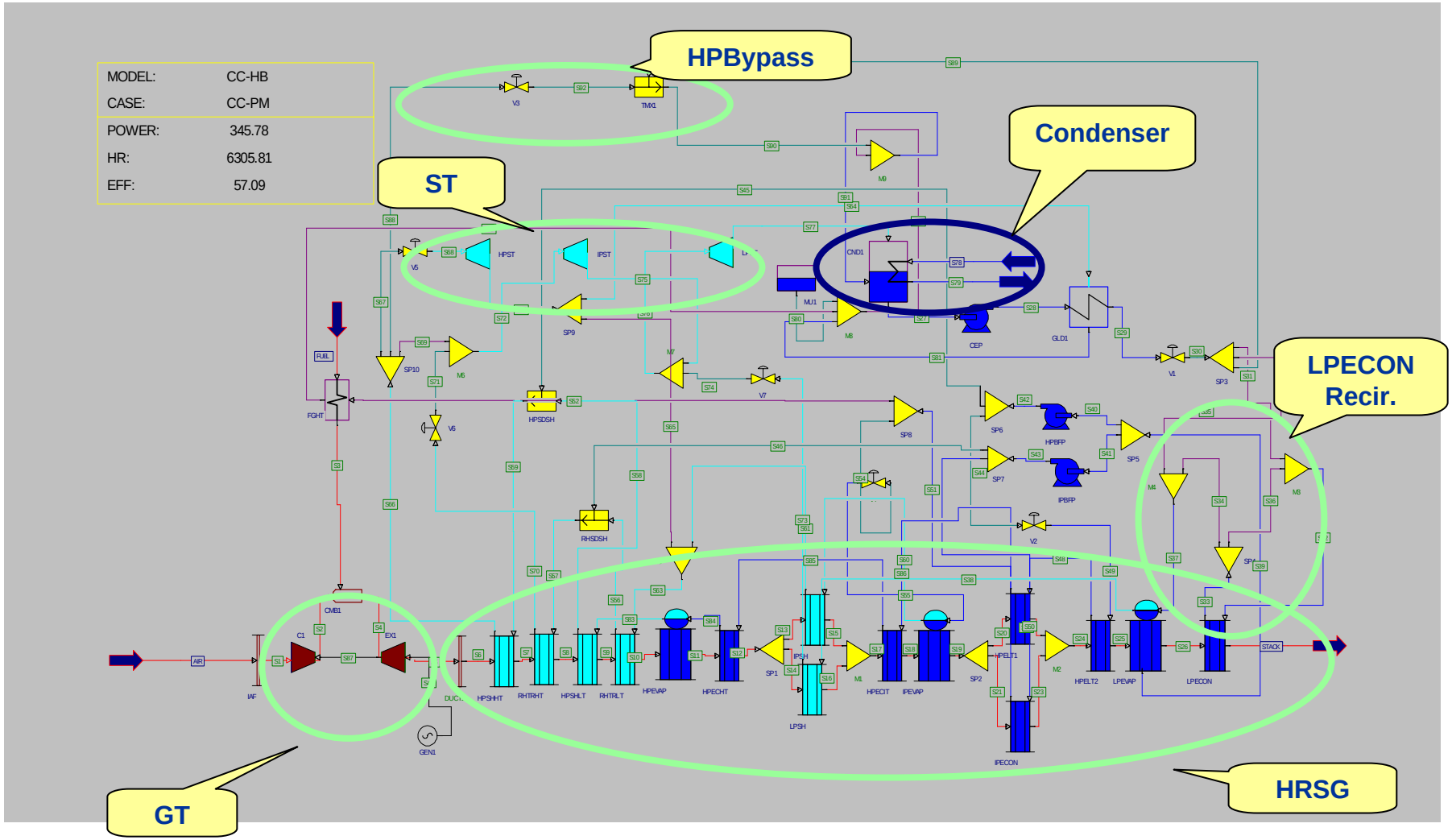
Performance Monitoring Heat Balance Model



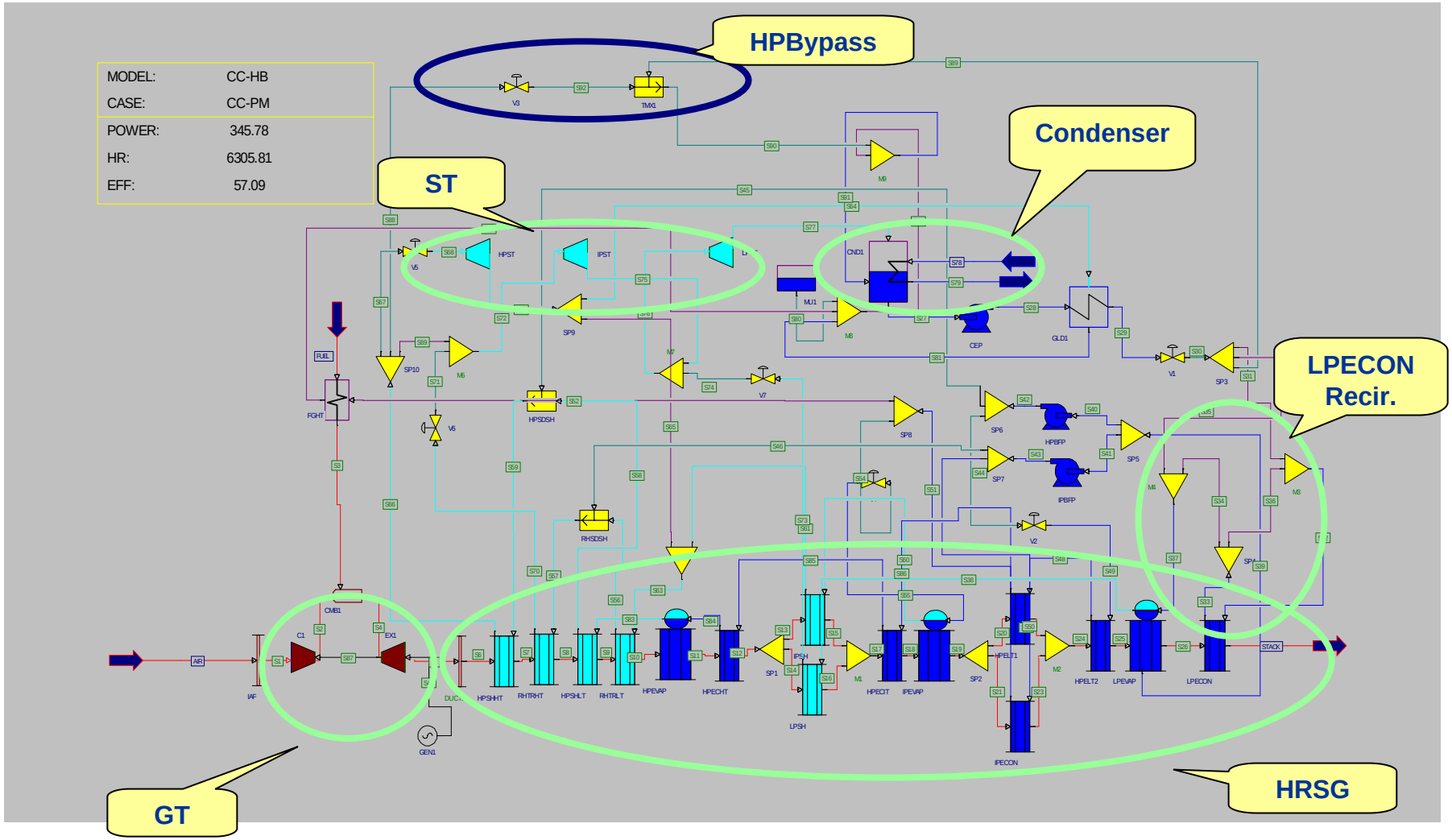
Performance Monitoring Heat Balance Model



Performance Monitoring Heat Balance Model



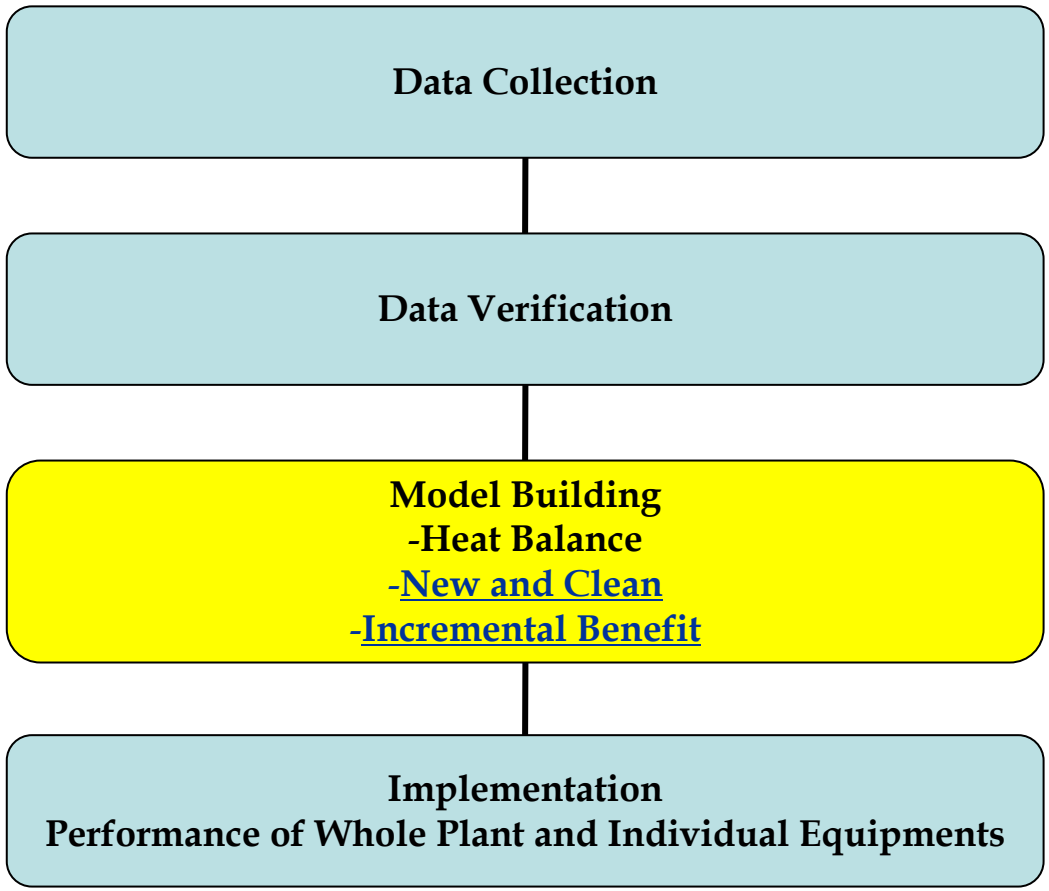
Performance Monitoring Heat Balance Model



TEKNIK JANAKUASA

MALAKOFF

Working Methodology



Performance Monitoring Methodology

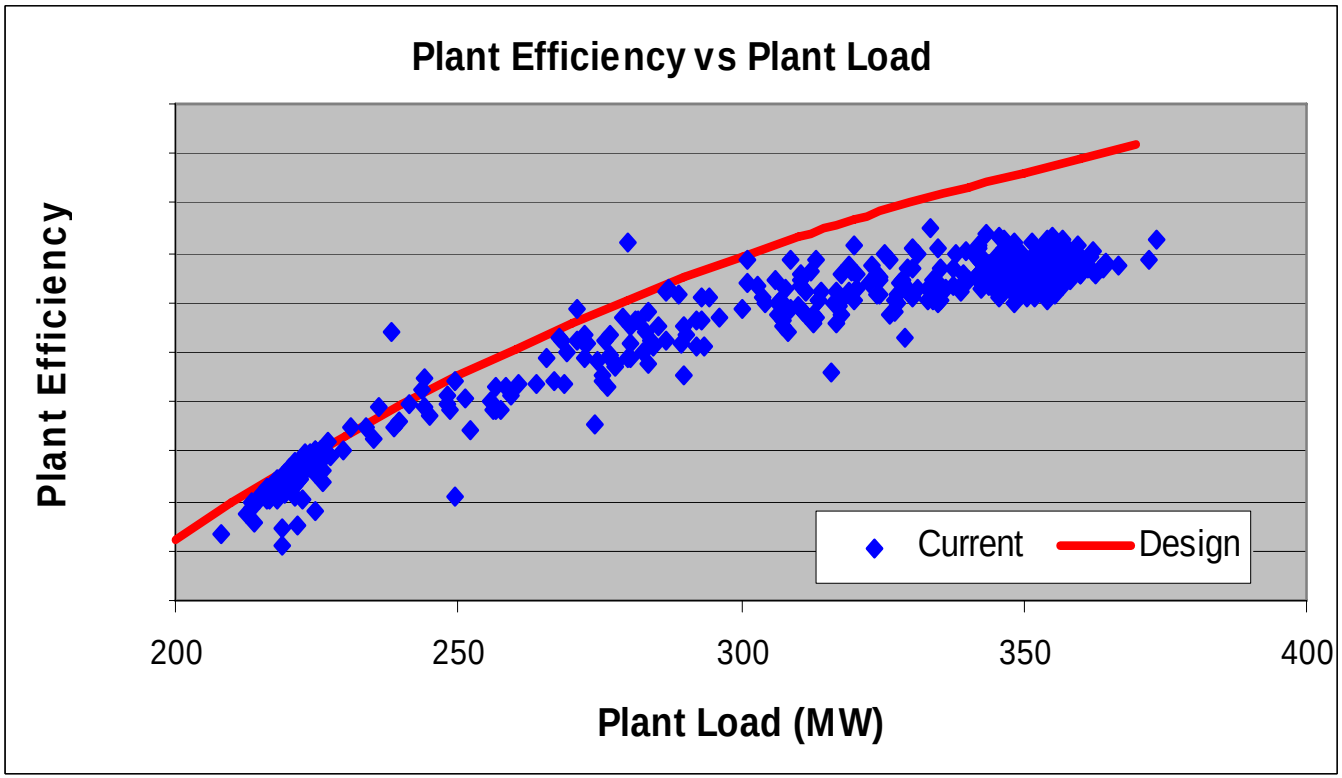
- Performance check of various individual equipment (HRSG, ST, Condenser, Pumps) in the plant
  - ❖ "Best achievable" efficiency or "New and Clean" Efficiency of individual equipment is established using simulation calculations.
  - ❖ Performance "Gap" of individual equipment is established by comparing the "Actual" efficiency to "New and Clean" efficiency.
  - ❖ Translation of "Performance Gap" into "Monetary Saving Potential"

Issues at Model Development Stage

Issues	Solutions
Inconsistent and Missing Design Heat Balance Data	1. Consolidating the Heat Balance Information from difference sources
Incomplete Commissioning Data	2. Engineering Judgments and assumptions
Change of Plant Owner	3. Best achieved performance of past data analysis are used
Resource allocation challenges	4. Buy-in required of all involved in power station

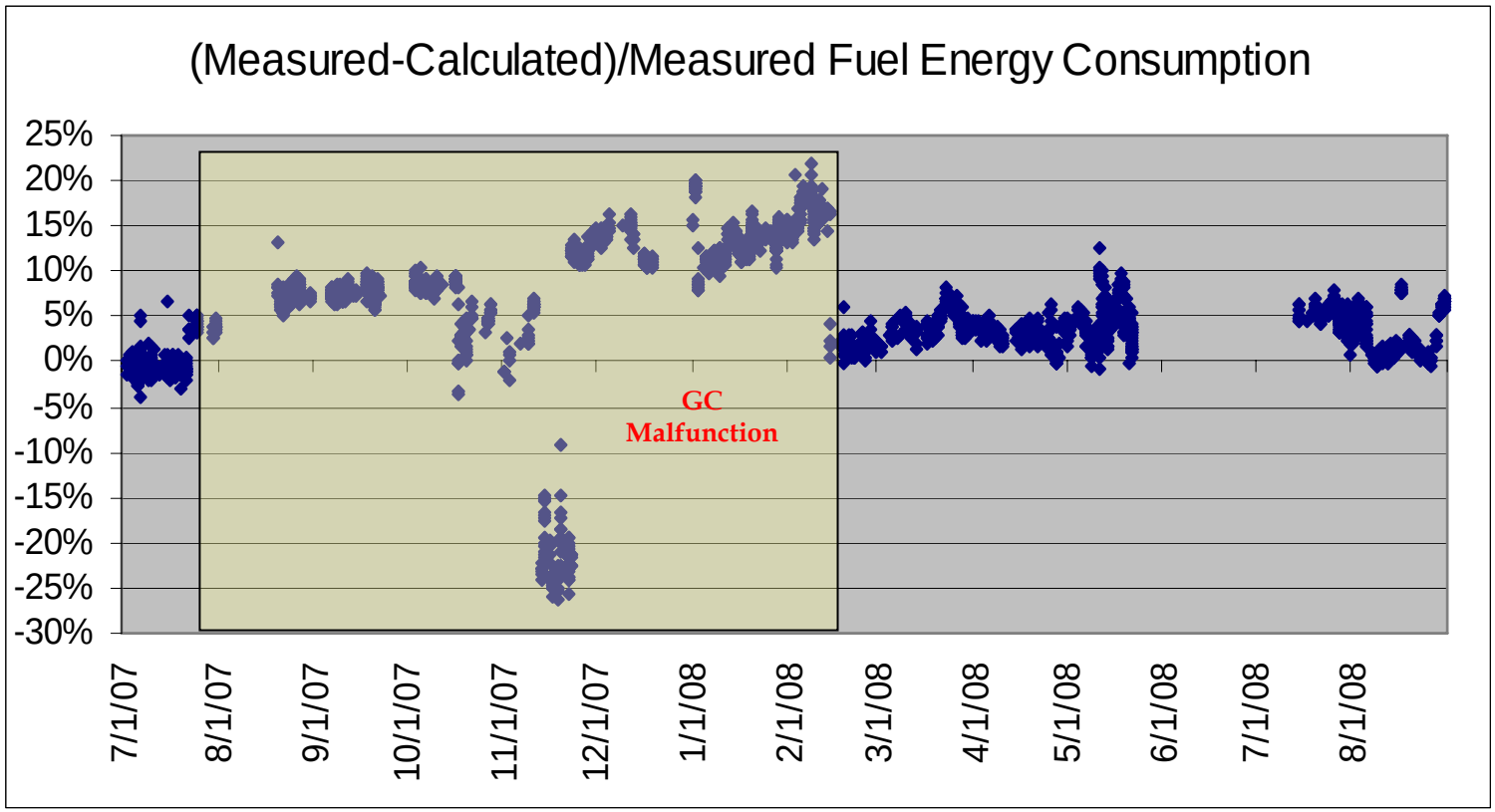
Plant Performance Results

- The Current plant efficiency is lower compared with Design at higher load range. Heat consumption calculated by heat balance.



Plant Performance Results

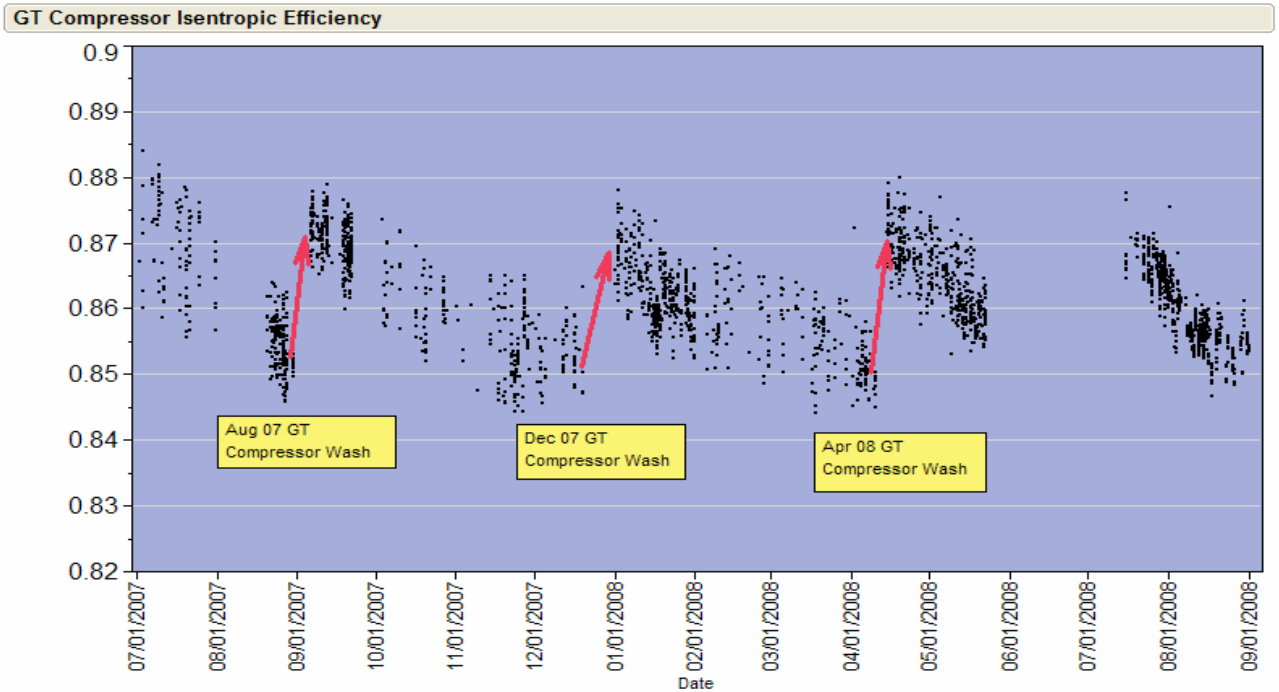
- **Accuracy of Gas Chromatography and Fuel Meter**
  - This program help us to cross check the fuel energy consumption measurement with the model calculated value to ascertain the meter accuracy



Plant Performance Results

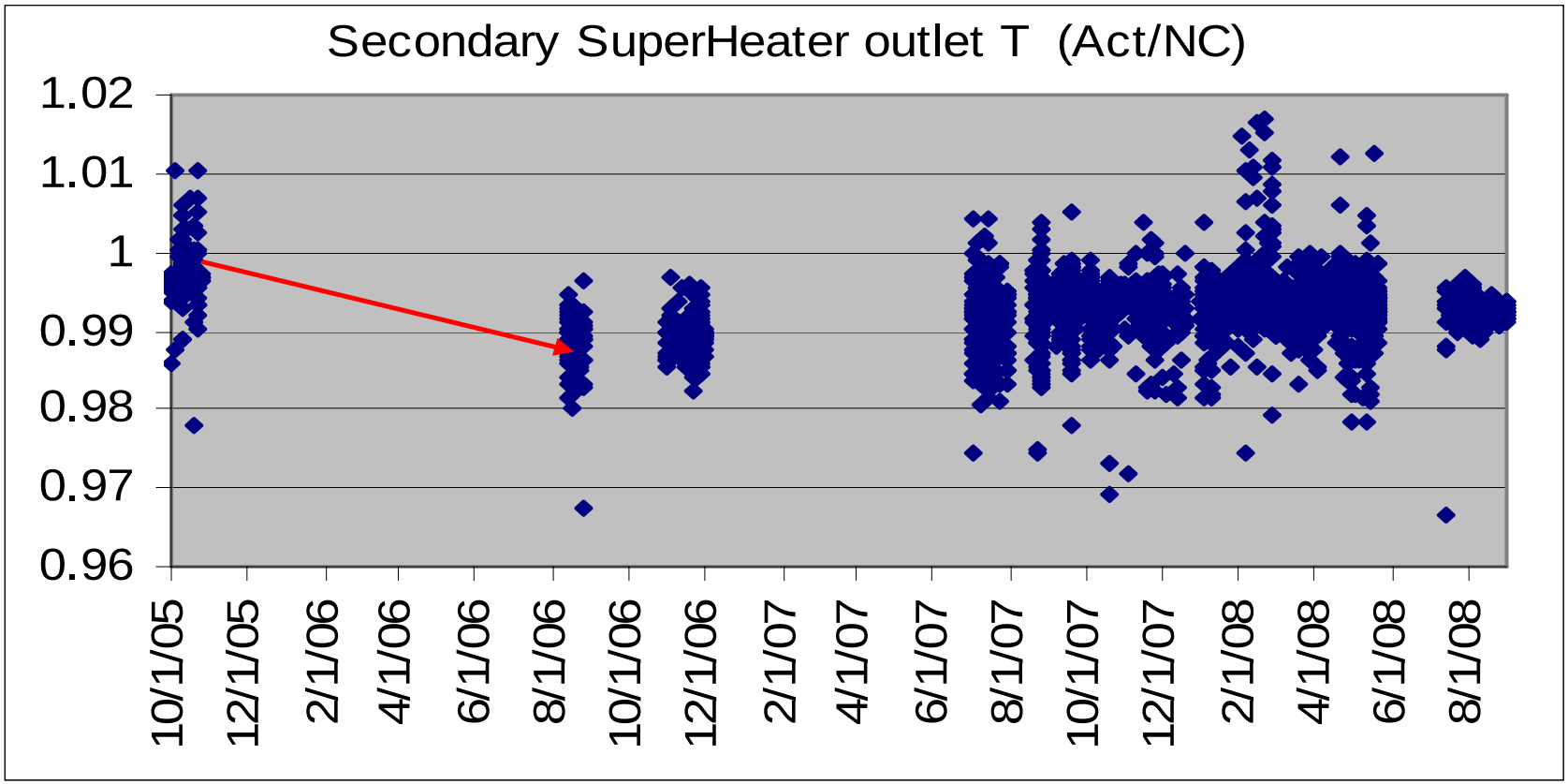
GT Compressor Performance

- Performance of GT Compressor after each Offline GT Compressor Wash can be monitored and the efficiency gain can be translated to monthly monetary saving achieved.



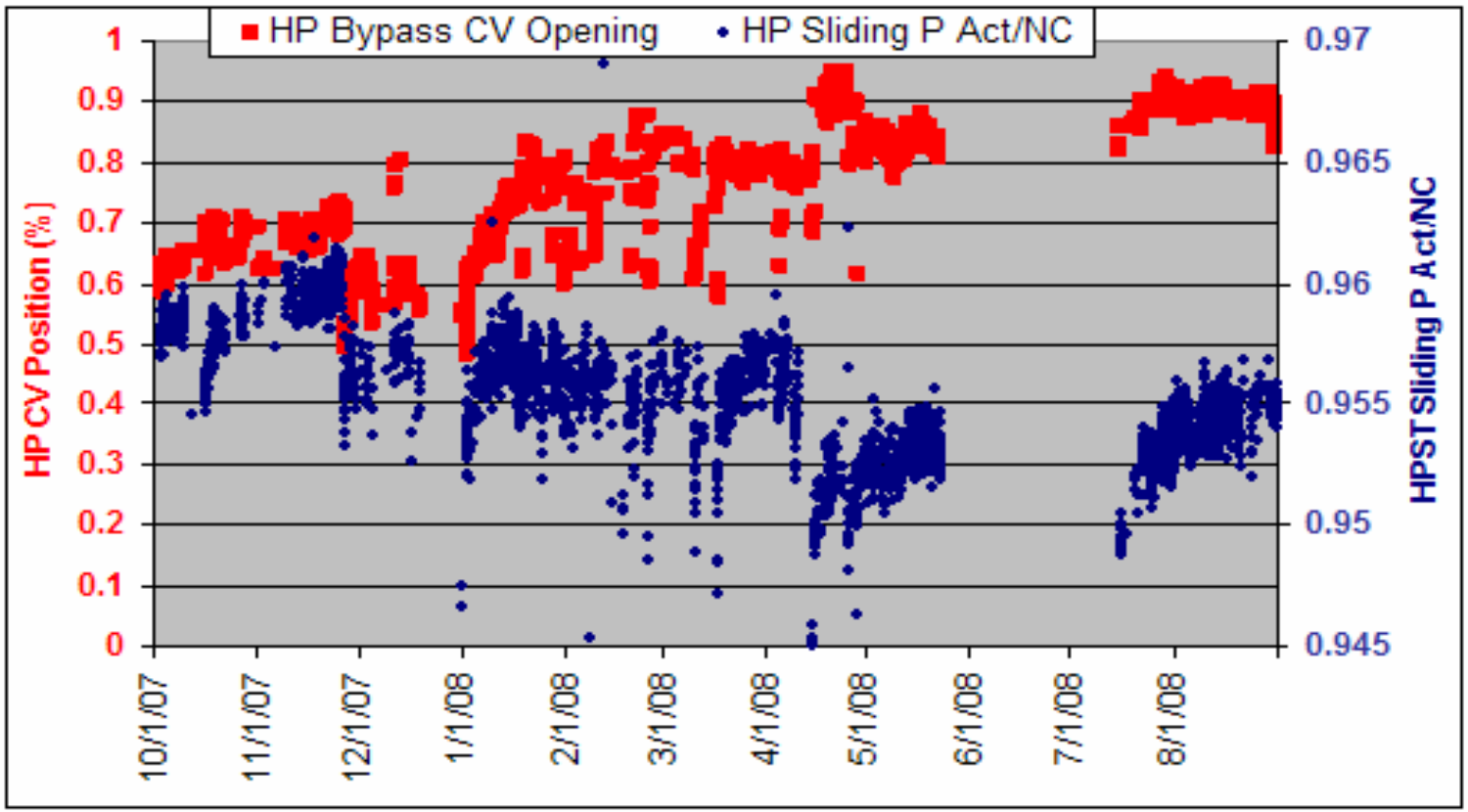
Plant Performance Results

- **Deterioration of the HP Superheater Performance**
  - Secondary Superheater outlet temperature Act/NC has deteriorated from 1 to 0.99 compared with year 2005 → 1% drop (around 5~6°C).



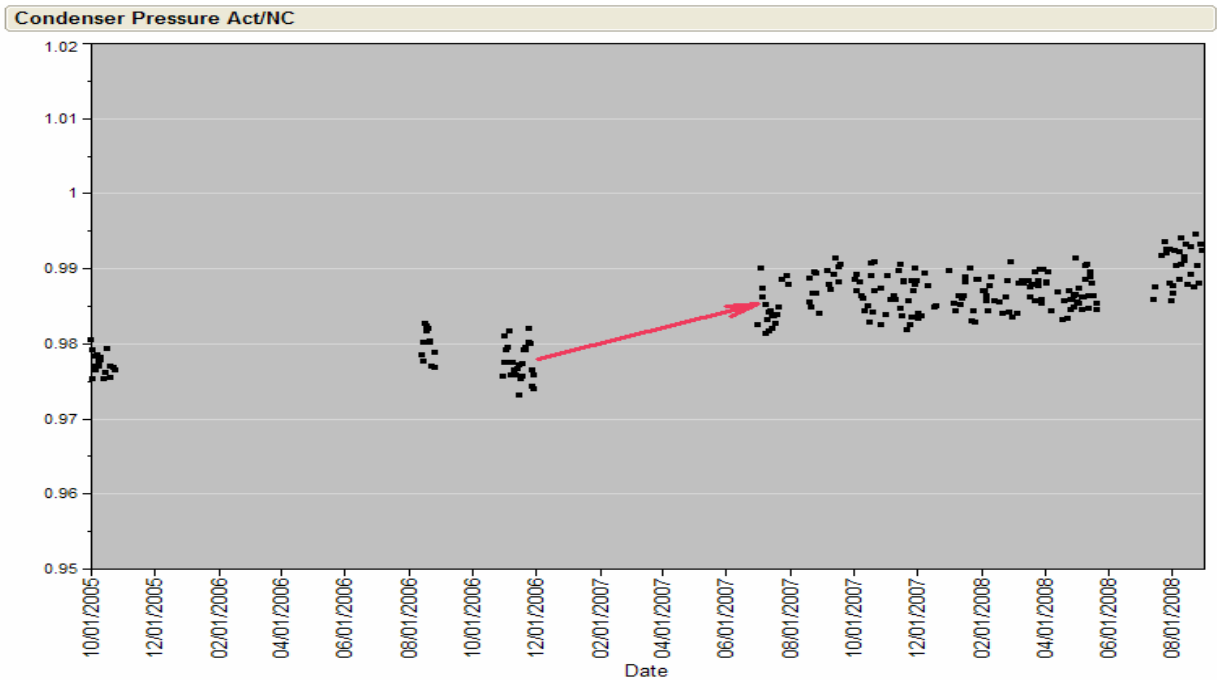
Plant Performance Results

- **Passing of HpBypass Control Valve**
  - HPST Sliding Pressure < 1 → Some steam is missing at the inlet of HPST.

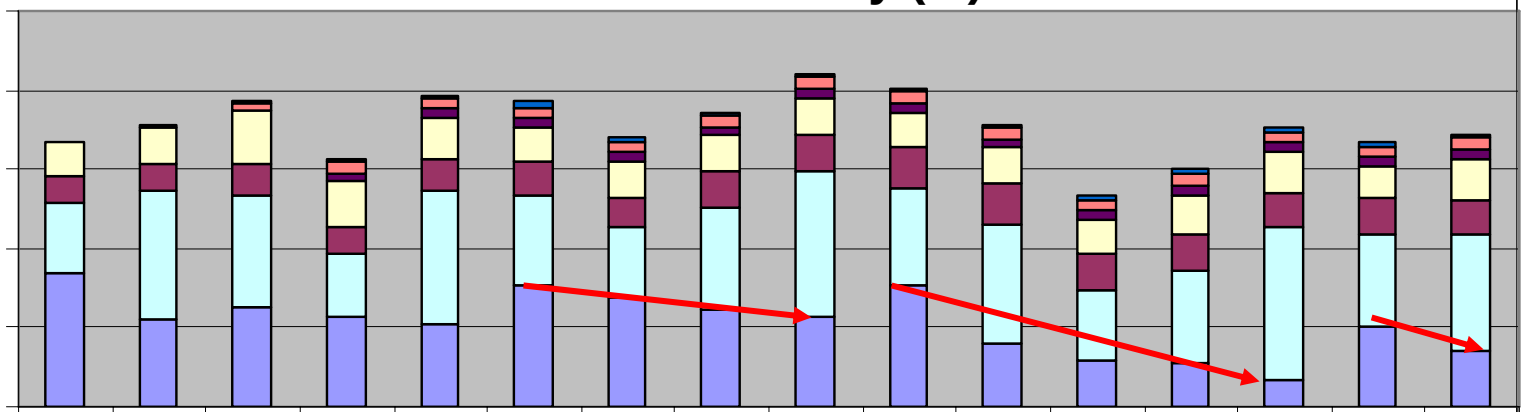


Plant Performance Results

- **Condenser Performance (Act/NC)**
  - ❖ Currently it has deteriorated a bit compared with year 2005.
    - 0.02% "Overall plant efficiency" loss
    - The deterioration indicates possibility of condenser fouling.



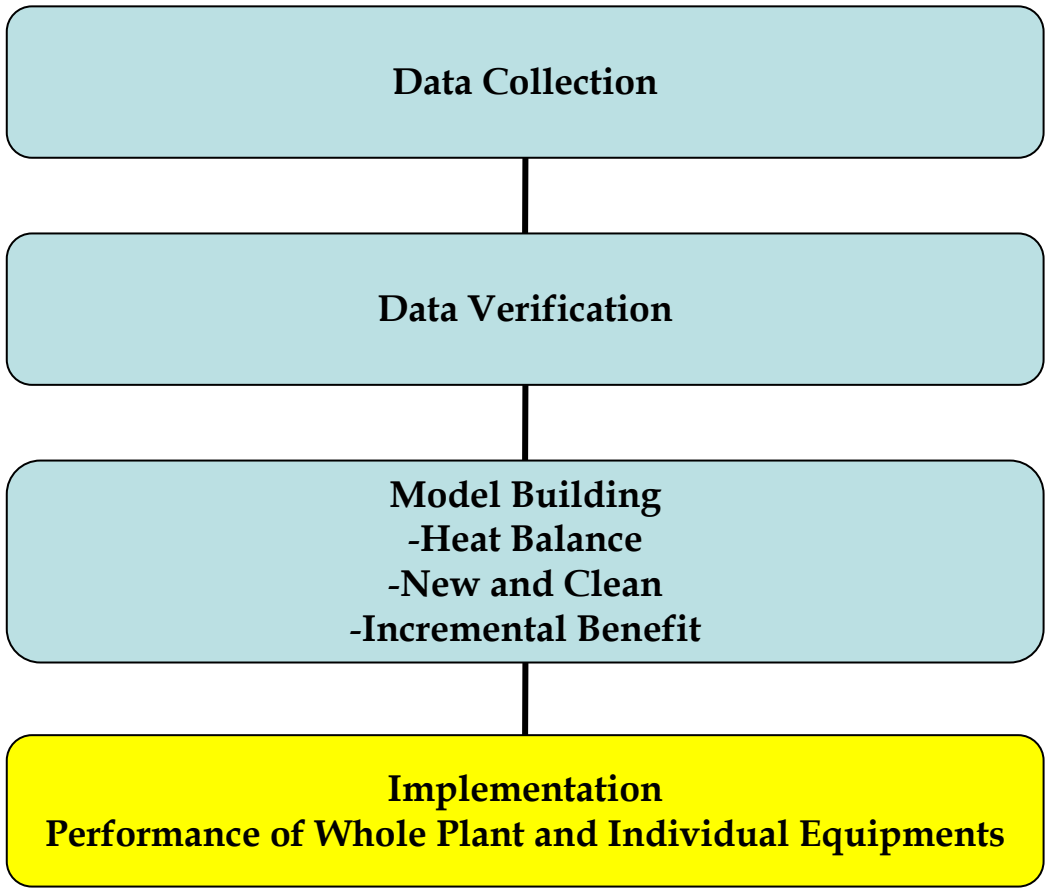
Incremental Benefit – Plant Efficiency



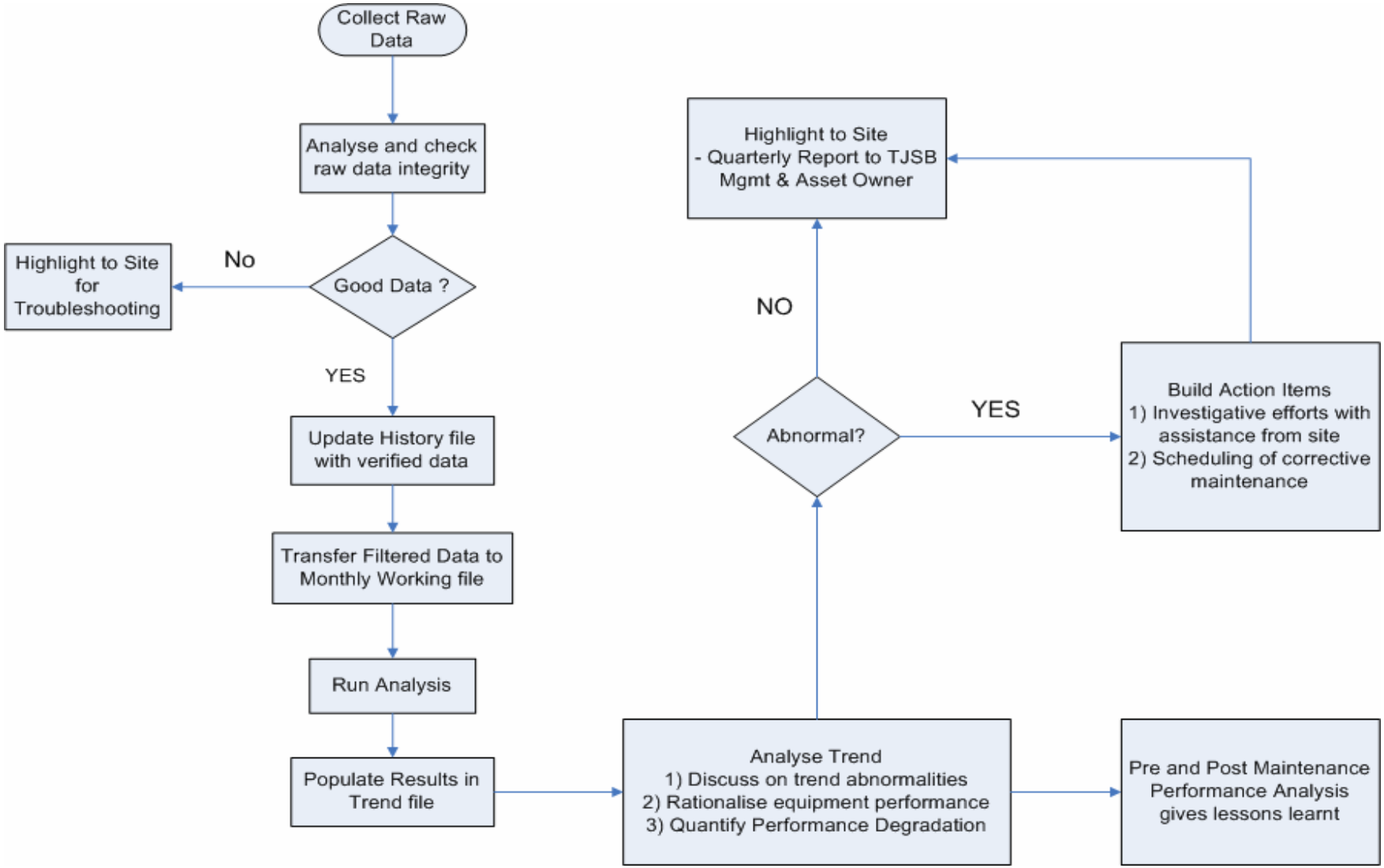
	Oct 05	Aug06	Oct-Nov06	Jul 07	Aug 07	Sep 07	Oct 07	Nov 07	Dec 07	Till 13th Jan 08	Since 14th Jan 09	Feb 08	Mar 08	Apr before shut	Apr after shut	May 08
Condenser	0.0019	0.0112	0.0042	0.0195	0.0235	0.039	0.0228	0.0187	0.0265	0.0176	0.0247	0.022	0.0281	0.0296	0.0186	0.0229
zero RHDSH spray	0	0	0.0568	0.0648	0.0627	0.0633	0.0682	0.0649	0.0684	0.0763	0.0702	0.0751	0.0742	0.0727	0.0714	0.0728
zero HPDSH spray	0	0	0	0.0568	0.0576	0.0543	0.0679	0.0536	0.0591	0.0597	0.0485	0.055	0.0549	0.0563	0.0553	0.0581
HRSG	0.2127	0.2352	0.3386	0.2781	0.2606	0.2258	0.2212	0.2218	0.2299	0.2154	0.2321	0.2093	0.2497	0.2581	0.2024	0.2643
ST	0.1745	0.1583	0.2	0.1798	0.2062	0.2114	0.1933	0.2313	0.2414	0.2593	0.2549	0.2306	0.232	0.2189	0.2219	0.2157
GT Compressor	0.4503	0.8147	0.6965	0.3968	0.8433	0.559	0.4343	0.6537	0.9077	0.6231	0.762	0.4444	0.5848	0.9619	0.5934	0.7272
Plant																

All the "Performance Gap" above can be translated into "Monetary Saving Potential"

Working Methodology



Project Implementation – Monthly Procedure



Schedule for Development of Performance Monitoring Tools and Methodology

Month	Jun 07	Jul 07	Aug 07	Sep 07	Oct 07	Nov 07	Dec 07	Jan 08	Feb 08	Mar 08	Apr 08
Project Preparation Stage											
Project Conceptualization and team forming											
Design & Commissioning Data Collection & Verification											
Training on GateCycle and Model building											
Design Template for Actual Plant Data Collection											
Model Building											
Heat Balance Gatecycle Model Building											
New and Clean Gatecycle Models Building											
Incremental Benefits Models Building											
Implementation											
Heat Balance Analysis Monitoring											
New and Clean Analysis Monitoring											
Incremental Benefits Analysis Monitoring											
Training of Operation and Maintenance Team										To be planned	

Prai Team sit in Actsys Office Singapore for 8 months to jointly set up the Performance Monitoring System

Project Outcome

- Quantification of plant and component performance.
- Filtering of an assortment of Design data to arrive at a consistent set of Design data.
- Usage of consistent set of Design data to build representative Design plant models.
- Identification of problematic field instruments as well as historian data storage.
- Identification of specific plant components that are contributing to the plant efficiency and generation loss.
- Early identification of new degradation areas
- Build up and increased cohesion of maintenance and operational best practices

Project Outcome

- Realized advantages of this approach over an Online Efficiency Monitoring system
  - ❖ Technology Transfer achieved from consultant to plant engineers
    - Thermodynamic modeling techniques
    - Performance monitoring methodology
    - Results interpretation and analyses
  - ❖ No black box effect
    - Ownership of calculations and therefore confidence in results
  - ❖ Participation in project development by all disciplines achieved teamwork for corrective maintenance efforts

Q&A

Thank You