Paiton 3 Heat Rate Review

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Rev.No	Description (Date)
1	1. Add the two slides on “What we are doing to address the issue during 2015 outage” 2. Add the data of May to Aug 2014 in the graphs in attachment 0 to attachment 3 for reference. 3. Add the Net Plant HR graph in attachment 0. 4. Add the Condenser Terminal Temperature Difference (TTD) graph in attachment 2.16. 5. Add the CONDENSER INLET WATER BOX INLET TEMP.(Sea Water temp) graph in attachment 2.17. (30 Sep 2015)

Summary

- 0.94% - 1.26% degradation on Unit 3 Heat Rate was found by Heat Loss method by PI.
- Breakdown is
  - Boiler Efficiency : 0.25% to 0.74%
  - Turbine Cycle HR : 0.08% to 0.51%
  - House Load : 0.19% to 0.28%
- Graphs for above items to be referred to Attachment 0.

Consideration/Recommendation (Overall)

- Same kind of Heat Rate tendency in historical trend is observed between In-Out method and Heat Loss method by PI.
- However still some amount of difference in degradation is observed.

  →Heat Rate monitoring by both In-Out method and Heat Loss method to be considered since both methods have advantage/disadvantage as described in next page.

  →Daily monitoring of Heat Loss method can be done by PCP.

Consideration/Recommendation (Overall)

Table 5 Typical Advantage/Disadvantage in both method

	In-Out method	Heat-Loss method
Easiness to identify Root Cause	× Difficult because basically the calculation can not be broken down	○ Easy because calculation is easy to be broken down
Uncertainty	× Large uncertainty due to influence of coal quality/quantity measurement (3% to 6% of uncertainty and not recommended by ASME PTC 4)	○ Small uncertainty due to less influence of coal quality/quantity measurement (0.4% to 0.8% of uncertainty and recommended by ASME PTC 4)
Easiness of calculation	○ Easy calculation and less possibility of error in calculation process	△ Complex calculation and possibility of error in calculation process
Extent of Coverage/Comprehensiveness	○ Completely covered from fuel to net electricity	△ Risk of fail to detect several effect e.g. -HP to IP Turbine leakage -Cycle leakage -Heat Loss due to radiant heat etc.
Easiness of taking data/ continuous monitoring	○ Easy to taking data e.g. coal proximate analysis	△ Potential difficulty to taking data e.g. Coal ultimate analysis Limited permenent instrument

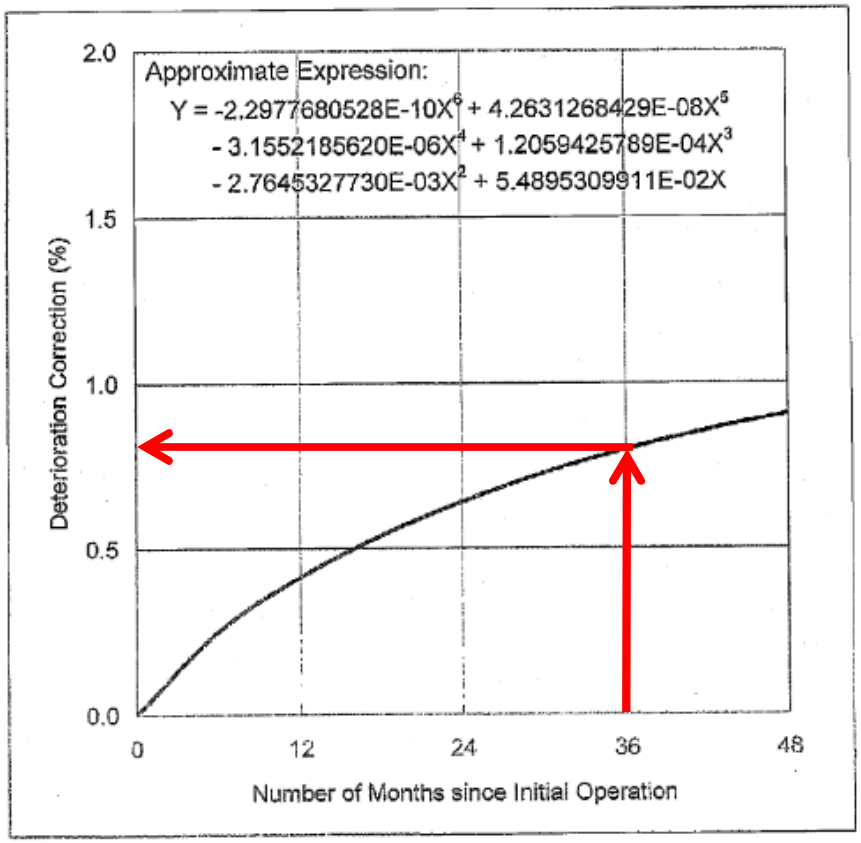
○: Advantage, △:Intermidiate, ×: Disadvantage

Consideration/Recommendation (Boiler Efficiency)

- Boiler Efficiency degradation mainly comes from AH outlet gas temperature. →Cleaning of attached ash on boiler tube and AH to be considered.
- AH inlet mean air temp and ECO outlet O2 do not make significant impact.
- Coal property (Total Moisture and Hydrogen content) makes slight impact.
- Other parameters related to Boiler Efficiency to be referred to Attachment 1.

Consideration/Recommendation (Turbine Cycle HR)

- Turbine Cycle HR degradation of 0.08% to 0.51% seems within expected degradation.(Applox. 0.8% degradation after 3 years of operation is expected by OEM original design.)
- In turbine main train, degradation mostly calculated in IP turbine. → Continuous inspection of turbine internal components to be considered.
- Parameters related to Turbine Cycle HR to be referred to Attachment 2.



Degradation Curve for Turbine Cycle HR by OEM (MHI)

Consideration/Recommendation (House Load)

- Approx. 5% to 10% motor input power increase is observed in large size Fan (FDF, IDF, PAF) → Cleaning and inspection of the equipment inside the Air/Gas system to be considered.
- Significant degradation is not observed in CWP, CP, CCCWP, FGD Absorber Pump, FGD Aeration Blower.
- Constant power regardless of low load is inputted into some of the auxiliary equipments (e.g. CWP, FGD Absorber Pump)→ Stop the part of auxiliary equipments during low load operation to be considered.
- Motor input power of major auxiliary equipments to be referred to Attachment 3.