Optimizing for the Lowest Cost Electrical Production Using Advanced Off-Line Analysis with On-Line Performance Monitoring Solutions

by

Duane Hill, Dairyland Power

Bob Holzworth, Scientech

EPRI Heat Rate Improvement Conference

February 3-5, 2009

CURTISS WRIGHT Flow Control Company

SCIENTECH

A Business Case for Advanced Technology

- Effective use of advanced *technology is critical for the success* of competitive electric power generation.
- This presentation will bring together some thermal performance *business drivers* that the market demands and the *advanced technologies* that will *satisfy those needs*.
- This interchange is *critical to the success*, and maybe *survival*, of each of our companies.

CURTISS WRIGHT Flow Control Company
SCIENTECH

Advanced Performance Technology Solutions

- Thermal Performance Solutions – Fossil Power Plants (today's discussions)
- Off-line First Principle thermal analysis modeling applications
- On-line First Principle thermal performance monitoring applications
- Using high-fidelity thermal models to generate correction curves for optimum targets
- Other performance solutions: Condition monitoring using advanced pattern recognition applications for equipment reliability

CURTISS WRIGHT Flow Control Company
SCIENTECH

Heat Rate Improvement – A Business Case Defined

- Power Plant Competitive Issues:
  - "The Tall Poles under the Tent": environmental, fuel costs, capacity factor, labor, and capital investments
  - Current conditions favor low-cost producers with strong balance sheets
  - The fuel cost pole: heat rate (HR) is a major driver of fuel costs

CURTISS WRIGHT Flow Control Company
SCIENTECH

The Fuel Cost Pole – Heat Rate (HR)

- Fuel costs: ~ 250% increase in last year's coal prices.*
- Fuel represents 77 - 93% of electrical production costs (depending on fuel type and transportation costs).*
- Profitable utilities must have a mandatory HR strategy for sustainable profits and survival, i.e. executive sponsorship.
- HR improvement program is more than routine engineering calculations.
- HR awareness and optimization is critical to competitive operations.

"Being available isn't good enough any longer!"

CURTISS WRIGHT Flow Control Company
SCIENTECH

*** Power-Gen 2008 – Orlando, FL**

Heat Rate Improvement Program – A Business Case for Advanced Technology

- Continuous HR Improvement Program
  - Sustaining executive sponsorship
  - HR Work process: attitudes and empowerment with pragmatic procedures
  - Engineering, operations & maintenance evolvement
  - Advanced technology focused at HR improvement
- Engineering analysis: Off-line HR assessments (establishing “as-is” and “to-be”)

CURTISS WRIGHT Flow Control Company
SCIENTECH

Heat Rate Improvement Program – A Business Case for Advanced Technology

- Situation appraisal: Establishing the current baseline ("as-is")
  - First principles modeling: thermal kit, acceptance tests and tuning
  - Thermal kit: design baseline
  - Acceptance tests: "as-was" condition
  - Tuning to current baseline (recent tests, acceptance data)
- Establishing the most accurate, best achievable ("to-be") targets for on-line thermal monitoring
  - Generate correction curves specific to plant configuration and current condition for optimum targets
  - Curves must be dynamic and appropriate for the process power profiles

CURTISS WRIGHT Flow Control Company
SCIENTECH

Heat Rate Improvement Program – Establishing the Business Case

- Developing a HR improvement program with a business case: i.e., the “Gap” (“as-is” vs. “to-be)
  - Establishing credible HR improvement work processes
  - On-Line monitoring to “accurate, best achievable” goals
  - Cost-effective capital investment projects (options)

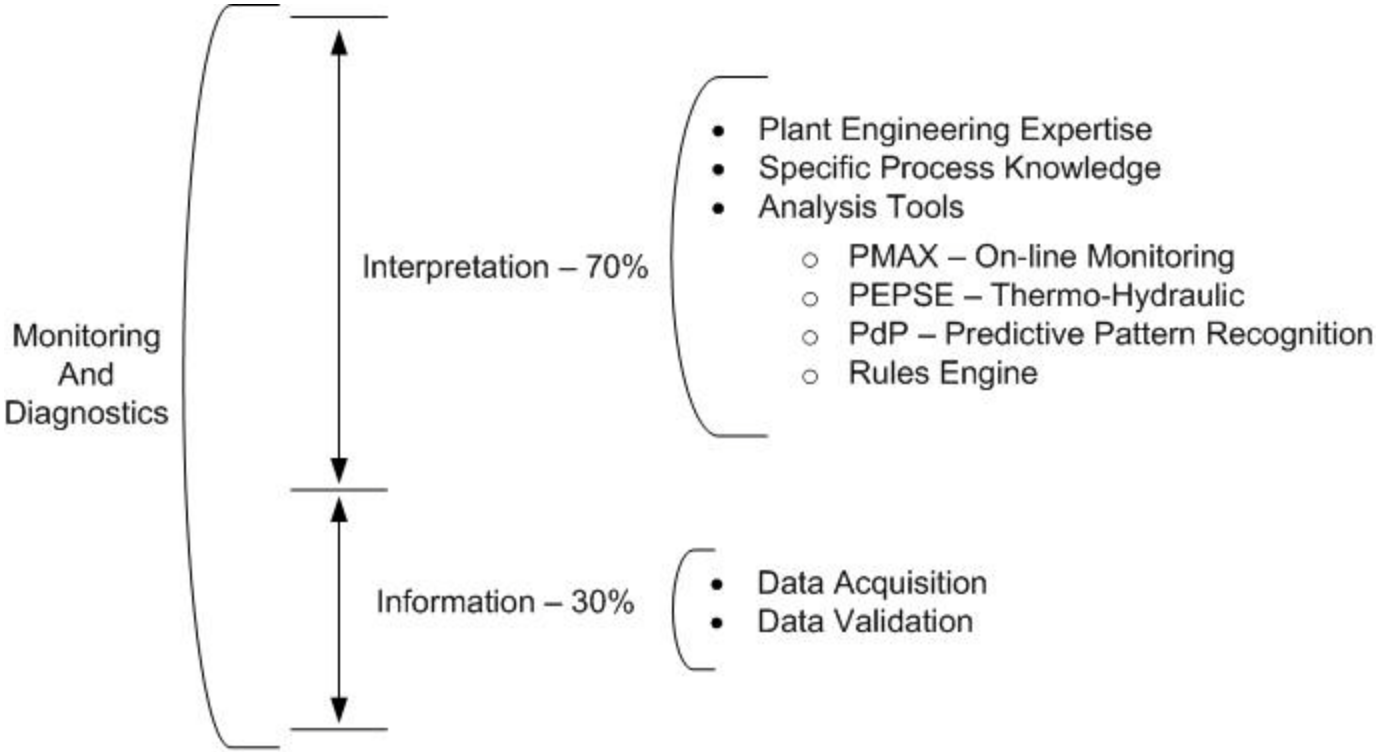
CURTISS WRIGHT Flow Control Company
SCIENTECH

Heat Rate Improvement Program – Establishing the Business Case (cont'd)

- On-Line monitoring applications characteristics
  - Several excellent, comprehensive, on-line HR monitoring applications, using recognized algorithms for heat rate improvement
  - Diagnostics for operations and maintenance
  - Accurate data validation using APR for results integrity
  - Web-based user interface
  - Key for on-line monitoring: Utilize most accurate, best achievable set points for HR and performance monitoring using advanced off-line modeling application

CURTISS WRIGHT Flow Control Company
SCIENTECH

Solutions – Transforming Plant Data into Business Value



IT IS ALL ABOUT THE MODEL!

CURTIS-WRIGHT Flow Control Company
SCIENTECH

Transforming Plant Data into Business Value - “It’s all About the Model.”

- Advanced technology and modeling: Off-line thermal performance analysis application
  - First Principles modeling for design or test modes
  - Detail, thermal-hydraulic component modules (100s of modules)
  - “What-If” studies: Predictive evaluation of plant modifications, operation changes, and variance analysis
  - Automated test data reduction
  - Utilize application that A/E’s and consulting engineers use
  - Drag and drop modeling features
  - Comprehensive thermal-cycle process capability (fossil and nuclear steam, gas turbine, combined cycle, cogeneration, alternate energy)
  - Utilizes recognized professional standards

CURTISS WRIGHT Flow Control Company
SCIENTECH

Establishing the Most Accurate, Best Achievable Condition and Targets

- Engineering services to analyze HR performance: use domain knowledge of HR subject matter expert
  - Perform off-line plant degradation studies and detailed analysis of boilers and turbine cycles, i.e., HR evaluation of complete thermal process cycle
  - Tune model to acceptance test data or other suitable operational data
  - Establish targets over the load range
  - Development of heat rate deviation curves (plant specific)
  - Evaluation of new or modified plant components
  - Incremental heat rate reduction studies

CURTISS WRIGHT Flow Control Company
SCIENTECH

An Advanced Off-Line Analysis Application

- PEPSE is a proven, off-line, thermal performance analysis application to determine most accurate, best achievable targets and analyzing the power cycle process
  - Hundreds of case histories documenting the success of PEPSE in modeling and solving HR issues can be downloaded from: http://famos.scientech.us/Technical_Papers.html
  - Used by all major A/Es for plant design and analysis

CURTISS WRIGHT Flow Control Company
SCIENTECH

The Business Case Results

- Financial payback achieved with the PEPSE/ PMAX applications using most accurate targets.
  - On a 500 MW unit, 1% heat rate improvement >/= $1.5M/yr in fuel savings*
  - Examples of heat rate improvements
    - Reduced sprays: 0.5 - 2%
    - Condenser cleanliness: 1 - 2%
    - Feedwater level control: 0.5 - 1%
    - Boiler exit gas temperature (sootblowing): 0.5 - 3%
    - Aux steam extraction usage: 1 - 5%
    - Turbine outage tracking: 1 - 5%

CURTISS WRIGHT Flow Control Company
SCIENTECH

*** Dairyland Power Cooperative reference data**

Conclusions

- There is a business case for implementing advanced technology to improve HR and reduce operating and maintenance costs.
  - Requires a formal HR program with executive sponsorship.
  - Requires a mature, detailed, First Principles, off-line modeling/analysis application in conjunction with an advanced on-line monitoring application.
  - Requires generation of correction curves specific to power cycle.
  - Requires engineering expertise to analyze existing component and system boundary conditions thus allowing definition of key performance parameters and process set-point optimization for monitoring and control.
  - Requires daily monitoring and diagnostics.
  - Payback may be within 6-12 months in the implementation of these advanced technologies.

CURTISS WRIGHT Flow Control Company
SCIENTECH

Conclusions (Cont'd)

- There has never been a better time for implementing advanced technology.
  - Doing more with less using technology to accelerate innovation and improve return on capital investments.
  - Empower People: Allows staff to learn, test and move up the learning curve.
  - Implementing new systems requires an investment of personnel resources and technology to realize an ROI.
  - Select the right innovation partners to achieve competitive objectives.

CURTISS WRIGHT Flow Control Company
SCIENTECH

Questions & Answers

CURTISS WRIGHT Flow Control Company
SCIENTECH