





Developing and Validating Load and Heat Rate Correction Curves Using PEPSE

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Background

- Load and Heat Rate Correction Curves
 - Important to a thermal performance program
 - Thermal performance reports
 - Assist in accounting for lost generation and heat rate
 - PTC 6 turbine warranty testing

Load and Heat Rate Correction Curves

- Turbine vendors typically provide updated thermal kits, heat balance diagrams and correction curves in conjunction with uprates and major plant modifications.
- Validation of these curves is often critical to ensure the utility is obtaining the best representation of corrected generation.
- Correction curves used for periodic thermal performance reporting, PMAX controllable losses and lost generation accounting.
 - Actual values (i.e. throttle pressure, condenser back pressure, etc.) are compared to design or best achievable targets.
 - Deviation between actual and target values are entered into the correction curves.
 - Results from the curves are used to calculate corrected generation and heat rate and subsequently lost generation and heat rate.

Sample Load Correction Curve





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Curve Validation

- Vendor load and heat rate correction curve issues
 - "Boiler plate" curve provided
 - Error in the curve resulting from incorrect assumptions
 - Curve not provided by the vendor
 - Not used in warranty testing
- Independent creation of correction curves can be performed using PEPSE
 - to validate the vendor provided load correction curves
 - to generate a desired curve not provided by vendor



Curve Validation Methods - Software

- Detailed PEPSE model of the generating unit is developed
 - Model is "Load Generalized" to operate from VWO down to low load (25-50%) to generate multivariate curves often provided by vendors (i.e. condenser back pressure load correction curve)
- Model is benchmarked against the vendor provided heat balance diagrams to ensure accuracy and repeatability
- Curves are generated using the completed model
 - Conventionally using the software or
 - Using spreadsheet interface to the modeling software



PEPSE - Methods to Generate Curves

One result at a Time

- Enter a value (i.e. throttle pressure), observe resulting generation, repeat
- Very time consuming, potential for user entry errors

Stacked Case Study

- Time consuming to setup studies for a set of curves

Sensitivity Study

- Fast and convenient
- Has curve export feature
- Uses PEPSE "Save Case" feature, potential to have issues with results
- Excel to PEPSE Automation Link Historical Approach
 - Typically done one curve at a time.
 - Convenient but can be time consuming to generate a set of curves



Newer Method to Validate Correction Curves

- Excel to PEPSE Automation Link Updated Approach
 - Visual Basic used to generate the complete set of curves at one time
 - User:
 - Enters PEPSE model name and directory
 - Puts in a list of desired load and/or heat rate correction curves
 - Presses a button to setup the curve templates
 - Executes PEPSE and generates the curve set



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Run PEPSE – Generates Curve Set



Vendor Curve Sample – Condenser Back Pressure



Curve Comparison Discussion – Condenser Back Pressure





Validating Curves – Vendor Curves Placed into Excel

- Use a curve digitizing product such as GetData Graph Digitizer
 - Each vendor correction curve is quickly and accurately placed into Excel for comparison to the PEPSE generated curve
 - Open a graph
 - Set the scale (coordinate system)
 - Digitize (automatically or manually) and
 - Export data to Excel



Validating Curves – Digitized Load Correction Curve





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Validating Curves – Curve Comparison

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Validating Curves – Curve Comparison





Other Curves

This approach can also be used to generate expected target conditions



Sample Target Curve – Expected Back Pressure





Summary

- Correction and other curves can be quickly created using PEPSE in conjunction with Excel and VB macros
- The resulting curves can be compared to vendor provided curves to determine accuracy
- Additional curves not provided by the vendor can be created for load and heat rate correction and for expected best achievable target values

