



OSIsoft®

UC2010

Real Time Information — Currency of the New Decade

Hilton San Francisco Union Square | San Francisco, CA

April 26-28, 2010

Leveraging ACE and AF for Plant Condition and Performance Monitoring

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OSI Users Conference

Leveraging ACE and AF for Plant Condition and Performance Monitoring

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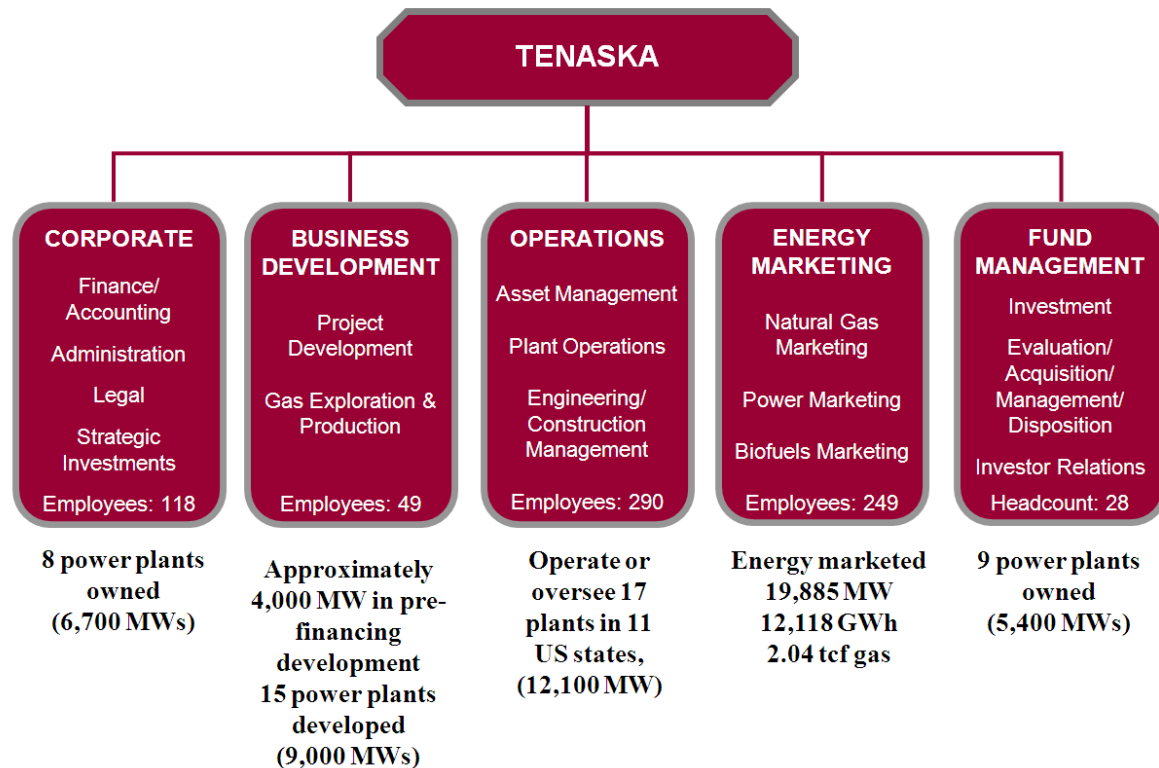


About Tenaska

- Develops, constructs, owns & operates electric generating plants. Has developed 9,000 MW in 15 domestic and international projects
 - Markets natural gas, electric power and biofuels
 - Manages private equity funds totaling nearly \$5 billion
- Headquartered in Omaha, Nebraska
- 2009 revenues of approximately \$8 billion
- Employee owned
- Forbes #16 – 2009 Privately Held Companies

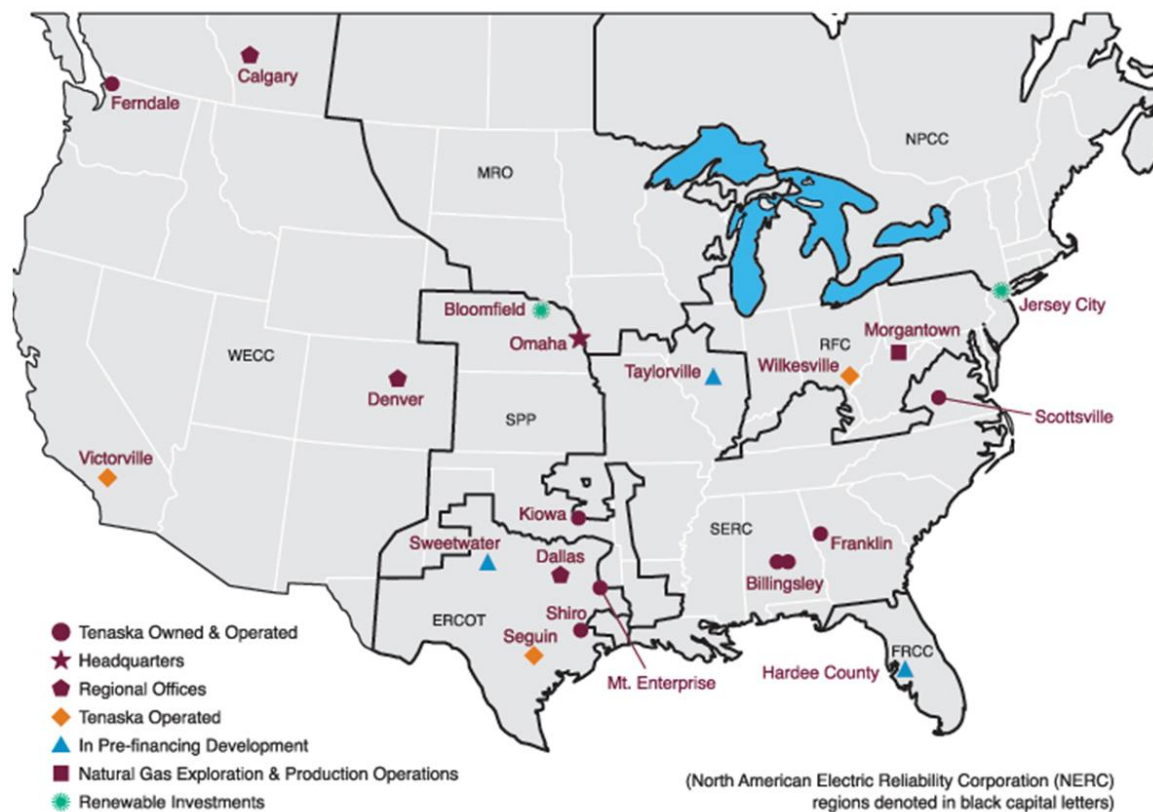


Structured to Develop, Own and Operate Power Plants





About Tenaska



Need to Monitor the Condition and Performance of Turbines

- Turbine reliability and performance is critical to the bottom line.
- There is a wide array of offerings in the market for monitoring and performance but all are third party software.
- Tenaska has a solid foundation of OSIsoft technology in place at all of our plants and needs a solution in PI.

Need to Monitor the Condition and Performance of Turbines

- We wanted a proprietary configuration for our gas turbines and other packages were too restrictive to allow this flexibility and the calculations occurred in a “Black Box” and we wanted to know what was being calculated and how.

Technology we are using to monitor our turbines

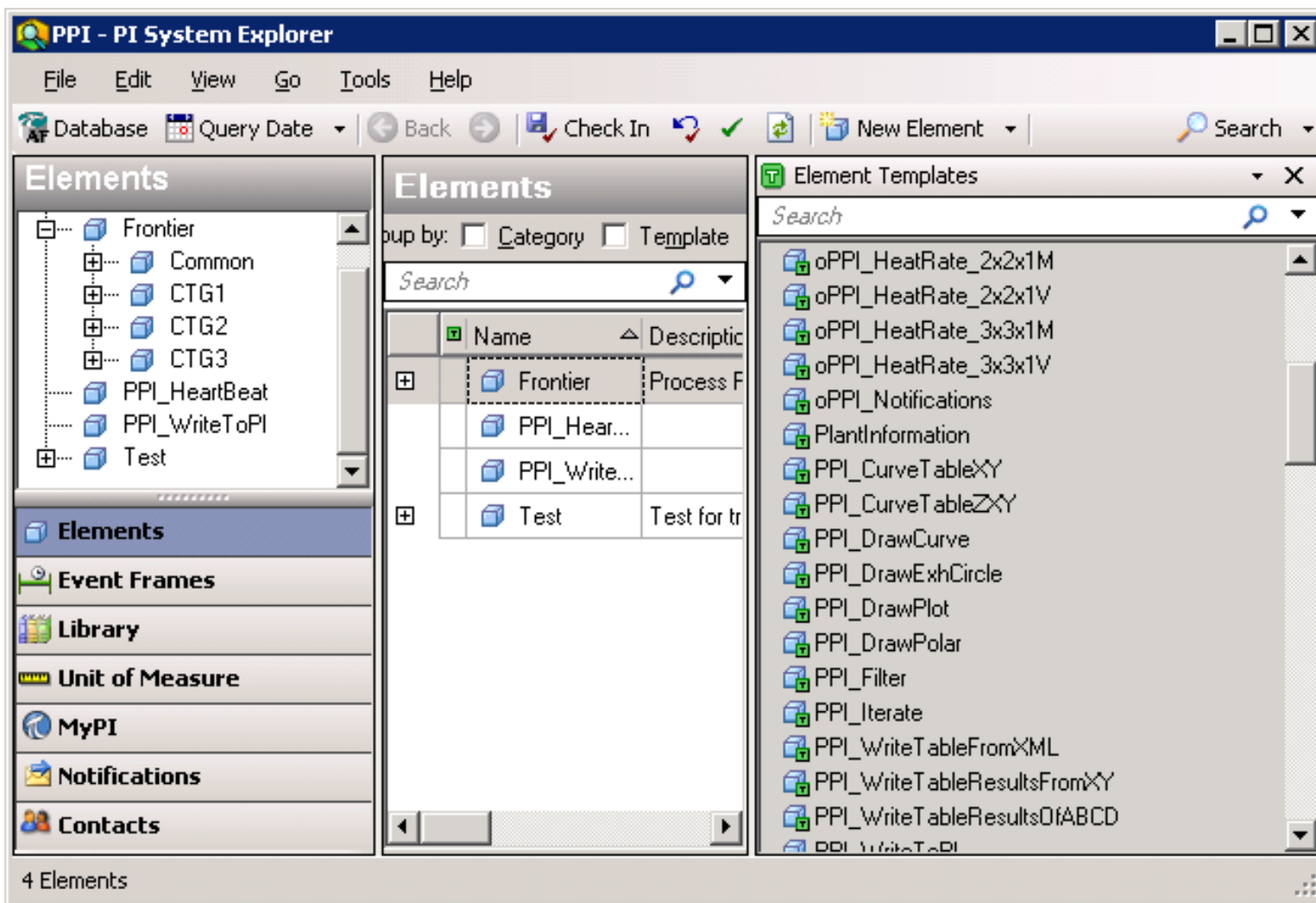
- OSIssoft AF

- Process Plugins with ACE, AF SDK and PI SDK backed AF Templates

Transitioning from Spreadsheets to Real Time Monitoring

- We have spreadsheet tools now that provide snapshots of performance
- Spreadsheets now provide Data Validation of Process Plugins solution

AF Provides Logical Layout



Leveraging AF Functions for Simple in Plain Sight Calculations

The screenshot displays the 'PPI - PI System Explorer' application window. The left sidebar shows a tree view of elements under 'Generator', with 'ApparentPower' selected. The main window has tabs for 'General', 'Child Elements', 'Attributes', 'Ports', and 'Version'. The 'General' tab is active, showing a table of attributes and a configuration panel on the right.

Name	Value
ActivePower	-314.984375 MW
AlarmNormal	False
ApparentPower	378.5677 MVA
Hydrogen	20.59245 °C
PowerFactor	-0.832042336
ReactivePower	-209.9961 MVAR
Theta	0.5880169 rad

Configuration Panel (Right):

- Name: ApparentPower
- Description:
- Configuration Item: ☐
- Categories:
- UOM: MVA
- Value Type: Single
- Value: 378.5677 MVA
- Data Reference: Formula
- Settings... button
- Formula: $A=ActivePower;UOM=MW;B=ReactivePower;UOM=MVAR;[(A^2+B^2)^{0.5}];UOM=MW$

Simple Formulas in Plain View

Formula Configuration:(ApparentPower)

Parameters

A=ActivePower;UOM=MW
B=ReactivePower;UOM=MVAR

☐ Default Values Allowed

Equations

$(A^2+B^2)^{0.5}$

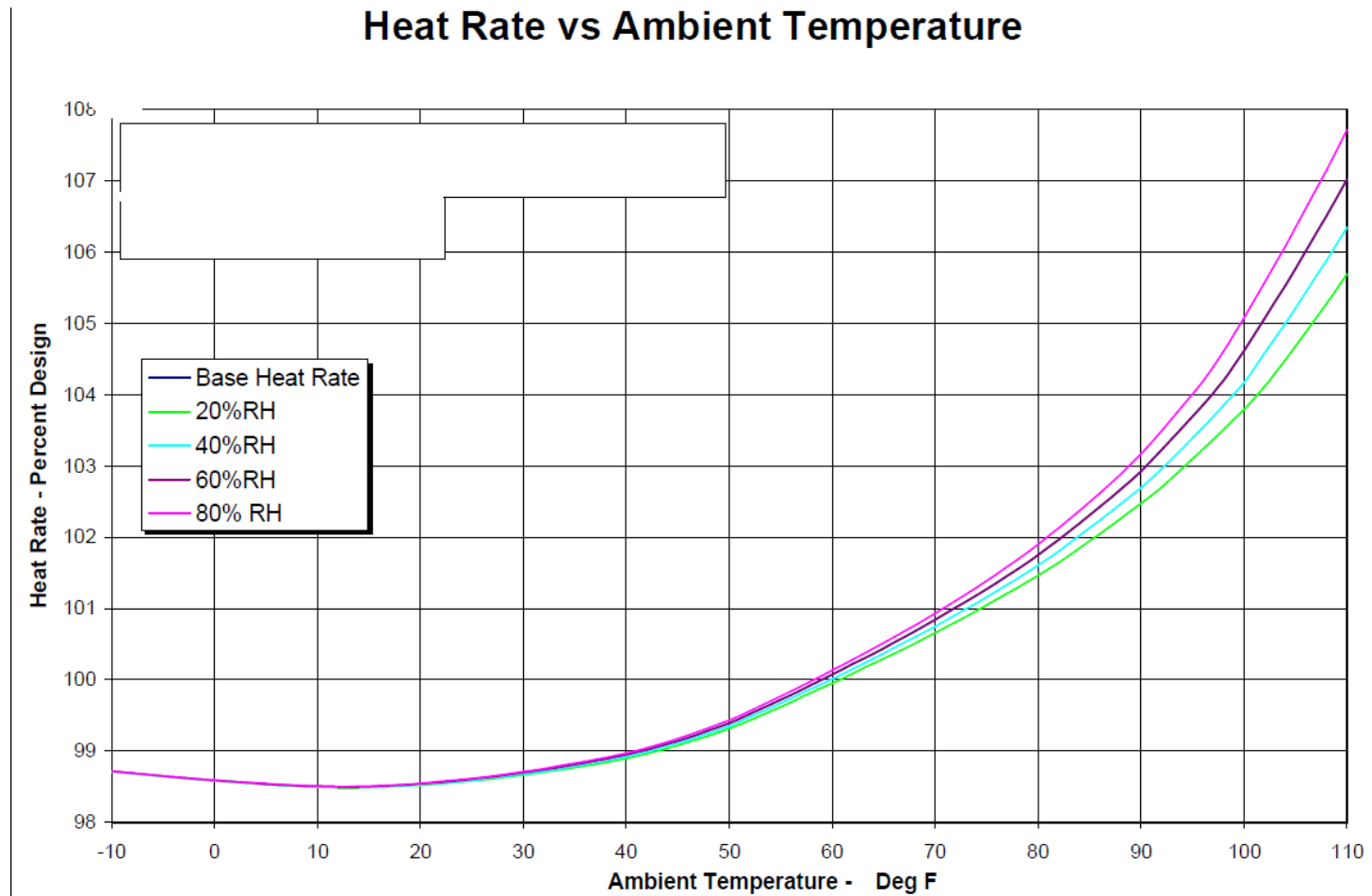
Result

Unit of Measure: MW Minimum: Maximum:

Evaluate

OK Cancel

Sample Curve to be is Entered Into AF Tables



Curve Converted to AF Table Data

PPI - PI System Explorer

File Edit View Go Tools Help

Database Query Date Back Check In New Table Search

Library

- ACCPressureFansHalf
- CombCans14
- CT1DesHeatRateVsAmbTemp**
- CT1DesHeatRateVsAmbTempEC
- CT1DesHeatRateVsLoad
- CT1DesOutputVsAmbTemp
- CT1DesOutputVsAmbTempEC
- CT1ForecastLoadCurve
- CT2DesHeatRateVsAmbTemp
- CT2DesHeatRateVsAmbTempEC
- CT2DesHeatRateVsLoad
- CT2DesOutputVsAmbTemp
- CT2DesOutputVsAmbTempEC
- CT2ForecastLoadCurve
- CTPlotEffvsDegC
- CTPlotEffvsMW

Elements

Event Frames

Library

Unit of Measure

MyPI

Notifications

Contacts

CT1DesHeatRateVsAmbTemp

General Table Define Table Version

CT1DesHeatRateVsAmbTemp

	Z	X	Y
▶	20	-10	98.71591
	20	-4.82014	98.64432
	20	-0.07194	98.58295
	20	5.28058	98.53181
	20	10.02878	98.50114
	20	20.04317	98.50114
	20	25.22302	98.57273
	20	29.97122	98.66477
	20	35.41007	98.76704
	20	39.98561	98.88977
	20	45.42446	99.09431
	20	50	99.30909
	20	55.8705	99.66705
	20	59.92806	99.94318
	20	65.45324	100.3216
	20	70.02878	100.6489
	20	75.38129	101.0784

CT1DesHeatRateVsAmbTemp Modified:11/24/2009 4:00:02 PM. Version: 1/1/1970 12:00:00 AM, Revision 1

Process Plugins AF Curve Template Backed by Code was Used for Many Curves

The screenshot displays the 'PPI - PI System Explorer' application window. The left sidebar contains a tree view of 'Elements' with 'PPI_CurveTableHRvAmbT' selected. Below the tree are buttons for 'Elements', 'Event Frames', 'Library', 'Unit of Measure', 'MyPI', and 'Notifications'. The main window has tabs for 'General', 'Child Elements', 'Attributes', 'Ports', and 'Version', with 'General' currently active. A table lists the attributes of the selected element:

Name	Value
InputX	70 °F
InputZ	82.74869 %
OutputY	100.9463 %
TableName	CT1DesHeatRate...

To the right of the table is a configuration panel with fields for 'Name' (InputX), 'Description', 'Configuration Item', 'Categories', 'UOM' (<None>), 'Value Type' (Single), 'Value' (70 °F), and 'Data Reference' (Formula). A 'Settings...' button is located below these fields. At the bottom of the configuration panel, the formula 'A=..\DryBulbTemperature.[A]:UOM=°F' is visible. The status bar at the bottom of the window indicates: 'PPI_CurveTableHRvAmbT Modified:11/24/2009 4:51:45 PM. Version: 1/1/1970 12:00:00 AM, Revision 1'.

Process Plugins AF Curve Template Writes Result to PI Tag

The screenshot displays the 'PPI - PI System Explorer' application window. The left sidebar contains a tree view of 'Elements' with the following items: PPI_CurveTableGENvAmbT, PPI_CurveTableHRvAmbT (selected), PPI_CurveTableHRvLoad, PPI_WriteToPI_BaseLoadExp, PPI_WriteToPIHRExp, PPI_WriteToPIHRExp1, and PPI_DrawCurve1. Below the tree are buttons for 'Elements', 'Event Frames', 'Library', 'Unit of Measure', 'MyPI', and 'Notifications'. The main area is titled 'PPI_CurveTableHRvAmbT' and has tabs for 'General', 'Child Elements', 'Attributes', 'Ports', and 'Version'. The 'General' tab is active, showing a table of attributes:

Name	Value
InputX	70 °F
InputZ	82.74869 %
OutputY	100.9463 %
TableName	CT1DesHeatRate...

On the right, the 'OutputY' attribute is selected, and its configuration is shown in a form. The 'Name' field is 'OutputY'. The 'Value' field is '100.9463 %'. The 'Data Reference' dropdown is set to 'PI Point'. The 'Path' at the bottom is '\\PROCESSPLUGINS1\\PPI_ECAP_OUT_U01'. The 'Settings...' button is visible below the form.

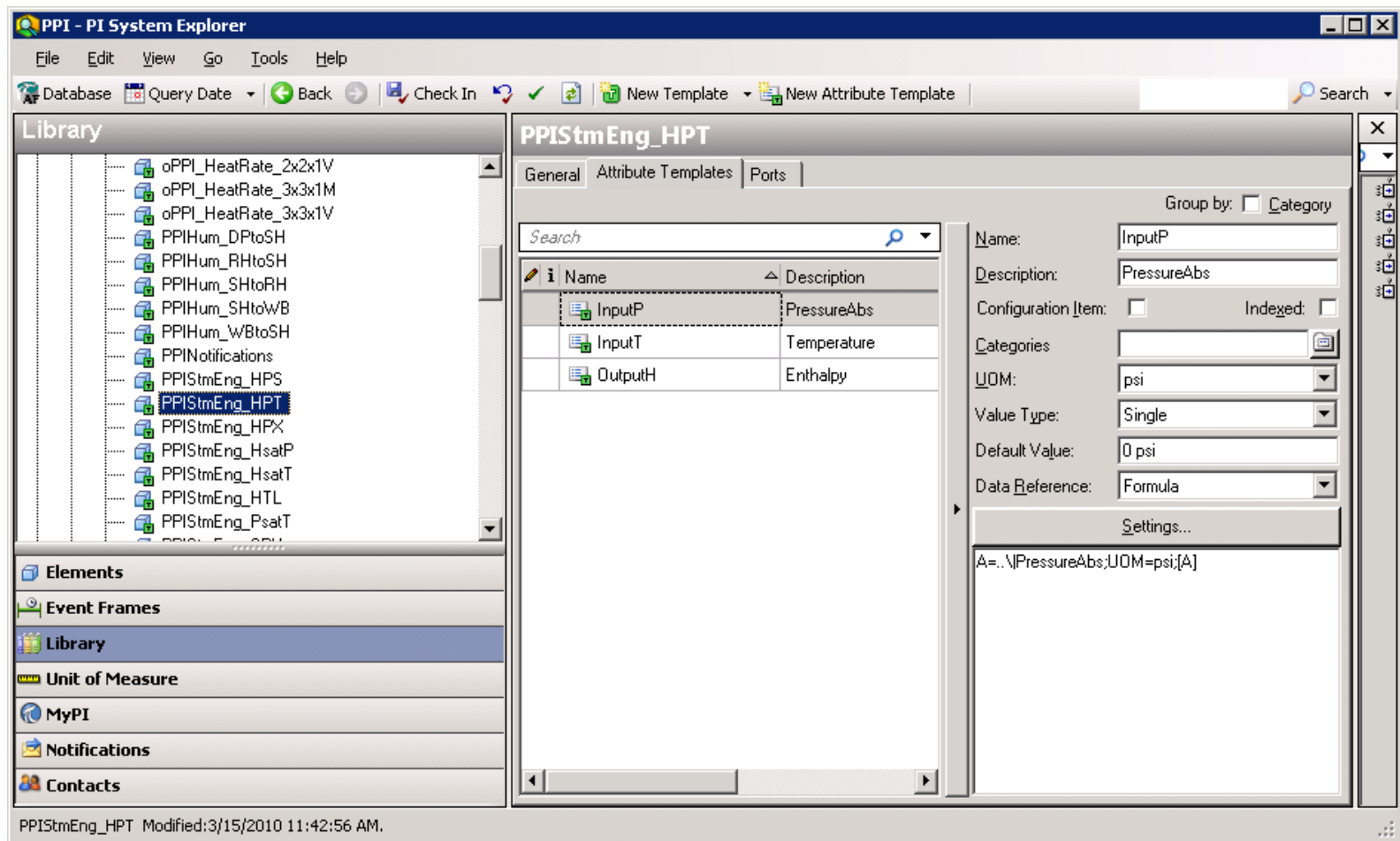
Template for Writing Data to PI Tag with Filtering Used to Write Multiple Calculation Results

The screenshot displays the PPI - PI System Explorer application. The left sidebar shows a tree view of elements, with 'PPI_WriteToPIvalidHRExp' selected. The main window is titled 'PPI_WriteToPIvalidHRExp' and has tabs for 'General', 'Child Elements', 'Attributes', 'Ports', and 'Version'. The 'General' tab is active, showing a table of attributes and a configuration panel on the right.

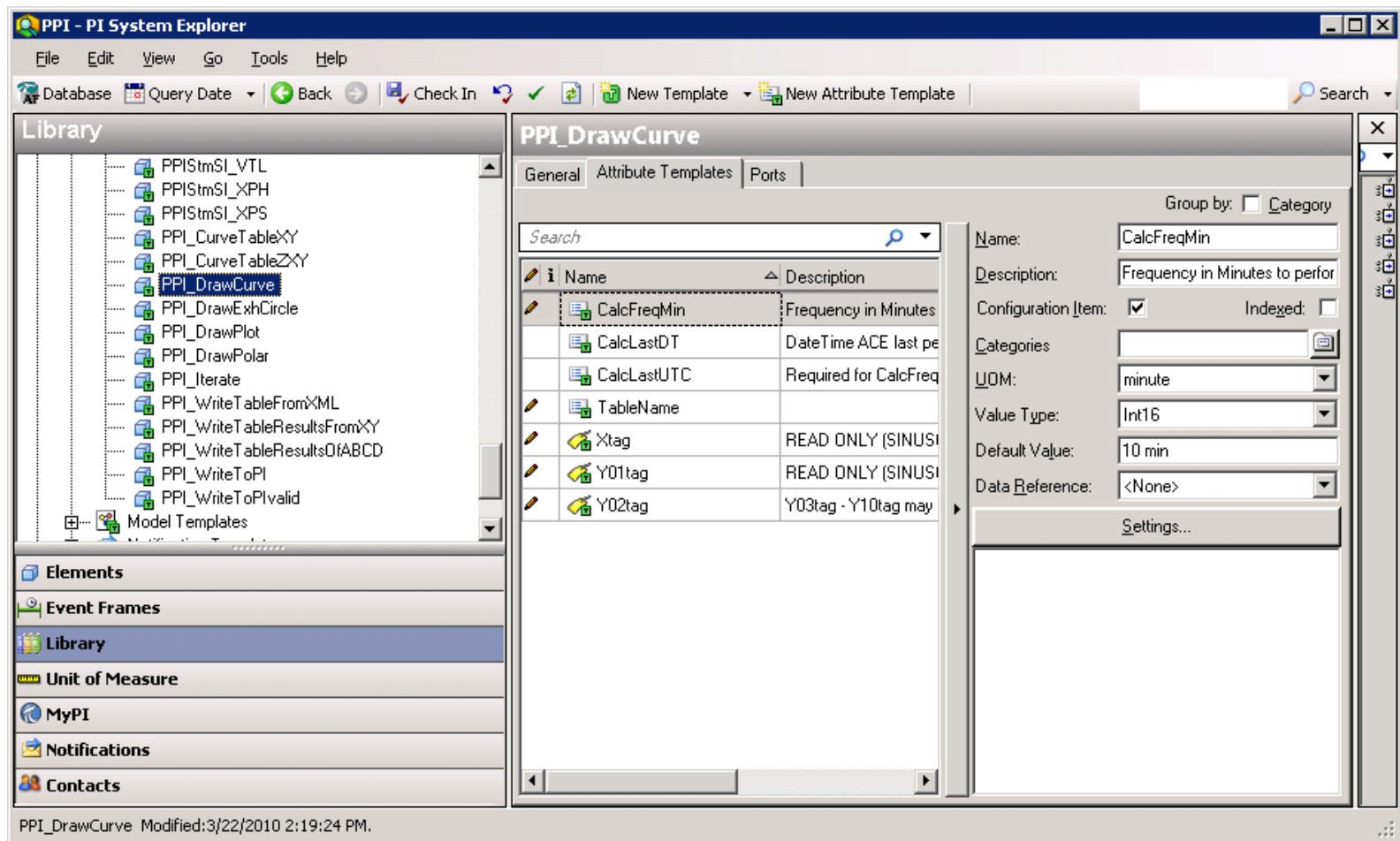
Name	Value
Formula	10473.09 Btu/kWh
PIPoint	10473.09 Btu/kWh
Validate	True
ValidationMax	14000
ValidationMin	6000

On the right, the configuration panel includes fields for Name (Formula), Description (Input the value or formula y), Configuration Item (unchecked), Categories, UOM (<None>), Value Type (Single), Value (10473.09 Btu/kWh), and Data Reference (Formula). A 'Settings...' button is also present. At the bottom, a text field shows the formula: `A=.. \HeatRateExpected;UOM=Btu/kWh;[A];U`.

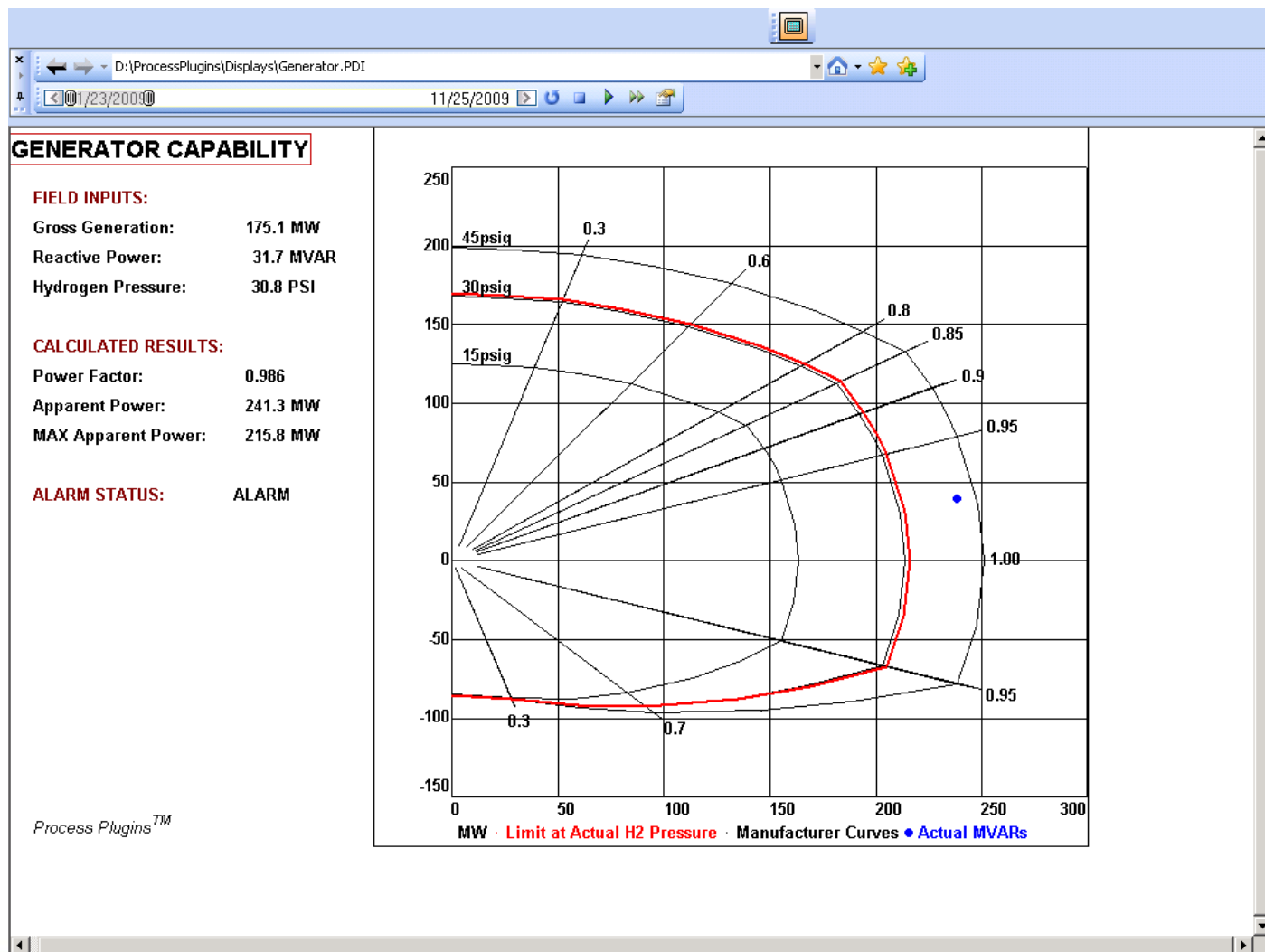
Steam Function Template



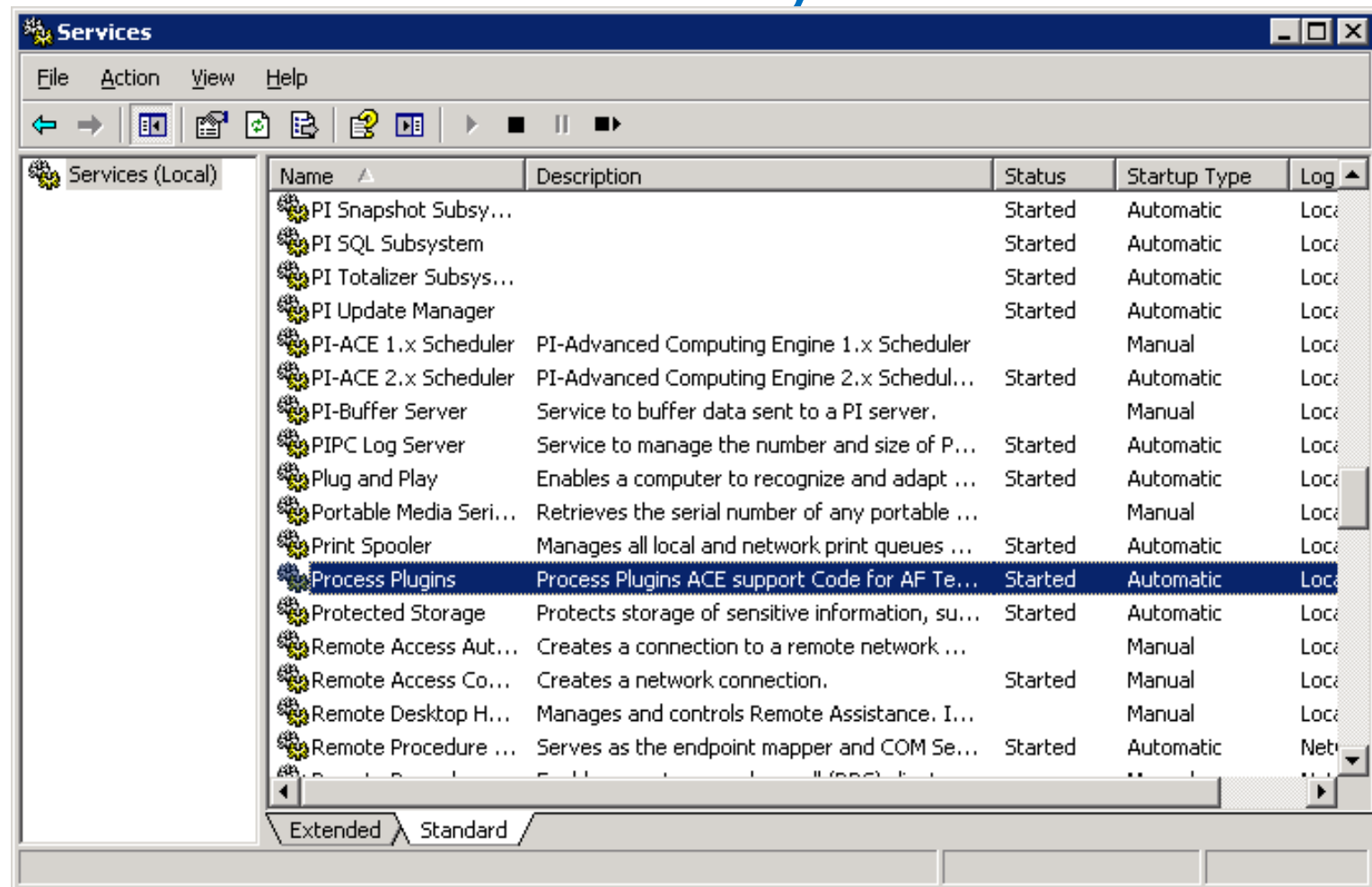
Visualization Template



Visualization Templates in Use



Service Provides Process Plugins Functionality to AF



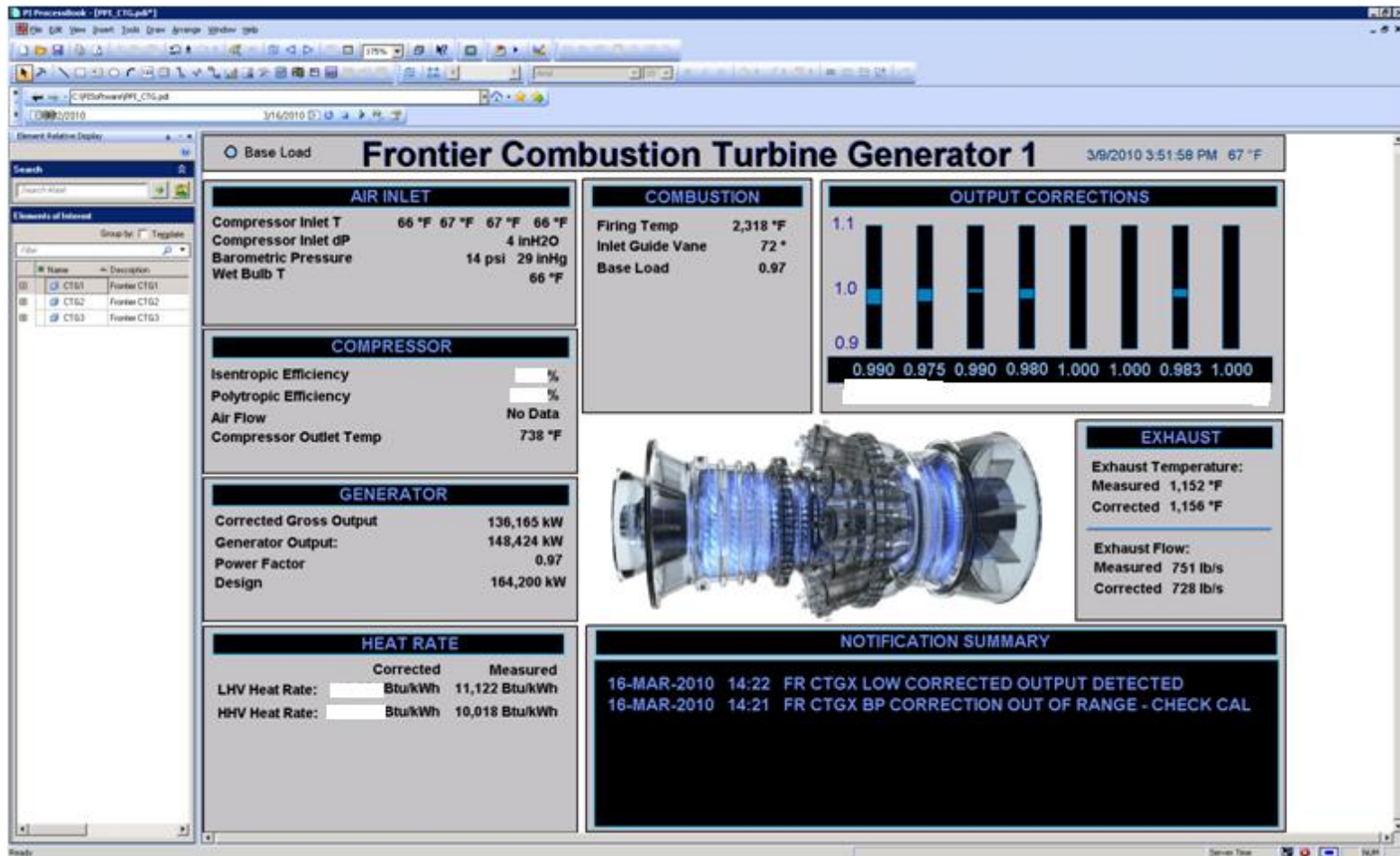
Visualizing with OSIsoft Technology

- With a foundation of PI clients already deployed throughout the Tenaska fleet and an instance of PI WebParts in place we are using tools familiar to everyone.
- Element Relative Displays to be used
- PI WebParts Element Relative Displays to be used soon

Getting the Information to the Operator

- Operators need data to act in real time
- They already know how to use the PI tools

Element Relative Display



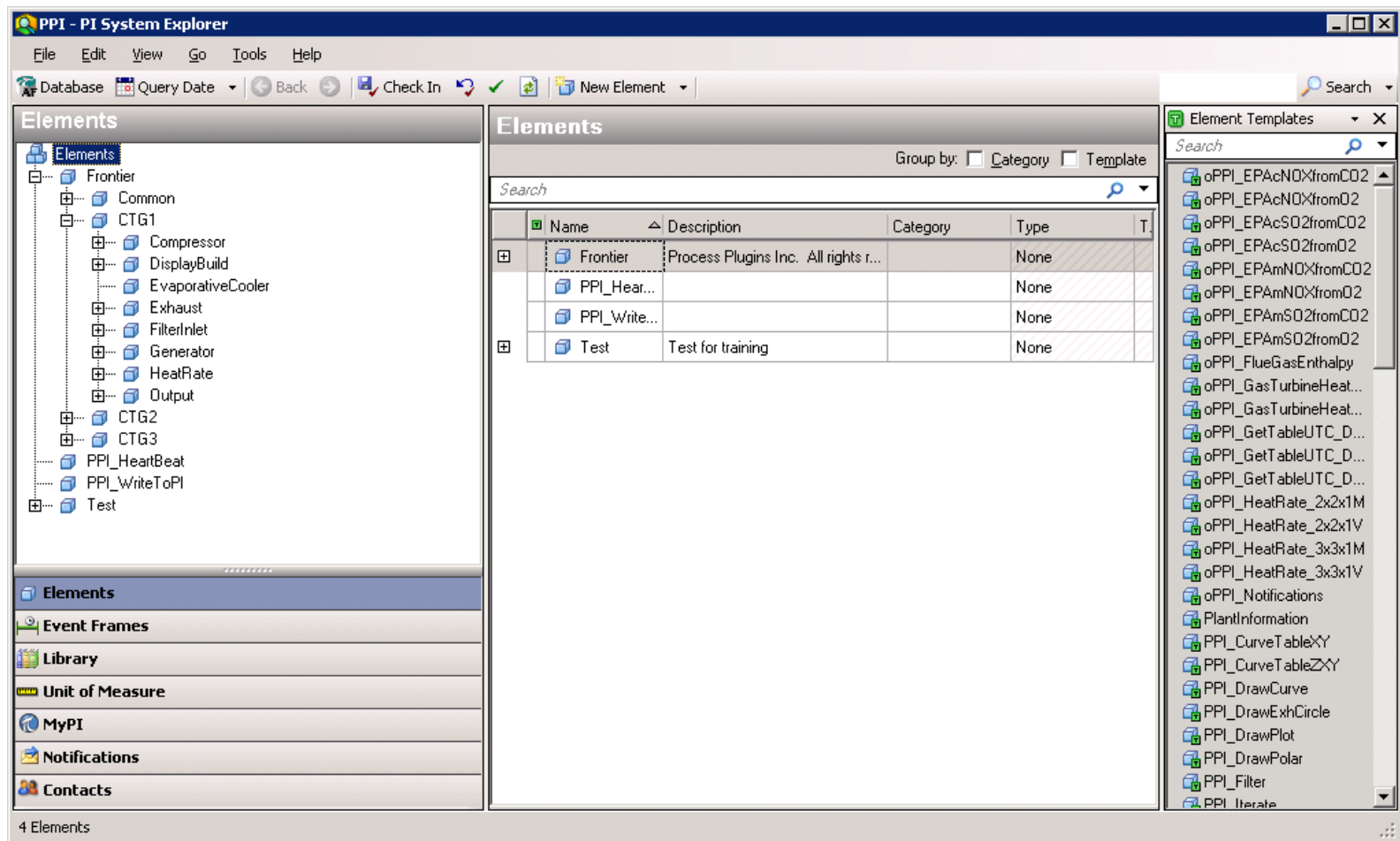
Design Considerations

- Fleet wide deployment needs to be scalable and repeatable
- AF gives us the perfect platform.

Fast Deployment

- Copy and paste for all similar turbines
- Site level deployment can also copy and paste

Once CTG1 was Complete we did a copy and paste for CTG2 and CTG3



Fast Deployment

- All plants to be deployed in Omaha in a single AF database
- Most of the work after the first configuration is with PI tag development and reworking curve table configurations.

Leveraging OSIsoft PI Notifications

- We need the turbines to tell us when something is wrong
- With all configuration in AF Notification is an easy task

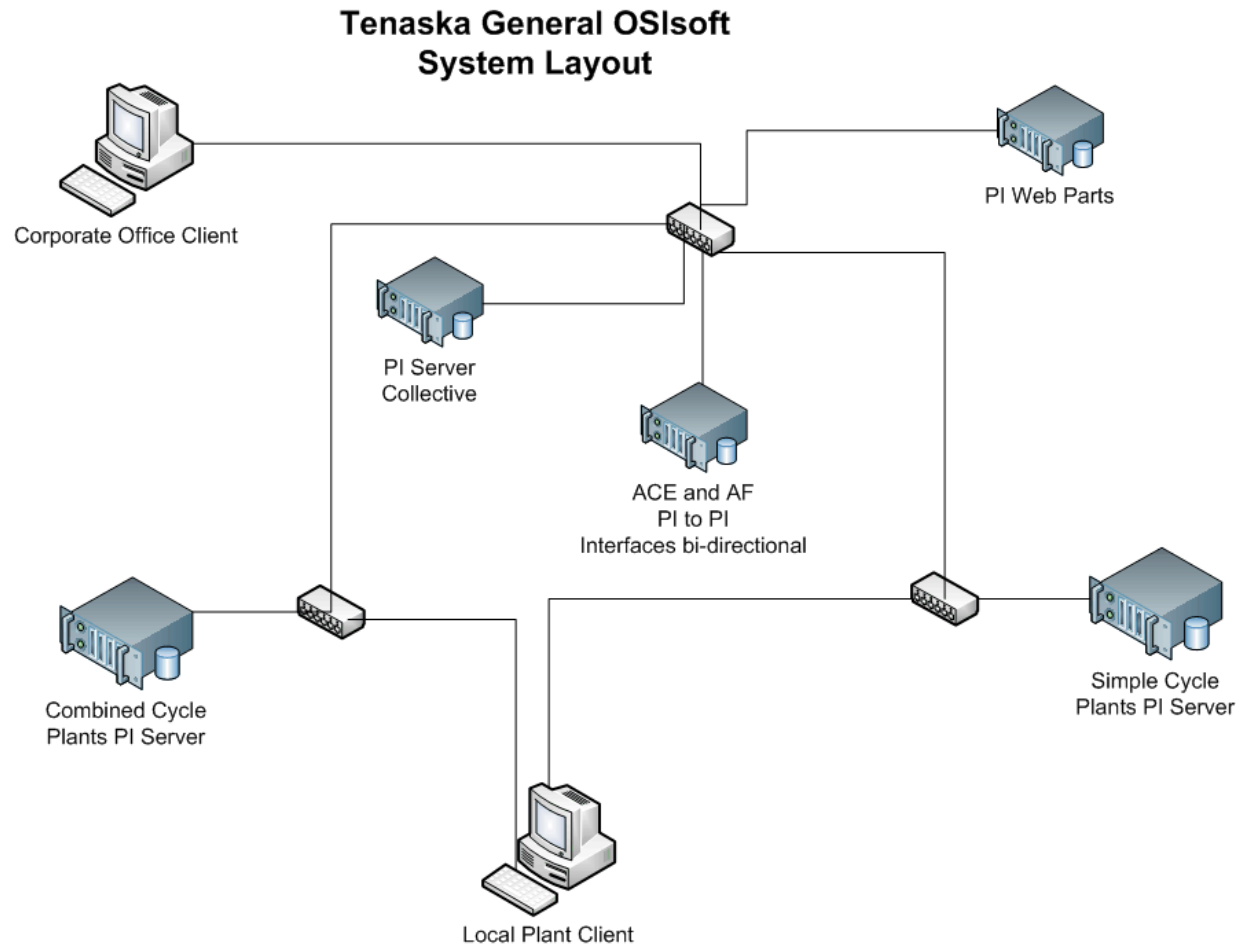
Data Validation

- Part of the Notification process is the validation of data that feeds the monitoring tools.
- For inputs into the model there are limits set for the input upper and lower limit with a constant or formula for substitution of a value with the AF elements

What OSIsoft Products We Use

- ProcessBook
- DataLink
- PI WebParts
- ACE
- AF
- PI Notifications
- Servers and interfaces at each site
- PI to PI to a central system in Omaha

PI SYSTEM ARCHITECTURE



Fast Deployment Results

➤ We are in the early stages of development of the project. We Started Feb. 23rd and had one plant configured by March 15th. We are in the data validation phase for this plant.

Results of Deployment

- Notifications will tell us when the turbines need attention
- Performance can now be monitored continuously instead of on demand occasionally.
- We are leveraging existing tools so we do not need to switch visualization or reporting from what we already know = Minimal investment for a lot of results

Tangible Results

- Minimal investment for Process Plugins provides more value for OSIsoft AF
- Catching one issue with continuous monitoring and notification will repay our investment

FUTURE PLANS / NEXT STEPS

- Continue our fleet deployment of the monitoring and performance tools.
- Build additional reporting and visualization
- Add other equipment monitoring beyond our turbines



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Thank you
Questions?

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