Migrating PE to Asset Analytics

Brent Bregenzer

Agenda

- Advantages of Asset Analytics over PE Tags
  - Performance
  - Ease of Configuration
  - Better Scalability
  - Greater Functionality
- Migration Strategies
  - J.I.T.: Convert as you build and expand AF
  - Bulk Conversion for many identical calculations

Advantages of Asset Analytics Over PEs

- **Performance**
- **Ease of Configuration**
- **Better Scalability**
- **Greater Functionality**

Performance: Calculation Engine

PI Analysis Service

- Stand alone service that can run on its own machine
- Compatible with Windows Clustering and PIBuffSS
- Can read from/write to any number of data archives via AF PI Point Attributes
- Data cache for faster input retrieval

PI PE Scheduler

- Runs only on data archive (DA) server
- No easy HA option
- Only reads from/writes to single DA server
- No cache; all history retrieved at runtime

Configuration

AF Analyses

- Expressions can use line breaks, variables, and comments
- More robust troubleshooting/ testing tools
- Highly flexible scheduling options

PE Tags

- Expression is one continuous string with no in-line documentation
- Limited troubleshooting tools
- Limited scheduling options

Configuration: Enter Expressions

AF Analyses

Line breaks, variables, & comments

Example: Heat transfer coefficient

- 14 variables
- Easy to understand names
- Comments

Heat Exchanger

Name

Heat Exchanger Mass Flow

Overall Heat Transfer Coefficient (U)

Name	Expression
TiH	'Hot Side Inlet Temperature'
ToH	'Hot Side Outlet Temperature'
tiC	'Cold Side Inlet Temperature'
toC	'Cold Side Outlet Temperature'
HotTdiff	TiH-ToH
ColdTdiff	toC-tiC
qs	//Shell side heat duty; m*Cp*deltaT 'Shell Side Mass Flow'*'Shell Side Heat Capacity'*HotTdiff*3600
qt	//Tube side heat duty; m*Cp*deltaT 'Tube Side Mass Flow'*'Tube Side Heat Capacity'*ColdTdiff*3600
R	HotTdiff/ColdTdiff
S	ColdTdiff/(TiH-tiC)
LMTD	//Log Mean Temperature Difference ((TiH-toC)-(ToH-tiC))/Log((TiH-toC)/(ToH-tiC))
F	//Correction factor for crossflow ((R+1)^0.5*Log((1-S*R)/(1-S)))/ ((1-R)*Log((2-S*(R+1-(R+1)^0.5))/(2-S*(R+1+(R+1)^0.5))))
CorrLMTD	F*LMTD //Corrected LMTD
U	Max(qs,qt)/('Area'*CorrLMTD) //Heat Transfer Coefficient

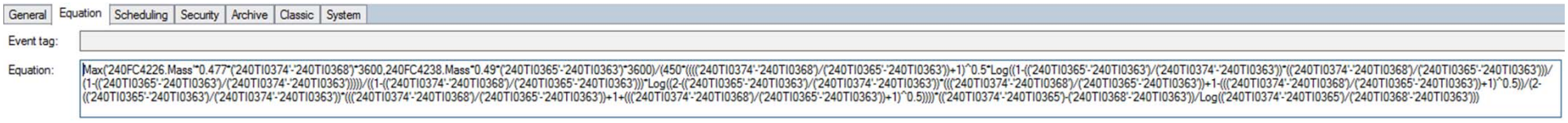
Configuration: Enter Expressions

PE Tags

One continuous string with no in-line documentation

Example: Heat transfer coefficient

- 886 characters!
- Must use tag names and hard coded constants



Configuration: Troubleshooting/Testing

AF Analyses

More robust troubleshooting/testing tools

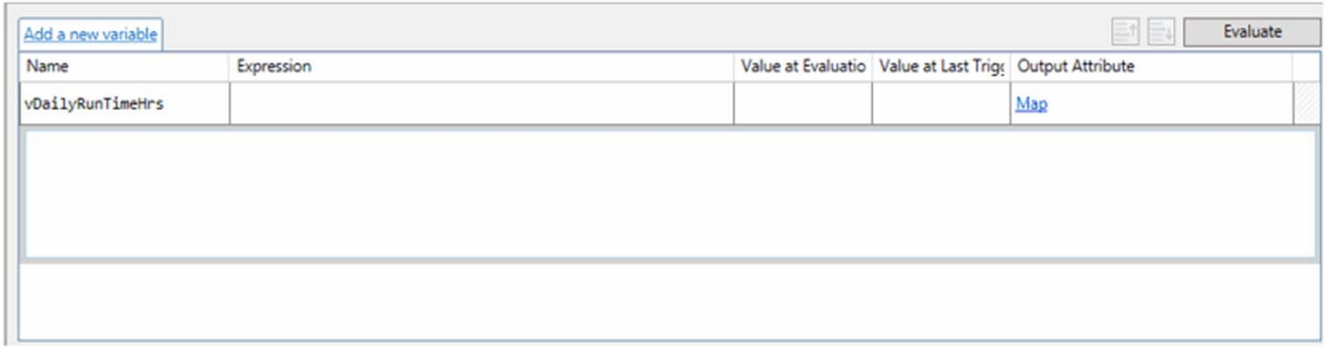
- Intellisense
- Syntax error marking
- On demand evaluation/error check

Configuration: Troubleshooting/Testing - Demo

AF Analyses

More robust troubleshooting/testing tools

- Intellisense
- Syntax error marking
- On demand evaluation/error check

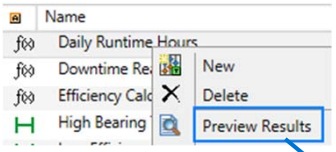


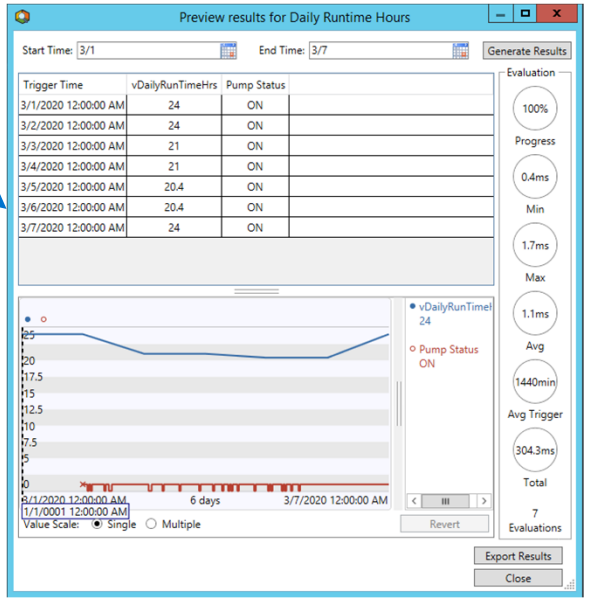
Configuration: Troubleshooting/Testing

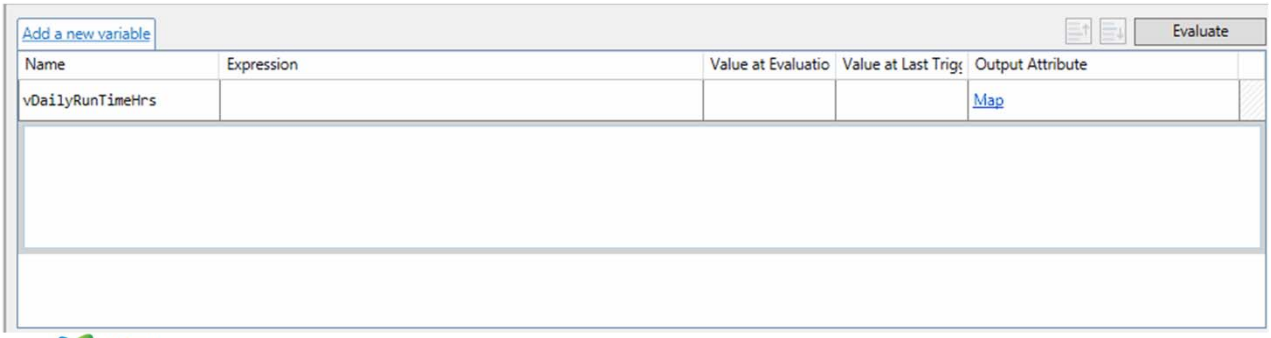
AF Analyses

More robust troubleshooting/testing tools

- Intellisense
- Syntax error marking
- On demand evaluation/error check
- Preview







Configuration: Troubleshooting/Testing

PE Tags

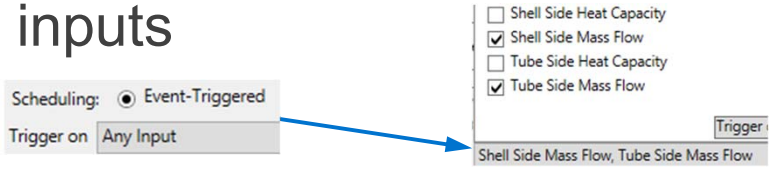
Limited troubleshooting/testing tools

- Evaluate, but no Preview
- No Intellisense
- No inline markers
- Limited error messaging; mostly:
  - Error -2147219650: PI PE syntax error in Expression. [-12301] Performance Equation parsing error
  - Calc failed

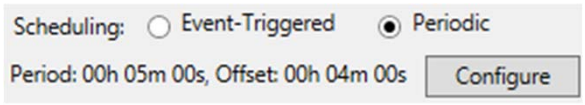
Configuration: Scheduling

AF Analyses

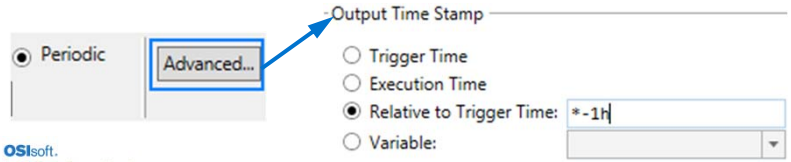
- Event triggered: one or more inputs



- Periodic: Configurable per analysis

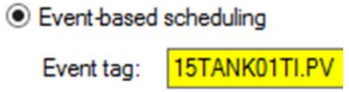


- Output timestamps: 4 Options

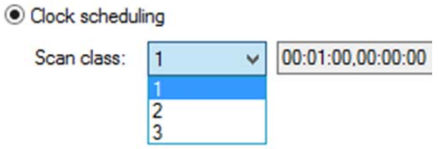


PE Tags

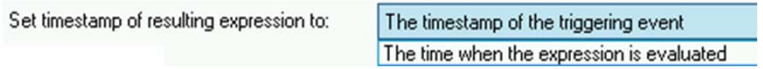
- Event triggered: single input



- Periodic: per scan class

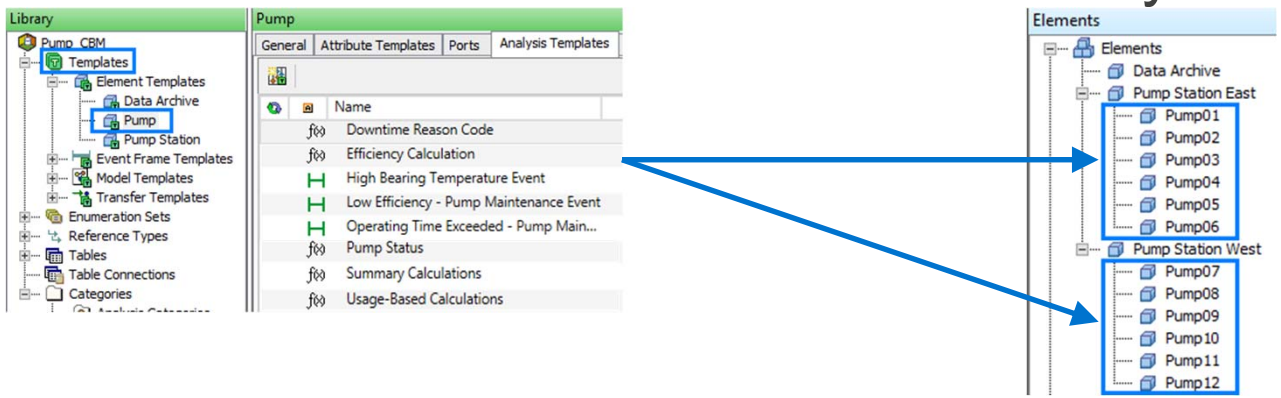


- Output timestamps: 2 Options



Scalability

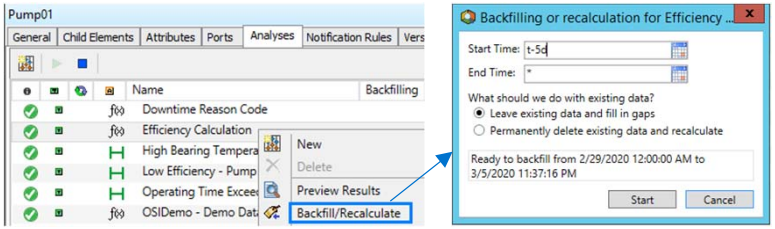
- Performance
  - Add resources to Analysis Service Machine
  - Dedicated Analysis Service per AF Server
- Configuration: AF templates
  - Build calculation once and reuse easily



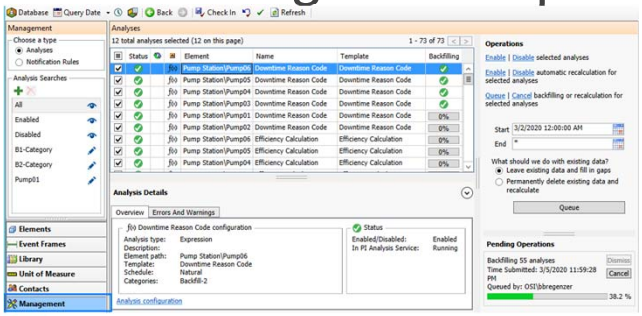
Functionality: Recalculation

AF Analyses

- Easy Recalculation with Backfill option

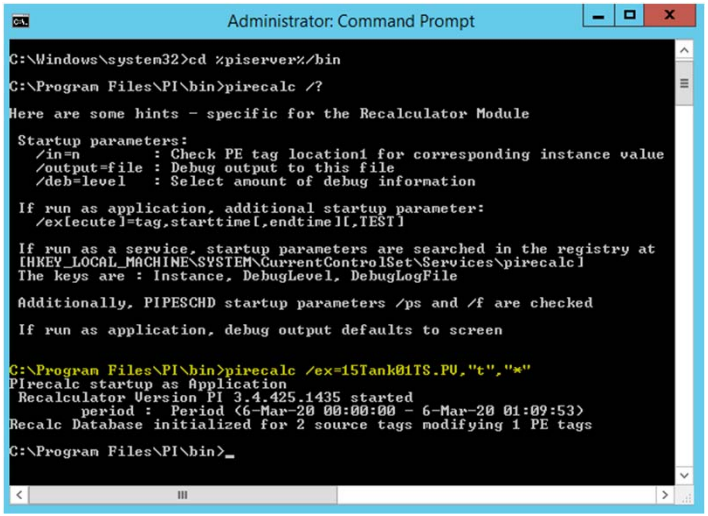


- Bulk management option



PE Tags

- Only Recalculation through command prompt



Functionality: Expanded Expression Library

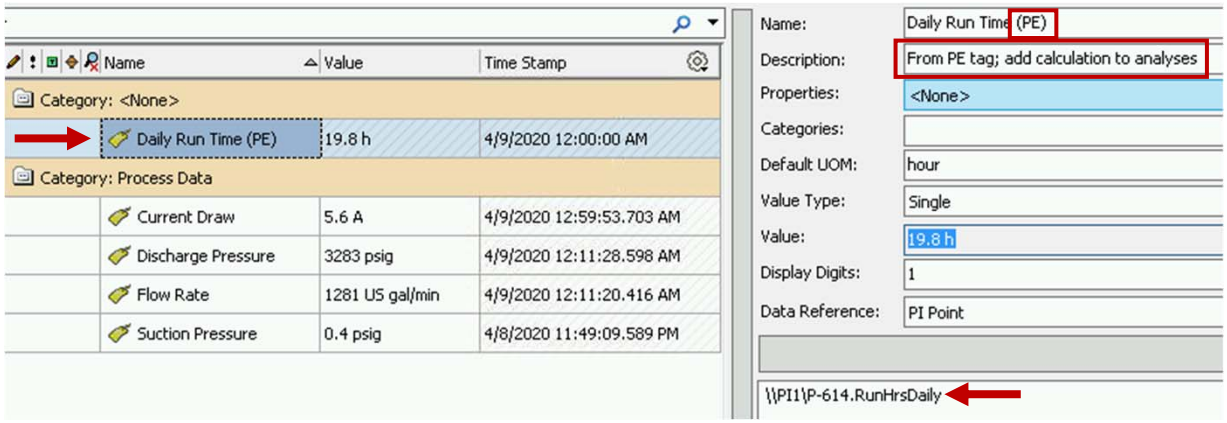
- 39 additional functions
  - Exit
  - Convert
  - TagXxx functions with event-weighted option
  - More flexible steam functions
  - LinReg and other array functions
  - Change tracking functions: DeltaValue, Rate, etc.
  - Statistical sampling: NormalRnd, Rand, Poisson

Migration Strategies

- **JIT: Convert as you build and expand AF**
- **Bulk Conversion for many identical calculations**

The “Just in Time” Approach

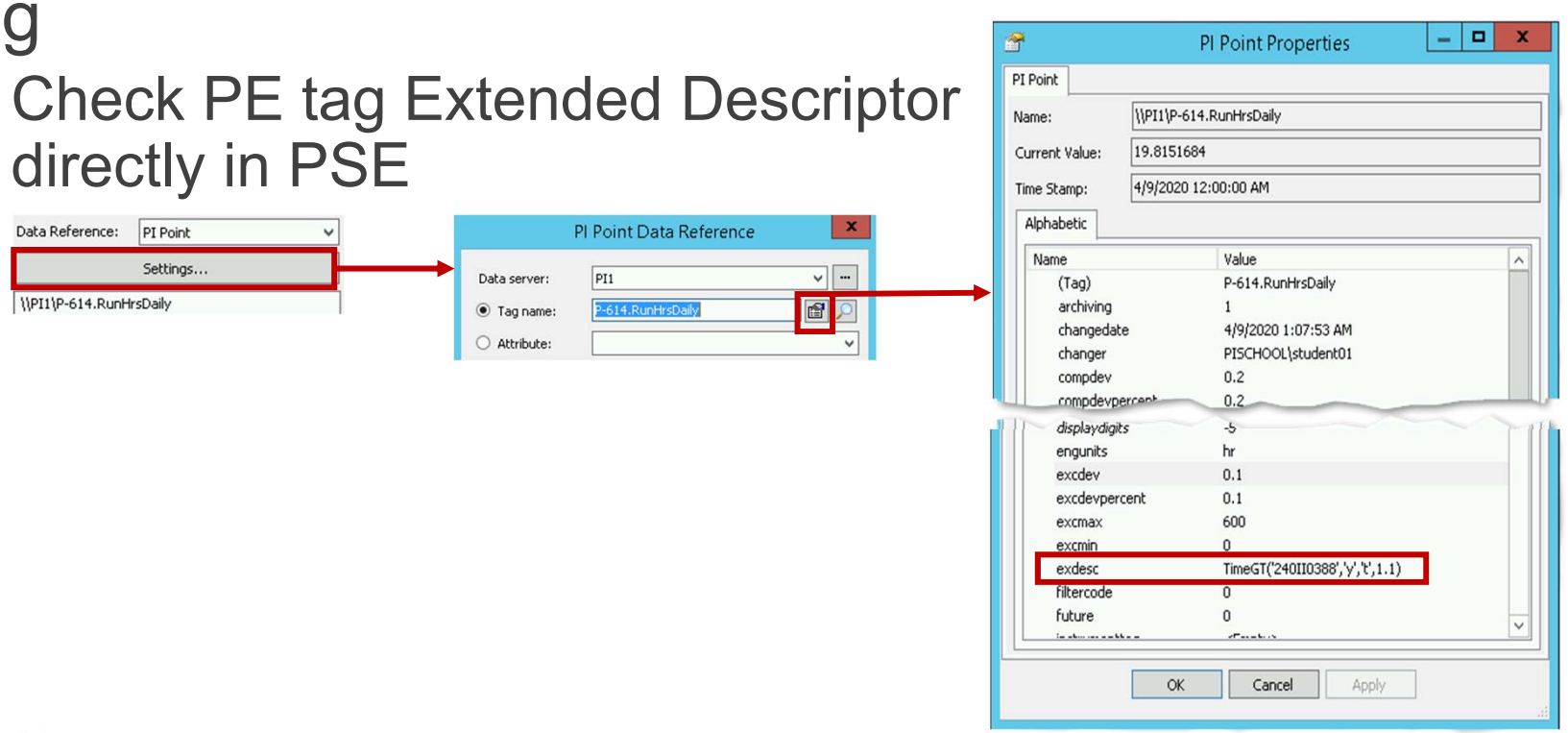
- Convert as you build templates/elements in AF
  - Search for PE tags built for the asset
  - Add PE Tags into AF; make the source clear
    - Example: Pump run time



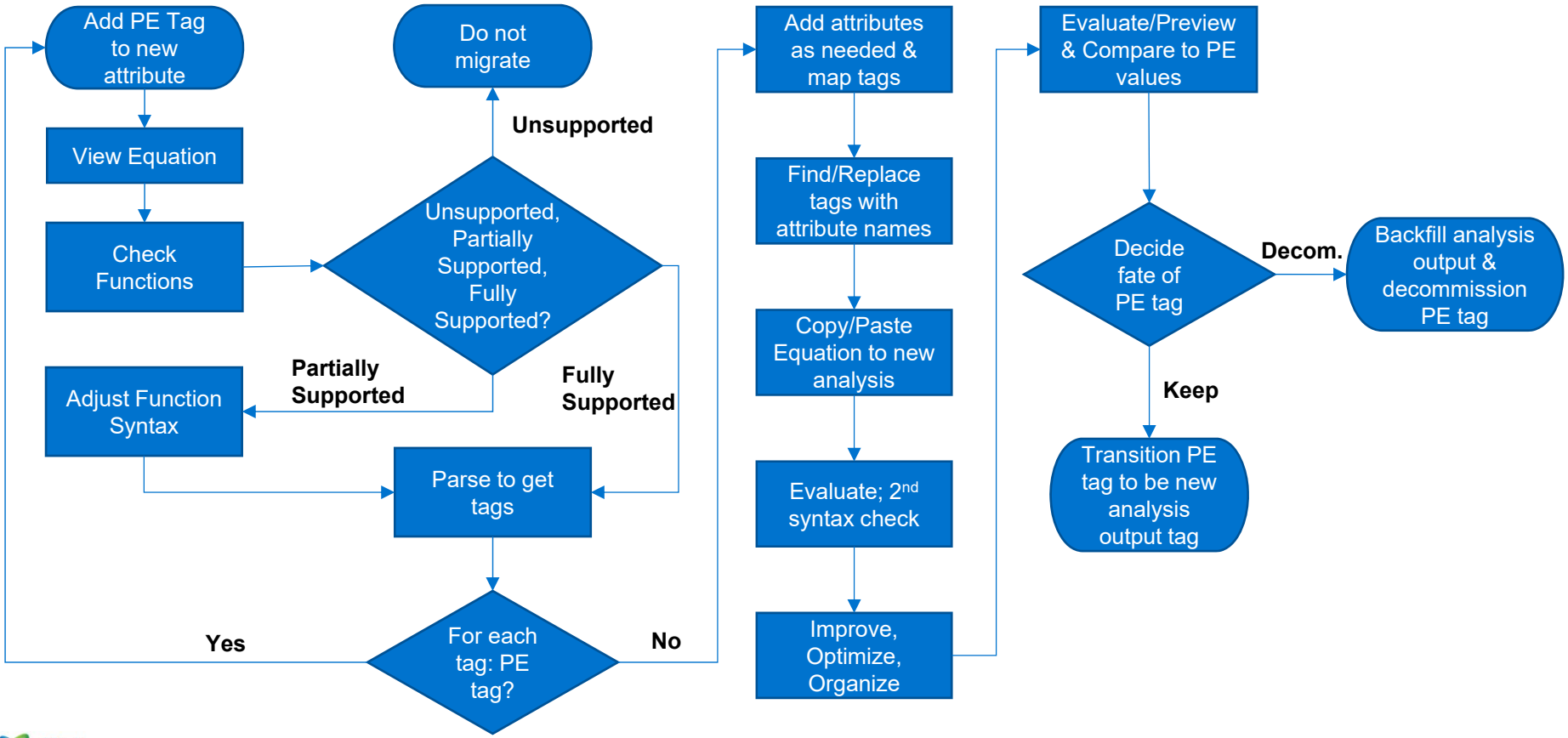
  - Get valuable data into AF immediately, then migrate calculation

The “Just in Time” Approach

- Build Analysis using Extended Descriptor of PE tag
  - Check PE tag Extended Descriptor directly in PSE



Migrating a PE tag: Process Flow



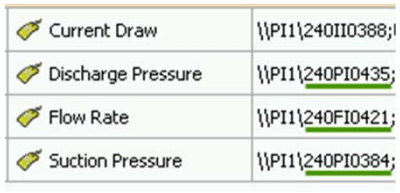
The “Just in Time” Approach Example

- Add performance curve-based KPI to pump

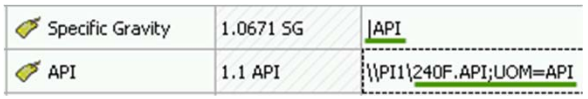
PE Tag: P8881.HeadRatio

Equation:

(((‘240PI0435’-‘240PI0384’)*2.31/(141.5/(‘240F.API’+131.5)))/Curve(‘240FI0421’,(0,9600) (400,9600) (500,9600) (600,9500) (700,9400) (800,9300) (900,9100) (1000,8900) (1100,8650) (1200,8350) (1300,8050) (1500,7350) (1700,6600)))*100



3 of 4 tags already mapped; add new attributes for API & conversion to specific gravity.



Update Equation:

(((‘Discharge Pressure’-‘Suction Pressure’)*2.31/‘Specific Gravity’)/Curve(‘Flow Rate’,(0,9600) (400,9600) (500,9600) (600,9500) (700,9400) (800,9300) (900,9100) (1000,8900) (1100,8650) (1200,8350) (1300,8050) (1500,7350) (1700,6600)))*100

The “Just in Time” Approach Example

- Improve, Optimize, Organize

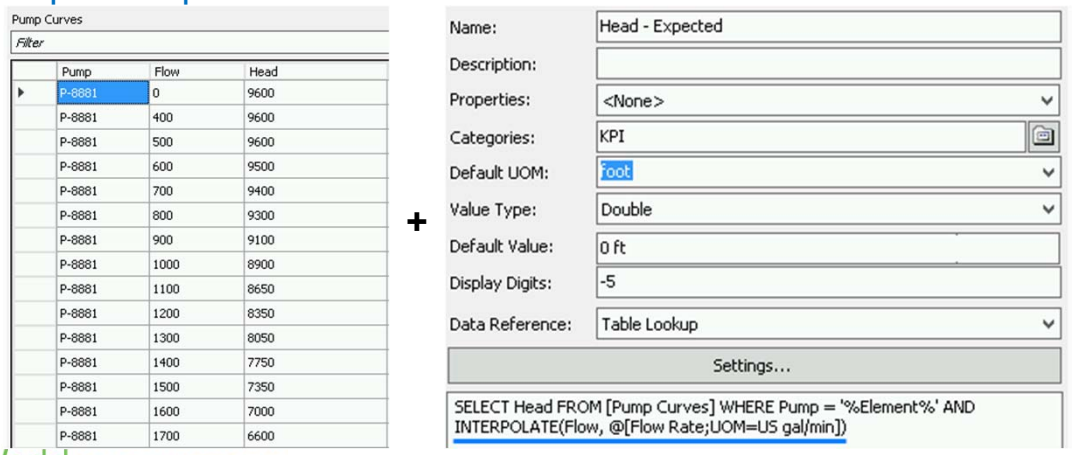
Updated Equation:

(((‘Discharge Pressure'-‘Suction Pressure')*2.31/‘Specific Gravity')/Curve(‘Flow Rate',(0,9600) (400,9600) (500,9600) (600,9500) (700,9400) (800,9300) (900,9100) (1000,8900) (1100,8650) (1200,8350) (1300,8050) (1500,7350) (1700,6600)))*100

Issue: Curve function difficult to templatize: Numeric constant pairs must be hard coded

Curve(number x, **(x1,y1) (x2,y2) … (xn,yn)**)
(x1,y1) (x2,y2) … (xn,yn): The pair of numeric constants (xi,yi) represents a point on the curve

Solution: Move these data pairs from the manufacturer’s curve to an AF table and lookup with Interpolate operator



=

Updated Equation:

(((‘Discharge Pressure'-‘Suction Pressure')*2.31/‘Specific Gravity')/ ‘Head - Expected')*100

The “Just in Time” Approach Example

- Improve, Optimize, Organize: The final result!

Name	Expression	Va	Va	Output Attribute
vdP	`'Discharge Pressure'-'Suction Pressure' //Differential Pressure`			dP
vBadValChk	`BadVal(vdP) or BadVal('Specific Gravity')`			Map

vdPtoHead	`IF vBadValChk`
	`THEN Exit() //If any bad values then quit`
	`ELSE 'dP (formula)'*2.31/'Specific Gravity' //Calculate head (ft) from dP (psi)`
				Head

vHRRaw	`vdPtoHead/'Head - Expected'*100`			Map

vHeadRatio	`If 'Head - Expected' <= 0`
	`Then 0`
	`Else If vHRRaw > 100`
	`Then 100`
	`Else vHRRaw`
				Head Ratio

Bulk Conversion for very similar calculations

- Same calculations repeated for many tags
  - Shift totals or averages
  - Flow compensation
  - Data validation/cleansing
  - Control loop or process limit monitoring
- Look for cases where a single general template can cover many PE tags
- Can implement in stand-alone database and output tags can be referenced in process hierarchies in other databases

Bulk Conversion Example

- Process Limit Monitoring

	A	B	C	D	E	F	G	H	I	J	K
1	**Process1**										
2	**Measurement**	**LoLimit**	**HiLimit**	**Min**	**Max**	**Value**	**1hAvg**	**ShiftAvg**	**1dAvg**	**7dAvg**	**1moAvg**
3	**Reactor1**										
4	Prod Rate	120	170	0	200	150	147	110	100	157	160
5	Feed Rate	195	230	0	250	150	147	110	100	157	160
6	Vessel Temp	100	185	0	200	165	164	161	163	170	158
7	**Filter1**										
8	Flow In	50	200	0	220	187	185	183	184	180	176
9	Flow Out	50	200	0	220	177	175	173	174	170	166
10	dP	0	30	0	50	31	31	30	29	27	25
11	**Cooling System**										
12	CW Temp In	100	140	0	180	115	113	111	109	107	105
13	CW Temp Out	33	80	0	100	76	75	74	73	72	71
14	Delta T	40	70	0	80	39	38	37	36	35	34
15	Flow In	200	500	0	550	346	342	346	346	345	343
16	Flow Out	190	500	0	550	340	342	347	347	352	350

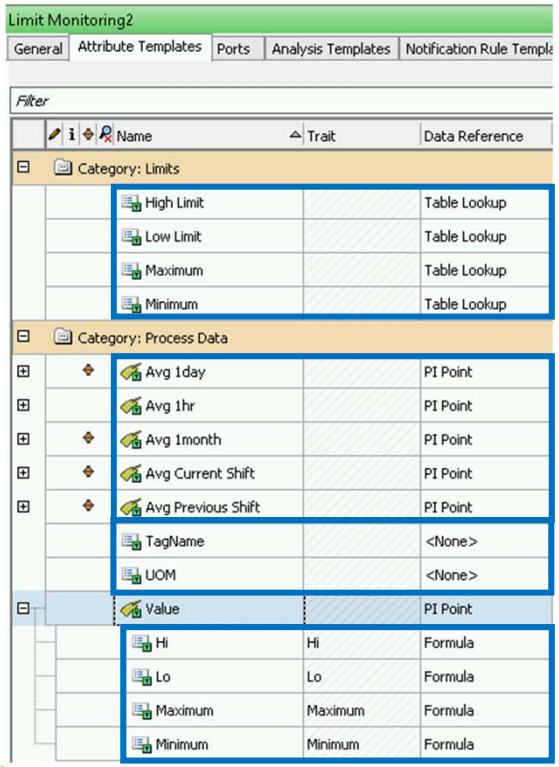
Limit Monitor Dashboard Asset: Cooling System ▼

Cooling System

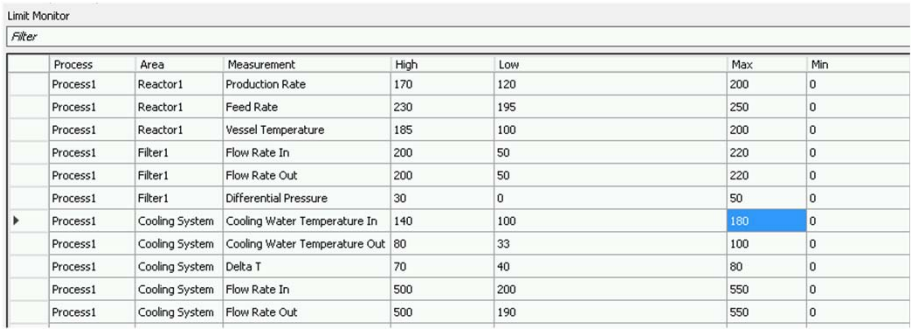
Asset	UOM	Low Limit	High Limit	Value	Avg 1hr	Avg 1day	Avg Previous Shift ▼	Avg Current Shift	Avg 1month
Delta T	Deg F	40	70	57.923	57.405	40.365	39.886	42.513	20.829
Cooling Water Temperature In	Deg F	100	140	179.11	28.695	35.565	39.331	30.209	40.192
Cooling Water Temperature Out	Deg F	33	80	0	39.55	35.141	34.371	35.272	21.317
Flow Rate Out	gpm	190	500	0	23.574	31.639	29.244	19.161	10.888
Flow Rate In	gpm	200	500	0	23.574	31.639	29.244	19.161	10.888

Bulk Conversion Example

- Process Limit Monitoring: Element Template



Limits stored in Table and looked up



Process	Area	Measurement	High	Low	Max	Min
Process1	Reactor1	Production Rate	170	120	200	0
Process1	Reactor1	Feed Rate	230	195	250	0
Process1	Reactor1	Vessel Temperature	185	100	200	0
Process1	Filter1	Flow Rate In	200	50	220	0
Process1	Filter1	Flow Rate Out	200	50	220	0
Process1	Filter1	Differential Pressure	30	0	50	0
Process1	Cooling System	Cooling Water Temperature In	140	100	180	0
Process1	Cooling System	Cooling Water Temperature Out	80	33	100	0
Process1	Cooling System	Delta T	70	40	80	0
Process1	Cooling System	Flow Rate In	500	200	550	0
Process1	Cooling System	Flow Rate Out	500	190	550	0

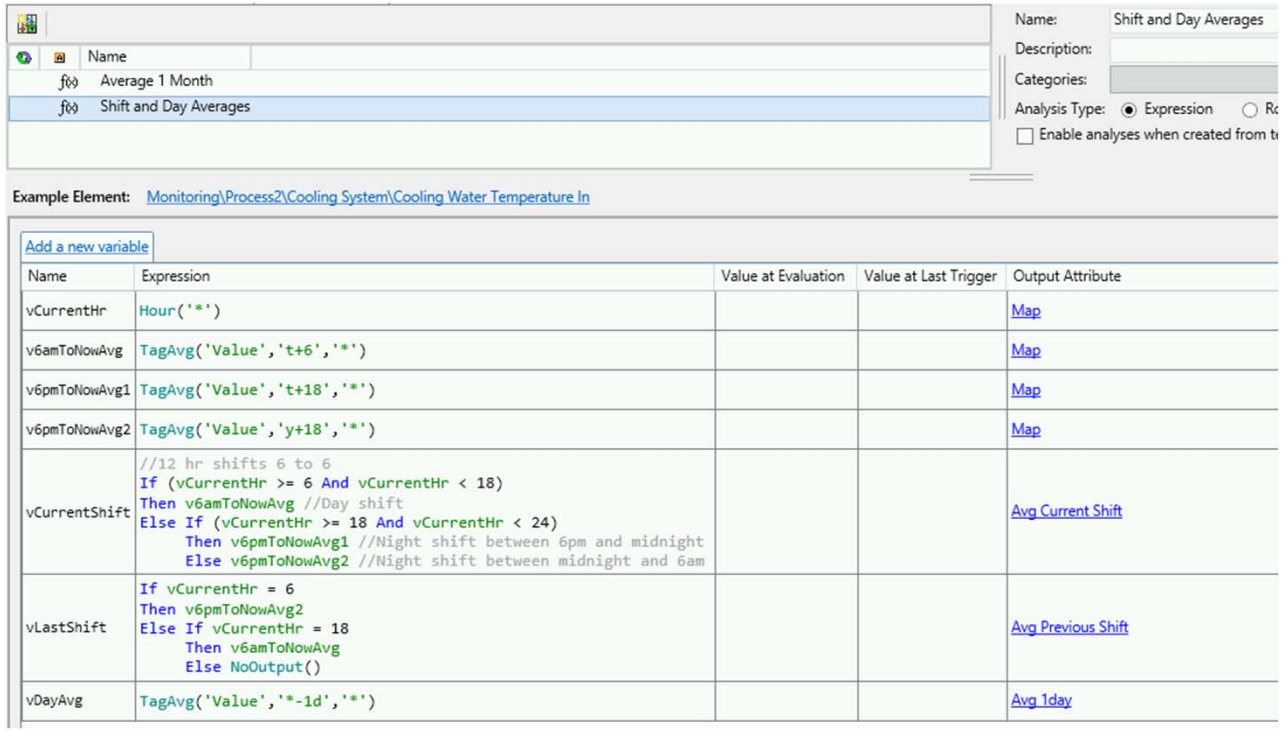
Calculations are standardized on template

TagName and UOM are only required user inputs

Limits above are replicated to each Monitoring attribute as children with Limit traits

Bulk Conversion Example

- Process Limit Monitoring: Analysis Templates

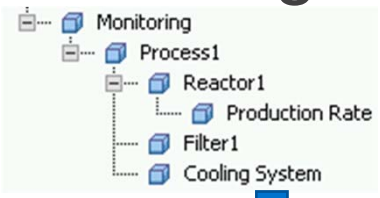


Shift and daily averages calculated every hour

1 Month averages calculated once per day

Bulk Conversion Example

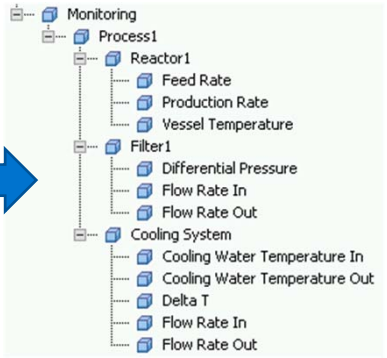
- Fast migration with single template



Build skeleton hierarchy in PSE with single monitoring element (Monitoring\Process1\Reactor1\Production Rate)

	A	B	C	D	E	F	G
1	Selected(x)	Parent	Name	ObjectType	Template	|TagName	|UOM
2		Monitoring\Process1\Reactor1	Production Rate	Element	Limit Monitoring	RE300.AGITATION	Mlb/h
3	x	Monitoring\Process1\Reactor1	Feed Rate	Element	Limit Monitoring	RE400.AGITATION	Mlb/h
4	x	Monitoring\Process1\Reactor1	Vessel Temperature	Element	Limit Monitoring	RE100.AGITATION	Deg F
5	x	Monitoring\Process1\Filter1	Flow Rate In	Element	Limit Monitoring	CDT158	gpm
6	x	Monitoring\Process1\Filter1	Flow Rate Out	Element	Limit Monitoring	CDT158	gpm
7	x	Monitoring\Process1\Filter1	Differential Pressure	Element	Limit Monitoring	ba:level.1	psi
8	x	Monitoring\Process1\Cooling System	Cooling Water Temperature In	Element	Limit Monitoring	RE200.AGITATION	Deg F
9	x	Monitoring\Process1\Cooling System	Cooling Water Temperature Out	Element	Limit Monitoring	PUMP1:SURFACE_TEMPERATURE	Deg F
10	x	Monitoring\Process1\Cooling System	Delta T	Element	Limit Monitoring	RE100.LEVEL	Deg F
11	x	Monitoring\Process1\Cooling System	Flow Rate In	Element	Limit Monitoring	RE400.AGITATION	gpm
12	x	Monitoring\Process1\Cooling System	Flow Rate Out	Element	Limit Monitoring	RE400.AGITATION	gpm

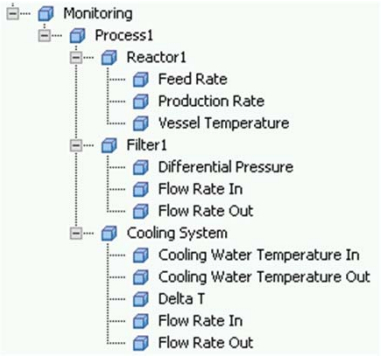
Publish



Simple configuration for remainder in Excel/PI Builder

Bulk Conversion Example

- Process Limit Monitoring Table in Vision



Limit Monitor Dashboard Asset: Cooling System

Cooling System

Asset	UOM	Low Limit	High Limit	Value	Avg 1hr	Avg 1day	Avg Previous Shift	Avg Current Shift	Avg 1month
Delta T	Deg F	40	70	57.923	57.405	40.365	39.886	42.513	20.829
Cooling Water Temperature In	Deg F	100	140	179.11	28.695	35.565	39.331	30.209	40.192
Cooling Water Temperature Out	Deg F	33	80	0	39.55	35.141	34.371	35.272	21.317
Flow Rate Out	gpm	190	500	0	23.574	31.639	29.244	19.161	10.888
Flow Rate In	gpm	200	500	0	23.574	31.639	29.244	19.161	10.888

Limit Monitor Dashboard Asset: Filter1

Filter1

Switch Asset

From
Filter1

To
Cooling System
Reactor1

Asset	UOM	Low L		Avg 1day	Avg Previous Shift	Avg Current Shift	Avg 1month
Flow Rate Out	gpm		53.39	174.64	172.67	164.28	132.01
Flow Rate In	gpm		53.39	174.64	172.67	164.28	132.01
Differential Pressure	psi		6.556	21.958	21.886	21.769	12.321

Presenter's Information

- Brent Bregenzer
- Systems Engineer
- OSIsoft, LLC
- bbregenzer@osisoft.com