

Migrating PE to Asset Analytics

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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: 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

Add a new variable

Evaluate

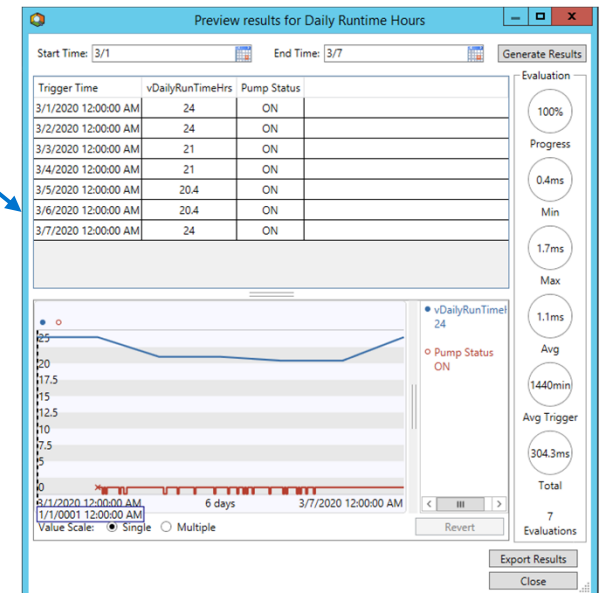
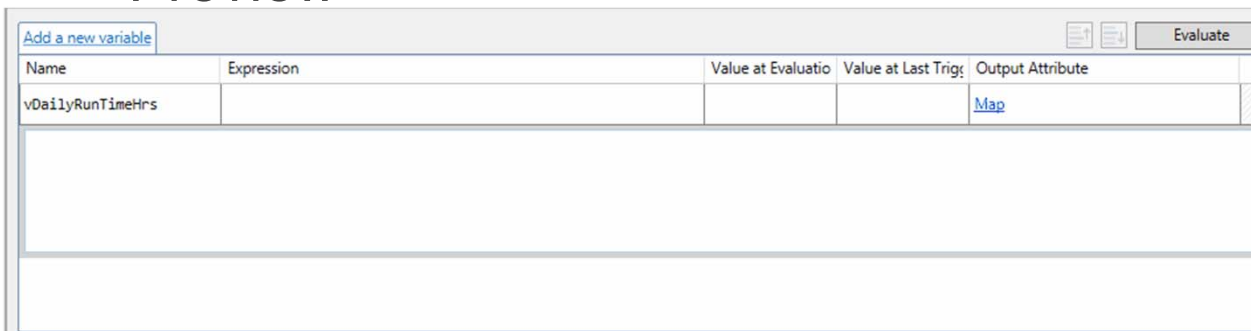
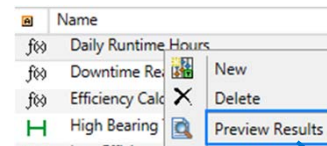
Name	Expression	Value at Evaluation	Value at Last Trigger	Output Attribute
vDailyRunTimeHrs				Map

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

Scheduling: ☒ Event-Triggered
Trigger on: Any Input

Shell Side Heat Capacity ☐
Shell Side Mass Flow ☒
Tube Side Heat Capacity ☐
Tube Side Mass Flow ☒

Trigger: Shell Side Mass Flow, Tube Side Mass Flow

A blue arrow points from the 'Any Input' button to the 'Trigger' field.

- Periodic: Configurable per analysis

Scheduling: ☐ Event-Triggered ☒ Periodic
Period: 00h 05m 00s, Offset: 00h 04m 00s Configure

- Output timestamps: 4 Options

☒ Periodic Advanced...

-Output Time Stamp-

☐ Trigger Time
☐ Execution Time
☒ Relative to Trigger Time: *-1H
☐ Variable:

PE Tags

- Event triggered: single input

☒ Event-based scheduling
Event tag: 15TANK01TI.PV

- Periodic: per scan class

☒ Clock scheduling
Scan class: 1 00:01:00,00:00:00

1
2
3

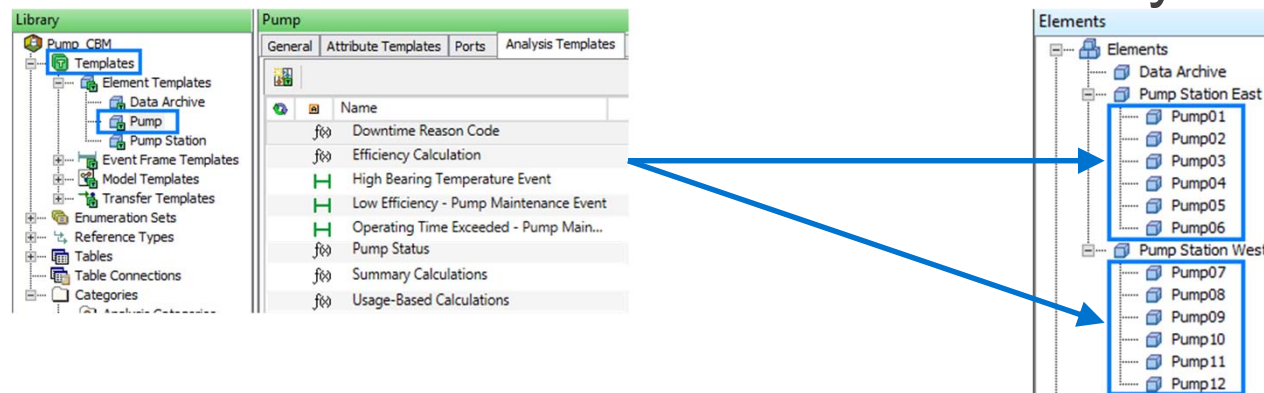
- Output timestamps: 2 Options

Set timestamp of resulting expression to:

The timestamp of the triggering event
The time when the expression is evaluated

Scalability

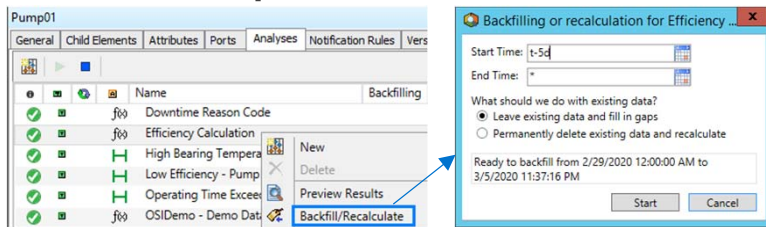
- Performance
 - Add resources to Analysis Service Machine
 - Dedicated Analysis Service per AF Server
- Configuration: AF templates
 - Build calculation once and reuse easily



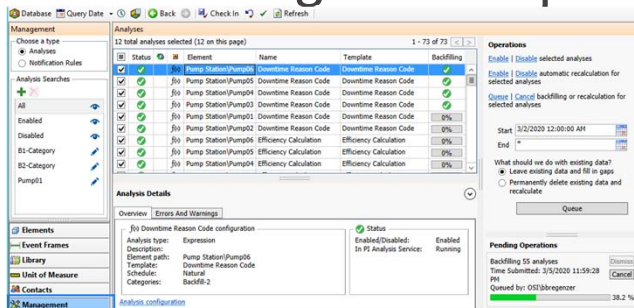
Functionality: Recalculation

AF Analyses

- Easy Recalculation with Backfill option

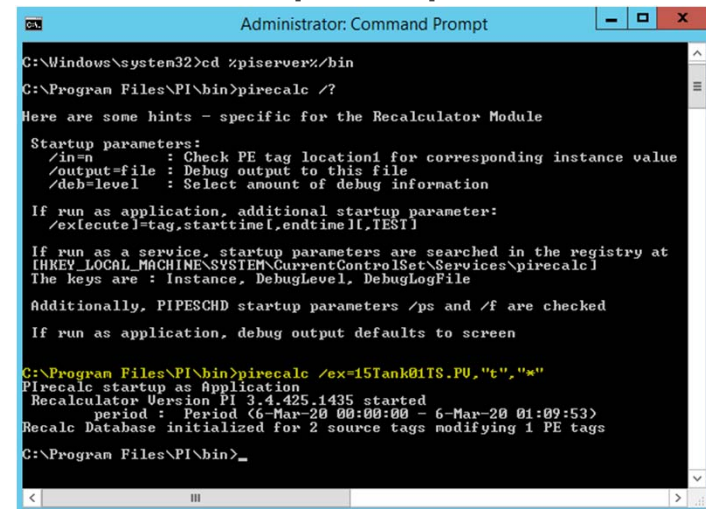


- Bulk management option



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

The screenshot displays the OSIsoft Asset Framework (AF) interface. On the left, a table lists process data points under the category 'Process Data'. A red arrow points to the 'Daily Run Time (PE)' tag, which has a value of 19.8 h and a timestamp of 4/9/2020 12:00:00 AM. On the right, the detailed view of this tag is shown. The 'Name' field is 'Daily Run Time (PE)', and the 'Description' field is 'From PE tag; add calculation to analyses'. The 'Value' field shows 19.8 h. The 'Data Reference' field shows the path '\\PI1\\P-614.RunHrsDaily', which is highlighted with a red arrow.

Name	Value	Time Stamp
Category: <None>		
Daily Run Time (PE)	19.8 h	4/9/2020 12:00:00 AM
Category: Process Data		
Current Draw	5.6 A	4/9/2020 12:59:53.703 AM
Discharge Pressure	3283 psig	4/9/2020 12:11:28.598 AM
Flow Rate	1281 US gal/min	4/9/2020 12:11:20.416 AM
Suction Pressure	0.4 psig	4/8/2020 11:49:09.589 PM

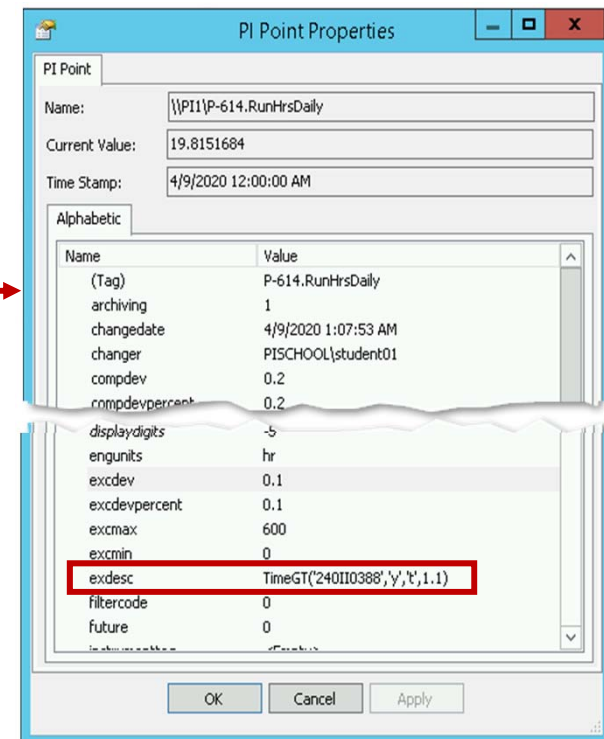
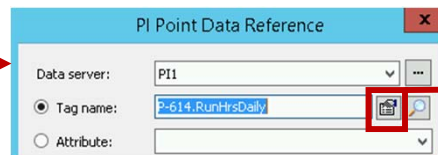
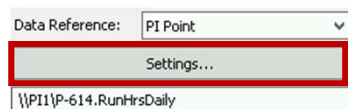
Tag Details:

- Name: Daily Run Time (PE)
- Description: From PE tag; add calculation to analyses
- Properties: <None>
- Categories:
- Default UOM: hour
- Value Type: Single
- Value: 19.8 h
- Display Digits: 1
- Data Reference: PI Point
- Data Reference Path: \\PI1\\P-614.RunHrsDaily

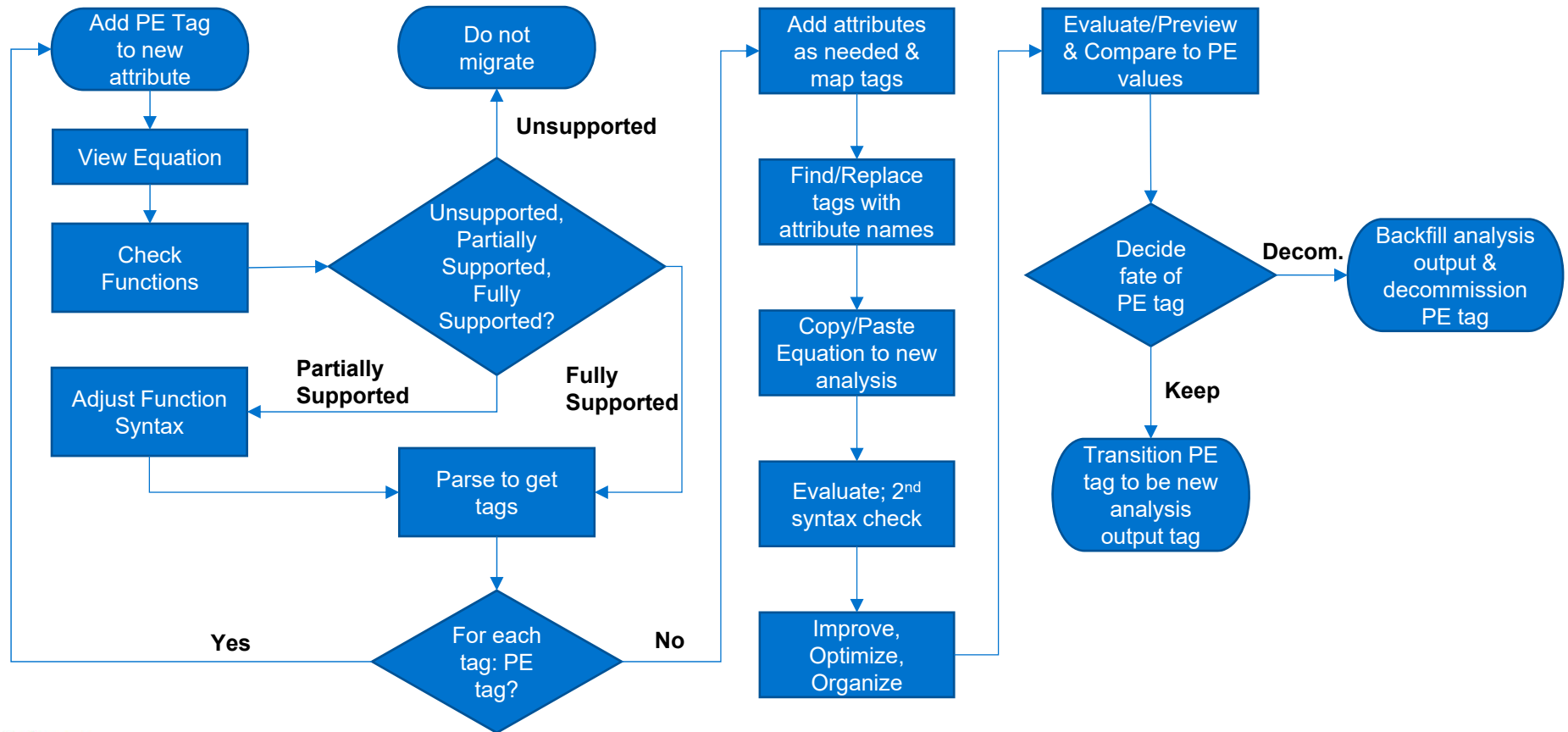
- Get valuable data into AF immediately, then migrate calculation

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

Category: KPI				
	Head Ratio (PE)	87.651 %	4/9/2020 6:07:30 AM	Actual head over pump curve head for Pump P-8881; From PE Tag; migrate to analysis

Equation:

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

Current Draw	\\PI1\240II0388;
Discharge Pressure	\\PI1\240PI0435;
Flow Rate	\\PI1\240FI0421;
Suction Pressure	\\PI1\240PI0384;

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

Specific Gravity	1.0671 SG	API
API	1.1 API	\\PI1\240F.API;UOM=API

Update Equation:

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

The “Just in Time” Approach Example

- Improve, Optimize, Organize

Updated Equation:

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

Issue: Curve function difficult to templatzize:
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

Pump	Flow	Head
P-8881	0	9600
P-8881	400	9600
P-8881	500	9600
P-8881	600	9500
P-8881	700	9400
P-8881	800	9300
P-8881	900	9100
P-8881	1000	8900
P-8881	1100	8650
P-8881	1200	8350
P-8881	1300	8050
P-8881	1400	7750
P-8881	1500	7350
P-8881	1600	7000
P-8881	1700	6600

+

Name:	Head - Expected
Description:	
Properties:	<None>
Categories:	KPI
Default UOM:	foot
Value Type:	Double
Default Value:	0 ft
Display Digits:	-5
Data Reference:	Table Lookup
Settings...	
SELECT Head FROM [Pump Curves] WHERE Pump = '%Element%' AND INTERPOLATE(Flow, @[Flow Rate;UOM=US gal/min])	

=

Updated Equation:

$$\frac{(((\text{'Discharge Pressure'} - \text{'Suction Pressure'}) * 2.31 / \text{'Specific Gravity'}) / \text{'Head - Expected'}) * 100$$

The “Just in Time” Approach Example

- Improve, Optimize, Organize: The final result!

Name	Expression	V _i	V _o	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

Limit Monitoring2

General Attribute Templates Ports Analysis Templates Notification Rule Template

Filter

Name Trait Data Reference

Category: Limits

High Limit		Table Lookup
Low Limit		Table Lookup
Maximum		Table Lookup
Minimum		Table Lookup

Category: Process Data

Avg 1day		PI Point
Avg 1hr		PI Point
Avg 1month		PI Point
Avg Current Shift		PI Point
Avg Previous Shift		PI Point
TagName		<None>
UOM		<None>
Value		PI Point
Hi	Hi	Formula
Lo	Lo	Formula
Maximum	Maximum	Formula
Minimum	Minimum	Formula

Limits stored in Table and looked up

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

Limit Monitor						
Filter						
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	Filter 1	Flow Rate In	200	50	220	0
Process1	Filter 1	Flow Rate Out	200	50	220	0
Process1	Filter 1	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

Bulk Conversion Example

• Process Limit Monitoring: Analysis Templates

Name
⌵ Average 1 Month
⌵ Shift and Day Averages

Name: Shift and Day Averages
Description:
Categories:
Analysis Type: ☒ Expression ☐ Rule
☐ Enable analyses when created from template

Example Element: [Monitoring\Process2\Cooling System\Cooling Water Temperature In](#)

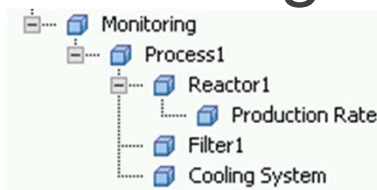
Name	Expression	Value at Evaluation	Value at Last Trigger	Output Attribute
vCurrentHr	Hour('*')			Map
v6amToNowAvg	TagAvg('Value', 't+6', '*')			Map
v6pmToNowAvg1	TagAvg('Value', 't+18', '*')			Map
v6pmToNowAvg2	TagAvg('Value', 'y+18', '*')			Map
vCurrentShift	<pre>//12 hr shifts 6 to 6 If (vCurrentHr >= 6 And vCurrentHr < 18) Then v6amToNowAvg //Day shift Else If (vCurrentHr >= 18 And vCurrentHr < 24) Then v6pmToNowAvg1 //Night shift between 6pm and midnight Else v6pmToNowAvg2 //Night shift between midnight and 6am</pre>			Avg Current Shift
vLastShift	<pre>If vCurrentHr = 6 Then v6pmToNowAvg2 Else If vCurrentHr = 18 Then v6amToNowAvg Else NoOutput()</pre>			Avg Previous Shift
vDayAvg	TagAvg('Value', '*-1d', '*')			Avg 1day

Shift and daily averages
calculated every hour

1 Month averages
calculated once per day

Bulk Conversion Example

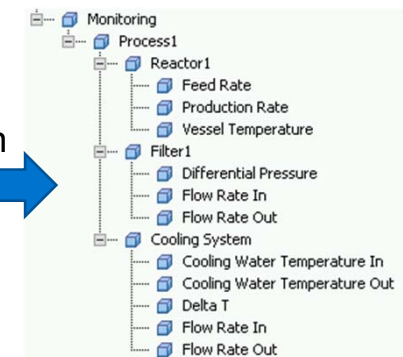
- Fast migration with single template



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

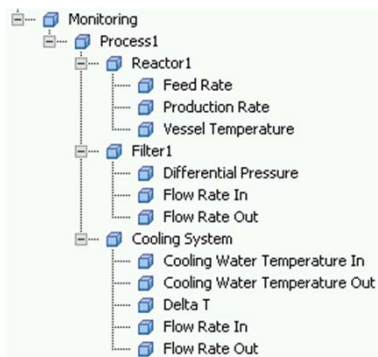
Publish



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

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



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