

# Asset Framework: Beyond the Basics

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# 1. Introduction



Before reading this section, please refer to the following course YouTube video: OSIsoft Learning: Course Introduction

In this course, we will continue our journey in setting up our AF database. We will explore additional functionality in working with AF. At this point, before continuing in this course, it is expected you know

- how to navigate between databases and create a new one,
- create an element with and without a template,
- how to create an attribute from a variety of data references,
- how to create a table and obtain data for an attribute,
- how to create an enumeration set,
- how to organize attributes with categories,
- how to create a referenced hierarchy,
- the importance of Unit of Measures,
- a brief understanding of substitution parameters and their usage,
- and how to check-in changes to commit them to the database.

# 2. Working with Attributes

## 2.1. View Time Series Data – Trend Preview of Attributes

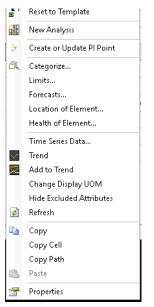


Before reading this section, please refer to the following course YouTube video: OSIsoft Learning: View Time Series Data – Trend Preview of Attributes

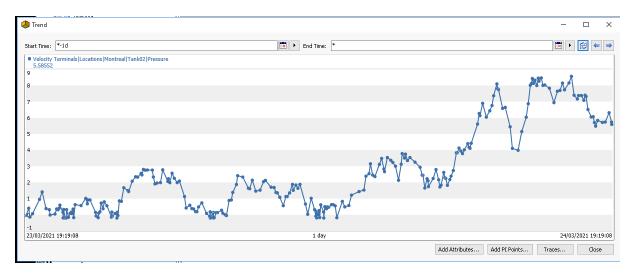
### Database: Velocity Terminals

In this short video, we are going to view attribute data from within the template.

- 1. Be sure your database is set to Velocity Terminals.
- 2. Navigate to Elements in the Navigator Panel. We are going to view data from Tank02.
- 3. Select Elements > Velocity Terminals > Locations > Montreal > Tank02 > Attributes tab.
- 4. Select one of the attributes with a 🔗 (tag icon) to the left of the attribute name and does not have a value of Pt Created.
- 5. Right click on the attribute, in this case, we are using the Pressure attribute. Then select Trend to display the data.



6. A trend will display. The timeframe of the trend can be modified to reflect the period of interest.



- 7. If a quick comparison needs to be made, additional attributes can be added to the display.
- 8. Additional attributes can be added through search functionality by selecting Add Attributes OR by navigating back to the viewer and select another attribute.
- 9. Let's start by selecting an attribute from the same element. In this case, we are selecting Level by right clicking on the attribute, then select Add to Trend.

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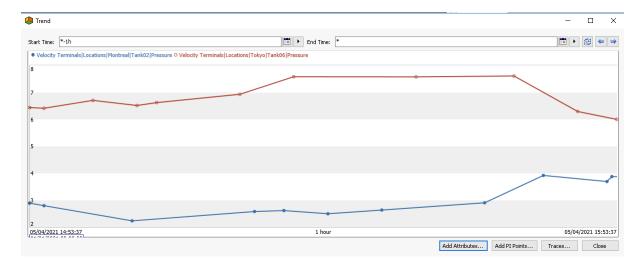
- 10. The Trace button at the base of the trend allows toggling attributes off and on.
- 11. Now, let's add an attribute from another element.
- 12. Start by removing the level attribute from the trend.

	05/04/2021 15:34:13
Add Attributes	Add PI Points Close
	Velocity Terminals Locations Montreal Tank02 Pressure (PISRV01\Velocity Terminals)
	Velocity Terminals Locations Montreal Tank02 Level (PISRV01\Velocity Terminals)

13. Select Add Attributes, an Attribute Search will display. Enter Pressure for Attribute Name, select Tank from the Template dropdown then check Search Sub-Elements. Select Search.

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- 14. Select Tank06 (by selecting the line verification by the line being highlighted) under the location of Tokyo followed by clicking OK
- 15. The two traces will appear on the trend to allow an easy comparison.



16. By clicking Close, the display will close.

# 2.2. Configuration of Retrieval Methods for Attribute Values

Client applications request attribute values for a specific time or for a time range. For example, in PI Vision, the display can optionally provide a time range context (a time range symbol, such as a trend, must be present on the display to enable reception of a time range). You typically configure the data reference to expect either a time or a time range. The attribute value will then be either:

• The value of the point at a specific time (functions similar to those associated with PI DataLink).

The following table describes the available options for the **By Time** value-retrieval method in the PI Point Data Reference window.

Option	Description				
After	Returns the first recorded value after the time requested by the client application.				
At or After	Returns a recorded value at the time requested by the client application. If no value exists at the specified time, returns the next recorded value.				
At or Before	Returns a recorded value at the time requested by the client application. If no value exists at the specified time, returns the previous recorded value.				
Automatic	A continuous point (step attribute = 0) is treated as Interpolated, whereas a discrete point (step attribute = 1) is treated as At or Before.				
Before	Returns the first recorded value before the time requested by the client application.				
Exact Time	Returns a recorded value at the time requested by the client application. If no recorded value exists at that time, an error is returned.				
Interpolated	Returns an interpolated value for the time requested by the client application. Discrete points (step attribute = 1) carry the previous value forward.				

Not Supported	Used in time range calculations only. If the client application sends a time instead of a time range, PI AF returns an error message as the attribute value.
Time Range	Used in time range calculations only. Creates a default time range to use if the client application sends a time instead of a time range. If you choose this option, you must type a PI relative time expression in the Relative Time field. See Create default time ranges for element attributes for details.
Time Range Override	Used in time range calculations only. Specifies a time range that always overrides the time range supplied by the client application.

• The result of a calculation on the point's values over a time range. For example, the attribute value could be the average of the point values over an hour.

The table below describes the available options for the **By Time Range** valueretrieval method in the PI Point Data Reference window.

Option	Description
Average	Returns the average value over the time range.
Count	Returns the event count over the time range, when Calculation Basis is set to Event Weighted. Returns the sum of event time duration over the time range, when Calculation Basis is set to any of the time weighted options.
Delta	Returns the difference in value from the end of the time range to the start of the time range.
End Time	Returns the value at the end of the time range.
Maximum	Returns the maximum value over the time range.

	Note: The timestamp value displays the time that the maximum value occurred.
Minimum	Returns the minimum value over the time range.
	Note: The timestamp value displays the time that the minimum value occurred.
Population Standard Deviation	Returns the population standard deviation over the time range.
Range	Returns the range of values over the time range (Maximum-Minimum)
Standard Deviation	Returns the standard deviation over the time range.
Start Time	Returns the value at the start time of the time range.
Total	Returns a totalization over the time range.

See also *Configuration of retrieval methods for attribute values* in the OSIsoft Documentation.

## 2.3. Create a 2HR Average using Retrieval Options



Before reading this section, please refer to the following course YouTube video: OSIsoft Learning: Create a 2HR Average using Retrieval Options

### Database: Velocity Terminals

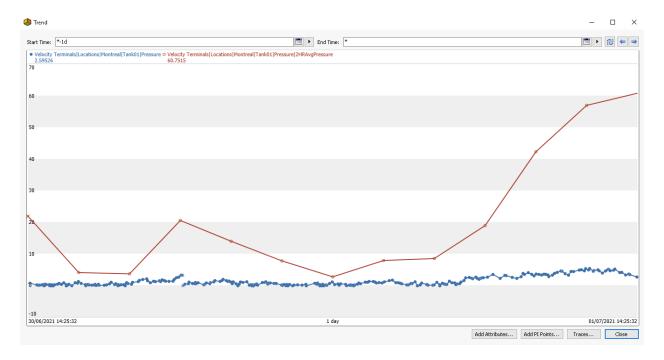
- 1. We are still using the **Velocity Terminals** database.
- 2. Navigate to Library > Templates > Element Templates > Tank
- 3. Navigate to the Pressure Attribute.
- 4. In the previous lesson, Value retrieval modes were reviewed. At this time, we will work with some variations of retrieval modes.
- 5. Pressure is critical in our process, so we want to track the two-hour average pressure.
- 6. From the viewer screen, right click on Pressure and select New Child Attribute.
- 7. Rename to 2HRAvgPressure to represent the 2-hour average of the pressure attribute.
- 8. Open the Settings screen.
- 9. Select Pressure as the attribute.
- 10. This child attribute is based on the Pressure attribute. Note the substitution parameter usage when selecting Pressure (denoting the parent child relationship: |Pressure).
- 11. Under Value retrieval methods> By Time: select Time Range Override, since we are wanting an average over a period of time.
- 12. In the Relative time box, enter -2h to indicate a period of two hours.
- 13. In the By Time Range drop down box, select Average.
- 14. In the Calculation basis: drop down box, event and time weighted options exist. In this instance, we are selecting Time Weighted.
- 15. The Min percent good box allows you to eliminate/filter out bad value associated with the Pressure attribute. By default, the field is set to 80%.

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Tag Creation		
Attribute:     IPress	ure	~
Unit of Measure		
Source Units:		
Value retrieval methods		
By Time:	Time Range Override	~
Relative time:	-2h	
By Time Range:	Average	~
Calculation basis:	Time Weighted	~
Min percent good:	80	
Preview		
Example instance: 56	elect example instance	
Configuration:		
Value:		
🗹 Read only	ОК	Cancel

- 16. Prior to accepting (check in) the results, verify the 2-hour average pressure correlates with the pressure that we are experiencing.
- 17. Navigate to one of the Tank assets.
- 18. Select Elements in the Navigator Pane  $\rightarrow$  Velocity Terminals  $\rightarrow$  Locations  $\rightarrow$  Montreal  $\rightarrow$  Tank01
- 19. Select Pressure and the child attribute 2HRAvgPressure, then select Trend.

Gene	eral Child Ele	ments Attributes	Ports	Analyses	Notification Rules	Version	
	luded attribute	es are hidden.					
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		Name					Value
•	🖻 Categor	y: <none></none>					
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				Сору	Path		
				Prop	erties		

20. Upon reviewing the trend, the 2HRAvgPressure should be in line with the Pressure value. In this trend, it appears the 2HRAvgPressure is much higher than anticipated. Close the trend and review the attributes.



21. It looks like we did not verify the UOMs for the two attributes were of the same unit. Navigate back to the library and update the 2HRAvgPressure attribute to bar.



- 22. Check-In to save the changes to the database.
- 23. Refresh the screen.
- 24. Verify new child attribute is added to the attributes for the tanks.
- 25. Navigate to Elements > Velocity Terminal > Locations > Sydney > Tank08.

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0	T	E Density	No Data	24/03/2021 2
Ð	T	🍼 Level	0.36 %	24/03/2021 2
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	T	💷 Night Shift Operator	Bob	01/01/1970 0
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		ne starte de la companya de la compa	7.1745 bar	24/03/2021 2
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				///////////////////////////////////////

26. Trend the Pressure and 2HRAvgPressure to verify the two are as expected.

## 2.4. Syntax for Relative Paths

Before we look into the details of the syntax used for relative paths, let us briefly summarize the difference between relative and absolute path.

Especially for the configuration of attribute templates we need to consider where to use relative or absolute references. When do we need which kind of reference?

- Relative references are used when we are looking for something *relative* to the current element. Example: We need an attribute from the respective parent element of each element.
- Absolute references are used when the attribute should be coming from the *same* element for *each* element from a template. Example: We need an attribute from an element from another branch of the hierarchy. All elements from the template require the attribute from that same element.

With the Attribute Search we create absolute references, for example: \\System\Database\Element|Attribute. Those can also be changed manually to relative references if needed following the syntax rules shown below. The single period (.) can be used to replace parts of the path with the current object, for example modifying the absolute path above like this \\.\Database\Element|Attribute makes it server relative.

• Use a double period (..) to indicate the parent object. The following example references Attribute1 of SiblingElement that is in the current database:

..\SiblingElement|Attribute1

For referencing an attribute of the parent element itself, the following syntax can be used:

..\|Attribute

• The single period (.) represents the current object. You can use it to create a relative path from the current object. For example to reference an attribute of a child element:

.\SubElement|Attribute

• When the current object is a PI AF attribute, a single period followed by a backslash (.\) represents the owning PI AF element. For example:

.\|Attribute1

• A single period followed by a vertical bar (.) references a child PI AF attribute, for example:

.|Attribute1|Attribute2

• When the current object is a PI AF element, a relative path is created from the database, for example:

\Element1\Element2|Attribute1

See also Indirect PI point references in the OSIsoft Documentation.

# 2.5. AF Attribute Properties

When attributes are created, there are four associated properties (configuration item, excluded, hidden, indexed). You have the option to set those properties for each element attribute.

In case of an element derived from a template, the properties of the attributes cannot be changed any more except for the Exclude property:

	Group by: 🗹 Category 🗌 Template
<u>N</u> ame:	Capacity
Description:	
Properties:	Configuration Item 🗸
Categories:	Configuration Item Excluded
Default <u>U</u> OM:	Hidden
Value Type:	Indexed
Default Va <u>l</u> ue:	20000 US gal
Data <u>R</u> eference:	<none> V</none>

Configuration Item	You assign the <b>Configuration Item</b> property to an attribute with a constant value that represents inherent properties of an asset (e.g. a device serial number). In PI System Explorer, configuration attributes are marked with a pencil icon (?). When you change the attribute value of a configuration item PI System Explorer automatically checks out the attribute. To commit the change, you need to Check In.
Indexed	<b>Indexed</b> attributes are attributes that are optimized for fast search results and fast value retrieval. You can only index attributes whose values are stored in the AF database. This means that you cannot index attributes that get their values from PI point data references or from linked table references.
Excluded	In situations where not all attributes in an element template apply, attributes that are not applicable can be excluded. <b>Example</b> : only some of the tanks have a second container coating. Set the attribute for the material of the second coating to <b>Excluded</b> property for the tanks with a single coating.
Hidden	The <b>Hidden</b> property is useful if an attribute is being used to hold an intermediate result, such as a table lookup result that can then be retrieved

by a PI point data reference, or is being used solely to populate a tag name in
a substitution parameter.

### 2.6. Use of Attribute Properties



Before reading this section, please refer to the following course YouTube video: *OSIsoft Learning: Use of Attribute Properties* 

### Database: Velocity Terminals

This video explores the use of attribute properties.

We will continue using the Velocity Terminals database. Right now, there are several attributes for the Tank template. In this video, we are going to assign attribute properties for specific use cases.

The first attribute property is **Configuration Item**:

The Capacity attribute for a tank is considered as a constant that represent an inherent property for the tanks at Velocity Terminals. The value will always be the same except for a change of the equipment itself. Capacity changes should require a Check-Out and Check-In sequence in AF.

To implement this:

Open the **Velocity Terminals** database in PSE and navigate to the Tank template in the Library.

The Capacity attribute is a constant and falls under the Configuration Item property.

Select the Capacity attribute, then from the configuration pane, select Configuration Item under Properties.

<u>N</u> ame:	Capacity
Description:	
Properties:	Configuration Item 💌
<u>C</u> ategories: Default <u>U</u> OM: Value Type:	Configuration Item Excluded Hidden Indexed Manual Data Entry
Default Value:	U US gal

Check-in the change.

Now, verify when a change is made to the Capacity attribute, the element is denoted with a change and requires a check-in.

Navigate to Elements in the Navigator Pane, then traverse the hierarchy to Tank01 (located under Locations > Montreal).

Switch to elements and select *Tank01*. Change the *Capacity* from 20,000 to 22,000.

Notice, that the Tank01 element has been checked out. It is marked accordingly in the Asset tree and Tank01.

If you select the element PI System Explorer status line displays details of the checked out element:

Tank01 Checked out to PISCHOOL\student01 at 01/04/2021 18:30:59 from PISRV01 Owner:PISCHOOL\student01

At this point, the change can be accepted (Check In) or rejected (undo Check out).

This was one of the requirements given to us from the Plant Management to prevent unnecessary changes.

We will accept the changes, to accept the change made to the Capacity attribute a check in is required.

If the changes need to be rejected:

Click on Undo Checkout button <sup>2</sup> in the toolbar to revert to the initial setting.

	Undo Check Out - \\PISRV01\	Velocity Term	inals			
	Name	Change	This Session	Path	Туре	User
	☑ 🎢 Tank01	Edited	True	Velocity Terminals\Locati	Element	PISCHOOL\student01
(	Click Undo Check Out	Undo C	heck Out			

The next property covered will be Excluded:

Only the first tank in every location of Velocity Terminals (Montreal, Sydney, Tokyo) has a dedicated night shift operator. Add attributes with the operator names, which should only exist for tanks Tank01, Tank05 and Tank08.

In the Tank template, add an attribute named Night Shift Operator and make it a string.

Give the attribute a Default Value of *Bob*. This will add the Night Shift Operator to all tanks using the Tank template.

<u>N</u> ame:	Night Shift Operator
Description:	
Properties:	<none></none>
<u>C</u> ategories:	<u> </u>
Default <u>U</u> OM:	<none></none>
Value T <u>y</u> pe:	String
Default Va <u>l</u> ue:	Bob
Data <u>R</u> eference:	<none></none>

Check-In changes.

Navigate to Elements in the Navigator Pane, then perform an attribute search for the *Night Shift Operator* attributes under Locations.

S	earch	View	Go	Tools	
Elei		ment Sea	arch	F3	
	Att	ribute Se	arch		
	Tag	j Search.			

Velocity Terminals

Enter Night Shift Operator to the attribute name, then select Locations from within the attribute search, select the ellipse ( ... ) to the right of the Search Root.

Attribute Search					– 🗆 🗙
Server:		WPISRV01		V - Connect	
Database:		Velocity Terminals		v 🕾	
Where Attribute name:		Night Shift Operator		~	1
Attribute description:					1
Attribute catego	ry:	<any></any>		~	1
Attribute value t	ype:	<anything></anything>		~	
Maximum results	a			1000	1
Element Criteria –					
Search Root:	Specify	search root element			Search Sub-Elements
Name:					
Description:					
Category:	<all></all>		als' vietor vie		
Template:	<all></all>		🚋 🗇 Moved Elements	~	Cancel Search
Type:	Any			~	
			🗄 🗊 Velocity Terminals		
Search results:					
Elements		Velocity Terminals <i>Filter</i>			
🗄 👘 🗇 Moved Elemer		/ : D & Name		Time Shares Dath	
	ements	V V Vame			
🗄 🗃 Velocity Termi	nals	ø 🗉 🎺 Pressure		01/04/2021 18 Velocity Ter	minals\Locations\Sy
		🖉 🔳 🎺 Pressure		01/04/2021 18 Copied Elem	nents\Tank03 Press
			OK Cancel	01/01/1070 00 Moved Flam	antelTank04lDroduct

Press Search, then OK.

Select all the tanks to return them from the search.

Only 3 of the tanks have a Night Shift Operator.

				Group by: 🔽 Categ
97				م
1 : 0	🞗 Name	Value	Path	
😑 Cate	egory: <none></none>			
	💷 Night Shift Operator	Bob	Velocity Terminals\	Locations\Tokyo\Tank07 Night Shift Operator
	💷 Night Shift Operator	Bob	Velocity Terminals\	Locations\Tokyo\TankD6 Night Shift Operator
	💷 Night Shift Operator	Bob	Velocity Terminals\	Locations\Tokyo\Tank05 Night Shift Operator
	💷 Night Shift Operator	Bob	Velocity Terminals\	Locations\Sydney\Tank10 Night Shift Operator
	💷 Night Shift Operator	Bob	Velocity Terminals\	Locations\Sydney\TankD9 Night Shift Operator
	💷 Night Shift Operator	Bob	Velocity Terminals\	Locations\Sydney\Tank08 Night Shift Operator
	🛄 Night Shift Operator	Bob	Velocity Terminals\	Locations Montreal Tank04 Night Shift Operator
	🛄 Night Shift Operator	Bob	Velocity Terminals\	Locations(Montreal)Tank03(Night Shift Operator
	🛄 Night Shift Operator	Bob	Volocity Torminold	Institions)Montreal(Tank02)Night Shift Operator
	💷 Night Shift Operator	Bob	Reset to Template	ns\Montreal\Tank01 Night Shift Operator
		(	🔍 Categorize	
			Trend	
			Add to Trend	
			🛃 Refresh	
			Сору	
			Copy Cell	
			Copy Path	
			Properties	

Start working through the tanks individually (or multiple rows by selecting them with the control or shift key) and update the Night Shift Operator for the tanks without a night operator (Tank02, Tank03, Tank04, Tank06, Tank07, Tank09, Tank10).

Select Properties and set **Excluded**. Click on OK.

The change applies to all the selected attributes.

Now, change the names for the first tanks in Tokyo (Akane) and Sydney (Alex):

🖆 🗝 Velocity Terminals	Filter			
白 🧊 Divisions	/ : = ×	Name	Value	Path
🗄 🧃 Receiving	🗆 💼 Cate	gory: <none></none>		
🖻 🗇 Locations 🖻 🗇 Montreal		💷 Night Shift Operator	Excluded	Velocity Terminals\Locations\Tokyo\Tank07 Night Shift Operator
🗇 Tank01		🗉 Night Shift Operator	///// Excluded	Velocity Terminals\Locations\Tokyo\Tank06 Night Shift Operator
		💷 Night Shift Operator	Akane	Velocity Terminals\Locations\Tokyo\Tank05 Night Shift Operator
Tank04		💷 Night Shift Operator	Excluded	Velocity Terminals\Locations\Sydney\Tank10 Night Shift Operator
🖨 🗇 Sydney		💷 Night Shift Operator	//// Excluded	Velocity Terminals\Locations\Sydney\Tank09 Night Shift Operator
🗇 Tank08 		💷 Night Shift Operator	Alex	Velocity Terminals\Locations\Sydney\Tank08 Night Shift Operator
Tank10		💷 Night Shift Operator	Excluded	Velocity Terminals\Locations\Montreal\Tank04 Night Shift Operator
ian 🗇 Tokyo		💷 Night Shift Operator	Excluded	Velocity Terminals\Locations\Montreal\Tank03 Night Shift Operator
🗇 Tank05 		💷 Night Shift Operator	//// Excluded	Velocity Terminals\Locations\Montreal\Tank02 Night Shift Operator
		🗉 Night Shift Operator	Bob	Velocity Terminals\Locations\Montreal\Tank01 Night Shift Operator

Click on Check-In. Then click on Refresh. Now the search returns only the nonexcluded attributes for Tank01, Tank05 and Tank08.

Select the tank elements individually and observe what is displayed for the *Night Shift Operator.* 

For all but Tank01, Tank05 and Tank08, Excluded should be in the Property field:

Name:	Night Shift Operator
Description:	
Properties:	Excluded
Categories:	E
Default UOM:	<none></none>
Value Type:	String
Value:	Excluded
Display Digits:	-5
Data Reference:	<none></none>

Current attributes for Tank02 lists Night Shift Operator:

Filte	ar			- م
	∕: ■ ♦	R Name	△ Value	Time Stamp 🔘
Ξ	🖻 Catego	ory: <none></none>		
	/ 🗉	E Capacity	30000 US gal	01/01/1970 00:0
	T	🗉 Density	3422 kg/L	01/01/1970 00:0
Ŧ		🎺 Level	38.11 %	01/04/2021 18:4
	T	🗉 Mass	1.4811E+08 kg	01/04/2021 18:4
	T	💷 Night Shift Operator	Excluded	01/01/1970 00:0
	<i>3</i> 0∎♦	Notification Email Address	Pt Created	04/02/2021 01:0

To eliminate it from the individual tanks where excluded, it is necessary to update the display properties of the elements.

Under Tools > Options select the *General* tab and uncheck the Show Excluded Attributes option.

Options											
General	General Time Context Server Options										
🗌 Only	Only show database Check-In dialog when Shift key is down.										
🗌 Only	show database	Undo-Checkout diak	og when Shift key is down.								
🗹 Displa	ay Asset Server	Name in Title Bar									
Maximun	Maximum Tree Branch Page Size:										
Maximun	Maximum Query Size:										
Reset fil	Reset file open prompts to the default setting:										
🗌 Use S	Use Source Unit-Of-Measure for attribute display.										
Display UOM Group: <pre></pre>											
Show Excluded Attributes.											
🗹 Use 🛙	Use DisplayDigits for Attribute and AttributeTemplate values										

Click OK. Select the tanks individually again and observe what is displayed now for the *Night Shift Operator*.

Tank02 after updating the display option:

ien	eral Child	Elements	Attributes	Ports	Analyses	Notification Rules	Version			
Exc	luded attri	outes are l	hidden.							
-Me	er									
	/: <b>•</b>	💂 Name					4	Value		
Ξ	🖻 Cate	gory: <na< td=""><td>ne&gt;</td><td></td><td></td><td></td><td></td><td></td><td></td></na<>	ne>							
	/ 🗉	<b></b> c	apacity			30000 US gal				
		🔳 D	🗉 Density				3422 kg/L			
Ŧ		🧭 Le	🍼 Level					77.51 %		
		Ш м	I Mass					3.012E+08 kg		
	⊘0∎∢	• 🛷 N	Votification Email Address					Pt Created		
Ŧ	0 🗉	🧭 P	ressure					9.0127 bar		
	T	P	roduct					HC1500		

### Hidden:

The tag name convention for process values at Velocity Terminals is the abbreviation ".PV" at the end of the tag name. The abbreviation should be defined in an AF attribute, but the attribute should not appear in PI Visualization Tools or in PI System Explorer Searches.

The PVCode is set-up to help during the creation of PI Point creation or look-up.

As this attribute is an intermediate it is unnecessary to any end users, let's mark it as a Hidden attribute.

<u>N</u> ame:	PVCode
Description:	
<u>P</u> roperties:	Hidden 💌
<u>C</u> ategories:	<u> </u>
Default <u>U</u> OM:	<none></none>
Value T <u>y</u> pe:	String 💌
Default Va <u>l</u> ue:	PV
Data <u>R</u> eference:	<none></none>

Check-In the new attribute.

Notice that the *PVCode* attribute is marked as hidden  $\Re \equiv PVCode$ .

Navigate to Elements in the Navigator Pane.

Perform an attribute search (search > Attribute Search) for all attributes using the Tank template that start with P\*. PVCode is not returned.

Attribute Search				- 🗆	×
Server:	2	ŠPISRV01 v Com	hect		
Database:	<	Velocity Terminals	8		
Where Attribute name:		p*	~		
Attribute descript	tion:				
Attribute categor	y:	<any></any>	$\sim$		
Attribute value ty	/pe:	<anything></anything>	$\sim$		
Maximum results:			1000		
Element Criteria					
Search Root:	Specify se	arch root element		Search Sub-Elem	ients
Name:					
Description:			] _		
Category:	<all></all>	×	- L	Search	P
Template:	Tank	~		Cancel Search	h
Type:	Any	v			

#### The search found 22 Attributes matching the search criteria.

iter		
	🗉 🔗 Name	4
0	Pressure	
0	Pressure	
0	Pressure	
	Product	

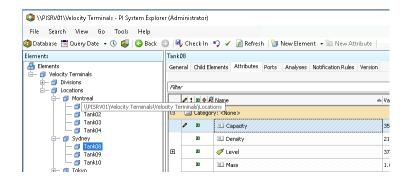
## 2.7. Column Visibility in Viewer Pane

### Database: Velocity Terminals

The fields in the viewer pane can be modified. Continue in Velocity Terminals database, navigate to Elements  $\rightarrow$  Velocity Terminals  $\rightarrow$  Locations  $\rightarrow$  Sydney  $\rightarrow$  Tank08. The column visibility can be modified to view the timestamp for the attributes.

### Step by step:

- 1. Click on a Tank08 under Sydney in the Browser pane
- 2. Click on the **Attribute** tab in the **Viewing** pane



 Right click on the header in the Viewing pane and select Column visibility>Time Stamp

ien	eral Child Ele	ments Attributes	Ports	Anal	/ses Notification Rules	Version		
Filte	v							
	∕ : ■ ♦ 8	Name	Г	67		ŕ	Val	lue
Ξ	🖻 Categor	y: <none></none>			ategorize ocation of Element			
	/	💷 Capacity			lealth of Element		35	000 US gal
		💷 Density		c	olumn Visibility	•	~	Configuration Item Indicator
Ŧ		🍼 Level		C	ollapse All		~	Quality Indicator
		💷 Mass		E	xpand All	ĺ	~	Template Indicator
		💷 Night Shift Op	erator		lide Excluded Attribute	s	~	Analysis Indicator
	0 🗉 🔶	🎺 Notification E	nail Add	R B	efresh		~	Hidden Indicator
	J 🔳	🍼 Pressure		P P	aste		~	Name
		III Product		×c	elete All		Value Time Stamp	
	🗉 🔒	I PVCode		////			*	Display Digits
		💷 Tank Level In	ormatio	ion				Value Type
		💷 Tank Name						Description
Ŧ	0 .	🍼 Temperature						Category
		U Volume						Configuration Item
		V/////////////////////////////////////	/////					Manual Data Entry
								Trait
								Unit Of Measure
								Data Reference
								Settings

4. Now you have the **Time Stamp** added to the **Viewing** pane. This one is especially useful since the PSE does not show the current time for performance purposes.

To update the values for the attributes you need to do a **Refresh**. With the **Time Stamp** being visible you have a time context for the values.

### 2.8. Bulk Editing in PSE

### Database: Tank Farm

### **Categories and Multi-select Editing**

When working in PSE, it can be tedious to edit objects one-by-one; however, there is are techniques to edit multiple objects at once. We already performed a multi-select edit when we assigned categories to the templates.

**Approach:** In the **Tank** template, assign categories to multiple attributes at the same time.

- 1. If you are not in the Library view press the Ctrl+3 key combination
- 2. Then select the Tank Template under Element Templates. Click on the Attribute Templates tab.
- **3.** Select the **Group by: Category** check box. So far we don't have any attribute categories and all attributes are grouped under <None>.

(Note: an attribute can belong to multiple Categories.)

Tank							
General	Attribute Templates	Ports	Analysis Templates	Notification Rule Temp	lates	5	
					_		Group by: 🗹 Category 📘 Template
Filter				<del>،</del> م		Name:	
Name				0	-	Description:	
8 🖻	Category: <none></none>					Properties:	
📑 Cap	acity					Categories:	Ē
E Den:	sity				-	Default UOM:	
🔏 Leve	el					Value Type:	
	ng Speed				-	Default Value:	Press F2 to show the Text Visualizer di
					-	Display Digits:	-5
	t Shift Operator				-	Data Reference:	
📑 Proc	luct				_		Settings
							Journagen

 First, we want to categorize the attributes associated with Operations. Select the Capacity Attribute, hold down the Ctrl key and select the Night Shift Operator Attribute so both Attributes are selected. Right click and select Categorize...

Tank				
General	Attribute Templates	Ports	Analysis Templates	Not
Filter				
Name				
8 🖻	] Category: <none></none>			
📑 Cap	acity			
📑 Den	sity			
🤏 Levi	el			
of Mixi	ng Speed			
📑 Nigh	it Shift Operator	100		_
Proc	 Juct	<sup>6</sup> ,	Categorize	
			Сору	
			Copy Cell	
			Copy Path	
		$ \mathbf{x} $	Delete	
		1	Properties	

5. In the Categorize window click New Category... and type the name Operations in the Attribute Category Properties window. Click Check In and OK.

Categorize		×		
Use the checkboxes to	o assign categorie	:s:		
Name	Descrip	otion		
	🚰 Attribute	Category Properties —		
	General			
	Name:	Operations		
	Description:			4
	Type:	Attribute Category Security		
New Category				
		OK Cancel Apply Check I	n	

6. We can see the two attributes are now grouped under the category Operations.

ank											
Sene	ral	Attribu	ite Templates	Ports	Analysis Templates	Notification Rule Templates					
Filter	-										
	∕   i	i   🗢 💂	Name				A Description				
	۵	Categ	ory: <none></none>								
			📑 Density								
Ð			🍊 Level								
			King Speed								
			🖫 Product								
		Categ	ory: Operation	s							
	1		📑 Capacity								
			📑 Night Shift	: Operato	or						

7. Of the remaining attributes we would like to group those with PI Point Data Reference into a category **Production Data**. To make an easier multi-selection, we sort the attributes by Data Reference by clicking on the header of the Data Reference column (use the gear icon to display the Data Reference column if it is not shown). Now we can select all PI Point DR attributes by clicking on the first one on the list (Level), holding down the Shift key and clicking on the last one on the list (Mixing Speed). This is particularly useful when there is a longer list of attributes to categorize.

Tank	ank											
Gen	Seneral Attribute Templates Ports Analysis Templates Notification Rule Templates											
Filte	Filter D 🗸											
	I ♦ € Name     Description     Default Value     Data Reference											
	🖻 Cateç	gory: <none></none>										
		🖫 Product		HC1500	<none></none>							
E		🦟 Level		0.00 %	PI Point							
		Kixing Speed		0 rpm	PI Point							
		📑 Density		0 kg/L	Table Lookup							
	🖻 Categ	gory: Operations										
	/	🖳 Capacity		0 US gal	<none></none>							
		🖫 Night Shift Operator		Bob	<none></none>							

8. Let us now apply a slightly different method. Select the attributes Level and Mixing Speed. This time we want to use the Configuration Panel to apply the configuration. Notice that the name field shows both selected attributes. Only those fields which are configured identically are active (Caution: the Settings... button is actually active. Clicking it resets the existing configuration.) and can be configured for all the selected attributes at once. We can click the folder symbol to the right of the Categories field to choose a category for both attributes.

	Group by: 🗹 Category 🔲 Template
Name:	Level, Mixing Speed
Description:	
Properties:	<none> ~</none>
Categories:	
Default UOM:	
Value Type:	Double ~
Default Value:	0
Display Digits:	-5
Data Reference:	PI Point ~
	Settings

**9.** The Categorize window opens up again. Now it shows the available category. We create another new category and name it Production Data.

Categorize		×					
Use the checkboxes to	assign categories	:					
	Description						
Operations	🚰 Attribute	Category Properti	25				×
	General						
	Name:	Production Data					
	Description:						
	Туре:	Attribute Categor	У				
		Security					
New Category		OK Car	ncel A	pply	Check I	In	

**10.** Click Check In and OK and again OK.

Tank						
Gen	General Attribute Templates Ports Analysis Templates Notification Rule Templates					
Filte					<del>-</del> م	
	/ i 🔶 🦧	Name	Description	Default Value	Data Reference	
	📄 Categ	gory: <none></none>				
		E Product		HC1500	<none></none>	
		E Density		0 kg/L	Table Lookup	
	Category: Operations					
	/	📲 Capacity		0 US gal	<none></none>	
		📇 Night Shift Operator		Bob	<none></none>	
	Category: Production Data					
Ð		🭊 Level		0.00 %	PI Point	
		Kixing Speed		0 rpm	PI Point	

### Some Tips for Bulk Editing of Elements

The Browser pane does not allow multi-selection, so we need to display the objects we want to select in the Viewer pane where this is possible. Here are some examples how this can be achieved:

• The whole element tree can be displayed in the Viewer by selecting Elements. This can be useful for selecting elements which are not child elements of the same parent at the same time.

Elements	Elements						
🔒 Elements							
🚔 🗝 Building A	Search	Search					
🗇 TankA1 🎯 TankA2	🛛 🖻 Name	△ Category	Template				
🖮 🗇 Building B	🛛 🖃 🗇 Building A	Buildings	Building				
🗇 TankB1 🎯 TankB2	🗉 🗇 TankA1	Tanks	Tank				
🖕 🖅 Building C	🛛 🔹 🎯 TankA2	Tanks	Tank				
TankC2	🖃 🐨 🗊 Building B	Buildings	Building				
	🗉 🗊 TankB1	Tanks	Tank				
	🛛 🔹 🗇 Tank82	Tanks	Tank				
	🛛 🖃 👘 Building C	Buildings	Building				
	🔲 🔟 🗊 TankC1	Tanks	Tank with Foam Sensor				
	🛛 🖾 🗇 TankC2	Tanks	Tank with Foam Sensor				
	🛛 🖾 🗇 TankC3	Tanks	Tank with Foam Sensor				
	Data Archive						

• An Element Search can be performed to selectively list elements. For example we can search for all elements using the Tank template. In the screenshot below the search results have been additionally grouped by template.

Elements	Elen	Element Search Results 1				
Elements 		Group by: 🗌 Category 🗹 Template				
	Filte	Filter				
🗇 TankA1 🗇 TankA2			Name	Category	0	
📮 🗇 Building B			Template: Tank		-04	
🗇 TankB1 🗇 TankB2			🗊 TankA1	Tanks		
			🗊 TankA2	Tanks		
🗇 TankC1		T	🔊 TankB1	Tanks		
🗇 TankC2 🗇 TankC3			 A TankB2	Tanks		
🛄 🗇 Data Archive		G.	Template: Tank with Foam S	ensor		
Element Searches     i=···*     i	<b></b>	•	🔊 TankC1	Tanks		
TankA1			🔊 TankC2	Tanks		
🗇 TankA2				Tanks		
1 TankB1 1 TankB2 1 TankC1 1 TankC2 1 TankC2						

# 3. Substitution Parameters Revisited

## 3.1. Advanced Substitution Parameters

Whoro

Not only can substitution parameters resolve to the name of an AF object like an attribute, but also to the value of an attribute.

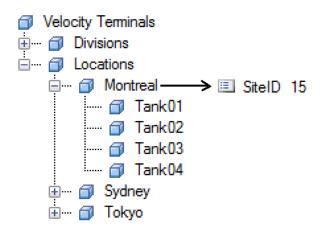
Imagine the Velocity Terminals example again. Imagine the tag names are always built the same way following this tag naming convention:

### 15Tank01TS.PV

### LocationCodeEquipmentNameMeasurementType.DataType

Where			
LocationCode =	Code for the location (ex.: Montreal is 15)		
Equipment Name	=	Equipment name (ex.: TANK01)	
MeasurementType	=	Measurement type (ex.: TS for temperature sensor)	
Data Type	=	Type of data (ex.: PV for process value)	

This could lead us to determine that the Tank01's temperature would have its tag named **15TANK01TS.PV**. With that in mind, substitution parameters make it possible to configure the temperature attribute at the template level in such a way that any newly created tank in the AF hierarchy would automatically see its temperature mapped to the correct Data Archive tag. The idea here is to have all the required information somewhere in the structure so the attribute can reconstruct the tag name depending on where it is in the hierarchy. A solution to the above tag naming convention would simply be to add an ID attribute under the city name element.



Then, the level attribute could be built using the following configuration string:

\\%Server%\%@..\|SiteID%%Element%TS.PV

### **Reading a Substitution Parameter**

The above *%@..\/SiteID%* substitution parameter can be read as: "Give me the value of the parent-element's SiteID attribute." In order to better understand the configuration string above, refer to the following table:

Symbol	Definition	Examples
%[]%	Consider the expression as a substitution parameter.	%Element%, %Attribute%
Navigate a level down.        Navigate a level up.       \     References an element.		%@.\ <childelement> <attribute> %</attribute></childelement>
		%\\Element%, % Attribute%
		% <b>\</b> Element%
	References an attribute.	% Attribute%, %@  <attribute>%</attribute>
@	References the value of the object instead of its name.	%@\\  <attribute>%</attribute>

### **General syntax for Substitution Parameters**

- Strings enclosed between % and % will substitute the name of the entity. So %Element% returns the name of the Element containing this Attribute, %Attribute% returns the name of the Attribute.
- | symbol indicates that the following string is an Attribute. If the Attribute is at the same level as the current Attribute, you do not need the | symbol.
- With the @ symbol the value of the Attribute is returned. For example,
   %@.|PITagName% means replace with the value of the child Attribute called
   PITagName.
- Using ..\ we can move upwards in the hierarchy. For example, %..\Element% means replace with the name of the parent Element of the current Element. Using this syntax repeatedly we can move up multiple levels, %..\..\Element% would return the grandparent (the parent of the parent) of the current Element.

For more information see also *List of PI AF Substitution Parameters* and *Substitution Parameters in Data References* in the OSIsoft Documentation.

# 3.2. Using Substitution Parameters in a Template Attribute



Before reading this section, please refer to the following course YouTube video: OSIsoft Learning: Using Substitution Parameters in a Template Attribute

### Database: Velocity Terminals

### **Exercise Objectives**

• Assemble substitution parameters to automatically map Data Archive tags to AF attributes.

### **Problem Description**

Velocity Terminals will buy other facilities in the next few months where multiple tanks are present. They are going to implement the same tag naming convention at those new locations and will want to save time when adding those extra assets to the actual AF hierarchy.

They want to use the substitution parameters to speed up the creation of additional assets in AF. To demonstrate that this is feasible, you are asked to add a new temperature attribute template to the Tank's template so that it uses substitution parameters to automatically find the correct PI tag.

To assist in simplifying tag creation, you plan to set-up a table as a look-up reference for sites.

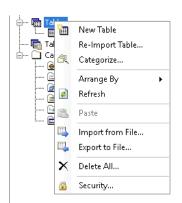
Site	SiteID
Montreal	15
Sydney	23
Tokyo	44

### Approach

When we created the hierarchy, we hard-coded the Locations in the elements. Now, that we are expanding, it might be easier to create a table reference for the locations.

In the C:\OSIsoft folder, there is a spreadsheet named SiteTable. The spreadsheet will be imported into a new table called SiteTable.

Create a table named **SiteTable** in Library > Tables.



At this time, we will not define the table, we are going to rely on the spreadsheet to create and populate the table.

General Table Def	ine Table Version
Name:	SiteTable
Description:	
Categories:	
Connection:	Internal
Query:	Internal Query
Time Zone:	<none></none>
Cache Interval:	0 Manual Refresh
	Security

Select Import to build the connection to the spreadsheet.



Select Build.

Si	teTable			
6	ieneral Table	Define Table Version		
P	lame:	SiteTable		
	escription:			
	Tategories:		🗊 Data Link Properties 🛛 🗙	
	Table Impoi	t	Provider Connection Advanced All	× =
1	Name:	SiteTable	Select the data you want to connect to:	
	Description:		OLE DB Provider(s)	
	Connection:	Press F2 to show the Text Visua		Build
	Query:	Press F2 to show the Text Visua	Microsoft Office 16.0 Access Database Engine OLE DB Pro Microsoft OLE DB Driver for SQL Server	
		Retain Query Information	Microsoft OLE DB Driver for SQL Server Microsoft OLE DB Provider for Analysis Services 11.0 Microsoft OLE DB Provider for Analysis Services 14.0 Microsoft OLE DB Provider for ODBC Drivers Microsoft OLE DB Provider for Search Microsoft OLE DB Provider for SQL Server Microsoft OLE DB Simple Provider MSDataShape OLE DB Provider for Microsoft Directory Services OLE DB Provider for SQL Server Integration Services SQL Server Native Client 11.0 ✓	
			OK Cancel Help	OK Cancel

On the **Provider** tab, select the provider according to the version of Microsoft Office that you are using. In our case select **Microsoft Office 12.0 Access Database Engine OLE DB Provider** (appropriate for Office 2007 and higher). Click Next.

Note: For Office 97-2003: select Microsoft Jet 4.0 OLE DB Provider.

On the **Connection** tab, specify the following and click OK.

🗊 Data Link Properties	×
Provider Connection Advanced All	
Specify the following to connect to this data:	
1. Enter the data source and/or location of the data:	
Data Source: C:\OSIsoft\SiteTable.xlsx	
Location:	
2. Enter information to log on to the server:	
<ul> <li>Use Windows NT Integrated security</li> </ul>	
Use a specific user name and password:	
User name: Admin	
Password:	
🗹 Blank password 🛛 Allow saving passwo	rd
3. Enter the initial catalog to use:	
	$\sim$
Test Conn	ection
OK Cancel	Help

o Data Source

The location and file name of the database or workbook (in our case C:\OSIsoft\SiteTable.xlsx). If you are linking, the path to the file must be relative to the PI AF server. Note that linking is not recommended for Excel spreadsheets.

o User Name

Login credentials of a user that has been granted read access to the database or workbook. We are using the **Admin** account here.

Note: To store the password with the connection information, select the Allow Saving Password check box. The password is stored as plain text (not encrypted).

On the Advanced tab, in the Access permissions list, select Share Deny None.

On the All tab, select the Extended Properties value and click Edit Value.

The Edit Property Value window opens.

Enter the property value according to the version of Microsoft Excel that you are using, and then click OK. In our case (for Excel 2007 and higher) we enter **Excel 12.0**.

Note: For Excel 97-2003 use Excel 8.0.

To verify that the spreadsheet is accessible, return to the Connection tab and click **Test Connection**.

If the settings are valid, a Test connection succeeded message displays.

Click OK to dismiss the window and return to PI System Explorer.

To define the data to be returned from the spreadsheet, enter an SQL query in the Query field. In this case we are using SELECT \* FROM [Sheet1\$]. To dismiss the window, click OK.

To review the resulting data, examine the Table tab. If the query is specified correctly, the tab contains a table displaying the results.

SiteTable	SiteTable									
General	Table	Define Table Ve		Version						
SiteTabl										
Filter										
	Site	SiteID		teID						
•	Montreal			15 23						
	Sydney									
Tokyo		44								

To save your changes, right-click the table node (or access from the top menu) and choose Check In.

Create a new template – called Site.

Site				
General	Attribut	e Templates	Ports	Analysis
Name:		Site		
Descripti	on:			
Base Ten	nplate:	<none></none>		
Categori	es:			
Naming F	attern:			

Create an attribute named SiteID in the Site template.

	· · · · ·					
Site						
General	Attribute Templates					
Filter						
🖉 i 🔶 🧖 Name						
8 🖻	] Category: <none></none>					
	📑 SiteID					
	L					

Earlier, we created a table named SiteTable that we will use to identify each Site. In order to populate the SiteID attribute.

Set value Type to Int16

Set the Data Reference to Table Lookup

Name:	SiteID
Description:	
Properties:	<none> ~</none>
Categories:	
Default UOM:	<none> ~</none>
Value Type:	Int16 ~
Default Value:	0
Display Digits:	-5
Data Reference:	Table Lookup 🗸

Open Settings to instruct the lookup how to identify the SiteID associated with the location (%Element%).

The statement passed to the database:

SELECT SiteID FROM SiteTable WHERE Site = '%Element%'

The set-up within the Table Lookup Data Reference screen:

Fable:	SiteTable		~ · · · · · · · · · · · · · · · · · · ·
Result column:	SiteID		V Stepped
Unit of Measure:	<none></none>		~
Behavior			
Rule:	Select first row (	matching criteria	~
Order by:	SiteID		✓ ASC ✓
Where			
Column:	Operator:	Attribute or Value:	Add And
Site	~ =	✓ %Element%	Add Or
			$\sim$
Table Parameters —			×
Table Parameters — Parameter		Value	~
Parameter		Value	~
Parameter Replacement Values	n no matching row fou		V

Check in the Site template.

Now, the temperature attribute can be completed. Navigate back to the Tank template.

Navigate to the Attribute tab and add a new attribute, change the name to Temperature. Set the default UOM to °C and Value Type to Double.

Name:	Temperature
Description:	
Properties:	<none> ~</none>
Categories:	
Default UOM:	℃ ~
Value Type:	Double ~
Default Value:	0 ℃
Display Digits:	-5
Data Reference:	PI Point ~
	Settings

Use substitution parameters so that the tag names are automatically built according to the expected tag naming convention.

Two options exist to create the PI Point syntax.

Option 1: Directly from the PI Point Data Reference.

%@..\|SiteID%%Element%TS.PV

%@..\|SiteID%: This portion of the syntax above obtains the value from the Primary Parent template SiteID attribute.

%Element% represents the Element name itself.

Data server:	%Server	%	~ •
Tag name:	%@\ Si	teID%%Element%TS.PV	
🔄 Tag Cre	ation		
Attribute:			
- Unit of Measure -			
Source Units:	°C	~	
Value retrieval me	thods		
By Time:		lutomatic	~
Relative time:			
By Time Range:		ind Time	
Calculation ba			
		Time Weighted	
Min percent g	ood:	80	
Preview			
Example instance	: <u>Selec</u>	t example instance	
Configuration:			
Value:			
Read only			

Option 2: As a Child Attribute of Temperature to contain the string

String Builder Settings: '..\|SiteID';"%Element%";TS.PV;

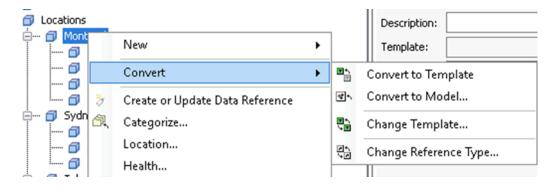
**Note:** There is a difference between the substitution parameters used in PI Point Data References and the syntax used by String Builder: %@..\|<attribute>% works for PI point references but not for the string builder reference, it is instead '..\|<attribute name>'.

For more information refer to "Configuration of data references" in OSIsoft Documentation.

Check in the changes.

One more step is required to complete the validation of the syntax. The site locations need to be associated with the newly defined Site template. Navigate to Elements> Velocity Terminals > Locations > Montreal

Right click to display the content menu, then select Change Template.



From the Choose Element Template display, select Site. Repeat this process for Sydney and Tokyo.

Choose Element Templ	ate X
Name:	Montreal
Element Template:	
<none></none>	
Templates of category:	<any> ~</any>
	template of an existing Element may quences. Use with caution.
	OK Cancel

Check in the changes.

Tip: Alternatively, you can navigate to Locations and open the Child Elements tab. Select all three elements, right click and select Change Template.

Locat	tion	s								
Gene	eral	Child Elements	Attributes	Ports	Analyses	Notification Rules	Version			
						Group	by: 🗌 C	atego	ry 🔲 Reference Type 🗹	Template
Filte	r									<mark>,</mark>
Category						©,				
		Template: <nor< td=""><td>ne&gt;</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></nor<>	ne>							
Ð		🗇 Montreal	_					1		_
Ð		🗇 Sydney	L	С	onvert		•	<b>*</b> ^	Convert to Model	
Ð		🗇 Tokyo		у С	reate or Up	date Data Referenc	e	<b>T</b> 4 14 <b>T</b>	Change Template	
				🕇 R	eevaluate N	aming Pattern			3	
			Ć	R C	ategorize					
			6	b C	ору					

Validate the Temperature attribute is displaying values by browsing the tanks. You will notice there are values for the Temperature and the PI Point resolved to the Site number + Element Name + TS.PV.

		es are hidden.	Analyses Notification Rules Version		Gro	oup by: 🗹 Category 🔲 Template	
Filte	v		٩	•	Name:	Temperature	
	∕!:■♦₽	Name 4	Value 🛞		Description:		
•	🖻 Categor	y: <none></none>			Properties:	<none> ~</none>	
	/ 🗉	Capacity	22000 US gal		Categories:		
		🗉 Density	3422 kg/L	3	Default UOM:	°C	
±	J 🗉	6 Level	13.90 %	2	Value Type:	Double	
		E Mass	3.9623E+07 kg	2	Value:	85.547 °C	
	I	I Night Shift Operator	Bob	4	Display Digits:	-5	
	<i>d</i> 0 ∎ ♦	Notification Email Add		7	Data Reference:	PI Point ~	
Đ	- J I	Pressure	1.7123 bar	2		Settings	
		Product	HC1500	4	\\PISRV01\15Tan	<pre>&lt;01T5.PV;UOM=°C</pre>	
	E 🔒	E PVCode	PV				
	T	I Tank Level Information	Tank01 is located in Montreal and the Level is 13.9%				
		🗉 Tank Name	Tank01	3			
	ø =	🍼 Temperature	85.547 ℃	2			
	Ŧ	🗉 Volume	11.579 m3	7.			

## 3.3. Setting Point Attributes for Tag Creation (optional)

#### Database: Tank Farm

PI Tags can also be created via AF. One way is going via the PI Analysis Service which is creating the tags for writing the calculation results, but another is independent of the data source and is done via template-based attributes with PI Point DR type. Since this is only possible for attributes based on a template, substitution parameters are crucial for defining the tag names and attributes. In the following we will go through an example of setting up tags for an OPC interface via PI Point DR attributes.

Before going through the steps of setting up an attribute for tag creation, let us first look at the attribute **Mixing Speed** which was built in a similar way. In the PI Point Data Reference Settings, note that Tag Creation is ticked. The Point Attribute configuration which is partly visible in the field below can be configured by clicking button with the three dots.

PI Point Data Reference		×
Tag Creation	1 ent%.MixingSpeed ;pointtype=Float64;descriptor=Mixing Speed of %Element%;engur	
O Attribute: Unit of Measure Source Units: rpm	· · · · · · · · · · · · · · · · · · ·	
Value retrieval methods By Time: Relative time:	Automatic	~
By Time Range: Calculation basis: Min percent good:	End Time Time Weighted 80	~
Preview Example instance: Sel Configuration: Value:	ect example instance	
Read only	ОК	Cancel

In the Tag Creation Settings window, note the use of substitution parameters for the descriptor and instrumenttag (in our case this is the address on the OPC Server).

Tag Creation Setti	ngs		Х
Point Class:	classic	✓ Import	
Point Type:	Float64	~	
Point Attribute		Value	^
archiving		1	
compdev		0.2	
compdevpercent		0.2	
compmax		28800	
compmin		0	
compressing		1	
convers		1	
datasecurity		piadmin: A(r,w)   piadmins: A(r,w)   PI Manager: A(r,	
descriptor		Mixing Speed of %Element%	
digitalset			
displaydigits		-5	
engunits		rpm	
excdev		0.1	
excdevpercent		0.1	
excmax		600	
excmin		0	
exdesc			
filtercode		0	
future		0	_
instrumenttag		Mixing Units/%Element%/MixingSpeed	
location1		1	
location2		0	_
location3		1	
location4		1	_
location5		0	
pointsource		OPC	
ptsecurity		piadmin: A(r,w)   piadmins: A(r,w)   PI Manager: A(r,	
scan		1	×
		OK Cancel	

We will now go through an example of setting up a new attribute for tag creation. In our database we want to include the **status** of the mixing units which are part of the tanks. The PI System Administrator has already set up the tag for TankA1 which will serve as a template for the configuration. We can find the tag by the name TankA1.Status.

Note that in a real-life scenario, you should have some expertise on tag creation and the interface in question. If you do not have this kind of expertise, speak to your local PI System Administrator to get assistance. In our example, we use tags from an OPC interface and use a configuration in which it is obvious which parts need to change from tank to tank.

- We open the Attribute Templates tab of the Tank template in the Library. We can again make use of the Palette to quickly build the new attributes. Open the Tag Search Palette from the menu with View > Palette > Tag Search.
- 2. In the Tag Search enter TankA1.S\* to find the pre-built tag.

1.2				
	🔎 Tag Search			• ×
	Server(s): PISRV01			•
	tanka1.s*		× • 😵	Search
	Name	Description	Point Source	Data Tyj 🞯
	🎺 TankA1.Status	Mixer Status of TankA1	OPC	Digital

**3.** Drag and drop the tag to the Attribute templates area. The attribute is created with the name of the tag. We will apply some changes to the configuration.

🐔 TankA1.Status	Mixer Status of TankA1	0
-----------------	------------------------	---

- 4. Rename the attribute to "Mixer Status".
- 5. Looking at the configuration of the Status attribute we notice that the tag is digital and we still need to create an Enumeration Set to match the Digital State Set. Later in the course we will discuss Digital State Sets and Enumeration Sets in more detail. In the menu we open File > Connections, right click on the Data Server and select Properties.

Servers		
🕭 Add Asset	t Server 🦓 Add Data Sen	ver 🔍 Connect 😁 Properties 🧔 Buffering Manager
Filter		
Name		Host
PISPUST		PISRV01
🥙 PISI 🦜	Add Data Server	PISRV01
۵	Add Asset Server	
	Disconnect	
<b>\$</b>	Refresh	_
×	Remove	_
1	Properties	
	6	-

6. In the PI Data Archive Properties window we navigate to the State Sets tab. Here we right click on the set MixerStates and select Create Enumeration Set from State Set... and confirm with Yes to create a matching Enumeration Set.

🚰 PI Data Archive Properties		— 🗆 X
General State Sets		
Name BatchAct California InterfaceStatus	Enumeration Set	Conflicts EnumerationSet 'BatchAct' not found. EnumerationSet 'InterfaceStatus' not found.
MixerStatus MixerStatus Create Enumeration Set fr Phases Refresh pialarmoderwore pialarmoderwore System	rom State Set	EnumerationSet InterfaceStatus not round. EnumerationSet 'MixerStates' not found. EnumerationSet 'Phases' not found. EnumerationSet 'pialarm33' not found. EnumerationSet 'pialarmcontrol' not found. EnumerationSet 'pisqcalarm' not found. Reserved
A matching EnumerationSet for the StateSet 'Mix	xerStates' does not exist in the AFDatabase 'Tan	k Farm'
Value 0 1 2 3 4	Digital State Name Very Low LOW Normal HIGH Very High	Enumeration Value Name
	OK Cancel Apply	

**7.** Now we can assign the Enumeration Set MixerStates as the Value Type for the attribute template Mixer Status.

<u>N</u> ame:	Mixer Status	Mixer Status					
Description:	Mixer Status of TankA1	lixer Status of TankA1					
Properties:	<none></none>	<none></none>					
<u>C</u> ategories:							
Default <u>U</u> OM:	<none></none>						
Value Type:	Double		~				
Default Value:	Basic Types	۲					
Dįsplay Digits:	Array Types	•					
Data <u>R</u> eference:	Enumeration Sets	•	MaterialID 🗸				
	MixerStates						
	System						
\\PISRV01\TankA1.							

8. We do not need the description (which came from the PI tag) in the attributes since the attribute names are descriptive enough, so we will delete those.

- **9.** Now that the basic configuration is set, we can configure the template further to create the tags for the other tanks. For this we click Settings... on the Mixer Status attribute to open the PI Point Data Reference window.
- 10. First we change the Tag name to create tags according to the naming convention <tank name>.Status. To do this we replace TankA1 with %Element% either by entering the substitution parameter manually or through selection from the Name Substitution Values list as shown below.

PI Point Data Refer	ence		×		
Data server:	PISRV01		•••		
Tag name:	.Status		R	estore default value	-
Tag Crea	ation	%Server%	N	ame Substitution Values	>
		%Database%	A	ttribute Values	>
0		%Element%	R	elated Attribute Values	>
Attribute:		%ElementID%	Ť		
Unit of Measure		%\Element%			
Source Units:	<none></none>	%\Element%			
Value retrieval me	thods	%ElementDescription%			
By Time:	Automatic	%Attribute%	$\sim$		
		%AttributeID%	_		
Relative time:		% Attribute%			
By Time Range:	End Time	%Description%	$\sim$		
Calculation ba	sis: Time Weighted	%Template%	$\sim$		

In the end, we should have %Element%.Status in the Tag name field.

**11.** Next, we tick the box for Tag Creation and click the ellipsis button on the right to open the Tag Creation Settings window.

PI Point Data Reference			
Data server:	PISRV01	~	
Tag name:	%Element%.Status	•	
Tag Crea			

12. In the Tag Creation Settings window we can manually make the required changes, but instead of starting from scratch it is easier to use an existing tag as a starting point. For doing so, we use the Import... button and search for the tag TankA1.Status which we used earlier to build the attribute.

	Tag Creation Settings ×						×	~	
	Point Class:     base     Import       Point Type:     Float64						~		
	Point Attribute archiving		Value 1					~	
🔎 Tag Search									$\times$
Server(s): PISRV01									
tanka1.*							× •	Search 🗧	
TankA1.MixingSpeed	Description Mixing Speed of TankA1		Floa		Point Class classic	Engineering U rpm	Value 1926.8	Time Stamp 30/05/2022 0	© Tr
TankA1.Status	Mixer Status of TankA1	OPC	Digi	tal	classic		Normal	30/05/2022 0	Tr

**13.** Next, a window opens to show all the differences to the default setting and we can decide for each Point Attribute if we want to import the settings from the example tag or stick with the default (or what is presented as the current configuration).

Import PI Point Attributes						
Select the PI Point Attributes to import. Only attributes which are not configured as the default value are listed :						
Point Attribute	Value	Current Configuration	^			
🗹 compdev	0	0.2				
descriptor	Mixer Status of TankA1					
🗹 excdev	0	0.1				
✓ instrumenttag	Mixing Units/TankA1/Sta					
✓ location1	1					
✓ location3	1					
✓ location4	1					
✓ pointsource	OPC	Lab	¥			
Select All		OK Cancel				

In this case, we will click OK to take all settings from the imported tag. Note that we still need to make changes to the configuration to make it universal for all tanks which we will do in the next step.

**14.** The Tag Creation Settings window now shows all Point Attributes which are differing from the default in bold. We still need to make changes where the configuration needs to be different between the tanks. This is the descriptor and the instrumenttag (this corresponds to the address on the OPC server).

Tag Creation Settings Import   Point Class: dassic   Point Type: Digital     Point Attribute Value   descriptor Mixer Status of TankA1   digitalset MixerStates   displaydigits -5   engunits excdev   excdev 0   excdev 0   excdev 0   excmax 600   excmin 0   exdesc instrumenttag   filtercode 0   future 0   location1 1   location3 1   location4 1						
Point Type:       Digital         Point Attribute       Value         descriptor       Mixer Status of TankA1         digitalset       MixerStates         displaydigits       -5         engunits       -         excdev       0         excdevpercent       0         excmax       600         excmin       0         exdesc       -         filtercode       0         future       0         instrumenttag       Mixing Units/TankA1/Status         location1       1         location3       1	Tag Creation Settin	gs				×
Point Type: Digital   Point Attribute Value   descriptor Mixer Status of TankA1   digitalset MixerStates   displaydigits -5   engunits -5   excdev 0   excdevpercent 0   excmax 600   excmin 0   exdesc -   filtercode 0   future 0   instrumenttag Mixing Units/TankA1/Status   location1 1   location3 1   location4 1	Point Class	daggie	~	Import		
Point Attribute       Value         descriptor       Mixer Status of TankA1         digitalset       MixerStates         displaydigits       -5         engunits       •         excdev       O         excdevpercent       O         excmax       600         excdesc       •         filtercode       O         future       O         instrumenttag       Mixing Units/TankA1/Status         location1       1         location3       1         location4       1	Point Class.	Classic	~	Importan		
descriptorMixer Status of TankA1digitalsetMixerStatesdisplaydigits-5engunits-5excdev0excdevpercent0excmax600excmin0exdesc-filtercode0future0InstrumenttagMixing Units/TankA1/Statuslocation11location31location41	Point Type:	Digital	$\sim$			
digitalsetMixerStatesdisplaydigits-5engunits-5excdev0excdevpercent0excmax600excmin0exdesc-filtercode0future0instrumenttagMixing Units/TankA1/Statuslocation11location31location41	Point Attribute		Value			^
displaydigits-5engunits-5excdev0excdevpercent0excmax600excmin0exdesc-filtercode0future0instrumenttagMixing Units/TankA1/Statuslocation11location20location31location41	descriptor		Mixer Status	of TankA1		
engunits         Image: constraint of the second of th	digitalset		MixerStates			
excdev0excdevpercent0excmax600excmin0exdesc0filtercode0future0instrumenttagMixing Units/TankA1/Statuslocation11location20location31location41	displaydigits		-5			
excdevpercent         0           excmax         600           excmin         0           exdesc	engunits					
excmax         600           excmin         0           exdesc         -           filtercode         0           future         0           instrumenttag         Mixing Units/TankA1/Status           location1         1           location2         0           location3         1           location4         1	excdev		0			
excmin         0           exdesc	excdevpercent		0			
exdesc filtercode 0 future 0 instrumenttag Mixing Units/TankA1/Status location1 1 location2 0 location3 1 location4 1	excmax		600			
filtercode 0 future 0 instrumenttag Mixing Units/TankA1/Status location1 1 location2 0 location3 1 location4 1	excmin		0			
future     0       instrumenttag     Mixing Units/TankA1/Status       location1     1       location2     0       location3     1       location4     1	exdesc					
instrumenttag     Mixing Units/TankA1/Status       location1     1       location2     0       location3     1       location4     1	filtercode		0			
location1         1           location2         0           location3         1           location4         1			-			
location2 0 location3 1 location4 1				TankA1/Status		_
location3 1 location4 1			_			
location4 1			-			
			_			
locationE 0			_			~
	location E		0			
OK Cancel				ОК	Cancel	

**15.** To make changes we click on the field and can again either type in the substitution string use the arrow for assistance.

Point Attribute	Value	<b>^</b>
descriptor	Mixer Status of TankA1	Restore default value
digitalset	M %Server%	Name Substitution Values >
displaydigits	-5 %Database%	Attribute Values
engunits excdev	0 %Element%	Related Attribute Values
excdevpercent	0 9/ Flam and D9/	

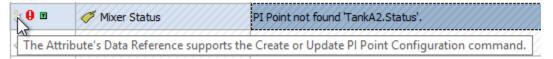
In this case we replace TankA1 with %Element% and do the same for the instrumenttag. The result should look like below.

Tag Creation Settin	ngs					×
Point Class:	classic	~	/	Import		
	clubble					
Point Type:	Digital	~	1			
Point Attribute		Value				^
descriptor		Mixer Statu	is of %Ele	ement%		
digitalset		MixerState	s			
displaydigits		-5				
engunits						
excdev		0				
excdevpercent		0				
excmax		600				
excmin		0				
exdesc						
filtercode		0				
future		0				
instrumenttag		Mixing Unit	s/%Elem	ent%/Sta	itus	
location1		1				
location2		0				
location3		1				
location4		1				
location E		0				×
				OK	0	
				ОК	Can	

**16.** We can close out of the windows with OK and OK. All changes to the default are displayed in the configuration string of the attribute.

Name:	Mixer Status					
Description:						
Properties:	<none> ~</none>					
Categories:						
Default UOM:	<none> ~</none>					
Value Type:	MixerStates $\checkmark$					
Default Value:	<none> ~</none>					
Display Digits:	-5					
Data Reference:	PI Point ~					
Settings						
<pre>\\PISRV01\%Element %.Status;ptclassname=classic;pointtype=Digital;compdev=0;compdevpercent =0;descriptor=Mixer Status of %Element %;digitalset=MixerStates;excdev=0;excdevpercent=0;instrumenttag=Mixing Units/%Element %/Status;location1=1;location3=1;location4=1;pointsource=OPC;span=4;ste p=1;typicalvalue=0;zero=8</pre>						

**17.** When we navigate to the Elements tab and look at a different tank than TankA1, say TankA2, we see the following.



The PI Point was not found since it was not created yet. The little white tag symbol on the left indicates that we can apply the Create or Update PI Point command (see "Attribute indicators for updates of PI point data references" in the OSIsoft Documentation for details).

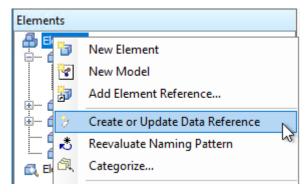
**18.** We can right click and apply Create or Update PI Point to create the tags.

	🎖 🔒 🗉	🍼 Mixer Stal	<b>S</b>	Reset to Template
	•	🗉 Product		New Analysis
Ξ	Category	y: Operations	3	Create or Update PI Point

Note that the attributes will probably show Pt Created when the tags got created since it can take a bit until the interface is aware of the new tag and the first values are written. How long this takes will depend on the interface setting how often to check for updates in the tag list (typically every 2 minutes) and how frequent the tag is getting new values. In our case it should not take longer than 2 minutes as the tags are updated frequently.

We do not need to perform this for each attribute individually as the Create or Update Data Reference option is also available from the element tree. It

can be performed from any element and would be applied to this element and all its descendants. In our case it is easiest to perform this on the highest level directly.



If this seems complicated, remember that this is just moving administration work to AF which might otherwise have been done within PI System Management Tools or PI Builder. The task of building the tags has to be done somewhere. The advantage of including it in the template is that whenever we build a new element from the template the tags will be created automatically (as long as we built the instrumenttag in the correct way to apply to all elements).

For full information refer to "*Configure creation of PI points*" and "*Edit PI point properties*" in the OSIsoft Documentation.

## 4. Tables

### 4.1. Parameterized Queries



Before reading this section, please refer to the following course YouTube video: OSIsoft Learning: Parameterized Queries

#### Database: Sweet & Savory Corps

In this video, we explore data retrieval from a table.

Tables in the AF database provide contextual information through the Table Lookup data reference. Tables can provide information about the equipment or process, store tag names or other configuration information.

Tables can be created internally, imported from an external relational or tabular data source, or linked dynamically to an external relational data source. In this way, Tables can expose information in maintenance, production planning, or equipment databases for use by PI client applications.

Switch to the Sweet and Savory database.

Navigate to Elements tab  $\rightarrow$  Sandbox  $\rightarrow$  Packaging  $\rightarrow$  FFS01 and click on the Attributes tab. It may take a few minutes for the data to update.

When you opened PSE and navigated to the Sandbox\_FFS\_Maintenance table in the Sweet & Savory Corps database, you may notice it takes a long time to initially open the table.

Why is the response so slow?

FS01	1	
Gene	eral Child E	Elements Attributes Ports Analyses Notification Rules Version
Excl	luded attribu	utes are hidden.
Filte	r	
	∕ : ⊡ ♦	R Name A Value
	🖻 Catego	ory: Identification
	√ <sup>2</sup> ∎	Asset     Retrieving the data reference values. Please wait
	\$ <sup>\$</sup>	E Last Service Date Retrieving the data reference values. Please wait
		I Model ADCO
	40° E	🗉 Nominal Max Throughput Retrieving the data reference values. Please wait
	4° •	Product     Retrieving the data reference values. Please wait
	40° E	Production Line     Retrieving the data reference values. Please wait
⊡	🖻 Catego	ory: Overall Equipment Effectiveness
Ŧ	√ <sup>2</sup> ⊠ ♦	Availability Retrieving the data reference values. Please wait
ŧ	🔶 🖬 🔶	Availability Monthly Average Retrieving the data reference values. Please wait
Ŧ	🔶 🖬 🔶	OEE     Retrieving the data reference values. Please wait
ŧ	🔶 🖬 🔶	Performance     Retrieving the data reference values. Please wait
Ŧ	🔶 🗉 🔶	The data reference values. Please wait

Based on the set-up of the Sandbox\_FFS\_Maintenance table, we suspect the slowness is caused by a single heavy hitter, the attribute **Last Service Date**. This attribute is a Table Lookup, which means that it... looks up a value in a table, using a SQL-like query of type:

SELECT [Last Service Date] FROM [Sandbox\_FFS\_Maintenance] WHERE Asset = @Asset ORDER BY Last Service Date

Elements			FFS01						
🖃 🔒 Elem	ents		Gener	ral Child El	ements Attributes Ports A	Analyses Notification	n Rules	Version	
	Data Archive								Group by: 🗹 Category 🗌 Template
	Production Sandbox		Filter			ې	) <b>-</b> (	Name:	Last Service Date
	🗇 Packaging 👝			∕: = ♦ 8	Name 🛆	Value 💿		Description:	
	🗗 FFS01			-	ry: Identification			Properties:	<none> ~</none>
	🗇 FFS02						2	Categories:	Identification
	🗇 FFS04				🗉 Asset	FFS01	4	Default UOM:	<none></none>
	🗇 FFS05				Last Service Date 2	11/1/2019 12:00:			
Elem	Element Attribute Search Results				I Model	ADCO		Value Type:	DateTime
				Results			I Nominal Max Throughput	75 Bags/min	8
				-			8	Display Digits:	-5
				×	Product	Salt	4	Data Reference:	Table Lookup
	Table Lookup Data Reference X						<		Settings
	Table:	Sandb	ox_FSS	_Maintenan	ce 🚺	~ - 😭 🛅			Settings
	Result column:	Last S	ervice D	ate		✓ Stepped			rice Date] FROM [Sandbox_FSS_Maintenance]
	Unit of Measure:								
	Unit of Measure:	<none< td=""><td>e&gt;</td><td></td><td></td><td><math>\sim</math></td><td></td><td></td><td></td></none<>	e>			$\sim$			

Let's look at the table we use to populate the Last Service Date attribute:

- 1. Move to the Library tab and open the Tables dropdown list. (5 in image below).
- **2.** Select table (6 in image below)
- 3. Move to the Table tab. (7 in image below)

Library	Sandb	ox_FFS_Mainte	enance		
Sweet & Savory Corp Templates 		oox_FFS_Mainte	ne Table Version		
Vent Frame Templates     Vent Frame Templates     Vent Transfer Templates     Wodel Templates     Wod		F1  2  3  4  5  6  7  8  9	Asset FFS01 FFS02 FFS03 FFS04 FFS05 FFS06 FFS06 FFS07 FFS08 FFS08 FFS09	Model ADCO ADCO ADCO MF TECNO ADCO MF TECNO MF TECNO ADCO MF TECNO MF TECNO	AD AD 2 MF 3 MF
Notification Rule Categories     Reference Type Categories     Table Categories     Table Categories		10 11 12 13 14 15	FFS10 FFS11 FFS12 FFS13 FFS14 FFS15	MF TECNO MF TECNO ADCO MF TECNO ADCO ADCO	MF MF AC MF AC
Hevent Frames		15 16 17	FFS16 FFS17	ADCO MF TECNO	AD MF

How many rows are present in this table? [hint: far too many!]

Do we need all these rows? [hint: no, we only need the FFS Units that appear in our database!]

The table Sandbox\_FFS\_Maintenance is stored in a central SQL Server at the corporate level and contains asset metadata from all the production sites around the world (around 1M FFS units... probably unrealistic, but good for our discussion!). For our goals, we only need to retrieve the data for our pilot site. This has already been done correctly in the Production environment, so we just need to understand how it works and replicate it in the sandbox environment.

- 4. Still on table Sandbox\_FFS\_Maintenance, move to the General tab.
- 5. Click on the "Link..." button. You'll see a Connection String and a query to an external SQL Server. The current query is retrieving all rows and columns from the external SQL table:

select \* from dbo.PackagingPlantMaint1M

Sandbox_FFS_Ma	intenance
General Table	Define Table Version
Name:	Sandbox_FFS_Maintenance
Description:	
Categories:	
Connection:	Linked - Provider = SQLOLEDB. 1; Integrated Security = SSPI; P
Query:	Linked - select * from dbo.PackagingPlantMaint1M
Time Zone:	<none></none>
Cache Interval:	1 Hours
	Security

It may take a few minutes to retrieve all the rows:

Sandbox_FFS_Maintenance. 1000000 Rows.

- 6. Once complete, the number of rows will display.
- 7. Select table Production\_FFS\_Maintenance.
- 8. Move to the Table tab, how many rows do you see?

**NB**: The Table tab shows only one row corresponding to the default value of the @Asset parameter (FFS01), but the query will work fine for any other AF element.

Library	Producti	on_FFS_I	Maintenanc	e		
Sweet & Savory Corp	General	Table	Define Tabl	e Version		
⊡ Im Templates 	Production_FFS_Maintenance Filter					
i∰ Sign Model Templates I∰ Tign Transfer Templates		Asset		Model	Last Service Date	
	•	FFS01		ADCO	11/1/2019 12:0	
Tables Model Specifications Model Specifications Packaging Target Product Assignment Production_FFS_Maintenance Sandbox_FFS_Maintenance						

**9.** Go to General --> **"Link..."** and check how the query is performed. You'll notice that the SQL query contains a parameter (*where @Asset=Asset*). You can hit Cancel to close the window.

_			
Table Link			
Name:	Production_FFS_Maintenance		
Description:			
Connection:	;Data Source=pisrv01;Use Procedure	for Prepare=1;Auto Translate=True	;Packet Size=40
Query:	select Asset, Model, [Last Service Da where @Asset = Asset	te] from dbo.PackagingPlantMaint 1N	1
	Parameter Name	Default Value	
Parameters:	@Asset	FFS01	<u>Delete</u>
	@		Add
Security:	Impersonate Client		
	O Supply Password Change Pass	sword	
	<ul> <li>No additional security context</li> </ul>		

Using parameters in a linked table query is useful to limit the number of rows returned from a very large external table. You can add conditions and parameters to return more targeted results, such as all rows that include a device or manufacturer ID number, specific for each table lookup data reference. (*Documentation*).

Now go back to the Sandbox table and edit the query so that only needed information is returned:

**10.** Open table Sandbox\_FFS\_Maintenance  $\rightarrow$  General tab.

11. Select the Link...

Library	Sandbox_FSS_Maintenance
<ul> <li>Sweet &amp; Savory Corp</li> <li>Templates</li> <li>Templates</li> <li>Event Frame Templates</li> <li>For the Event Frame Template</li></ul>	General       Table       Define Table       Version         Name:       Sandbox_FSS_Maintenance         Description:
Analysis Categories     Attribute Categories     Attribute Categories     Attribute Categories     Attribute Categories     Analysis Categories     Attribute Categories     Attribute Categories     Table Categories	Table Link       X         Name:       Sandbox_FSS_Maintenance         Description:       Connection:         Connection:       ISRV01;Use Encryption for Data=False;Tag with column collation when possible=False;          Query:       select * from dbo.PackagingPlantMaint

**12.** Edit the query as follows (feel free to copy and paste from the .PDF file of this workbook):

Select \* from dbo.PackagingPlantMaint

#### Where @Asset = Asset

**13.** In the Parameters Section, add the parameter @Asset with a default value of FFS01. Press Add (located to the right of the Default value box) to include it in the query statement at run time.

Parameter Name	Default Value
@Asset	FFS01

Table Link				×
Name:	Sandbox_FSS_Maintenance			
Description:				
Connection:	Provider=SQLOLEDB. 1;Integrated S	ecurity=SSPI	;Persist Security Info=Fa	lse;Initial Ca 🗸
Query:	select * from dbo.PackagingPlantMaint Where @Asset = Asset			
	Parameter Name	Default	Value	
Parameters:	@Asset	FFS01		<u>Delete</u>
	e			Add
Security:	<ul> <li>Impersonate Client</li> </ul>			
	O Supply Password Change Pa	ssword		
	○ No additional security context			
			ОК	Cancel

**14.** Check In and Click on Refresh and open the Table tab: how many rows are present now?

General	neral Table Define Table Version					
PackerMaintenance						
Filter						
	Asset	Model	Serial Number	Installation Date	Last Service Date	Service Crew
•	FFS01	ADCO	ADA5FFS01	5/1/2017 12:00:00 AM	11/1/2019 12:00:00 AM	Red

Only one row is returned, and it corresponds to the Default value of the SQL query.

**Note**: as stated before, the parameter value in the configuration above is just an example parameter value (a default value) and it doesn't affect the query when evaluated for a different AF element.

- **15.** Move to the Templates → Element Templates → **Sandbox\_FFS** and select the Attribute Templates tab.
- 16. Select the Last Service Date and click on Settings...
- 17. Add the Table Parameter as in the screenshot below (Parameter: @Asset; Value: %Element%).

<ul> <li>\\PISRV01\Sweet &amp; Savory Corps - PI System Explorer (Administrator)</li> <li>File View Go Tools Help</li> <li>Database Cuery Date          <ul> <li>G Back </li> <li>C Check In </li> <li>C Check In </li> <li>C Sweet &amp; Savory Corps </li> <li>Emplates </li> <li>Element Templates </li> </ul> </li> </ul>	Sandbox_FFS General Attribute Templates Ports Analysis Templates	Time Zone:	sence Sandbox_FFS_Mainten Last Service Date <none> <none></none></none>	· · · · · · · · · · · · · · · · · · ·	> > >
	Filter       Name       Category: Identification       Asset       Last Service Date       Model       Nominal Max Throughput       Product	Behavior     Rule:     Select first row matching criteris       Order by: <none>       Where        Column:     Operator:       Astribute or Value:       Asset     =       Complete WHERE Clause:       Asset</none>			~ Ac
Product Assignment     Production_FF5_Maintenance     Sandback_FF5_Maintenance     Sandback_FF5_Maintenance     Elements     Event Frames     Library     Contacts     Contacts		Table Parameters Parameter @Asset Replacement Values		Value Y∈%	
⅔ Management	7	Value to return when no No Data	matching row found: $\checkmark$	Value to return when NULL resu DBNull	ult f

In this way, every time a value is requested by a Table Lookup attribute, the parametrized query will be passed to the external SQL server and only the requested value will be returned.

- **18.** Important: Click on Check In to save your changes.
- **19.** In order to verify whether the caching performance has improved, close PI System Explorer. Then reopen PI System Explorer and move between AF elements under the Sandbox branch (make sure you have the Attributes tab open). Do you notice any improvements in terms of data retrieval speed? [*hint: yes! :D*]

**Note:** Don't forget the **square brackets** around Last Service Date. The space characters in the column name Last Service Date would break the SQL query unless square brackets are used.

Still hungry for knowledge on AF Tables? For more information on parametrized queries, please visit *Data references from outside the PI System* and *Parameters for linked table queries*.

Last but not least, this PI Square post illustrates good and bad uses of Table Lookup, Formula and Analysis data references: *Asset Analytics Best Practices - Part 3: Input Attributes* (5).

$\checkmark$	Don't bring data you don't need into the PI System. In the case of table
<b>Best Practice</b>	lookups, you can use parametrized queries to only fetch data that will be
	used.
	A rule-of-thumb is to avoid importing tables with over 10 000 rows.

# 4.2. Introduction to Building SQL Queries for Targeted Data Retrieval (optional)

To retrieve data from relational databases we need to build queries which specify which data is needed. While those queries can be kept simple to retrieve a complete table it is often times better to make a more specific request to limit the amount of data and therefor keep the processing load small.

SQL stands for Structured Query Language. SQL is an American National Standards Institute (ANSI) definition for the language used to communicate with relational database systems. It is used by virtually all relational databases in the world today. (Even the PI Data Archive has a SQL Subsystem that can act as a translator to make it "look" like a relational database). SQL Commands are often called "**SQL Statements**." They can be executed interactively or as stored procedures.

While SQL is a standard and every relational database you encounter will understand it there are slight differences as most databases have unique extensions and/or syntaxes that are unique to those systems.

To give a simple example, when passing dates into Access you use pound signs (#) for surrounding dates. On the other hand, in SQL Server you need to use apostrophes (').

Access: [...] WHERE dtColumn >= #2001-11-05# SQL Server: [...] WHERE dtColumn >= '20011105'

A common SQL syntax starting command is **SELECT** which is used to query the database. The data retrieved from the statement is based on the criteria specified in the SELECT statement. Following the **SELECT** command identifies the columns to be selected from the tables(s). The **FROM** command identifies the first (or perhaps only) table being queried.

The WHERE command contains criteria to filter the data being retrieved.

The conditional operators include:

- o equal (=)
- o greater than (>)
- less than (<)
- $\circ$  greater than or equal (>=)
- less than or equal (<=)</li>
- not equal to (<>)
- LIKE (which is a pattern matching operator)

**Note:** If the conditional clause is set to compare to text, the text value is encased in single quotes ('text').

#### **ORDER BY clause**

To guarantee the order of rows returned by a query, the ORDER BY clause can be used. Ascending order is assumed by default if not specified otherwise. To be explicit, ASC for ascending can be placed behind the column to sort by, or if sorting in descending order is needed an explicit DESC needs to be set.

If the column which is used for sorting does not have unique entries, additional columns can be used. After each column the sorting order can be specified with ASC or DESC.

#### AND and OR statements

- **AND** indicates both statements must be TRUE for the row to be returned when the query is executed.
- OR returns data rows if either condition is met

The **LIKE** operator is used to search for a specific pattern in a column. In conjunction with the LIKE operator a **wildcard of %** is used for comparison. The % can represent a single character or multiple characters. Another wildcard is the underscore (\_) which can be used to represent a single character.

To work with column/table names which have special characters, such as a space, use square brackets.

Any name may be wrapped in square brackets, so when in doubt as to what constitutes a special character, wrap the name in square brackets.

#### **Examples:**

In the last section we have seen where SQL queries can be used in linking and importing tables in AF. For more interactive testing we will use the **Microsoft SQL Server Management Studio** in the examples below. The same queries could be used in PSE.

When we open Microsoft SQL Server Management Studio we find the table dbo.PackagingPlantMaint1M in the database PackagingPlantMaint. To get us started

we can run a predefined query by selecting "Select Top 1000 Rows" from the menu we get on right mouse click.

Object Explorer	<b>→</b> ₽ ×				
Connect - 🛱 🎽 🔲 🝸 🖒 🧀					
<ul> <li>PISRV01 (SQL Server 14.0.1000.169</li> <li>Databases</li> <li>Database Snapshots</li> <li>HMAILDB</li> <li>PackagingPlantMaint</li> <li>Database Diagrams</li> <li>Tables</li> <li>System Tables</li> <li>FileTables</li> <li>Graph Tables</li> </ul>	9 - PISCHOOL\student01)				
i i i i i i i i i i i i i i i i i i i	tMaint1M				
⊕ 📻 Views	New Table				
🕀 🛑 External Resources	Design				
🕞 💼 Synonyms	Select Top 1000 Rows				
🕀 📁 Programmability 🕀 📁 Service Broker	Edit Top 200 Rows				
🖽 💻 Storage	Script Table as				
🕀 🛑 Security	View Dependencies				
	Memory Optimization Advisor				
🕀 📄 PIVision 🕀 📁 Security	Encrypt Columns				
	Full-Text index 🔹 🕨				
	Storage 🕨 🕨				
🗉 📁 Always On High Availability 🗉 📁 Management	Stretch •				
Integration Services Catalogs	Policies •				
🗄 📕 SQL Server Agent	Facets				
표 📧 XEvent Profiler	Start PowerShell				
	Reports •				
	Rename				
	Delete				
	Refresh				
	Properties				
<	>				

This produces the following query: SELECT TOP (1000) [Asset] ,[Model] ,[Serial Number]

,[Installation Date]

,[Last Service Date]

,[Service Crew]

FROM [PackagingPlantMaint].[dbo].[PackagingPlantMaint1M]

The resulting table looks like this:

	Asset	Model	Serial Number	Installation Date	Last Service Date	Service Crew	^
1	FFS01	ADCO	ADA5FFS01	2017-05-01 00:00:00	2019-11-01 00:00:00	Red	
2	FFS02	ADCO	ADA5FFS02	2017-05-01 00:00:00	2018-04-09 00:00:00	Orange	
3	FFS03	ADCO	ADA5FFS03	2017-05-01 00:00:00	2018-01-01 00:00:00	Yellow	
4	FFS04	MF TECNO	MFM5FFS04	2017-05-01 00:00:00	2019-11-01 00:00:00	Green	
5	FFS05	ADCO	ADA5FFS05	2017-05-01 00:00:00	2019-11-01 00:00:00	Blue	
6	FFS06	MF TECNO	MFM5FFS06	2017-05-01 00:00:00	2018-03-20 00:00:00	Red	
7	FFS07	MF TECNO	MFM5FFS07	2017-05-01 00:00:00	2018-02-25 00:00:00	Orange	
8	FFS08	ADCO	ADA5FFS08	2017-05-01 00:00:00	2019-11-01 00:00:00	Yellow	
9	FFS09	MF TECNO	MFM5FFS09	2017-05-01 00:00:00	2019-12-29 00:00:00	Green	
10	FFS10	MF TECNO	MFM5FFS10	2017-05-01 00:00:00	2018-03-31 00:00:00	Blue	
11	FFS11	MF TECNO	MFM5FFS11	2017-05-01 00:00:00	2019-11-01 00:00:00	Red	
12	FFS12	ADCO	ADA5FFS12	2017-05-01 00:00:00	2019-11-01 00:00:00	Orange	~

The easiest query however would be to just select everything from this table:

SELECT \* FROM [PackagingPlantMaint].[dbo].[PackagingPlantMaint1M]

To test, we can modify the query and execute.

	QLQuery1.sql - PISRV01.PackagingPlantMaint (PISCHOOL\student01 (64))* - Microsoft SQL Server Management Studio (Administrator)	
File	Edit View Query Project Tools Window Help	
80	- ②  稔 - 七 - 🏩 💾 🎥 New Query 🗯 📾 🏫 🏫 🎧 🕹 🗗 缶 🛛 🏞 - 🖓 - 🤍 -  🕅 🏓 -	🖓 🎤
80 <b>#</b>	₩   PackagingPlantMaint 🛛 🗸   🕨 Execute 🛛 🖌 🛱 🗐 🔚 📅 🐯 😰   🗐 🌆 🗗   🗏 🦉 -Ξ Ξ=   🐲 🚽	
Object		
Conn	ct - 🛱 🎽 = 🝸 🖒 🚸 SELECT * FROM [PackagingPlantMaint].[dbo].[PackagingPlantMaint]	:1M]

The result will show the entire table and displayed below the Results window we can see how many rows of data we have.

	Asset	Model	Serial Number	Installation Date	Last Service Date	Service Crew	
1	FFS3586	MF TECNO	MFM5S3586	2017-05-01 00:00:00.000	2019-11-01 00:00:00.000	Red	
2	FFS3587	MF TECNO	MFM5S3587	2017-05-01 00:00:00.000	2019-12-06 00:00:00.000	Orange	
3	FFS3588	ADCO	ADA5S3588	2017-05-01 00:00:00.000	2018-02-07 00:00:00.000	Yellow	
4	FFS3589	ADCO	ADA5S3589	2017-05-01 00:00:00.000	2019-11-01 00:00:00.000	Green	
5	FFS3590	ADCO	ADA5S3590	2017-05-01 00:00:00.000	2019-11-01 00:00:00.000	Blue	
6	FFS3591	MF TECNO	MFM5S3591	2017-05-01 00:00:00.000	2018-02-09 00:00:00.000	Red	
7	FFS3592	ADCO	ADA5S3592	2017-05-01 00:00:00.000	2019-11-21 00:00:00.000	Orange	
8	FFS3593	MF TECNO	MFM5S3593	2017-05-01 00:00:00.000	2019-11-01 00:00:00.000	Yellow	
9	FFS3594	MF TECNO	MFM5S3594	2017-05-01 00:00:00.000	2019-11-01 00:00:00.000	Green	
10	FFS3595	ADCO	ADA5S3595	2017-05-01 00:00:00.000	2018-04-09 00:00:00.000	Blue	
11	FFS3596	MF TECNO	MFM5S3596	2017-05-01 00:00:00.000	2018-01-01 00:00:00.000	Red	
12	FFS3597	MF TECNO	MFM5S3597	2017-05-01 00:00:00.000	2019-11-01 00:00:00.000	Orange	
13	FFS3598	MF TECNO	MFM5S3598	2017-05-01 00:00:00.000	2019-11-01 00:00:00.000	Yellow	
14	FFS3599	ADCO	ADA5S3599	2017-05-01 00:00:00.000	2018-03-20 00:00:00.000	Green	
15	FFS3600	MF TECNO	MFM5S3600	2017-05-01 00:00:00.000	2018-02-25 00:00:00.000	Blue	
16	FFS3601	ADCO	ADA5S3601	2017-05-01 00:00:00.000	2019-11-01 00:00:00.000	Red	

For this table there are 1,000,000 rows. We can also see how long it took to retrieve the information from the server. We will get back to this later.

If we are interested only in a **subset of columns**, we can specify those after the SELECT. For example:

SELECT [Asset], [Model], [Serial Number], [Service Crew] FROM [PackagingPlantMaint].[dbo].[PackagingPlantMaint1M]

Note that while we can wrap all column names in square brackets in our example it would be only necessary for the columns Serial Number and Service Crew since they contain a space.

To limit the **number of rows** returned the WHERE clause can be used. For example, to only show the assets maintained by the "Red" Service Crew we can use the query:

SELECT Asset, Model, [Serial Number], [Service Crew] FROM [PackagingPlantMaint].[dbo].[PackagingPlantMaint1M]

WHERE [Service Crew]='Red'

In some cases, it might be necessary to **filter using a wildcard**. For example, if we are looking for all assets ending with the number 6:

SELECT Asset, Model, [Serial Number], [Service Crew] FROM [PackagingPlantMaint].[dbo].[PackagingPlantMaint1M]

WHERE Asset LIKE '%6'

Sometimes the **order of results** might be important. For example, if there is a date column and we want to see the most recent entries. We can sort by the column Last Service Date to find the assets with the most recent service:

SELECT [Asset], [Model], [Serial Number], [Installation Date], [Last Service Date], [Service Crew] FROM [PackagingPlantMaint].[dbo].[PackagingPlantMaint1M]

ORDER BY [Last Service Date] DESC

If we want to see the assets which are around for the longest we can sort by Installation Date:

SELECT [Asset], [Model], [Serial Number], [Installation Date], [Last Service Date], [Service Crew] FROM [PackagingPlantMaint].[dbo].[PackagingPlantMaint1M]

ORDER BY [Installation Date] ASC

Here, specifying ASC is optional as ascending order is assumed by default.

It is also possible to use a combination of columns if the column used has not unique entries. For example, we might want to see the assets by Service Crew, with the most recent services listed on top:

SELECT [Asset], [Model], [Serial Number], [Installation Date], [Last Service Date], [Service Crew] FROM [PackagingPlantMaint].[dbo].[PackagingPlantMaint1M]

ORDER BY [Service Crew] ASC, [Installation Date] DESC

## 4.3. Table Caching

The AF Table cache interval is strictly a client-side property. This also means that each AF Client using the AF Table will have its own cache and cache interval start and end time. The cache interval expires relative to the last time data in the AF Table on the AF Client was updated. Note that while the cache is "automatically" refreshed, **the cache is actually NOT updated on a schedule**; it is only refreshed if the cache interval has expired when the client calls for the AF Table data.

This implies that if your AF client has to keep a large amount of unnecessary table information in memory and / or update this table frequently, you might start seeing performance issues. Parametrized queries means that the extra, unneeded data is processed out on the external SQL side and not on the AF SDK client side (as it would have to be if you were not using parametrized queries) leading to better performance. Thus, you should always try to limit the size of your in memory AF tables as much as possible through parametrized queries.

AF Tables can be one of two types - Internal or External.

- Internal tables are stored in the PIFD database. For an Internal table, when the cache interval expires and the AF Table is refreshed, the AF SDK client will update its cache with data from the AF Server.
- External tables retrieve their data from an external data source. For an External table, when the cache interval expires and the AF Table is refreshed, the AF Client will request the AF Server to make the external query to the external data source. The AF Server will then return the results to the AF Client, which will then update its in-memory copy with these results.

#### Example:

You have PI System Explorer (PSE) and PI Vision (Vision) both looking at a Table lookup attribute (TL) which itself is set to get its value from an externally linked table. Say the cache interval is set to 1 hours for this table.

You first open PSE and navigate to the TL at 10:00 am. Then you open Vision to a display also looking at this same TL attribute at 10:15 am. At 10:30 am, this value (the one being looked at by TL) in your external table is updated. At 11:00 am, you refresh PSE to get the newest value of TL as reflected in your external table, and both systems match. However, even if you refresh Vision at the same time, you will still see the older value of TL. This is because each client maintains its own cache, and while PSE's cache interval has expired (1 hour) since 10:00 am, Vision's has not (45 min); thus, Vision will not update its cache, and it will still show the older value for this refresh.

Each client's cache will only update if 2 criteria are met:

- 1. The client requests values from the table.
- 2. The Cache Interval has expired for that particular client (this is because the AF server will only query the external table on the client's behalf if the client's cache interval has expired relative to the last update time of the client's in memory copy of the table).

# 5. Working with Templates

## 5.1. Template Inheritance and Base Template

A powerful feature of the element template is the ability to set a base template. Once a base template is created, it can be used to create a number of derived templates. When an element is created from a derived template, the element contains all attributes from both the base template and the derived template.

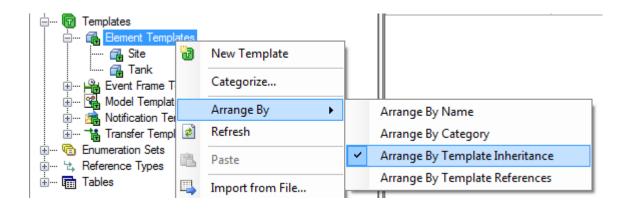
Base Template	
Tank	Derived Template
Tank Attributes:	Mixing Tank
Diameter	Mixing Tank Attributes:
Height	Mixer Speed
Fill Level	Mixer Blade Size

- An element created from the Tank element template has three attributes: Diameter, Height and Fill Level.
- An element created from the Mixing Tank element template has five attributes: Diameter, Height, Fill Level, Mixer Speed and Mixer Blade Size

A base template is best used when you are modeling elements that have a set of attributes in common with a few attributes that differ. For example, if you have a set of tanks, some with two valves and some with one valve, you can create an element template for the one-valve models and use that as the base template for the two-valve models. Set the base template of an element template in the *General* tab; alternatively, you can set the base template at creation time by right clicking the base template and select *New Derived Template*.

Eement Templates     Genenic Tank	late ate				
		New	•	ъ	New Element
🖅 🙀 Notification Templ		Find	•	1	New Template
	2	Refresh		9	New Derived Template
T	b	Сору		1	New Referenced Template

To view the template inheritance tree from the PSE Library, simply organized the templates by inheritance.



# 5.2. Tips for Dealing with Differences in Template-based Assets

#### A tip for working with derived templates:

The standard view of the Attribute Template list of derived templates is only showing the attributes which are special to the derived template and not those of the base template. We can use the Group by Template option also in the Library to see all attributes an element from this template will get.

Tank with Foam Sensor								
General	Attribute Templates Ports Analy:	is Templates Notification Rule Temp	lates					
						Group b	y: 🗌 Category 🗹 Template	
Filter				<del>ب</del> م	<u>N</u> ame:	Foam		
/ i	🔶 💂 Name	△ Description	Default Value	٢	Description:			
Ξ 🔒	Template: Tank				Properties:	<none></none>	~	
/	🕞 Capacity		0 US gal		<u>C</u> ategories:		ē	
	🖳 Density		0 kg/L		Default <u>U</u> OM:	%	~	
Ð			0.00 %		Value Type:	Double	~	
	Kixer Status		0		Default Value:	0%		
	Kixing Speed		0 rpm		Dįsplay Digits:	-5		
	🖫 Night Shift Operator		Bob		Data <u>R</u> eference:	PI Point	~	
	- Product		HC1500			Settings		
8 🔒	Template: Tank with Foam Sensor				\\%Server%\%El	ement%%Attribute%;UO	M="%"	
	Kara Foam		0 %					

This view is also useful when attributes from the base template have a different definition in the derived template. In the example below, which will be discussed in the next section, the Level attribute from the Tank template is marked as Overridden since the derived template Special Tank has a different definition for this attribute.

Gene	ral Attrib	ute Templates Ports Analysis	Templates Notification Rule Templates					
								Group by: 🗌 🧕 dategory 🗹 Template
Filte	r					• م	Name:	Level
	/ i 🔶 🦧	Name	△ Description	Default Value	Data Reference	۲	Description:	
₽	🔂 Temp	late: Tank					Properties:	<none></none>
	1	📑 Capacity		0 US gal	<none></none>		⊆ategories:	
		E Density		0 kg/L	Table Lookup		Default UOM:	%
Œ		Kevel		Overridden	PI Point		Value Type:	Double
		📑 Mass		0 kg	Formula		Default Value:	0.00 %
		🔜 Night Shift Operator		Bob	<none></none>		Display Digits:	2
		K Notification Email Address			PI Point		Data <u>R</u> eference:	PI Point v
		M Pressure		0 bar	PI Point			Settings
-		Product			<none></none>		\\%5erver%\%8	Element%%Attribute%.%@PVCode%;UOM="%"
	R	PVCode		PV	<none></none>			
		Tank Level Information			String Builder			
		Tank Name		0	String Builder			
		Temperature		0 °C	PIPoint			
				0.000 m3	Formula			
	_	S Volume		0.000 m3	Formula			
	📸 Temp	late: Special Tank						
		≪≦ CO2		0.00 %	PIPoint			
Œ		🐔 Level		0.00 %	PI Point			

#### A note on Allow Extensions:

There is also the option to add attributes to individual template-based assets by allowing extensions. Using derived templates should always be the preferred method over Allow Extensions even if the exception only applies to a single asset. As soon as it is more than one, derived templates help to ensure consistency.

#### How to deal with assets which are lacking measurements or properties?

Looking at the opposite problem, one or just a few assets might lack a measurement most assets of the type have. Instead of creating a base template with all attributes but the one in question and a derived template with that additional attribute, we can also exclude attributes for individual assets. We have discussed how to apply the excluded property in the earlier section *AF Attribute Properties*.

### 5.3. Working with derived element templates



Before reading this section, please refer to the following course YouTube video: *OSIsoft Learning: Working with derived element templates* 

#### Database: Velocity Terminals

#### Activity Objectives (Working with Velocity Terminals)

- Create a derived template for a special tank that has an additional sensor for CO2 measurement
- Use a derived template to accommodate a different PI Point reference for the Level attribute in a special tank.

Two modifications were done on Tank10, which means that the tank deviates from the normal ones on the following details:

- There is an additional sensor for CO2 measurement. The tag name is: Tank10CO2.PV
- The name for the Level sensor is different now. Instead of Tank10LI.PV the name is Tank10LEVEL.PV

This means the name does not follow the normal name pattern %Element%LI.PV. Instead the name pattern has to be %Element%Level.PV (or: %Element%%Attribute%.PV).

#### Approach

Create an element template for a Special Tank that has an additional sensor and a different naming pattern for the Level attribute.

- 1. Open the Tank template in the Library of the Velocity Terminals database.
- 2. From the Tank template context menu and select New Derived Template

Library			Т	ank 👘		
Velocity Terminals				General	Attribute Templates	Ports
🚊 同 Templates						
🖃 🖷 🔂 Element Templates				<b>5</b> 4		
🔂 Site			ļĻ	Filter		
		ערק				
🔅 🗝 🗖 Event F	New 🕨	1	1	New	Element	
🗄 📽 Model T	Catagoriza	215			<b>T</b> 1.	
🗄 🗝 📲 Transfe 🌄	Categorize	ľ	J	New	Template	
🗄 ···· 隨 Enumeration	Location	8	9	New	Derived Template	
🗄 🗝 🖞 Reference T	Health	2	a	New	Referenced Template	•
🚊 🗝 🛅 Tables					nererencea remplati	-

- 3. Rename the new element template to Special Tank.
- 4. On the Attributes Templates tab, add a new attribute template CO2:
- 5. Additional Attribute for CO2 (PI Point: Tank10CO2.PV)

Default UOM = percent (Ratio) Value Type= Double DisplayDigits=2 Data Reference = PI Point

- Click on Settings... to enter the PI Point name. Use substitution parameters to define a standard naming pattern based on the element and the attribute name. What do you write? %Element%%Attribute%.PV
- 7. Change the Source Unit from <Default> (%) to %., Select OK.
- 8. Check in the change, then refresh.

9. In the Navigator, switch to Elements. Select Tank10 and change the template from Tank to Special Tank.

🗊 Sydney	Sydney Tank08				E	🗉 De	ensity	3.422 k
🗇 Tar	nk09		Œ	T		🍼 Le	vel	58.83 %
L 🗊 Ta	-1.10	New	111		•	E M		2.6671
		Convert			•		Convert to Model	C. Freehood
	3	Create or Update	Data Ref	erence		<b>▼</b> *, '+ <b>▼</b>	Change Template	
	R	Categorize					Change Reference Typ	e

10. Verify the Tank10 has the CO2 attribute, the value is from PI Point Tank10CO2.PV.

#### **Override for Level**

11. On the Attributes Templates tab, add a new attribute template Level (in the Special Tank template) :

Default UOM = percent (Ratio) Value Type= Double DisplayDigits=2 Data Reference = PI Point Setting - (PI Point: **Tank10LEVEL.PV**)

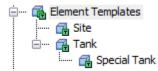
- 12. Click on Settings... to enter the PI Point name. Use substitution parameters to define the different naming pattern based on the element and the attribute name. %Element%%Attribute%.%@PVCode%
- 13. Change the Source Unit from <Default> (%) to %.
- 14. To define the limits, select the Level attribute and click on Limits...in the context menu. Set the limits in the same way as for the normal tank:

~	Trait	Attribute	Value	Data Reference	Settings
~	Minimum	Minimum	0%	<none></none>	
~	LoLo	LoLo	15 %	<none></none>	
7	Lo	Lo	25 %	<none></none>	
~	Target	Target	50 %	<none></none>	
~	Hi	Hi	80 %	<none></none>	
~	HiHi	HiHi	90 %	<none></none>	
~	Maximum	Maximum	100 %	<none></none>	

- 15. Check-In your changes and refresh.
- 16. In the Navigator, switch to Elements. Select Tank10 and verify the PI Point for the Level attribute of Tank10 is Tank10Level.PV

#### Show element templates based on inheritance

17. Open the Element Templates in the Library of the Velocity Terminals. From the context menu, select Arrange By > Arrange By Template Inheritance. Result: Special Tank is shown below Tank.



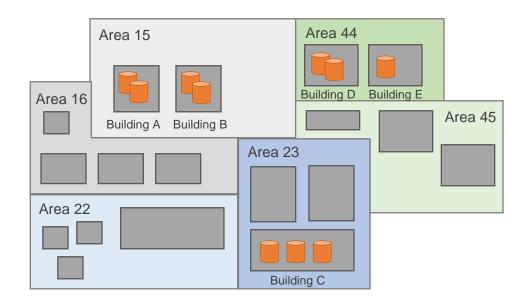
## 5.4. Working with Referenced Templates

#### Database: Tank Farm

When starting out with AF some people get confused with the hierarchical structure of derived templates and hierarchical structure of elements. Those are different concepts since Base Templates and Derived Templates are both dealing with elements of the same type – typically located at the same level of a hierarchy. However, there is another type of template relationship which reflects the hierarchical structure of elements: Referenced Templates.

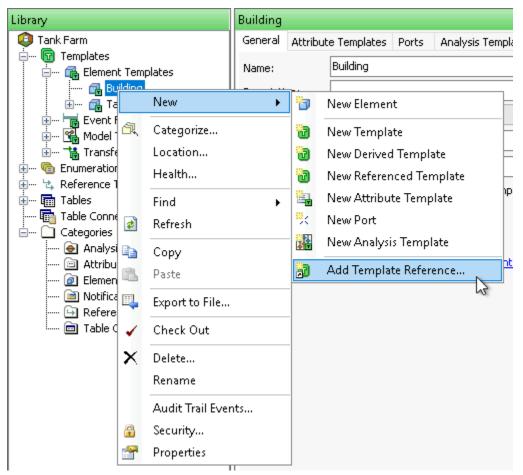
AF has the concept of referenced templates to create a parent-child relationship between templates. This does not enforce that a referenced Child Template is used for the Child elements of a referenced Parent Template, but the reference type will appear in the Choose Element Template window and this reference type will only allow referenced Child Templates to the referenced Parent Template. We will go through an example to see how this works in detail.

In the Tank Farm database we want to establish a certain structure: tank elements should be grouped under a building element which should be part of an area element. Below is a sketch of the plant map. We are only interested in the areas and buildings which contain tanks (red cylinders). Our goal is to reflect the physical structure (areas contain buildings, buildings contain tanks) in the template structure.



We start with assigning a relationship to the existing templates. The templates of the category Tanks (Tank and Tank with Foam Sensor) should become referenced templates of the Building template.

 In the Library, right click on the Building template and select New > Add Template Reference...



Note: In this example we establish a reference relationship between existing templates. It is also possible to create a new Child Referenced Element Template directly by using the New Referenced Template option as can be seen in the screenshot above.

2. In the Add Element Template Reference window we select Tank as the Child Referenced Element Template. The derived template Tank with Foam Sensor will be implicitly included. To view the configuration for the newly created reference type, we tick Edit reference type and click OK.

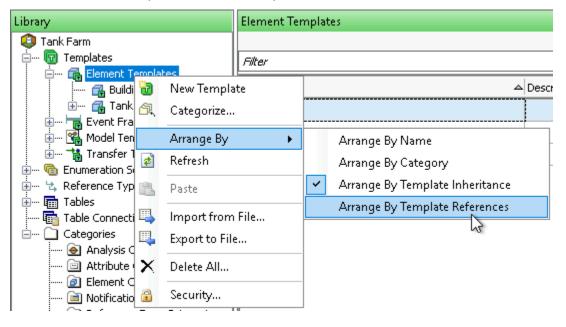
Add Element Template Reference		$\times$
Child Referenced Element Template:	Tank	$\sim$
Edit reference type		
	OK Cancel	

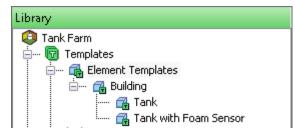
3. The Reference Type Properties window opens up.

🚰 Reference Type	Properties		_		×				
General									
Name:	Building-Tan								
Child Name:	Tank	ank							
Parent Name:	Building	luilding							
Categories:									
Reference Strength:	Strong	Strong							
Allowed Parent Element	Allowed Parent Element Template: Building								
Allowed Child Element	Template:	Tank			~				
		Security							
		OK Cancel Apply Check In							

We do not need to make any modifications. Just to mention, here we could change the name of this new reference type and modify which elements are allowed as parent or child. Those settings can be also changed later via the Reference Types section of the Library. Click Check In and OK.

**4.** Right click on Element Templates and click Arrange By > Arrange By Template Reference to see the relationship between the templates.





5. We can also search for the reference parent or child templates by navigating to the General tab of a template and use the Find option. For the Building template we click Find: Referenced Child Templates.

Building					
General	Attribut	e Templates	Ports	Analysis Templates	Notification Rule Templates
Name:		Building			
Description:					
Base Template: <none></none>					
Categorie	es:	Buildings			
Naming P	attern:				
		Allow Ext	ensions	Base Template	Only
		Extended Pro	operties	(0) Location Hea	lth <u>Security</u>
Find:		Derived Tem	<u>plates</u>		Referenced Parent Templates Referenced Child Templates

A window opens up with all referenced child templates for the Building template.

Filter					<u>م</u>
Name 🛆 Desi	cription C	ategory	Туре		0
🔁 Tank	T	anks	Element		
🗃 Tank with Foam Sensor	Т	anks	Element		

The effect of this new reference type can be seen when a new child element is created for any of the building elements. We don't need to actually create one now,

we just go through the first steps to see what choices we get for selecting an element template. When we select Building-Tank as the reference type, the only options for element templates to use are the two templates from the Tanks category.

Choose Element Template	×
Parent:       Building A         Add child element using the reference type:              Building-Tank            Composition           Parent-Child	
Element Template:	_
nank I ank with Foam Sensor	
OK Cancel	

In fact, only the Building-Tank reference type will now allow the creation of child element from the Tank or Tank with Foam Sensor templates for a Building element. The other two reference types, Composition and Parent-Child, do not allow the Tank or Tank with Foam Sensor templates for a Building element.

Choose Element Template X	Choose Element Template X
Parent: Building A Add child element using the reference type: → Building-Tank → Composition → Parent-Child	Parent: Building A Add child element using the reference type: → Building-Tank → Composition → Parent-Child
Element Template:	Element Template: <none> Building</none>
OK Cancel	OK Cancel

Why is this? Remember when we created the reference type we specified (following the default settings) the allowed parent element template and the allowed child element template.

- If we would choose <Any> for the allowed parent element template, the tank templates could be also used with other reference types as child elements of the Building template. Additionally, this reference type would be available for elements which are not from the Building template.
- If we would choose <Any> for the allowed child element template, the Building-Tank reference type would also allow other templates as children (in our case this would add the Building template to the choices).

Together, setting specific templates as the allowed types ensures that the reference type can only be used for elements from the allowed parent template and that the allowed child template can only get connected through this reference type.

In the next lesson we will create elements using the new reference type and change the reference type for the existing elements.

## 6. PI Builder Tasks

## 6.1. Working with PI Builder

So far, we have worked with PI System Explorer which is a great tool for AF administration work. Although we have just seen ways to perform bulk edits, there are limits in practicality of creating or editing objects in large numbers in PSE. When it comes to large scale edits PI Builder is the better suited tool. In practise, both tools will probably often be used in combination: Starting out in PSE and taking the existing structures as syntax examples for building out the rest of the database in PI Builder.

In this section we will partly following this approach as we revisit areas where we have started building out our database in PSE. For the purpose of this training, we will stick to rather small scale editing in PI Builder as well, but using the capabilities of Microsoft Excel together with the PI Builder plugin the methods we show can be easily scaled up to large numbers.

Whenever we start working with PI Builder, we have to make sure to be connected to the correct servers and database.



## 6.2. Build and Edit Templates and Other Library Objects

#### Database: Tank Farm

In this section we will go through some examples for applying configuration changes to Library objects with PI Builder.

#### Build a new attribute template for an existing element template

For the Tank template we want to introduce an additional attribute template to display the building letter code (A, B, etc.). This attribute will be very similar to the attribute TankID, only that we will use the name of the parent element and take just one character from the right instead of two. We can therefor use the attribute TankID as a starting point to apply modifications.

 First, we load in the configuration of the Tank template with its attribute templates. For doing so, we select Library > Templates > Find Templates... and select the Tank template in the following window.

			Template Selection X
Libra	ry Elements Event • Frames •	Security Retrieve	Type: Element ~
	<u>C</u> ategories →	G Attribute D	Name 💿
	<u>T</u> emplates →	📴 Eind Templates	
	Enumeration Sets	Case Templates	🔂 Tank
4	Reference Types	🔂 Element Templates	🛱 Tank with Foam Sensor
(1999)	<u>U</u> nits of Measure →	Event Frame Templates	
- 88	Contacts >	Model Templates	
		Transfer Templates	< >>
		<u>∐</u> eaders ►	OK Cancel

In the Select Object Types and Column Headers window, click Clear All. This clears all not required selections and is a good starting point in many cases when a targeted selection should be made. We then add some columns from the AttributeTemplate category: Type, DataReference and ConfigString and click OK.

Select Object Types and Column Headers X								
Object Type:	Object Type: ElementTemplate							
Template:	Template: Tank V							
Object Types:	2 selected, Columns: 7 selected							
Object Types: 2 selected, Columns: 7 selected								
Clear All	Select All More Attribute Columns							
Description:	Description:							
		^						
		$\sim$						
E	OK Cancel Reset							

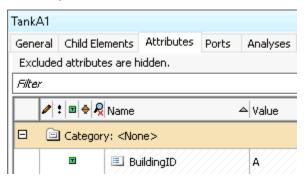
2. In the Retrieve Selected Objects window, click Close once the line "The requested action is complete." appears. We are getting the Tank template and all its attribute templates loaded into the spreadsheet.

	A	В	с	D	E	F	G
1	Selected(x)	Parent	Name	ObjectType	AttributeType	AttributeDataReference	AttributeConfigString
2	х		Tank	ElementTemplate			
3	х	Tank	Capacity	AttributeTemplate	Double		
4	x	Tank	Density	AttributeTemplate	Double	Table Lookup	SELECT Density FROM [Material Properties] WHERE MaterialD = @Product
5	х	Tank	Level	AttributeTemplate	Double	PI Point	\\%Server%\%Element%LI.PV
б	x	Tank	Level Hi	AttributeTemplate	Double		
7	х	Tank	Level HiHi	AttributeTemplate	Double		
8	х	Tank	Level Level.2HoursAgo	AttributeTemplate	Double	PI Point	Level;RelativeTime=-2h
9	х	Tank	Level Level.2HoursAverage	AttributeTemplate	Double	PI Point	Level;TimeMethod=TimeRangeOverride;RelativeTime=-2h;TimeRangeM
10	x	Tank	Level Lo	AttributeTemplate	Double		
11	х	Tank	Level LoLo	AttributeTemplate	Double		
12	x	Tank	Level   Maximum	AttributeTemplate	Double		
13	х	Tank	Level   Minimum	AttributeTemplate	Double		
14	x	Tank	Level   Target	AttributeTemplate	Double		
15	х	Tank	Mixer Status	AttributeTemplate	Double	PI Point	\\PISR\/01\%Element%.Status;ptclassname=classic;pointtype=Digital;com
16	х	Tank	Mixing Speed	AttributeTemplate	Double	PI Point	\\PISRV01\%Element%.MixingSpeed;UOM=rpm;ptclassname=classic;poin
17	х	Tank	Night Shift Operator	AttributeTemplate	String		
18	х	Tank	Product	AttributeTemplate	AFEnumerationValue		
19	x	Tank	TankID	AttributeTemplate	String	String Builder	Right(%Element%,2);

- **3.** We copy the row with the attribute TankID and name the new attribute template BuildingID. We also need to change the AttributeConfigString to Right(%..\Element%,1);
- **4.** We deselect all rows apart from the new attribute template (delete the x in the Selected(x) column or click Deselect All and place an x in the row with BuildingID).

	A	В	с	D	E	F	
1	Selected(x)	Parent	Name	ObjectType	AttributeType	AttributeDataReference	AttributeConfigString
2			Tank	ElementTemplate			
3		Tank	Capacity	AttributeTemplate	Double		
4		Tank	Density	AttributeTemplate	Double	Table Lookup	SELECT Density FROM [Ma
5		Tank	Level	AttributeTemplate	Double	PI Point	\\%Server%\%Element%
б		Tank	Level   Hi	AttributeTemplate	Double		
7		Tank	Level   HiHi	AttributeTemplate	Double		
8		Tank	Level Level. 2HoursAgo	AttributeTemplate	Double	PI Point	Level;RelativeTime=-2h
9		Tank	Level Level. 2HoursAverage	AttributeTemplate	Double	PI Point	Level;TimeMethod=Tim
10		Tank	Level Lo	AttributeTemplate	Double		
11		Tank	Level   LoLo	AttributeTemplate	Double		
12		Tank	Level   Maximum	AttributeTemplate	Double		
13		Tank	Level   Minimum	AttributeTemplate	Double		
14		Tank	Level   Target	AttributeTemplate	Double		
15		Tank	Mixer Status	AttributeTemplate	Double	PI Point	\\PISRV01\%Element%.St
16		Tank	Mixing Speed	AttributeTemplate	Double	PI Point	\\PISRV01\%Element%.N
17		Tank	Night Shift Operator	AttributeTemplate	String		
18		Tank	Product	AttributeTemplate	AFEnumeration∨alue		
19		Tank	TankID	AttributeTemplate	String	String Builder	Right(%Element%,2);
20	х	Tank	BuildingID	AttributeTemplate	String	String Builder	Right(%\Element%,1);

- 5. Click Publish. Select Edit Mode: Create Only.
- 6. We can confirm in PSE that the tanks got the new attribute and that it is working correctly.



#### Edit an element template to change a property: add a naming pattern

When new elements are created from a template the default naming pattern uses the template name and adds a number. In the case of the template Tank with Foam Sensor we might want to change this to also simply use Tank. We have just created a new attribute BuildingID which we can use in the naming pattern to include the correct Building ID (A, B, etc.). Let us have a look at the syntax options for the naming pattern in PSE:

Tank with Foam Sensor								
General Attribute Templates Po		Ports	Analysis Templates Notification		on Rule Templates			
Name:	Tank with Fo	Tank with Foam Sensor						
Description:								
Base Template:	Tank		~	Type:		Element	~	
Categories:	Tanks		0	Default /	Attribute:	<none></none>	~	
Naming Pattern:	l						Þ	
	Allow Ext	ensions	🗌 Ba 🦻	%TIME:yy	yy-MM-d	d HH:mm:ss.fff%		
	Extended Pr	Extended Properties (0) Lo		%UTCTIME:yyyy-MM-dd HH:mm:ss.fff%				
Find:	Derived Tem	Derived Templates Element		%TEMPLATE%				
			Derived 9	@Attrib	ute%			

In our case we will use: Tank%@BuildingID%.

Note: This syntax will always try to create elements with a fixed name (e.g. TankC for child elements of Building C) unless an element with this name already exists. In our example we would have to assign the tank number manually. We could automate this by introducing another attribute which increments the number (for example a counter of the child elements of the Building).

- On a new spreadsheet we go to Library > Templates > Find Templates... and select Tank with Foam Sensor.
- In the Select Object Types and Column Headers window we reset the selection by clicking Clear All. Since this time we want to make changes to the property of the element template itself we open the category ElementTemplate, tick NamingPattern and click OK.

Select Object Types and Column Headers X								
Object Type: ElementTemplate								
Template: Tank with Foam Sensor <								
Object Types: 1 selected, Columns: 5 selected								
ElementTemplate     Type     Type     NewName     Description     BaseTemplate     AllowElementToExtend     BaseTemplateOnly     DefaultAttribute     ManingPattern     DefaultDuptPort     DefaultDuptPort     DefaultUndirectedPort     Categories     GreationDate								
<	>							
Clear All Select All More Attribute Columns								
Description:								
	OK Cancel Reset							

**3.** In the column NamingPattern we enter for Tank with Foam Sensor Tank%@BuildingID%.

	А	В	С	D	E
1	Selected(x)	Parent	Name	ObjectType	NamingPattern
2	x		Tank	ElementTemplate	
3	x		Tank with Foam Sensor	ElementTemplate	Tank%@BuildingID%

Note: If we want to apply this also to elements created from the Tank template we would have to set this for both templates.

- **4.** We select only the row for Tank with Foam Sensor, click the Publish button and choose Edit Only.
- 5. We can verify the change in PSE (click Refresh if PSE is still open):

Tank with Foam Sensor									
General	Attribut	e Templates	Ports	Analysis Template	s Notification Rule Templates				
Name:		Tank with Fo	am Sens	or					
Descriptio	on:								
Base Terr	nplate:	Tank	Tank						
Categorie	es:	Tanks							
Naming P	attern:	Tank%@BuildingID%							
		Allow Extensions Base Template Only							
		Extended Pro	operties	(0) Location He	alth <u>Security</u>				
Find:		Derived Tem		<u>Elements</u> Derived Elements	Referenced Parent Templates Referenced Child Templates				

We will test this new setting at the end of this section.

#### Edit an element template to change/set the default value of an attribute

We want to change the Tank template to provide HC1500 as default value for the attribute Product.

- 1. On a new spreadsheet, go to Library > Templates > Find Templates..., select Tank and confirm with OK.
- **2.** Click Clear All. We want to set the Default Value of an attribute, so we tick DefaultValue in the category AttributeTemplate and click OK.

🛄 Select Obj	ect Types and Column Headers	×					
Object Type: ElementTemplate							
Template:	Tank	$\sim$					
Object Types: 2 selected, Columns: 5 selected							
Attribu	ject7ype teTemplate MParent lidden lanualDataEntry iit infgurationItem xxduded ndexed faultUOM	^ <i>f</i>					
	-1R	~					
Clear All	Select All More Attribute Columns.						
Description:							
		^					
		$\vee$					
	OK Cancel Reset						

**3.** We enter HC1500 in the column AttributeDefaultValue for the attribute Product and deselect all other rows.

	А	В	С	D	E
1	Selected(x)	Parent	Name	ObjectType	AttributeDefaultValue
2			Tank	ElementTemplate	
З		Tank	BuildingID	AttributeTemplate	
4		Tank	Capacity	AttributeTemplate	0
5		Tank	Density	AttributeTemplate	0
6		Tank	Level	AttributeTemplate	0
7		Tank	Level   Hi	AttributeTemplate	80
8		Tank	Level   HiHi	AttributeTemplate	90
9		Tank	Level Level. 2HoursAgo	AttributeTemplate	0
10		Tank	Level   Level. 2Hours Average	AttributeTemplate	0
11		Tank	Level   Lo	AttributeTemplate	25
12		Tank	Level   LoLo	AttributeTemplate	15
13		Tank	Level   Maximum	AttributeTemplate	100
14		Tank	Level   Minimum	AttributeTemplate	0
15		Tank	Level   Target	AttributeTemplate	50
16		Tank	Mixer Status	AttributeTemplate	0
17		Tank	Mixing Speed	AttributeTemplate	0
18		Tank	Night Shift Operator	AttributeTemplate	Bob
19	х	Tank	Product	AttributeTemplate	
20		Tank	TankID	AttributeTemplate	0

- 4. Publish with Edit Mode: Edit Only.
- 5. We can verify in PSE that this action had no influence on the Product values of the elements. The only thing that was changed is the default value in the attribute template.

#### Build a new template

Build a template for the area elements. This template will get an attribute which gives the size of the area.

- To have an example for the correct format we can load the configuration of the Building template. We go to Library > Templates > Find Templates..., select the Building template and click OK.
- 2. For the column selection we clear all and then select the properties from the category AttributeTemplate which will be different from the default settings for the attribute Size. We will create an attribute of with no Data Reference type (<None>). For this we will only have to set the DefaultUOM and the Type (value type).

Select Object Types and Column Headers X							
Object Type: ElementTemplate							
Template: Building							
Object Types:	2 selected, Columns: 6 selected						
	wParent iidden IanualDataEntry iit ionfigurationItem xoduded ndexed FaultUOM	^ <i>f</i>					
Clear All	Select All More Attribute Columns	s					
Description:							
		^					
		$\sim$					
	OK Cancel Reset						

**3.** We get the following:

	А	В	С	D	E	F
1	Selected(x)	Parent	Name	ObjectType	AttributeDefaultUOM	AttributeType
2	x		Building	ElementTemplate		
3	x	Building	ArealD	AttributeTemplate		Int16

Here we replace Building with Area (you can use the Replace function of Excel) and AreaID with Size. In row 3, we set the AttributeDefaultUOM to m2 and the AttributeType to Single.

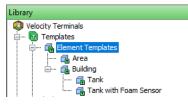
	А	В	С	D	E	F
1	Selected(x)	Parent	Name	ObjectType	AttributeDefaultUOM	AttributeType
2	x		Area	ElementTemplate		
3	x	Area	Size	AttributeTemplate	m2	Single

- **4.** Make sure both rows are selected, click the Publish button and choose Create Only as the Edit Mode.
- 5. We can verify again in PSE that the new element template was created together with the Size attribute template.

Library		Area						
🤤 Tank Farm	General	Attribute Templates	Ports	Analysis Templates	Notification Rule Templates			
🚊 🚾 Templates								
🗄 🔂 Element Templates	Filter							
🕀 🗝 🚰 Area								
🖮 🔂 Building		i 🔶 🧏 Name	Description			Default Value		
🗄 ···· 🔂 Tank		Townlates Aven						
🗄 🗝 🚮 Tank with Foam Sensor		Template: Area						
i Event Frame Templates i Model Templates		📇 Size				0 m2		
		L						

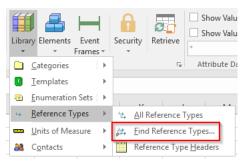
#### Build a new reference type

Remember that we wanted to establish an element hierarchy through parent-child relationships between the templates. When we look into the Library and arrange the element templates by template references, we see that the Area template is not yet placed into a relationship with the Building and Tank templates.



To achieve this, we build a new reference type Area-Building. The configuration of the reference type is the only thing needed to set this relationship. We do not need to make any configuration change on the template(s) involved.

 Again we load some existing configuration to have some guidance. We go to Library > Reference Types > Find Reference Types...



From the Reference Type Selection window we choose the Building-Tank reference type since we want to build the new type analogously.

2. Click Clear All and select from the ReferenceType category: ChildName, ParentName, Strength, AllowedParentElementTemplate, AllowedChildElementTemplate.

Select Object Types and Column Headers	×							
Object Type: ReferenceType	~							
Object Types: 1 selected, Columns: 9 selected								
Arrent     AllowedParentElementTemplate     AllowedChildElementTemplate     CreationDate     Arrent     ModifyDate     ModifyDate     SecurityString     V	<u>ታ</u>							
Clear All Select All More Attribute Columns								
Description: The columns in this group are required. They may not be deselected and neither the group nor the 'Selected(x)' column may be moved.								
and relater the group for the selected (y countring you noved.	~							
OK Cancel Reset								

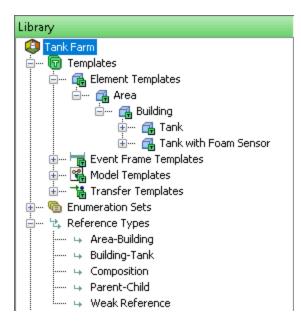
**3.** We get the following result:

		А	В	С	D	E	F	G	н	I
1		Selected(x)	Parent	Name	ObjectType	ChildName	ParentName	Strength	AllowedParentElementTemplate	AllowedChildElementTemplate
2	2	x		Building-Tank	ReferenceType	Tank	Building	Strong	Building	Tank
-										

We can use the Replace function of Excel (Home ribbon > Find & Select > Replace...) to replace Building with Area and <u>afterwards</u> Tank with Building.

	А	В	С	D	E	F	G	Н	I
1	Selected(x)	Parent	Name	ObjectType	ChildName	ParentName	Strength	AllowedParentElementTemplate	AllowedChildElementTemplate
2	x		Area-Building	ReferenceType	Building	Area	Strong	Area	Building
-									

- 4. Publish with Edit Mode: Create Only.
- 5. Checking in PSE we see that the new reference type was created. This might not be reflected in how the element templates are arranged. If this is the case you might need to close and reopen PSE.



#### Testing out what we have just built

Let's take a moment to test if the newly built template and reference type are working as expected. In PI System Explorer, we will create an Area element Area 44 together with a child element Building D. Building D should get one child element for now: TankD1.

1. Right click on Elements and select New Element. Select the Area template and click OK.

Choose Element Template	Х								
Parent: Velocity Terminals Add child element using the reference type:									
↔ Parent-Child									
Element Template:									
<none></none>									
📑 Area									
🔂 Building									
🔂 Tank									
🗃 Tank with Foam Sensor									
OK Cancel									

2. Rename the new area element by pressing F2 or changing the name on the General tab to Area 44. Navigate to the Attributes tab and assign a value of 15,000 square meters to the attribute Size.

3. Right click on Area 44 and select New > New Child Element. In the Choose Element Template window, we get the new reference type Area-Building as an option. Selecting it, we can only create child elements using the Building template, which is what we had intended. Click OK.

Choose Element Template	<
Parent: Area 44 Add child element using the reference type: → Area-Building ↔ Composition ↔ Parent-Child	
Element Template:	
OK Cancel	]

- 4. Rename the new building element to Building D.
- 5. Create a child element for Building D by right clicking and selecting New > New Child Element. Select the reference type Building-Tank which we defined earlier. Now, we can only choose between the two tank templates. We select Tank with Foam Sensor and click OK.

Choose E	lement Template		×					
	Building D element using the refe ding-Tank	erence type:						
→ Cor	nposition ent-Child							
🔂 Tanl	Element Template:							
		OK	Cancel					

- **6.** The newly created tank element automatically got the name TankD following the naming pattern we have set. Rename to set to TankD1. Check in the changes.
- 7. Check the attributes of TankD1. Product shows a value of HC1500 which we have set as the default value and the newly created attribute BuildingID picked up the last character from the parent element and is showing "D"

## 6.3. Resetting Attributes to Template in Bulk



Before reading this section, please refer to the following course YouTube video: OSIsoft Learning: Resetting Attributes to Template in Bulk

#### Database: Velocity Terminals – To RESET

In this video we are going to revert attributes back to their template using PI Builder. In PSE there is an option to Create and Update Data References for all Elements. We can reset single attributes back to template by right clicking on an attribute and resetting that to template. In PI Builder we can accomplish the bulk reset.

**Note:** In PSE it is also possible to perform multi-select editing if you know how to approach it: To select multiple objects at once to edit, they need to be displayed together in the Viewer pane. For attributes this can be achieved via Search > Attribute Search. In the below example, we searched for the attribute Product in the Tank Farm database. We can then reset multiple attributes to template by selecting them (using Strg or Shift key) and using the right click menu on one of the selected items.

ilter					Q
	Name		Value	Path	0
T	Product	////	AQ4500	Building C\TankC3 Product	/////
	Product		HC1500	Building C\TankC2 Product	
	💷 Product 📔		Reset to Template	Nilding C\TankC1 Product	
T	I Product	2 61.	Categorize	ding B\TankB2 Product	
T	Product			ilding B\TankB1 Product	
T	E Product	24	Trend	ilding A\TankA2 Product	////
T	Product		Add to Trend Refresh	iilding A\TankA1 Product	
			Сору		
			Copy Cell		
			Copy Path		
	1		Properties		

#### **Exercise (Use the Velocity Terminals To RESET database):**

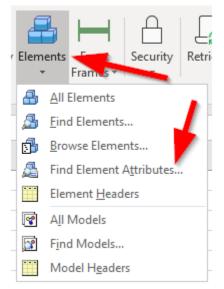
This section will be an exercise where you notice that many of your attributes have been altered away from their template. Your goal is to revert them back to template by using PI Builder. Notice that many of the attributes under Tank01 for Montreal are showing errors since the configuration strings have deviated away from the template definition.

Fank Gen		ments Attributes Ports Analyses Notification Rules Version			
Filte	er				
	<b>∕</b> :∎♦ <b></b>	Name 4	Value		
Ξ	Categor	y: <none></none>			
	/ 0	E Capacity	20000 US gal		
		🗉 Density	0 kg/L		
Ħ	ø 🔒 🗉	🎺 Level	PI Point not found '\\PISRV01\Ta'.		
	0	I Mass	Unknown Attribute 'Den' in configurati		
		III Night Shift Operator	Bob		
	0 🔒 🖬 💠	notification Email Address	PI Point not found '\\PISRV01\Tank01		
	ø 🔒 🗉	4 Pressure	PI Point not found '\\PISRV01\Montre		
		E Product	HC1500		
	• A	E PVCode	PV		
	0	I Tank Level Information	Input string was not in a correct format		
		I Tank Name	Tank01		
ŧ	ø 🔒 🔳	Temperature	PI Point not found '\\PISRV01\15Tank'.		
	0	U Volume	At least one formula is needed.		

\*\*Note the Product Value of HC1500.

#### Step-by-step:

- 1. Open Excel and load the PI Builder Add In.
- 2. Be sure to set the database to Velocity Terminals To RESET.
- 3. Select "Elements" and "Find Element Attributes".

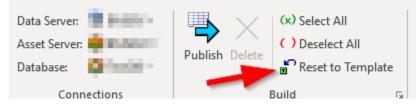


3. Enter any search criteria you need so that you search for the relevant attributes. If you would like to load all attributes leave everything blank and select "OK". For this case, we'll use the Tank01 element under Montreal as our search root and then click search:

Attri	bute Search				- ×				
Server:		2	💖 PISRV01 🗸 🚥 Connectri						
	ibase:		🔕 Velocity Terminals - To RESET 📃 🗸 🚥						
Whe	Attribute name:		*		-				
	Attribute description:								
	Attribute catego	ory:	<any></any>						
	Attribute value t	type:	<anything></anything>	<anything> V</anything>					
	Maximum results	s:		1000	ז				
	Element Criteria								
	Search Root:	Search Root: Velocity Terminals' Locations Montreal		· · · ·	Search Sub-Elements				
	Name:								
6	Description:								
10	Category:	<ai></ai>		×	Search 🔎				
	Template:	<al></al>		v	Gancel Search				
	Type:	Any		v					
Se	arch results:	Th	e search found 22 Attributes matching t	he search criteria.					

4. Ensure that "Value" and "Data Reference" under Attribute are selected in the next window, then select "OK".

5. Within the Excel workbook press Control + A to select all items in the workbook, then select the button "Reset to Template".



- 6. Now select "Publish"
- 7. In the Publish Options box make sure that the Edit Mode is set to "Edit Only".
- Navigate back to PI System Explorer → Elements → Velocity Terminals TO Reset → Locations → Montreal → Tank01 and verify the attributes have been reset. A Refresh may be necessary.
- 9. Note that the Density and Mass values have not updated. In resetting the template, we reset the Product to NULL. Enter/Select HC1500 for the Product and refresh the screen. The Density and the Mass should update.

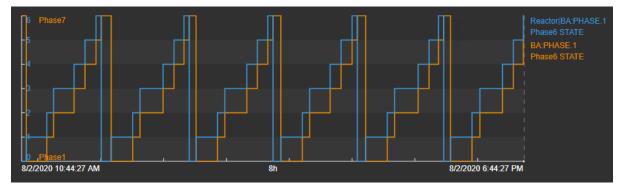
Note: Use caution when using reset to template. This example is one situation to be aware of when resetting to template. As there was no Default value in the product field, it is apparent the field needs to be updated. If we had a default value, how long would it have taken to determine a problem?

## 6.4. Working with Digital Tags in AF

#### Database: Tank Farm

When creating attributes which are referring to PI Points with a Point Type digital, the Value Type can be set to digital to use the digital state set defined on the Data Archive to display the string values. However, this method has the disadvantage that in contrast to the order of digital states we have on the Data Archive, AF would not be aware of an order and the string values might be displayed differently than expected when trending the attribute.

Let's look at an example. In the trend below, the orange line is from the Data Archive tag directly, while the blue line is the representation of the same tag via an AF attribute with Value Type String.



The difference in the two trends is coming from a different association of the states ("Phases" in this example) with numbers. While for the tag Phase1 is associated with 0 on the Data Archive, the corresponding string arbitrarily gets associated with 1 in AF.

To avoid this issue the recommended method is to create an Enumeration Set in AF from the Digital State Set. We discuss three ways to do this, first we will look into two methods introduced in version 2018 SP2. After this we will also show in a video how this can be achieved in a simple way also on older systems via the PI Builder.

Note that all methods discussed below work on a per database basis. If State Sets are used in multiple AF databases the according Enumeration Sets would need to be created for each separately.

#### Create an Enumeration Set for a new attribute

For this example, we create a new element Reactor under the root level and choose <None> for Element Template. We use the Palette to quickly build attributes:

1. The Palette can be opened via the Menu or through key shortcuts. We will use the Tag Search, so the key shortcut is Ctrl+Shift+8.

	Viev	v Go T	Tools Hel	р				
4	~	Toolbar			Ð	💐 Check In 🦻 🗸	🔹 Refresh	词 N
1	~	✓ Status Bar		Reactor				
		Show Tren	d			General Child Elements	Attributes	Ports
		Palette		•		Show Palette	Ctrl+Shift+P	
1	\$	Refresh	F5		Ð	Element Templates	Ctrl+Shift+1	
1	G	Back	Alt+Left		:	Data References	Ctrl+Shift+3	
	Ð	Forward	Alt+Right			Contacts	Ctrl+Shift+5	
		Language	Settings		$\mathbf{P}$	Tag Search	Ctrl+Shift+8	

2. We want to create an attribute for a digital tag, so open up the menu by using the double arrows and select Digital as the Data Type. In this example, we will use the tag BA:PHASE.1.

🔎 Tag Search	🔎 Tag Search 🛛 🗸 🗸					
Server(s): PIS	RV01		•			
DataType:Digita		× 🔻 🛛	Search			
Name:			×			
Point Source:			×			
Data Type:	Digital	~	×			
Point Class:	*	~	×			
🖧 Add <u>C</u> riteria 🔻						
Name		Description	Point Source	٢		
📕 🍼 BA:ACTIVE	.1	Batch Active Reactor 1	L	٢		
A:PHASE.1		Phase Reactor 1	L	C		
CDM158		Light Naphtha End Point	R	C		
OSIsoftHVACSim.Y		Equipment State - Blowe	R	C		
Ø OSIsoftHV		Equipment State - Chiller	R	0		
OSISOFTHV	ACSim.Y	Equipment State - Heate Equipment State - Plaus	R	C r		

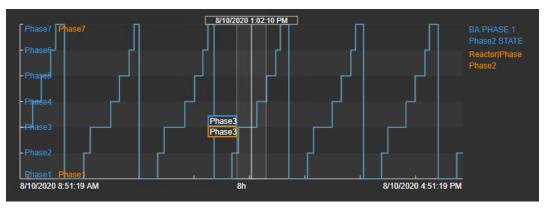
- **3.** To create an attribute for the tag BA:PHASE.1 drag the tag name from the Tag Search Palette into the attributes pane of the Reactor element.
- **4.** Since we do not have an Enumeration set matching the digital state set used for this tag a dialog box appears to create one. We choose Yes to create an Enumeration Set named "Phases" (same name as the Digital State Set).

EnumerationSet not found	×
An AFEnumerationSet matching the digital state set for PI Point "BA:PHASE.1" was not found. Would you like to create one? It will be named "Phases".	
Yes No	

5. The new set should get automatically selected as the Value Type of the attribute.

Name:	BA:PHASE.1			
Description:	Phase Reactor 1			
Properties:	<none></none>			~
Categories:				
Default UOM:	<none></none>			~
Value Type:	Phases			~
Value:	Basic Types	►		
Display Digits:	Array Types	•		
Data Reference:	Enumeration Sets	•	MaterialID	~
	Objects	•	Phases	
		etung	System	
\\PISRV01\BA:PHAS	SE.1			-

- **6.** The attribute can also be renamed with a friendlier name. Select the attribute and press F2 to rename or click in the name field and change BA:PHASE.1 to Phase.
- 7. We can verify that this solved our trending issue by creating a trend in PI Vision. The trends of both PI tag and AF attribute are now aligned.



#### Create Enumeration Sets for Digital State Sets on the Data Archive Server in bulk

Instead of following the above method to create Enumeration Sets from the Digital State Sets as needed, we can also do this globally for all sets or for some selected sets.

1. Open the Servers window by selecting File > Connections. Right click the Data Server and select Properties or mark the Data Server and click on Properties above.

Filter									
Name		Host	User		Buffer Status	Description	Туре	Default Databa	æ
PISRVI V PISRVI	*** >>	Add Data Se Add Asset S Disconnect Refresh	Server	tudent01 (piadmins   PIWorld) tudent01 (Administrators   PI Users   World)	Not Running		Data Server Asset Server	Demo	
Buffer sta	×	Remove							Clos
Buffer sta		Properties	1						_

2. In the PI Data Archive Properties window open the State Sets tab. Here we can review the Digital State Sets on the Data Archive Server and if they are matched in the current AF database.

For example, the set "Phases" which we used in the previous example now exists as a State Set and Enumeration Set and we get a message displayed that both are identical:

	Archive Properties				×		
General St	tate Sets						
Name							
🖻 BatchA	ct						
🖻 Interfa	ceStatus						
C Modes							
la Phases							
la rialarm33							
nialarm							
isqcala 💼							
C SYSTEM	4						
<							
The selected	d StateSet and Enumeration	Set are identical.					
The selected	d StateSet and Enumeration Digital State Name	Set are identical. Enumeration Value	e Name	2			
			e Name	2			
Value	Digital State Name	Enumeration Value	e Name	2			
Value 0	Digital State Name Phase1	Enumeration Value Phase 1	e Name	2			
Value 0 1	Digital State Name Phase1 Phase2	Enumeration Value Phase 1 Phase 2	e Name	2			
Value 0 1 2	Digital State Name Phase1 Phase2 Phase3	Enumeration Value Phase 1 Phase 2 Phase 3	e Name	2			
Value 0 1 2 3 4 5	Digital State Name Phase 1 Phase 2 Phase 3 Phase 4 Phase 5 Phase 6	Enumeration Value Phase1 Phase2 Phase3 Phase4 Phase5 Phase6	e Name	2			
Value 0 1 2 3 4 5 6	Digital State Name Phase 1 Phase 2 Phase 3 Phase 4 Phase 5 Phase 6 Phase 7	Enumeration Value Phase 1 Phase 2 Phase 3 Phase 4 Phase 5 Phase 6 Phase 7	e Name	2			
Value 0 1 2 3 4 5	Digital State Name Phase 1 Phase 2 Phase 3 Phase 4 Phase 5 Phase 6	Enumeration Value Phase1 Phase2 Phase3 Phase4 Phase5 Phase6	e Name	2			
Value 0 1 2 3 4 5 6	Digital State Name Phase 1 Phase 2 Phase 3 Phase 4 Phase 5 Phase 6 Phase 7	Enumeration Value Phase 1 Phase 2 Phase 3 Phase 4 Phase 5 Phase 6 Phase 7	≥ Name	2			
Value 0 1 2 3 4 5 6	Digital State Name Phase 1 Phase 2 Phase 3 Phase 4 Phase 5 Phase 6 Phase 7 Phase 8	Enumeration Value Phase 1 Phase 2 Phase 3 Phase 4 Phase 5 Phase 6 Phase 7		2			

If we look at a set which has no correspondence in the current database yet, e.g. Modes, we see the following:

eneral State Sets		1
ame	Enumeration Set	Conflicts
🖻 BatchAct		EnumerationSet 'BatchAct' not found.
🖻 InterfaceStatus		EnumerationSet 'InterfaceStatus' not found.
MixerStates	MixerStates	None
Modes		EnumerationSet 'Modes' not found.
Phases	Phases	None
🖻 pialarm33		EnumerationSet 'pialarm33' not found.
ialarmcontrol		EnumerationSet 'pialarmcontrol' not found.
isqcalarm		EnumerationSet 'pisqcalarm' not found.
C SYSTEM	System	Reserved
matching EnumerationSet	t for the StateSet 'Modes' doe:	s not exist in the AFDatabase 'Tank Farm'
	: for the StateSet 'Modes' doe: Digital State Name	s not exist in the AFDatabase 'Tank Farm' Enumeration Value Name
/alue	Digital State Name	
/alue 0	Digital State Name <b>Manual</b>	
/alue 0 1	Digital State Name Manual Auto	
/alue 0 1 2	Digital State Name Manual Auto Cascade	
Value 0 1 2 3	Digital State Name Manual Auto Cascade Program	

**3.** We can right click on the set name and click Create Enumeration Set from State Set... to create a match for the database.

🚰 PI Data Archive	Properties	— 🗆 X
General State Sets		
Name Carl BatchAct Carl InterfaceStatus	Enumeration Set	Conflicts EnumerationSet 'BatchAct' not found. EnumerationSet 'InterfaceStatus' not found.
Canal MixerStates	MixerStates	None
G Modes G Phases G pialarm33 G pialarmcor G piacalarm G SYSTEM	Create Enumeration Set from State Refresh Select All System	FormerationSet 'Modes' not found. Set nSet 'pialarm33' not found. nSet 'pialarmcontrol' not found. nSet 'pisqcalarm' not found. Reserved
A matching Enumerati	onSet for the StateSet 'Modes' does no Digital State Name Manual Auto	ot exist in the AFDatabase 'Tank Farm' Enumeration Value Name
1 2 3 4	Auto Cascade Program Prog-Auto	
	OK Cancel	Apply

Note: At this step, multiple or all State Sets can be selected to create Enumeration Sets in bulk.

**4.** Click Yes on the dialog window to confirm this action. The PI Data Archive Properties window now shows that the Enumeration Set Modes has been created.

🚰 PI Data Archive Prope	rties	– 🗆 X			
General State Sets					
Name	Enumeration Set	Conflicts			
💼 BatchAct		EnumerationSet 'BatchAct' not found.			
💼 InterfaceStatus		EnumerationSet 'InterfaceStatus' not found.			
Calification MixerStates	MixerStates	None			
Contraction Modes	Modes	None			
💼 Phases	Phases	None			
nialarm33 💼		EnumerationSet 'pialarm33' not found.			
a pialarmcontrol		EnumerationSet 'pialarmcontrol' not found.			
💼 pisqcalarm		EnumerationSet 'pisqcalarm' not found.			
C SYSTEM	System	Reserved			
The selected StateSet and E	EnumerationSet are identical.				
Value	Digital State Name	Enumeration Value Name			
0	Manual	Manual			
1	Auto	Auto			
2	Cascade	Cascade			
3	Program	Program			
4	Prog-Auto	Prog-Auto			
	OK Cano	cel Apply			

For full information refer to "*Review digital state sets on a PI Data Archive*" in the OSIsoft Documentation.

## 6.5. Moving Digital States to Enumeration Sets

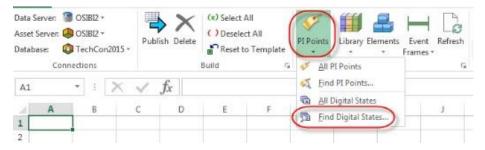


Before reading this section, please refer to the following course YouTube video: OSIsoft Learning: Moving Digital States to Enumeration Sets

#### Database: Velocity Terminals

Create Enumeration Sets in PI AF from the Digital States you have created in the PI Archive. **Step by step:** 

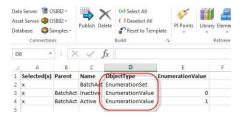
a. Create a new workbook. In the ribbon click the down arrow under the **PI Points** and select **Find Digital States**.



b. Select **BatchAct** and click the **OK** button.



c. Under the **ObjectType** property change the **DigitalStateSet** to **EnumerationSet**, and **DigitalState** to **EnumerationValue**.



d. Click the <sup>1</sup>/<sub>2</sub> in the ribbon, select Create Only, then click the **OK** button on the next dialog, and the **Close** button on the last dialog that pops up.

e. Open the **PI System Explorer** if it is not already open, and press the **Ctrl+3** key combination to navigate to the **Library** view. Expand the **Enumeration Sets** in the **Browser** pane and you will see the **BatchAct** Enumeration Set and the Enumeration values. If BatchAct does not display, perform a refresh.

ibrary	BatchAct	
TechCon2015     Tenglates     G. G. Beennt Tenglates     G G. Beennt Tenglates     G G. Beennt Tenglates     G G. Model Templates     G G. Model Templates     G G. Model Templates     G G. Model Templates	General   Name:  BetchAct Description:    Hexadecimal Security	
Bundard Connection Sets       Bundard Sets       Beneric Categories       Beneric Categories       Beneric Categories       Beneric Categories	value 0 1	/ Remo

### 6.6. Expand and Edit the Unit of Measure Database

#### Database: Tank Farm

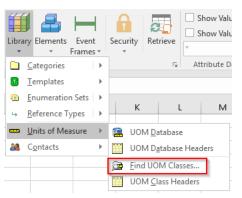
The PR team wants to communicate the size of some areas within the plant. For a press release they want to give the size in soccer fields for the European journals and in football fields for the American journals. To have a convenient way to calculate the numbers automatically, we will add the two field sizes as new units of measure.

For the purpose of this exercise, we will use the following size definitions:

Standard Soccer field: 7,140 square meters

American Football field: 57,300 square feet

 We will first load the relevant classes and units by going to Library > Units of Measure > Find UOM Classes...



2. We select Area from the Unit-of-Measure Class Selection window and click OK.

Unit-of-Mea	sure Class Selection				Х
Type:	Unit-of-Measure Class				
Filter				Q	•
Class					^
Acceler	ation				
Acidity					
Angular					
Aparen 🔤	t Power				
🔤 Area					
Comput					
Conduc					
Conduc					
Corrosi					
Currenc	cy				¥
			ОК	Cancel	

**3.** In the Select Object Types and Column Headers window, click Clear All to reduce the selection to the required columns. Since we want to introduce new units we will need the columns of the category UOM. We select the whole category UOM and click OK.

Select Object Types and Column Headers	Х
Object Type: UOMClass	~
Object Types: 2 selected, Columns: 11 selected	
UniqueID    Description    CanonicalUOM	۶ ۲
Clear All Select All More Attribute Columns	
Description: The columns in this group are required. They may not be deselected	~
and neither the group nor the 'Selected(x)' column may be moved.	~
OK Cancel Reset	

**4.** We get the classes Area and Length (as the base class) with all their units loaded into the spreadsheet.

1	А	В	С	D	E	F	G	н	1	J	К
1	Selected(x)	Parent	Name	ObjectType	Abbreviation	Origin	RefUOM	RefFactor	RefOffset	RefFormulaFrom	RefFormulaTo
2	х		Length	UOMClass							
3	x	Length	meter	UOM	m	SystemDefined		1	0		
4	x	Length	inch	UOM	in	SystemDefined	meter	0.0254	0		
5	x	Length	U	UOM	U	UserDefined	inch	1.75	0		
6	x	Length	mils	UOM	mils	UserDefined	inch	0.001	0		
7	x	Length	mil	UOM	mil	UserDefined	inch	0.001	0		
В	x	Length	foot	UOM	ft	SystemDefined	inch	12	0		
9	x	Length	furlong	UOM	fl	UserDefined	foot	660	0		
0	x	Length	F	UOM	Feet	UserDefined	meter	0	0		
1	x	Length	DM	UOM	dm	UserDefined	meter	0	0		
2	x	Length	Ales	UOM	afeet	UserDefined	foot	1.1	0		
3	x	Length	32nd of an inch	UOM	32nd in.	UserDefined	inch	0.03125	0		
4	х	Length	sixteenth of an inch	UOM	sxi	SystemDefined	inch	0.0625	0		
5	х	Length	32nd inch	UOM	32nd in	UserDefined	sixteenth of an inch	0.5	0		
6	x	Length	μM	UOM	μm	UserDefined	meter	0	0		
7	x	Length	centimeter	UOM	cm	SystemDefined	meter	0.01	0		
8	x	Length	International nautical mile	UOM	nmi	SystemDefined	meter	1852	0		
9	х	Length	kilometer	UOM	km	SystemDefined	meter	1000	0		
0	х	Length	millimeter	UOM	mm	SystemDefined	meter	0.001	0		
1	x	Length	mile	UOM	mi	SystemDefined	inch	63360	0		
2	x	Length	yard	UOM	yd	SystemDefined	inch	36	0		
3	x		Area	UOMClass							
4	х	Area	square meter	UOM	m2	SystemDefined		1	0		
5	х	Area	square inch	UOM	in2	SystemDefined	square meter	0.00064516	0		
6	x	Area	square foot	UOM	ft2	SystemDefined	square inch	144	0		
7	x	Area	acre	UOM	acre	SystemDefined	square foot	43560	0		
8	x	Area	square mile	UOM	mi2	SystemDefined	square foot	27878400	0		
9	x	Area	square yard	UOM	yd2	SystemDefined	square foot	9	0		
0	x	Area	hectare	UOM	ha	SystemDefined	square meter	10000	0		
1	x	Area	square centimeter	UOM	cm2	SystemDefined	square meter	0.0001	0		
2	x	Area	square kilometer	UOM	km2	SystemDefined	square meter	1000000	0		
3	x	Area	square millimeter	UOM	mm2	SystemDefined	square meter	0.000001	0		

5. We add the definition of the two new units as follows (lines 2-33 as shown above have been deselected and are hidden in this screenshot for presentation purposes):

	А	В	с	D	E	F	G	н	1	J	К
1	Selected(x)	Parent	Name	ObjectType	Abbreviation	Origin	RefUOM	RefFactor	RefOffset	RefFormulaFrom	RefFormulaTo
34	х	Area	soccer field	UOM	soccer field		square meter	7140	0		
35	x	Area	football field	UOM	football field		square foot	57300	0		

Leave the column Origin blank as it will be automatically set to UserDefined.

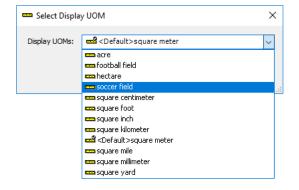
- 6. Publish with Edit Mode: Create Only.
- **7.** We can check the result also in PSE.

Area					
Filter					
Name	Abbreviation	Class	Origin	Canonical	Reference
acre	acre	Area	System Defined	4046.8564224 m2	43560 ft2
📟 football field	football field	Area	User Defined	5323.344192 m2	57300 ft2
	ha	Area	System Defined	10000 m2	10000 m2
soccer field	soccer field	Area	User Defined	7140 m2	7140 m2
square centimeter	cm2	Area	System Defined	0.0001 m2	0.0001 m2
📟 square foot	ft2	Area	System Defined	0.09290304 m2	144 in2
📟 square inch	in2	Area	System Defined	0.00064516 m2	0.00064516 m2
square kilometer	km2	Area	System Defined	1000000 m2	1000000 m2
🛁 square meter	m2	Area	System Defined	1 m2	
square mile	mi2	Area	System Defined	2589988.110336 m2	27878400 ft2
square millimeter	mm2	Area	System Defined	1E-06 m2	1E-06 m2
square yard	yd2	Area	System Defined	0.83612736 m2	9 ft2

**8.** The new units can be used in any client tool. As a test we can see if the conversion works for Area 44. Right click on the Size attribute and select Change Display UOM.

Area 44						
General	Child Elements	Attributes	Ports	Analyses	Not	ification Rules
Filter	1 = 1				_	1
	Name		4	Value		Data Refere
	📃 Size	<b>F</b>		15000 m2 to Templa	te	None>
				Analysis		
		<u>A</u>		gorize		
			Limit			
				asts		
				tion of Eler		
			Healt	h of Eleme	nt	
			Time	Series Data	a	
		$\sim$	Trend			
				to Trend		
				ge Display		
			Refre	Excluded A	ttrib	utes
		<b>\$</b>		sn		
			Сору			
		1990		Path		
			Paste	1		
		1	Prop	erties		

9. Choose soccer field and click OK.



**10.** We can see the conversion resulted in a value of roughly 2 soccer fields.

Area 44					
General	Child Elements	Attributes	Ports	Analyses	Notification
Filter					
/ : I	Name		~	Value	
	🔳 Size			2.1008 soco	er field

Analogously, we can change the display unit to football fields.

# 6.7. Retrieve Attribute Values

#### Database: Tank Farm

Instead of going to PSE (or another client tool) to check the values of an attribute as we usually do, we can also get the values displayed in a spreadsheet with PI Builder.

- 1. Go to Elements > Find Elements... and search for all elements from the Tank template (which include the derived template Tank with Foam Sensor). Click OK.
- **2.** Click Clear All and expand the Attribute Columns to select a couple of attributes: Capacity, Density, Product and BuildingID. Click OK.

	A	В	С	D	E	F	G	н
1	Selected(x)	Parent	Name	ObjectType	Capacity	Density	Product	BuildingID
2	х	Building A	TankA1	Element	20000	=Table Lookup.SELECT Density FROM [Material Properties] WHERE MaterialD = @Product	HC1500	=String Builder. Right(% \Element%, 1);
3	х	Building A	TankA2	Element	30000	=Table Lookup.SELECT Density FROM [Material Properties] WHERE MaterialD = @Product	HC1500	=String Builder. Right(% \Element%, 1);
4	х	Building B	TankB1	Element	35000	=Table Lookup.SELECT Density FROM [Material Properties] WHERE MaterialD = @Product	AQ4500	=String Builder.Right(%\Element%,1);
5	х	Building B	TankB2	Element	40000	=Table Lookup.SELECT Density FROM [Material Properties] WHERE MaterialD = @Product	HC1500	=String Builder.Right(%\Element%,1);
6	х	Building C	TankC1	Element	15000	=Table Lookup.SELECT Density FROM [Material Properties] WHERE MaterialD = @Product	WX1200 New Recipe	=String Builder.Right(%\Element%,1);
7	x	Building C	TankC2	Element	25000	=Table Lookup.SELECT Density FROM [Material Properties] WHERE MaterialD = @Product	HC1500	=String Builder.Right(%\Element%,1);
8	х	Building C	TankC3	Element	0	=Table Lookup.SELECT Density FROM [Material Properties] WHERE MaterialD = @Product	HC1500	=String Builder.Right(%\Element%,1);
9	х	Area 44\Building D	TankD1	Element	0	=Table Lookup.SELECT Density FROM [Material Properties] WHERE MaterialD = @Product	HC1500	=String Builder.Right(%\Element%,1);

For Capacity and Product we see the values since those attributes have the data reference set to <None>.

**3.** For attributes with a data reference, PI Builder displays the configuration string and not the current value. To show the values instead of the configuration, we can tick Show Values in Columns (for attributes listed in rows there is the Show Values in Rows option to populate the column AttributeValue).

Data Server: 🏾 🍟 PISRV01 +	🕒 🗙 (x) Select All	💉 🌐 🖴 🛏 🔒 📰	Show Values in Rows	🛄 Headers 🕕 About
Asset Server: 👃 PISRV01 -	Publish Delete ( ) Deselect All	PI Points Library Elements Event Security Retrieve		📃 Settings 🛛 🕜 Help
Database: 🚺 Tank Farm 🕶	🔓 Reset to Template	• • • Frames • •	* •	🐀 Errors 🛛 🙂 Feedback
Connections	Build 5	Retrieve	Attribute Data References	Resources

**4.** Click the Retrieve button. This will give us the actual values of the attributes at the current time.

	A	В	С	D	E	F	G	Н
1	Selected(x)	Parent	Name	ObjectType	Capacity	Density	Product	BuildingID
2	х	BuildingA	TankA1	Element	20000	3422	HC1500	А
3	х	BuildingA	TankA2	Element	30000	3422	HC1500	А
4	х	Building B	TankB1	Element	35000	2100	AQ4500	В
5	x	Building B	TankB2	Element	40000	3422	HC1500	В
6	х	Building C	TankC1	Element	15000	9213	WX1200 New Recipe	С
7	х	Building C	TankC2	Element	25000	3422	HC1500	С
8	х	Building C	TankC3	Element	0	3422	HC1500	С
9	х	Area 44\Building D	TankD1	Element	0	3422	HC1500	D

5. Different time contexts can be chosen via the field and associated drop-down list below.

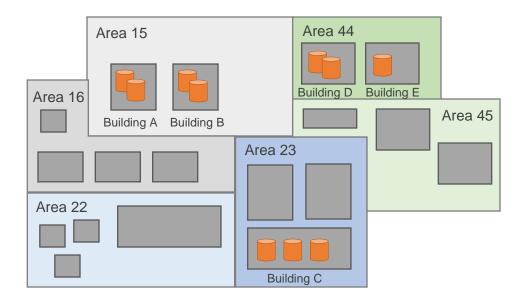
Show Values in Rows
✓ Show Values in Columns
*
Values at Yesterday Midnight
Values at Today Midnight
Values at Current Time
Select Date and Time

For full information refer to "*Show values from data references*" in the OSIsoft Documentation.

# 6.8. Create New Elements

Database: Tank Farm

We will now proceed to create the remaining elements as shown in the plant map below.



In the final version, we want to have all buildings grouped under area elements. We will not do this yet for the buildings which have already been created at the root level. In the next section we will see how to move elements in the hierarchy and will then finalize the configuration. For now, we will create the remaining elements and apply the correct hierarchy wherever this is possible without moving existing elements. Also, we need to consider where attribute values have to be set when creating the elements.

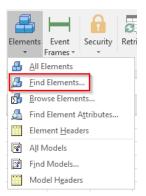
We need to create:

- TankD2 (Parent: Building D; template: Tank with Foam Sensor)

- Building E (Parent: Area 44; template: Building)
- TankE1 (Parent: Building E; template: Tank)
- Area 15 (template: Area; Size: 32,000 square meters)
- Area 23 (template: Area; Size: 24,000 square meters)

We will first create the remaining building and tank elements.

 To see in PI Builder what we already have and the structure we need to create for the new elements we first load the existing elements into a spreadsheet. Open Elements > Find Elements...



 Clear all search criteria to find all elements in the database. Click OK. In the Select Object Types and Column Headers, click Clear All. Since the new elements should be generated from templates, we need to add the Template column from the Element category.

🧾 Select Obje	ect Types and Column Headers	×
Object Type:	Element	
Template:	Area	$\sim$
Object Types:	1 selected, Columns: 5 selected	
	wName iqueID scription faultAttribute faultInputPort faultUuputPort faultUuputPort tegories sationDate difyDate curityString wParent ferenceType	*
Clear All	Select All More Attribute Columns	
Description:		
		^
		~
[	OK Cancel Reset	

**3.** We get the following loaded into the spreadsheet:

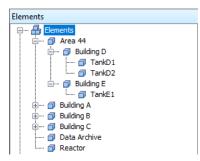
	А	В	С	D	E
1	Selected(x)	Parent	Name	ObjectType	Template
2	х		Area 44	Element	Area
З	x		Building A	Element	Building
4	x		Building B	Element	Building
5	x		Building C	Element	Building
6	x	Area 44	Building D	Element	Building
7	x		Data Archive	Element	
8	x		Reactor	Element	
9	x	Building A	TankA1	Element	Tank
10	x	Building A	TankA2	Element	Tank
11	x	Building B	TankB1	Element	Tank
12	x	Building B	TankB2	Element	Tank
13	x	Building C	TankC1	Element	Tank with Foam Sensor
14	x	Building C	TankC2	Element	Tank with Foam Sensor
15	x	Building C	TankC3	Element	Tank with Foam Sensor
16	x	Area 44\Building D	TankD1	Element	Tank with Foam Sensor

We can follow the example of Building D to build Building E as a child of Area 44 (row 6) and TankD1 to build TankD2 and TankE2 (row 16). Note that all other tanks and buildings still need to be moved under area elements which we will build soon and are therefore not a good syntax example in the sense of our desired final configuration.

**4.** We copy row 6 once and row 16 twice and make modifications to get what we show in rows 17 to 19:

	Α	В	С	D	E
1	Selected(x)	Parent	Name	ObjectType	Template
2			Area 44	Element	Area
3			Building A	Element	Building
4			Building B	Element	Building
5			Building C	Element	Building
6		Area 44	Building D	Element	Building
7			Data Archive	Element	
8			Reactor	Element	
9		Building A	TankA1	Element	Tank
10		Building A	TankA2	Element	Tank
11		Building B	TankB1	Element	Tank
12		Building B	TankB2	Element	Tank
13		Building C	TankC1	Element	Tank with Foam Sensor
14		Building C	TankC2	Element	Tank with Foam Sensor
15		Building C	TankC3	Element	Tank with Foam Sensor
16		Area 44\Building D	TankD1	Element	Tank with Foam Sensor
17	x	Area 44	Building E	Element	Building
18	x	Area 44\Building D	TankD2	Element	Tank with Foam Sensor
19	x	Area 44\Building E	TankE1	Element	Tank
20					

- 5. We select only those three rows and click Publish. We choose Edit Mode: Create Only and tick Create or update PI points to create the OPC tags right away.
- 6. In PSE, we now see the following hierarchy:



Next, we need to create the remaining area elements.

7. In a new spreadsheet, we go on Elements > Browse Elements..., select Area 44 in the Element Browser and click OK. We can use the previous column selection as a starting point (Required Columns and Template from the Element category). Since we want to specify the Size attribute for the elements we want to create, we additionally select the column Size from the Attribute Columns category. Click OK and Close.

🧾 Select Obje	ect Types and Column Headers		×
Object Type:	Element		
Template:	Area		$\sim$
Object Types:	1 selected, Columns: 6 selected		
Attribut	e Columns m Template 'Area'	^	<b>ب</b>
	n Template Area Size er Attributes AreaID Product BuildingID Capacity Density Foam Level Level Ad hoc display Level Hii Level Hii Level Hii Level Hii Level.2HoursAqo		¢
	Level Level. 2 HoursAverage	¥	
Clear All	Select All More Attribute Columns		
Description:			
			^
			~
[	OK Cancel Reset		

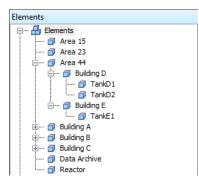
8. We get the following:

	Α	В	С	D	Е	F
1	Selected(x)	Parent	Name	ObjectType	Size	Template
2	x		Area 44	Element	15000	Area
-						

**9.** We copy row 2 twice, deselect row 2 and make modifications to rows 3 and 4 to arrive at the following:

	А	В	С	D	Е	F
1	Selected(x)	Parent	Name	ObjectType	Size	Template
2			Area 44	Element	15000	Area
3	x		Area 15	Element	32000	Area
4	x		Area 23	Element	24000	Area
-						

- **10.** Click Publish with Edit Mode: Create Only and click OK.
- **11.** Checking the hierarchy in PSE (Refresh first), we should now see the following:



In the next section we will arrange the elements into the final configuration.

### 6.9. Move Elements within the Hierarchy

#### Database: Tank Farm

As you build an AF hierarchy you may need to move elements around. This can be done in PSE or in PI Builder, but we will only show the steps for PI Builder below. You might remember from your basics AF training that elements can be moved in PSE by dragging the element while pressing the Shift key. Later in this course you will find a refresher on this topic.

To arrive at our desired hierarchy we need to move Buildings A and B under Area 15 and Building C under Area 23. In PI Builder we will achieve this by assigning new parent elements.

1. Go to Elements > Find Elements..., select the Building template in the Element Search and click Search to find all building elements. Click OK.

Eler	ment	Search						Х
				Conne	ction Options (\\PISRV01\Velocity	Terminals)		۲
Tem	plate:	Building					× •	Search
					Criteria			۲
Nam	e:					×		
Elem	ent S	earch Root:				×		
All D	escen	idants:	True		~	×		
Tem	plate:		Building		~	×		
Cate	gory:		<all></all>		~	×		
Ŗ	Add Q	<u>C</u> riteria 🔻				1		
					Results			
						G	roup by: C	ategory 🗌 Template
		Name	~	Туре	Template			٢
Ð		🗊 Building /	4	None	Building			
Ð		🗊 Building B	3	None	Building			
Ð		🗊 Building (	0	None	Building			
Ð		🔊 Building (	D	None	Building			
Ð		🔊 Building B	3	None	Building			
The	o ar ch	n found 5 Elem	ont(a) m-t	china tha ca				
me:	calu	riounu s ciem	enu(s) mau	uning the se	carun untena.			
<u> </u>						ОК	Cancel	Reset

2. In the Select Object Types and Column Headers window click Clear All and then select NewParent from the Element category. Click OK and Close.

🧾 Select Obje	ect Types and Column Headers		×
Object Type:	Element		
Template:	Building		~
Object Types:	1 selected, Columns: 5 selected		
	ed Columns lected(x)	^	۶
🗹 Pai	rent		<b>Ť</b>
	me jectType		
Error	<i>jeti ype</i>		
Elemen			
	wName		
	iqueID wParent		
	rentUniqueID		
	scription		
	ferenceType		
	nplate		
	faultAttribute faultInputPort		
		Υ.	
Clear All	Select All More Attribute Colum	ns	
Description:			
			~
			$\sim$
[	OK Cancel Reset		

**3.** We get the following:

	А	В	С	D	E
1	Selected(x)	Parent	Name	ObjectType	NewParent
2	х		<b>Building A</b>	Element	
3	x		<b>Building B</b>	Element	
4	x		<b>Building C</b>	Element	
5	x	Area 44	<b>Building D</b>	Element	
6	x	Area 44	<b>Building E</b>	Element	

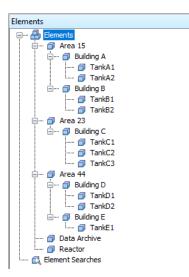
The buildings in Area 44 (rows 5 and 6) are already correctly placed. For the other buildings we need to assign the area as parent element in the column NewParent.

**4.** We apply the changes to arrive at the following:

	Α	В	С	D	E
1	Selected(x)	Parent	Name	ObjectType	NewParent
2	x		<b>Building A</b>	Element	Area 15
3	x		<b>Building B</b>	Element	Area 15
4	x		Building C	Element	Area 23
5		Area 44	<b>Building D</b>	Element	
6		Area 44	Building E	Element	
-					

Rows 5 and 6 were deselected here since nothing needs to be changed.

- 5. Click Publish and choose Edit Mode: Edit Only. Click OK and Close.
- **6.** We can verify the result in PSE. Click Refresh and expand the hierarchy in the Browser. If the hierarchy is not correctly presented you might need to close and reopen PSE.



# 6.10. Change Reference Types

#### Database: Tank Farm

Since we also have dedicated reference types (see section *Build and Edit Templates and Other Library Objects* earlier in this lesson) for the relationship between areas and buildings and between buildings and tanks we will also set the reference types where it is still on the standard Parent-Child.

Let us first see how this can be done in PSE before we make the remaining changes in bulk in PI Builder.

1. In the Browser select Area 44 and open the Child Elements tab. Select Group by Reference Type.

Area	44					
Gene	eral	Child Elements	Attributes Por	rts Analyses	Notification Rules	Version
			(	Group by: 📃 🖸	ategory 🗹 <u>R</u> efere	nce Type 🗌 Temp <u>l</u> ate
Filte	r					<del>،</del> م
		Name	△ Type	Tem	plate	0
	4	Reference: Are	a-Building			
Ð	T	🗊 Building D	None	Build	ling	
	4	Reference: Pare	ent-Child			
Œ	T	🗊 Building E	None	Build	ing	

Building D already uses the reference type Area-Building, while Building E has a reference type of Parent-Child.

2. To change the reference type for Building E, we right-click on Building E and select Convert > Change Reference Type...

lene	eral	Child Elemen	ts A	ttributes	Ports	Analyse	s Notification	n Rule	s V	/ersion
										Group by: Categor
Filte	er.									
		Name		_ Тур	be	Te	emplate			
Ξ	4	Reference: /	Area-B	Building						
Ŧ		🗇 Building	j D	No	ne	Bu	uilding			
	4	Reference: F	Parent	-Child						
Ŧ		🗇 Building	) E	No	ne	Bu	uilding			
		•	-	New				•		
				Conve	rt			•	∢≁	Convert to Model
			3	Create	or Upd	ate Data	Reference		1 1 1	Change Template
			£,	- 1					24 40	Change Reference Type
				Locati					-	
				Health						
			B	Annot						

**3.** In the Change Reference Type window, select Area-Building as the new reference type.

Change Reference Type X				
Pick parent and new reference typ	e for child Building E.			
Parent:	New Reference Type:			
Area 44 $$	Parent-Child 🗸			
Primary Parent OK	Area-Building Composition Parent-Child			

Click OK. Check In the change.

**4.** Both buildings are now shown with reference type Area-Building (you might need to refresh the view).

Area	44							
Gene	eral	Child Elements	Attributes	Ports	Analyses	Notification Rules	Version	
	Group by: 🗌 Category 🗹 Reference Type 🗌 Templat						Group by: Category Reference Type Template	
Filte	r							• م
🛛 🖻 Name 🛆 Type		Tem	plate		0			
	🖯 😔 Reference: Area-Building							
Đ		🗊 Building D	No	ne	Build	ling		
Đ	T	🗊 Building E	No	ne	Build	ling		

5. For changing the remaining reference types, we use PI Builder. Go to Elements > All Elements. In the Select Object Types and Column Headers window, Clear All and then select ReferenceType from the category Element and Child Elements at the bottom of the list. This is necessary to get not only elements from the root level. Click OK and Close.

Select Object Types and Column Headers X	Select Object Types and Column Headers X
Object Type: Element Template: Area	Object Type: Element Template: Area
Object Types: 3 selected, Columns: 5 selected	Object Types: 2 selected, Columns: 5 selected
	VersionModifier VersionComment VersionEffectiveDate VersionDosoleteDate CreationDate ModifyDate SecurityString Error ExtendedProperty Attribute NotificationRule Port Attribute Columns (from Template 'Area') Vill Elements Element References V
Clear All Select All More Attribute Columns	Clear All Select All More Attribute Columns
Description:	Description:
OK Cancel Reset	OK Cancel Reset

**6.** We want to change the Parent-Child reference types to Area-Building or Building-Tank, respectively.

	А	В	С	D	E
1	Selected(x)	Parent	Name	ObjectType	ReferenceType
2	х		Area 15	Element	
3	x	Area 15	Building A	Element	Parent-Child
4	x	Area 15\Building A	TankA1	Element	Parent-Child
5	x	Area 15\Building A	TankA2	Element	Parent-Child
6	x	Area 15	Building B	Element	Parent-Child
7	x	Area 15\Building B	TankB1	Element	Parent-Child
8	x	Area 15\Building B	TankB2	Element	Parent-Child
9	x		Area 23	Element	
10	x	Area 23	Building C	Element	Parent-Child
11	x	Area 23\Building C	TankC1	Element	Parent-Child
12	x	Area 23\Building C	TankC2	Element	Parent-Child
13	x	Area 23\Building C	TankC3	Element	Parent-Child
14	x		Area 44	Element	
15	x	Area 44	Building D	Element	Area-Building
16	x	Area 44\Building D	TankD1	Element	Building-Tank
17	x	Area 44\Building D	TankD2	Element	Parent-Child
18	x	Area 44	Building E	Element	Area-Building
19	x	Area 44\Building E	TankE1	Element	Parent-Child
20	x		Data Archive	Element	
21	x		Reactor	Element	

**7.** Change the reference type for all tanks to Building-Tank and for all buildings to Area-Building.

	А	В	С	D	E
1	Selected(x)	Parent	Name	ObjectType	ReferenceType
2	х		Area 15	Element	
3	x	Area 15	Building A	Element	Area-Building
4	x	Area 15\Building A	TankA1	Element	Building-Tank
5	х	Area 15\Building A	TankA2	Element	Building-Tank
6	x	Area 15	Building B	Element	Area-Building
7	x	Area 15\Building B	TankB1	Element	Building-Tank
8	x	Area 15\Building B	TankB2	Element	Building-Tank
9	x		Area 23	Element	
10	x	Area 23	Building C	Element	Area-Building
11	x	Area 23\Building C	TankC1	Element	Building-Tank
12	x	Area 23\Building C	TankC2	Element	Building-Tank
13	x	Area 23\Building C	TankC3	Element	Building-Tank
14	х		Area 44	Element	
15	x	Area 44	Building D	Element	Area-Building
16	x	Area 44\Building D	TankD1	Element	Building-Tank
17	x	Area 44\Building D	TankD2	Element	Building-Tank
18	x	Area 44	Building E	Element	Area-Building
19	x	Area 44\Building E	TankE1	Element	Building-Tank
20	x		Data Archive	Element	
21	x		Reactor	Element	

- 8. Click Publish and choose Edit Mode: Edit Only. Click OK and Close.
- **9.** In PSE, we can check the Child Element tabs of the area and building elements to verify the modification.

# 7. Security

# 7.1. Introduction to AF Security

#### **AF Identities and Mappings**

AF Identity	Description
Administrators	By default, this identity has all access permissions to every collection and object on the AF server, including all databases. It cannot be modified or deleted.
	It is recommended that access to this identity is restricted to only a few users.
Engineers	This identity has the same privileges as <i>Administrators</i> , with the exception of the <i>Admin (a)</i> permission. This identity is also not allowed to delete AF databases.
	It is recommended that this identity be restricted to those users who are defining the asset database. Additional identities should be created to narrow the scope of access within AF.
World	This identity has read access permissions to every collection and object on the AF server. More information see below.

The following table describes the access permissions you can assign to AF identities for all objects in the AF hierarchy.

Access right	Abbreviation	Definition
Read	r	Enables a user to view the object.
Write	w	Enables a user to create and modify an object. The exception is that event frames and transfers also require Write Data permission on the element template from which they are created. Additionally, if users do not have Write permission on the AF database, they cannot modify any object within the database, regardless of the specific permission on that object.
Read/Write		Enables a user to read and write to the associated object.

Read Data	rd	Enables a user to read element's attribute values (non- configuration items).
Write Data	wd	Enables a user to modify element's attribute values (non-configuration items). Additionally, this permission controls whether a user can create or modify event frames.
Subscribe	S	Enables a user to subscribe and unsubscribe to a notification.
SubscribeOthers	SO	Enables a user to subscribe and unsubscribe other users to a notification.
Delete	d	Enables a user to delete an object.
Execute	x	Enables a user to perform most actions on an analysis case. Only used in Pimsoft SigmafineTM data reconciliations. The PI Analysis Service does not use this permission. The Write permission is required to modify, run, and stop asset analyses.
Admin	a	Enables a user to modify the security settings, or owner, of an object. Also allows to force an Undo Check Out on an object that is checked out to another user, as well as to lock and unlock an event frame

Setting permissions can be done for individual AF objects or for collections of objects. When you create new objects, except for child elements, the collection security is used as the default security. When you create a child element, the security descriptor of the parent element becomes its default security.

#### **AF Security Hierarchy**

The following chart shows the structure of the AF objects in an AF Server. Each securable AF object (element, event frame, and notification, and so on) throughout the hierarchy has an associated security descriptor that contains the access permissions information for that object.

All AF objects of the same type belong to a collection. For example, every AF element in a database belongs to the Elements collection for that database. Each collection also has an associated security descriptor that contains access permission information.

Server	
Contacts	
Notification Contact Temp	lates
Identities	
Mappings	
Databases	Database
	Analyses
	Analysis Templates
	Categories
	Elements
	Element Templates
	Enumeration Sets
	Event Frames
	Notifications
	Reference Types
	Tables
	Table Connections
	Transfers

#### Permission Inheritance

When you change the access permissions for an element, the access permissions for any parent or child elements might also change. The behavior depends on the reference type.

When an object or collection is created, a default set of access permissions is assigned, based on the access permissions that are set on the parent. When access permissions are set on a parent, the following Child Permission settings on the Permissions page of the Security Configuration window are evaluated:

Reference Type	Behavior		
Composition	Access permissions for child and parent are always the same.		
Weak	Access permissions are never inherited.		
Parent – Child	When access permissions are set on a parent, the Child Permission settings in the Security Configuration window depend on option used		
	<ul> <li>Child Permissions</li> <li><u>D</u>o not modify child permissions</li> <li><u>Update child permissions for modified identities</u></li> <li><u>R</u>eplace child permissions for all identities</li> </ul>		

Option	Description
Do not modify child permissions	Prevents access permissions that have been set for the current object or collection from being replicated to child collections and objects in the AF hierarchy. Default for AF server 2.5 and earlier
Update child permissions for modified identities	For each selected item on the Items to Configure list in the Security Configuration window, replicates the access permissions for all child collections and objects for each identity on the Identities list whose access permissions have been modified. Default for AF server 2.6 and later.

Replace child permissions for all identities	For each selected item on the Items to Configure list in the Security Configuration window, replaces all child permissions for every identity on the Identities list with the parent access permissions.
	Hint: Before you apply this option, review access permission settings for all items on the Items to Configure list to avoid unintentionally overwriting custom permissions that may have been applied elsewhere in the collection hierarchy!

See also *Security configuration in PI AF* in the OSIsoft Documentation.

#### View Effective Access by User

To open from	Do this
PI AF Server Properties Window	On the toolbar, click 🕌. In the PI AF Server Properties window, click the Security link.
Select Database Window	On the toolbar, click the Database button. In the Select Database window, click the Edit Security button.
PI System Explorer Browser	Right -click an object or collection and click Security. In the PI AF Server Properties window, click the Security link.

1. Choose one of the following methods to open the Security Configuration window:

- 2. In the Security Configuration window, click the Effective Access tab.
- 3. In the Domain User field, enter a user's Windows domain name whose permissions you want to view.

l	Security Co	nfigu	iration								
1	Permissions	Effe	ctive Access								
e	Account										
	Domain Us	er:	PISCHOOL\stu	ident02							
ł	User SID:		5-1-5-21-6268	31697-2470743929	113331490-1105						
]		l	S-1-5-21-626831697-2470743929-113331490-1105								
	Identities:		as Administra S Engineers S World								
•											
ic											
t:											
ar											
	Items to Vie		tess:				Permissions:				
a' r	PISRVO						Read				
r	PISRV0						Write				
Ί			tification Cont				Delete				
			curity Identitie curity Mapping				Admin				
	PISRVO			12							
			atabase - Analy	/ses							
			atabase - Anal								
			atabase - Cate								
	A PISRVO	1 - Da	atabase - Elem	ents							
	🛛 🖓 PISRVO	1 - Da	atabase - Elem	ent Templates							
	🛛 🔞 PISRVO	1 - Da	atabase - Enum	ieration Sets							
			atabase - Even								
			atabase - Notif								
				ication Rule Templat	•						
			atabase - Refe								
			atabase - Table								
			atabase - Table								
	PISRAO	u - Da	atabase - Trans	srers							

4. Press Tab or Enter to validate your entry.

Note:You can click 🔎 next to the Domain User field to search for a user's Windows domain name.

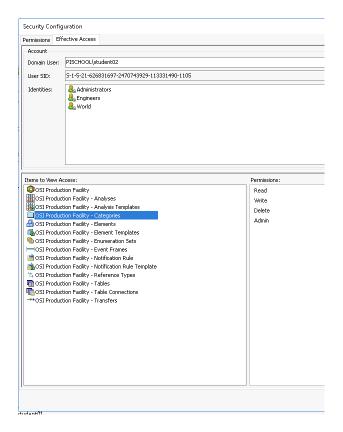
The fields and lists on the Effective Access page are populated with the following information:

- a. User SID field: Displays the user's security identifier
- b. Identities list: Lists all the PI AF identities that are mapped to the Windows domain user account entered in step 3
- c. Items to View Access list: Displays the item(s) selected for security configuration. This list is reflective of the item(s) shown in the Items to Configure list on the Permissions card.
- d. Permissions list: Displays the access permissions for the currently selected item in the Items to Configure list.
- 5. Select a different item in the Items to View Access list. The user's access permissions for the selected item are displayed in the Permissions list.

Examples:

			Security Config	guration	
Sec	urity Configuration		Permissions Eff	fective Access	
Pern e Ac Do	sissions Effective Access issions Effective Access imain User: PISCHOOL\student02 ier SID: 5-1-5-21-626631697-2470743929-113331490-1105 entities: & & & & & & & & & & & & & & & & & & &		Account Domain User: User SID: Identities:	PISCHOOL(student02 S-1-5-21-626831697-2470743929-113331490-1105 Administrators Engineers World	
аг 8 ач 8 8 8 8	ns to View Access: PISRV01 PISRV01 - Contacts PISRV01 - Notification Contact Templates PISRV01 - Security Mappings PISRV01 - Security Mappings PISRV01 - Database - Analyses	Permissions: Read Write Delete Admin	<ul> <li>PISRV01 - 5</li> <li>PISRV01 - 5</li> <li>PISRV01 - 6</li> <li>PISRV01 - 6</li> <li>PISRV01 - 6</li> <li>PISRV01 - 6</li> </ul>	Contacts Volfication Contact Templates Security Identities Security Mappings	Permissions: Read Write Read Data Write Data Delete Execute Admin

- 6. Repeat step 6 as needed to view access permissions for other items.
- 7. Click OK to exit the Security Configuration window.



## 7.2. UOM Database Security



Before reading this section, please refer to the following course YouTube video: OSIsoft Learning: UOM Database Security

The AF Unit of Measure (UOM) database is shared across all AF databases. You cannot set permissions for individual UOMs or UOM classes. Permissions for individual UOMs or UOM classes. Permissions can only be set for the entire UOM database.

To open UOM Security Configuration window:

- 1. In the Navigator pane, select Unit of Measure.
- 2. On the toolbar, click the **UOM Security** button.

	Security Configuration		- •	x				
Items to Configure:								
Item Security String								
☑ 🖀 Unit-of-Measure Database World:A(r) Administrators:A(r,w,d,x,a) NT AUTHORITY(NETWORK SERVICE:A(r,w,								
<	Ш			>				
Identities: Add Rer	Permissions for World:							
Name	Permission	Allow	Deny					
Sea World	All							
administrators	Write							
SG NT AUTHORITY WETWORK LEF	VICE Admin			1.1				

- 3. Examine the difference between World and Administrators Identity Permissions.
  - a. World has no permissions to make changes within the UOM database.
  - b. Administrators have access to make changes to the UOM database.
- 4. Effective permissions can be reviewed to verify individual access. Examine student01low's permissions.
  - a. Select the Effective Access Tab.
  - b. Search for a domain user; student01low.
  - c. Review effective access for individual. The individual has access to read all units of measure configured within the UOM database.

#### Security Tips

- Administrator privileges at the server level provides access to EVERY OBJECT, regardless of their security settings
- If you want to edit an element, you need *write* permissions on the Elements collection **AND** on the particular element
- Library objects, such as templates, enumeration sets, UOMs, and references types **ALWAYS** have read permission regardless of their security settings
- Deny settings override any granted allow permissions

# 7.3. AF Permissions



Before reading this section, please refer to the following course YouTube video: OSIsoft Learning: AF Permissions

#### Database: OSI Production Facility

#### Exercise:

Use your knowledge of AF security to accomplish the following use case in the OSI Production Facility database: You want to create an AF identity which, when used for a user or a user group, will allow that identity to create elements from template, but that identity should NOT be able to edit library objects at all i.e. they should not be able to edit the template. (you can use the pischool\student01low account for your testing. This account has the same password as student01 and it is currently mapped to the ElementBuilders identity.

#### Step by Step:

The main idea here is that we want to give the user access to the non template collections, but not the template collections. This will allow them to create instances of templates, but not create or alter the templates themselves.

1. Sign in to the AF Server with an account with Administrator's permissions (for example Student01) and go to File > Server Properties > Security:

🚰 PI AF Server Prop	perties				Х
General Plug-Ins Li	braries Identities Mappings Counts RPC Metrics Connections				
Name:	PISRV01			Rena	me
Description:					
Host:	PISRV01	Port:	5457		
Account:		Timeout:	300	seco	nds
ID:	19cae388-d434-4071-8591-51b1882c9af6				
Time Zone:	(UTC) Co-ordinated Universal Time				
Version:	Server:2.10.6.195; Database:2.10.6.195				
Default Data Server:	<inherit data="" default="" local="" server=""></inherit>				$\sim$
Aliases:	localhost				*
	PISRV01.PISCHOOL.INT				$\times$
	Extended Properties (0) Security				
	Configure Active Directory Access for Contacts				

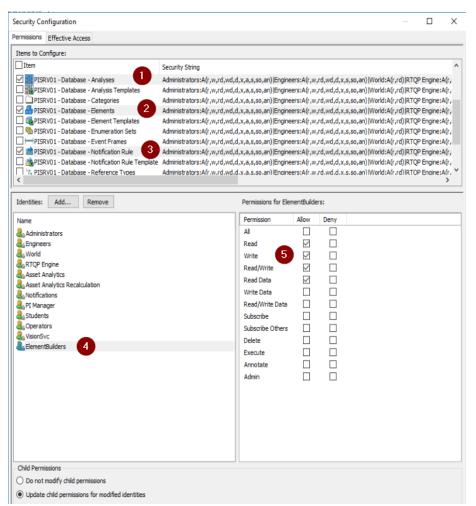
- 2. Next to identities click 'Add...' to open the 'Select Identity' dialog box and choose ElementBuilders and OK.
- 3. Next ensure that you have all 'Items to Configure' selected, choose ElementBuilders and then click the check box by Allow: All to remove all permissions and then select only Read and Read Data. Finally click 'Apply'

Security Configuration							×
Permissions Effective Access							
Items to Configure:	Security String						Â
PISRV01 - Contacts     PISRV01 - Contacts     PISRV01 - Notification Contact Templates     PISRV01 - Security Identities     PISRV01 - Database     PISRV01 - Database - Analyses     PISRV01 - Database - Analyses     PISRV01 - Database - Categories     PISRV01 - Database - Elements     <	Administrators: $A(r, w, rd, wd, rd, administrators: A(r, w, rd, wd, rd, administrators: A(rd, wd, rd, wd, rd, administrators: A(r, w, rd, wd, rd, administrators: A(rd, wd, rd, wd, rd, wd, rd, wd, rd, wd, rd, administrators: A(rd, wd, rd, wd, rd, administrators: A(rd, wd, rd, wd, rd, rd, wd, rd, $	I,x,a,s,so,an) (Enginee I,x,a,s,so,an) (Enginee I,x,a,s,so,an) (Enginee I,x,a,s,so,an) (Enginee I,x,a,s,so,an) (Enginee I,x,a,s,so,an) (Enginee I,x,a,s,so,an) (Enginee I,x,a,s,so,an) (Enginee	ers:A(r,w, ers:A(r,w, ers:A(r,w, ers:A(r,w, ers:A(r,w, ers:A(r,w, ers:A(r,w, ers:A(r,w,	rd,wd,d,x,s,so,ar rd,wd,d,x,s,so,ar rd,wd,d,x,s,so,ar rd,wd,d,x,s,so,an)] rd,wd,d,x,s,so,ar rd,wd,d,x,s,so,ar rd,wd,d,x,s,so,ar	)  World:A(r,rd)  R )  World:A(r,rd)  R )  World:A(r,rd)  R )  World:A(r,rd)  R World:A(r,rd)  R )  World:A(r,rd)  R )  World:A(r,rd)  R	TQP Engine:A( TQP Engine:A( TQP Engine:A( TQP Engine:A( P Engine:A( TQP Engine:A( TQP Engine:A( TQP Engine:A( TQP Engine:A(	(r) (r) (r) (r) (r) (r) (r)
Identities: Add Remove		Permissions for Elem	nentBuilde	rs:			
Name  Constraints ators Constraints ators Constraints ators Constraints ators Constraints ators Constraints Constr		Permission Al Read Write Read/Write Read/Write Data Read/Write Data Subscribe Subscribe Subscribe Others Delete Execute Annotate Admin					
Child Permissions Do not modify child permissions Update child permissions for modified identities Replace child permissions for all identities	3					5	
				OK	Cancel	Apply	

This will give the ElementBuilders identity read access to the entire AF server.

- 4. Then with this same window still open, let's select the checkbox at the very top to unselect all the Items. Next check the boxes next to
  - a. PISRV1 Database Elements,
  - b. PISRV1 Database Analyses,
  - c. and PISRV1 Database Notification Rules

while making sure that you then select ElementBuilders again. Next select the option for Write. Your screen should look like this:



Now hit OK to apply the changes and close the window. This should allow your test account to create and check in Elements created form templates, but not allow that account to create or make changes to templates.

5. Upon closing and reopening the AF security (using previously outlined steps), verify the ElementBuilders permissions are correct. The boxes may appear different as all Items are selected in the Security Configuration options. Boxes filled in completely do not apply to all items selected; in this case, the Write permission is limited to the 3 previously identified databases.

# 7.4. Database Level Security Settings

#### Database: OSI Production Facility

What we did in the previous exercises was changing permissions on the AF server on a server wide level. But say for instance, you would like to do something similar on a database level or you only want to make changes within a particular database that you manage without changing server level permissions. In this case, you could open the database security by opening File > Database... > Right click the database of interest and then choose Security...

Notice how we have a very similar dialog box to what we were working with in the last exercise, but this one lists the 'Items to Configure' in a slightly different way:

Permissions	Effective Access
Items to Co	onfigure:
☑ Item	
Ø © OSI	Production Facility
OSI OSI	Production Facility - Analyses
✓ MOSI	Production Facility - Analysis Templates
	Production Facility - Categories
_	Production Facility - Elements
	Production Facility - Element Templates
-	Production Facility - Enumeration Sets
and the second s	Production Facility - Event Frames Production Facility - Notification Rule
	Production Facility - Notification Rule Template
<	

Here we see the form <DatabaseName> - <collection type> instead of <server> -[Database] – [<Collection>] So here we can see that any changes we make here will apply to this database and the objects in it. The server level is not affected. Essentially, we can only edit security of the Database (green) section in the security hierarchy diagram rather than the Server (yellow) sections. In addition, we can edit security of individual objects by right clicking on the object and choosing security. For example, we can do this for an element and we would see this:

ecurity Configuration	1										
ermissions Effective A	ccess										
Items to Configure:											
🗹 Item	Security String	9									
🗹 🗾 Production Area	Administrators	s:A(r,w,rd,wd	l,d,x,a,s,so,a	an) Engineers:A(r	,w,rd,wd,d,x,s,so,an) V	/orld:A(r,r	d)  RTQP E	ngine:A(r,rd)	Asset Analytic	s:A(r,w,n	d,wd,:
(											
	Remove				Permissions for Ad	ministrator	s:				
Identities: Add	Remove										
dentities: Add	Remove				Permissions for Ad	Allow	Deny				
dentities: Add Vame Administrators	Remove				Permission	Allow	Deny				
identities: Add Name Administrators	Remove				Permission All	Allow	Deny				
identities: Add Name Administrators Engineers World RTQP Engine	Remove				Permission All Read	Allow	Deny				
identities: Add Name Administrators Engineers World RTQP Engine Asset Analytics					Permission All Read Write	Allow V V V	Deny				
Identitites: Add Administrators Geninistrators Genineers World RTQP Engine GASset Analytics Asset Analytics Rec					Permission All Read Write Read/Write	Allow V V V V	Deny				
Identities: Add Name Administrators Engineers World World ART(P Engine Asset Analytics Rec Asset Analytics Rec Notifications					Permission All Read Write Read/Write Read Data	Allow M	Deny				
Identities: Add Name Administrators Gingineers World GRTQP Engine Asset Analytics Asset Analytics Rec Notifications Notifications PI Manager					Permission All Read Write Read/Write Read Data Write Data	Allow	Deny				
<ul> <li>Identities: Add</li> <li>Name</li> <li>Administrators</li> <li>Engineers</li> <li>World</li> <li>RTOP Engine</li> <li>Asset Analytics</li> <li>Asset Analytics</li> <li>Asset Analytics</li> <li>Students</li> <li>Operators</li> <li>Velontsvice</li> </ul>					Permission All Read Write Read/Write Read Data Write Data Read/Write Data	Allow M	Deny				

So, depending on the granularity you need in your AF system: server level, database level, object level, you can get the security you require.

## 7.5. Editing Security in PI Builder

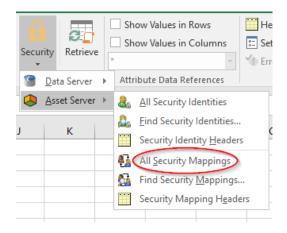


Before reading this section, please refer to the following course YouTube video: OSIsoft Learning: Editing Security in PI Builder

We are going to use the PI Builder functionality to add an **Engineers** mapping to correspond with the **Students** Active Directory (AD) group.

#### Step by step:

Create a new workbook or sheet. In the ribbon click the down arrow under Security
 > Asset Server > All Security Mappings



2. The **Select Object Types and Column Headers** dialog pops up. Here you can make selections on what information about the PI AF Mapping you would like to retrieve into the workbook. Just accept the default by clicking the **OK** button.

🧾 Select Obj	ject Types and Column Headers	×
Object Type:	SecurityMapping	
		$\sim$
	1 selected, Columns: 7 selected	
	vlected(x) ame bjactType tyMapping wWame	<del>}</del>
Clear All Description:	Select All More Attribute Columns.	
The columns i	in this group are required. They may not be	^
deselected ar may be move	nd neither the group nor the 'Selected(x)' colur d.	nn
	OK Cancel Reset	
角 Retrieve S	elected Objects	
Operations Co		
Processing Se	ecurity Mapping "PISCHOOL\student01low"	

	Operations Completed:	14	
	Processing Sequences of Processing Sequences of Processing Security Map Processing Security M	ing "PISCHOOL\stuc ing "PISCHOOL\Dor ing "BLULTIN\Admin ing "NT AUTHORITY ing "NT SERVICE\PI ing "NT SERVICE\PI ing "PISCHOOL\Ope ing "PISCHOOL\Ope ing "PISCHOOL\Stuc ing "PISCHOOL\stuc ing "PISCHOOL\stuc ing "PI Web API Adm ing "PI Web API Adm ing "PI Web API Adm	lain Users" strators" SySTEM" SqDas.RTQP" rators" NotificationsService" sionService" lent01" nins (PISRV01)1' ineers"
1	The requested detorns e	ompioco.	

3. Copy the row with 'Everyone' in column B and paste it at the base of the spreadsheet. Select only the new bottom row and change the rest of that row as shown below.

#### PAGE 140 OF 155

	А	В	C	D	E	F	G	н
1	Selected(x)	Name	ObjectType	Error	Description	MappingIdentity	MappingAccountName	ModifyDate
2		PISCHOOL\student01low	SecurityMapping			ElementBuilders	PISCHOOL\student01low	12/02/2021 02:45
З		PISCHOOL\Domain Users	SecurityMapping			World	PISCHOOL\Domain Users	12/02/2021 02:57
4		BUILTIN\Administrators	SecurityMapping		Administrators on the AFServer machine	Administrators	BUILTIN\Administrators	20/12/2019 22:27
5		NT AUTHORITY\SYSTEM	SecurityMapping			Asset Analytics Recalculation	NT AUTHORITY\SYSTEM	17/07/2020 07:25
6		NT SERVICE\PIAnalysisManager	SecurityMapping		Account configured to run PI Analysis Service	Asset Analytics	NT SERVICE\PIAnalysisManager	20/12/2019 22:35
7		NT SERVICE\PISqlDas.RTQP	SecurityMapping		Account configured to run RTQP Engine	RTQP Engine	NT SERVICE\PISqlDas.RTQP	20/12/2019 22:29
8		PISCHOOL\Operators	SecurityMapping			Operators	PISCHOOL\Operators	01/06/2020 04:30
9		NT SERVICE\PINotificationsService	SecurityMapping		Account configured to run PI Notifications Service	Notifications	NT SERVICE\PINotificationsService	20/12/2019 22:36
10		Everyone	SecurityMapping		Authenticated users on the AFServer Domain	World	Everyone	20/12/2019 22:27
11		PISCHOOL\PIVisionService	SecurityMapping			VisionSvc	PISCHOOL\PIVisionService	17/07/2020 01:27
12		PISCHOOL\student01	SecurityMapping			PI Manager	PISCHOOL\student01	30/12/2019 03:20
13		PI Web API Admins (PISRV01)1	SecurityMapping			PI Web API Admins (PISRV01)	PISCHOOL\PIVisionService	17/07/2020 05:08
14		PISCHOOL\engineers	SecurityMapping			Engineers	PISCHOOL\Engineers	05/06/2020 05:13
15		PI Web API Admins (PISRV01)	SecurityMapping			PI Web API Admins (PISRV01)	NT SERVICE\piwebapi	30/12/2019 23:04
16	х	Students	SecurityMapping		Students on the AFServer Domain	Engineers	PISCHOOL\Students	

- 4. Click the button in the ribbon. Click **OK** and **Close** on the next two dialogs that pop up.
- 5. Open the **PI System Explorer** and click <sup>O Database</sup>. Once there click on the **AF Server Properties.**

Select Database		×
🔕 New Database 🛛 🗙 Delete Databa	ase 🕋 Database Properties 🔒 Edit Security	
Asset server: 💖 PISR V01		🗸 🗝 📓 Connect
Databases:		
Filter		<del>-</del> م
Name	Description	Last Modified
Configuration	A store for configuration data.	02/06/2022 08:41:03
OSI Production Facility	Grand Prixl Award for the Best Oil Terminals and Tank Farms winner	02/06/2022 08:38:06
Sweet & Savory Corps		01/06/2022 09:41:06
👰 Tank Farm	PI AF class	01/06/2022 09:41:06
Velocity Terminals	PI AF class	02/06/2022 07:34:42
Velocity Terminals - To RESET	PI AF class	01/06/2022 09:41:06
		OK Close .:i

6. Then inspect the **Mappings** tab to confirm the change that was made.

Seneral	Plug-Ins	Libraries	Identities	Mappings	Counts	RPC Metrics	Connections	
Siter								م
Name				Description			Identity	Account
🛃 BUII	.TIN\Admir	nistrators		Administrat	ors on th	e AFServer m	. Administrators	BUILTIN\Administrators
🚺 Ever	ryone			Authentical	ted users	on the AFSer.	. World	Everyone
👫 NT A	UTHORIT	Y\SYSTEM					Asset Analytics Re	calcul NT AUTHORITY\SYSTEM
🚺 NT S	ERVICE\P	IAnalysisMa	anager	Account co	nfigured (	o run PI Anal	. Asset Analytics	NT SERVICE\PIAnalysisManage
👰 NT S	SERVICE\P	INotificatio	nsService	Account co	nfigured t	o run PI Notifi.	Notifications	NT SERVICE\PINotificationsSer
🚺 NT S	SERVICE\P	ISqlDas.RT	QP	Account co	nfigured t	o run RTQP E.	. RTQP Engine	NT SERVICE\PISqlDas.RTQP
🚺 PI V	/eb API Ac	lmins (PISR	V01)				PI Web API Admins	(PIS NT SERVICE\piwebapi
🚺 PI V	/eb API Ac	lmins (PISR	V01)1				PI Web API Admins	(PIS PISCHOOL\PIVisionService
🛃 PISC	HOOL\Do	main Users					World	PISCHOOL\Domain Users
🚺 PISC	HOOL\eng	gineers					Engineers	PISCHOOL\Engineers
🚺 PISC	THOOL\Op	erators					Operators	PISCHOOL\Operators
🚺 PISC	HOOL\PI\	isionServic/	e				VisionSvc	PISCHOOL\PIVisionService
🚺 PISC	HOOL\stu	ident01					PI Manager	PISCHOOL\student01
Land		dent01low					ElementBuilders	PISCHOOL)student011pw
🛃 Stuc	lents			Students of	n the AF :	5erver Domain	Engineers	PISCHOOL\Students

# 8. Working with the Elements

# 8.1. Copying, Moving, Creating References, and Arrange Elements



Before reading this section, please refer to the following course YouTube video: *OSIsoft Learning: Copying, Moving, Creating References, and Arrange Elements* 

#### Database: Velocity Terminals

Elements can be referenced, copied, or moved using the mouse by dragging and dropping. By using the **Ctrl** or the **Shift** key you can control the behavior of the drag and drop result.

Within **Velocity Terminals**, this is already a complete referenced hierarchy already created. The initial hierarchy is under the Locations with the referenced hierarchy being organized slightly different under Division.

Add three new Elements and name them **Copied Elements**, **Moved Elements**, and **Referenced Elements** based on no Template. You are going to use these to be parents for copied, moved, and referenced child-Elements, respectively. Arrange the Elements view to be by **Template**. Copy a tank Element as a child-Element to **Copied Elements**, move a tank Element as a child-Element to **Moved Elements**, reference a tank Element as a child-Element to **Referenced Elements**.

#### Step by step:

- 1. If you are not in the **Elements** view press **Ctrl+1** key combination.
- Right click the Elements in the Browser pane and select New Element (select <None> as the Template). Rename the new Element by selecting it, pressing the F2 key, and type Copied Elements. Create two more Elements in the same way and rename them to Moved Elements and Referenced Elements, respectively.

🔕 \\P	ISRV <b>01</b> \Ve	locity Te	rminal	s - PI Sys	stem Explor
File	Search	View	Go	Tools	Help
(1) Data	base 🛅 (	Query Da	ate 🔻	0 🤩	🌍 Back
Element	3				
	Elements 	city Term ed Eleme ed Eleme renced E	nts nts	5	

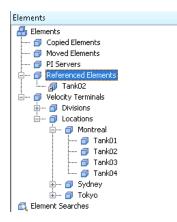
3. Select the **Elements** in the **Browser** then right click it. Select **Arrange By>Arrange By Template**.

🖴 Eleme 🍙	New Element New Model			
	Add Element Reference		≏ De	scription
	Create or Update Data Reference	pied El	e	
	Reevaluate Naming Pattern	cility1		
	Categorize	cility2		
	Arrange By		200	By Name
2	Refresh		Arrange	By Category
123.	Paste	-	Arrange	By Template
風	Paste Reference			

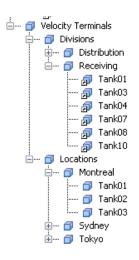
4. Expand the tree in the **Browser** pane to show the Elements under **<None>** and the Elements under **Velocity Terminals>Locations>Montreal>Tank02.** 

5e,	arch					
	🛛 🕒 Name 🗠					
	T	Template: <none></none>				
	Copied Elements					
ocit	y Term	ninals oved Elements				
		Referenced Elements				
Velocity Terminals						
E		Divisions				
	Đ	Distribution				
	±	Receiving				
E	J	Locations				
	<b>•</b>	🖬 🗇 Montreal				
		🖻 🎯 Tank01				
		🗉 🎯 Tank02				
		🖻 🎒 Tank03				
		🗉 🗇 Tank04				
	÷ .	🛭 🍯 Sydney				
	÷	🛚 🧊 Tokyo				
Ξ	G.	Template: PI Servers				

5. Drag Locations>Montreal>Tank02 Element to the Referenced Elements Element. Select Weak Reference in when the Choose Reference Type dialog pops up. This now makes a reference to the Tank02 Element, but the two Elements are identical. Note that the mouse icon changes to when you hover over the destination Element.

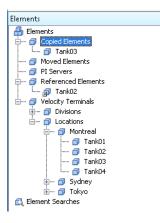


6. In the original Velocity Terminal, Division is set up as a Referenced Element copy organized in another hierarchy of Locations.



 Hold down the <u>Ctrl key and drag</u> Locations>Montreal>Tank03 Element to the Copied Elements Element. This now makes a copy Tank03 and the two Elements are now different.

**Note** that the mouse icon changes to  $\stackrel{\frown}{\cong}$  when you hover over the destination Element.



8. Hold down the <u>Shift key and drag</u> Locations>Montreal>Tank04 Element to the Moved Elements Element. This now moves that Tank04 from one location to the other.

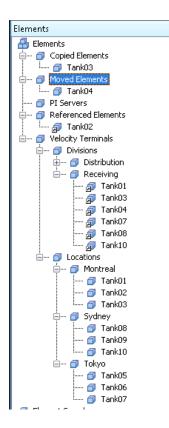
During the move, a dialog screen to select the type of reference type is requested.

Choose Reference Type 🛛 🗙					
Reference Type:	Composition	~			
	ОК	Cancel			

A reference type with a *reference strength of composition* means that the child element is really a part of the parent and does not exist without the parent. If you delete a parent element that has a child element that is compositionally referenced, you delete the child element also.

For example, use a composition reference when the two objects in the relationship are considered one item. For example, a meter might be composed of two sensors, and so you would use a composition reference between the *Meter* element and each of its two child *Sensor* elements. When you delete the *Meter* element, the child *Sensor* elements are also automatically deleted.

Note that the mouse icon changes to ဳ when you hover over the destination Element.



9. Be sure to check in changes to save the database modifications.

For more information see also *Element references in the asset hierarchy* in the OSIsoft Documentation.

### 8.2. Locate Other References to the Same Element

Database: Velocity Terminals

A single element can be referenced in multiple places in a hierarchy. You can find all the elements in the hierarchy that contain the element or a reference to the element.

#### Procedure

- 1. Select the element Tank02 in the Elements browser.
- 2. In the General tab, click the Parents link.

The element's parents are displayed in the Parents of *Element* window.

Tank02							
General Chi	id Elements	Attributes	Ports	Analyses	Notificatio	on Rules	Version
Name:	Tank02						
Description:							
Template:	Tank						
Categories:							
	Extended P	Properties (0)	Annot	ations (0)	Location	<u>Health</u>	Security
Find:			ent Fram Innection				

ter	
ame	Path
Distribution	Velocity Terminals\Divisions\Distribution
Montreal	Velocity Terminals\Locations\Montreal
Referenced Elements	Referenced Elements

The check mark next to Montreal indicates the original element.

3. Click Close

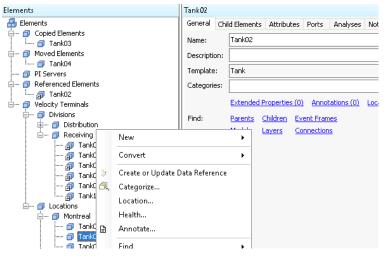
### 8.3. Annotations

You can add annotations to Elements and Event Frames to document something about them and attach certain document types to the annotation.

**Approach**: Add a comment to the **Tank02** Element and attach the **Tank02.pdf** document to the comment.

#### Step by step:

- Press the Ctrl+1 key combination to navigate to the Elements view and click on the Tank02 Element.
- You can either right-click the Tank02 Element or you can select it and then double-click the <u>Annotations (0)</u> in the Viewing Pane.



3. In the Annotations window click on New Annotation.

otations				
New Annotation 🕖 Add	d Attachment 🛛 🐹 Delete Annot	ation 🛞 Delete Atta	chment 🛃 Refresh	
hermocouple 1				
				p.
omment	Attachment	Creation Date	△ Creator	٢

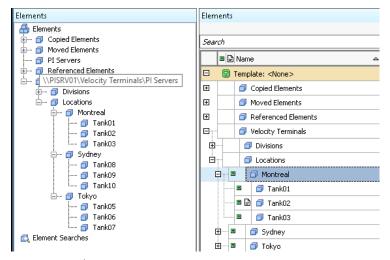
 In the Comment field type in, Tank replaced. Click on the Attachment field and then on the → symbol. Select Upload, navigate to the Desktop and select the Tank02\_specs.pdf file. Then click on Close to close the window.

_					_	
,	Annotations					
	New Annotation	Add Attachment	×	Delete Annotation 🥻	( c	)elete Attachment 🛛 🛃
	Comment	Attachment		Creation Date	۵	Creator
	Tank replaced		►	29/03/2021 18:44:44	/	PISCHOOL\student01
				Upload		
				Save As		
				Open		
				Delete		

 Notice that when you select the Element you can see how many annotations that particular Element has in the General tab of the Viewing Pane. For Tank02 Element it shows <u>Annotations (1)</u>.

Tank02
General       Child Elements       Attributes       Ports       Analyses         Name:       Tank02         Description:

6. Click on **Elements** in the **Browser Pane** and in the **Viewing Pane**, you can see which Elements have annotations by the <sup>□</sup> icon. Hover the mouse cursor over the <sup>□</sup> icon and a tooltip appears with the comment and the name of any attachment.



7. Double-click the icon that you just hovered over. The **Annotations** window opens, select the **Annotation** field, and click on the symbol. Select the **Open** option. The document is opened in Acrobat Reader. This is a good way to attach important instructions and documentation about the asset so that it is available for all users. Close the Acrobat Reader.

	0	•	Delete Attachment 🛛 🔊 Refresh	
	1		1	<u></u>
Comment	Attachment	Creation Date 4	≏ Creator	@
Tank replaced	=	29/03/2021 18:44:44	PISCHOOL\student01	

Note: The following formats are supported as attachments.

Allowed Files (*.docx;*.xlsx;*.csv 🔽
llowed Files (*.docx;*.xlsx;*.csv;*.pdf;*.txt;*.rtf;*.jpg;*.jpeg;*.png;*.svg;*.tiff;*.gif;*.pdi;)
locx (*.docx;)
lsx (*.xlsx;)
sv (*.csv;)
df (*.pdf;)
xt (*.txt;)
tf (*.rtf;)
pg (*.jpg;)
peg (*.jpeg;)
ng (*.png;)
vg (*.svg;)
iff (*.tiff;)
if (*.gif;)
di (*.pdi;)

# 9. Administrator Tasks (optional)

# 9.1. Customization Options in PI System Explorer

You can customize many aspects of PI System Explorer to suit your needs with Tools > Options.

#### **General tab**

You use the General tab to control display options for several features. You can control:

- Keystroke to open **Check-In** and **Undo-Checkout** windows. For more information, see *Check-in of database changes*.
- Title bar appearance.
- Page size for browser objects. For more information, see *Configure browser page size*.
- Number of queries returned in object searches. For more information, see *Search result paging*.
- Unit of measure appearance for attributes. For more information, see *Show attribute values in source unit of measure*.
- Display of attribute values to the units of measure that are mapped to a selected UOM group. When no UOM group is selected, attribute values are based on the default UOM defined in attribute templates or their source unit of measure (if Use Source Unit-Of-Measure for attribute display is selected). For more information, see UOM groups.
- Display of excluded attributes. For more information, see *Excluded attribute property*.
- Number of digits displayed for attribute values. For more information, see *Control the display of attribute and attribute template values*.

#### Time Context tab

You use the Time Context tab to define the time or time range that PI System Explorer uses to display attribute values. For more information, see *Set time context for displayed attribute values*.

#### **Server Options tab**

You use the Server Options tab to define how PI System Explorer should connect to a PI AF collective or PI Data Archive collective. For more information, see *Manage connection preferences for PI System Explorer*.

Source: PI System Explorer customization options

# 9.2. Viewing RPC metrics

You can view remote procedure call (RPC) metrics for the current server connection. The RPC Metrics page displays performance data about RPC calls by name, including the number of calls and call duration.

Note: Only users with administrator privileges can view the RPC Metrics page. Beginning with PI AF 2018 SP2, only certain column headers on the RPC Metrics page are visible.

#### Procedure

- On the PI System Explorer toolbar, click 4.
- 2. In the PI AF Server Properties window, click the RPC Metrics tab.
- 3. You can view, sort, and copy data on the RPC Metrics page:
  - To sort data by a particular column heading such as Calls or Total Duration, click the column heading.
  - To copy one row of connection data, right-click the row and then click Copy.
  - To copy all connection data, right-click the row, click Select All and then click Copy.
- 4. Review information about each call as needed. You can expand the width of the columns as needed.
- 5. The RPC Metrics page displays the following information:

Column Title	Explanation	
RPC Name	The name of the client process executed by the server	
Calls	The number of total calls for the individual RPC since the server was last started	
Total Duration	The total length of all the calls to the server from a particular client	
Per Call	The average length of each call	
Calls (Delta)	A count of the number of calls since the list was last displayed or refreshed	
Duration (Delta)	The total length of the calls to each RPC since the list was last displayed or refreshed	
Per Call (Delta)	The average length of the calls to each RPC that occurred since the list was last displayed or refreshed	
Calls (Client)	The number of calls to each RPC that was made by the client retrieving the RPC metrics	

Column Title	Explanation	
Duration (Client)	The length of the RPC call made by the client retrieving the RPC metrics	
	The average length of the calls to each RPC that was made by the client retrieving the RPC metrics	
Retries	The number of times the client process has been attempted	

Note: Use the Refresh button to update the RPC Metrics page with the latest RPC call data. Source: *View RPC metrics* 

# 9.3. AF SDK Capture

You use the AFGetTrace utility (afgettrace.exe) to capture event trace output from the AF SDK. Event tracing can help you debug an application and perform capacity and performance analysis.

**Note:** Starting with PI AF 2018, the **AFGetTrace** utility includes a graphical user interface (GUI) that allows you to configure and view event trace sessions. By default, the AFGetTrace utility runs in GUI mode. To run AFGetTrace in the old console mode, use the /NoGUI (/NG) switch.

#### Procedure

1. Open a command window and change directory to PIPC\AF.

То	Do this
Display syntax and parameters	At the command prompt, type: afgettrace /?
Run AFGetTrace with default settings	At the command prompt, type:
	afgettrace
	Default output goes to standard output.
	Default output goes to standard output.
Run AFGetTrace with specific parameters	At the command prompt, type:
	afgettrace /parameter
	Refer to AFGetTrace utility parameters for details on
	the parameters you can use.
Terminate event tracing	In the command window, type:
	x
	<b>Note:</b> If you close the command window without terminating afgettrace, trace events continue to be generated, which can slow down your AF SDK applications.

2. Choose from the following actions:

Source: Capture AF SDK event trace output

# 9.4. Audit Trail Functionality

The Audit Trail feature allows you to review changes to PI AF objects, as well as certain system and security settings. You must have administrative privileges to turn on or off Audit Trail and view audit information. See *Audit Trail implementation* for instructions on how to enable Audit Trail.

**Note:** Audit Trail requires the use of SQL Server Change Data Capture (CDC), which is a feature of Microsoft SQL Server. Audit Trail does not capture changes related to enabling or disabling the CDC table.

#### What is audited?

The following PI AF objects are tracked when Audit Trail is enabled:

- Element objects:
  - o Databases
  - Elements
  - o Static attribute values that are not data references
  - Analyses
  - Notifications
  - Models
- Event frame objects:
  - Event frames
  - Transfers
  - Cases
- Library objects:
  - Templates
  - Enumeration sets
  - Reference types
  - Tables and table connections
  - Categories

#### What user actions are audited?

The following user actions are recorded when Audit Trail is enabled:

- When an AF object is added, modified, or deleted. For example, when an object is renamed or when its description is changed.
- Changes to the security rights for a system collection, a database collection or an individual object.
- Changes to the UOM database. For example, adding a UOM.
- Changes to the AF Server. For example, turning on the Audit Trail feature or removing a plug-in.
- When the Audit Trail feature is turned on
- Changes to an AF security certificate (when a certificate is added, modified or deleted)
- When an AF plug-in is added or deleted
- When a trusted AF plug-in provider is added or deleted
- When an AF database is deleted
- When analyses, legacy notifications or notification rules are enabled or disabled

To enable the audit trail,

- administration level privileges are required on the AF Server
- sysadmin privileges to the AF database (PIFD)
- working knowledge of PI System administration

To enable the audit trail, use the AFDiag Utility (from the command window with elevated privileges and navigate to Program Files\PIPC\AF) and EnableAuditTrail (/AT) parameter: Afdiag /AT

To disable the audit trail, use the /ATD parameter. Upon disabling the audit trail, the collected audit trail records are permanently deleted and not recoverable.

Once enabled, with sufficient privileges, can right-click an object in the browser or an object on a list in the viewer and click **Audit Trail Events**. This allows review audit data specific to the selected object only. Each row in the table of the AF Audit Trail window contains data that identifies a specific change to an AF object. Double clicking the row will display details about the change(s). The details of the change can be copied (CTRL + C) and pasted (CTRL + V) from the window into a document.

There is an *Audit Trail utility* which can be accessed by individuals with administrator privileges to the AF Server.

Source: Overview of Audit Trail

# 10. Final Exam

The final exam in this course is taken online. Please check the course listing online for more details.