

# ASSET FRAMEWORK: BASICS

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### What does Asset Framework (AF) do for me?

The *PI Data Archive* focuses on a points database and is extremely good at storing vast amounts of data collected by interfaces. It allows easy and performant retrieval of time-series data. The PI Data Archive architecture is scalable, maintainable and highly available.



The *Asset Framework (AF)* supplements the architecture by providing a Meta-data structure for all data in the organization (“Data Directory”). Asset Framework (AF) has a rich set of features and functions to organize and enhance the data in the PI Data Archive. Because it offers user-friendly access to the data it is the preferred way for users to interact with their PI system data.

What are the benefits of Asset Framework?

#### **Easy way to navigate throughout the system**

The hierarchical asset structure gives a convenient way for navigation that can also be used by people, who are not familiar with the technical details of how the data is retrieved from the data source.

#### **Unify data from disparate source systems**

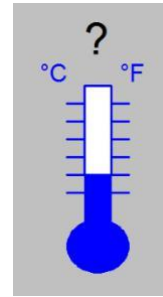
PI Point attributes get their data from PI Data Archives. AF is not limited to one PI Data Archive. Attributes can refer to multiple PI Data Archive Servers (either standalone or collective)

The origin of data can also be a relational database. While some attributes of an element representing a reactor are time-series data coming from PI tags (such as the temperature), data for some other attributes can be from an external database (such as the physical characteristics or inventory data).

All attributes are listed side by side giving the user a comprehensive insight into all the relevant data of the asset.

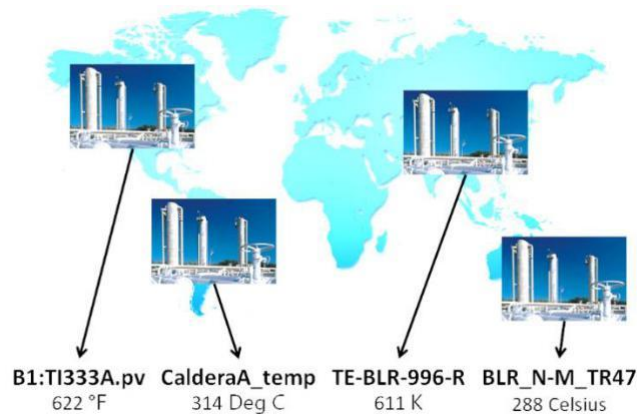
## Supports different Units of Measure

PI Asset Framework (PI AF) attributes are associated with specific Units of Measure. AF is preloaded with numerous standard unit-of-measure classes and conversion factors based on the International System of Units (SI). It also supports user defined classes and Units of Measure. For example, the source unit for a temperature sensor attribute in a reactor in the USA can be associated with degrees Fahrenheit, the corresponding attribute for a reactor in Italy can be associated with degrees Celsius. When working with the data (doing calculations or displaying the data) this is properly taken into account.



## Standardization with Templates

At many sites there are no rigorous naming standards for the points. There may be missing descriptions and/or engineering units. The PI System is often used to integrate information from different sources and these sources may not have been configured consistently:



Element templates in AF provide the basis for standardization. When applied for elements that represent the same type equipment, all elements have the same set of attributes with a consistent, user friendly naming. The attributes have same unit of measurement, same data type, the same description, etc. This allows a harmonized, consistent representation of your system.

Another benefit of using templates is the quick creation of many elements of the same type.

## Powerful Calculation Options (Asset Analytics)

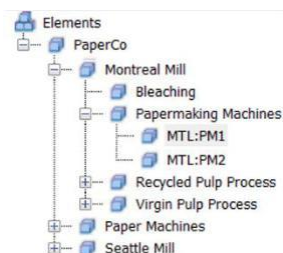
Users can configure, schedule and run calculations written using PI Performance Equation (PE) syntax acting on their PI Asset Framework (PI AF) attributes. PE expressions, Rollup calculations and generation of PI Event Frames based on trigger conditions are all supported analysis types. In addition, analysis templates enable users to manage their analyses in a standardized and consistent manner. Typical applications are Key Performance Indicator (KPI) calculations and condition based maintenance (CBM).

## Introduction to AF Key Features

Asset Framework provides an additional data layer in the PI System. It is based on an asset model of your plant that you define for your company. The model consists of elements and attributes.

You can model your plant by organizing and structuring the data according to how you work with your company data. Examples include organizing by physical location or by physical objects in their processes like reactors, transformers and meters.

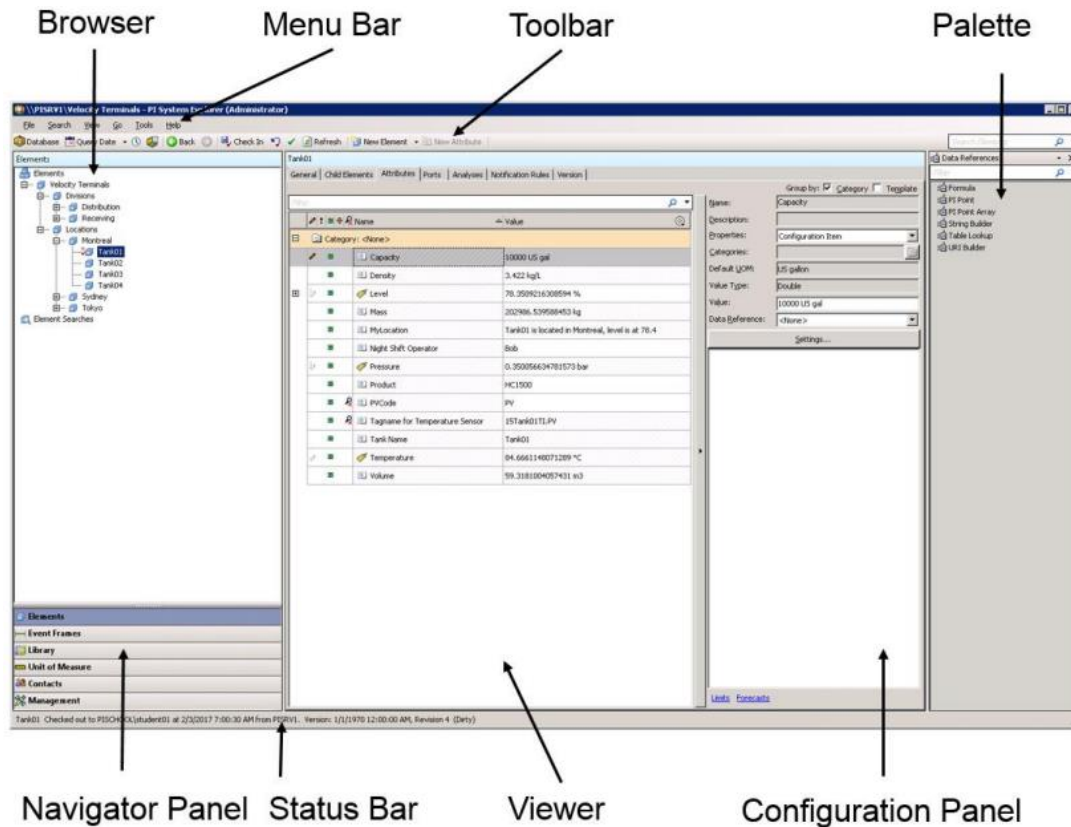
Since the AF asset model can span PI Data Archives, it allows you to organize and search for PI System information across multiple PI Data Archives.



The basis for the asset model is an **Element**, which contains **Attributes** that can reference PI System data, design data or data from other systems:


Filter	
Name	Value
Basis Weight	51.95576 lb
Broke Cost	93.75 \$
Broke Flow	228.65 ft/m
Children Element Attribute	71
Grade	RECYCLE3
GrdIndex	5
Gross Tons	84 tpd
ID	MTL:PM1
Machine Availability	Available

# PI System Explorer (PSE) Navigation



In this section, we'll be discussing the basics of PI system explorer, or PSE as it is frequently referred to for short.

PI system explorer is the main tool for configuring and managing PI asset frameworks, PI notifications and PI event frames.

We'll start by opening PI System Explorer by going to all programs, PI System folder and look for this icon .

Now as PSE starts up, you'll notice that the screen is divided into several different sections. So we'll go over each of these, starting in the bottom left, we have what is known as the navigator panel.

Here you'll see that there are several different objects that you might want to work on within PSE. In this course, our primary focus will be on the Elements and Library options.

In the elements section which is where your hierarchy resides, this can be a physical or logical representation of your process.

The library is a collection of objects that can be used throughout your AF hierarchy. This includes templates, enumerations sets, tables, etc.



Although not modified in this course, but it should be acknowledged due to its importance is the Unit of Measure. This database provides automatic handling of simple conversions between units of measures for attributes of the same UoM class. A UoM class is defined by the fundamental dimension of its measurement. Some examples of UoM classes are Mass, Temperature Volume, and Density.

You may have noticed as we selected different sections on the navigator pane, available options were changing above it – this section is known as the browser. With Elements selected, your hierarchy is visible, if the Library is selected, options to work on building templates, tables, enumerations sets are brought into view.

To the right of the browser area, we have the viewer, which is your primary work area. From this pane, we can build templates, add attributes, configure tables, etc.

The final section we can display is called the palette. By default, this pane is hidden to optimize screen visibility/workspace. To make the pallet visible, go to the view menu, select palette, and show palette. From the palette area, we have several options available. For now, we will mention the tag search. We can perform a tag search allowing us to quickly drag and drop already defined data into the attribute area to make new attributes on a template.

Another option to increase viewing space is to minimize the configuration window.

If we explore the menu options, we can see one item labelled 'Go'. This menu option gives keyboard short cuts to traverse the navigator pane.

The last thing to mention is the status bar. It's at the base of the PI System Explorer window. This will tell you the status of a selected element. For example, from the Library, I have selected the PressTemplate. You can identify when it was last modified and by whom from the status bar.

To review, we went over the major components of PI System Explorer.

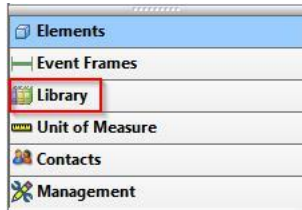
The components being the status bar, menu bar, and navigator panel for selecting groups of objects to work on. The browser for selecting individual objects. The viewer for configuring objects. And finally, the palette where we have quick access to templates and tags for drag and drop editing.

## Keyboard Shortcuts (optional)

For those that like keyboard shortcuts, these navigation tips may be of interest to you.

It is a lot faster to use the keyboard shortcuts to move between the ribbons as well as to perform other tasks in PSE. While there are many keyboard shortcuts, the most important will be those that switch options in the Navigator Panel. This is because you will need to switch views frequently.

Navigate to the Library in the Navigator Pane using the keyboard. Then navigate back to the Elements.



Step by step:

1. Press the Ctrl+3 key combination to navigate to the Library view. To navigate back to the Elements view press the Ctrl+1 key combination. The Ctrl+<number> key combinations to navigate to different views are (all these are found under the 'Go' drop down menu):

	Elements	Ctrl+1
	Event Frames	Ctrl+2
	Library	Ctrl+3
	Unit of Measure	Ctrl+4
	Contacts	Ctrl+7
	Management	Ctrl+0

The table below shows other very useful keyboard shortcuts.

Key Combination	Action
CTRL+A	Selects all objects in the Viewer.
CTRL+C	Copies the selected object to the clipboard.
CTRL+ALT+C	Copies the path of the selected object to the clipboard.
CTRL+V	Pastes the object on the clipboard to the Viewer.
CTRL+X	Cuts (deletes) the selected object and copies it to the clipboard.
DELETE	Deletes the selected object.
SHIFT+DELETE	Same as CTRL+X
INSERT	Adds a new object to the Viewer or Browser.
HOME	Selects the first row in the Viewer, for example, the first row in a table of attributes.
END	Selects the last row in the Viewer.

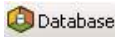
<b>Key Combination</b>	<b>Action</b>
CTRL+HOME	Selects the first cell of the current page in the Viewer.
CTRL+END	Selects the last cell of the current page in the Viewer.
ALT+HOME	Selects the first page of objects in the Viewer.
ALT+END	Selects the last page of objects in the Viewer.
CTRL+PAGE UP	Selects the previous page of objects in the Viewer.
CTRL+PAGE DOWN	Selects the next page of objects in the Viewer.
CTRL+ENTER	If the Viewer contains multiple pages of objects, displays the Select Page Number window.
ALT+ENTER	In the Browser, displays the properties of the selected object.
SPACE or ENTER	Presses the currently selected button.
Left, Right, Up, and Down Arrows	Navigate objects in the Viewer or Browser.
F2	Edits the selected object on the Viewer. For complex objects, displays the edit window for the object.
F4 or ALT+Up Arrow or ALT+Down Arrow	Displays the choices in the selected list box. For layered lists, displays the complete hierarchy of choices.
F1	Brings up the Help Menu

# Connecting and Verifying Data Archive and AF Servers

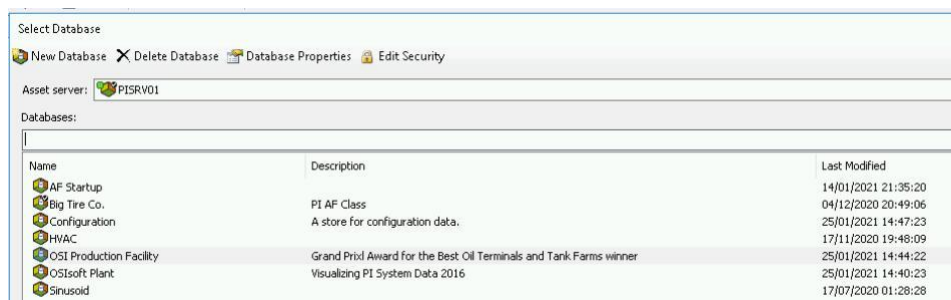
In this section we will review connecting to an AF Database.

To work in PI System Explorer, a connection needs to be made to a PI System.

To connect to the AF Server simply open PSE. The default AF Server was set during installation, so you will be automatically connected to it. If a default AF database has already been defined, PSE will automatically connect to it as well. If no default AF database has been defined, a window will pop up and you will be invited to create a new AF database.

It is possible to see which AF server the user is connected to by selecting the  button on the toolbar. The **Select Database** dialog box will show the current server name in the top drop-down “AF Server” list.

From the left-hand corner of PSE, you see the word Database, from here, you can connect to the correct AF Database (providing multiple databases exist). As we click on Database, in our case, multiple databases display on the screen.



The database named Configuration is a database that should not be modified. It is used internally.

Throughout this course, we will be using the Big Tire Co. databases unless otherwise directed.

Although, we are using AF to organize our company process data in a readable format, the data actually exists in the Data Archive.

From PSE, the PI Server and AF Servers must be identified so the tool can connect to the database created for your company's data. During installation of the PI System, the connections are built, however, it is good to know how to verify the connection.

From the File menu option, under Connections, a list of servers can be found. The name, user logged in and type of server can be found in the connection window.

You can validate your connection to the Data Archive via PSE. Notice AF Server icon (  ) is different than Data Archive server icon (  ).

Servers		
Add Asset Server Add Data Server Connect Properties Buffering Manager Refresh		
Filter		
Name	Host	User
PISRV01	PISRV01	PISCHOOL\student01 (piusers   PI Manager   PIStudents   PIWorld)
PISRV01	PISRV01	PISCHOOL\student01 (Administrators   PI Manager   Students   World)

The connection information is not only important for connecting PSE to the correct database, this information is critical in locating the data (or storing the data) being collected within your facility.

An alternate means of validating your connection to the Data Archive is via the PI SDK utility.

From the program menu, select PI System → PISDKUtility. The default view opens with Connections selected. (From the *PI-SDK > Connections* section, the Data Archive servers configured on the local machine are displayed.) To validate a connection to a Data Archive, simply check the checkbox next to its name or IP address. If connection succeeds, connection information will be shown.

The screenshot shows the 'PI SDK Utility (Administrator)' window. The 'Connections' tab is selected in the left-hand tree view. A list of connections is shown, with 'PISRV01' selected and its checkbox checked. To the right of the list, the connection details for 'PISRV01' are displayed in a form:

Network Node:	PISRV01
Port Number:	5450
Default User Name:	pidemo
Connection Timeout:	10 Seconds
Data Access Timeout:	60 Seconds
Connection Type:	PI3 protocol 3.5
ServerID:	dc6abb97-a1be-4188-ab3b-c85b51d12c49
Description:	
Connected User:	PISCHOOL\student01 as piadmins   PIWorld
IP Address:	192.168.0.7
PI Version:	PI 3.4.420.1182
Operating System:	Windows NT AMD64 6.2.9200

At the bottom right of the form is a 'Save' button. The status bar at the bottom of the window displays 'PISRV01 connected as piadmins | PIWorld'.

The user that was used to authenticate on the Data Archive will be shown in the status bar and the connection information section on the right.

**Note:** The PI SDK Utility is a particularly useful tool to troubleshoot permission issues.

# Finding Data Demonstration

In this section, we will demonstrate some options to search for information.

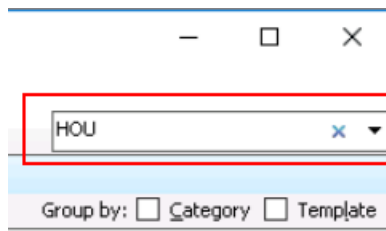
- Perform a quick element search based on a name pattern
- Perform an element search with multiple search criteria.
- Perform an attribute search.

Let's start with the Quick Element Search:

### Approach

#### Quick Element Search

1. Open the PI Big Tires Co. AF database from PSE, verify Elements is selected in the Navigator.
2. Explore the element hierarchy: it contains 3 locations (Houston, Montreal and Philadelphia ("Philly")) with four presses in each location. (Slight pause as locations are being opened)
3. Above the viewer pane, there is a Search box in the upper right-hand corner. Enter **HOU** into the quick search and press Enter. The results of the search will appear in the browser screen under the 'Element Searches' option and in the viewer pane.




(Pause as 5 results should appear on the screen)

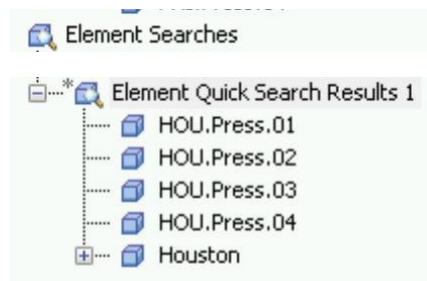
4. Now let's try a different search. Enter **HOU\*Press** into the quick search and click on Enter.

(Pause as 4 results should appear on the screen)

**Note:** one has been eliminated due to the additional criteria added to the search and an additional quick search will display under the Element Searches option.

**Note:** The searches created display a little asterisk  next to the searches name. If you created a search to be used periodically, you can save it by right clicking on the Element Search name, then select Save. From the same context menu, you can rename the search.

If you do not save the search, it will not be available the next time you open PI System Explorer.



### **Advanced Element Search (multiple search criteria)**

5. From the PSE menu, select Search – Element Search...
6. (optional) If criteria was cached from the last search, click the blue "x" in the search line on the top to reset.
7. Enter criteria to search for the presses in Montreal.
  - a. Select the ellipse (...) towards of the 'Element Search Root' entry box.
  - b. A screen appears, from here you can select the item of interest. We will select 'Montreal'. Click OK.
  - c. In the template field, we can add PressTemplate. This will become more important as additional templates are created.
  - d. The search criteria should have the Element Search Root= Montreal and the template= PressTemplate.
  - e. Click on Search to get the results – the search field is in the upper right hand corner of the screen.

Pause – as all 4 presses appear upon select search.

8. Let's add an additional piece of information into the search. Enter \*1 in name field to specify another criteria, click on Search to get the results.

Pause – as only 1 press from Montreal appears.

In the above two searches, we had 'All Descendants' set to False.

**Note:** *All Descendants* specifies whether the search returns elements from the selected levels and all levels below. The option should be set to true in most cases. The Name field can make use of the wildcard characters (\* and ?).

9. Let's reset the criteria by clicking the reset button in the lower right hand corner.

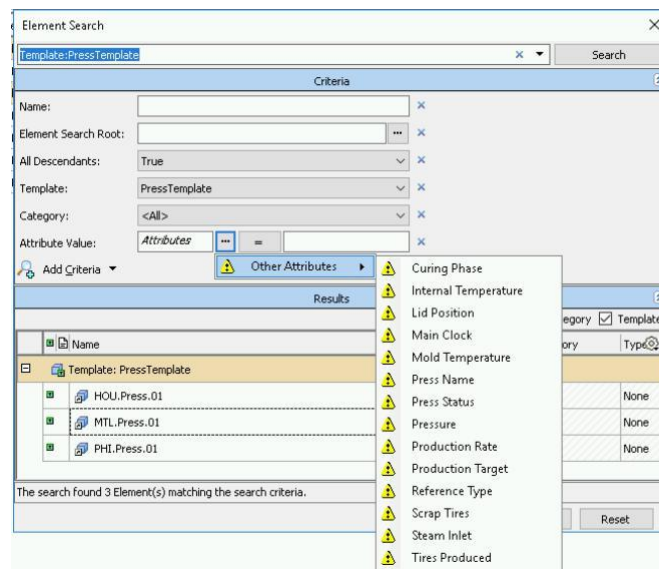
10. Now, set 'All Descendants' to True and enter \*1 into the Name field.

Pause – 3 records are found throughout the hierarchy.

11. Reset the criteria again. When you specify a template (e.g. PressTemplate) you can add additional criteria. Click Add Criteria, select Attribute Value.



12. To select the attribute of interest, select the ellipse field next to the word Attributes. Select Other Attributes, then the attribute of interest, for now, Press Status.



13. Press Status is based on an enumeration set, so a drop down box has the potential values for the attribute. Set the value to "Running".

14. Press Search. Currently there are 12 elements with the attribute Press Status. Odds are some but not all Presses will be running.



### **Attribute Search**

15. From the PSE menu, select Search – Attribute Search...
16. Verify the PI Big Tires Co. AF database is selected
17. Enter **Press Status** into the attribute name field. Click Search. Result: The Press Status attributes for all 12 presses are listed. Click on OK.

# Searching and Filters

As your AF hierarchy grows, it is important to be able to find the Elements you need. In the following exercise, we will discuss searching, then filtering the search results.

**Approach:** Create a search view named **Tanks** that contains all the **Storage Tanks** for our creatively named **Production Area**

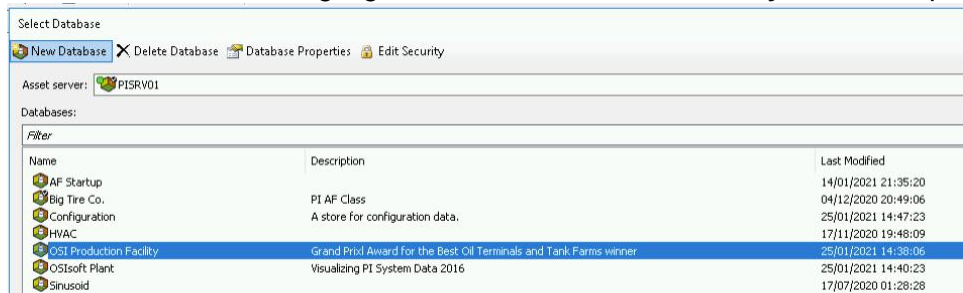
## Step by step:

Before creating the search and filters, the database needs to be changed.

- a. Verify current database, so far, the **Big Tire Co.** database has been used.



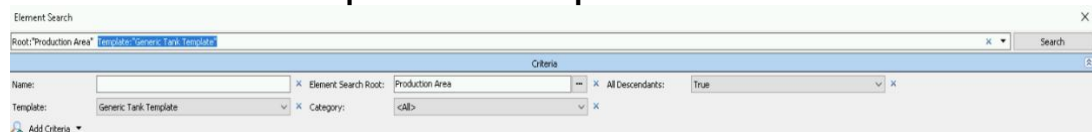
- b. Press Database, then highlight the **OSI Production Facility** database, press OK.



- c. If you are not in the **Elements**, go to Elements in the Navigation pane or press the **Ctrl+1** key combination

- d. Press the **F3** key to bring up the Element Search window **or** from the menu, select **Search** then **Element Search**.

- Enter Production Area for the **Element Search Root** **OR** click ... to select the root from the hierarchy.
- Select **True** for **All Descendants**
- Select **Generic TankTemplate** for the **Template**



- Press **Search** to preview the results.
- Click the **OK** button.

Element Search

✕

::"Production Area"
Template:"Generic Tank Template"
✕
▼

Search

Criteria

Name:

Element Search Root:

Production Area

All Descendants:


True

Template:

Generic Tank Template

Category:

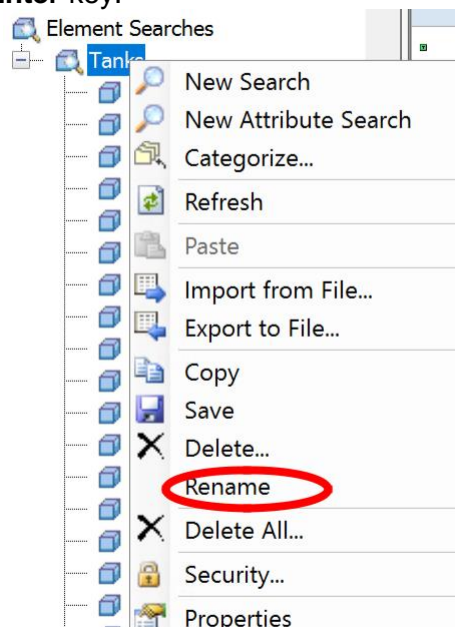
<All>


Add Criteria
▼












- e. You can rename the search results in two ways.

Option 1: Right click the **Element Search Results 1** in the **Browser** pane and select **Rename**. Type in **Tanks** and press the **Enter** key.

Option 2: Click on the **Element Search Results 1** and the press the **F2** key, type in **Tanks** and press the **Enter** key.

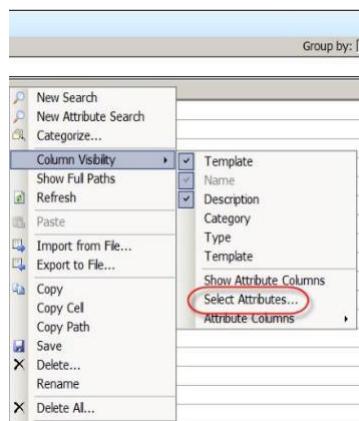


- f. Additional filtering can be done from the **Viewer** pane.

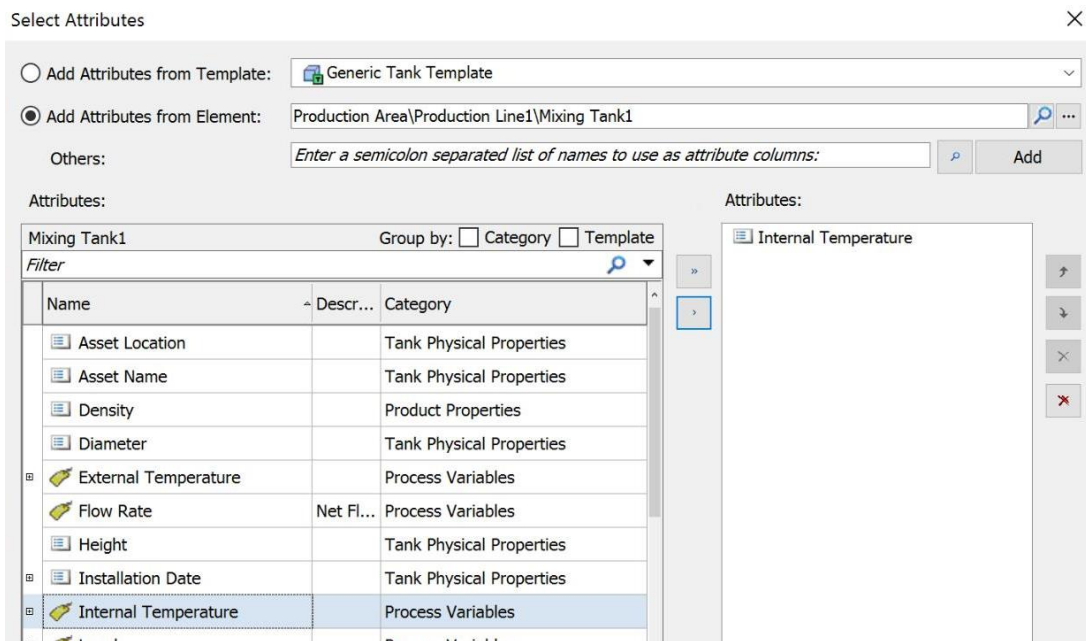
Tanks						Group by: <input type="checkbox"/> Category <input type="checkbox"/> Template
Filter						
ID	Name	Description	Category	Type	Template	Recent Searches
*	 Mixing Tank1			None	Generic Tank Template	Contains
*	 Mixing Tank10			None	Generic Tank Template	Exact Match
*	 Mixing Tank2			None	Generic Tank Template	<input checked="" type="checkbox"/> Starts With
*	 Mixing Tank3			None	Generic Tank Template	Ends With
*	 Mixing Tank4			None	Generic Tank Template	Set Maximum Query Size
*	 Mixing Tank5			None	Generic Tank Template	<input checked="" type="checkbox"/> Name
*	 Mixing Tank6			None	Generic Tank Template	<input checked="" type="checkbox"/> Description
*	 Mixing Tank7			None	Generic Tank Template	<input checked="" type="checkbox"/> Category
*	 Mixing Tank8			None	Generic Tank Template	<input checked="" type="checkbox"/> Type
*	 Mixing Tank9			None	Generic Tank Template	<input checked="" type="checkbox"/> Template

## Viewing Additional Columns in Searches

- a. All the **Tanks** are listed in the **Viewing** pane.
  - i. To view every **Internal Temperature** of **Tanks** we first need to add an **Attribute** to the header to make it visible.
  - ii. An **Attribute** named **InternalTemperature** has been configured in the **PressTemplate**.
  - iii. Right click on the gray area of the header and select **Column Visibility>Select Attributes**.



- b. In the **Select Attributes** dialog select the row with the name **Internal Temperature** and click the **>** button. Then click the **OK** button.



- c. Now in the Viewer, we are able to see all the internal temperatures associated with all the tanks using the Generic Tank Template.

Tanks						
Filter						
	Name	Description	Category	Type	Template	Internal Temperature
■	Mixing Tank1			None	Generic Tank Tem...	144.4 °C
■	Mixing Tank10			None	Generic Tank Tem...	156.7 °C
■	Mixing Tank2			None	Generic Tank Tem...	184.3 °C
■	Mixing Tank3			None	Generic Tank Tem...	203.1 °C
■	Mixing Tank4			None	Generic Tank Tem...	157.5 °C
■	Mixing Tank5			None	Generic Tank Tem...	228.4 °C
■	Mixing Tank6			None	Generic Tank Tem...	181.5 °C
■	Mixing Tank7			None	Generic Tank Tem...	151.1 °C
■	Mixing Tank8			None	Generic Tank Tem...	98.8 °C
■	Mixing Tank9			None	Generic Tank Tem...	198.6 °C
■	Storage Tank1			None	Generic Tank Tem...	213.1 °C
■	Storage Tank10			None	Generic Tank Tem...	235.8 °C
■	Storage Tank2			None	Generic Tank Tem...	135.2 °C

**Note:** For large databases/hierarchies, the rows displays can be controlled by the 'Maximum Query Size' located in Tools>Options menu.

# Finding Points through PI System Explorer

## Activity Objectives

- Review the search capabilities and options of PSE Tag Search.

## Approach

1. Verify Elements is selected in the Navigation Pane. The menu varies with navigation item selected.
2. From the PSE menu, select Search – Tag Search...
3. (optional) If criteria were cached from the last search, click the blue “x” in the search line on the top to reset.
4. Search for tags matching the name pattern **CD\*158**



3 items display with this search.

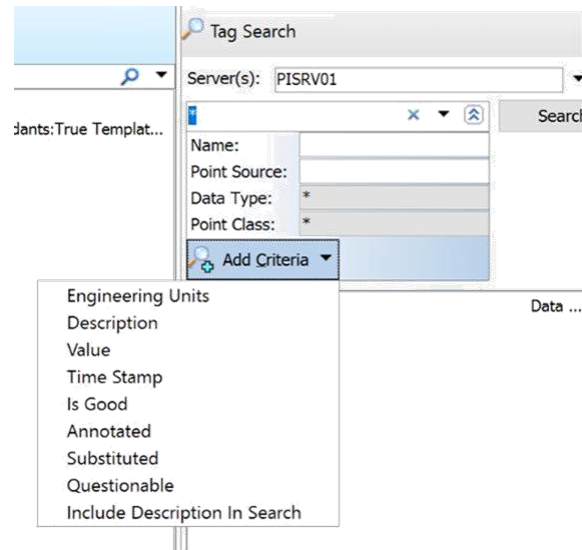
5. Search for tags matching the name pattern **CD?158**. What is the difference to the previous search results?

2 items display with this search.

**Note:** an \* can represent 1 or more characters; whereas the ? represents a single character.


6. Reset the search, by pressing the 'Reset' button to clear previously entered information.
7. By default, the Tag Search window defaults to searching against the point name mask. If you click on the control to display extra search features, you will get more options to further refine the search using additional common point attributes like the descriptor.





This option is convenient in instances where a common point source is used in setting up interfaces or specific groupings of data.

For example, enter point source=R to search for all tags with this criterion. In our PI Server configuration, the R in point source indicates all tags associated with the Random interface.

 Tag Search

Server(s): PISRV01


pointsource:R

Name:

















Point Source: R

Data Type: \*

Point Class: \*

 Add Criteria ▼

Name

-  CDEP158
-  CDM158
-  CDT158
-  SINUSOID
-  SINUSOIDU
-  OSIsoftHVACSim.T000.pv
-  OSIsoftHVACSim.Y110.PV
-  OSIsoftHVACSim.Y120.PV
-  OSIsoftHVACSim.Y130.PV
-  OSIsoftHVACSim.Y210.PV
-  OSIsoftHVACSim.Y220.PV
-  OSIsoftHVACSim.Y230.PV
-  OSIsoftHVACSim.Y310.PV
-  OSIsoftHVACSim.Y320.PV
-  OSIsoftHVACSim.Y330.PV
-  MyPressureTag

If you are working on setting up your hierarchy, it may be more convenient to bring up the Tag Search in the Palette view. The same functionality exists, but it is viewed in a fixed pane.

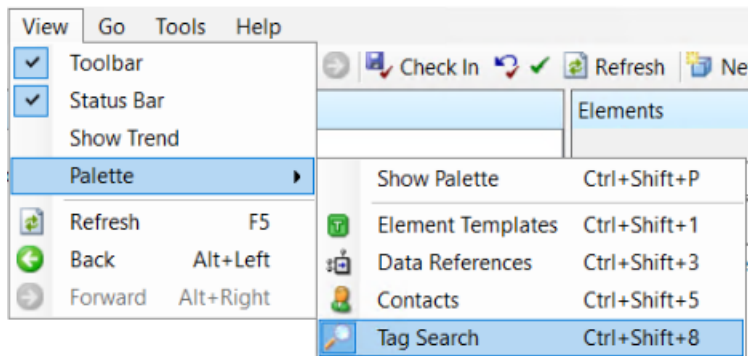


# Create an Element using the Palette functionality

Work with the Palette using the OSI Production Facility database.

Verify the database is set to the OSI Production Facility.

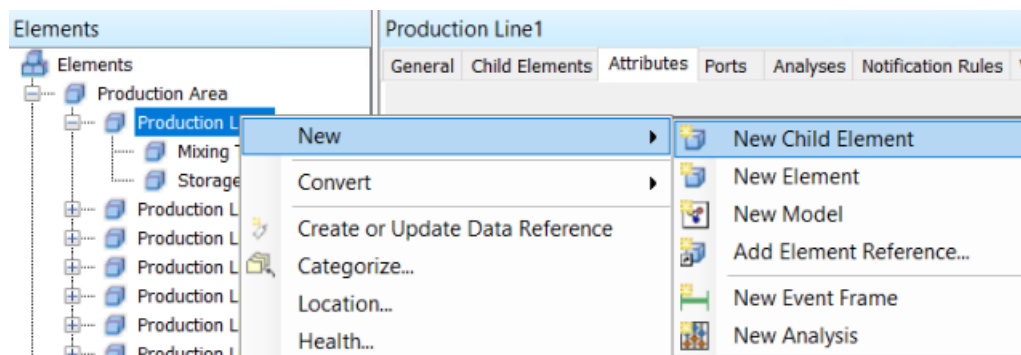
Display the Tag Search functionality within the Palette.



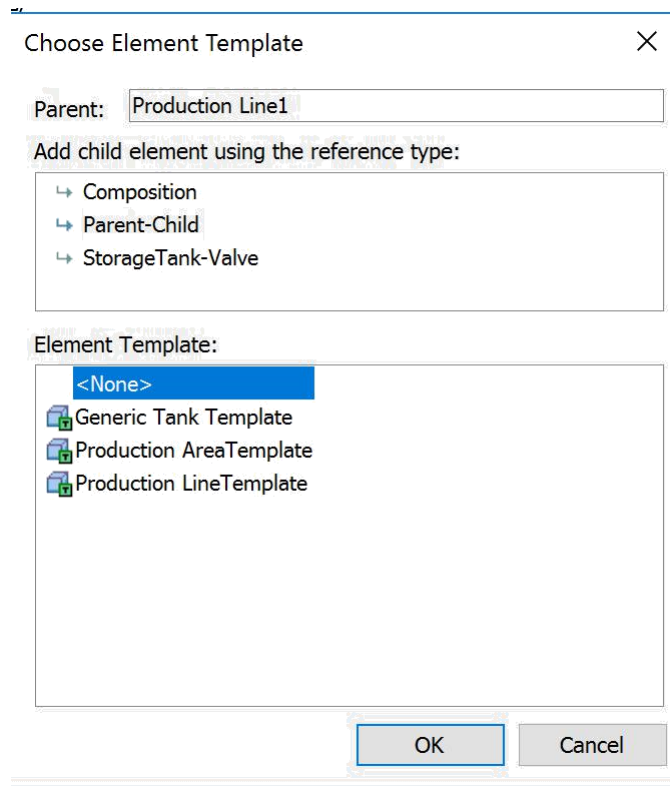
When you start building an Element it can be hard to find tags and fill out all attribute fields. Thankfully, the **Tag Search Palette** process is streamlined. We will create a new **Element** called **Extruder** containing all relevant PI Points.

## Step by step:

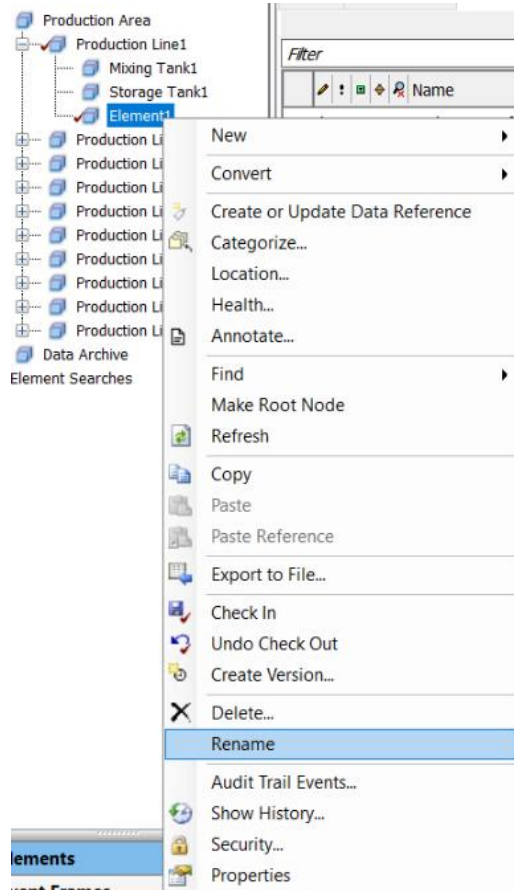
- Step 1.** Navigate to the **Elements** view.
- Step 2.** Open up **Production Line1** location. Right Click on **Production Line1** and select **New Child Element**.



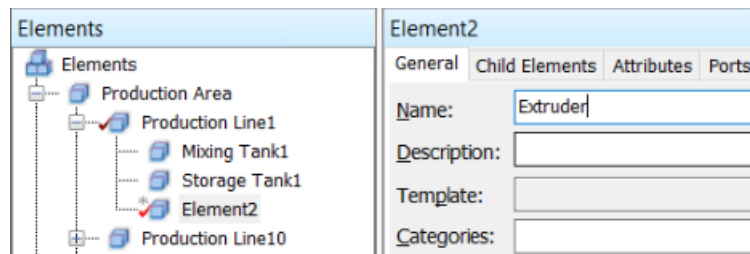
- Step 3.** Choose <None> for the Element Template and click OK.



- Step 4.** Name the non-templated Element **Extruder**. You can press **F2** to rename quickly or right click on the new element.

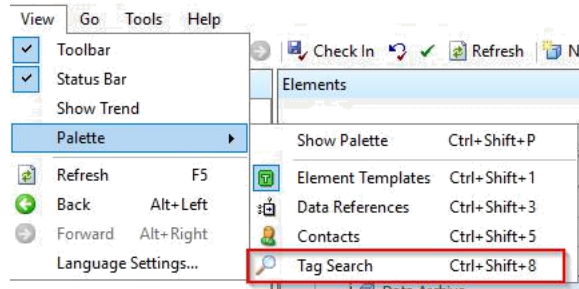


OR

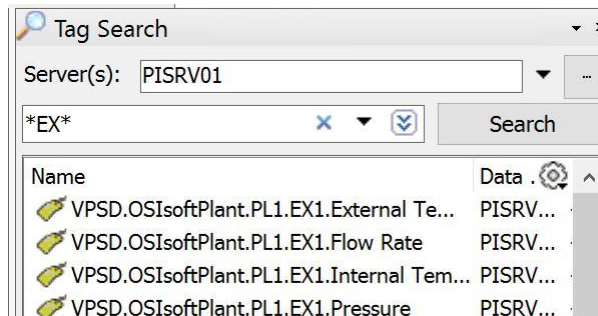


**Step 5.** Navigate to the **Attributes** tab.

**Step 6.** If you have not already opened the Palette, in the **Menu** bar click on **View** and then select **Palette>Tag Search**. (you can also use short cut key combination of **Ctrl+Shift+8**)

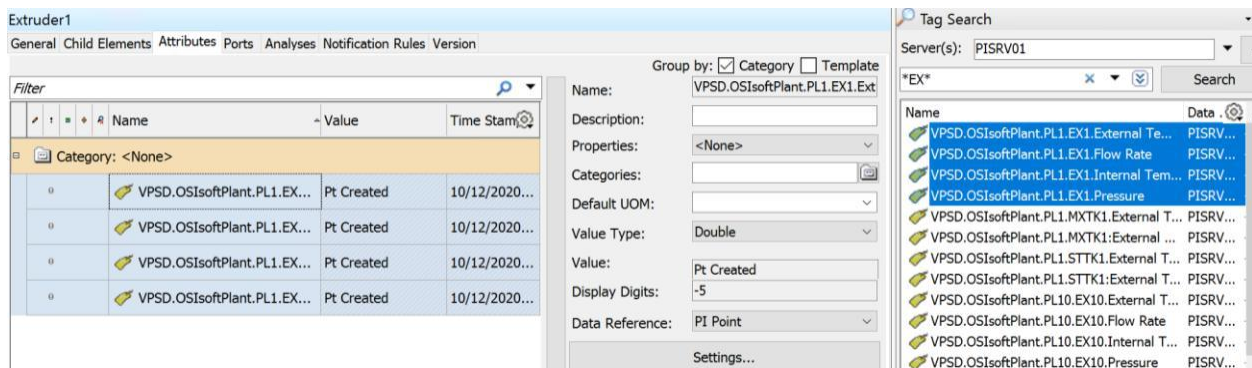


**Step 7.** Search for **\*EX\*** to find the appropriate PI Tags associated with the extruder. The **\*** is either a single or multicharacter wild card.



**Step 8.** As we are currently under Production Line1, Add the tags **\*PL1.EX1\*** for **External Temperature, Flow Rate, Internal Temperature and Pressure** by **clicking and dragging** each tag in the Viewer area. Notice how the description, point type, and UOM match the PI tag definition.

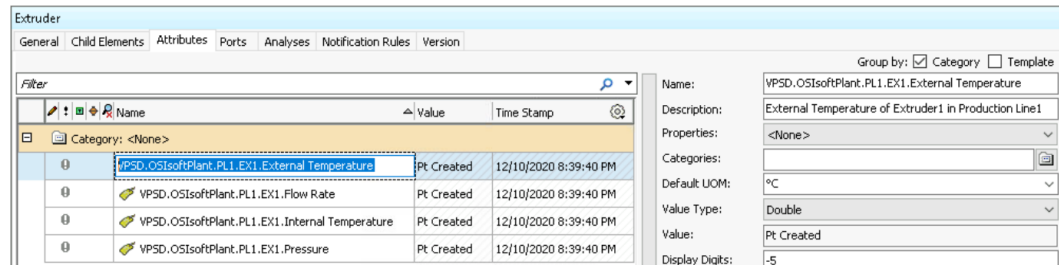
**Note:** The tags can be added individually or all together – by selecting each with the control key selected.



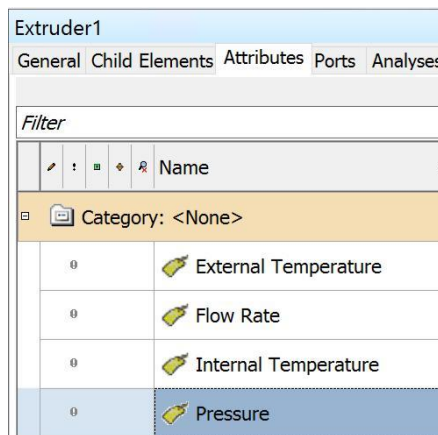
**Note:** The units of the PI Tag must exist in the UOM database before dragging tags from the palette.

**Step 9.** Close the Palette window to allow more space to configure the attributes.

**Step 10.** Once added we can change the individual Attribute names. The names can be updated through the configuration screen, select Name or by double clicking the individuals name in the viewer screen.




**Step 11.** Rename the four attributes as per the following:



**Step 12.** Check-In your changes, by selecting Check In or press the **Ctrl+S** key combination to Check In your changes.

**Note:** We have not discussed the Check-Ins and their need to save changes to the database.

Whenever you make a change to an object, including whenever you create a new object, PI System Explorer checks that object out from the database. You need to save these changes in the database, although you can apply a change to a selected object by clicking  in the toolbar and then check in your changes later.

Live Library link to Check-in database changes: [PI Server 2018 \(osisoft.com\)](http://PI Server 2018 (osisoft.com))

# Hiding Check In and Check Out Dialogs (optional)

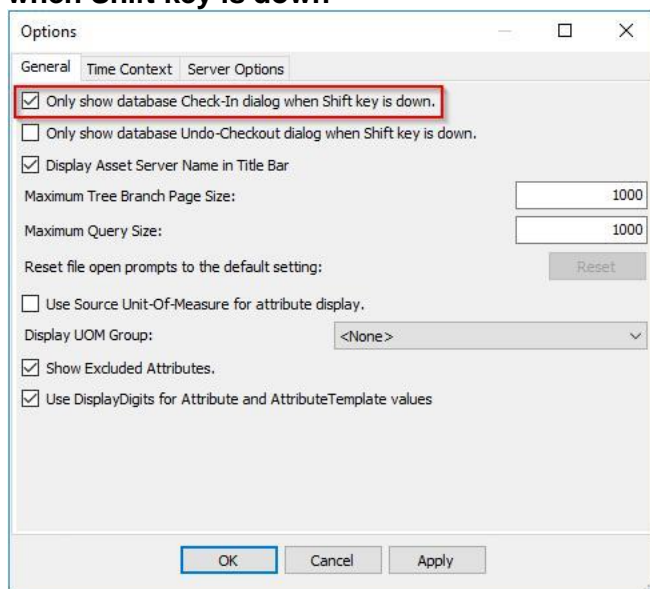
When performing a **Check In**, it is timesaving to avoid the **Check In** dialog.



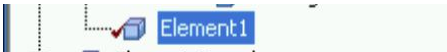
To hide the dialog, you can enable 'Only show database Check-In dialog when Shift key is down' in PSE.

**Part 1:** Create a new element and check it in without the dialog popping up.  
(Database: OSIsoft Plant)

## Step by step:

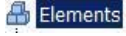

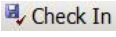
- If you are not in the **Elements** view press the **Ctrl+1** key combination or Select Elements from the Navigator Pane
- In the menu, navigate to **Tools>Options...**
- In the **Options** dialog check the Check Box **Only show database Check-In dialog when Shift key is down**



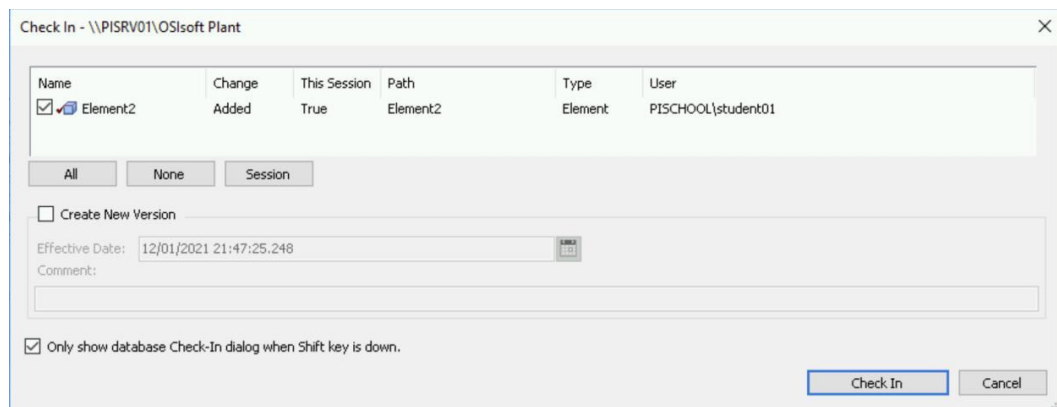
- Click the Apply, then **OK**
- Right click the **Elements** (  **Elements** ) in the **Browser** pane and select **New Element** (choose element template <None>). Alternately, you can also select **Elements** (  **Elements** ) and press the **Insert (Ins)** key.
- Note, a new Element exists named Element1 with a check next to the New Element 
- Press the **Ctrl+S** key combination. The changes are now checked in. (Another option is File → Check In)
- Verification of Check-in can be seen, by the disappearance of the check mark next to the newly created element.

**Part 2:** Create a new element and check it in, but have the **Check In** dialog appear first.

**Step by step:**

- a. Right click the **Elements** (  ) in the **Browser** pane and select **New Element** (choose element template <None>). Alternately, you can also select **Elements** (  ) and press the **Insert (Ins)** key.
- b. While holding the **Shift** key down, click  in the Toolbar. A new screen appears for verifying check-in.


Note that you cannot use the **Ctrl+S** key combination while holding down the **Shift** key.



Check In - \\PISRV01\OSIsoft Plant

Name	Change	This Session	Path	Type	User
<input checked="" type="checkbox"/> Element2	Added	True	Element2	Element	PISCHOOL\student01

☐ Create New Version

Effective Date: 12/01/2021 21:47:25.248 

Comment:

☒ Only show database Check-In dialog when Shift key is down.

- c. Click the **Check In** button in the dialog.
- d. Reset Check-In functionality if you prefer seeing the dialog.

### Asset Hierarchy Design Strategies

In an AF database, assets can be organized or structured into hierarchies. According to its definition a hierarchy is “a system of persons or things arranged in a graded order” ([thefreedictionary.com](http://thefreedictionary.com)). Logical hierarchies of assets or people are common in companies from any industry. They are used to convey the place/location of each entity in the company. Since the AF system is probably not the only enterprise system in your company, other systems in place might already make use of asset hierarchies (maintenance systems, etc.).

Those systems will often have an option to export the hierarchy information into a flat file (.csv, .txt, .xml, etc.). The content of this file can then be opened in Microsoft Excel and be used as a starting point to build the hierarchy in AF using the PI Builder add-in.

**Note:** The whole company does not need to be modeled in AF for you to be able to get value out of it. In fact, the AF structure build-up is often project-driven. This means to begin with, a small structure containing your pumps might be built for use in PI ProcessBook displays. As more and more applications start making use of AF, the structure will continuously grow to include more and more of your assets.

That being said, it is still a good idea to define the various hierarchy levels that will be represented in the AF structure (divisions, locations, production lines, process, etc.) before gradually adding the assets to that hierarchy.

There are several styles for designing asset models in AF.

Even if the following approaches will result in a complete asset model, there will always be more information to add in the future. That is fine and is in fact a relief, since it means the AF model does not need to be perfect and complete the first time.

#### Bottom-up

Often a Data Archive is already in place so one approach is to group the assets by similar Data Archive points. These “similar object” groups become AF element templates, and the “objects” become AF elements. Any foreign data that is available is imported. Next, analytics that may seem useful are added, and finally consumers such as PI ProcessBook displays or PI Datalink reports.

The **bottom-up** approach has the advantage of being a clear, reality-based path to follow. The Data Archive points are known and analytics can be added on top of them.

However, a clear disadvantage is that this approach lacks vision. This approach does not guarantee the result to be useful since the asset model was not built with a particular goal in mind.



## Top-down

Another approach is to start by asking theoretical questions:

- ✓ What is the goal of the asset model?
- ✓ What do the consumers need from AF?
- ✓ What are the business requirements?
- ✓ What analytics will be desirable?
- ✓ What sort of foreign data might be useful?

After answering these questions, the element templates and elements can be sketched, and organized in a hierarchy. Next, AF attributes can be added for the desired data points, even if the source for the data is not known yet. The first stage is simply to add the placeholders for that data, i.e. non-configured attributes. If these attributes are confirmed to be the ones needed, then the analytics can be added, the Data Archive tags can be mapped, and the model can be fully implemented.

This **top-down** approach has the advantage of planning for the usefulness of the AF model. Confidence that the model will be well designed and reusable is assured. This advantage cannot be understated and usually outweighs all of the following disadvantages. One disadvantage is that the design can drift away from reality and be incredibly hard to implement while having little benefit over an easier alternative, which is hard to tell beforehand. Another inherent disadvantage is that much of the available raw data that is not “necessary” will be ignored from the model.

## Design top-down, then work bottom-up

The preferred approach will be a compromise: begin top-down, identifying goals and trying to identify a “good” design for everything, then quickly move to a mix of this theory and bottom-up experimentation. If a piece of data looks useful, add it to the model because it is rarely a mistake to do so.

This planned approach combines the advantages of top-down and bottom-up: assurance that the model will be useful, yet a good grounding in reality and completeness during construction. The steps of this approach are:

- Define the assets.
- Design the element templates and inheritance tree.
- Add attribute templates.
- Configure the attributes to point to foreign data or Data Archive points, all with proper units of measure.
- Add calculations/analytics.
- Test the model using consumers (sample reports, displays, etc.).

## Create an AF Database, Element and Attributes

In previous lessons, connections to the servers and database, search functionality and how to create an element from the palette have been covered.

In this exercise, a new database is being created to start a new element. Attributes will be added to the element with different data reference types.

### Create a database:

You are working for Velocity Terminals, a chemical company producing various chemicals. The company has a number of storage tanks located in different countries that they would like to monitor. You have been tasked with creating an asset model for these tanks in AF.

Open PSE and choose **File > Database**. If PSE does not open and a pop-up appears, click on the **Select** option to get to the Select Database window.

To create a new database, right-click anywhere in the list of databases and choose **New Database** or click on the New Database button on the toolbar.



Enter the name AF Startup into the Name field of the Database Properties window

A description can be added as the usage of the database – in this case, Velocity Terminals test database.

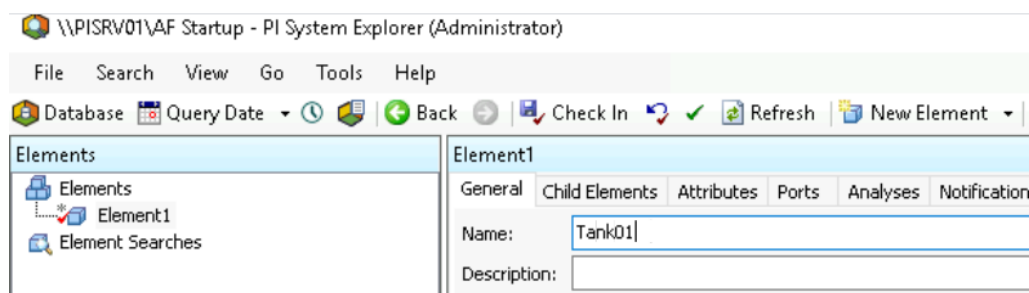
Select OK to complete database creation.

### Now that we have a clean database, let's create your first element:

Make sure the Elements section is selected from the Navigator Panel and create a new element called Tank01.


From the Browser, right-click on  **Elements** and select **New Element** or click the  **New Element** button from the toolbar and select <None> as the element template.

Under the **General** tab from the Viewer, change the default name of the element to **Tank01**.



Notice the small check mark next to the newly created Tank01 element. The check mark indicates, changes are being made to the database and have not be 'saved'.

## Create AF Attributes

From the Viewer, select the **Attributes** tab and then right-click on the white space to select **New Attribute** to define attributes or click the  **New Attribute** button from the toolbar.

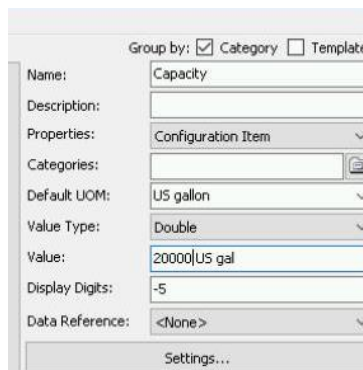
As with elements, attributes must also be uniquely named along their path within the element they belong to. Attributes can have a configured constant value or can get a value dynamically from a Data Reference.

Let's create a static capacity value for the Tank.

Rename Attribute1, to Capacity, by double clicking Attribute1 in the viewer pane or navigating to the Name field in the configuration pane.

Set the Unit of Measure to US Gallons (it will be under the Volume class). Setting the UoM is important to prevent misinterpretation of the measurement. The Unit of measure will be displayed with the attributes value.

Set the Value type as a Double with a default value of 20,000.



Since the Capacity attribute is a static value, the Data Reference is <None>.

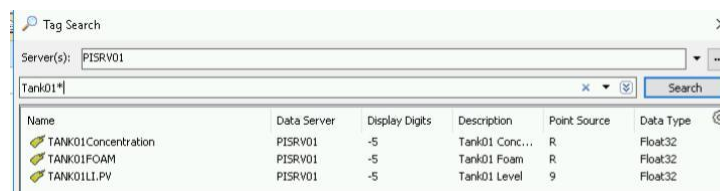
Let's go a little deeper in setting up two more attributes, each will use another form of data reference.

Attribute Name	Default UOM	Value Type	Value	Display Digits	Data Reference
Level	% (Ratio)	Double	N/A	2	PI Point
Volume	m3 (Volume)	Double	N/A	3	Formula

Another method of creating a new attribute is to right click in the viewing pane, then select New Attribute.

Start entering the Level attribute information. Default UoM as %, Value Type Double, and Display Digits 2. After setting the Data Reference to PI Point, select the Settings button.

A search window will display – verify the Data Server is PISRV01, then either enter Tank01LI.PV in the field next to the Tag Name OR select the tag search (magnifying glass) and enter a portion of the tag name (for example, tank01\*). (The tag search may need to be reset to remove any cached information.) After selecting the tag name, select OK.



The current value of TANK01LI.PV will display in the Value column.


Let's add one more attribute to the Tank01 element.

Add the Volume attribute. Enter the Unit of measure as m3 located under the Volume class. Another means of setting the Unit of Measure is to type the abbreviation into the field.

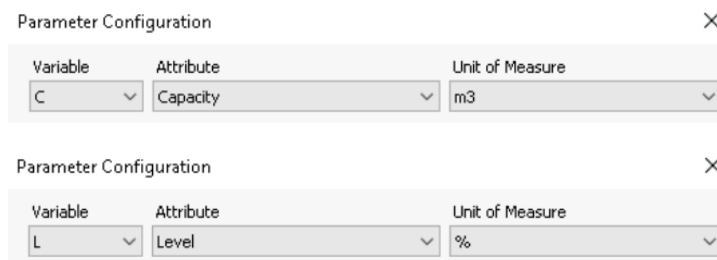
For this attribute, we are going to use a **Formula** Data Reference. Press the Settings button to finish the configuration.


- Use the new button (  ) to add parameters to use in the formula.

### Volume Attribute

- Select the **Volume** attribute.
- Click on **Settings...** to bring up the Formula Configuration window.
- Use the formula data reference to calculate the volume using the level (%) and the capacity (m3).
- Use the new button (  ) to add parameters to use in the formula.

Two previously created attributes are being used in this formula. Capacity and Level to calculate the volume.



- Click the New Button, then expand the list of functions from the equations section (  ) to pick the operators/functions to use in the formula.

Formula Configuration:(Volume)

**Parameters**

C=Capacity;UOM=m3  
L=Level;UOM=%

☐ Default Values Allowed

**Equations**

C\*(L/100)

**Result**

UOM: m3 Minimum: Maximum: ☐ Stepped

Evaluate

OK Cancel

- For completion, select Check In to save the changes in the database.

## Units of Measures in Formulas

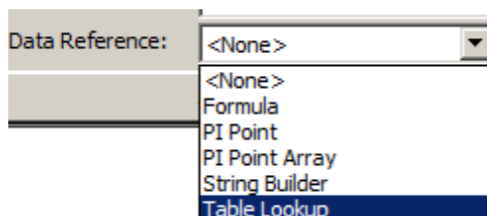
You can perform unit conversions by setting the units of measure (UOM). Units of measure can be explicitly set for the parameters as well as for the result. Do this from the parameters configuration section by choosing the appropriate UOM from the *Unit of Measure* drop down. Do this also in the *Result* section at the bottom left.

**Note:** It is recommended that you **always** assign the units explicitly! If you leave units selector at "<default>" then no unit conversion takes place. If the default UOM of an attribute is changed later on, then no corresponding conversion will happen and results will not be correct!

## Create an AF Table


Building the table is similar to building a table in other programs that have simple table building capabilities.

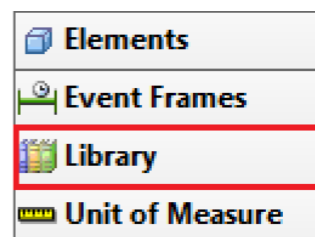
Tables are held in the AF database to provide contextual information through the **Table Lookup** data reference. Tables can provide information about the equipment or process entities or they can be used to store tag names or other configuration information to be used in AF.



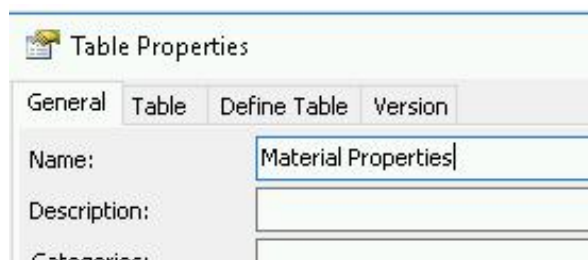
In the PSE, first verify the AF Start up database is selected.


Then navigate to the **Library** section from the Navigator Panel.

Right-click on the **Tables** item to select **New Table**, or click on the  **New Table** button from the toolbar or from the link in the viewer.




Under the **General** tab, change the name of the table to “**Material Properties**”.



Select the **Define Table** tab and add two (2) rows by right-clicking in the blank area to select **Insert** or by selecting the starburst “Insert a row” button () on the right-hand side. Define the table as follows:

Column Name	Value Type	Unit Of Measure
MaterialID	String	<None>
Density	Double	kg/m3 (Density)

 Table Properties

General Table Define Table Version

Material Properties

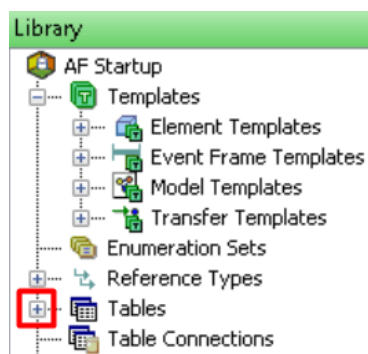
Name	Value Type	Time Zone	Unit Of Measure
MaterialID	String	<None>	<None>
Density	Double	<N/A>	kg/m3

Under the **Table** tab, enter the following fictitious chemicals:

MaterialID	Density
AQ4500	2100 kg/m3
HC1500	3422 kg/m3
WX1200 Old Recipe	8943 kg/m3
WX1200 New Recipe	9213 kg/m3

After completing the information in the table, select Check-In to save the information to the database, then press OK to exit the Table Properties window.

Now, a plus (+) sign appears next to tables, indicating a table exists.



Tables can be created internally (like in this exercise), 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. For further information on tables and other advanced AF topics with 'Asset Framework: Beyond the Basics' or with [LiveLibrary](#).

## Create an AF Enumeration Set


An enumeration set is an ordinal list of sequential integer values, which are mapped to names. It allows AF attributes to refer to a common term instead of a number. This is analogous to the Data Archive digital state sets used by Digital points. It is not needed to rebuild the digital state sets or maintain them in AF. Enumeration sets are just a meaningful way to display information, perform data validation and maintain data consistency across the AF structure.

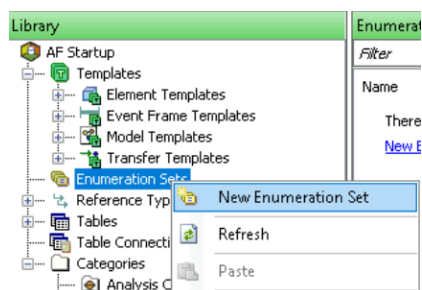
Enumeration values can be nested in hierarchy. The hierarchy can have as many levels as needed. In our case, WX1200 is produced with different recipes, which results in different physical characteristics and density values. By adding an additional level below the WX1200 value we can distinguish between the old and new recipe.

An enumeration set is a table that correlates numbers with strings. Enumeration sets allow attributes to be trended based on their numeric string equivalent. Enumeration sets are analogous to digital state sets used in the Data Archive.

Be sure you are in the AF Startup Database.

From the Navigator Panel, select the **Library** section.

Right-click on the **Enumeration Sets** item to create a **New Enumeration Set**, or click the  **New Enumeration Set** button from the toolbar or from the New Enumeration Set link in the viewer.



Update the name to **MaterialID**.

Enter the material IDs from the table below as the names of that set:

Value	Name
0	AQ4500
1	HC1500
2	WX1200

In the last lesson, a table was created with an Old and New Recipe associated with material id WX1200.

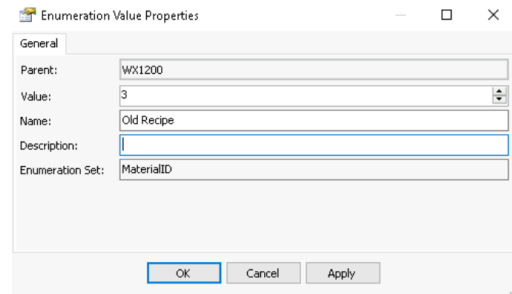
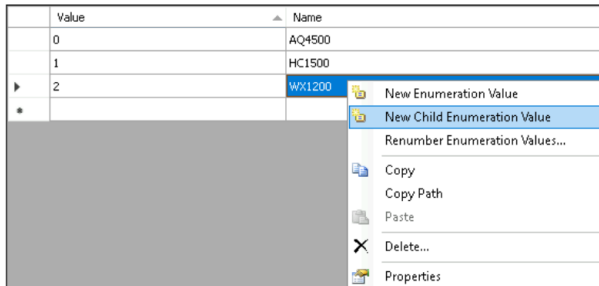
To distinguish WX1200 produced with either the old or new recipe, we will add two child values in a level below WX1200:



Value	Name
3	WX1200 Old Recipe
4	WX1200 New Recipe

Select the name value associated with WX1200 and right click to create a new Child Enumeration Set.

Enter the value of Old Recipe or New Recipe. The above information will be displayed in the enumeration set table.



Repeat creating a Child Enumeration Value for the New Recipe.

Check-In changes to save them to the database.

# Unit of Measures Overview

The units of measure (UOM) feature allow automatic unit conversions for data values. Within AF a measurement can be stored in one technical unit for a measurement and displayed with a different unit of measure within the same measurement class.

For example, suppose AF attributes of a tank represents the diameter and the height and have a UOM of meters. AF considers the selected unit of measure. This provides the option to show the diameter and height in other units than in meters, e.g. to show it in inches. Another consideration is in attributes with a formula. It is possible to calculate the tank volume in liters based on the physical dimensions provided in meters. AF does the automatic conversion for you.

The relations between UOMs are defined with simple or formula conversion methods.



There is **one** repository with all **units of measurement** (UOMs), which is shared by **all** AF Databases. In other words, the UOMs defined for one AF database on your server is used in any AF database on your server.

Unit of Measurements are organized in **UOM classes**. UOM classes represent measurable properties, such as temperature, length, time, and mass. To facilitate region specific use of UOMs, the UOMs are associated with a **UOM group**, which can either be *Metric* or *US Customary* (additional UOM groups can be defined).

Unit of Measure classes can be modified or the database can be expanded or added to based on your specific requirements.

In this course, we are restricting our usage to assigning unit of measures to measurements and exploring Unit of Measures.

Explore the **Unit of Measure** class **Length**:











1. Navigate to Unit of Measure and from the list of UOM classes, locate the UOM class for *Length* and display its properties. What is the canonical UOM?
2. From the list of UOMs for *Length*, open the Properties for centimeter (right click on cm and select properties). What is the conversion between meter and centimeter? What is the corresponding unit for the US Customary UOM group?


Scroll down for the answers.....

Canonical UOM – will have the same value of the unit and will have a check mark by the name.

Answers:

1. Meter
2. 1 cm = 0.01 meter; either yard or foot (ft)

Length				
Filter				
Name	Abbreviation	Class	Origin	Canonical
 centimeter	cm	Length	System Defined	0.01 m
 foot	ft	Length	System Defined	0.3048 m
 inch	in	Length	System Defined	0.0254 m
 International nautical mile	nmi	Length	System Defined	1852 m
 kilometer	km	Length	System Defined	1000 m
 meter	m	Length	System Defined	1 m
 mile	mi	Length	System Defined	1609.344 m
 millimeter	mm	Length	System Defined	0.001 m
 sixteenth of an inch	sxi	Length	System Defined	0.0015875 m
 yard	yd	Length	System Defined	0.9144 m

 Unit of Measure Properties

General

Name:

cm

Abbreviation:

cm

Description:

Origin:

System Modified

Canonical UOM:

m

Reference UOM:

m

Method:

Type

☒ Simple

☐ Formula

Factor:

0.01

Offset:

0

0.01 m

Time-Weighted Total Result UOM

Automatic:

milli-inch per year

Per-Day:

UOM Group Mappings

Group	Mapping
Metric	
US Customary	in

OK

Cancel

Apply

For future reference, creating new and editing existing UOMs can be made in the database.  
Click on ***Unit of Measure*** in the PSE Navigator to edit UOMs, UOM classes and UOM groups.









Creating New

Editing existing

### Attribute Data Reference Types

Attributes represent a unique property associated with an asset. The *Data Reference Type* of an attribute defines from where to get the data for the attribute. The following Data Reference Types exist:

-  PI Point
-  PI Point Array
-  Formula
-  Table Lookup
-  String Builder
-  URI Builder

**Note:** <none> means there is a static value for this attribute

### Data Reference Types Examples:

PI Point	\\MyPIDataArchiveServer\sinusoid
PI Point Array	\\MyPIDataArchiveServer\Point.1  Point.2 Point.3
Table LookUp	SELECT Density FROM [Material Specifications] WHERE <u>MaterialID</u> = @Product
String Builder	"%Attribute% value is"
Formula	D= <u>Density</u> ;V=Volume;[D*V]
URI Builder	https://MyDataServer.int:443/Coresight/#/displays /AdHoc?DataItems=\\pisrv1\Tanks\Tank1 Level &Mode=Kiosk

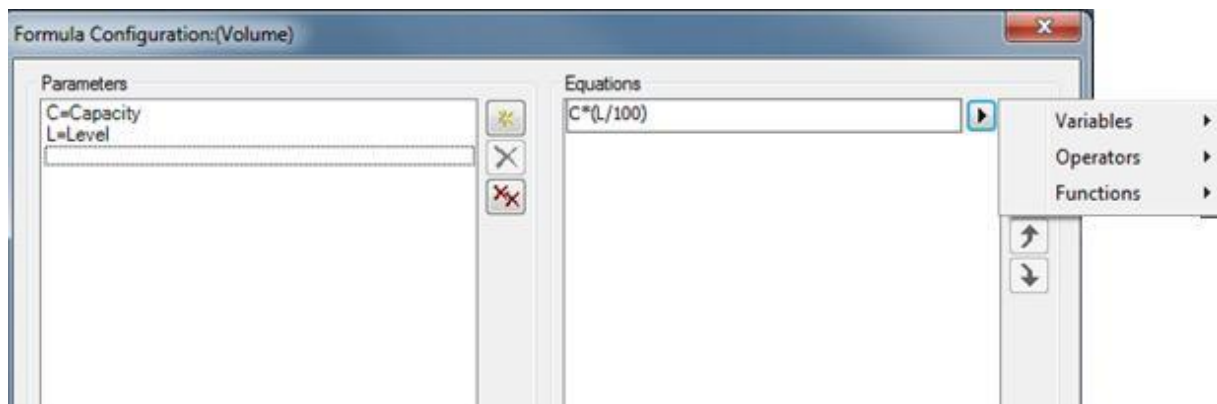
## Formula Data Reference

Formula data reference allows you to perform **simple** calculations that are evaluated on-the-fly by the client application (e.g. PI Vision, PI DataLink). Performance issues can arise in case of long dependency chains (i.e. when a Formula needs to wait for its input values coming from a chain of other Formulas). The best solution is to move the calculation to Asset Analytics (discussed in Asset Analytics: Basics course) and use PI Points to store the calculation results.

Earlier, we created a Formula Data References to determine the Volume of a tank based on the static value of the tank's capacity and the current level of the tank.

Formula Data References allow the creation of simple custom calculations. Calculations can be in the form of a single formula or a sequence of calculations. The calculations are executed on demand, and the results are not archived anywhere. The functions available are limited and they are not time-weighted.

Below is the calculation we created earlier in our Tank01 Element.



We can add an additional calculation to the formula to discard values below a specific level (to potentially take in the deviation error into account).

Verify the database is **AF Startup** in PSE.

Navigate to **Elements** in the Navigator Panel, then select the **Tank01** element.

Select the **Attributes** tab in the viewer pane and select the **Volume** attribute.

Select **Settings...** from the configuration pane, to add an additional formula to the configuration.

As stated, if the result is less than a specific value, we want a 0 to display due to measurement tolerance values.

In order to use the result of Volume in another formula and eliminate getting a circular reference error, the initial equation needs to be modified.

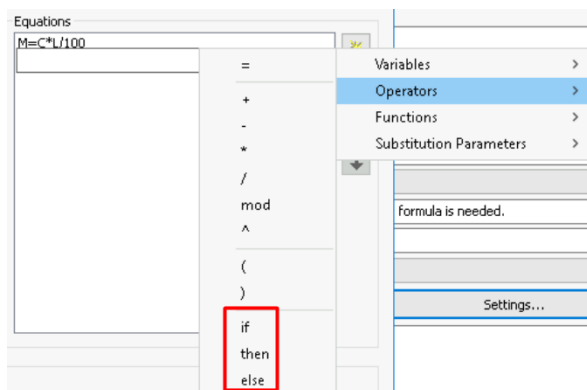
- Double click the equation (or Highlight) the original equation to edit the formula.



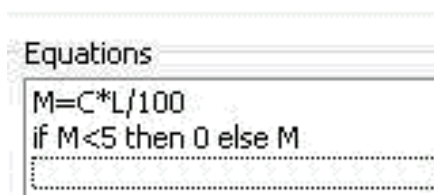
- Place the cursor at the beginning of the equation and enter **M=**, so the full equation is now  $M = C \cdot L / 100$
- Now, select New in the Equation section of the Formula Configuration window.



The following equation can be typed into the field or the formula can be input through the use of the menu structure:



IF  $M < 5$  THEN 0 ELSE M



To verify your formula is working, select **Evaluate** while the formula is highlighted.

Result

UOM: m3 Minimum: Maximum: ☐ Stepped

**Evaluate** 9.18371087480482 m3

OK Cancel

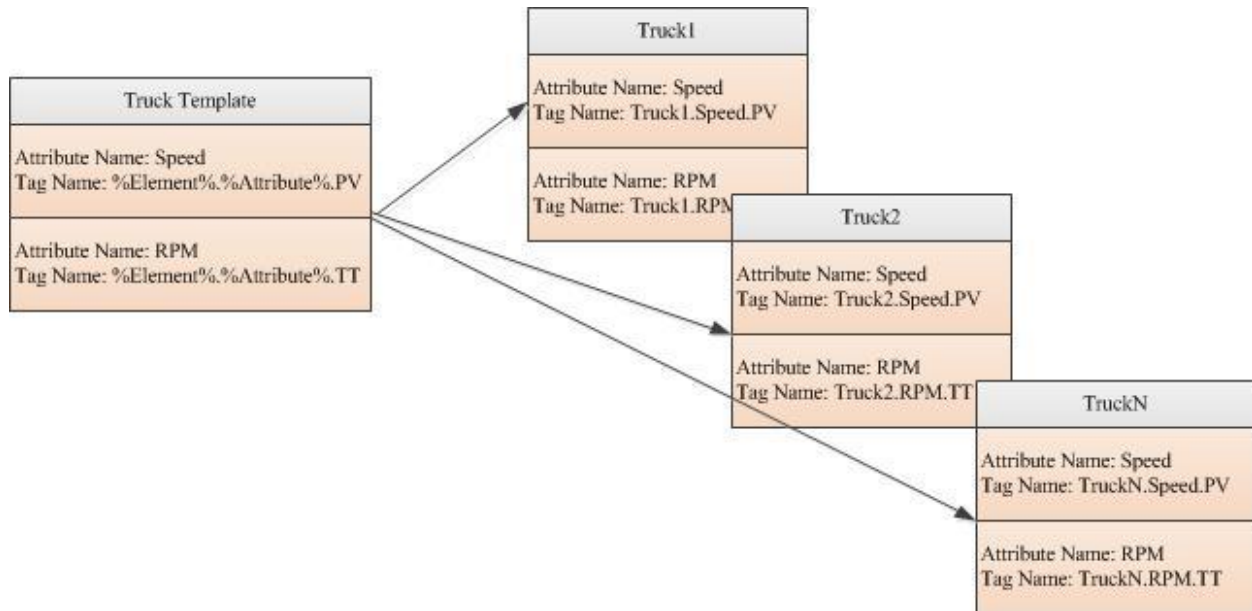
Accept the formula changes by clicking OK. Then Check In your changes.



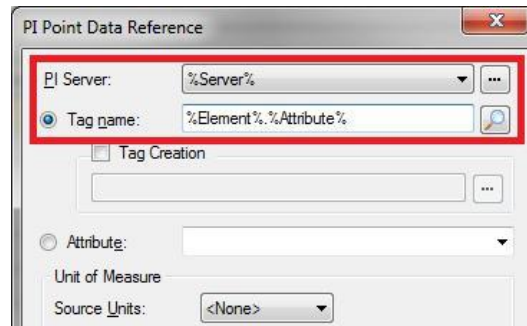
## Substitution Parameters in an Attribute Template

Substitution parameters are variables that be placed in attribute templates for PI point data references. AF resolves a substitution parameter when elements are created. As an example, the substitution parameter *%Element%* would resolve to the attribute's element name.

For example, in a truck template, the tag for the speed attribute is configured as *%Element%.%Attribute%.PV*. Once Truck1 is created from this template, AF would try to find a tag named Truck1.Speed.PV.



Notice the default configuration for a PI Point Data Reference attribute template:  
*\\%Server%\%Element%.%Attribute%.*



Substitution parameters can also be applied in Table Lookup and String Builder Data References.

## Defining the Substitution Parameters

AF supports numerous substitution parameters, which can be used in attribute templates. The following table lists the ones most commonly used.

Parameter Name	Substitution
%Attribute%	Name of the attribute that holds this data reference.
%Description%	Description of the attribute that holds this data reference.
%Element%	Name of the element in which the attribute resides. For event frames, this refers to the name of the primary-referenced element.
%..\Element%	Name of the parent element of the element in which the attribute resides. To retrieve further ancestors, use the ..\ notation, such as %..\..\Element%.
%Server%	<p>Name of the default Data Archive for the computer on which you create the attribute. The default Data Archive for the computer on which PSE is running.</p> <p><b>Note:</b> The %Server% parameter does not resolve to the computer on which the AF database resides. The %Server% parameter can resolve to a different Data Archive depending on the default in AF Client.</p>

[LiveLibrary Link](#) to substitution parameters in data references.

## Creating a Template from an Element

So far, in our Velocity Terminal database, an element and attribute have been created. Now we are moving to one of the advantages of AF – templates.

Verify you have PSE open and the database set to AF Startup.

Select **Tank01** from the Browser (verify the **Elements** section in the Navigator Panel is selected) and right-click on it to select **Convert > Convert to Template** (note this does not delete or change the element, but does set it to a new template).

When converting you have to decide, how the PI Point Data Reference for the Level attribute should be set. Select **Substituted**, which will set the PI point name according to a naming pattern rule.

The default naming rule is %Element%.%Attribute%.%ID%.

Under *Suggested Point Name*, enter **%Element%LI.PV** and click *Apply*. Be sure to deselect 'Include Tag Creation'.

Convert Attribute to Template

These attributes have data references to specific PI Points.  
Choose how each data reference should be defined in the template by selecting and/or editing the choices below:

Suggested Point Name:

☐ Include Tag Creation

Attribute	<input type="checkbox"/> Current	<input checked="" type="checkbox"/> Substituted	<input type="checkbox"/> No Data Reference
Level	<input type="checkbox"/> \\PISR\01\tank01LI.PV;UOM="%"	<input checked="" type="checkbox"/> \\PISR\01\%Element%LI.PV;UOM="%"	<input type="checkbox"/>

If you create elements for another tank based on the template, the substitution parameters in the point reference (enclosed with %) for the *Level* attribute will be replaced according to the name of the new element:

Naming Pattern: %Element%LI.PV	
Element Name	PI Point Name
Tank02	Tank02LI.PV
Tank03	Tank03LI.PV
Tank04	Tank04LI.PV
etc.	

]

Substitution parameters were discussed in the previous lesson.

Substitution parameters can be confusing at times, so we will briefly review their usage in this template and attribute.

In this case, the level tags were previously created with a defined nomenclature: Element Name including tank number, followed by LI.PV where LI = Level Indicator and PV denotes process variable. In later lesson, as we create additional Elements with the template, the advantage of templates and substitution parameters will become apparent.

Check-In the changes.



A screenshot of a 'Check In' dialog box for 'AF Startup'. It contains a table with columns: Name, Change, This Session, Path, Type, and User. Two items are listed: 'Tank01' (Edited) and 'TankTemplate' (Added). Both have 'This Session' set to 'True'.

Name	Change	This Session	Path	Type	User
Tank01	Edited	True	Tank01	Element	PISCHOOL\student01
TankTemplate	Added	True	TankTemplate	Element T...	PISCHOOL\student01

Let's verify the template has been created (the check-in screen already verified it, but....)

Navigate to Library → Element Templates → The Tank Template should be visible in the browser.



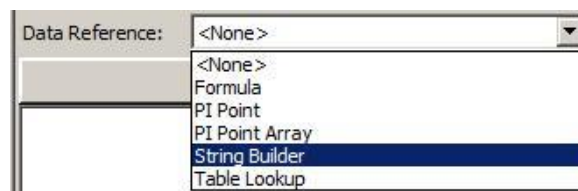
## String Builder Data Reference

The *String Builder* data reference allows you to use substitution parameters and functions to manipulate values and output a string.

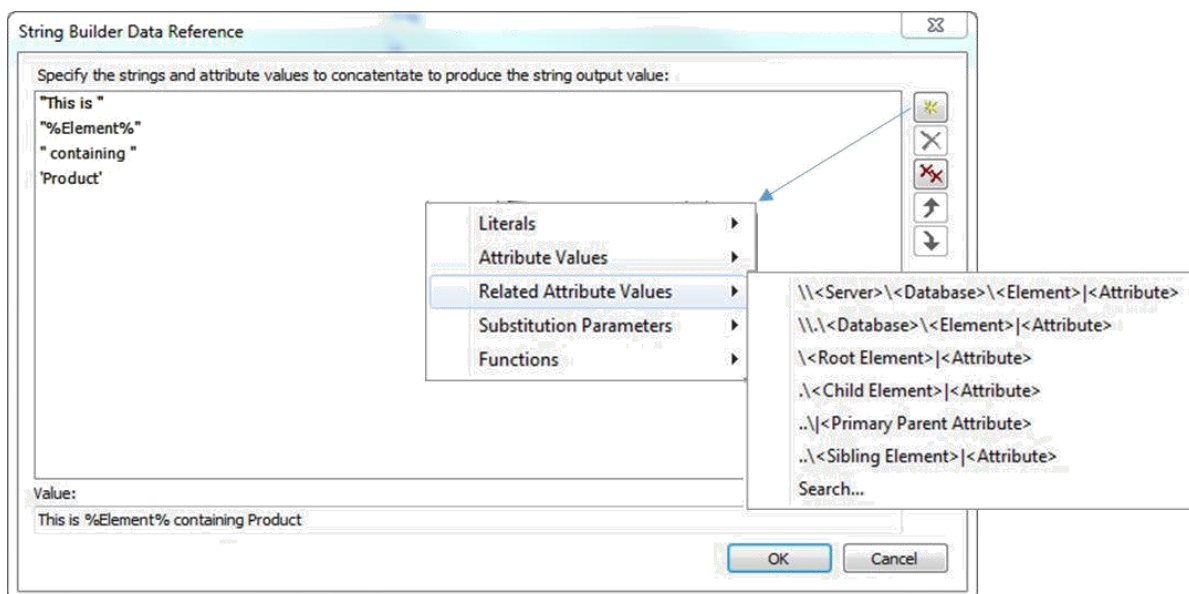
Below some cases where the *String Builder* data reference is useful:

- ✓ Concatenate strings (Element Name + Attribute Name + Value).
- ✓ Format dates and numbers.
- ✓ Build paths to elements and attributes.
- ✓ Parse comments from operators stored in PI tags.
- ✓ Display element information as an attribute.

**Note:** Since this data reference supports substitution parameters, when used in a template, value substitutions takes place at run time.




*String Builder* allows you to manipulate strings located anywhere in your hierarchy by using the *Related Attribute Values* contextual menu (see figure below).



## Adding to the Hierarchy

### Add attributes to the template

Locate your new element template from the **Library > Templates > Element Templates** section and change its name to “**Tank**”.

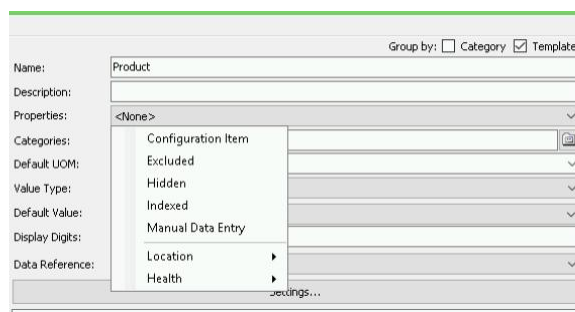
Under the **Attribute Templates** tab of the *Tank* template, add four (4) new attribute templates by clicking the  **New Attribute Template** button from the toolbar.

Attribute Name	Default UOM	Value Type	Data Reference	Display Digits
Product	<None>	Enumeration Sets > MaterialID	<None>	(*)
Density	kg/L (Density class)	Double	Table Lookup	-5
Mass	kg (Mass class)	Double	Formula	-6
Tank Name	<None>	String	String Builder	(*)

**Note:** though the display digits are not applied for non-numerical values, the default value for Display Digits (-5) will be displayed, do not change the value.

#### Product Attribute

When you create the Product attribute, enable the **Configuration Item** Property.



#### Density Attribute

Configure the **Table Lookup** data reference for the **Density** attribute using the following:

Table	Result Column	Where
Material Properties	Density	MaterialID = @Product

Table Lookup Data Reference

Table: Material Properties

Result column: Density

Unit of Measure: kg/m3

Behavior

Rule: Select first row matching criteria

Order by: <None> ASC

Where

Column: MaterialID Operator: = Attribute or Value: @Product

Add And

Add Or

Complete WHERE Clause:

MaterialID = @Product

After entering the Where clause information, select either 'Add And' or 'And Or' to complete the WHERE Clause.

Select OK

### Mass Attribute

Configure the **Formula** data reference for the **Mass** attribute using the following:

Parameters			Equations
Variable	Attribute	Unit of Measure	D * V
D	Density	kg/L	
V	Volume	L	

Formula Configuration

Parameters

D=Density;UOM=kg/L

V=Volume;UOM=L

Equations

D\*V

Note we are converting the Volume from US gallons to L in this calculation.

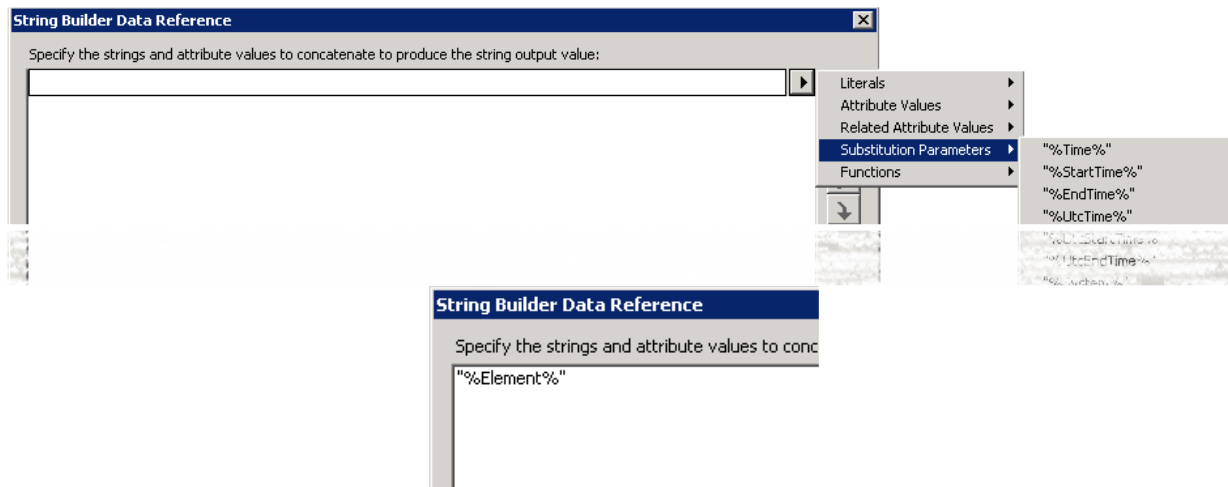
Select OK.

## Tank Name attribute


This attribute will use String Builder as the Data Reference. To configure the attribute for *Tank name*.

Select *String Builder* from the *Data Reference* dropdown selection and click on the Settings...

Click on the Add New String  button, click on  to get further selection options, then select "%Element%" from Substitution Parameters:



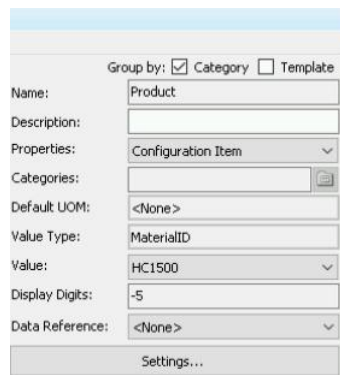
Select OK

 Check In the changes.

Now to examine one advantage of using templates.

Go back to the **Elements** section, select the **Tank01** element and look at its attributes.

Pick material "HC1500" in the Value field for the **Product** attribute enumeration list.



and then click on  Refresh.

Note the value of the Density attribute. Check the correct tank name.



Tank01

General Child Elements Attributes Ports Analyses Notification Rules Version

Filter

Name	Value	Time Stamp
Category: <None>		
Capacity	20000 US gal	1/1/1970 12:00:00 AM
Density	3.422 kg/L	1/1/1970 12:00:00 AM
Product	HC1500	1/1/1970 12:00:00 AM
Tank Name	Tank01	1/1/1970 12:00:00 AM
Level	29.239 %	9/20/2021 2:41:51 AM
Mass	75750 kg	9/20/2021 2:41:51 AM
Volume	22.136 m3	9/20/2021 2:41:51 AM

**Note:** Elements should always be created from a template, even if at the moment of creation only one asset would make use of that template. This ensures consistency in the creation and management of AF elements.

However, for elements that would act only as organizing assets (folders) and that have no attributes, a template is not required.

# Creating an Element from a Template

In the last lesson, a template was created for tanks.

In this exercise, we will create a new element based on the Tank template.

A new element can be created from either the Library or Element Navigation Path.

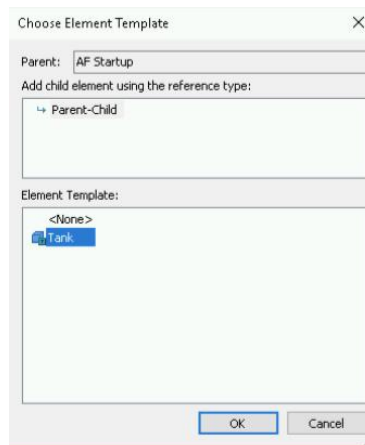
From Library:

Navigate from Templates → Element Templates → Right click on Tank → select New  
→ Then New Element

From Elements:

Right click on Elements → select New Element

Upon selecting New Element, choose the Tank Element Template



A new element is created in the hierarchy. Note it has the same characteristics as Tank01.

Navigate to the **General** tab of the new element.

Rename the Element to **Tank02**.

Update the attributes as indicated below for Tank02. Remember the capacity is a static value and Product is selected from an Enumeration Set.

Attribute Name	Value
Capacity	30,000
Product	AQ4500

Check-In the changes and select Refresh.

All attributes should have values after the refresh. (Note values will not exactly match the screenshot below.)

Elements

Elements

Tank01

Tank02

Element Searches

Tank02

GeneralChild ElementsAttributesPortsAnalysesNotification RulesVersion

Filter

Name

Value

Display Digits

Value Type

Unit

Category: <None>

Capacity

30000 US gal

-5

Double

US gallon

Density

2.1 kg/L

-5

Double

kilogram

Level

39.09 %

2

Single

percent

Mass

93221.1 kg

-6

Double

kilogram

Product

AQ4500

-5

MaterialID

<None>

Tank Name

Tank02

-5

String

<None>

Volume

44.391 m3

3

Double

cubic met


## Adding Layers to the Hierarchy

Our assignment was to create an AF hierarchy representative of our process which includes the location of the storage tank.

You are working for Velocity Terminals, a chemical company producing various chemicals. The company has a number of storage tanks located in different countries that they would like to monitor. You have been tasked with creating an asset model for these tanks in AF.

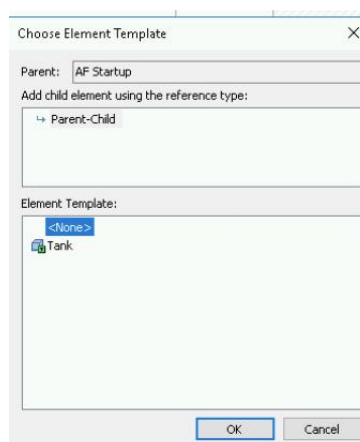
Elements can be moved under other elements (then called Parent Elements) in order to represent a logical hierarchy to be used by your applications

You can move elements around in the *Viewer* using the mouse and keyboard. This will result in creating an element reference, or making a copy of the element or simply moving it.

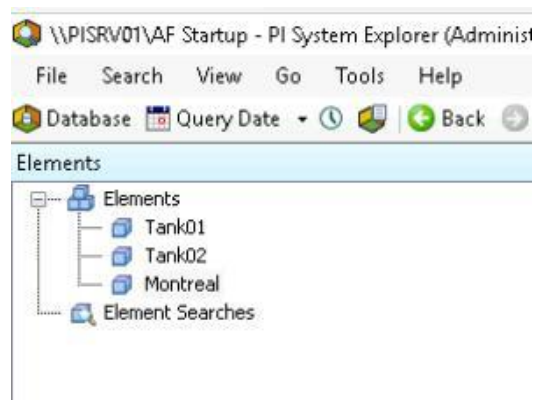
Dragging an element while pressing the...	Action
Ctrl Key	Copies the original element under another parent element. The original and the copy will not be linked.
Shift Key	Moves the element.
No key	Creates an Element Reference. The element will now exist in two places in the hierarchy. In this case, the element icon has a “link” designator (  ) , like in the case of a file shortcut.

In retrospect, you realize Tank01 and Tank02 are located in Montreal, Canada. The hierarchy needs to be updated to indicate the location of the tanks.

From the Elements Browser, right click on Elements → select New Element with <None> for Element Template → press OK.



Navigate to the General tab and rename the element to Montreal. Check in the changes.



Select a tank with the mouse and **drag and drop** it while holding the **Shift key** on the keyboard in order to move the element under the Montreal element so it becomes child element of that location.

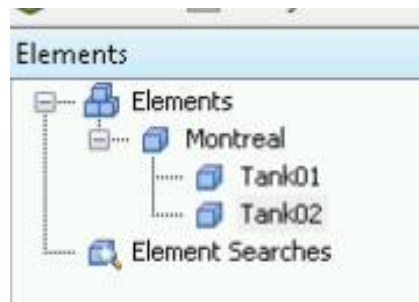
Select the **Parent-Child Reference Type** for each tank element.



After moving Tank01:



Repeat for the second tank. Check-in the changes.

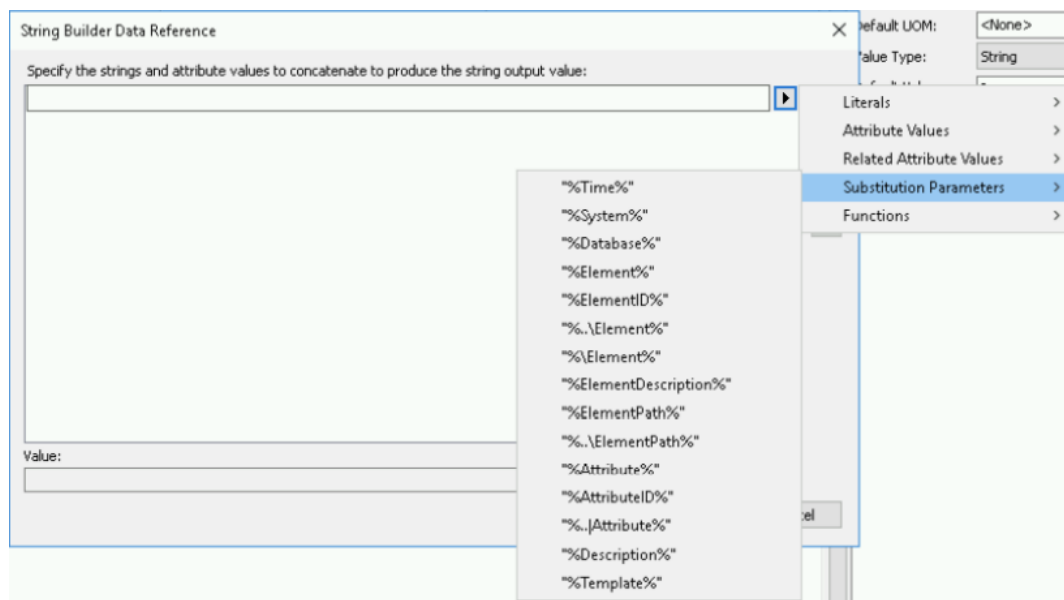


Now that the location is part of the hierarchy, we would like to create a new attribute called *Tank Level Information* on the Tank Template with information in a string like the following:

Tank01 is located in Montreal, level is at 99.8%

### Approach

1. From the Navigator Panel, select the **Library** section. Open the **Tank** Template under Templates → Element templates.
2. Add the **Tank Level Information** attribute, value type= String, Data Reference= String Builder.
3. Use the String Builder Data Reference dialog box to construct the string:



One option to create the requested string:

```
String Builder Data Reference

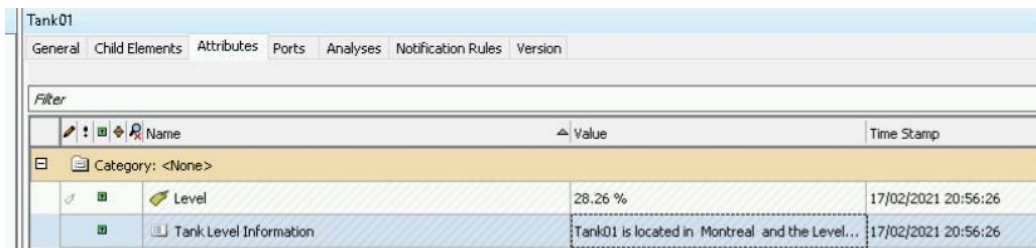
Specify the strings and attribute values to concatenate to produce the string output value:

"%Element%"
" is located in "
"%..\Element%"
" and the level is "
Format('Level', "%3.1f")
%
```

**Note 1:** to display the level value in the requested format (one digit after the decimal point), use the *Format (real,format)* function in String Builder. Format follows Performance Equation (PE) style syntax, e.g.: "%3.1f". The number before the decimal indicates the minimum total number of characters to output, pre-padding with blanks, the number after the decimal indicates the number of digits to display after the decimal point.

**Note 2:** You can construct an expression on a single line, using semicolons to separate its terms. But you can also place each term on its own line, which eliminates the semicolons and makes the expression structure more apparent (see above).

4. Click on Check-In
5. Navigate to Elements in the Navigator Pane, select Tank01 in the Browser, and select the Attributes tab. Verify the attribute string for the Tank Level Information is as expected. If required, correct the String Builder definition. (Be careful with the use of single and double quotes.)



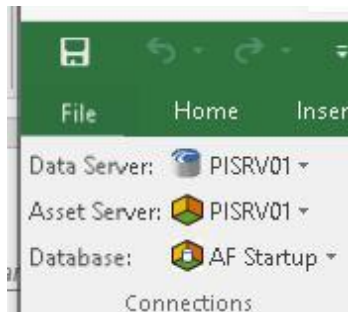
Tank01			
General Child Elements Attributes Ports Analyses Notification Rules Version			
Filter			
	Name	Value	Time Stamp
	Category: <None>		
	Level	28.26 %	17/02/2021 20:56:26
	Tank Level Information	Tank01 is located in Montreal and the Level...	17/02/2021 20:56:26

## Bulk edits of the AF Hierarchy

PI Builder is an add-in to Microsoft Excel allowing rapid creation and edition of AF objects and PI points in bulk.

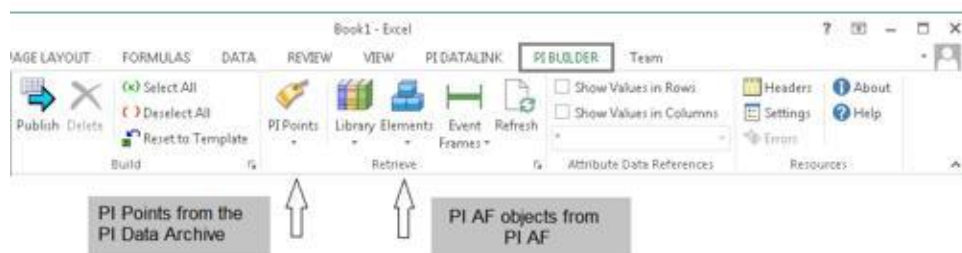
Open **Microsoft Excel**, to a blank worksheet and select the **PI Builder** ribbon menu. (An activation message will appear – X out of the wizard. We have a license but due to the transient nature of the virtual environments the license is not validated.)

In the **Connections** section, select the Asset Server (AF Server: PISRV01) and the AF database (AF Startup).



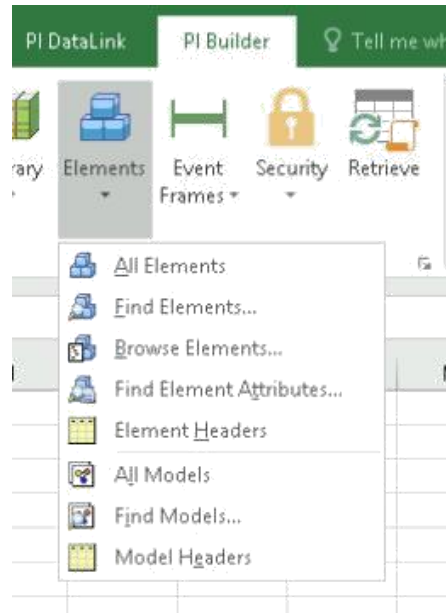
It maybe necessary to select AF Startup as your Database. To connect to your AF database click on the dropdown next to the database name.

Now that two tanks have been created for Montreal, we can use those as a base for creating additional Elements.

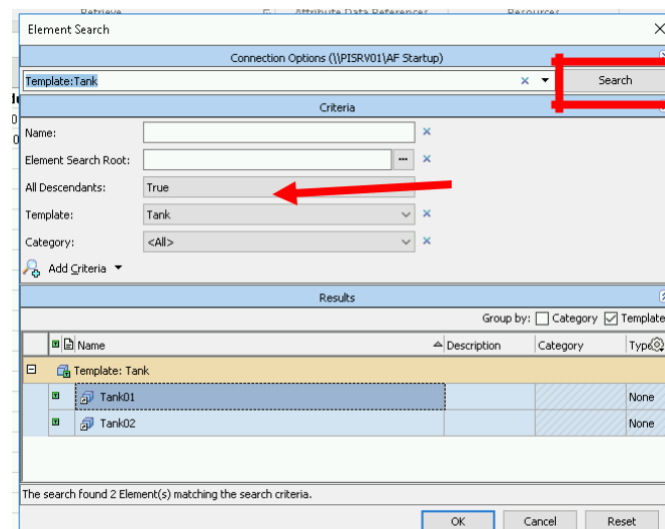


Import the tank elements from AF. To do this, select **Elements > Find Elements** from the PI Builder ribbon menu, then select the Tank Template to search and find both tanks. (Note: It maybe necessary to clear the search by clicking the Reset button in the bottom right hand corner.)



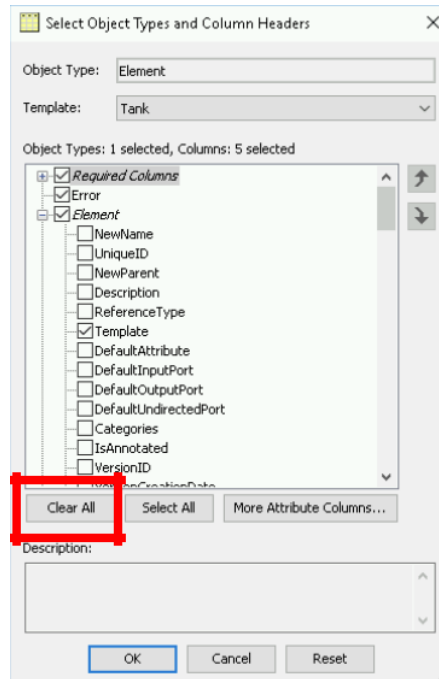


Make sure to **search child elements** (verify 'All Descendants'=True).

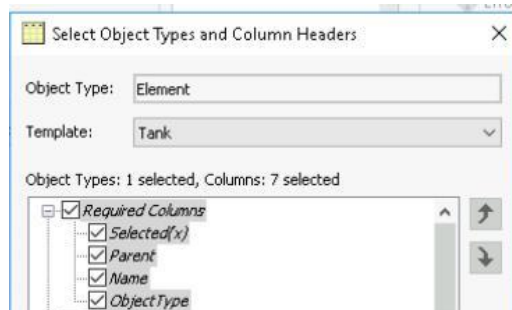


Highlight both Tanks for importing into PI Builder.

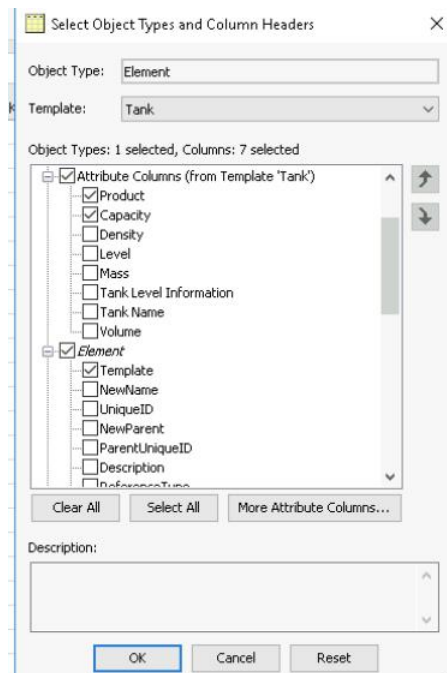
Select OK.



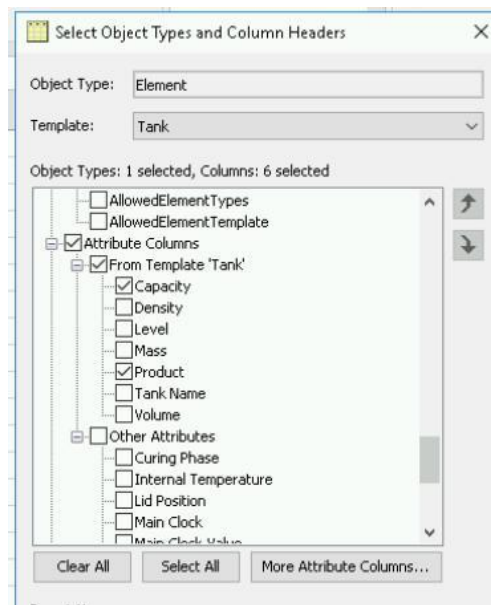
Select 'Clear All'. Some columns remain selected as they are required.



Under Element, select to import the **Template** configuration of the element. This is important to bring all components of the 'Tank' template to the individual elements being created.



Then Navigate to the **Attribute Columns**. From Template 'Tank' select **Product** and **Capacity**. All attributes will be copied from the template during the creation of the new elements. Product and Capacity are static values associated with individual tanks. By adding them to the spreadsheet, an update can be made to these attributes at the time of creation.



Click OK


	A	B	C	D	E	F	G
1	<b>Selected(x)</b>	<b>Parent</b>	<b>Name</b>	<b>ObjectType</b>	<b>Template</b>	<b>Capacity</b>	<b>Product</b>
2	x	Montreal	Tank01	Element	Tank	20000	AQ4500
3	x	Montreal	Tank02	Element	Tank	30000	HC1500
4							

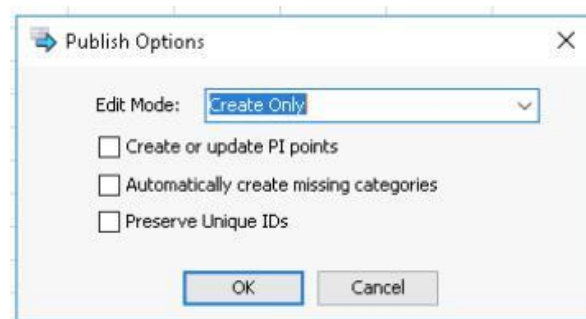
Modify the Tank 01 and Tank 02 records to Tank03 and Tank 04 respectively.


Verify the Product name matches one of the valid materials from the Material Properties AF table as shown in the table below. Update the capacity for each tank as shown below.

Name	Capacity	Product
Tank03	10000	HC1500
Tank04	10000	WX1200 Old Recipe

The records are now ready to be exported to AF; which will create two new tanks.

Click on the “**Publish**” button from the ribbon menu (  ). A dialog for Publishing options will display – by default the ‘Edit Mode’ is selected. Update it to either ‘Create Only’ or ‘Create and Edit’. In this case, my preference is to select ‘Create Only’ as I know these should not exist in this database.



Confirm your work by going to PSE > Elements and pressing the  Refresh button or the F5 key on the keyboard.

Let's verify the product and capacity fields are correct and the data is being updated for Tank03 and Tank04.

# Attribute Traits

Attribute traits hold characteristic information for their parent attribute. These can be limits, forecast values, geolocation information, reason codes, asset health, and analysis start triggers. They can either be defined as a fixed value or in combination with a Data Reference such as e.g. PI Point or Table Lookup. Attribute traits are child attributes.

**Limit attribute traits:** limits typically represent the expected range of a process variable. Following limit traits are defined:

- Minimum and Maximum (very lowest/highest possible value)
- LoLo and HiHi (very low/high value for an abnormal situation, typically initiates an alarm)
- Lo and Hi (low/high value that needs attention, typically initiates a warning)
- Target (aimed-for value such as setpoint)

**Forecast attribute traits:** forecasts contain predicted values, which allow to compare actual value with the parent attribute. It typically comes from a future PI point.

**Location attribute traits:** use location attributes to define longitude, latitude, and altitude information for an asset. You can use this information to identify the location of the asset on a map. Used by Integrator for ArcGIS.

**Reason attribute traits:** use reason attribute traits on event frames and transfers to enable users to select a reason code for excursions, downtime, and other events. The reason attribute trait must be an enumeration set that is previously defined, or a system enumeration set delivered with PI AF.

**Analysis start-trigger traits:** When users configure analytics to generate event frames, they can optionally elect to store the name of the start trigger in the value of an attribute (string) and mark that attribute with the analysis start trigger trait. This enables clients like PI Vision to indicate the start trigger that created that particular event frame.

**Health attribute traits:** use health attribute traits on elements and models to enable users to set a numeric health score and a health status (for example, healthy, out of service, in maintenance, warning, or error). The HealthStatus attribute trait uses values from the HealthStatus enumeration set, which is delivered with PI AF. Administrators can modify the HealthStatus enumeration set as required.

## Putting it into practice:

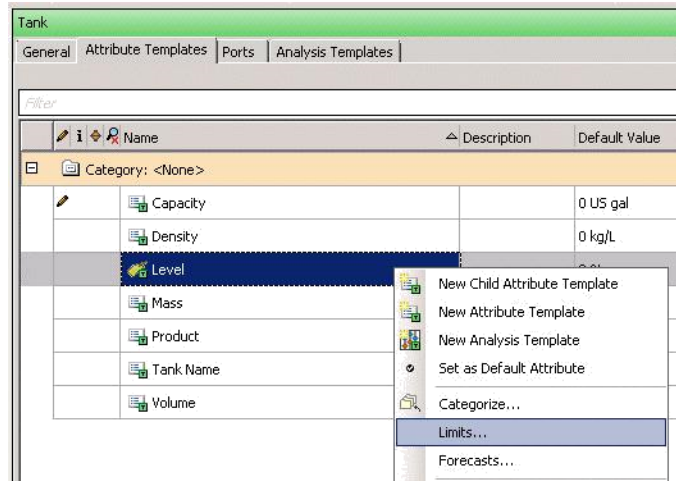
Add value limits for the attribute level on the Tank Template Attribute.

## Problem Description

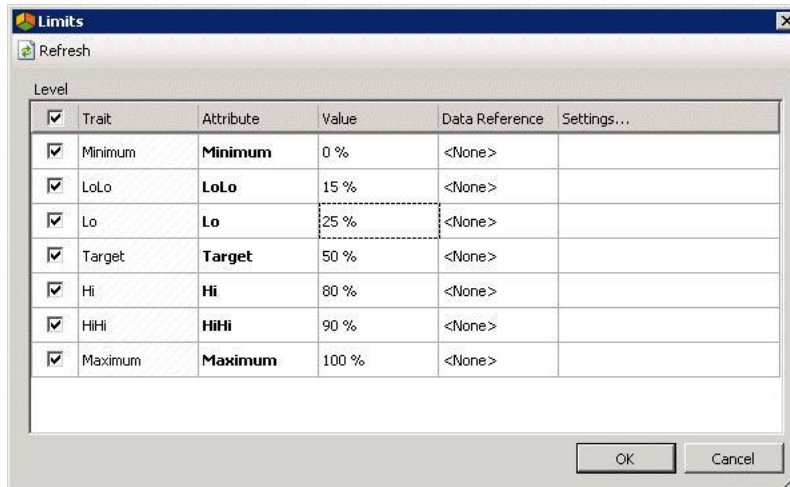
You would like to use attribute traits to maintain limits for the normal operation of the tanks. For all tanks the limits are the same.

## Approach

1. In the PSE Navigator, select Library and open the Tank element template.
2. Select *Limits...* from the context menu of the *Level* attribute:



3. Set the limit traits as follows and click on OK.



# Use of Categories

## About Attribute Categories

Categories can be used to group AF objects like elements, attributes, or tables together to facilitate the administration of those objects. To add an attribute to a category, simply select one or more categories from the Categories field of the attribute's Configuration Panel, or alternatively write the category name. If that category does not exist yet, a prompt will be shown to ask if this category should be created.

In this exercise, Attribute categories will be explored.

Open PSE > Change database to OSIsoft Plant.

In the Navigator Pane > select Library.

Open Templates > Element Templates > Generic Tank Template.

Open the Attribute Template tab.

Above the configuration panel, there is a Group By selection. The attributes can be grouped by Category or Template. In this example, if we select Template, all attributes remain together. As you develop more involved templates, a derived template could be used and grouping by templates will allow easy visibility of the template origins.

In this exercise our focus is to group by category.

Upon selecting category, the attributes are grouped into several categories for potentially easier viewing/editing. In this view, product properties, tank properties and process variables are grouped together.

Now, move back to the AF Startup Database we are creating for our Velocity Terminal plant. We are going to add some attribute categories.

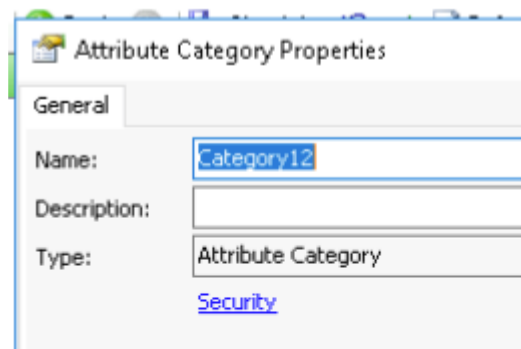
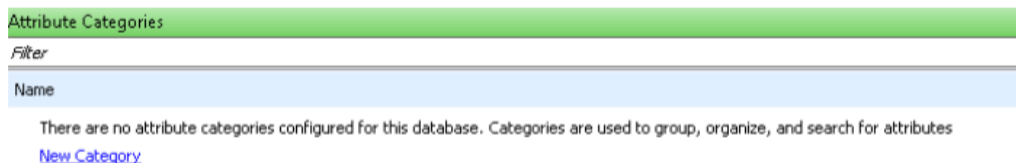
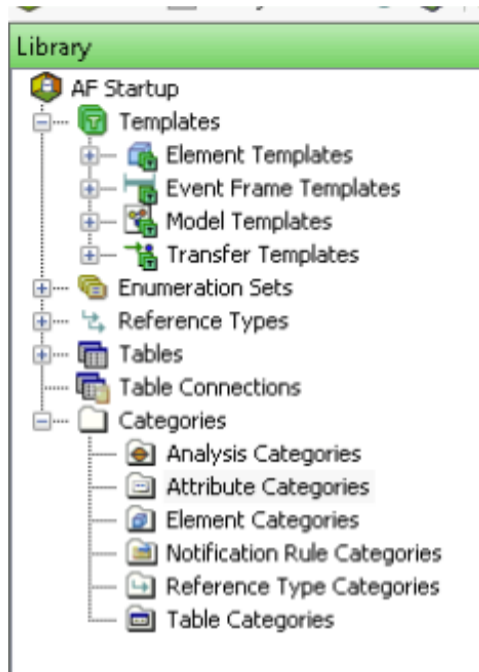
Navigate to Library > Templates > Element Templates > Tank.

Select Category to group attributes.

Currently, there are no categories for grouping attributes into any categories.

Categories can be created from Library > Categories > Attribute Categories

Using this method, we will create 3 of the 4 attribute categories we need to group our attributes.



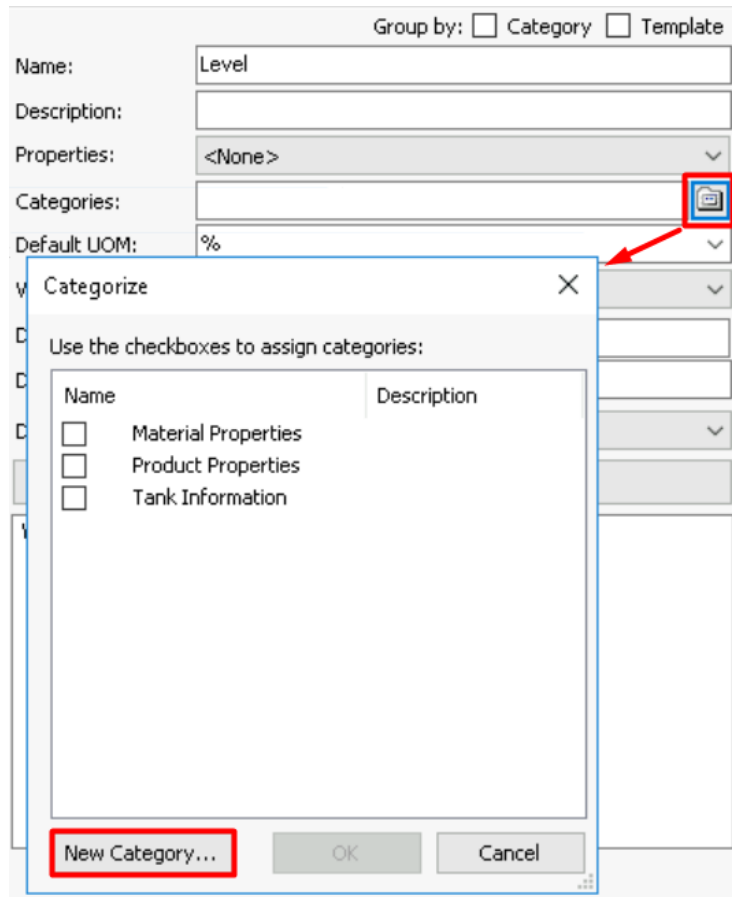
Three additional categories to be added are Material Properties, Product Properties, and Tank Information.

Now we will use another method of creating a category.

Navigate to Library > Templates > Element Templates > Tank > Attribute Templates tab.

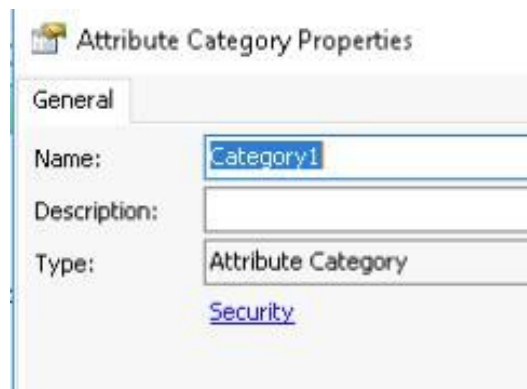
Select Level from the attributes, then from the configuration panel, select the browse button on the right end of categories.





Select New Category.

Enter Process Variable as the name of the new Category.



Once all categories are created, begin updating the remaining attributes configuration with the appropriate categories.

Attribute	Category
Capacity	Tank Information
Density	Product Properties
Level	Process Variables (already completed – but can be verified)
Mass	Product Properties
Product	Tank Information
Tank Level Information	Tank Information
Tank Name	Tank Information
Volume	Tank Information

After updating all the attributes with the appropriate category. Group the attributes by category.

Be sure to check-in your changes.

# Discover Tag Creation

## Objectives

- Create a new attribute in a template
- Use AF attributes substitution parameters.
- Demonstrate automatic tag creation.

## Problem Description

A new pressure transducer has been installed on every tank at Velocity Terminals. You have to add a pressure attribute to the tanks in your AF structure; however, the PI points have not been created.

Velocity Terminals would like you to use a meaningful naming convention for the PI tags created as part of this project; they would like the tags to be named something like:

### **Tank01.Pressure.PV**

Since our company has sites globally, it is better to use International units for pressure (Bar)

## Approach

Add a new attribute to the *Tank* template, name it **Pressure**, *Categorize it to Process Variable* and use **Bar** as the default UOM.

Select **PI Point** as the *Data Reference*, and click on *Settings* to configure it.

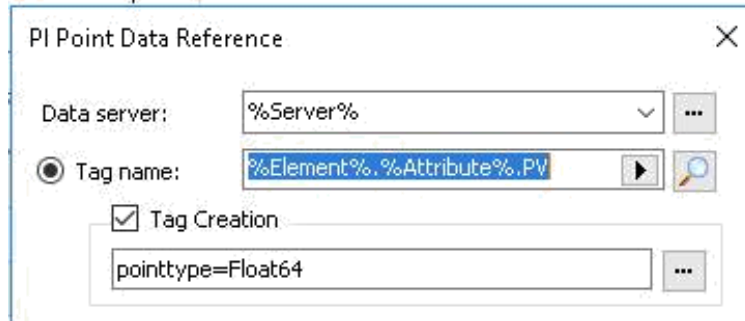
Data Server defaults to %Server%.

Under *Tag Name*, in order to match the naming convention they want, enter %Element%.%Attribute%.PV which results in TankXX.Pressure.PV.

In the future, as Velocity Terminal builds out additional sites, it might be necessary to include the site/location which is represented as %..\Element%-%Element%.%Attribute%.PV results in Montreal-TankXX.Pressure.PV

Since the tags have not been created, check *Tag Creation*.

**Tip:** You could configure the tag settings (PointSource, InstrumentTag, Location codes, etc.) from the *Tag Creation Settings* dialog window or import the settings of a working tag by selecting the ellipsis (...).



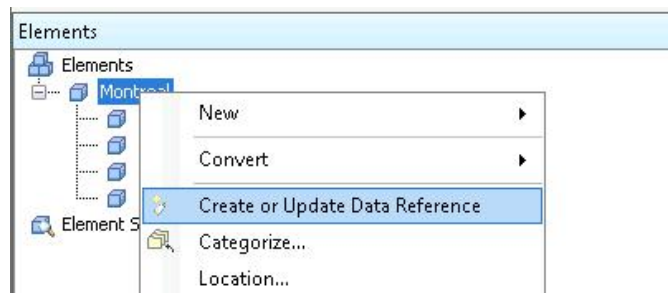
Check-In the Tank Template with the Pressure attribute added.

Navigate to Elements → Elements → Montreal → Tank01 → Attributes.

What value is shown for the Pressure attribute?

“PI Point Not Found”

Now, let's create the PI point, by right clicking on Montreal → select Create or Update Data Reference. A window will indicate when the PI Point creation is complete, close the window.



Refresh the display.

Now, what is the value shown for the Pressure attribute for any of the Tanks?

All should show **Pt Created**.

Note: In this example, we took the default settings associated with PI Point creation. By default, there is no configuration associating the PI Point to any interface for data.

# Visualizing Velocity Terminal Data with PI Vision


## Activity Objectives

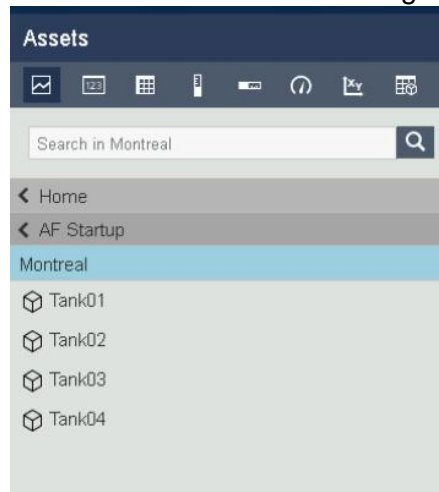
- Create a PI Vision display with tank data (AF database: Velocity Terminals)
- Incorporate objects with current data (trend, value object, gauge)
- Incorporate a tank from the Graphic Library
- Asset swap in PI Vision displays

1. Click on the desktop link to open **PI Vision**. The link is <http://pisrv01/PIVision> (or <http://pisrv01.pischool.int/PIVision>)

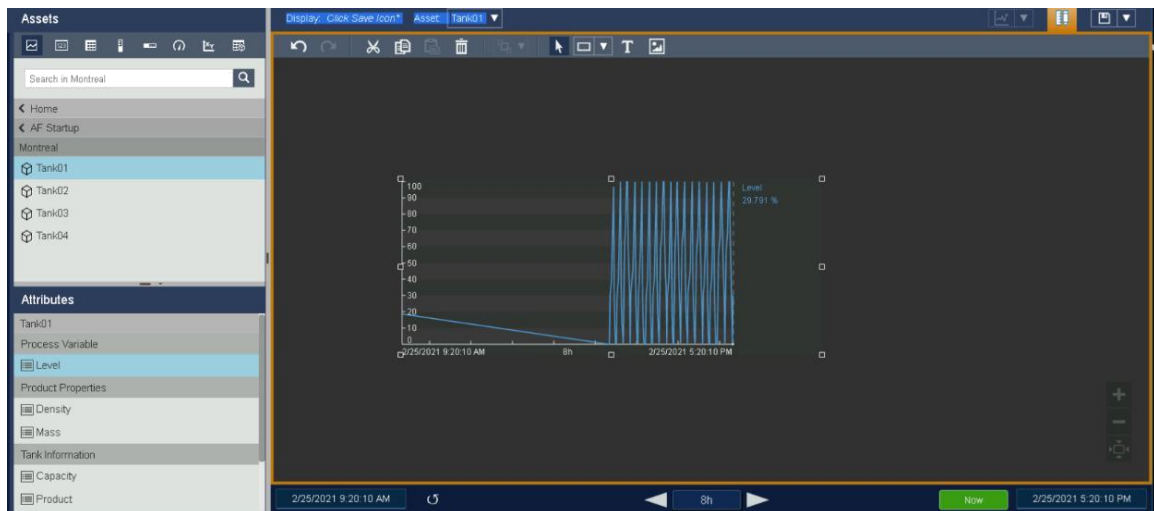
Note: The first time PI Vision is started can take a few minutes.

The homepage provides an overview with thumbnails of the displays, which have been prepared for the training.

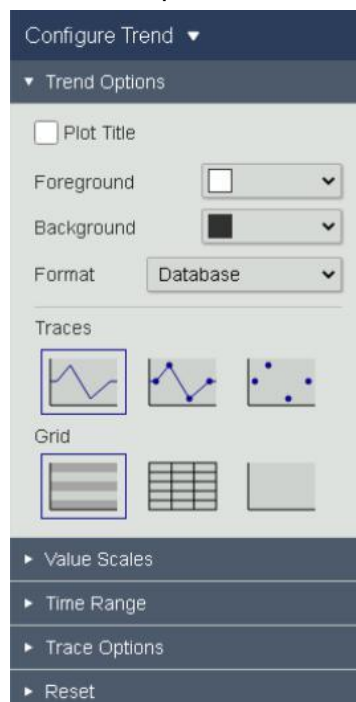
2. To create a new display, click on the link 
3. The search pane displays search paths for elements in the AF databases and for tags in Data Archive.
4. Expand the asset structure to navigate to the Tank01. Select AF database *AF Startup* and navigate to Montreal > Tank01. Select Tank01 to get the attributes for that tank.



5. Select *Level* attribute and drag it to the display canvas on the right-hand side.

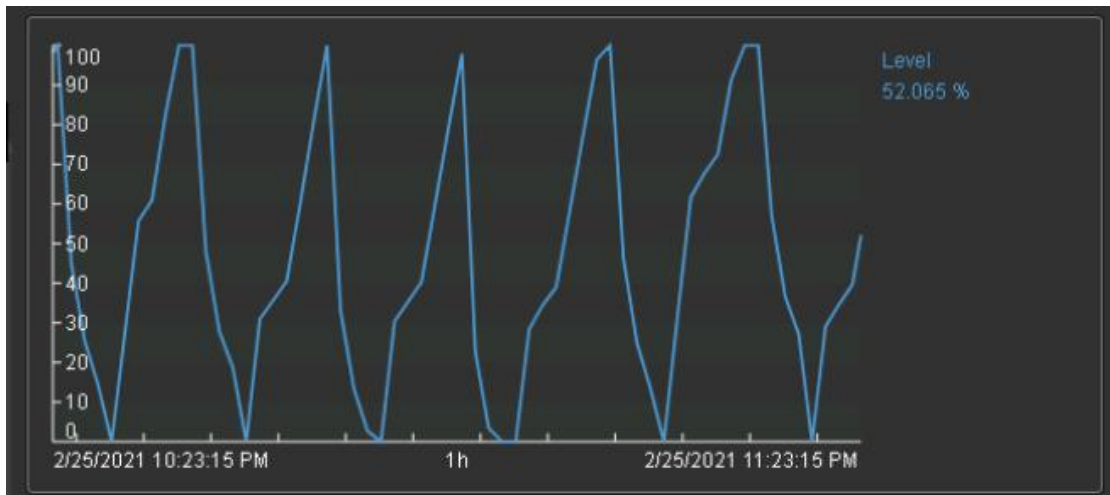



6. From within the Trend, right click to select Configure Trend. A menu will appear on the right-hand side of the screen. From the menu, various options exist to format the trend, values, default time range, and trace options.



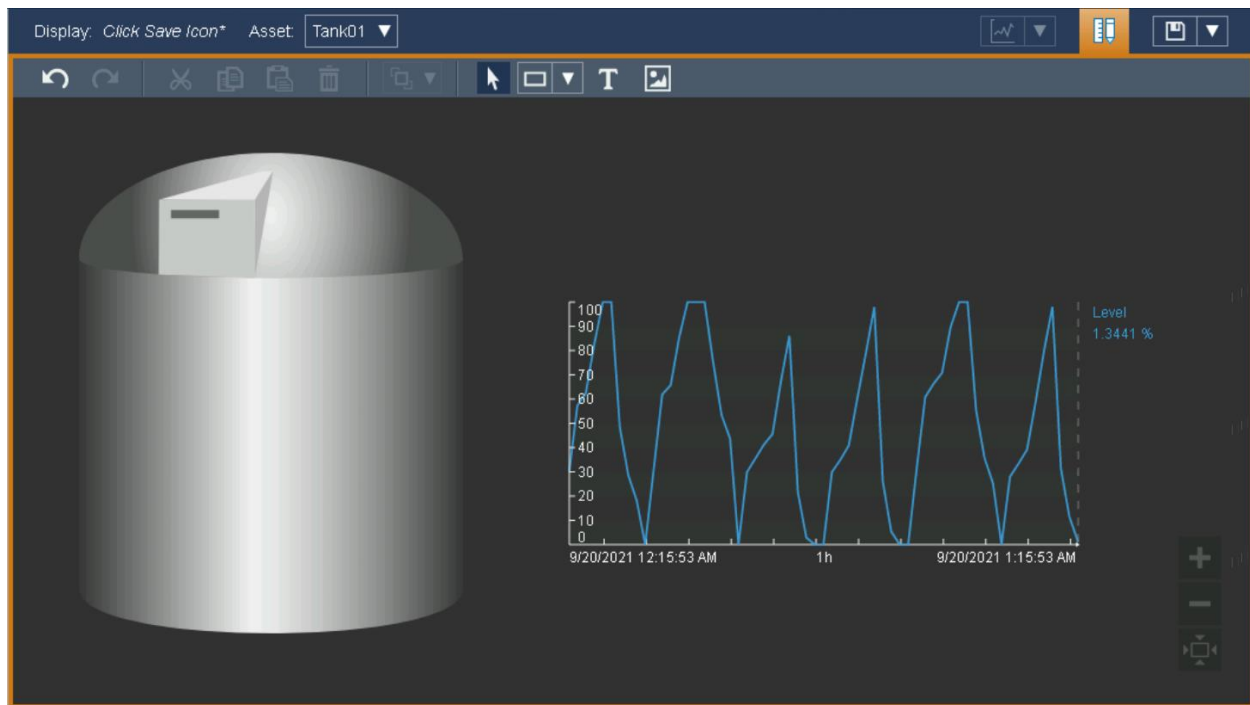
7. Click on the time selector at the bottom and switch time display range to one hour.







8. Click on the Graphic Library icon . Navigate to Tanks then select a tank and drag it to the display.



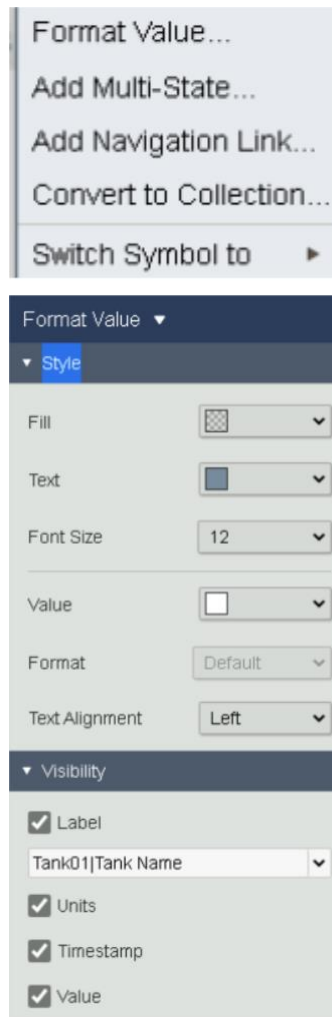


- Navigate back to Assets , select the Value object . Drag *Tank Name* (from the attribute list) to the top of the tank picture.





10. From the right mouse button menu of the Value object, select Format Value.




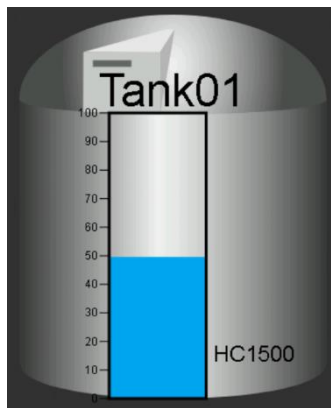
Uncheck Label, Units and timestamp. Change Value color to black and font size to 36.



11. Now position a value object for the Product attribute in the right bottom corner. Format in the same manner as the Tank name with the exception of font size of 18.

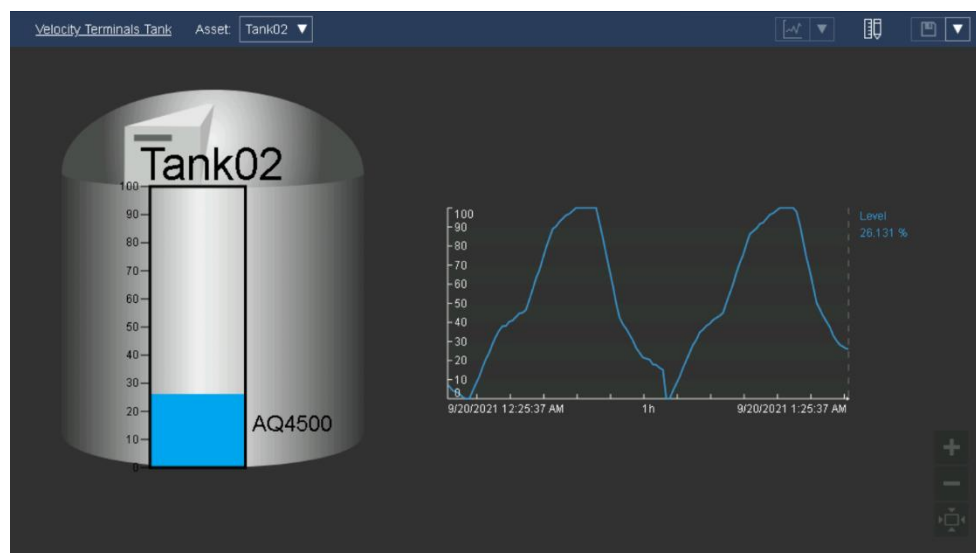


12. From the object list, select the Vertical Gauge object . Drag Level to the center of the tank picture. Use Format Gauge (by right clicking on the gauge) to change the appearance by removing the label and value.





13. Click on the Save icon  on top right corner. Save display as Velocity Terminals Tank.

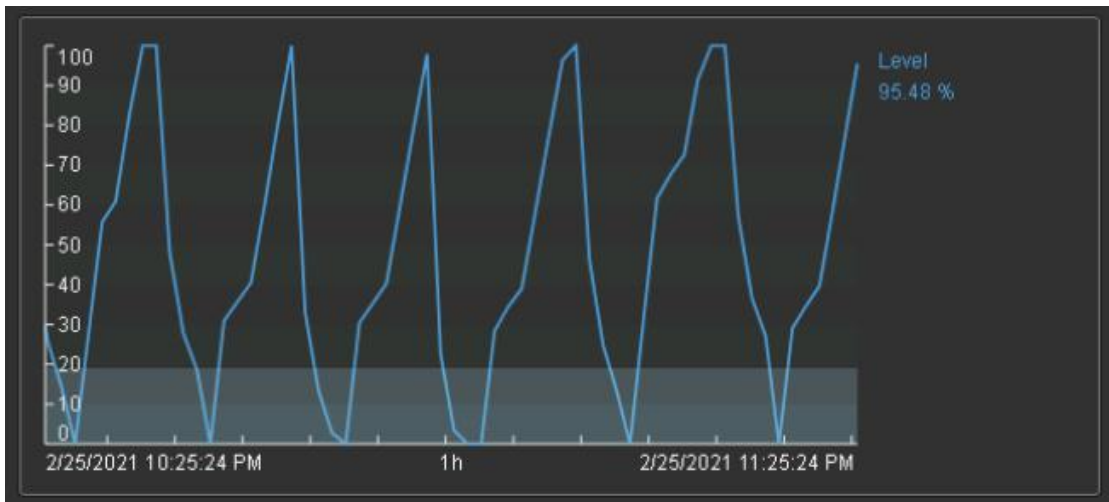
14. Use the Asset selector  to switch to another tank, Tank02.



15. Use the time control at the bottom to change the display ranges. Use the left arrow to step through past time periods.




16. Another means of changing the time range is from within the trend. Switch to Read Only by deselecting the Edit Mode . Now, position the cursor in the bottom area of the trend and drag (  ) the cursor back and forth to switch the time range.



17. To revert to the last hour from now, click on the *Now* button, then select the 1h from the time range selector.
18. Note: after you have made a modification in a display, the display name will have an asterisk at its end to indicate there have been changes.

Display: Velocity Terminals Tank\*

To save your changes, click on the Save icon . To save the modified display under another name select Save As from the dropdown next to the Save button and save under another name.

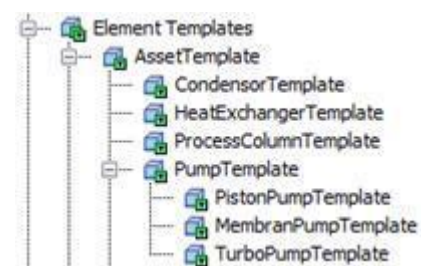
19. To view Saved displays, navigate Home by selecting . If the display was saved, it should be present in the list.

## Summary Lesson: Best Practices - Written

The following recommendations provide some guidelines on how to best setup your AF asset structure based on experience from existing AF installations.

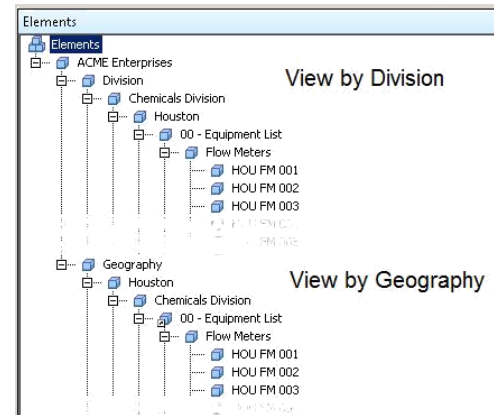
Be aware that in real life you cannot follow all these recommendations!

- All elements should be based on a template
  - Even if the template has no attributes in the beginning
  - Easier maintenance
- All elements at the same level should be of the same type
  - Enterprise at the first level, Site the second level, Area the third, etc.
  - Easier use of relative references from child-elements
- Do not only consider Bottom-Up approach
  - Try to achieve a well-designed structure, plan for the usefulness of the AF model
- Categories for elements attributes and analyses
  - Organizes large numbers of attributes/elements
  - A fast way to search for elements and attributes
- Always set the unit of measure explicitly
  - PI Point attributes: set source unit for the tag
  - Formulas: set units for all variables and the result
  - Analyses: use the Convert() function
  - Avoid defaults
- Use inherited templates (covered in Asset Framework: Beyond the Basics)
  - Allows Flexibility but keeps the standardization



- Build Different Views specific for your users (covered in Asset Framework: Beyond the Basics)

Use element references



- Use Enumerations

Limit the choices that can be entered in attributes

ControllerMode			
General			
Name:		ControllerMode	
Description:			
<input type="checkbox"/> Hexadecimal		<a href="#">Security</a>	
Value	Name	Description	
0	Manual	Manual Mode	
1	Auto	Automatic Mode	
2	Cascade	Cascade Mode	
3	Program	Program Mode	
4	Prog-Auto	Automatic Program Mode	

- Use Hierarchies of Attributes

Group details or aggregations on a different level

	Level	5.30978918075562 %
	Level.2HoursAgo	6.12112998962402 %
	Level.2HoursAverage	40.8897792753879 %

- Use all Data References

Many options with Table Lookup and for String Builder

- Keep relational data in relational database

Link AF Tables to results and views

Use Cache and Parameters