OSIsoft UC 2017 Lab

Incorporating Condition Monitoring Data -Vibration, Infrared and Acoustic for Condition-based Maintenance OSIsoft, LLC 1600 Alvarado Street San Leandro, CA 94577 USA Tel: (01) 510-297-5800 Web: http://www.osisoft.com

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Condition-based Maintenance – Hands-on Lab – OSIsoft Users Conference 2017

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Incorporating Condition Monitoring Data – Vibration, Infrared and Acoustic for Condition-based Maintenance

Lab Description

Traditionally, the PI System has worked with process data from plant instrumentation such as PLC and SCADA. However, newer IoT and edge device capabilities allow you to bring data from condition monitoring systems such as vibration, infrared (thermography), acoustic, etc. to the PI System. Take this lab to learn how to use condition-monitoring data along with process data in your condition-based maintenance programs to improve equipment uptime. The lab will also include the use of alert roll-ups, watch lists, KPIs and others for a holistic view of asset health and reliability.

Level: 200 Duration: 2 hours

Summary

Condition-based maintenance (CBM) is a strategy where you monitor the actual condition of an asset to decide what maintenance needs to be done – see <u>wiki</u> for a broader definition.

The learning objectives for this lab are:

- Understand the condition monitoring (CM) data collection process –with a <u>live demo</u> of a handheld device used for collecting vibration, infrared and acoustic data for a motor
- Understand how the condition monitoring data is transformed and written to PI
- Configure condition assessment calculations for the CM data and recognize the use of dynamic thresholds for the CM data
- Incorporate CM data such as oil analysis (that may reside in external databases) in the condition assessment calculations
- Incorporate manual input CM data (aka operator rounds) from PI Manual Logger
- Create displays, notifications, alerts watch list etc. using various PI System capabilities and tools
- Review the PSE&G customer use case on combining PI System data with CM data for calculating asset health score

In this lab, we will use a hand-held device to collect vibration, infrared, and acoustic data. The device is a Windows 10 based unit (it can also be an iPad) with suitable attachments based on National Instruments <u>http://www.ni.com</u> technologies. Please see <u>AR-C10</u> for hardware details.



Figure 1: AR-C10 Unit

With such condition monitoring (CM) data, typically we do not store the raw data in the PI System. Instead, the data is transformed, and aggregate/derived values are written to the PI System.

Even though you can store raw CM data in the PI System, it is out-of-scope for this lab.

For vibration data, the raw time-series wave form may have 10,000 or more values per second, and often data is collected for several seconds (depending on the motor rpm and other analysis requirements). This time-series (time domain) data is converted to frequency-domain using FFT (Fast Fourier transform). And, calculated values derived from both time-series wave-form and FFT analysis are written to the PI System.



Figure 2: g (acceleration, y-axis) vs. time (x-axis) - Vibration time-series wave form, about 10,000 readings per second



Figure 3: rms value g (acceleration, y-axis) vs. frequency (x-axis) - Vibration time-series waveform data is converted to frequency domain using FFT analysis

Mc	otor_Inboard	MIV							
Ge	eneral Child	Elements Attributes Ports Analyses	Version						
ac C	14								
Central Plant CP	Value Time Stamp								
Chilled Water Pump P-1		jury. Metauata							
Motor_Inboard_MIV		DisplayNum	31	1/1/1970 12:00:00 AM					
Motor_Outboard_MOV	T	Equipment	Chilled Water Pump P-1	1/1/1970 12:00:00 AM					
Pump_Outboard_POV		MeasureLoc	Motor_Inboard_MIV	1/1/1970 12:00:00 AM					
Chilled Water Pump P-2 Secondary Chilled Water Pump P-4	T	🗉 Path	Austin\Mopac C\CP\Chi	1/1/1970 12:00:00 AM					
Secondary Chilled Water Pump P-5	T	Пуре	MIV	1/1/1970 12:00:00 AM					
eather Feeds thes		URL URL	http://mckinseyPI.clou	1/1/1970 12:00:00 AM					
	🖾 Categ	jory: Vibration data							
	<i>I</i> .	asynchronous	0.3679557 g (vib)	1/29/2017 12:44:57 AM	ASync				
	ø 🗉	🎺 Crest Factor	3.040749 g/g (vib)	1/29/2017 12:44:57 AM	Crest Factor				
	<i>I</i> .	🍼 Derived Peak	0.5442402 g (vib)	1/29/2017 12:44:57 AM	Derived Peak				
	0	🎺 High Frequency	0.1448086 g (vib)	1/29/2017 12:44:57 AM	High Freq				
	0	🍼 Peak-Peak	2.268219 g (vib)	1/29/2017 12:44:57 AM	Peak-Peak				
	ø 🗉	🞺 RMS	0.384836 g (vib)	1/29/2017 12:44:57 AM	RMS				
	4 🗉	Single Integrated_1x Magnitude	0.03433325 ips	1/29/2017 12:44:57 AM	Vel 1x				
	<i>্</i> =	🎺 Single Integrated_2x Magnitude	0.007174384 ips	1/29/2017 12:44:57 AM	Vel 2x				
	<i>্</i> =	Single Integrated_Derived Peak	0.0651958 ips	1/29/2017 12:44:57 AM	Vel Derived Peak				
	<i>্</i> =	🎺 Single Integrated_True Peak	0.1517071 ips	1/29/2017 12:44:57 AM	Vel True Peak				
	4	💞 Synchronous	0.09153856 g (vib)	1/29/2017 12:44:57 AM	Sync				
		🎺 True Peak	1.170189 g (vib)	1/29/2017 12:44:57 AM	True Peak				
		Alert	1	1/29/2017 12:51:10.148 AM					
		E H	1 g (vib)	1/1/1970 12:00:00 AM					
		(I) HiHi	2 g (vib)	1/1/1970 12:00:00 AM					
		Minimum	0 g (vib)	1/1/1970 12:00:00 AM					

Figure 4: PI System Explorer screen showing the various AF attributes (see Category - Vibration data); values derived from timeseries wave-form and FFT analysis for each sample are written to the PI System

Infrared – a non-contact technology – is convenient for measuring temperatures of mechanical equipment (motors), electrical equipment (circuit contacts), and others. The device interprets the image and estimates the temperature at the crosshair location and the temperature(s) are written to the PI System.





Figure 5: Infrared camera image for a motor – the crosshair identifies the location for estimating the surface temperature – Motor at 69.6 °F (left image) and at 85.4 °F (right image)

Native infrared images can be stored in the PI System but is out-of-scope for this lab.

Ultrasonic measurements are made using acoustic sensors which measure sound waves, including high frequency sounds – above human hearing range. Acoustic sensors can "hear" the sounds from internal friction or metal deformation - in Figure 6, the ultrasound level increases from about 10dB to 40dB.

The raw acoustic waveform is similar to those for vibration. FFT analysis transforms the time-domain data to frequency-domain, and overall sound level in decibels (dB) is written to the PI System.

- 1

Part - In



Figure 6: Acoustic time-series wave form (in red) and frequency plot (in blue); sound level has increased from 10 dB to 40 dB between the left and right sample for the same motor

Regarding condition assessment, with the CM data in the PI System, you can use the various PI System capabilities such as AF Analytics, Event Frames, Notifications, OSIsoft Visualization displays, watch-list, and others.

Watchlist	of all Vibration	Sensor Alerts	Back to Ov	Configure Table
vatormat		Ochsor Aichts		Descending •
Event Name	Asset	T Start Time 🔻	Y Severity	
Crest Factor Event 2017-02-27 2 2:00:00.000	Motor_Inboard_MIH	2/27/2017 10:00:00 PM	Critical	▼ Dynamic Criteria
Crest Factor Event 2017-02-27 2 2:00:00.000	Motor_Inboard_MIV	2/27/2017 10:00:00 PM	Warning	Database National Instrum Time Range Timebar Duration
Crest Factor Event 2017-02-27 2 1:55:00.000	Motor_Inboard_MIH	2/27/2017 9:55:00 PM	Critical	Event Severity Event Name
Crest Factor Event 2017-02-27 1 8:00:00.000	Pump_Inboard_PIV	2/27/2017 6:00:00 PM	Warning	Event Type and Attribute Value
Crest Factor Event 2017-02-27 1 2:10:00.000	Motor_Inboard_MIH	2/27/2017 12:10:00 PM	Warning	► Asset Name Any
Crest Factor Event 2017-02-27 1 2:10:00.000	Motor_Inboard_MIH	2/27/2017 12:10:00 PM	Critical	► Asset Type NI Device Vibrati
Crest Factor Event 2017-02-27 1 2:10:00.000	Motor_Inboard_MIV	2/27/2017 12:10:00 PM	Critical	Event State In Progress Any
Crest Factor Event 2017-02-27 1				In Progress Completed
				► Event Category

Figure 7: OSIsoft Visualization screen – Watch list of Alerts from vibration measurements exceeding threshold limits

Alert Watch List	11 Events Crit	} ical	3 Warning		
Equipment	Measure Location	Severit	Start	URL 🔻	Link
Secondary Chilled Water Pump P-4	Pump_Outboard_POV	20	9/20/2016 12:29:57 AM	0	P
Secondary Chilled Water Pump P-4	Pump_Inboard_PIV	20	9/20/2016 12:09:57 AM	Ø	ø
Secondary Chilled Water Pump P-4	Motor_Outboard_MOV	20	9/20/2016 12:09:57 AM	Ø	B
Secondary Chilled Water Pump P-4	Motor_Inboard_MIV	20	9/20/2016 12:34:57 AM	Ø	ø
Secondary Chilled Water Pump P-4	Motor_Inboard_MIH	20	9/20/2016 12:54:57 AM	B	3
Chilled Water Pump P-2	Pump_Outboard_POV	20	9/19/2016 11:49:58 PM	ø	Q
Chilled Water Pump P-2	Pump_Inboard_PIV	20	9/19/2016 11:49:58 PM	Ø	3
Chilled Water Pump P-2	Motor_Outboard_MOV	10	9/20/2016 1:29:58 AM	B	®
Chilled Water Pump P-2	Motor_Inboard_MIH	10	9/20/2016 1:39:58 AM	3	S
Chilled Water Pump P-1	Pump_Inboard_PIV	10	9/20/2016 1:39:58 AM	B	Ø
Chilled Water Pump P-1	Motor Outboard MOV	20	9/20/2016 12:39:58 AM	9	9

Chiller Plant – Watch List (Power Bl)

Chi	lled Water Pump P-1
Chi	lled Water Pump P-2

Motor	Inboard	I_MIH
Motor	Inboard	J_MIV
Motor_	Outboar	d_MOV
Pump	_Inboar	d_PIV
Pump	Outboar	d POV

Figure 8: Microsoft Power BI screen - Watch list of Alerts from vibration measurements exceeding threshold limits

<u>Vibration Sensor Details</u> Asset: Motor_Inboard_MIV ▼									
Secondary Chilled Water Pump P-4									
Back to Overview									
Motor Inboard MIV									
— — —	Crost Eactor	1 0122	15	5		10			
		4.9125	4.5	5		Q			
Number of Alerts	True Deak	2 0636	15	2		5			
	IIUC I Cak	2.0000	1.5	2		Q			
	Name	_		Value	Maximum	Units	Trend		
	Motor Inboard MIVIAsynchro	onous		0.3288	0 3650	a (vib)	~		
	Motor Inboard MIV/Crest Fa	Motor_Inboard_MIVJCrest Factor Motor_Inboard_MIVJDerived Peak Motor_Inboard_MIVJHigh Frequency Motor_Inboard_MIVJPeak-Peak			4.9268	g/g (vib)	~~~~		
	Motor_Inboard_MIV Derived				0.6507	g (vib)			
	Motor_Inboard_MIV High Fre				0.4531	g (vib)	~~~		
	Motor_Inboard_MIV Peak-Pe				4.1942	g (vib)	~~~		
	Motor_Inboard_MIV RMS			0.42043	0.46013	g (vib)	\sim		
	Motor_Inboard_MIV Single In	tegrated_1x Ma	gnitude	0.0027	0.0027	ips	\sim	L L	
S pul	Motor_Inboard_MIV Single In	tegrated_2x Mag	gnitude	0.0122	0.0165	ips	$\sim\sim$	T	
lide Side	Motor_Inboard_MIV Single In	tegrated_Derive	d Peak	0.0585	0.0585	ips	~~~	—	
0	Motor_Inboard_MIV Single In	tegrated_True P	eak	0.15204	0.15773	ips	~~~~		
	Motor_Inboard_MIV Synchron	nous		0.2592	0.2917	g (vib)	~~~	₽Ŭ₹	
	Motor_Inboard_MIV True Pea	ak		2.0636	2.2489	g (vib)	- w		
3/1/2017 8:59:59 PM		1h			Now	3/	1/2017 9:59	9:59 PM	

Figure 9: OSIsoft Visualization screen for Pump P-4 Motor Inboard Vertical

An example condition assessment for infrared temperature measurement is a rate-of-change logic, say, an increase of more than 20 °F in a 24-hour period for a motor running under similar operating conditions.

For acoustic data, an increase in the overall sound level (decibels) above a threshold level can be used to set an alert.

With access to both CM data and process data in the PI System, you can also specify dynamic threshold limits for condition assessment – for example, a higher vibration threshold for a pump at full load vs. another at partial load.

Finally, you can also combine SCADA/PLC data with CM data to calculate asset health score.

🞁 Hom	🖗 Home Documents and Lists Create Site Settings Help Up to PSE&G Delivery																	
O PS	ēG	LTC CA	New Action A	Igorithm D	etails													Modify Shared Page 🕶
Namepla	ate																	*
Oneline	Division Central	Station Code POH	Station POLHEMUS LANE	Station Type H	Floc Descr # 1 Transformer	Equipment	010504694	Equip Load	ment D Tap Ch	escr anger (UVT)	Equipment E-LTC	Туре	Cor	nstruction Ye	ar Sei 1988 SLI	rial Number 1156073	Manufacture ABB	r Model Number UVT
Content	Editor We	b Part						• 0	DeltaX	Total Comb	ustible Gas							
© View © CA LT	and Trend E 'C New Acti	Equipment PI Po on Algorithm Ru	ints Iles						Details	ApprType LTC	Sample Date 07/06/2009	C0 475	H2 305	Acetylene 4915	Ethane 40865	Ethylene 2.1297E+05	Methane 10714	Combustible Gas
Algorith	m Factors								•	LTC	04/05/2007	47	0	0	1	4	2	54
Factor			Raw Value	Case Va	lue Weig	iht %	Score	-	•	LTC	08/29/2006	168	37	0	1	3	3	212
Detectab	le Acetylen	e	4915	10	25		2.5	-	•	LTC	05/11/2006	10	0	0	1	0	2	13
Gas Rate	of Change		6.08	5	15		0.75		•	LTC	04/28/2006	48	0	0	8	28	5	89
High Wat	er		48	0	10		0											Showing 1 to 5 of 23
Low Diele	ectric		34.4	0	10		0	0	DeltaX	Water								•
LTC Oper	ations		95	0	10		0											
LICINK	JINCUTRAL		1	10	10		1		Details	App	ortype	San	nple (Date		Fluid Ternp (C)	1	Water
CA Score	в							• 1	•	LTC	;	07/	06/20	09		45		48
Score	n	naxScore	Rank	ing(%)	Peer	Group			0-	LTC	2	04/	05/20	07		35		21
6.25	6	.25	100		VACL	IUM			~		;	08/	29/20	06		47		38
RtTrend						•			č.	110	,	05/.	28/20	00		42 91		28
7	_				, altoNeeAd	ionTreadB				-	,	047	20/20					Showing 1 to 5 of 23
					6.25				- It - V I	elucal								_
6								L	Deitax	Fluid								त्व स स स
									Details	Aport	vne s	ample	Date		Fluid Te	mn (C)	D87	D1816
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)								-	•	LTC	(18/07/2	002				43.7	
								-	•	LTC	0	7/11/2	000				37.5	
	++							-	•	LTC	0	1/14/1	998					29.9
								-	0 -	LTC	0	3/10/1	997				42.4	42.4
3					_													Showing 1 to 5 of 6
								6	6 Month	s Counter (Operations							*

Figure 10 PSE&G use case showing asset health (condition assessment) score for a distribution transformer – load tap changer (LTC)

As previously mentioned, the learning objectives for this lab are:

- Understand the condition monitoring (CM) data collection process the lab includes a live demo with a portable device for collecting vibration, infrared and acoustic data for a motor
- Understand how the condition monitoring data is transformed and written to PI
- Configure condition assessment calculations for the CM data and understand the use of dynamic thresholds for the CM data
- Incorporate CM data such as oil analysis (that may reside in external databases) in the condition assessment calculations
- Incorporate manual input CM data (aka operator rounds) from PI Manual Logger
- Create displays, notifications, alerts watch list etc. using various PI System capabilities and tools

PI System software

The VM (virtual machine) used for this lab has the following PI System software installed:

Software	Version
PI Data Archive	2016 R2
PI Asset Framework (PI AF) server	2017 (pre-release)
PI Asset Framework (PI AF) client (PI System Explorer)	2017 (pre-release)
PI Analysis & PI Notifications Services	2017 (pre-release)
OSIsoft Visualization	2017 (pre-release)
PI Web API	2017 (pre-release)
PI Connector for UFL	2016

For details on PI System software, please see <u>http://www.osisoft.com/pi-system/pi-capabilities/product-list/</u>

Exercise 1 – Use a hand-held device to collect Vibration, Infrared and Acoustic data

The device is a Windows10 unit (can also be an iPad) with suitable attachments based on National Instruments <u>http://www.ni.com</u> technologies. Please see <u>AR-C10</u> for hardware details.



Figure 11: AR-C10 Device

<u>Video demo</u> – data collection with the AR-C10 device.

During the lab, the instructor will collect the data for a motor rotating at 1800 rpm.



Figure 12: AR-C10 device with three sensors connected to it.

In Exercise 2, since we need several vibration data samples for analysis, we will be using data from a continuous online system but with data similar to those collected by the hand-held device.

Exercise 2 – Analyze Vibration data

In this exercise, you analyze the accelerometer measurements from an online vibration data-collection system <u>National Instruments InsightCM</u>. Data is captured by the <u>NI cRIO</u> module, an FFT analysis is performed at the edge, and select data is written to the PI System.



Figure 13: Vibration data collection for a Chilled Water Pump-Motor

The sensors installed on chilled water pumps (motor-pump assembly) are:

- Motor Inboard Vertical (MIV)
- Motor Inboard Horizontal (MIH)
- Motor Outboard Vertical (MOV)
- Pump Inboard Vertical (PIV)
- Pump Outboard Vertical (POV)



Horizontal Pumps - Sensor Placement

Figure 14: Chilled water pump-motor with vibration sensors

In Step 1, we review the vibration sensor data organized using the equipment hierarchy in PI Asset Framework. We also review the condition assessment calculations for setting alert levels when vibration exceeds defined threshold limits.

Step 1: AF configuration for sensor data

1. Open PI System Explorer, and connect to the National Instruments PI AF database. If the top bar of the window does not show \\PI1\National Instruments, then click on the top toolbar

Database button to select the PI AF database.										
Select Database										
💐 New Database 🗙 Delete Database 🐨 Database Properties 🔒 Edit Security										
Asset server: 🍞 PI1 🗸 🖷 😭 Connect										
Databases:		<mark>ب</mark> م								
Name	Description	Last								
Configuration	A store for configuration data.									
Devices	IIoT	2/27								
MDB to AF Sync		2/27								
National Instruments	CBM TechCon 2017 Database	3/2/2								
PI Server Monitoring		2/27								
<	ш	>								
р <u>-</u>	OK	Close								

 From the AF equipment hierarchy, drill down under Austin > Mopac C > CP > Chilled Water Pump P-1 > Motor_Inboard_MIV. Click on the Attributes tab.

Mot	tor_Inboard_N	1IV							
Ger	neral Child Ele	ements Attributes Ports Analyses	Version						
ac C	lar.								
Central Plant CP									
Chilled Water Pump P-1		y, metauata		Time Stamp	Description				
- Motor Johoard MIH Motor_Inboard_MIV	T	🗉 DisplayNum	31	1/1/1970 12:00:00 AM					
	T	Equipment	Chilled Water Pump P-1	1/1/1970 12:00:00 AM					
Pump_Outboard_POV	T	MeasureLoc	Motor_Inboard_MIV	1/1/1970 12:00:00 AM					
Chilled Water Pump P-2 Secondary Chilled Water Pump P-4	T	🗉 Path	Austin\Mopac C\CP\Chi	1/1/1970 12:00:00 AM					
Secondary Chilled Water Pump P-5		🗉 Туре	MIV	1/1/1970 12:00:00 AM					
eather Feeds thes		URL	http://mckinseyPI.clou	1/1/1970 12:00:00 AM					
	Categor								
	J 🗉	I Asynchronous	0.3679557 g (vib)	1/29/2017 12:44:57 AM	ASync				
	ø 🗉	🍼 Crest Factor	3.040749 g/g (vib)	1/29/2017 12:44:57 AM	Crest Factor				
	ø 🗉	🎺 Derived Peak	0.5442402 g (vib)	1/29/2017 12:44:57 AM	Derived Peak				
	ø 🗉	of High Frequency	0.1448086 g (vib)	1/29/2017 12:44:57 AM	High Freq				
	ø 🗉	🍼 Peak-Peak	2.268219 g (vib)	1/29/2017 12:44:57 AM	Peak-Peak				
	J 🔳	💞 RMS	0.384836 g (vib)	1/29/2017 12:44:57 AM	RMS				
	J 🔳	🎺 Single Integrated_1x Magnitude	0.03433325 ips	1/29/2017 12:44:57 AM	Vel 1x				
	J 🔳	🎺 Single Integrated_2x Magnitude	0.007174384 ips	1/29/2017 12:44:57 AM	Vel 2x				
	ø 🗉	🍼 Single Integrated_Derived Peak	0.0651958 ips	1/29/2017 12:44:57 AM	Vel Derived Peak				
	ø 🗉	🎺 Single Integrated_True Peak	0.1517071 ips	1/29/2017 12:44:57 AM	Vel True Peak				
	ø 🗉	🍼 Synchronous	0.09153856 g (vib)	1/29/2017 12:44:57 AM	Sync				
	J I	🍼 True Peak	1.170189 g (vib)	1/29/2017 12:44:57 AM	True Peak				
		I Alert	1	1/29/2017 12:51:10.148 AM					
		/■/H	1 g (vib)	1/1/1970 12:00:00 AM					
		I HH	2 g (vib)	1/1/1970 12:00:00 AM					
		🗉 Minimum	0 g (vib)	1/1/1970 12:00:00 AM					

Figure 15: PI System Explorer screen showing readings for the MIV (Motor Inboard Vertical) vibration sensor; note the Hi, and HiHi limit settings for the True Peak alert calculation

- 3. Select the **Crest Factor** attribute and expand its child attributes to view the limits. Repeat the same for the **True Peak** attribute. The limits are defined in AF but these can also be referenced from an external system using the Table Lookup feature.
- 4. Select the **Motor_Inboard_MIH** (horizontal sensor) element of the **Chilled Water Pump P-1**, and confirm that the attributes are the same. Both Pump P-1 and P-2 use same Element Template, named **NI Device Vibration**.

Note: Your vibration data collection vendor may not expose the same number of calculated values as provided by National Instruments and shown in the Attributes category.

The definition for a few of the attributes are:

Vibration Data	Definition
True Peak	The maximum of the positive peak and negative peak
Peak-Peak	The positive peak minus the negative peak
RMS	The root mean square of the signal
Derived Peak	RMS $\times \sqrt{2}$
Crest Factor	True Peak / RMS

Please see <u>http://zone.ni.com/reference/en-XX/help/374419A-01/cmanlsmain/features_definitions/</u> for more details.

To better understand Peak, Peak-to-Peak, and RMS values, please see the diagrams below for a sine wave:



Step 2: Condition assessment

The vibration sensor measurements are written to the PI System every 5 minutes. The figure below shows a simple threshold-based Hi alert calculation for the Crest Factor.

	Genera	al Chi	ld Ele	ments Attributes Port	s Analyses	Notification Rules Version					
iac C									Name: C	rest Factor Alert	
Central Plant	0		A	Name	Backfilling			^	Description:		
CP	0		f⊗	Crest Factor Alert							_
Chilled Water Pump P-1	ã		Н	Crest Factor Event				=	Categories:		
Motor Inboard MIH	Ø		fø	True Peak Alert					Analysis Type:	 Expression 	С
- Motor_Outboard_MOV	0		H	True Peak Event							
- Pump_Inboard_PIV	\odot		0	ZZ_Overall Alert				\sim			
Chilled Water Pump P-2								_			
Motor_Inboard_MIH									≣ ↑ ■ ↓	Evaluate	1
Motor_Outboard_MOV	Na	me	E	xpression			Value at Eval	uatio	Value at Last Trigg	Output Attri	T.
🗇 Pump_Inboard_PIV 🗇 Pump_Outboard_POV	Var	iabl	e1 I	f 'Crest Factor'	>'Crest	Factor Hi' then 1 else	0 0		0	Crest Factorl	
Secondary Chilled Water Pump P-4											1

Figure 16: Alert calculation for Crest Factor

- Select Chilled Water Pump P-1 > Motor_Inboard_MIV element and review the calculations in the Analyses tab as shown in the above figure.
- 2. Select the **Crest Factor Alert** analysis and examine its Expression, then click the **Evaluate** button. Value at Evaluation will show 0 (Not Active) or 1 (Active).
- 3. Next, select the True Peak Alert analysis.
- 4. Write an expression to test whether or not the True Peak data is above the Hi limit.
 - a. Position the cursor in the **Variable1** Expression, where it states "Type an expression"

(the previous row shows the syntax)



- An If-Then-Else statement will be used along with a simple "greaterthan" comparison to determine if the alert flag should be set to 0 or 1.
- c. Start typing the following expression (Intellisense like feature helps you to quickly complete the expression):

If 'True Peak'> Then 1 Else 0

d. Then add the reference to the Hi limit next to the greater-than (">") sign. Do this by selecting - add a Relative reference to the Hi attribute. Please ensure that you first select the Attributes section from the righthand side panel (at the bottom) as shown in this figure →



- 5. Evaluate the newly added expression using the **Evaluate** button.
- 6. Save your changes by clicking the *d* Check In button from the top toolbar.
- 7. This analysis expression now only exists for the inboard vertical vibration sensor of pump P-1.
 In order to deploy this analysis to all vibration sensors of the same type, right-click the True Peak Alert analysis from the list of analyses, and select Convert to Template.
- 8. Confirm that the analysis has propagated to all sensors with current Element template.



The analysis executes every time new vibration data comes into the PI System. If the value is above the Hi threshold, then the Alert flag will be set to 1 - for both Crest Factor and True Peak.

Step 3: Alert rollup

The individual alerts can be rolled up to get an overall Alert level for an asset or a group of assets. Please see **ZZ_Overall Alert** – it uses the Rollup calculation to sum all alerts from each sensor location.

Motor_In	nboard_N	1IV													
General	Child Ele	ements	Attributes	Ports	Analyse	s Version]								
					-						Name:	ZZ_Overall Alert			
	■ H ■ f⊗ ■ H ■ @	Name Cres True True ZZ_0	t Factor Eve Peak Alert Peak Event Overall Alert	Back	cfilling						Description: Categories: Analysis Type:	C Expression	 Rollup 	⊖ Event Fra	▼ me Generatio
Rollup Ch Th	attribute hild elements elements	ents of nt - Mo	Motor_Inbo tor_Inboard	ard_MI\ _MIV	/					Attributes	Name actor Alert	Pare Motor_Inbo	nt Element ard_MIV	Alert	Group By: Categories
lo sele	ect attribu	ites set	criteria bel	ow						v True Pe	ak Alert	Motor_Inbo	ard_MIV	Alert	
Attrib	oute Nam	e:	Alert							Crest Fa	actor Hi	Motor_Inbo	ard_MIV		
Attrib	oute Level	:	Child Level						-	True Pe Crest Fa	ak Hi actor HiHi	Motor_Inbo Motor Inbo	ard_MIV ard_MIV		
Attrib	ute Cate	none	Alert						-	True Pe	ak HiHi	Motor_Inbo	ard_MIV		
Auto	Juic Calc	gory.								Crest Fa	actor Minimum	Motor_Inbo	ard_MIV		
Select	the func	tion(s)	to write to a	an attrik	oute			Evalu	ate	True Pe	ak Minimum	Motor_Inbo	ard_MIV		
	Fu	unction		(Output(s)	Value	At Eval	Value At I	Last						
Solution	Sum			Ale	<u>ert</u>										
	Average														
	Minimum														
	Maximum	ı													

Figure 17: Motor Inboard Vertical (MIV) vibration sensor alert rollup.

- 1. Review **ZZ_Overall Alert** rollup analysis for one of the vibration sensor element as shown in the above figure.
- 2. Note the rollup configuration where a filter retrieves only the child attributes named **Alert**. The rollup analysis then sums the alert value for all the attributes, and writes the result to its own Alert attribute.
- 3. Click the **Evaluate** button, and confirm the same value is available by examining the **Alert** attribute of the element.

General Ch	ild Elements	Attributes	Ports	Analyses	Notif	ication Ru	les	Version
Filter							_	
/: 🗉	🔶 🦧 Name				▲ Va	lue		
🗆 📄 Cat	egory: Metad	ata						
	💷 Dis	playNum			31			
	🔳 Equ	ipment			Ch	illed Wate	er Pu	imp P-1
	💷 Mei	asureLoc			Mo	otor_Inbo	ard_	MIV
	🔳 Pat	h			Au	istin\Mopa	ac C	CP\Chilled Wa
	🔳 Тур	be and a second s			MI	V		
	💷 UR	L - External			htt	p://mckir	sey	PI.cloudapp.net
	💷 UR	L - Internal			htt	p://localh	ost:	8080/Coresight
🗆 📄 Cat	egory: Rollup							
0 🗉	🛹 Ale	rt			1			

The total number of alerts is now at each sensor level, but it is also useful to have it at the pump level, and eventually, at the plant/site, division, company level.

This is especially useful when high-level dashboards need to show aggregated or rolled-up data. Let us now configure a rollup for the pump level assets.

4. Select the Chilled Water Pump P-1 element from the left hierarchy and select its Analyses tab.



- 5. Finalize the configuration of the **Alert Rollup** analysis.
 - a. Filter by Attribute Name, by entering the value Alert.
 - b. Confirm that the filter found an attribute from the right-hand side list of attributes.
 - c. Check the **Sum** function to perform a sum of Alert values and map its output to the pump's **Alert** attribute.

Rollup attributes from	1 f Chilled Water Pump P-1		Sample Child Element: Motor_Inbo
O This element - Ch	illed Water Pump P-1	1	Name
To select attributes se	t criteria below		√ Alert
Attribute Name:	Alert		Crest Factor
Attribute Levels	Root Level		Derived Peak
Attribute Level.			DisplayNum
Attribute Category:		-	Equipment
		-	High Frequency
Element Category:		-	MeasureLoc
Element Template:		-	Path
ciement remplate.			Peak-Peak
Select the function(s)	to write to an attribute Evaluate		RMS
Eunction	Output/c) Value At Eva Value At Laci		Single Integrated_1x Magnit
Function	T Output(s) Value At Eval Value At East		Single Integrated_2x Magnit
y sum	Alert		Single Integrated_Derived P
Average			Single Integrated_True Peak
Minimum			Synchronous

- 6. Click the **Evaluate** button to confirm a valid calculation.
- 7. Click on the Hy Check In button from the top toolbar to save your changes.
- Assign this analysis to the pump template by right-clicking the Alert Rollup analysis and selecting Convert to Template.

Note that this analysis is configured to execute periodically, every 30 seconds.

Step 4: Visualization of the data and alerts

We use OSIsoft Visualization to visualize the measurement data from the sensors. Click on the URL below to display the alert status for the chilled water pumps:

https://pi1.pischool.int/PIVision/#/Displays/38/Pumps-Alert-Overview



Figure 18: Home screen for the chilled water pumps alert monitoring



The following screen show how to drill-down and navigate among related displays:

Figure 19: OSIsoft Visualization drill-down capability for chilled water pump alerts

Displays 2, 3, and 4 shown above are element relative and re-usable for similar assets.

Navigate to the Sensor Alerts display from the above figure (https://pi1.pischool.int/PIVision/#/Displays/40/Vibration-Sensor-Details).

1. From the **Asset** pick list, select a different vibration sensor. Hover over the element name to see the full AF path with the pump name.

Vibration Sensor Details Asset	Motor_Inboard_MIV		🐺 Ad Hoc Display 🛛 🗍 🛛 🔳 🔻
Chilled Water Dump	Switch Asset	poord MIV	Back to Pump Alert Details
Chilled Water Fullip	From Motor_Inboard_MIV	Juaru_IVII V	Back to Overview
	To Motor_Inboard_MIH	or 3.2450 2	Hi Limit
2/28/2017 6:	Motor_Inboard_MIH	ak 1.1142 1.5	Hi Limit 🧧 14
	Motor_Inboard_MIH \\PI1\Nationa	ll Instruments\Austin\Mopac C\CP\Chi	illed Water Pump P-2\Motor_Inboard_MIH
	Motor_Inboard_MIV	(Asymphropous	Value Maximum Units Trend

Figure 20: Switch asset pick-list for the Vibration Sensor Details display

The most recent release of OSIsoft Visualization introduces a new Collections feature.

2. Navigate to the Sensors in Alert display

(<u>https://pi1.pischool.int/PIVision/#/Displays/42/Vibration-Sensors-Alert-Overview</u>) to view a list of all Alert attributes for all vibration sensors.

HVAC Pumps - Vibration Sensors Aler		
Over	view of Vibration Sensor	rs Alerts
Chilled Water Pump P-1 Motor_Inboard_MIH Alert 1 Chilled Water Pump P-1 Motor_Inboard_MIV Alert	Chilled Water Pump P-2 Motor_Inboard_MIH Alert 1 Chilled Water Pump P-2 Motor_Inboard_MIV Alert	Secondary Chilled Water Pump P-4 Motor_Inboard_MIH Alert 1 Secondary Chilled Water Pump P-4 Motor_Inboard_MIV Alert
0 Chilled Water Pump P-1 Motor_Outboard_MOV/Alert 1 Ct all block and pump P-1	0 Chilled Water Pump P-2 Motor_Outboard_MOV(Alert 1	0 Secondary Chilled Water Pump P-4 Motor_Output Edit Collection U Edit Collection Criteria
Chilled Water Pump P-1 Pump_Inboard_PIV Alert 1 Secondary Chilled Water Pump P-5	Chilled Water Pump P-2 Pump_Inboard_PIV Alert 1 Chilled Water Pump P-1	Secondary C Refresh Pump_Inboarte_crypton 1 Chilled Water Pump P-2
Pump_Inboard_PIV Alert 1 Secondary Chilled Water Pump P-4 Pump_Outboard_POVIAlert	Pump_Outboard_POV[Alert 1 Secondary Chilled Water Pump P-5 Pump_Outboard_POV[Alert	Pump_Outboard_POV Alert 1

Figure 21: OSIsoft Visualization Vibration Sensors Alert Overview display

In Collections, you can use dynamic filters:

- Right-click the Collection symbol on the screen, and select
 Edit Collection Criteria...
- 4. Expand the **Asset Type** section in the right-hand pane. It already has a filter criterion; the next step shows the details for adding a filter.
- 5. Click the + sign to add an **Asset Attribute** filter criteria.
 - a. Select the **Alert** attribute.
 - b. Select the not equal sign.
 - c. Type in a value of **0**.
- 6. Click the **Refresh** button at the bottom of the pane to apply the changes.



Step 5: Event Frames

The vibration sensor Elements include analyses to create event frames for each alert as shown in the figures below:

Motor_Inboard_MIV							
General Child Elements Attributes Ports Analyses Version							
		Name:	True Peak E	/ent			
🛛 🖬 🛛 Name Backfilling	^	Description:					
⊘ ■ f⊗ Crest Factor Alert		Categories:				*	
🖉 🗉 🛏 Crest Factor Event	≡				0.5.15		~ ~~~
⊘		Analysis Type:	 Express 	ion O Kollup	e Event Fram	le Generation	⊖ sqc
🖉 🗉 💾 True Peak Event							
Ø ■ @† ZZ_Overall Alert	~						
Event Frame Template: WorkOrder							-
						↓ Evaluate	e
Name Expression			True for	Severity	Value at Evaluatio	Value at Last Trig	99
Start triggers							
True Peak Hi 'True Peak'>'True Peak Hi'			Not Set	Warning 💌			
End trigger							
EndTrigger							

Figure 22: AF Analysis to generate Event Frames

• 🔒 🗈	A Name	Duration	Start Time	End Time	Severity	Template	Primary Element	Equipment
National	Instruments Event Frames 1 Next							
* ۲		0:02:41.41	9/20/2016 7:24:59 PM	9/20/2016 7:27:40.40	Critical	WorkOrder	Pump_Inboard_PIV	Chilled Water Pump P-1
* ک		0:05:00	9/20/2016 7:19:59 PM	9/20/2016 7:24:59 PM	Warning	WorkOrder	Pump_Inboard_PIV	Chilled Water Pump P-1
* ک		0:07:41.616	9/20/2016 7:19:59 PM	9/20/2016 7:27:40.61	Critical	WorkOrder	Pump_Outboard_POV	Secondary Chilled Water Pump P-4
🖈 🗉		0:05:00	9/20/2016 7:19:58 PM	9/20/2016 7:24:58 PM	Warning	WorkOrder	Motor_Inboard_MIH	Chilled Water Pump P-2
🖈 🗉	H True Peak Event 2016-09-20 19:14:59.000	0:10:00	9/20/2016 7:14:59 PM	9/20/2016 7:24:59 PM	Warning	WorkOrder	Motor_Inboard_MIH	Chilled Water Pump P-1
*		0:12:41.592	9/20/2016 7:14:59 PM	9/20/2016 7:27:40.59	Critical	WorkOrder	Pump_Inboard_PIV	Secondary Chilled Water Pump P-4
*		0:05:00	9/20/2016 7:14:59 PM	9/20/2016 7:19:59 PM	Warning	WorkOrder	Pump_Outboard_POV	Secondary Chilled Water Pump P-4
*		0:10:00	9/20/2016 7:09:59 PM	9/20/2016 7:19:59 PM	Critical	WorkOrder	Pump_Inboard_PIV	Chilled Water Pump P-1
*		0:05:00	9/20/2016 7:09:59 PM	9/20/2016 7:14:59 PM	Warning	WorkOrder	Pump_Inboard_PIV	Secondary Chilled Water Pump P-4
* ک		0:05:00	9/20/2016 7:09:58 PM	9/20/2016 7:14:58 PM	Warning	WorkOrder	Motor_Outboard_MOV	Chilled Water Pump P-2
*		0:05:00	9/20/2016 7:04:59 PM	9/20/2016 7:09:59 PM	Warning	WorkOrder	Pump_Inboard_PIV	Chilled Water Pump P-1
* ک	H True Peak Event 2016-09-20 19:04:59.000	0:05:00	9/20/2016 7:04:59 PM	9/20/2016 7:09:59 PM	Warning	WorkOrder	Motor_Inboard_MIH	Chilled Water Pump P-1
* ک	H True Peak Event 2016-09-20 19:04:58.000	0:05:00	9/20/2016 7:04:58 PM	9/20/2016 7:09:58 PM	Warning	WorkOrder	Motor_Inboard_MIH	Chilled Water Pump P-2
* ک		0:27:41.495	9/20/2016 6:59:59 PM	9/20/2016 7:27:40.49	Critical	WorkOrder	Pump_Inboard_PIV	Chilled Water Pump P-2
👷 🗉		0:09:59	9/20/2016 6:59:59 PM	9/20/2016 7:09:58 PM	Warning	WorkOrder	Motor_Inboard_MIH	Chilled Water Pump P-2
👷 🗉		0:27:41.466	9/20/2016 6:59:59 PM	9/20/2016 7:27:40.46	Critical	WorkOrder	Pump_Outboard_POV	Chilled Water Pump P-2
👷 🗉	H True Peak Event 2016-09-20 18:54:59.000	0:32:11.196	9/20/2016 6:54:59 PM	9/20/2016 7:27:10.19	Warning	WorkOrder	Motor_Outboard_MOV	Chilled Water Pump P-1
*		0:32:41.4	9/20/2016 6:54:59 PM	9/20/2016 7:27:40.4 PM	Warning	WorkOrder	Motor_Outboard_MOV	Chilled Water Pump P-1
* ک		0:05:00	9/20/2016 6:54:59 PM	9/20/2016 6:59:59 PM	Warning	WorkOrder	Pump_Outboard_POV	Chilled Water Pump P-2
= 🖈	True Peak Event 2016-09-20 18-49-59 000	0-10-00	9/20/2016 6-49-59 PM	9/20/2016 6:59:59 PM	Warning	WorkOrder	Motor Inhoard MIH	Chilled Water Pump P-1

Figure 23: Alert events along with their severity

The event frames use a template of type **Work Order**.

Event frames can be configured to include all the required information for integration with CMMS (Computerized Maintenance Management System) such as SAP PM, IBM Maximo, Oracle EAM, and others – to trigger a Work Order, or update a Meter reading etc.

- 1. From PI System Explorer, navigate to the Event Frames section.
- 2. Expand the Event Frame Search 1 object.

Q		\\P	11\National Instrume	ents - PI System Explorer (Adm	ninist	rator)		
File Search View Go Tools Help								
🟮 Database 🛅 Query Date 🔹 🕓 🥥 Back 💿 💐 Check	In 🍤 🗸 📄	Refresh 💾 New Ever	nt Frame					Se
Event Frames	True Peak Ev	vent 2017-02-20 18:09:	58.000					
Event Frame Searches	General Chi	ld Event Frames Referenc	ed Elements Attributes					
Event Frame Search 1	Name:	True Peak Event 2017-0	2-20 18:09:58.000					
Crest Factor Event 2017-02-19 17:49:54.000	Description:							
	Ecochpaon.	WashOadaa				Country	Warning	
Crest Factor Event 2017-02-19 19:49:54.000	Template:	workOrder				Seventy:	waining	
Crest Factor Event 2017-02-20 18:09:58.000	Start time:	2/20/2017 6:09:58 PM				End time:	2/20/2017 6:49:58 PM	
Crest Factor Event 2017-02-20 18:09:58:000	Categories:				9	Default Attribute:	<none></none>	
		Extended Properties (0)	Annotations (0) Security					
- I True Peak Event 2017-02-20 18:09:58.000	Find:	Parents	Children					
True Peak Event 2017-02-20 18:09:58:000	Actions:	Recepture Values	Lock					
		Acknowledge	ALCOLO IN THE REAL OF THE REAL					
Crest Factor Event 2017-02-20 18:09:58:000		Acknowledge						
Crest Factor Event 2017-02-20 18:09:59.000								
Crest Factor Event 2017-02-20 18:09:59.000								
Crest Factor Event 2017-02-20 18:09:59.000								
Crest Factor Event 2017-02-20 18:09:59.000								
Crest Factor Event 2017-02-20 18:09:59:000								
Crest Factor Event 2017-02-20 18:14:58.000								
Image: Crest Factor Event 2017-02-20 18:19:58.000								
Crest Factor Event 2017-02-20 18:29:58.000								
Crest Factor Event 2017-02-20 18:29:59.000								
MIH Crest Factor Event 2017-02-20 18:29:59.000								
Crest Factor Event 2017-02-20 18:39:58.000								
Crest Factor Event 2017-02-20 18:39:58.000								
Erest Factor Event 2017-02-20 18:39:59.000								
Crest Factor Event 2017-02-20 18:44:59.000								
Crest Factor Event 2017-02-20 18:49:58.000								
E-Trans Search 2								
⊟- → Transfer Searches								
Elements								
Event Frames								
1 ibrary	0							

3. Select any **True Peak Event** and explore its properties from the middle pane.

Figure 24: Selecting a True Peak Event from the Event Frames section

Let us now force the generation of some alerts, and some **Work Order** events. In order to trigger an alert, simply lower the value of the **Hi** limit of a sensor.

- 4. Navigate back to the **Elements** section of PI System Explorer.
- 5. Select the \\PI1\National Instruments\Austin\Mopac C\CP\Chilled Water Pump P-1\Motor_Inboard_MIV element.
- 6. Look at its Attributes, and expand the Crest Factor or the True Peak attribute level.

7. Modify the value of the **Hi** attribute to a lower value such that Crest Factor or True Peak will go into Alert.

Search View Go Tools Help				
atabase 📅 Query Date 🔹 🔿 💶 🙆 Back 🕥 🛃	Check In 🥄 🖌 🛃 R	afresh 🛅 New Element 🔹	New Attribute	
	Motor Johoor			
lements	General Child I	Elements Attributes Dorts Ar	aduses Notification Pules Version	
🗇 Austin	General Child	Jenens Autouco Poro A	alyses Nouncation Rales Version	
🖮 – 🗊 Mopac C	Filter			
		Name	A Value	Time Stamp
⊨ ☐ Chilled Water Pump P-1	E Catego	rv: Metadata		
🗇 Motor_Inboard_MIH		DisplayNum	31	1/1/1970 12:00:00 AM
Motor_Outboard_MOV		Equipment	Chilled Water Pump P-1	1/1/1970 12:00:00 AM
Dump_Inboard_PIV		MeasureLoc	Motor_Inboard_MIV	1/1/1970 12:00:00 AM
- 7 Chilled Water Pump P-2		💷 Path	Austin\Mopac C\CP\Chilled Water Pu	1/1/1970 12:00:00 AM
Motor_Inboard_MIH		📃 Туре	MIV	1/1/1970 12:00:00 AM
Ø Motor_Outboard_MOV		URL - External	http://mckinseyPI.cloudapp.net:8080/	1/1/1970 12:00:00 AM
Pump_Inboard_PIV Pump_Outboard_POV		URL - Internal	http://localhost:8080/Coresight/#/Dis	1/1/1970 12:00:00 AM
- Secondary Chilled Water Pump P-4	🗆 📄 Catego	ry: Rollup		
- Motor_Inboard_MIH	B \$	💷 Alert	0	1/1/1970 12:00:00 AM
- Motor_Inboard_MOV	🗆 📄 Catego	ry: Vibration data		
Pump_Inboard_PIV	0 🔳	n Asynchronous	0.3692186 g (vib)	2/20/2017 6:54:58 PM
Secondary Chilled Water Pump P-5		🞺 Crest Factor	3.160136 g/g (vib)	2/20/2017 6:54:58 PM
Pump_Inboard_PIV		Alert	0	2/20/2017 6:59:27.367 PM
NOAA Weather Feeds		I Hi	B.5 g/g (vib)	1/1/1970 12:00:00 AM
Element Searches		💷 ніні	4 g/g (vib)	1/1/1970 12:00:00 AM
		💷 Maximum	10 g/g (vib)	1/1/1970 12:00:00 AM
		💷 Minimum	1 g/g (vib)	1/1/1970 12:00:00 AM
	0 1	Ø Derived Peak	0.542371 g (vib)	2/20/2017 6:54:58 PM

Figure 25: Lowering the Hi limit of the Crest Factor attribute

8. While waiting for new vibration measurement data to come in (every 5minutes), look in the **Analyses** tab to **Evaluate** the event frame generation analysis.

Motor_	Inbo	bard_N	ЛIV															
General	Ch	ild Ele	ments	Attributes	Ports	Analys	ses	Notifica	ation Rules	Version				_				
															Name:		True Peak Ev	ent
0 () () () () () () () () () () () () ()		هر ال ال ال ال	Nam Cre Cre Tru Tru ZZ	e est Factor A est Factor B le Peak Ale e Peak Eve Overall Al	Alert Event ert ent	B	Back	cfilling							Descrip Categoi Analysis	tion: ries: s Type:	C Expressi	on 🔿
Even	t Fra	ame Te	empla	te: Work	Order				True	for	Severity		Value a	t Evi	aluation	Value	at Last Trigge	r
	Vari	iables																
Tru	ePe	ak		'True	Peak	·							1.10	52 g	(vib)	1.7	1052 g (vib)	
Hil	imi	t		'True	Peak	Hi'							1	g (v	ib)		1 g (vib)	
HiH	iLi	mit		'True	Peak	HiHi	1						2	g (v	ib)		2 g (vib)	
-	Star	rt trigg	jers															
Tru	e P	eak H	i	TrueP	eak>H	iLimi	t		Not	Set	Warning	٣		Tru	e		True	
Tru	еP	eak H	iHi	TrueP	eak>H	iHiLi	mit	:	Not	Set	Critical	٣		Fals	e		False	
=	End	trigge	er															
End	Tri	gger																

Figure 26: True Peak - Analysis for event frame generation

Step 6: Event Frames as a Watch List using OSIsoft Visualization

OSIsoft Visualization Events Table (new feature) is used to build a watch list.

- Navigate to the overview screen (<u>https://pi1.pischool.int/PIVision/#/Displays/38/Pumps-Alert-Overview</u>) and click the Vibration Sensors Alerts Watchlist link (will bring you to: https://pi1.pischool.int/PIVision/#/Displays/45/Vibration-Sensor-Alerts-Watchlist).
- 2. The watch list shows the event frames currently in progress. Confirm this by right-clicking the events table and selecting **Configure Table...**
- 3. From the right hand pane, expand the Event State section to see the In Progress filter.

Watchlist	of all Vibration	Sensor Alerte	Back to Ov	Configure Table
valorinst		Sensor Alerts		Descending •
Event Name	Asset	Y Start Time ▼	Y Severity	
Crest Factor Event 2017-02-27 2 2:00:00.000	Motor_Inboard_MIH	2/27/2017 10:00:00 PM	Critical	▼ Dynamic Criteria
Crest Factor Event 2017-02-27 2 2:00:00.000	Motor_Inboard_MIV	2/27/2017 10:00:00 PM	Warning	Database National Instrum Time Range Timebar Duration
Crest Factor Event 2017-02-27 2 1:55:00.000	Motor_Inboard_MIH	2/27/2017 9:55:00 PM	Critical	Event Severity
Crest Factor Event 2017-02-27 1 8:00:00.000	Pump_Inboard_PIV	2/27/2017 6:00:00 PM	Warning	Event Type and Attribute Value
Crest Factor Event 2017-02-27 1 2:10:00.000	Motor_Inboard_MIH	2/27/2017 12:10:00 PM	Warning	Selected Asset Name Any
Crest Factor Event 2017-02-27 1 2:10:00.000	Motor_Inboard_MIH	2/27/2017 12:10:00 PM	Critical	► Asset Type NI Device Vibrati
Crest Factor Event 2017-02-27 1 2:10:00.000	Motor_Inboard_MIV	2/27/2017 12:10:00 PM	Critical	Event State In Progress Any
Crest Factor Event 2017-02-27 1				In Progress Completed
				► Event Category

Figure 27: Alerts Watch List using OSIsoft Visualization Events Table

4. Double-click on an event in the table to see the Details window. Items showing the red Critical state indicate those exceeding HiHi limit; the items in blue Warning indicate those exceeding the Hi limit.



Figure 28: OSIsoft Visualization details page for an Event Frame

Exercise 3 – Other Data Types

Other condition monitoring data, such as temperature readings, acoustic data, lab results from oil analysis, etc. are all part of the condition assessment done to ensure equipment reliability. In this exercise, let us look at three different kinds of measurements and how they are used for CBM.

A. Motor Oil Lab Results and AF Table

Motor oil analysis for critical motors are often performed on a regular basis.

Hangtown >> Finishing Area >> Force Variation Testing & Buffing Area >> Force Variation Testing & Buffing Proc >> V1 FV Hydraulic Unit >> 10002374 RESEVOIR >> Hydraulic Systems >1000 PSI - Sampling Schedule: 90 days

S:	amp	le Ir	nfor	mati	on						Sam	ple Date	s				Ргос	duct	Info	orma	tior	1	
San	n ple La D Anal	ID: ID: lyst:	401 633 Ang	1 611 ie Bo	rella	1				<	Sampled: 7/27/2016 Manufacturer: Mabil Received: 7/27/2016 Viscosity: 68 Completed: 7/28/2016												
	High Limit Alarm						m	H	gn Limit	Alert	Lar	w Lim	1 il										
					W	/ear	Met:	als (ppm	i)			Conta Metals	minate ; (ppm)	Mu Me	ulti-: :tal <i>s</i>	Sour (pp	rce m)	A	ddit I	ive ppn	Metal n)	ls
Sample Date	Iron	Chromium	Aluminum	Copper	Lead	Tin	Silver	Nickel	Cadmium	Vanadium	ANTIWEAR LOSS	OXIDATION / SULFATE	Silicon	Sodium	Manganese	Boron	Molybdenum	Titanium	Magnesium	Calcium	Barium	PHOSPHORUS	Zinc
7/27/2016	1	D	D	8	D	D	D	D	D	D	D. DDD	24.39D	1	1	D	D	D	D	D	51	D	329	424
4/18/2016	1	D	D	7	D	D	D	D	D	D	D.DDD	24.83D	1	1	D	1	D	D	D	52	D	327	429
1/19/2016	1	D	D	8	D	D	D	D	D	D	D.DDD	22.77D	1	1	D	D	D	D	D	52	D	327	44]
10/30/2015	1	D	D	7	D	D	D	D	D	D	D.DDD	22.55D	1	Z	D	1	D	D	D	53	D	336	452
7/23/2015	1	D	D	5	D	D	D	D	D	D	D.DDD	23.64D	1	D	D	D	D	D	D	55	D	338	439
4/21/2015	1	D	D	5	D	D	D	D	D	D	D.DDD	24.14D	1	D	D	D	D	D	D	52	D	34D	46D
					Co	onta	mina	ates						Fluid	d Pro	рег	ties						
Sample Date			WATED /BV	ABSORPTION)							abs/cm		abs/cn	n	o Viscositu	D OP St		VADI DISCUED			TOTAL ACID NUMBER		
7/27/2016			D	.DDD							2.544		4.176		62	.8		2	8.6		D. 38	:	
4/18/2016			D	.DDD						1	2.563		1.991		61	.9		1	8.4		D. 37	r	
1/19/2016			D	.DDD							2.533		J.664		62	.8		5	6.3		D. 34		
10/30/2015			D	.DDD							2.627		1.884		62	7		7	2.4		D.41		
7/23/2015			D	.DDD							2.639		3.909		62	б		2	4.1		D.41		
4/21/2015			D	. DDD							2.639		4.DZ4		61	9.		2	2.6		D.40)	
											1	Particle	Count	(particl	es / i	mL)							
Sample Date					-4MM	BE			MMO		>14MM	20MM	-30MM		>40MM		ISO PC>4		ISO PC>6			ISO PC>14	
//27/2016					25	05		4	1/1		52	14	4		1		19		1			13	
414 010 04 4																				-			

Figure 29 Sample motor oil analysis report

These lab results may exist in an external database but they can be referenced and used as part of condition assessment in an AF calculation via PI AF Table.

Step1: Data from an external database

1. In PI System Explorer, navigate to the Library section.



2. Expand Table Connections, and select **SQLServer**. A connection has already been established between PI Asset Framework and a SQL Server database that holds lab results, called **Lab**

Analyses.

Library	SQLServer
National Instruments Templates Element Templates Model Templates Mode	General Seenal Name: SQLServed Description: Connection: Provider=SQLOLED8.1;Integrated Security=SSPI;Persist Security Info=False;Initial Catalo Security: Impersonate Client Supply Password: No additional security context Security: Security: Security: Supply Password: No additional security context Security:

3. Create a PI AF Table to reference the lab result. Right-click the **Tables** and select **New Table**.



4. Enter **Oil Analysis** in the **Name** field.

 Click the Link button at the bottom of the configuration pane. Select SQLServer for the Connection field, and then enter the following SQL query to reference the Oil Analysis table: SELECT * FROM [Oil Analysis]

Oil Analysis				
General Table Defin	e Table	Version		
Name:	Oil Anal	ysis		
Description:				
Categories:				
Connection:	Internal			
Query:	Interna		Table Link	×
Time Zone: Cache Interval:	<none< td=""><td>Name: Description: Connection: Query:</td><td>Oil Analysis SQLServer SELECT * FROM [Oil Analysis]</td><td></td></none<>	Name: Description: Connection: Query:	Oil Analysis SQLServer SELECT * FROM [Oil Analysis]	

The SQL query tells AF to select everything (or *) from the Oil Analysis table. Click **OK** to confirm the query.

6. Confirm that the data is now available by selecting the **Table** tab.

Oil	Analysis											
Gen	eral Table De	fine Table Ve	rsion									
Oil	Analysis											
	har .											
Fill	er											
	Sample Date	Asset ID	Boron	Hydrogen	Zinc	Calcium	Phosphorus	Acetylene	Magnesium	Molybdenum	Oxygen	Nitrogen
•	11/23/201	Chilled Wa	50	1298	540	1021	407	0.01	330	65.24	1127	24651
	2/15/2015	Chilled Wa	50	1360	670	1190	609	0.01	693	59.52	1160	25069
	2/25/2016	Chilled Wa	50	1560	689	1590	670	0.01	707	60	1179	25944
	11/27/201	Chilled Wa	50	1673	703	1609	690	0.01	745	64.05	1204	26609
	11/23/201	Chilled Wa	50	1298	540	1021	407	0.01	330	65.24	1127	24651
	2/15/2015	Chilled Wa	50	1360	670	1190	609	0.01	693	59.52	1160	25069
	2/25/2016	Chilled Wa	50	1560	689	1590	670	0.01	707	60	1179	25944
	11/27/201	Chilled Wa	50	1673	703	1609	690	0.01	745	64.05	1204	26609
	10/24/201	Chilled Wa	50	1698	712	1723	739	0.01	809	66	1267	2909
	6/24/1965	TR0842	50	20	68	101	29	0.01	7	20.05	2340	22698
	8/22/1969	TR0842	50	279	194	175	51	0.01	341	42.13	2627	25482
	9/18/1973	TR0842	50	1298	2009	1021	369	0.01	530	65.24	732	24800
	9/11/1977	TR0842	50	1360	2554	1332	561	0.01	554	59.52	1027	24651
	6/25/1979	TR0842	50	21	68	101	29	0.01	203	20.05	2340	22698

7. Click the top-toolbar 🗟 Check In button to save the changes.

Step 2: Confirm that the Oil Analysis data is now available via PI AF attributes

- 1. Navigate to the **Elements** section in PI System Explorer and navigate to <u>\\PI1\National</u> <u>Instruments\Austin\Mopac C\CP\Secondary Chilled Water Pump P-4</u>.
- 2. Select the **Attributes** tab, and confirm that the attributes in **Oil Analysis** category show the oil analysis lab data. You may have to click the top-toolbar **Refresh** button.

Categ	ory: Oil Analysis		
۲	Calcium	1190 ppm	
	Copper	3 ppm	
	💷 Iron	10 ppm	
	💷 Magnesium	693 ppm	
	Desphorus	609 ppm	
	💷 Sodium	11 ppm	
	I Zinc	670 ppm	

The lab data for Oil Analysis can now be used (in the same manner as any other sensor data) as part of condition assessment and to trigger events and notifications.

B. Infrared Temperature Readings, PI Manual Logger, and Notifications

Often, temperature or infrared readings are collected using portable data collectors.

If a device such as the AR-C10 (see Exercise 1) is available, then it sends the data directly to the PI System. However, if are using another device without direct write capability to PI, then you can use <u>PI</u> <u>Manual Logger</u> on a tablet or phone to manually input the reading.

In this section, we review manual input data for a temperature reading and its use with PI Notification to send an email as an alert for an out-of-spec reading.

Step 1: Examine the available temperature data

 Navigate to \\PI1\National Instruments\Austin\Mopac C\CP\Chilled Water Pump P-1, and check its Motor Inboard Temperature attribute. This temperature sensor is online and data is collected in real-time via an interface to the BMS (building management system). Right-click the attribute and select Trend to view its data.



Navigate to \\PI1\National Instruments\Austin\Mopac C\CP\Secondary Chilled Water Pump
P-4. The secondary chilled water pumps have not been instrumented with temperature sensors
for continuous online data collection. As such, temperature readings (from an infrared device) is
entered manually in PI-Manual Logger.

٥	Trend	_ D X
Start Time: [*-50d] Austin Mopac C CP Secondary Chille 96 96 97 P-4_Motor_Inboard_MIT 96	End Time: *-2h Water Pump P-4 Motor Inboard Temperature	
92 90 88 1/9/2017 7:00:46 AM	49.92 days Add Attributes Add PI Points	2/28/2017 5:00:46 AM
	Add <u>A</u> ttributes Add <u>P</u> I Points.	<u>I</u> races Close

Right-click the attribute and select **Trend** to view its data.

Step 2: Temperature rate of change analysis, and PI Notification

- 1. Select the **Analyses** tab of the Secondary Chilled Water Pump P-4 element.
- 2. Select the **High Temperature RateOfChange** analysis from the list. The expression triggers an event frame generation when the rate of change for the temperature is greater than 0.25 °F per day. The manual data collection via operator rounds is done once a week.

ieral Child Element	s Attributes Ports Analyses No	buncation Rules Version			
				Name:	High Temperatu
🛚 🔳 Na	me	Backfilling		Description:	
) 🗉 f(x) C	Cooling Power Data	Ø		Categories:	
) ■ Н №	ligh Temperature RateOfChange	•		Analysis Type:	Expression
				Create a new n	notification rule fo
Name	Expression				
Name Variables DeltaMotor	Expression DeltaValue('Motor Inbo	ard Temperature')			
Name Variables DeltaMotor DeltaPump	Expression DeltaValue('Motor Inbo DeltaValue('Pump Inboa	ard Temperature') rd Temperature')			
Name Variables DeltaMotor DeltaPump MotorDailyRate	Expression DeltaValue('Motor Inbo DeltaValue('Pump Inboa DeltaMotor/(PrevEvent(ard Temperature') rd Temperature') 'Motor Inboard Temperature	','*+1s')-TimeSta	amp(PrevVal	('Motor Inbo
Name Variables DeltaMotor DeltaPump MotorDailyRate PumpDailyRate	Expression DeltaValue('Motor Inbo DeltaValue('Pump Inboa DeltaMotor/(PrevEvent(DeltaPump/(PrevEvent('	ard Temperature') rd Temperature') 'Motor Inboard Temperature Pump Inboard Temperature',	','*+1s')-TimeStam	amp(PrevVal	('Motor Inbo Pump Inboard
Name Variables DeltaMotor DeltaPump MotorDailyRate Start triggers	Expression DeltaValue('Motor Inbo DeltaValue('Pump Inboa DeltaMotor/(PrevEvent(DeltaPump/(PrevEvent('	ard Temperature') rd Temperature') 'Motor Inboard Temperature Pump Inboard Temperature',	','*+1s')-TimeStam '*+1s')-TimeStam	amp(PrevVal p(PrevVal('	('Motor Inbo Pump Inboard
Name Variables DeltaMotor DeltaPump MotorDailyRate PumpDailyRate Start triggers Motor Inboard	Expression DeltaValue('Motor Inbo DeltaValue('Pump Inboa DeltaMotor/(PrevEvent(' DeltaPump/(PrevEvent(' MotorDailyRate>0.25	ard Temperature') rd Temperature') 'Motor Inboard Temperature Pump Inboard Temperature',	','*+1s')-TimeStam '*+1s')-TimeStam	amp(PrevVal p(PrevVal('	('Motor Inbo Pump Inboard

Figure 30: Rate of change Expression analysis

3. Evaluate the expressions to see whether the alert is true.

Step 3: Examine the Notification rule for the high temperature Event Frame

- 1. Select the **Notification Rules** tab for the Secondary Chilled Water Pump P-4 element.
- 2. Click the **View/Edit Trigger** to confirm that a notification will be triggered when a High Temperature RateOfChange Event Frame is triggered.

General Child Elements Attributes Ports Analyses Notificat	ion Rules Version		
Image: Second	Criteria i Analysis = High Temperat	Name: Description: Categories:	High Temperature RateOfChange Notificatio
Trigger		Subscri	ptions
Trigger A notification will be triggered when an event frame is crea	ated that satisfies all of these criteria.	Subscri	ptions rrently 1 subscribers to this Notification Rule.
Trigger A notification will be triggered when an event frame is creat Referenced Element = Secondary Chilled Water Pump P-	nted that satisfies all of these criteria.	Subscri There are cu View/Edit.Su	ptions mently 1 subscribers to this Notification Rule.
Trigger A notification will be triggered when an event frame is crea Referenced Element = Secondary Chilled Water Pump P- Analysis = High Temperature RateOfChange	ated that satisfies all of these criteria.	Subscri There are cu View/Edit Su Manage For	ptions rrently 1 subscribers to this Notification Rule. bscriptions mats

3. Click the **View/Edit Subscriptions** to review the email format; click the pencil icon next to the format field.

Subscriptions								
\times								
	Name	Configuration		Notify Op	tion			
1	📑 Student - Email	Table	~ 🧪	vent start	~			

4. Note that the email includes URL links in the bottom portion of the email body, one URL for using from within the lab VM environment (internal link), and another URL that can be used from any external computer or device (external link).

Step 4: Modify the Student's email address to receive the notification in your inbox

1. From PI System Explorer, select the Contacts section from the bottom left of the screen.

_	mmm
٦	Elements
H	Event Frames
1	Library
	Unit of Measure
88	Contacts
*	Management

2. Type **student** in the search field near the top, then select the **Student** contact, and edit the **Email address** field to replace it with your own email.

Contacts	Student	
🖥 New 🔹 student 🛛 🔑	Name:	Student
	Description:	
Name - "student*"	Department:	
E & Student	Manager:	
🗉 🔮 student02	Web	
 	Email address:	lpagemorin@osisoft.com
🗉 🔮 student05	IM address:	
	Phone numbers	
student07 student08	Business phone:	

3. Click the top-toolbar Hy Check In button to save the changes.

Step 5: Use PI Manual Logger to enter a value that will trigger an alert

- Launch PI Manual Logger Tour shortcut from the VM desktop, or click the link below: <u>https://pi1.pischool.int:6443/piml.web/#/tourrun?id=new&name=Pump+Manual+Readings</u> This opens a new tour run to enter temperature and acoustic data for pumps P-4 and P-5. It shows the current timestamp at the top of the screen. Click the Switch to grid data entry view link found in the top right of the screen.
- 2. Expand the first tag to see the previous data entries:

ump Manual Readings:	February 28.	2017 7:00:00 AM 🗠				Switch to individual data
Community of the second s						
Group X						
Name	~ Valu	le	~ Timestamp	~	Limits	 Instructions
Group: Secondary Chilled	d Water Pump P-4	4				
National Instruments_Austin_Mo C_Central Plant_Secor Chilled Water Pump P- 4_Motor_Inboard_MIT	opac ndary		February 28, 2017 7:00:00 AM		HiHi(150) Hi(120)	Take reading on "IR" identified screw.
Dravieway 00 Februar	n 14 2017 2:15:0	O DM				
Instructions: Take read	ding on "IR" identi	fied screw.				
Instructions: Take read	ding on "IR" identi	fied screw.	85	89	90	88
Instructions:Take read	ding on "IR" identi	85	85 O	89 O -	90 	88
nstructions: Take read	ding on "IR" identi	85	85 O	89 0	90 •••••	88 O
revious: 88 - Pebruar Instructions: Take read	Jing on "IR" identi	85	85 O	89	90 	88
rrevious: 85 - Pebruar Instructions: Take read	Jing on "IR" identi	85	85 O	89	90 	88
Previous: 88 - Pebruar Instructions: Take read	Jing on "IR" identi	85	85 O	89 	90 ••••••••••••••••••••••••••••••••••••	88

- 3. Enter values for up to six (6) tags, making sure to enter at least one very high value for a temperature to trigger an event frame generation.
- 4. Click the **Save** button at the bottom to send the values to the PI Server.

Cancel	₩ 3	Save
(+ (1) (+) 10 • items per page		1 - 6 of 6 items
Water Pump P-5_Acoustic Reading		•

5. In the PI Manual Logger Web homepage, click **Refresh** to clean any tour run information.



~

Step 6: Verify Notification delivery and web visualization of the alert

1. Confirm that an Event Frame has been generated for either Pump P-4 or P-5 and that you received an email.

Reply Reply All G Forward ♥IM
 Mon 27-Feb-2017 23:16
 pitechcon2017@gmail.com
 New HighTemp_2017-02-27 20:15 for Secondary Chilled Water Pump P-4!
 To ❷Louis-Philippe Page-Morin

Event: HighTemp_2017-02-27 20:15 Name: High Temperature RateOfChange Notification

Start Time: 2/27/2017 8:15:34 PM Pacific Standard Time (GMT-08:00:00) Target: Austin\Mopac C\CP\Secondary Chilled Water Pump P-4 Trigger: Start Trigger Name Severity: Warning

Attribute	Value	Time				
Motor Inboard Temperature	96 °F	2/27/2017 8:15:34 PM Pacific Standard Time (GMT- 08:00:00)				
Pump Inboard Temperature	89 °F	2/27/2017 8:15:34 PM Pacific Standard Time (GMT- 08:00:00)				

View notification details

Internal link: https://pi1.pischool.int/pivision/#/EventDetails? server=PI1&eventid=2862dcb8-a7f0-4f21-0000-000000974bd External link: https://3796vlecs1.cloudapp.net/pivision/#/EventDetails? server=PI1&eventid=2862dcb8-a7f0-4f21-0000-0000000974bd

2. Use the links at the bottom to navigate to the Notification details page. The link takes you to a Coresight display.

Copy-paste the internal link in the browser address bar from within the lab VM. If prompted for login, enter the following credentials (user: pischool\student01, password: student). If you get an error, use the **Notification Page Example** shortcut from the desktop to open the details page from a previous notification.

 Review the notification details page. Note the Acknowledge button in the upper right (optional), and the Add Comment section. The acknowledgement workflow ensures that someone will look into the event.

Events		HighTemp_2017-0	2-27 20:15					Acknowledge
Automatically refresh the list	Warning	2/27/2017 11:15:34 PM	- In Progress	Event Type: ⊦ Asset:\Mop	High Temperature R bac C\CP\Secondar	ateOfChange / Chilled Water Pump P	-4	Comments
	97 90 96.8					Motor Inboard Temp 96.0000 °F	erat	Add Comment
HighTemp_2017-02-27 20:15 (2/27/2017 11:15:34 PM - *	- 96.6					Pump Inboard Temp 89.0000 °F	erat	^
	-96.2							Ľ
	- 96 -95.8							Add
	- 95.6 - 95.4							Actions and Comments (1)
	- 95.2 95 88						I	Notification sent to 1 subscriber(s).
	1h 2h 2/27/2017 11:15:34 P	3h 4h 5h M	6h 71	n 8h 9 2/	9h 10h /28/2017 10:25:49 f	M	ľ	11 hours ago
	Trigger /	Attributes (2)					^	
	Seconda P-4	ary Chilled Water Pur	np	Start Value	Current Value	Units –	П	

4. Acknowledge the notification by clicking the green **Acknowledge** button. Then enter a comment by typing in something inside the **Add Comment** box, and then by clicking the Add button. Note that you can also attach a file (including a picture, video etc.) to the event.

C. Acoustic Data and Dynamic Threshold

In the previous example, we used a rate of change logic to trigger an event/notification. However, for early detection of degrading equipment conditions, your condition assessment can be based dynamic thresholds for Limit values that reflect the current operating context. For example, the Hi Limit threshold for a chilled water pump at full load can be proportionately higher than one running at partial load.

As such, let us look at the acoustic readings, but in the context of the cooling power corresponding to the chilled water pump load.

Step 1: Examine the acoustic data and cooling power

- 1. Navigate to the **\\PI1\National Instruments\Austin\Mopac C\CP\Secondary Chilled Water Pump P-4** element.
- 2. Examine its **Attributes** from the **Acoustic** category.
- 3. Right-click the **Cooling Power** attribute and select **Trend** to see that the cooling power varies with time.



The varying cooling power is incorporated into the condition assessment as a dynamic threshold for the acoustic dB limit which determines whether the motor-pump assembly is making more noise than expected for a given cooling power value.

Step 2: Review the dynamic acoustic limit

- 1. Select the **Analyses** tab of the Pump P-4 asset.
- 2. Select the **Dynamic Acoustic Threshold** from the list.

Secondary Chilled Water Pump P-4						
General Child Elements Attributes Ports Analyses Notification Rules Version						
	Name:	Dynamic Acoustic Threshold				
🛛 🕷 📓 Name Backfilling	Description:	E				
for Cooling Power Data for Dynamic Acoustic Threshold	Categories:	· · · · · · · · · · · · · · · · · · ·				
✓ ■ H High Temperature RateOfChange	Analysis Type:	pe: Expression Rollup Event Frame Generation SQC				
Evaluate						
Name Expression		Value at Evaluatio Value at Last Trigg Output Attribute				
Variable1 If BadVal('Cooling Power') Then 40 Else Curve('Cooling Power', (0,0) (50,10) (100,10) (120,15) (1						
If BadVal('Cooling Power') Then 40 Else Curve('Cooling Power', (0,0) (50,10) (100,10) (120,15) (135,20) (145,35) (170,45) (200,45))						

3. The Curve() function is used to map the acoustic Hi limit (Y) with its corresponding cooling power value (X).

Using AF calculation, the acoustic limit is written to the PI Server to illustrate how it varies with the cooling power.



Figure 31: OSIsoft Visualization trend showing the acoustic reading against its dynamic Hi limit

Note that the Decibel Limit (purple trace) varies with the cooling power (orange trace). Also note that the acoustic readings (blue trace) are below the Decibel Limit (purple trace).



You can also use an XY chart to view the acoustic readings and its limit.

Figure 32: OSIsoft Visualization XY Chart showing the last 4 acoustic readings (purple) against its limit curve (blue)

This concludes the hands-on portion of the lab.

In summary, we covered the learning objectives stated at the beginning of the lab:

- Understand the condition monitoring (CM) data collection process with a live demo of a handheld device used for collecting vibration, infrared and acoustic data for a motor
- Understand how the condition monitoring data is transformed and written to PI
- Configure condition assessment calculations for the CM data and recognize the use of dynamic thresholds for the CM data
- Incorporate CM data such as oil analysis (that may reside in external databases) in the condition assessment calculations
- Incorporate manual input CM data (aka operator rounds) via PI Manual Logger
- Create displays, notifications, alerts watch list etc. using various PI System capabilities and tools
- Review the PSE&G customer use case on combining PI System data with CM data for calculating asset health score

Please take a few minutes to give us your feedback https://www.surveymonkey.com/r/QMBJP2G.

Other Resources

OSIsoft Users Conf. 2016 TechCon Lab Notes Condition-based Maintenance with PI AF

OSIsoft Users Conf. 2015 Presentation Keeping Assets Healthy – PI System's Role in Asset Maintenance

Calculating Asset Health Score - OSIsoft vCampus 2013 Lab Notes

PSE&G use case showing asset health score <u>http://www.osisoft.com/Presentations/Condition-Based-Maintenance/</u>

http://www.ni.com/condition-monitoring/

National Instruments InsightCM[™] Enterprise for Condition Monitoring

Allied Reliability Group AR-C10 Data Collector for Condition Monitoring

MetrixSetpoint Condition Monitoring

Emerson Vibration Monitoring