



# Gas Compressor Performance Analysis

Mike Teter, Sr. Engineer - Williams

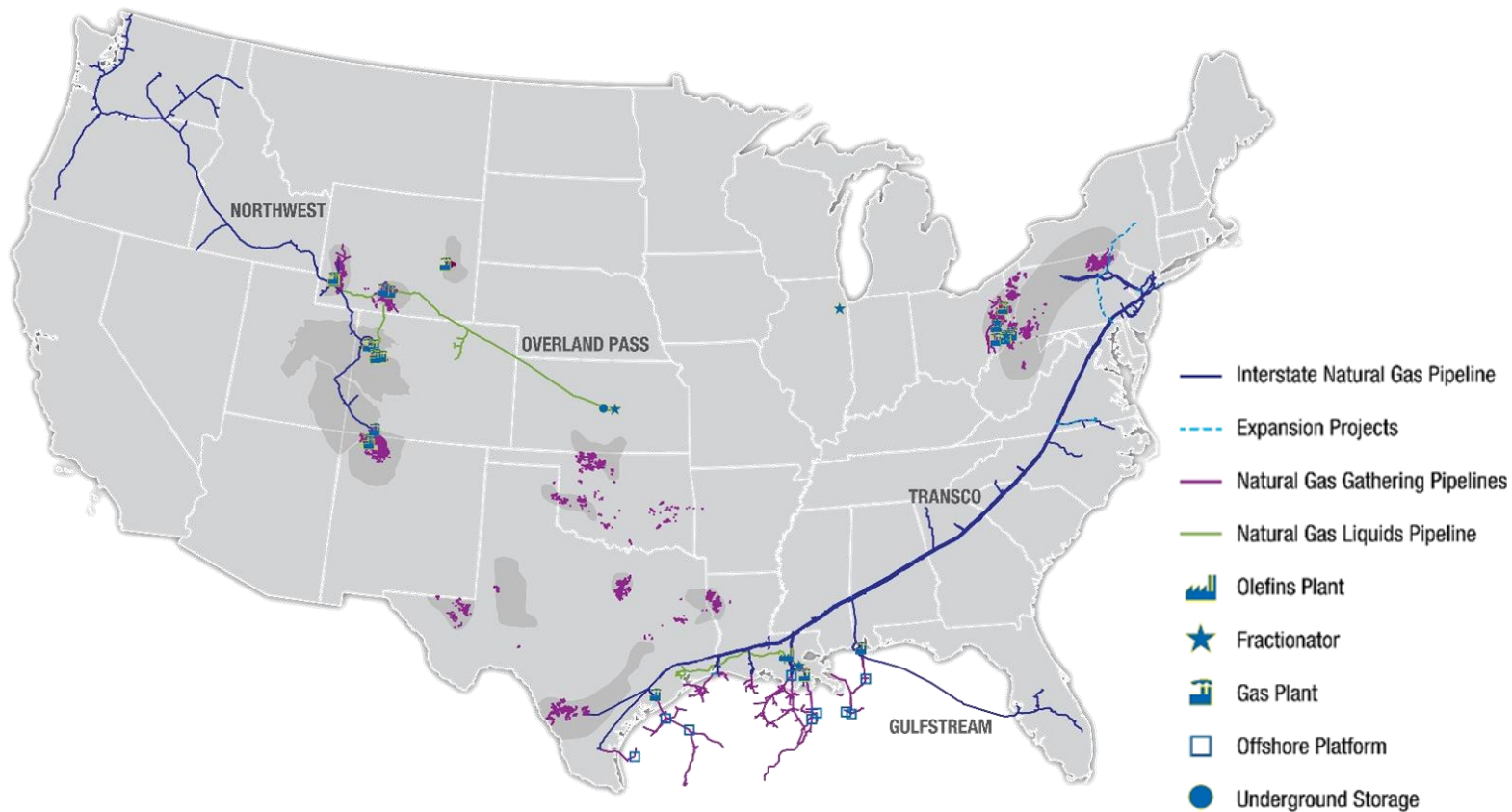
October, 11 2016



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# Williams Reciprocating Compressor Equipment Monitoring Program

- The PI System is used to monitor, evaluate and assess asset condition in order to reduce undesired down time and improve equipment efficiency.
- The tools built are designed to expose data exceptions and provide users quick access to supporting information to determine if a data exception is actionable.
- There are two AF Databases constructed to perform the different analytic functions described in this presentation
- PI AF, PI Asset-Based Analytics, PI Coresight, and Microsoft SSRS reporting tools provide the foundation that supports data examination

# PI System Data Flow

Engine &  
Compressor Sensors

PLC



PI AF



PI Data  
Archive



Microsoft®  
**SQL Server®**  
Reporting Services

- Sensor data from the engine and compressor are collected by the PLC
- PI Interfaces collect data from the PLC and send that data to the PI Data Archive
- PI AF reads data from the PI Archive, performs calculations, and contextualizes results in a format that SQL Server Reporting Services can surface in the form of an exception report

<div> <b>Baseline Maintenance Report</b>  <small>Last Refreshed at: 10/5/2016 2:04:42 PM                      Facility: ABA Lathrop                      Start Date: y+7h                      End Date: t+7h                      Interval: 1h</small> </div>														
Excursions:														
Franchise	Facility	Equipment	Process Value	Status Tracker	Total Excursion	Low Excursion	High Excursion	Low Threshold	Min Value	High Threshold	Max Value	Loss Per Day	Breakeven Days	Last Exc
ABA	ABA Lathrop	Unit 250 Cat 3608 / JGD 4 Single Stage	<a href="#">Eng Oil In Eng Oil Diff Temp</a>		24	0	24	(30.00)	14.28	0	35.99	N/A	N/A	10/5/2016
ABA	ABA Lathrop	Unit 230 Cat 3516 / JGT 4 Single Stage	<a href="#">Eng Oil 13 Inlet</a>		25	0	25	10.00	93.42	90	94.68	N/A	N/A	10/5/2016
ABA	ABA Lathrop	Unit 230 Cat 3516 / JGT 4 Single Stage	<a href="#">Eng Oil 05 Inlet</a>		25	0	25	10.00	92.54	90	94.09	N/A	N/A	10/5/2016
ABA	ABA Lathrop	Unit 230 Cat 3516 / JGT 4 Single Stage	<a href="#">Eng Oil 13 Inlet</a>		25	0	25	10.00	92.37	90	94.24	N/A	N/A	10/5/2016
ABA	ABA Lathrop	Unit 230 Cat 3516 / JGT 4 Single Stage	<a href="#">Eng Oil 13 Inlet</a>		25	0	25	10.00	92.37	90	94.24	N/A	N/A	10/5/2016



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# Asset Framework Database

Elements

- Recip 01
- Recip 02
- Recip 03
- Recip 04
  - Calculations
    - OperPerfCalc
    - CompressorTempDeviation
      - Comp Cyl 01
      - Comp Cyl 02
      - Comp Cyl 03
      - Comp Cyl 04
      - Comp Cyl 05
      - Comp Cyl 06
  - Data
  - Notification
    - IgnitionVoltage
    - PowerCylinderTemps
  - RecipDashboard
  - Report Groups
    - Catalyst Group
    - Cyl Burn Time
    - Cylinder Discharge Temp
    - Cylinder Discharge Temp Delta
    - Cylinder Ignition Voltage
    - Efficiency Group
    - Engine Group
    - Exhaust Group
  - Tags
- Fraser
- Gibson
- Hawley
- Jones
- Kane
- Lathrop
- Miller
- Northeast

Elements

- Event Frames
- Library
- Unit of Measure
- MyPI
- Notifications
- Contacts

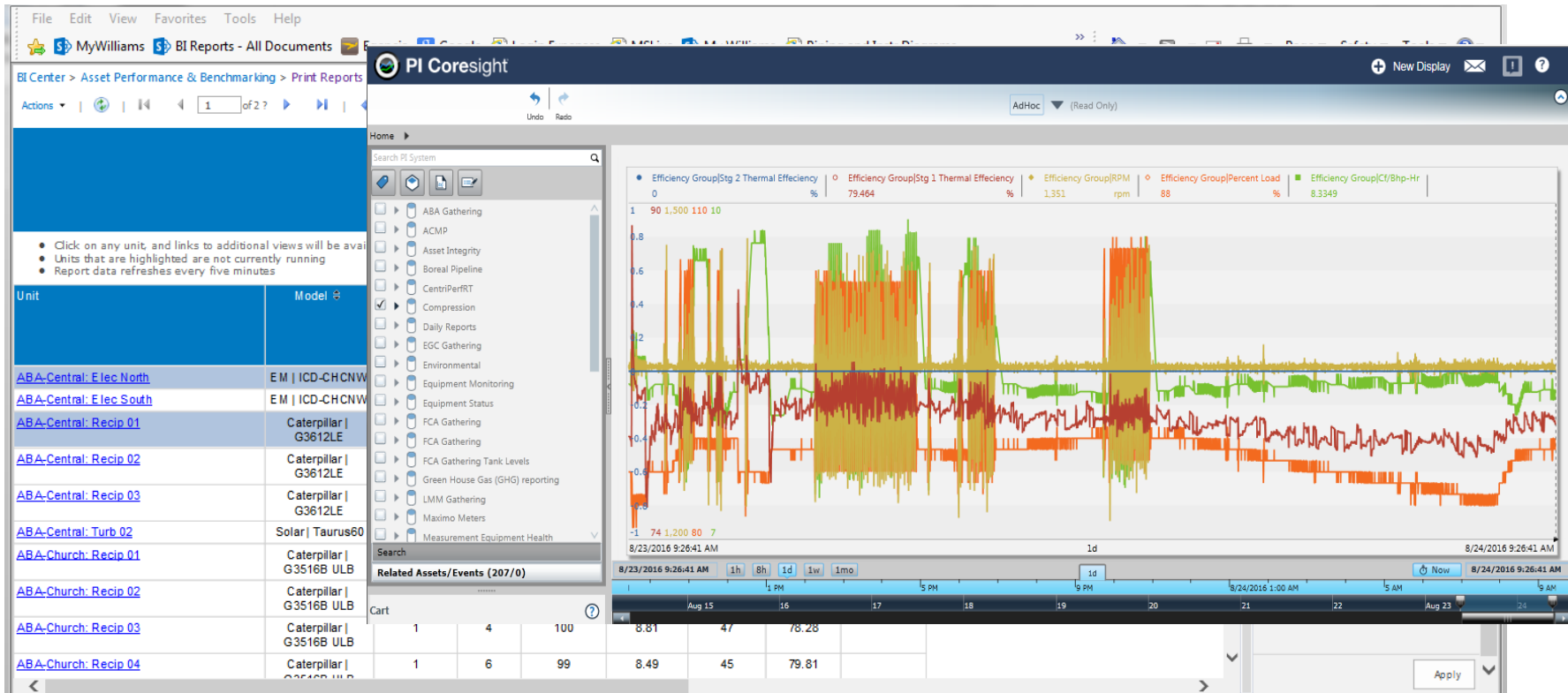
Tags

General Child Elements Attributes Ports Analyses Version

Filter

Name	Value	Time Stamp
Category: <None>		
Ambient Temp	53.11186 °F	10/4/2016 8:12:53.091 AM
Auxiliary Status Word	128	10/4/2016 8:07:11.001 AM
Burn Time Dev from Desired	0.086250007152557373	10/4/2016 8:12:58.044 AM
Desired Air Manifold Pressure	34.51	10/4/2016 8:12:53.091 AM
Desired Air to Fuel Ratio	19.8000011	10/4/2016 8:06:33.033 AM
Engine Fail Status	0	9/26/2016 8:54:52.427 PM
Load Step	0	1/1/1970 12:00:00 AM
Normal Stop Status	1	9/26/2016 8:54:52.427 PM
Ready Status	1	9/26/2016 8:54:52.427 PM
Running Status	1	10/4/2016 8:00:00 AM
Station Fuel Flow	0	1/1/1970 12:00:00 AM
Category: Calculation		
Burn Time Avg	4.2237499356269836	10/4/2016 8:12:58.044 AM
Burn Time Dev	0.59827745033053714	10/4/2016 8:12:58.044 AM
Comp Cyl 01 Predicted Disc Temp	108.871971	10/4/2016 8:12:53.091 AM
Comp Cyl 02 Predicted Disc Temp	108.871971	10/4/2016 8:12:53.091 AM
Comp Cyl 03 Predicted Disc Temp	108.871971	10/4/2016 8:12:53.091 AM
Comp Cyl 04 Predicted Disc Temp	108.871971	10/4/2016 8:12:53.091 AM
Comp Cyl 05 Predicted Disc Temp	108.871971	10/4/2016 8:12:53.091 AM
Comp Cyl 06 Predicted Disc Temp	108.871971	10/4/2016 8:12:53.091 AM
Compressor Flow	186.947021484375 MMSCFD	10/4/2016 8:12:53.091 AM
Exhaust Port Average Temp	987.8125 °F	10/4/2016 8:12:58.044 AM
Exhaust Port Delta Temp	21.66281 °F	10/4/2016 8:12:58.044 AM
Ign Sec Voltage Avg	75.5	10/4/2016 8:12:53.091 AM
Ign Sec Voltage Dev	5.2796780204857185	10/4/2016 8:12:53.091 AM

# Reciprocating Compressor Dashboard



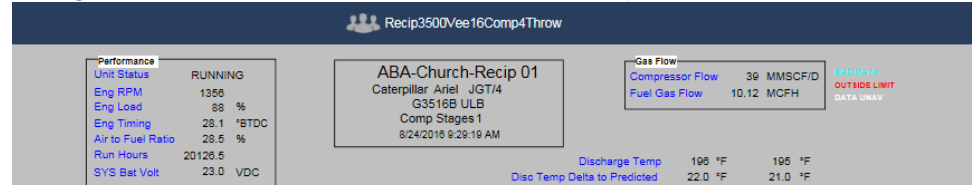
# Overview Screens

Ad hoc trends

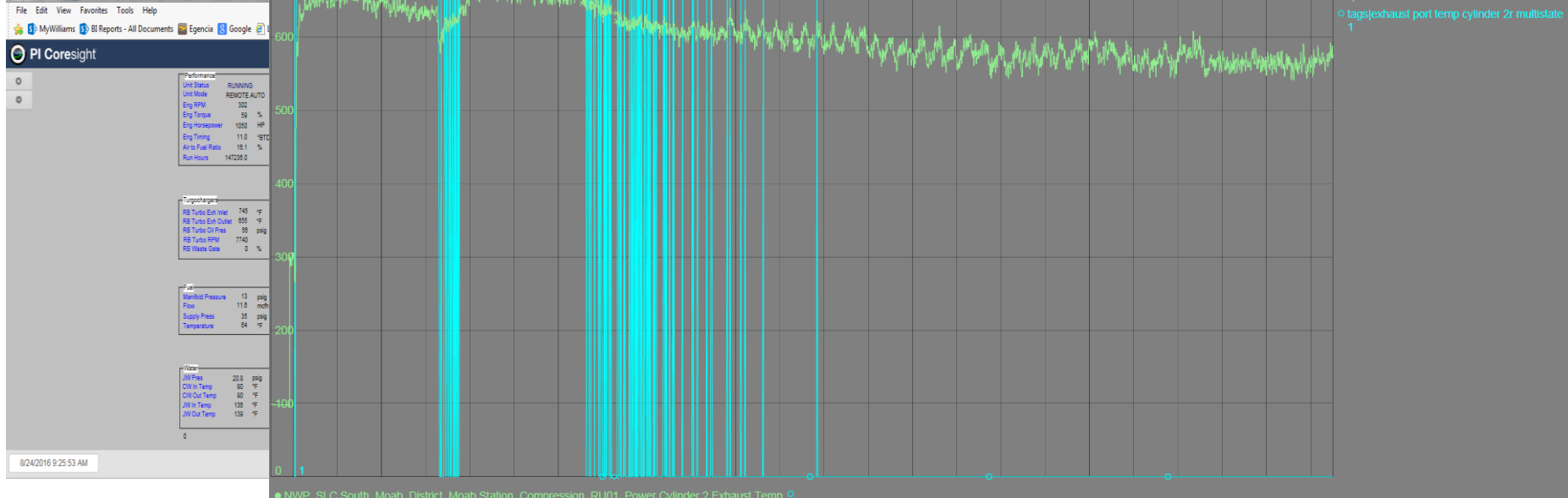
Multi-state colors for high or low alerts

Mobile compatibility

## High Speed Compressor Display



## Slow Speed Co



# Baseline Data Mining

- Evaluates one hour after startup until one hour prior to shutdown
- Shows data values outside normal operating thresholds
- Shows number of excursions over the report period
- Links to a Coresight trend with data, average, thresholds, and analysis window

Asset Performance & Benchmarking > Print Reports

1 of 2 ? Find Next 100%

## Williams

**Baseline Maintenance Report**  
 Last Refreshed at: 10/4/2016 8:11:09 AM  
 Facility: ABA Hawley  
 Start Date: y+7h  
 End Date: t+7h  
 Interval: 1h

### Excursions

Franchise	Facility	Equipment	Process Value	Status Tracker	Total Excursion	Low Excursion	High Excursion	Low Threshold	Min Value	High Threshold
ABA	ABA Hawley	Unit 2 Cat 3516 / JGT 4 Single Stage	<a href="#">Sto 1 Comp Oil Discharge Temp Spread</a>	Watching	4	0	4	0.00	9.22	10
Franchise	Facility	Equipment	Process Value	Status Tracker	Total Excursion	Low Excursion	High Excursion	Low Threshold	Min Value	High Threshold
ABA	ABA Hawley	Unit 1 Cat 3516 / JGT 4 Single Stage	<a href="#">Sto 1 Comp Oil Discharge Temp Spread</a>		25	0	25	0.00	10.19	10
ABA	ABA Hawley	Unit 1 Cat 3516 / JGT 4 Single Stage	<a href="#">Comp Oil Temp Inlet</a>	Reported to Field	25	25	0	150.00	141.18	190
Franchise	Facility	Equipment	Process Value	Status Tracker	Total Excursion	Low Excursion	High Excursion	Low Threshold	Min Value	High Threshold
ABA	ABA Hawley	Unit 3 Cat 3516 / JGT 4 Single Stage	<a href="#">Sto 1 Comp Oil Discharge Temp Spread</a>	Reported to Field	25	0	25	0.00	11.60	10
ABA	ABA Hawley	Unit 3 Cat 3516 / JGT 4 Single Stage	<a href="#">Catalyst Temp (post)</a>	Reported to Field	25	25	0	625.00	211.22	1000
ABA	ABA Hawley	Unit 3 Cat 3516 / JGT 4 Single Stage	<a href="#">Catalyst Temp (pre)</a>	Reported to Field	25	25	0	625.00	72.76	1000

### Manual Entries

Franchise	Facility	Equipment	Entry Time	Technician	Comments
ABA	ABA Hawley	Unit 1 Cat 3516 / JGT 4 Single Stage	9/29/2016 10:07:00 AM	McCain, Mike	
	ABA Hawley	Unit 1 Cat 3516 / JGT 4 Single Stage	9/28/2016 6:10:00 AM	Figura, Tommy	



# Baseline Data Mining

- Powered by PI AF and Microsoft Reporting Tools
- Assigns each data value is to a specific template designed to supply the report
- Accepts manual data entry
- Evaluates parameters under normal operation against normal operating thresholds

The screenshot displays the Catalyst DP software interface. On the left, a hierarchical tree under 'Elements' shows a path from 'ABA' to 'ABA Dunbar' to 'Unit 4 Cat 3616 / JGC 6 Single Stage' to 'Catalyst DP'. Below this tree are tabs for 'Elements', 'Event Frames', 'Library', 'Unit of Measure', 'MyPI', 'Notifications', and 'Contacts'. On the right, the 'Catalyst DP' window has tabs for 'General', 'Child Elements', 'Attributes', 'Ports', 'Analyses', and 'Version'. The 'Attributes' tab is active, showing a table of data points with columns for Name and Value.

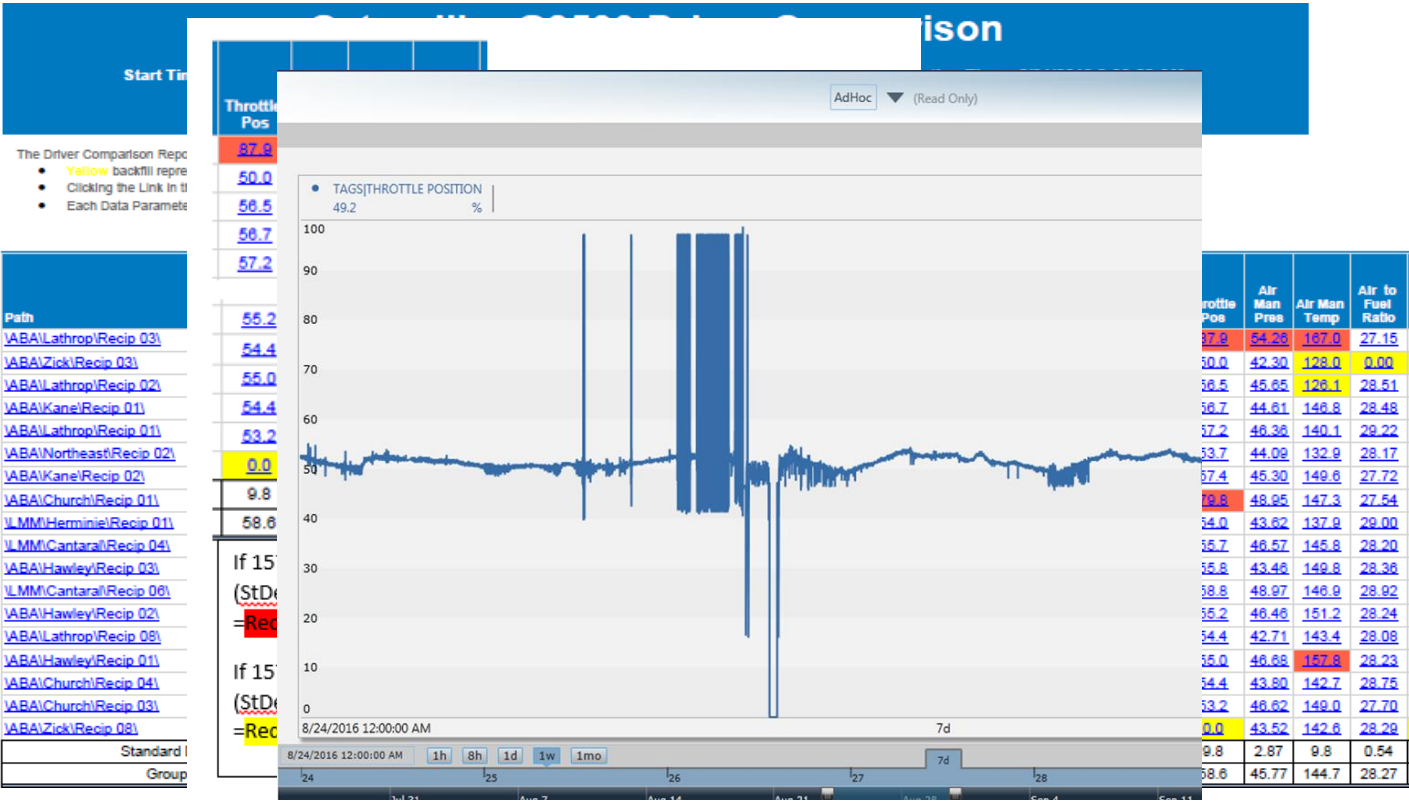
Name	Value
Breakeven Days	0
Compression Path	ABA\Dunbar\Recip 04
Coresight URL	<a href="https://wvmsutbiap02.williams.com/coresight/#/Di">https://wvmsutbiap02.williams.com/coresight/#/Di</a>
CustomAlarmDesc	
Data Type	Numeric
Group	
Loss Per Day	0
NonNumerical	False
PME Precision	2
Required	Yes
Site	ABA Dunbar Unit 4 Cat 3616 / JGC 6 Single Stage
Tag Name - Preferred	ABA_Dunbar_Unit 4_ENG-Catalyst-DP
Tag Name - Prefix	ABA_Dunbar_Unit 4
Tag Name - Standard Name	ENG-Catalyst-DP
Trend Time Range	24
UOM - Preferred	in H2O

Below the table, a 'Category: Common' section lists additional attributes:

Name	Value
Comment Field	
Data	0.181778327
Data - Raw	0.18222498893737793
High	6
Low	-0.2
SortOrder	20
Status Tracker	None
Writeable	False



# Compressor Comparison Report



# Reciprocating Compressor On-Line Monitor Report

File Edit View  
MyWillia  
BI Center > Asset  
Actions  
Unit  
TGPL: Station 14  
TGPL: Station 14  
TGPL: Station 14

**PI Coresight**

**COMPRESSOR REPORT**

**Williams**

**Compressor Performance Report**  
TGPL-STA140: Recip 01

**Make:** Cooper  
**Model:** GMW-10 HPFI

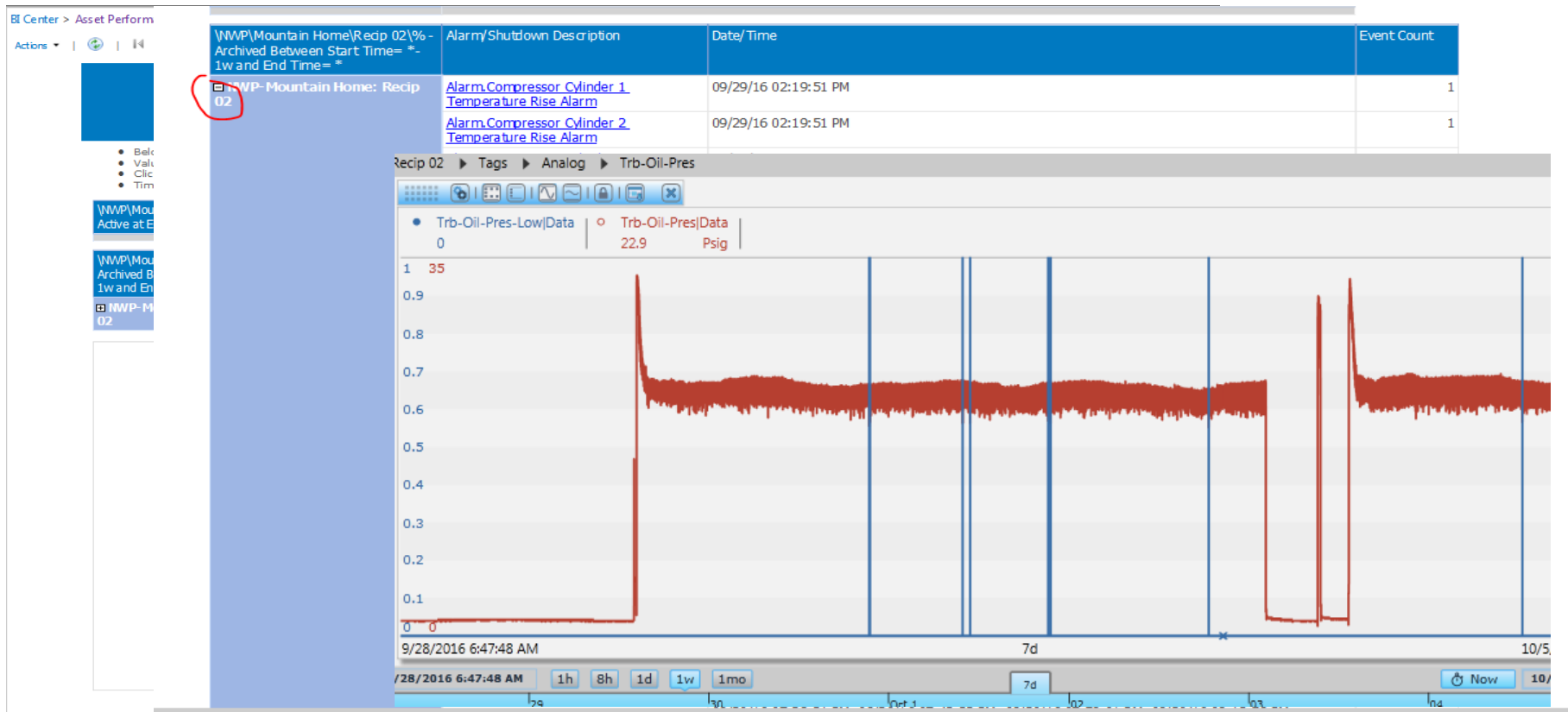
Mechanical Efficiency :		0.85		PLC Hp : 2236		PLC Cap : 169	
Overall Efficiency :		0.95		IHp : 1869		Cal Cap : 176	
Compressor Efficiency %:		89.9		BHp : 1967		Rated Hp : 2500	

Atmospheric pressure : 14.365 psia
RPM : 238.3
Load Step : 1

Cyl End	Stg	Calc Clearance (In*3) (%)	Suc Prs (Psig)	Dis Prs	Suc Tmp (°F)	Dis Tmp	Pred Dis Tmp	Dis Tmp Delta	Comp Ratio	Capacity (MMSCFD)	Flow Bal	IHp	Evs (%)	Evd	Rod Load %	Reversal (Degrees)
Cyl1 HE	1	2154 57	587 715	74.0 111.9	100	16.5	1.23	31	0.97	353	93 82	48.0 36.5	155			
Cyl1 CE	1	2369 67	591 692		91	1.15	28	1.04	249	93 79						
Cyl2 HE	1	1623 43	572 708	110.1	100	11.5	1.23	31	1.00	357	94 79	44.8 40.9	152			
Cyl2 CE	1	2159 61	600 728		97	1.15	28	1.02	253	92 77						
Cyl3 HE	1	1593 42	577 708	110	99	8.4	1.22	30	1.02	348	93 75	49.6 39.1	158			
Cyl3 CE	1	1495 42	589 746		104	1.27	28	1.02	307	93 76						


10/4/2016 2:25:53 AM
8h

# Alarm/Shutdown Report



# Event Notifications

- SQL query of AF allows determining if a new event has occurred
- AF both decodes the event codes from the control system into associated text and supplies links
- Alarm, shutdown, status, diagnostic, and analog threshold deviations are distributed in one notification
- Email includes links for the associated process variable – if applicable – and for unit overview displays  
(Mobile and desktop PI Coresight)



Mon 10/3/2016 1:40 PM  
DoNotReply@Williams.com  
APB Notifications: LMM Herminie Recip 07 | Not Running

To [REDACTED]

Retention Policy 1 Year Delete (1 year) Expires 10/3/2017

**Name:** AlmSDNotify LMM Herminie II Recip 07  
**Database:** Compression  
**Server:** TULPWPIAF03  
**Target Path:** LMM\Herminie\Recip 07  
**Query Period:** 10/3/2016 1:03:32 PM (Central Time)

Data Type	New	Count
Alarm	NONE	0
First Out Shutdown	NONE	0
Shutdown	NONE	0
Status	NONE	0
Diagnostic	ActEvtBuffer10 - 1542-5 Exhaust Port Temperature Sensor Cylinder #12 : Current Below Normal, ActEvtBuffer10 - 1540-5 Exhaust Port Temperature Sensor Cylinder #10 : Current Below Normal, ActEvtBuffer10 - 1536-5 Exhaust Port Temperature Sensor Cylinder #6 : Current Below Normal	107
Analog	NONE	0

Coresight Alarm PV Trend: [Alarm PV Trend](#)  
Mobile Coresight Alarm PV Trend Link: [mibrowsers://wmstutpiap02.williams.com/coresight/#/Displays/AdHoc?&dataitems=None](#)

Desktop Overview: [https://wmstutpiap02.williams.com/Coresight/#/PBDisplay/Name/Recip3600Vee12comp6Throw?CurrentElement=%5C%5CTULPWPIAF03%5CCompression%5CLMM%5CHerminie%5CRecip%2007%5C](#)  
Mobile Overview: [mibrowsers://wmstutpiap02.williams.com/Coresight/#/PBDisplay/Name/Recip3600Vee12comp6Throw?CurrentElement=%5C%5CTULPWPIAF03%5CCompression%5CLMM%5CHerminie%5CRecip%2007%5C](#)

# Summary

## COMPANY and GOAL

Williams - Equipment monitoring

- 1) Improve reliability
- 2) Increase operating efficiency



## CHALLENGE

Improve the efficiency and reliability of the operating assets

- Focus on the low hanging fruit by identifying the fruit
- Use the operational data to provide warning of pending issues to help eliminate and reduce costly unexpected down time

## SOLUTION

Expose opportunities through analysis of operating data

- Provide early warning of possible issues through exposing operational data exceptions
- Using operational data to Identify opportunities for improvement

## RESULTS

Creation a suite of tools that help identify opportunities for improvement and reduce steps between identification and action

- Eliminate as many of the steps as possible between identifying an issue and examining the supporting information
- Provide the right data to the right individuals at the right time



# Contact Information

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Sr. Engineer – Asset Performance and Benchmarking  
Williams

# Questions

Please wait for the  
**microphone** before asking  
your questions



State your  
**name & company**

# Please remember to...

Complete the Survey  
for this session

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Safeco Field – Seattle, WA – September 20, 2016

**Evaluation Form**

Name: \_\_\_\_\_ Company: \_\_\_\_\_  
Email: \_\_\_\_\_

**Quality of presentations**

	Poor	Good	Excellent	N/A
1. Digital Transformation with Today's PI System – OSIsoft	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. PI Coresight 2016: New Vision, New Display Editor, New Look and Feel – OSIsoft	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Monitoring Health and Performance of Grid-Scale Energy Storage Systems – UniEnergy Technologies	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Using PI Integrators to Improve the Value of your PI Data – OSIsoft	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. PI Asset Framework Ties Together Enterprise OEE for Clearwater Paper – Clearwater Paper	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. Solving Business Initiatives with the PI System – OSIsoft	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. PI Analytics and Coresight for Business Process Improvement – Arista	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. Seq helps customers get even more value from their OSIsoft PI System – Seq Inc.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9. What's Really Going on with your Beer's Fermentation? – Deschutes Brewery	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**Quality of seminar**

	Poor	Good	Excellent	N/A
1. Presentation topics meeting your needs or interests	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Time allowed for lunch/breaks/discussions	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Pace and time allocated to the presentations	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>





# Thank You



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